Independent verification report

RCP4 base expenditure and service measures 2025-30 proposal

Transpower New Zealand Limited

12 September 2023

→ The Power of Commitment

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The Power of Commitment

Executive Summary

GHD has been engaged by Transpower and the New Zealand Commerce Commission (the Commission), under a Tripartite Deed, to independently verify Transpower's proposed expenditures and service measures for the fourth Regulatory Control Period (RCP4) from 2025 to 2030. GHD engaged Castalia as their sub-consultant to assist in delivering this Independent Verification (IV) role. The requirements for Transpower's RCP4 proposal are set out in the Capex Input Methodology (Capex IM)[1] and Transpower Input Methodologies (Transpower IMs)[2].

Our verification work has been guided by the Terms of Reference (ToR) agreed with the Commission and Transpower, including the schedules of evaluation criteria contained in it. The evaluation criteria in the agreed ToR presently reflects the requirements of the current Capex IM (dated Jan 2020) and Transpower IMs (dated Jan 2020) that existed during bulk of the IV engagement timeline. We have engaged with Transpower in an independent manner in accordance with the Tripartite Deed.

The guiding principle in our verification work and in forming our opinions has been whether Transpower's RCP4 expenditure forecasts and associated grid output measures are consistent with an expenditure outcome that represents the efficient costs of a prudent supplier having regard to Good Electricity Industry Practice (GEIP). This term is defined as follows:

> *Good electricity industry practice in relation to transmission, means the exercise of that degree of skill, diligence, prudence, foresight, and economic management, as determined by reference to good international practice, which would reasonably be expected from a skilled and experienced asset owner engaged in the management of a transmission network under conditions comparable to those applicable to the grid consistent with applicable law, safety and environmental protection. The determination is to take into account factors such as the relative size, duty, age and technological status of the relevant transmission network and the applicable law.*[3]

We consider the above definition is consistent with the use of regulatory prudency and efficiency tests generally applied by the Commission and economic regulators in similar jurisdictions. In simple terms, prudency relates to confirming that expenditure is necessary to maintain the safety, quality, reliability and security of supply of regulated services. Efficiency relates to the provision of regulated services in a least cost manner having regard to conditions in relevant markets for labour, capital and materials inputs.

In forming our verification opinions, we have assessed Transpower's development of its RCP4 expenditure forecasts at an aggregate and individual programme level. Our review of individual expenditure programmes has been guided by criteria agreed between Transpower and the Commission set out in our Terms of Reference.

Our verification is based on IMs as applicable during March-August 2023. The Commission is currently reviewing the Capex IM and Transpower IMs and will make its final determination post submission of this IV report.

All figures in this report are in constant 2021/22 New Zealand dollar (NZD) terms unless otherwise stated. All capex values (i.e., base capex and uncertainty mechanism capex) includes interest during construction (IDC).

[1] Transpower, Capital Expenditure Input Methodology Determination 2012 (Principal Determination) or Capex IM, dated 29 Jan 2020.
[2] Transpower, Input Methodologies Determination 2010 or Transpower IMs, dated 29 Jan 2020.
[3] Part 1 of the Electricity Industry Participation Code 2010. Access: **https://www.ea.govt.nz/code-and-compliance/code/**.

Verification of expenditure levels

The ToR requires us to review Transpower's proposed capex and opex forecasts for RCP4 and express an opinion as to whether the proposed expenditure is prudent and efficient having regard to GEIP. Where this is the case, we have identified the proposed expenditure as accepted. Where this is not the case, we have identified the proposed expenditure as not accepted.

We have reviewed the following proportion of Transpower's total proposed expenditure, broken down as follows:

- $1,933.2 million (96.6%) of the $2,001.4 million total base capex. We did not review $50.0 million in capitalised leases and $18.2 million in ICT capex which were non-identified programmes.
- All of $1,797.3 million total opex.
- All of $526.3 million of total capex being proposed using uncertainty mechanisms or cost recovery pathways other than base capex[4].

We reviewed all of the identified programmes agreed by Transpower and the Commission as set by clause 2.2.2(1) of the Capex IM. We also reviewed most of the non-identified expenditure programmes except for capitalised leases and 6 investment cases in ICT capex as highlighted above. We applied proportionate scrutiny principle while undertaking our review of the proposed expenditures.

Overall, we find that the proposed expenditure amounts that we reviewed and accepted are consistent with an expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.

Table ES 1 presents a summary of the outcome of our assessment of verified programmes.

Table ES 1 Summary of expenditure verification outcomes

	Amounts in constant 2021/22 NZD	Percent of total
Base capex (including IDC)		
Total proposed base capex	$2,001.4m	
Reviewed and accepted	$1,873.8m	93.6%
Reviewed and accepted but needs re-categorisation	$18.0m	0.9%
Reviewed and not accepted	$41.4m	2.1%
Not reviewed	$68.2m	3.4%
Uncertainty mechanism capex (including IDC)		
Total proposed uncertainty mechanism capex	$526.3m	
Reviewed and accepted	$526.3m	100%
Opex		
Total proposed opex	$1,797.6m	
Reviewed and accepted	$1,797.6m	100%
Reviewed and not accepted	$0.0m	0%

Source: Transpower RCP4 forecast data and IV analysis

[4] For avoidance of doubt, we did not review Major Capital Projects as they are excluded from our IV scope of work.

Base capex

Table ES 2 shows the proposed RCP4 base capex by expenditure category, forecast amounts and verification status.

Table ES 2 Proposed base capex and verification status

Expenditure category	RCP4 forecast	Verification status
Network base capex		
Alternating current substation replacement and refurbishment	$441.5m	Reviewed and accepted: $416.1m Reviewed and not accepted: $25.4m
Buildings and grounds replacement and refurbishment	$121.0m	Reviewed and accepted: $108.0m Reviewed and accepted but needs re-categorisation: $13.0m
Transmission lines replacement and refurbishment	$647.2m	Reviewed and accepted: $647.2m
High voltage direct current and reactive assets replacement and refurbishment	$150.5m	Reviewed and accepted: $150.5m
Secondary assets replacement and refurbishment	$251.1m	Reviewed and accepted: $251.1m
Enhancement and development capex	$98.5m	Reviewed and accepted: $93.5m Reviewed and accepted but needs re-categorisation: $5.0m
Non-network base capex		
Information and communications technology capex (excluding software as a service)	$198.5m	Reviewed and accepted: $180.3m Not reviewed: $18.2m
Business support capex	$43.1m	Reviewed and accepted: $27.1m Reviewed and not accepted: $16.0m
Capitalised leases	$50.0m	Not reviewed: $50.0m

Source: Transpower RCP4 forecast data and IV analysis

Uncertainty mechanism capex

We evaluated a newly proposed ‘use it or lose it’ uncertainty mechanism by Transpower and found it to support accurate cost recovery and efficient investment incentives when assessed against the ToR evaluation criteria. Transpower is proposing two capex programmes using this new uncertainty mechanism in RCP4.

Transpower is also proposing four large replacement and refurbishment capex using the established listed project cost recovery pathway or mechanism in RCP4.

Table ES 1 shows the proposed RCP4 capex being proposed using uncertainty mechanisms by expenditure category, forecast amounts and verification status.

Table ES 3 Proposed uncertainty mechanism capex and verification status

Expenditure category	RCP4 forecast	Verification status
Uncertainty mechanism capex		
Resilience programme using ‘use it or lose it’ mechanism	$53.2m	Reviewed and accepted: $53.2m
Enabling customer electrification programme using ‘use it or lose it’ mechanism	$100.0m	Reviewed and accepted: $100.0m
Four large R&R projects using ‘listed projects’ mechanism	$373.1m	Reviewed and accepted: $373.1m

Source: Transpower RCP4 forecast data and IV analysis.

As the IV, we have not been asked to express an opinion on the suitability of existing uncertainty mechanisms. For reference, existing mechanisms include:

– Listed projects
– Low incentive rate base capex projects
– Reopeners for a number of matters including a catastrophic event, a change in legislative or regulatory requirements, an error event, a large build up in the economic value account balance, and for both foreseeable and unforeseeable E&D projects.

We note that these existing mechanisms are being reviewed by the Commerce Commission as part of their review of the Capex IM.

Opex

The majority of Transpower's overall opex proposal has been developed utilising a combination of base-step-trend and bottom-up cost estimation approaches with 2021/22 as the base year.

We have reviewed Transpower's proposed opex for RCP4 and can conclude that the opex allowances are consistent with GEIP.

Transpower is proposing an opex productivity target of 0.5%, based primarily on New Zealand Institute of Economic Research Inc (NZIER) analysis (NZIER estimates a range from 0.4% to 0.6%), which Transpower then cross-checked with a range of other estimation approaches. We agree with that the approach of relying on the NZIER figure as the most robust and relevant estimate, and then cross-checking it with other, less robust and relevant estimates, is appropriate given that Transpower is the sole electricity transmission operator in New Zealand.

While we would have preferred for Transpower to have performed more checks to verify the forecast, we consider that the cross-checks Transpower did perform are sufficient to verify its proposed productivity forecast of 0.5%. In our IV report, we suggest additional cross-checks that the Commission could perform if it wanted to further increase its confidence in the appropriate productivity forecast figure.

Table ES 4 shows the RCP4 opex by expenditure category, forecast expenditure size and verification status.

Table ES 4 Proposed opex and verification status

Expenditure category	RCP4 forecast	Verification status
Network opex		
Grid maintenance	$619.1m	Reviewed and accepted: $619.1m
Asset management and operations	$408.9m	Reviewed and accepted: $408.9m
Non-network opex		
Information and communications technology	$219.9m	Reviewed and accepted: $219.9m
Software as a service	$55.8m	Reviewed and accepted: $55.8m
Business support	$310.4m	Reviewed and accepted: $310.4m
Insurance	$183.5m	Reviewed and accepted: $183.5m

Source: Transpower RCP4 forecast data and IV analysis.

Verification of key processes

Overall, we find that the qualitative elements of Transpower's proposal, and key supporting processes are consistent with delivering an expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.

However, we were unable to accept some elements of Transpower's proposal in relation to uncertainty mechanisms and service measures.

Below, we summarise our overall conclusions regarding the qualitative aspects of the RCP4 proposal, organised against the content areas specified in the ToR.

Strategy development and implementation

Transpower's relevant policies and governance processes have been effectively implemented in Transpower's development of its RCP4 proposal. Moreover, Transpower's relevant policies and governance processes are directed towards the expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.

Asset health and network risk modelling

We have observed that Transpower continues to mature its asset health and network risk (AHNR) modelling and has leveraged its maturing tools, data and AHNR knowledge to identify appropriate levels of expenditure for RCP4 to maintain asset health and avoid any appreciable deterioration of network risk. In October 2022, GHD Advisory provided an Expert Opinion Progress Review report on Transpower's asset health and risk modelling. A key finding from that review was that Transpower's existing asset management practices after considering the recent development in asset health modelling, impact modelling, criticality and risk-based decision-making frameworks demonstrated GEIP.

Expenditure forecast governance and review

Transpower has relied on its asset planning decision framework and ICT investment framework to develop its RCP4 proposal. These frameworks along with the grid Asset Management Framework and ICT strategy provides a consistent, repeatable risk-based approach for investment planning decisions. The frameworks provide for a bottom-up and top-down challenge process. The top-down challenge process allows oversight by the Economic Regulatory Matter Governance Group to review and agree appropriate trade-offs between expenditure portfolios and ensure appropriate consideration of customer feedback.

Service levels

In general, Transpower has demonstrated the prudency of the proposed RCP4 expenditure by undertaking scenario analysis to investigate the implications on asset health and service levels of altering the amount of expenditure across RCP4. Through that process we have been satisfied that Transpower is targeting a level of performance consistent with maintaining existing service levels.

Capex/opex trade-offs

Transpower's asset planning decision framework and ICT investment framework involves an explicit option analysis step prior to including the preferred solutions and expenditures into its asset management plans and ICT investment cases. It prompts Transpower to consider various alternatives to mitigate and resolve a given constraints or risks such as piecemeal refurbishments, asset life extension interventions, and investment deferrals versus residual risk analysis, with the aim of embedding the capex/opex trade-off consideration into Transpower's decision-making process.

We sighted such decisions in various portfolio management plans (PMPs) that formulates the forward-looking expenditures. We also noticed it being practiced during our evaluation of recent RCP3 business cases and while interrogating the Integrated Works Plan record. For example, the options considered for steel lattice gantries in the substation structures and buswork portfolio include protective coating/recoating of galvanised surfaces versus piecemeal in-situ replacement of structure components versus total replacement. Another example is the asset renewal options considered for the power transformer asset portfolio that includes piecemeal replacement of tap changers/bushings, tap changer overhaul, corrosion painting of tanks, oil leak repairs, gasket replacements, workshop pipework refurbishment versus complete asset replacement.

Cost estimation

Based on our evaluation, we conclude that the cost estimation framework meets all the evaluation criteria, including GEIP. Subject to Transpower updating its cost escalators in line with the latest report from the NZIER, we consider we have verified the escalators proposed.

Electricity demand forecast

We have verified Transpower's demand forecasting approach against the evaluation criteria and consider it sound. Nevertheless, we consider the bottom-up modelling that incorporates electricity distributor-provided step changes could be further improved. A step in the right direction would be to undertake a review to understand any systematic trends that may show a predictable lag between the distributor-estimated timing of demand step changes compared to when those step changes tend to occur.

Stakeholder consultation

The extent and effectiveness of Transpower's consultation and engagement with its stakeholders is compliant with the relevant Input Methodologies and ToR evaluation criteria.

Stakeholders have been provided with extensive relevant information and with sufficient opportunity to comment on major issues that drive Transpower's approach to its expenditure and service standards proposal. Transpower has ensured that stakeholder feedback is recorded and properly considered as part of its decision making.

Overall, Transpower's stakeholder consultation for RCP4 significantly improved upon that for RCP3. Though the consultation process is ongoing, we expect Transpower to continue engaging with stakeholders at a high standard as the RCP4 process continues.

Deliverability

Transpower has developed a workforce planning framework which outlines how the company intends to harness its resources to deliver RCP4. Whilst Transpower has implemented several recruitment and training initiatives, it is likely that Transpower will face significant competition for skilled and experienced electricity transmission industry resources from external companies and jurisdictions that offer greater renumeration.

As such, we are concerned about Transpower's ability to recruit approximately 200 additional staff (often in specialised areas) over the next three-year period required to deliver the expected programmes. Whilst Transpower's framework and recruitment planning is proactive and reasonable, in our opinion the Commission should request an update on Transpower's recruitment of specialised resources closer to the submission date as well as regular reporting on the status of its specialist workforce before and during RCP4.

Uncertainty mechanisms and expenditures

Transpower has proposed to carry forward uncertainty mechanisms from RCP3 and to introduce a new type of mechanism (use it or lose it or UIOLI) in RCP4. They are also proposing two capex programmes ($53.2m for resilience programme and $100.0m for enabling customer electrification programme) using this mechanism in RCP4. We have reviewed and accepted these two capex programmes being proposed by using UIOLI uncertainty mechanism.

UIOLI mechanism create relatively little risk for customers. The total amount of potential approved expenditure, and therefore revenue recovery from customers, is capped by the Commission at the start of the period. Provided that the cap is small relative to other major categories of expenditure, the impact on revenues and prices is minimal. Any overspend beyond the allowance is penalised in much the same way as any other capex overspend. Revenue is only recovered if, and only to the extent that, Transpower goes ahead with actual expenditure allowed for under this mechanism, and so any "underspend" does not benefit Transpower at the expense of consumers. The UIOLI mechanism is also relatively low cost to administer once it has been set up.

Additionally, Transpower is also proposing changes to the following mechanisms/thresholds:

– Resource Management Act reform materiality threshold for triggering the "legislative or regulatory change" reopener to be reduced to 0.5% of maximum allowed revenue or MAR (compared to current 1% of MAR used for all triggers)
– Insurance – a new cost category to be included as a recoverable cost with a 0.5% MAR cap and collar.

At this stage we have not accepted these two changed mechanisms/thresholds.

Pass through or reopener mechanisms are much more powerful tools that can shift significant (often uncapped) risks back to consumers. Administering such mechanisms also requires significant cost and effort on behalf of both the regulator and the regulated entity. We are not satisfied that a revenue-based materiality threshold test is appropriate. We suggest that for the Resource Management Act reopener (and other reopeners) Transpower consider proposing an expenditure-based materiality threshold test grounded in the likely costs of undertaking the reopener process. We note that under the draft decisions for the IM Review, the Commission now proposes to change the reopener materiality threshold test to be an expenditure test. We support this approach.

We are not satisfied that including insurance premiums as a recoverable cost with a cap and collar is warranted. While the evidence presented to us did show that insurance premium increases have in recent year become steeper, it did not demonstrate how those increases have become more volatile or less predictable. While there may well be a strong argument to forecast large increases in the insurance expenditure allowance for RCP4, at this stage in our view there is insufficient evidence to move away from setting an approved expenditure allowance based on forecasts and towards a recoverable cost approach.

Grid output (service) measures

Transpower proposes to:

– Continue revenue-linking four Grid Performance and Asset Performance measures (GP1, GP2, AP1 and AP2)
– Retain quality standards for three Grid Performance and Asset Performance measures (GP1, GP2 and AP1)
– Employ reporting-only measures for six measures of Asset Performance (AP3, AP4), Asset Health (AH), Network Risk – energy not served (NR) and Customer Service (CS1 and CS2)
– Remove or modify the RCP3 quality standards for one Asset Performance measure (AP2) and the Asset Health measure (AH).
– Remove the RCP3 measures for N-Security reporting (AP-5) and Momentary Interruptions reporting (GP-M)

For GP1 and GP2, we consider the method proposed to set the target, caps and collars, and incentive rates are appropriate. While we agree that targets should reflect historical performance, we recommend that targets are checked to ensure that they do not inappropriately reflect any deterioration in service levels that might be present in historical data.

For AP1, we consider the method proposed to set the target, caps and collars, and incentive rates are appropriate and support the adoption of the proposed quality standard with the following exception. We do not support limiting the impact of a single event when assessing performance against the target and recommend maintaining the current approach which allows the full incentive per event.

For AP2, we consider the consider method proposed to set the target, caps and collars, and incentive rates are appropriate and support the adoption of the proposed quality standard. We support the adoption of a linear regression-based approach for setting the target for unavailability due to planned outages as this allows alignment with the planned outages needed to deliver the RCP4 programme and should reduce the risk of quality standard breaches.

We note that Transpower has raised concerns regarding the significant time and effort necessary to investigate breaches of quality standards for AP2. While we recommend quality standard be retained for this service measures, we also recommend that Transpower and the Commission review the breach investigation process to explore opportunities for improvement.

In our opinion, it is beneficial that the existing AP3 and AP4 measures are retained, as this provides an incentive for Transpower to exercise GEIP by appropriately planning and managing outages and communicating changes to planned outages on the high voltage alternating current (HVAC) network.

Regarding the AH measure, we support the proposed changes that expand the number of assets for which AH is used as a performance measure. This expanded use of asset health as a tool for monitoring and selecting assets for remediation is consistent with GEIP. We recommend that the relevant asset health models continue to be matured and validated. Consideration should also be given to this measure becoming an incentivised measure in the future. We do not support removing the quality standard for this measure as AH can be an effective leading indicator of the future performance of the network. We recommend retaining the quality standard but implementing pooling across subcategories and disclosure years.

In our opinion, the inclusion of the NR measure (which monitors energy not served) would be beneficial as it provides a quantifiable measure of the level of energy Transpower is not able to serve for interruptions within its control. This measure does not quantify the impact of interruptions on generation customers. However, it should be noted that this is still a reasonable measure, and that service performance to generation customers is supported through other measures such as GP1, GP2, AP1 and AP2. Furthermore, the inclusion of the CS1 and CS2 measures to understand and improve the customer experience would be beneficial.

We support removing RCP3 measures related to N-Security reporting (AP-5) and Momentary interruptions reporting (GP-M). Customer feedback obtained by Transpower supports removal of these measures. Transpower indicated that other mechanisms exist for providing information to customers. Existing outage planning and reporting processes can provide information related to N-security, while information on momentary outages can be provided via individual customer engagement plans.

IV Opinion

We have reviewed 96.6% of Transpower’s proposed base capex for RCP4 and all of the proposed RCP4 opex against the evaluation criteria in the ToR. We consider that all but $41.4m (2.1%) of the proposed RCP4 base capex and 100% of the proposed base opex represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.

Apart from the exceptions noted in this Executive Summary, the grid output (service) measures proposed for RCP4 are consistent with an expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier, having regard to GEIP and the evaluation criteria.

Transpower has effectively implemented and applied relevant policies and governance processes and utilised AHNR modelling in developing the RCP4 expenditure proposal and the associated output measures. The asset health modelling is consistent with GEIP.

Delivering the proposed programme of work across RCP4 is a significant challenge considering the increase in workforce required. Transpower has developed a workforce planning framework and has implemented several recruitment and training initiatives. We therefore consider that Transpower has adequately addressed in its proposal its ability to deliver against its proposed base capex and proposed opex during RCP4, taking into account the expected availability of Transpower and external resources required to deliver the proposed work. We note however that the required workforce increase is yet to be achieved and recommend the Commission request an update on Transpower's recruitment of specialised resources closer to the submission date as well as regular reporting on the status of its specialist workforce before and during RCP4.

The extent and effectiveness of Transpower's consultation and engagement with its stakeholders is reasonable. Stakeholders have been provided with relevant information and with sufficient opportunity to comment on major issues that drive Transpower's approach to its expenditure and service standards proposal. Transpower has ensured that stakeholder feedback is recorded and properly considered as part of its decision making.

In most cases, Transpower has provided us with the type and depth of information we needed to provide our IV opinion and assess the prudency and efficiency of the proposed expenditure. In a few instances we identified gaps in the information provided and were therefore unable to verify that the proposed expenditure is prudent and efficient as documented in the earlier sections of this Executive Summary.

Areas of focus for the Commission

We recommend the Commission focus on the key areas identified in Table ES 5 when reviewing Transpower's RCP4 proposal.

Table ES 5 Key focus issues for the Commission

Resources to deliver RCP4	Transpower and its service providers will need to grow its Asset Management and Operations, Business Support and field-based teams relatively rapidly to be able to deliver the RCP4 programme. The Commission should request an update on Transpower's recruitment of specialised resources closer to the RCP4 submission date as well as regular reporting on the status of its specialist workforce before and during RCP4.
Reopener materiality threshold	The Commission should review the revenue-based materiality threshold test for Resource Management Act reopener (and other reopeners) for appropriateness. We note that under the draft decisions for the IMs review, the Commission now proposes to change the reopener materiality threshold test to be an expenditure test. We support this approach.
Status of draft IMs review	Our analysis and opinion in this IV report are based on the ToR evaluation criteria that reflects the requirements of the current Transpower IMs (dated Jan 2020) and Capex IM (dated Jan 2020) that existed during bulk of the IV engagement timeline, i.e., from March till June 2023. We acknowledge that the Commission in late June 2023 published its draft determination of the Transpower IMs and Capex IM, and presently the revision process is undergoing consultation phase. We did not incorporate the draft changes in the IMs proposed by the Commission in our final IV report due to the timeline of the draft determination against our IV reporting timeline. We also note that in absence of the next final version of IMs, the current version of the IMs still holds valid.
Productivity forecast cross-checking	We suggest additional cross-checks that the Commission could perform if it wanted to further increase its confidence in the appropriate productivity forecast figure.
Application of UIOLI uncertainty mechanism	The Commission should focus on the implementation of this mechanism pertaining to exclusive separation of expenditure, tracking and reporting its delivery, its cost recovery pathway, impact to future asset refurbishment and replacement activities, current asset health scores and service performance, and timing of the MAR adjustments.

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Appendices

Appendix A	Acronyms
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Part A

Introduction and background

1. Introduction

GHD was engaged to perform the role of an Independent Verifier (IV) to scrutinise the proposed service measures, base capital expenditure (capex), and operating expenditure (opex) components of Transpower's fourth Regulatory Control Period (RCP4), which extends for five years from 1 April 2025 to 30 March 2030. GHD engaged Castalia as its sub-consultant to independently verify certain components of Transpower's RCP4 proposal. This document is the IV report.

1.1 Regulatory context

Every five years Transpower must submit a price-quality proposal to the industry regulator, the New Zealand Commerce Commission (the Commission), on how it will operate, maintain, and invest in the electricity transmission network. Transpower is subject to a price-quality regime (referred to as 'individual price quality path' regulation) under Part 4 of the New Zealand *Commerce Act 1986* (the Act). The Commission sets the allowance and measures of service quality that Transpower is incentivised to deliver on for the following five-year period known as a Regulatory Control Period (RCP).

Transpower is presently preparing its price-quality regulatory proposal for the RCP4 period, which commences on 1 April 2025 and continues until 30 March 2030. Transpower is required to engage an IV to objectively review its regulatory proposal for RCP4. Transpower is also required to submit its RCP4 proposal, together with the IV report, to the Commission by 1 December 2023.

The IV's role is to evaluate whether Transpower's proposed services measures, base capex, opex, and key assumptions and inputs are consistent with the efficient costs of a prudent supplier. Both the RCP4 proposal and the IV report will be published by the Commission.

GHD, together with Castalia, meets the definition and requirements of the IV role with respect to the commercial engagement. While GHD (and Castalia) have been engaged by Transpower, we have a duty of care towards the Commission in reporting our findings with a signed tripartite deed, including that there is no conflict of interests in undertaking this role.

1.2 Purpose of this report

The purpose of this report is to inform Transpower and the Commission of our findings after independently verifying the merits of the proposed service measures, base capex and opex components of Transpower's RCP4 submission based on the evaluation criteria set out in the Terms of Reference (ToR).

Our review is based on the documentation supplied by Transpower during the March-August 2023 period.

1.3 Independent verification

The rules, requirements and processes that underpin the price-quality regulation under Part 4 of the Act are detailed in the following documents:

– Transpower, Capital Expenditure Input Methodology Determination 2012 (Principal Determination), 29 January 2020 (Capex IM); and
– Transpower, Input Methodologies Determination 2010, 29 January 2020 (Transpower IMs).

The two Input Methodology (IM) documents also prescribe evaluation criteria for verifying the proposed service measures, base capex, and opex components of Transpower's RCP4 proposal. However, for the purpose of this review, the evaluation criteria included in the two IMs have been translated into our Terms of Reference (ToR). As such, the evaluation criteria used and referred to in this report is the evaluation criteria set out in the ToR.

The Commission is currently reviewing the Capex IM and Transpower IMs and will make its final determination post submission of this IV report. Hence, our verification is based on IMs as applicable during March-August 2023.

Additionally, our role, obligations, process matters, scope of work, evaluation criteria used for various components of the RCP4 proposal, and reporting requirement for this document is prescribed in the Terms of Reference (ToR) finalised on 5 May 2023 (which is contained in Appendix B of this report).

The IMs together with the ToR forms the basis of our scope of work, evaluation criteria and reporting of our findings in this document.

1.4 Terms of reference

Consistent with previous regulatory periods, Transpower worked with the Commission to develop a ToR to guide our verification review. The ToR establishes the overarching basis of our verification review that, at a high level (as per clause 3 of the ToR), is to:

1. Engage with Transpower in an independent manner in accordance with the tripartite deed.
2. Evaluate whether Transpower's RCP4 proposed base capex, proposed opex, proposed service measures (including grid output measures as apply under the Capex IM and Transpower IMs) and key assumptions are consistent with an expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier, having regard to:
    a. Good Electricity Industry Practice (GEIP) as reflecting the appropriate planning and performance standards for a prudent supplier; and
    b. the evaluation criteria in Attachment A of the ToR.
3. Produce a verification report that meets the requirements in these terms of reference.

Appendix B of this report provides a copy of the ToR. In Appendix C, we then provide mapping between clauses in the ToR and sections of this report to assist with the Commission's review. Specifically, Appendix C provides mapping between:

- Clause 4 in the ToR, which lists the content requirements for this IV report, and sections of this report.
- Clause 18 of the ToR, which outlines the scope of the IV review, and sections of this report, and
- Attachment A of the ToR, which outlines the evaluation criteria, and sections of this report where specific evaluation criteria have been applied.

Transpower's proposed capex for major capital projects and enhancement & development (E&D) re-opener projects are excluded from the IV scope of work.

Finally, we have not evaluated the capitalised lease capex that is included in Transpower's RT01 expenditure schedule within the non-network capex category. And, we have only evaluated six (6) out of the twelve (12) information and communication technology (ICT) investment cases included in Transpower's RCP4 proposal as the remain six (6) were non-identified programmes and the expenditure requirements is immaterial.

1.5 Overview of review and verification approach

Our review and verification of Transpower's RCP4 proposal consisted of four key stages:

- Inception
- Documentation review
- Interviews
- Verification

1.5.1 Inception

In March 2023 a kick-off meeting was held between Transpower, the Commission, and key representatives of the GHD and Castalia project team to:

- Confirm the refined ToR scope of work and the proposed IV approach.
- Understand the status of Transpower's RCP4 development progress, timetable, outstanding milestones and activities.
- Identify key RCP4 focus areas or material issues of concern arising from RCP3.
- Overview of documents, processes, tools, and systems to be considered in the independent verification.
- Establish communication and information protocols to be followed by all parties.
- Agreement on roles, reporting structure, deliverables style and other administrative arrangements.

After the kick-off meeting Transpower provided a series of overview presentations on the base capex and opex forecasts, grid output measures, and support systems such as ICT and asset management. Based on these overviews, GHD initially submitted a number of requests for information (RFI) to review Transpower's documentation. Several additional RFIs were issued after the initial RFI. Transpower's responses were either addressed in the RFI response document or additional documentation was provided. Appendix D contains a list of documents and RFI responses sighted for this IV report.

1.5.2 Documentation review

Our review of relevant Transpower documents and information included:

- Expenditure trends, drivers, focus areas and risks during the current RCP3, including incentive scheme performance, cost/delivery efficiency, matter raised by the Commission (if any) etc.
- RCP4 proposal and its supporting inputs.
- Policies, strategies, asset management plans, network development plans and associated investment governance and decision frameworks and processes.
- The basis of base capex needs (network risk analysis, demand forecast, network planning and design standards, compliance etc.) and solutions (optioning, investment timing/deferral analysis, cost estimation, capex/opex trade-off etc.).
- The basis of opex needs (asset class plans, technologies, network risk analysis, operational philosophy).
- Evidence of stakeholder consultation and engagement.
- Supply chain, resourcing, and deliverability considerations.
- Grid output reporting.
- Annual performance reporting against information disclosure regulations, as applicable.
- Recent and relevant determination from the Commission, as applicable including previous RCP3 outcomes.
- Current IMs for Transpower.

1.5.3 Interviews

As part of the IV, a series of formal interviews were conducted with Transpower executives, managers, functional leads, project sponsors, and subject matter experts. These interviews focused on gaining a greater understanding of governance, strategy and decision making for each of the main expenditure categories (and support systems) for base R&R capex, opex, listed projects, base E&D portfolio, new uncertainty mechanism and proposed expenditure using it, and grid output measures. Additionally, the meetings discussed how expenditures were built up, their main components, risks and issues associated with each expenditure area.

The interviews were held in two rounds with the first round consisting of:

- Base E&D capex and enabling customer electrification capex
- Cost estimation framework
- Resilience workstreams

– Base R&R capex - substation switchgear and buswork and structures
– Propose uncertainty mechanism (and its proposed expenditure programs) and listed projects
– Grid opex
– Other opex - Asset Management and Operations (AM&O) and insurance
– Grid services contract and programme delivery
– Service measures
– Base R&R capex – power transformers
– Base R&R capex – transmission lines
– Base R&R capex – buildings and grounds
– Base R&R capex – secondary systems
– Base R&R capex – HVDC and reactive assets
– Demand forecasts
– Stakeholder engagement
– Business support capex and opex
– ICT capex including individual investment cases
– ICT opex

After the first round of interviews additional RFIs were sent to Transpower, and the responses were reviewed prior to the second round. The second round of interviews were conducted with the same cohort of key stakeholders so that we could test our work-in-progress opinions and to gather any additional information if needed. Final RFIs were sent out after the second-round interviews.

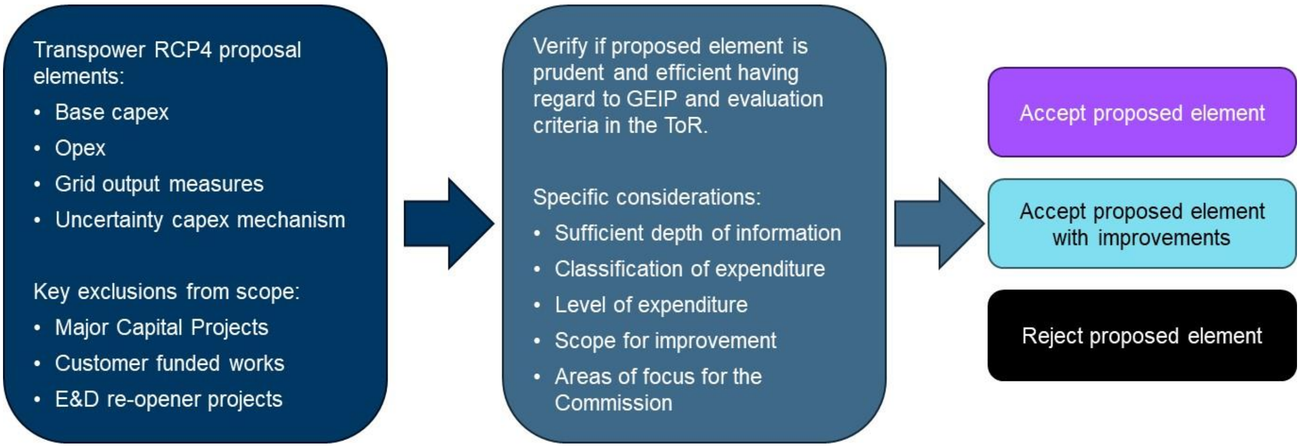
1.5.4 Verification

The verification process systematically analysed the information provided by Transpower against the requirements of the ToR and Capex IM to develop our opinion on whether Transpower's individual price quality path for RCP4 satisfies those requirements.

Transpower's proposed expenditure and the associated underlying drivers, key assumptions, key input data, methods, processes, and the resulting grid output measures were evaluated. Our opinion considered Transpower's governance arrangements, the sufficiency (completeness, quantity) and adequacy (quality, relevancy) of supporting information made available to us, the extent and effectiveness of Transpower's stakeholder engagement (including on service measures), and the extent to which Transpower has considered stakeholder feedback in developing its regulatory proposal.

The verification process occurred in parallel with the document review and interview processes. Our verification approach for each element of the scope of works is listed in Appendix E of this report.

Figure 1-1 Overview of verification process



1.6 Conventions used in this report

The following conventions are used in this report unless otherwise stated for specific instances:

– Expenditure values are expressed in constant NZD 2021/22 terms.
– Monetary values have been expressed in millions of dollars, rounded to one decimal place.
– All capex values (meaning base capex and uncertainty mechanism capex) include interest during construction (IDC).

Two types of years are used in reporting by Transpower:

– The pricing year runs from 1 April to 31 March the following year and sets the prices for transmission customers for the year (under the Electricity Authority's Transmission Pricing Methodology (TPM)).
– Transpower reports its performance against service measures across each disclosure year which runs from 1 July to 30 June the following year.

Information provided by Transpower for the purposes of the RCP review is based on the Commission's information disclosure years with the exception of the service measures discussed in Section 20 of this report.

Information provided by Transpower for the purposes of the RCP review is based on the Commission's information disclosure years. As such, data in this report is based on information disclosure years unless otherwise specified.

The following versions of expenditure values have been used:

– The forecast expenditure values provided by Transpower is based on RT01 expenditure schedule spreadsheet (REG016 version dated 7 August 2023).
– The RCP3 expenditure values provided by Transpower is based on RT01 expenditure schedule spreadsheet (REG016 version dated 7 August 2023) that consist of two years (2020/21 and 2021/22) of historical data and three years (2022/23, 2023/24 and 2024/25) of forecast data. For avoidance of doubt, the RCP3 expenditure values are not referred from the old RT01 expenditure schedule spreadsheet (version from 2018) prepared for RCP3 IV and submission purpose.

1.7 Disclaimers

This report has been prepared by GHD and Castalia exclusively for Transpower New Zealand Limited and the Commerce Commission and may only be used and relied on by Transpower New Zealand Limited and the Commerce Commission for the purpose agreed between GHD and Transpower New Zealand Limited as specified in this report.

GHD and Castalia otherwise disclaims responsibility to any person other than Transpower New Zealand Limited and the Commerce Commission arising in connection with this report. GHD and Castalia also exclude implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD and Castalia in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

GHD and Castalia do not accept liability for any loss or damage including without limitation, compensatory, direct, indirect or consequential damages and claims of third parties, that may be caused directly or indirectly through the use of, reliance upon or interpretation of the contents of the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD and Castalia have no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD and Castalia described in this report. GHD and Castalia disclaims liability arising from any of the assumptions being incorrect.

GHD and Castalia have relied on the information provided to us by Transpower, collected via interviews and gathered through the analysis of the information to formulate our opinion. We have utilised a degree of professional scepticism to review the provided information while applying the proportionate scrutiny principle. Otherwise, we have treated the provided information in good faith and have assumed them to be free of errors. For the avoidance of doubt, we did not undertake an audit of the provided information.

2. Background

The purpose of this Section is to provide relevant context for Transpower's RCP4 expenditure proposal.

An overview of Transpower's roles is provided, including that this IV report focuses only on Transpower's role as the owner and operator to the transmission network. We also provide information about the economic regulation of Transpower in this role and its current performance in the role as measured by actual expenditure compared with forecast expenditure for RCP3 (the current RPC).

An overview of Transpower's RCP4 proposal is provided. We identify the focus of their proposal, summarised proposed expenditure and outline the proposed service measures.

Concurrently with the development of this IV report, Transpower are preparing their formal proposal to the Commission. As part of the IV process, Transpower can adjust their submission to reflect our findings, as such the numbers presented in this report may vary from those submitted by Transpower to the Commission following the conclusion of the IV process.

2.1 Transpower's roles

Transpower owns and operates the electricity network that connects various participants to the market, transports electricity, manages New Zealand power system and operates the wholesale electricity market in real-time. Transpower does not generate, own or sell electricity.

Transpower is a state-owned enterprise that undertakes two essential roles of national significance in New Zealand:

- Owner and operator of the national transmission network, i.e., the high voltage (HV) electricity grid infrastructure. This physical infrastructure transports bulk electricity around New Zealand from where it is generated to where it will be finally consumed. It supplies the electricity either directly to major industrial users or to local Electricity Distribution Businesses that then finally delivers power to end consumers. This physical infrastructure is made up of approximately 11,000 km of transmission line, 3 subsea HVDC cables, 170 substations, 7,500 km of telecommunication fibre, 12 radio connections and various other supporting assets. Given the nature of this physical infrastructure it is a natural monopoly and hence is economically regulated by the Commerce Commission (the Commission).
- System operator and responsible for managing the real-time power system and operating the wholesale electricity market. Transpower is regulated by the Electricity Authority for undertaking this role in accordance with the rules and regulations that defines the market structure.

Like other jurisdictions, New Zealand's energy sector is rapidly transitioning to electrification due to decarbonisation drivers while society and its economy becomes increasingly reliant on electricity. Both Transpower's roles are important to enabling this transition to occur without impacting on the cost and performance of the electricity system.

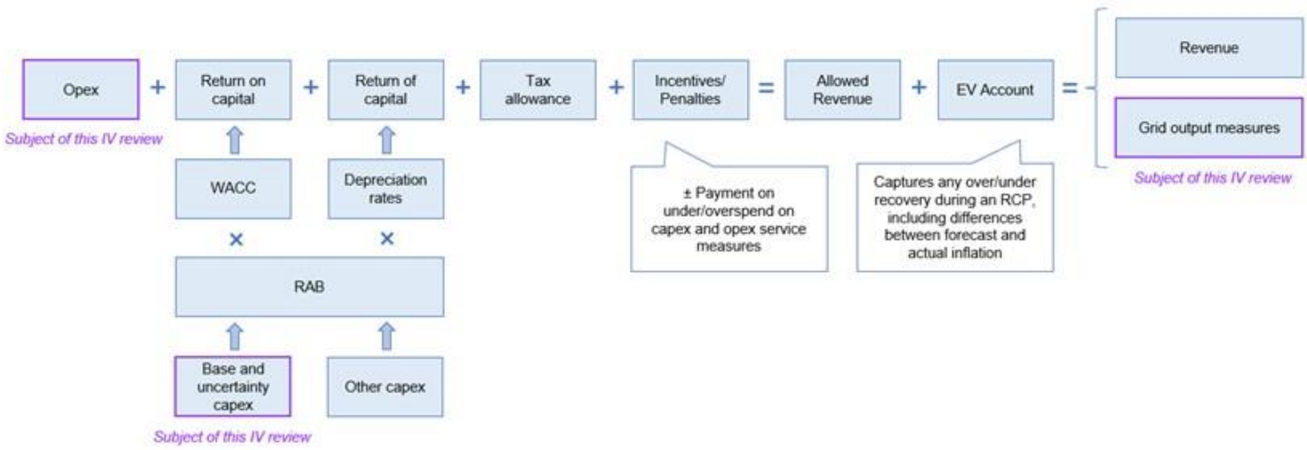
This IV report and its scope of work considers only Transpower's role as the owner and operator of the national transmission network and its economic regulation by the Commission.

2.2 Economic regulation of Transpower

The Commission regulates Transpower's economic performance by setting its service performance targets and revenue allowance it can recover from customer during a given RCP. At a high level, this is done by regulating Transpower's inputs (expenditure requirements) and grid outputs (service measures performance) whilst considering various organisational and market variables (state of the existing asset base, risk exposure, demand forecast, cost of capital etc.).

This IV report reviews only parts of the Transpower's inputs and grid outputs. Specifically, this IV review covers the proposed opex, the proposed base capex and the proposed grid output measures for RCP4 along with associated and supporting information. The following diagram highlights the elements within the revenue building blocks.

Figure 2-1 Economic regulation building blocks



The economic regulation of Transpower relies on the Commission determining prudent and efficient capex and opex allowances required to meet minimum targeted service levels. Once the expenditure levels are set, Transpower has the ability to adjust expenditure within an RCP so long as it continues to deliver its minimum service levels. The performance against this minimum service levels is incentivised/penalised in a symmetrical fashion against capex and opex allowances. This enables Transpower to prioritise work between within a given RCP.

Grid output service measures provide Transpower's stakeholders and the Commission a method to monitor its performance. Some of these measures are revenue incentivised where performance against the proposed or set quality standards are incentivised or penalised through changes in allowed revenue and other measures represent a minimum required standard or compliance level.

2.3 Overview of current expenditure (RCP3)

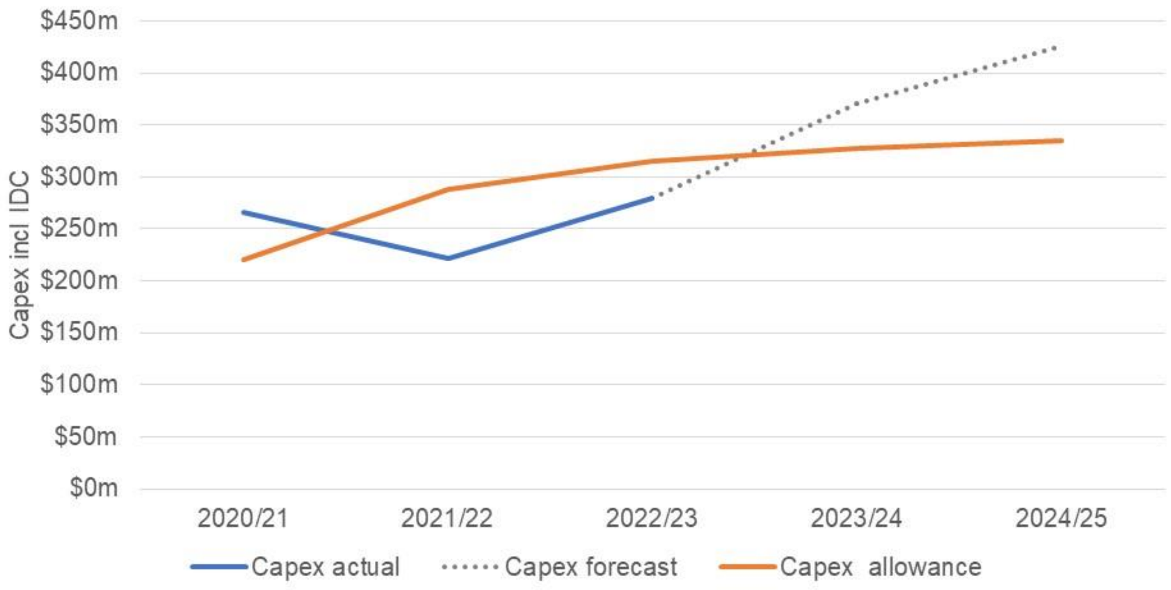
Transpower is currently in the middle of RCP3, which runs from 2020 to 2025. During this period Transpower's focus has been on renewing its ageing asset fleet, maintaining service level performance against grid output measures and improving its asset management system including data analytics.

Transpower's current expenditure performance is shown in the following figures. The first chart shows capex inclusive of IDC and the second chart shows opex. For capex, Transpower have under spent relative to forecast in the first few years of RCP3. They have explained this is due to:

– Covid 19 lockdowns
– Supply chain disruptions, and
– The reset of key Grid Contracts.

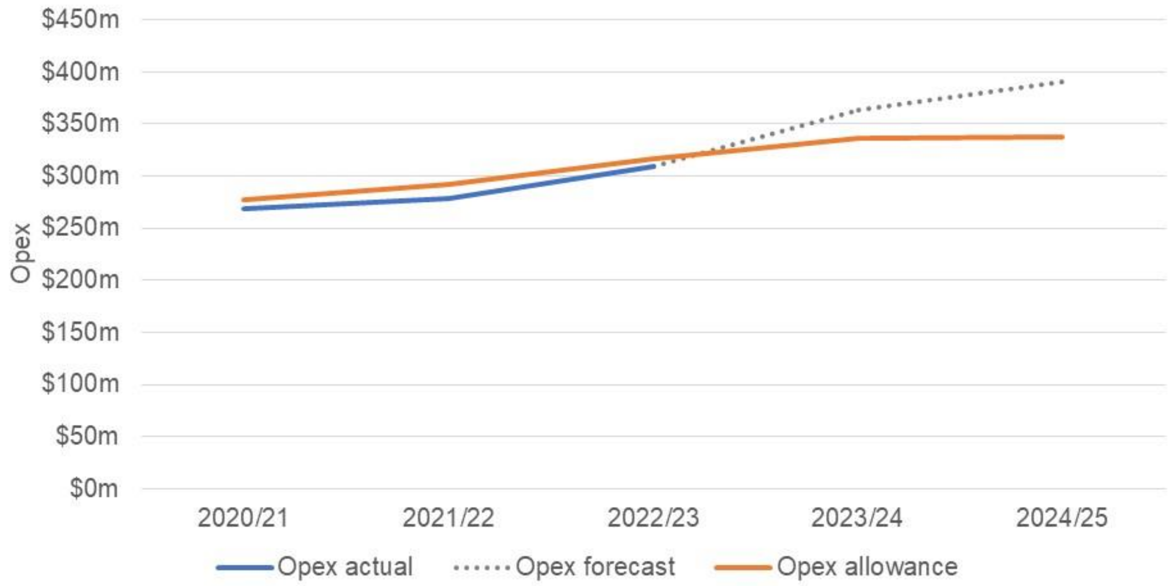
In the second half of RCP3, Transpower now expect to spend more than the previous forecast amounts in both capex and opex. The change is likely the results of proceeding with capex programs that could not be progressed in the first half of RCP3.

Figure 2-2 RCP3 capex – actual versus forecast



Source: Transpower, IVP001 RCP4 IV kick-off session.pdf.

Figure 2-3 RCP3 opex – actual versus forecast



Source: Transpower, IVP001 RCP4 IV kick-off session.pdf.

Transpower has made the following improvements to its asset management systems and associated data and reporting tools and customer engagement process in response to the 53ZD notices that were issued by the Commission with its RCP3 decision:

– **Asset health and network risk (AHNR) modelling:** Transpower has further developed its AHNR modelling as outlined in the AHNR Roadmap for asset health modelling, impact modelling, and network risk analysis workstreams from RCP3 submission time. As part of the IV we considered each asset class, topic and hazard assessed Transpower's practice against GEIP and its ability to use the AHNR modelling to inform the RCP4 expenditure requirements. We leveraged the GHD Advisory Expert Opinion Progress Review report[5] on asset health and risk modelling dated 21 October 2022 for our IV review. In the Expert Opinion report, we concluded that Transpower had progressed well against its AHNR Roadmap goals with few exceptions or improvement opportunities identified. Overall, Transpower's asset management system was found to be in a

[5] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

mature state, well-developed, governed and practiced. We have described the overall findings on AHNR modelling is outlined Section 3 of this report.

– **Cost estimation:** Transpower established improved cost information reporting and tracking across various project development and delivery phases. This allowed for variance analysis (between proposal, delivery business case and incurred costs) and performance monitoring by portfolio and asset classes. The improved cost information reporting and tracking uses Transpower's existing cost estimate reporting which monitors estimation accuracy and will enable Transpower to have up-to-date cost information that reflect likely expected costs (feedback loops). In RCP3, Transpower will report this information for all listed projects and for all base E&D capex projects over $5m.
– **Customer engagement:** Transpower's proposed customer engagement process leading up to its RCP4 proposal was independently assessed by SenateSHJ. The assessment found that it met the expectation for providing meaningful customer engagement, demonstrating commitment to proactive and consistent relationship building with stakeholders. In addition, Transpower was also independently assessed by SenateSHJ as reasonably allocating resources to the customer engagement process, having a robust method for prioritising customers/stakeholders and demonstrating ongoing commitment to continuous improvement.

2.4 Overview of proposed expenditure (RCP4)

The following provides an overview of Transpower's RCP4 proposal at the time of our independent verification. We have highlighted the focus of Transpower RCP4 proposal, summarise the expenditure categories at aggregated level and compared them to RCP3 expenditure level and briefly explain the expenditure drivers in RCP4 at a high level. We have also highlighted the identified and non-identified programmes and highlighted the changes being proposed for service measures.

2.4.1 Focus of proposal

Transpower has relied on its asset planning decision framework and ICT investment framework to develop its RCP4 budget. These frameworks along with the grid Asset Management Framework and ICT strategy provides a consistent, repeatable risk-based approach for investment planning decisions. The key drivers for investment are safety, network performance, future demand, risk of asset failure and cost performance. These frameworks principle apply to all grid and ICT expenditures. Transpower developed its RCP4 proposal using a bottom-up and top-down challenge process based on these frameworks.

The bottom-up budgeting process included:

– Identifying and prioritising investment need.
– Identifying and assessing options including the impact on risk/service
– Choosing preferred solutions.
– Varying the level of analysis with the degree of risk, need, and investment requirement.
– Incorporating condition-based failure and network risk levels in addition to the AHNR modelling.
– Considering relevant components of its Asset Class Strategies and other Grid Strategies such as prioritising replacement or phasing out of certain make and model of asset types.

The top-down challenge process included:

– Assurance and validation steps achieved by engaging with its Governance Group.
– Reviewing and agreeing trade-offs within various portfolios and overall expenditure.
– Confirming investment analysis is commensurate to expenditure.
– Engaging with customers and incorporation of feedback into the RCP4 proposal where relevant
– Conducting a high-level deliverability review and analysis.
– Sign-off on proposed expenditure plan.

At a high level the proposed RCP4 expenditure builds on the similar investment framework approach used in the RCP3 proposal, (for e.g., grid asset renewal driven by conditions and risk of failure, grid development is driven by increasing demand and maintaining current service levels, ICT programme driven by cybersecurity needs etc.). Additionally, the RCP4 proposal introduced the following topics:

– Enabling customer electrification driven by the need to decarbonise the New Zealand economy.
– Grid resilience strategy driven by increasing severity and frequency or knowledge of natural hazards including weather related risks and asset related risk events.
– SF6 Strategy that reduces Transpower's volume of SF6 stock holding and its leakage rate and investigates the use of non-SF6 interrupter technology at higher voltage levels.
– Deliverability and resourcing strategy driven by a forecast scenario of inflationary market pressure, industry supply chain risk and a constrained labour market.
– Renewing the information technology (IT) communication assets (TransGo refresh).
– Replacing or phasing out specific asset types that are operationally underperforming or present safety or failure risks such as oil impregnated transformer bushings, HV cable joints and termination, pre-2010 Nissin branded current transformers etc.
– Proposing a new uncertainty mechanism (use it or lose it or UIOLI) via consultation with the Commission to update the Transpower IMs.
– Proposing various capex programs (such as enabling customer electrification and several resilience workstreams) using the above designed UIOLI uncertainty mechanism.
– Proposing changes to pass-through uncertainty mechanism thresholds.
– Proposing few new service measures and discontinuing few existing service measures.

2.4.2 Proposed expenditure

The proposed base expenditure in RCP4 consists of base capex and opex as outlined in the figure below.

Figure 2-4 Base capex and opex

Base capex		Opex	
Network capex	Non-network capex	Network opex	Non-network opex

• Base R&R capex for:
  • AC substations
  • buildings and grounds
  • transmission lines
  • HVDC and reactive assets
  • secondary assets
• Base E&D capex
	• ICT capex[1] for:
	  • asset management systems
	  • corporate systems
	  • ICT shared services
	  • IT telecoms
	  • network and security services
	  • transmission systems
	• Business support capex
	• Capitalised leases[2]
		• Grid maintenance (consisting of preventive, predictive, corrective, and proactive maintenance)
		• Asset management and Operations (AM&O)
			• ICT opex which includes Software as a Service (SaaS)
			• Business support opex
			• Insurance

[1]ICT capex was covered in 12 investment cases. We evaluated 6 of the cases that collectively constitute the majority of total ICT capex, including all identified programs.
[2]Capitalised leases were not assessed.

As part of its grid resilience strategy Transpower is proposing a programme of resilience workstreams. Most of these resilience workstreams are embedded in the above itemised base expenditures (grid maintenance, ICT opex, base R&R capex and ICT capex). The remainder of the resilience workstreams are capex programme and are being proposed using the UIOLI uncertainty mechanism. They reside within multiple asset portfolios.

Driven by the decarbonisation need Transpower is proposing capex to enable customer electrification. This capex sits outside the E&D base capex and is being proposed using the UIOLI uncertainty mechanism.

Transpower has also identified four listed projects in RCP4. Listed projects are projects where there is a degree of uncertainty around costs, timing and/or scope, and those projects are expected to need to commence in RCP4. Listed project expenditure is subject to a separate submission pathway by Transpower and approval by the Commission.

We have verified the proposed base expenditures, capex programmes being proposed using the UIOLI uncertainty mechanism and the listed projects as itemised above, except for where we noted otherwise. We have reported our findings in this IV report.

For avoidance of doubt, we did not verify the following expenditures during RCP4 because they were excluded from our scope of IV work:

- System Operator Service Provider Agreement (SOSPA).
- Major capital projects.
- E&D re-opener projects.
- Customer funded investments.

Comparison of RCP4 with RCP3 baseline expenditures

The table below shows the proposed total RCP4 expenditure and compares it with the total RCP3 expenditure. Transpower is proposing increase fundings across most asset/expenditure categories in RCP4 compared to the RCP3.

The proposed RCP4 opex and base capex is 24% more than the RCP3 and the proposed RCP4 opex, base capex and uncertainty mechanism capex is 41% more than the RCP3.

Table 2-1 Comparison between RCP3 and proposed RCP4 expenditure

Expenditure type	Asset category	Expenditure category	RCP3	RCP4	% change in RCP4
Opex	Network	Grid maintenance	$566.6	$619.1	9%
		AM&O	$338.0	$408.9	21%
	Non-network	ICT opex	$170.7	$219.9	29%
		SaaS	$26.2	$55.8	113%
		Business support	$278.9	$310.4	11%
		Insurance	$128.3	$183.5	43%
Base capex	Network	AC substation R&R	$332.0	$441.5	33%
		Buildings and grounds R&R	$79.4	$121.0	52%
		Transmission lines R&R	$463.3	$647.2	40%
		HVDC & reactive assets R&R	$116.6	$150.5	29%
		Secondary assets R&R	$233.6	$251.1	7%
		E&D capex	$106.6	$98.5	-8%
	Non-network	ICT capex (excluding SaaS)	$151.9	$198.5	31%
		Business support capex	$21.4	$43.1	102%
		Capitalised leases	$52.6	$50.0	-5%
Uncertainty mechanism capex	Network	Resilience (using UIOLI uncertainty mechanism)	$0.0	$53.2	--
		Enabling customer electrification (using UIOLI uncertainty mechanism)	$0.0	$100.0	
		Listed project	$0.0	$373.1	--
Opex + Base capex			**$3,066.1**	**$3,799.0**	**24%**
Opex + Base capex + Uncertainty mechanism capex			**$3,066.1**	**$4,325.3**	**41%**

Source: GHD analysis of Transpower data.

In most of the categories the proposed RCP4 expenditure has increased compared to RCP3. At a high level, Transpower has explained the reason for these increase in expenditures as following:

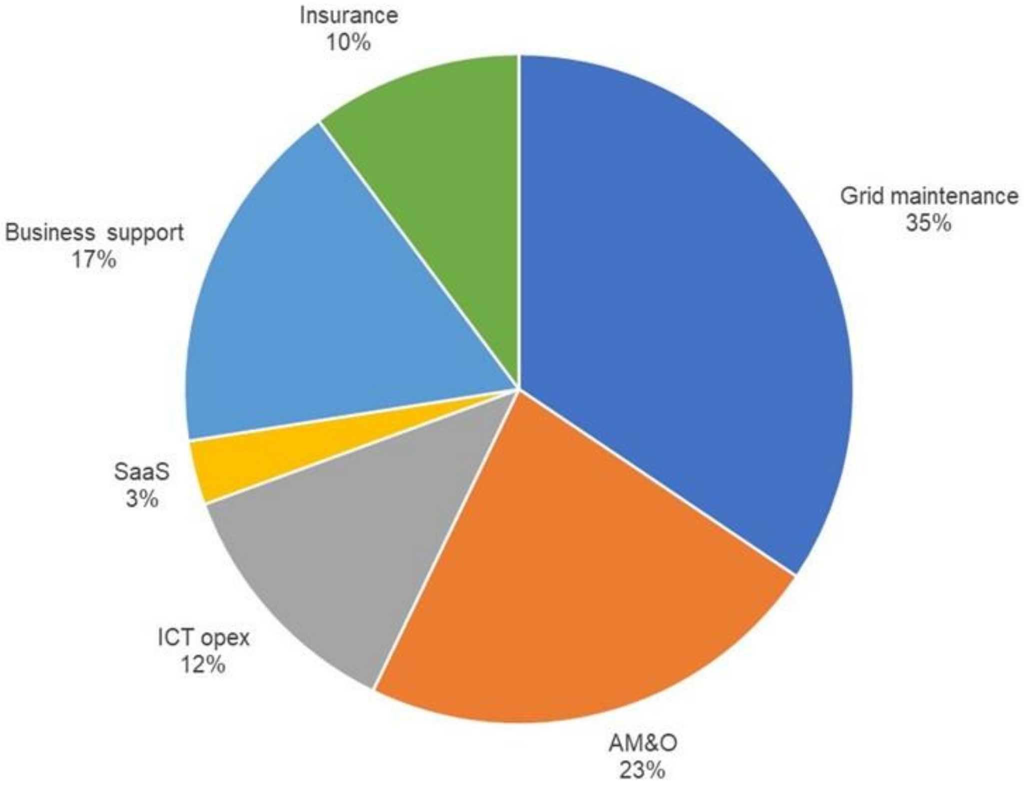
– Network opex, in particular AM&O expenditure, is increasing as a function of the proposed increased capex work programme.
– Non-network opex is increasing for a variety of reasons including:
  - growth in ICT opex to support the delivery of ICT investments aligned with strategic priorities,
  - growth in business support functions to facilitate the increase in workforce required to deliver the increased levels of network capex and opex, address increasing regulatory requirements, and keep pace with growing volume of customer connection enquiries.
  - increasing insurance premiums.
– Network base R&R capex is increasing across all expenditure categories, with the largest increases occurring in transmission line and substation asset portfolios, driven by aging assets that must be replaced or refurbished to arrest the risk of deteriorating assets and associated services.
– Non-network base R&R capex is increasing primarily due to increases in ICT expenditure, with the TransGo Refresh programme being a major component of this increase.

Each of these reasons are explored in detail at respective section of this IV report when evaluating the proposed asset portfolio within each expenditure categories.

RCP4 proposed opex and identified programmes

Transpower is proposing a total opex of $1,797.6m in RCP4. Of this 57% is network opex and 43% is non-network opex. A breakdown of proposed opex is illustrated in the following figure.

Figure 2-5 Breakdown of RCP4 opex



Source: GHD analysis of Transpower data.

Clause 2.2.1(1) of the Capex IM requires Transpower to agree with the Commission a set of criteria for determining the identified opex programmes. Transpower and the Commission have agreed on the following criteria for selecting identified programmes for RCP4:

– The top four portfolios by proposed expenditure across all opex portfolios
– Where the opex meeting the first criterion does not cover 75% of proposed opex, the next largest opex portfolio(s) until 75% of the proposed opex coverage is achieved.

The portfolios listed in the table below constitute 88% of proposed RCP4 opex and are identified programmes in the RCP4 submission. We have evaluated these opex identified programmes using the proportionate scrutiny principle and the relevant ToR evaluation criteria. We have also evaluated the remaining non-identified opex programme.

Table 2-2 Identified opex programmes

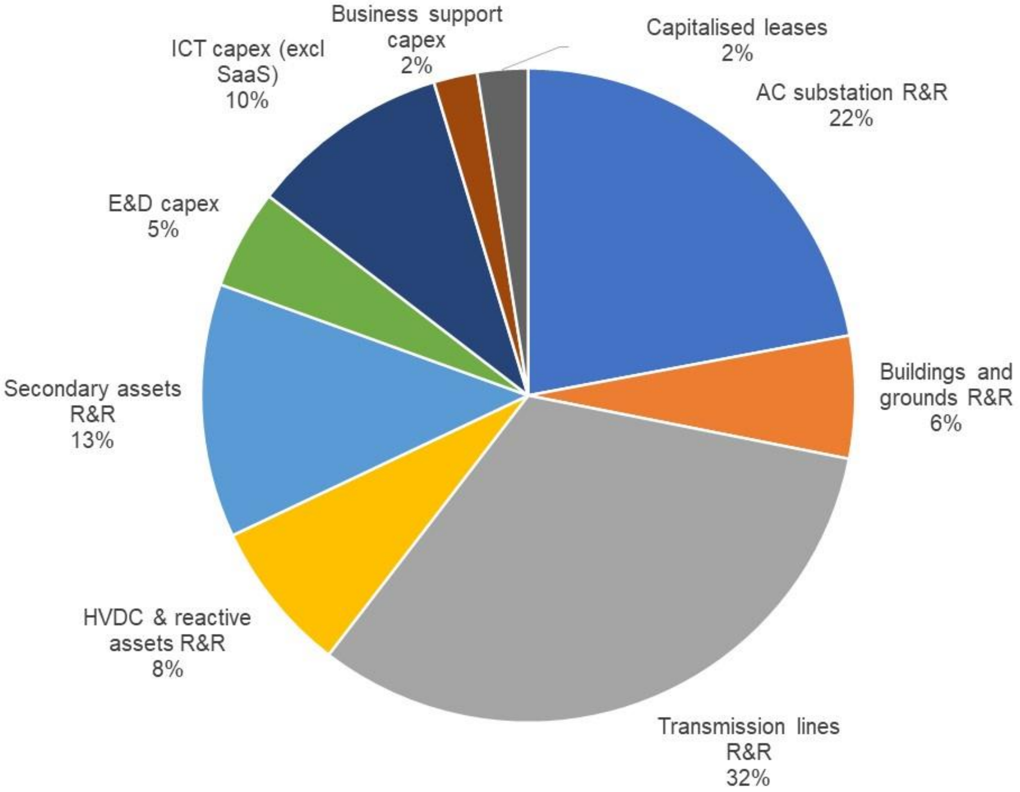
Asset category	Expenditure category	Proposed amount	Proportion of total opex
Network	Grid maintenance – preventive	$206.9m	12%
	Grid maintenance – predictive	$383.9m	21%
	AM&O	$408.9m	23%
Non-network	ICT opex (including SaaS)	$275.8m	15%
	Business support	$310.4m	17%
	Total	**$1,585.9m**	**88%**

Source: GHD analysis of Transpower data.

RCP4 proposed base cape and identified programmes

Transpower is proposing a total base capex of $2,004.6m for RCP4. Of this 85% is network capex and 15% is non-network capex. Further breakdown of this proposed capex is illustrated in the following figure.

Figure 2-6 Breakdown of RCP4 capex



Source: RCP4 IV kick-off session presentation slide, Transpower

Clause 2.2.1(1) of the Capex IM requires Transpower to agree with the Commission a set of criteria for determining the identified capex programmes. Transpower and the Commission have agreed on the following criteria for selecting identified capex programmes:

- The top two base R&R capex for the following asset portfolios:
  - Substations
  - Transmission lines
  - HVDC & reactive assets
  - Secondary assets
- Base R&R capex for buildings & grounds asset portfolio
- All base E&D capex
- Non-network capex including ICT capex and business support capex
- Where the capex meeting first three criteria do not cover 70% of forecast base capex for RCP4, the next largest RCP4 forecast base capex portfolio(s) until 70% of base capex coverage is achieved.

The capex portfolios listed in the table below are the identified programmes for RCP4. They constitute 81% of the total proposed RCP4 base capex. We have evaluated these base capex identified programmes using the proportionate scrutiny principle and the relevant ToR evaluation criteria. We have also evaluated the remaining non-identified capex programmes except for the capitalised leases and the ICT capex in the 6 of the 12 ICT investment cases.

Table 2-3 Identified base capex programmes

Asset category	Expenditure category	Proposed base capex	Proportion of total base capex
Network	AC substation R&R – power transformer	$154.1m	8%
	AC substation R&R – outdoor switchgear	$106.5m	5%
	R&R Buildings and grounds	$121.0m	6%
	Transmission lines R&R – structures & insulators	$421.6m	21%
	Transmission lines R&R – conductor & hardware	$155.8m	8%
	R&R – HVDC	$78.1m	4%
	R&R – reactive assets	$72.5m	4%
	R&R – protection, battery systems & rev. meters	$227.6m	11%
	Secondary assets R&R – substation management system	$23.5m	1%
	E&D capex	$98.5m	5%
Non-network	ICT capex (excluding SaaS) – TransGo	$93.7m	5%
	ICT capex (excluding SaaS) – maintain services	$67.6m	3%
	Total	**$1,620.5m**	**81%**

Source: GHD analysis of Transpower data.

RCP4 proposed service measures

Transpower is planning to deliver similar service levels during RCP4 as it is during RCP3. Transpower is seeking to refine its service measures to reflect outcomes that are valued by customers and consumers. In developing their proposed service measures Transpower have undertaken benchmarking of the service measures from other jurisdictions as well as a formal customer engagement process.

Transpower are proposing the following main changes for RCP4:

– Broadening the AH (Asset Health) measure to include more asset classes.
– New pilot measure providing a report on energy not served.
– Two new pilot measures around customer service and connections.
– Discontinue AP5 N-Security reporting and GP-M momentary interruptions.
– Proposing to remove quality standard for AP2 (HV AC availability) and AH.
– Expansion of pooling for quality standards.

2.5 Performance benchmarking

As part of the develop of its RCP4 proposal, Transpower undertook economic benchmarking to measure how efficient it is as a supplier over time compared with its peers.

Benchmarking draws on existing processes and data used by the Australian Energy Regulator (AER), which oversees the economic regulation of Transmission Network Service Providers (TNSPs) in Australia.

The AER reports annually on productivity growth and efficiency of the TNSPs using three measures:

– Multilateral Total Factor Productivity (MTFP), which uses a mathematical index to measure the relationship between multiple outputs relative to multiple inputs;
– Partial Factor Productivity (PFP), which uses multiple outputs against a single input (opex or capital); and
– Partial Performance Indicators (PPIs), which relates one input to one output.

The outputs used (in order of weighting) are circuit length, ratcheted maximum demand, energy and customer numbers. And the inputs used (in order of weighting) are transformer capacity, opex, overhead lines and underground cables.

Transpower have replicated the AER's model and included Transpower within the existing AER dataset of TNSPs[6]. The outputs of the AER and Transpower models are shown in the figures below. Transpower have stated that they believe this method is significantly more robust when compared to the benchmarking undertaken by the IV as part of Transpower's RCP3 proposal (which used capex as an input).

2.5.1 Multilateral total factor productivity

Transpower's MTFP level for 2022 was 0.801, placing it fourth overall, in a cluster with four of the other five networks. TasNetworks is the outlier, with the introduction of restructuring and reform initiatives significantly reducing its level of opex post-2014. Transpower's productivity dropped from 0.93 in 2012 to 0.85 in 2013. This followed the completion of NI-GUP which added an additional 200 km of overhead line and significantly more capacity to the grid. This increased Transpower's inputs while not improving the outputs in the MTFP model significantly, suggesting relative inefficiency.

Since 2013, Transpower's MTFP has been stable. Adjusting for cost inflation, Transpower's opex has remained consistent over the years.

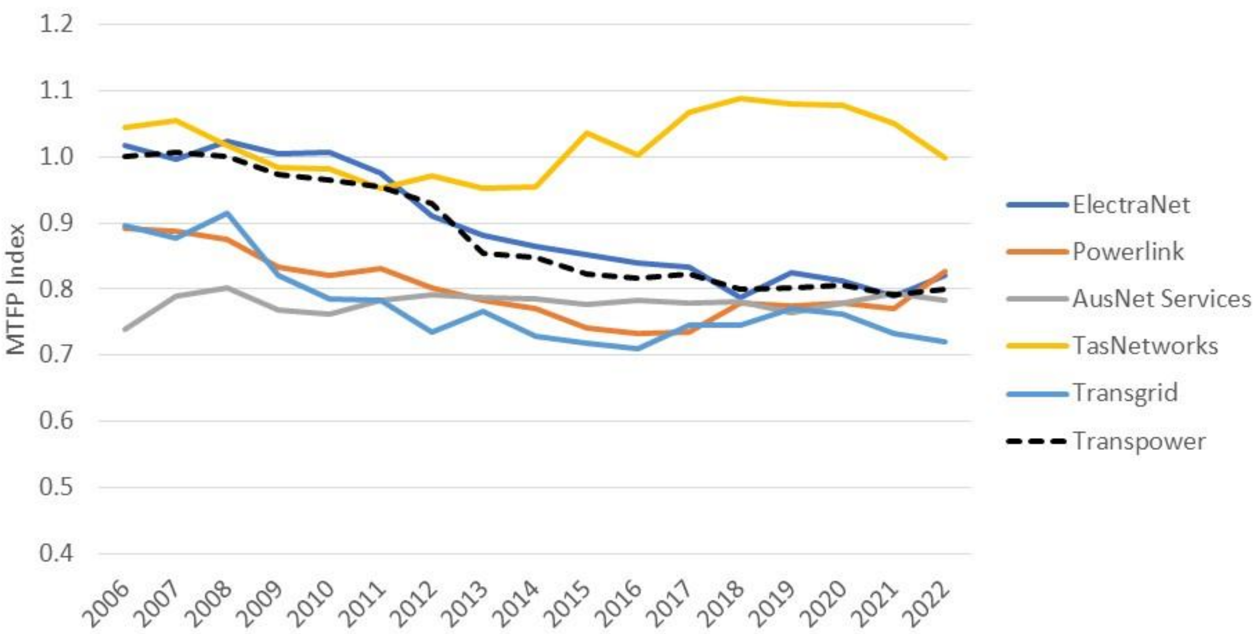
The following adjustments have been made:

- Purchasing power parity for operating expenditure
- Adjustment out all HVDC outputs and inputs inclusive of HVDC insurance and an allocation of overhead (based on revenue)
- Transpower's productivity in 2006 is set as the base (i.e. index = 1.00)

In our opinion the removal of HVDC assets is appropriate given none of the Australian TNSPs own HVDC assets.

Transpower have stated that in their opinion, the most comparable networks to Transpower are TasNetworks and ElectraNet, followed by Powerlink. In addition, Transpower asserted that investment in resilience and system strength and other improvements, that do not directly impact any of the outputs (circuit length, demand, energy throughput, customers), will have an adverse impact on productivity.

Figure 2-7 Multilateral total factor productivity – Transpower compared with Australian TNSPs



Source: Transpower analysis including AER data.

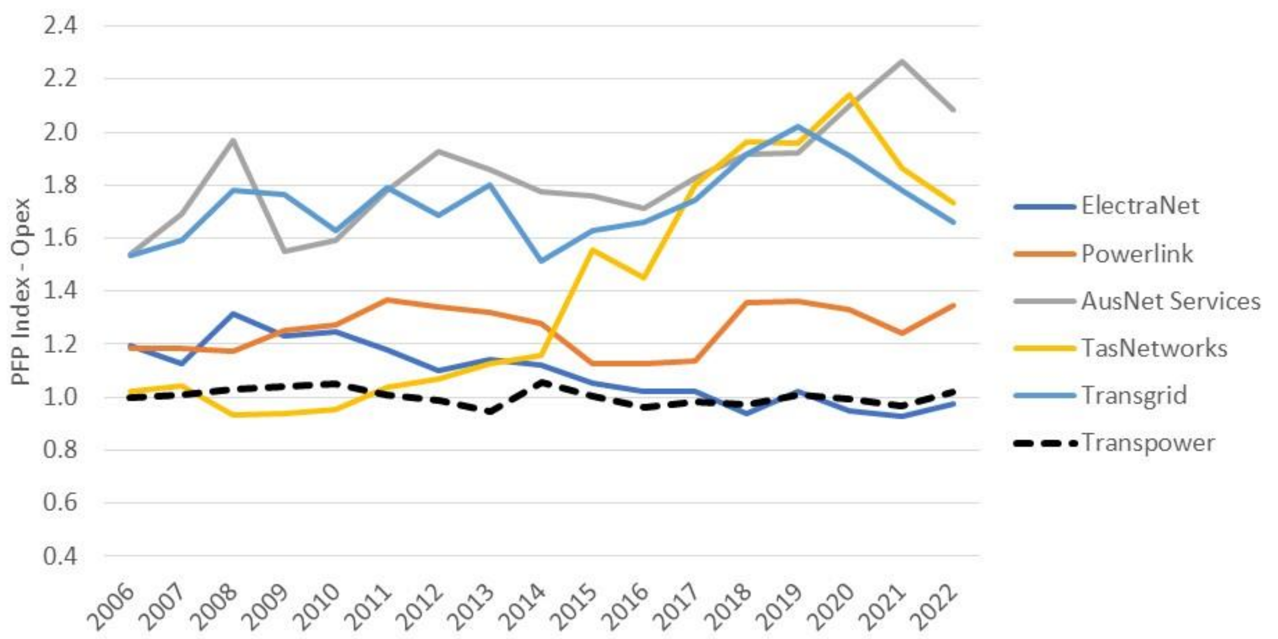
[6] Transpower excluded quality (ENS) as we could not get comparable estimates with the Australian TNSPs.

2.5.2 Opex and capital partial factor productivity

Transpower benchmarks poorly when relying on opex as the sole input as shown in the opex partial factor productivity graph. However, Transpower performs better against its peers when using capital inputs only.

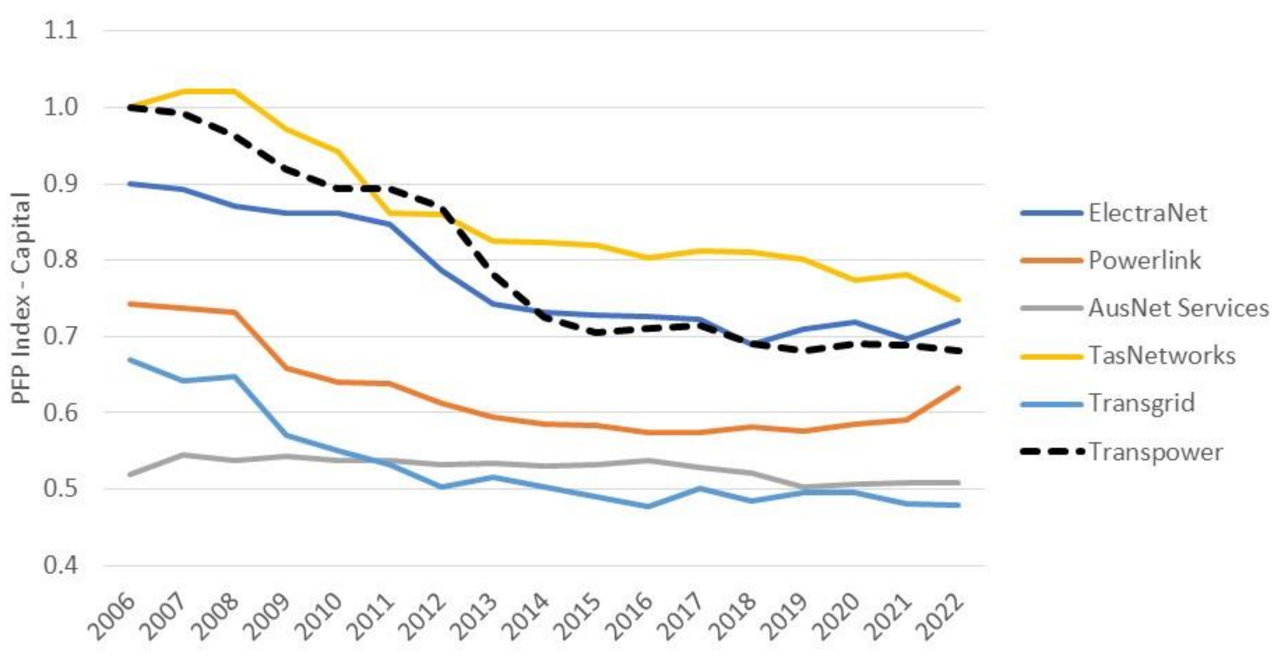
This performance is likely due to a Transpower having higher ratio of opex to capex compared to Australian TNSPs. Transpower, as we have observed in undertaking this review, relies more heavily on opex solutions to extend the life of existing assets. Transpower is also subject to different capitalisation rates as well as other operating environment differences. Transpower's average opex to totex ratio from 2016-2022 was 48%, whilst the Australian TNSPs averaged 40%.

Figure 2-8 Opex partial factor productivity – Transpower compared with Australian TNSPs



Source: Transpower analysis including AER data.

Figure 2-9 Capital partial factor productivity – Transpower compared with Australian TNSPs



Source: Transpower analysis including AER data.

2.5.3 IV comments

As noted by the AER in its reporting and acknowledged by Transpower, the results of economic benchmarking of TNSPs should be used with caution due to difficulty in selecting appropriate outputs and inputs, weighting the outputs and inputs, getting comparable data, and different operating environments of each supplier. There may also be a greater difference in accounting calculation methods, capex and opex definitions and the appropriateness of inputs and outputs and their weightings for comparisons between New Zealand and Australia.

With consideration to the limitations of this benchmarking, we have only considered it where it would be useful for the verification (for example in assessing opex productivity in Section 4 of this report). More detailed benchmarking or comparisons have been considered in the suite of evaluation techniques and has been used for evaluation of selected work programmes as needed throughout this report.

In addition to noting this qualification on the macro level organisational productivity and performance benchmarking, we further explored benchmarking Transpower's ICT total expenditure (totex) against 11 electricity transmission businesses.

We utilised similar ICT information based on our work on regulatory revenue determinations for these electricity transmission businesses in other jurisdictions and Transpower actively engaged with us to assist with this ICT totex benchmarking process. Most of the comparator data is not publicly available and to comply with our client confidentiality requirements we had to anonymise the data when benchmarking against Transpower's ICT totex information.

This ICT benchmarking process revealed a range of data qualification issues caused by differences in reporting style, expenditure categorisation, accounting specification, adopting different definitions etc. between Transpower and the other electricity transmission businesses. It also revealed contextual challenges such as:

– The operating environment of these transmission networks is different, which leads to different solutions to the same problem. For example, the use of fibre, satellite, copper pair and third-party service provision will lead to different outcomes and therefore costs.
– The maturity in ICT is different. Some electricity transmission businesses may be seen as 'trailblazer' for adopting new technologies, some are 'slow adopters' who prefer to wait for the more mature technologies.
– The timing of certain large scale ICT projects can impact the results. For example, Transpower is intending on delivering a large scale TransGo refresh. Other electricity transmission businesses may have recently completed similar activities.

Each of these differences skewed the benchmarking analysis producing weak results that were not useful in assessing Transpower's propose ICT expenditure for RCP4. We have therefore decided not to rely on ICT totex benchmarking as part of the IV of the RCP4 proposal. Instead, we undertook a bottom-up assessment of Transpower's ICT investment plans. We do not consider that the lack of benchmarking effected the robustness of our evaluation.

Part B

Strategy, cost estimation and demand forecasting

3. Strategy development and implementation

Our assessment of Transpower's strategy, priorities and policy in relation to its RCP4 proposal development against the relevant ToR evaluation criteria is presented in this section. The strategy, priorities and policy are implemented through both grid and ICT asset management strategies and systems, as such our assessment of these components of Transpower's governance and planning arrangements are also assets in this section.

Our overall findings are summarised in the following table. Consistent with the ToR, we consider in more detail in this section, Transpower's organisational strategy, priorities and policy, their existence, their intent, their implementation and practice in relation to Transpower's RCP4 development.

Table 3-1 Verification summary of Transpower's strategy development and implementation

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	None identified
Key issues that Commission should focus on	None identified

3.1 Evaluation approach

The following table outlines the applicable evaluation criteria stipulated in the ToR and our approach to assessing each element. The same evaluation criteria apply to both our verification of Transpower's strategy, priorities and policy and our verification of Transpower's grid and ICT asset management strategy and systems. However, the considerations for evaluation vary between the two focuses, as shown in the table below.

Table 3-2 Evaluation criteria and approach: Strategy development and implementation

ToR Clause	Evaluation criteria	Evaluation approach
4.2, 4.3	Policies and governance processes are consistent with good asset management practice, have been effectively implemented, and are directed towards achieving efficient and prudent expenditure outcome	– Review the intent of Transpower's Whakamana i Te Mauri Hiko report, Transmission Tomorrow report (2023), Strategic Asset Management Plan, future workforce priority, digital journeys priority and ICT Strategy and check if reflects good asset management practice. – Check if the intent of the above strategic direction influences and cascade down to Transpower's asset management system and its frameworks and processes and also to ICT sub-strategies. – Review network strategy (and its supporting asset class strategies and portfolio management plans) and grid delivery strategy (and its supporting annual business plan and integrated works plan) and check if they reflect good asset management practice. – Review ICT strategy (and its supporting sub-strategies, portfolio of drivers and investment cases) and check if they reflect good asset management practice. – Review the evidence or output from the asset management system framework and ICT sub-strategies such as past decision, expenditure profile and service/benefit outcomes to check for consistency with its strategy, priorities and policy. This was undertaken in Sections 8 to 20 of this report to evaluate respective expenditure category and asset portfolios within them and service measures and referred here.

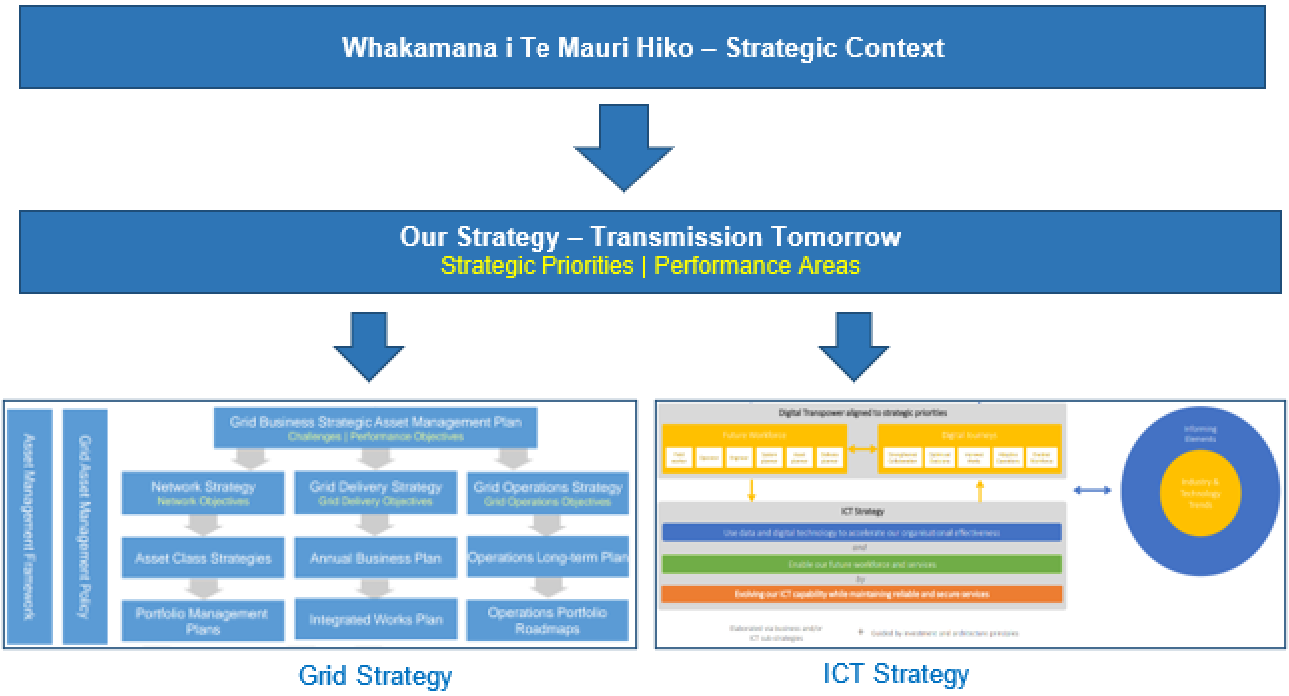
ToR Clause	Evaluation criteria	Evaluation approach
A1(b)	Whether policy regarding the need for, and prioritisation of, projects and programme demonstrate a risk-based approach consistent with good asset management practice and are directed towards achieving cost-effective and efficient solutions	– Check the linkages between the industry and technology trends, ICT Strategy, sub-strategies and goals to achieve/enable ICT objectives. – Check PMP includes investment need. Check PMP and ACS are aligned. This was undertaken in Sections 8 to 20 of this report to evaluate respective expenditure category and asset portfolios within them and referred here. – Check the proposed programme is risk based supported by systematic approach to determine the likelihood of event occurring, consequences of those event and quantified risk value. This was undertaken in Section 8 of this report to evaluate respective expenditure category and asset portfolios within them and referred here. – Where applicable, review choice of proposed project and nominated quantities in RCP4 for prioritisation based on risk (asset health index score × impact). – Refer to GHD Advisory's Expert Opinion Progress Review[7] to understand Transpower's AHNR modelling maturity to consider application of asset management policy and investment decision framework to justify the base R&R projects in RCP4. – Check possibility of deferring investment against Transpower's risk exposure level and its risk appetite/averseness. – Review Transpower connection process, generator connection management framework, and the guidance available in Transpower's website to appreciate the connection process across various stages (high level governance and process review). This was undertaken Sections 8 to 20 of this report to evaluate the relevant expenditure category and referred here.
A3(b)	Policies and planning standards were applied appropriately	– Process review to check if PMP and ACS have alignment or have line of sight to Network Strategy, Asset Management Plan, Strategic Asset Management Plan and Transmission Tomorrow. – Check if the outcome of the PMP forecast and ICT investment cases achieve the organisation goals, objectives with respect to people, safety, performance etc. This was undertaken Sections 8 to 20 of this report to evaluate respective expenditure category and asset portfolios within them and referred here. – Review Transpower's annual transmission planning process including the type and quality of information documented in its Transmission Planning Report, customer technical request and concept assessment process, asset feedback and decision framework and options assessment approach against GEIP (process benchmarking). This was undertaken in Sections 8 to 20 of this report to evaluate the relevant expenditure category and referred here. – Whether Transpower has demonstrated the ICT investment cases are in line with internal polices, companion strategies, Transpower business drivers, external drivers and that the investments are prioritised and directed to achieving a cost-efficient solution. This was undertaken in Sections 8 to 20 of this report to evaluate the relevant expenditure category and referred here.

[7] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

3.2 Observations

The following figure shows GHD's understanding of the hierarchical structure and approach that Transpower takes in embedding its strategic priorities within its business environment, functions and roles within both grid asset management and ICT management frameworks. It shows the Transpower's strategic context informing its priorities and performance areas and giving direction to both grid strategy and ICT strategy. These management frameworks and strategies are relied on for developing and estimating the RCP4 proposal.

Figure 3-1 Hierarchical view of context, priorities and policy embedded within grid strategy and ICT strategy



Source: GHD diagram based on Transpower's documents

Our review of Transpower's strategic context, focus on performance areas, asset management policy, future workforce and digital journey priorities indicates suitable organisational goal setting and policy establishment that identifies future states and guides the organisation in a chosen path to meet its business objectives.

The network strategy (and its supporting asset class strategies and portfolio management plans) and grid delivery strategy (and its supporting annual business plan and integrated works plan) are evaluated separately in this IV report within the respective Sections of expenditure category and asset portfolios within them. Similarly, the ICT strategy (and its supporting sub-strategies, portfolio of drivers and investment cases) are evaluated separately in this IV report within the respective ICT expenditure category Sections. We have referred those evaluations, along with the evaluation undertaken in this Section, to arrive at our conclusion with respect to Transpower's strategy, priorities and policy.

3.2.1 Strategic context, priorities and policy

Transpower's strategic context is provided in the Whakamana i Te Mauri Hiko report. In this report, Transpower describes various future scenarios to 2050, identifies risks and opportunities for a series possible scenario including an identified base case scenario. Through the scenario analysis and in the report, Transpower charts a way forward toward decarbonisation and electrification that recognises New Zealand's unique energy systems, market and industry behaviour.

Six monthly monitoring of various market and industry indicators against the base case in the Whakamana i Te Mauri Hiko report is reported on to gauge movement against various scenarios and demonstrate whether Transpower is on target with its assumed 'accelerated electrification' base case scenario.

Transpower's strategic priorities are listed in the Transmission Tomorrow report (2023), which describes the overarching business direction containing five strategic priorities and six performance measures.

The five strategic priorities are:

– Evolve service to meet customers' needs.
– Play an active role in enabling NZ's energy future.
– Sustain social licence to operate.
– Match infrastructure to need over time.
– Accelerate organisational effectiveness.

The six performance measures are a mix of forward and current indicators, providing Transpower with future targets and also historical performance result. The six performance measures are:

– People
– Customers
– Relationships
– Safety
– Sustainability
– Financials

Transpower measure and track each of these performance measures each month and report on them in its annual report.

Transpower's Grid Asset Management Policy describes its commitment, as the owner and operator of the national electricity transmission grid, to applying good asset management practice to manage the grid. The policy guides the development of Transpower's asset management strategies/objectives and seeks to promote continual improvement in how its assets are managed. The asset management policy describes Transpower's intent to provide safe, reliable and cost-effective electricity transmission services for benefit of its customers. To achieve this, the policy specifies the following:

– Alignment of Transpower asset management activities with strategic priorities detailed in Transmission Tomorrow.
– Compliance with all relevant laws and regulations.
– The need to consult with customers and stakeholders.
– Application of GEIP to its asset management activities.
– Assigning resources to deliver on its obligations.
– Ensuring staff are trained, competent and demonstrate commitment to and understanding of asset management.
– Network assets delivery the expected performance.
– Continually improve the asset management systems.

Transpower's ICT strategy is to support its business to accelerate its organisational effectiveness by addressing key business drivers. Transpower's ICT assets include the software and hardware necessary to operate the grid and support its corporate functions. The ICT strategic objective is to adapt and respond to changes in Transpower's business requirements by using new and emerging technologies. Transpower's ICT capabilities exists to support the business. It does this by identifying the areas of business drivers and defining how the ICT capabilities supports them by establishing the following five strategic ICT objectives:

– Enable a digital Transpower.
– Enable data-driven insights.
– Adopt new ways of working.
– Drive cybersecurity by design.
– Maintain and modernise services.

3.2.2 Grid asset management strategy and systems

Transpower's asset management system for grid assets is described collectively by the Strategic Asset Management Plan, and Transpower's Asset Management Framework that applies to grid assets.

Transpower's grid Strategic Asset Management Plan sets out its asset management approach in a hierarchical structure that links the Transmission Tomorrow performance measures and strategic priorities to individual asset class strategies and/or asset management system support services and core asset management activities. It describes the challenge, strategic goals, plan and objectives for each performance measures. In this way, the asset management system for grid assets enables Transpower to coordinate its activity so that it can fulfil its asset management performance objectives and ultimately the strategic priorities, including those set out in the Transmission Tomorrow report.

Transpower's various grid asset management framework documents also contribute to the delivery of Transpower's strategic priorities. The grid asset management framework includes asset class strategies, health models, a criticality framework, and a decision framework. Importantly, these processes inform the annual Integrated Transmission Plan that forecast Transpower's expenditure profile for various asset portfolios.

The Integrated Transmission Plan is supported by the following documents:

– Annual Asset Management Plan that outlines the forward-looking R&R capex profile for various asset portfolio and the opex profile
– Annual Transmission Planning Report that outlines the forward-looking E&D capex profile to relieve various upcoming network constraints.

The Integrated Transmission Plan is complemented by the annual Grid Output Report that is a backward-looking report on Transpower's performance to date. In the Grid Output Report, Transpower describes its service framework, which consists of nine service measures including service measures intended to drive cost and quality of transmission services for end-consumes. While the Integrated Transmission Plan outlines the required inputs (investments) to the business, the Grid Output Report outlines the expected output (services) from the business.

The underlying processes, tools, models, data and assumptions are evaluated separately within the respective expenditure categories and asset portfolios within them in Sections 9, 14 and 15 of this report.

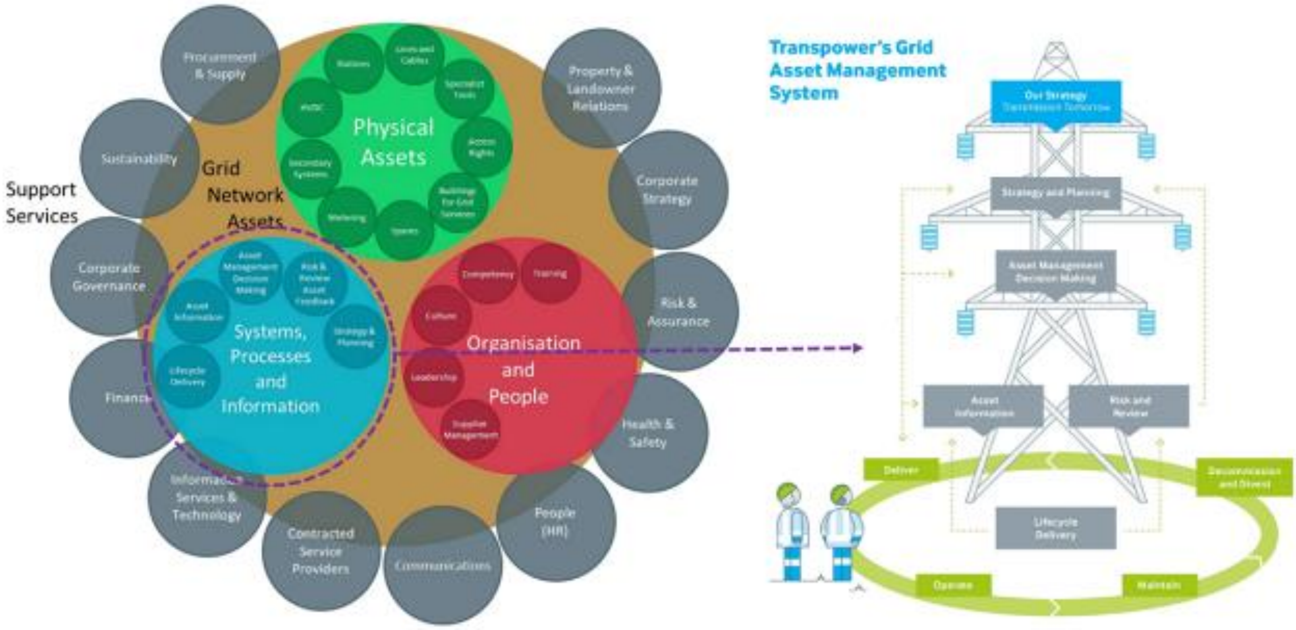
Grid asset management framework

Transpower's assets, at a high level, consists of physical electricity network assets, systems, processes, information and people. This ecosystem along with the supporting services and their respective systems is illustrated in the left-hand side of the following figure. Transpower's systems, processes and information (collectively its asset management system) is unpacked and illustrated on the righthand side of the figure that shows various elements of its grid asset management system and how it is informed or directed by strategic priorities in Transmission Tomorrow.

Transpower's grid asset management system consists of the following elements:

– Strategy and planning
– Asset management decision making
– Lifecycle delivery
– Risk and review
– Asset information

Figure 3-2 Grid asset management framework



Source: Transpower diagrams, GHD illustration.

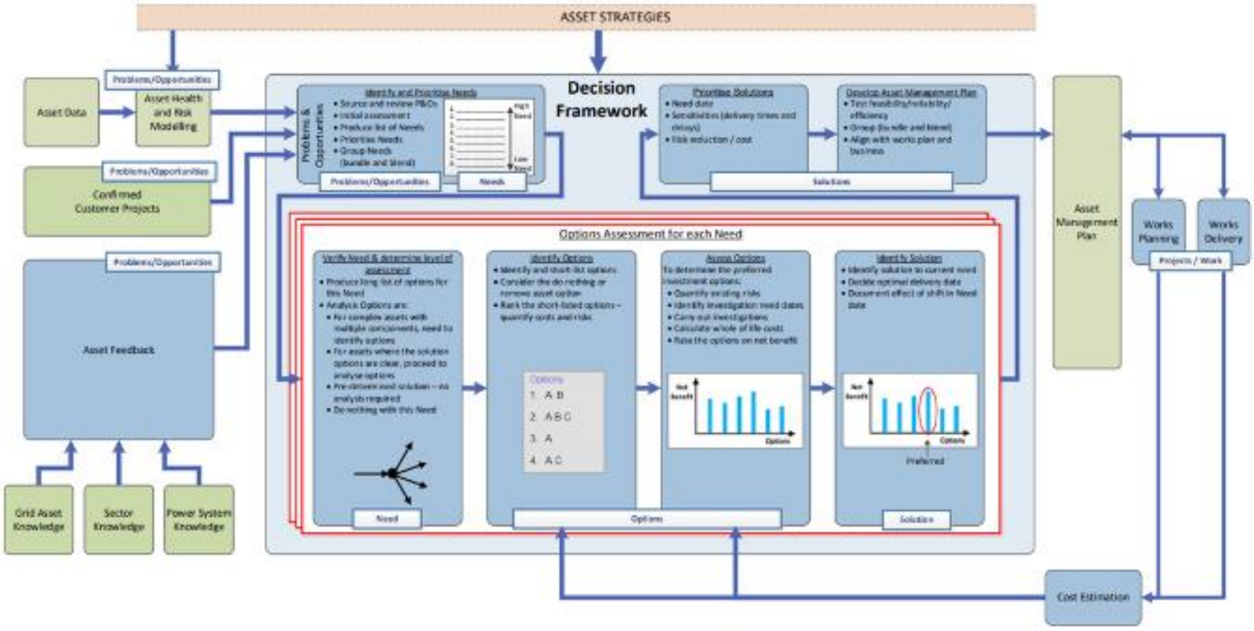
Business functions

Transpower's business functions are generally aligned with the grid asset management system elements (identified above) and reflected in its organisational reporting structure. The business functions for each of these elements is described below:

– **Strategy and planning** - The strategy and planning function aligns Transpower's asset management activities, and outputs from its grid assets, with the Transmission Tomorrow strategic priorities enabling a direct line of sight. This allows them to trace the rationale of day-to-day asset management activities to the Transmission Tomorrow strategic priorities. This function is responsible for asset management policy development, strategy development, demand forecasting, strategic planning and asset management planning.

– **Asset management decision making -** The asset management decision making function considers challenges faced by Transpower and approaches to decision-making throughout the asset lifecycle delivery stages. This function is responsible for capital investment decision making (base R&R capex and base E&D capex), maintenance decision making (opex), life-cycle value realization, resourcing strategy and outage strategy. The asset planning decision framework within this function comprises of the activities illustrated in the following figure.

Figure 3-3 Asset planning decision framework

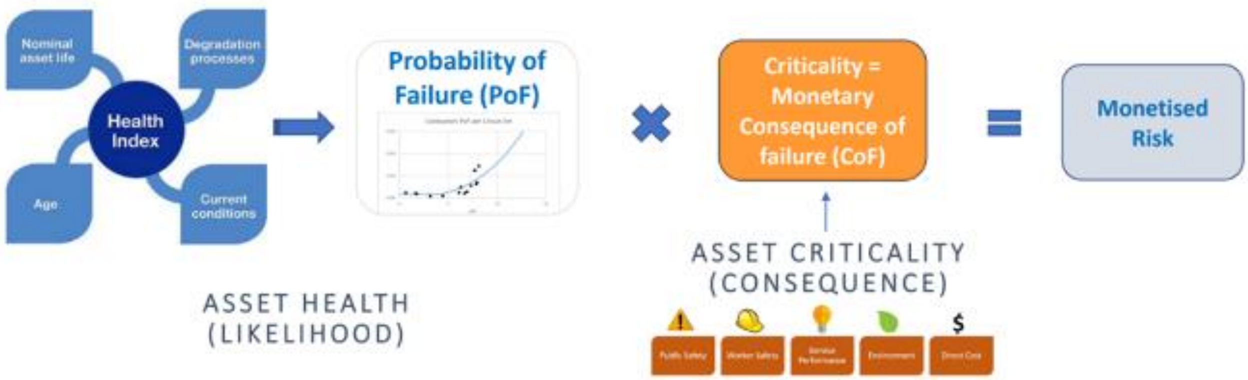


Source: Transpower, AM014 DG 25.04 Key principles of the asset planning decision framework.pdf

– **Asset information -** The asset information function is the key enabler of the grid asset management system and is based on identified and defined information, data and quality requirements. These are both an input to the asset management process, where processes can be used to modify it or created as an output of an asset management process. This function is responsible for maintaining asset information strategy, ensuring asset information standards, managing asset information systems and managing asset data and information.

– **Risk and review -** The risk and review function involves identifying, understanding, and managing risks, establishing effective feedback loops to provide assurance to relevant stakeholders that objectives are met, and to support the continual improvement. This function is responsible for risk assessment and management, contingency planning and resilience analysis, sustainable development, change management, AHNR modelling, asset management system monitoring, management review and assurance, cost estimation and stakeholder engagement. The following figure illustrates the risk assessment using the AHNR model.

Figure 3-4 AHNR model



Source: Transpower, IVP002 RCP4 IV Presentation - Asset Management System and Decision Framework.pdf

The risk assessment using the AHNR model is being practiced by the risk and review function of Transpower's grid asset management system and is an important factor informing the forecast base R&R capex volume and timing. In recent years Transpower has been obliged to undergo a grid asset management system maturity journey, focusing on the AHNR modelling practice, after the Commission served Transpower with 53ZD notice along with the final RCP3 revenue decision in 2019.

Our ToR specifically requires us to take into consideration this progress status achieved by Transpower when evaluating the proposed base expenditure for RCP4. The description and the milestone progress status of this maturity journey including our assessment is provided in Section 3 of this report.

– **Life cycle delivery** - The life cycle delivery function overlooks the entire life cycle stages and is responsible for the following:
  - Maintaining specifications (for design, safety, quality, documentation, engineering and procurement standards), acquire and commission assets, asset capability and configuration management, resource management and reliability engineering within the delivery stage.
  - Planning and management of access to assets, real-time asset operation, outage management and incident management within the operate stage.
  - Deliver maintenance work.
  - Undertake asset decommissioning.

Asset health and network risk modelling

As part of our assessment, we have referred to the GHD Advisory Expert Opinion Progress Review report dated October 2022[8] that documents the review undertaken to assess the progress made by Transpower against its AHNR Roadmap. This roadmap was prepared by Transpower in November 2020 and outlined plan for developing its asset health and risk models, asset life-extension models, and risk-based decision-making frameworks in preparation for Transpower's proposal for its individual price-quality path for RCP4. In summary, this roadmap identified:

– Three broad workstreams consisting of:
  - Asset health modelling across a number of asset classes
  - Impact modelling across a number of asset classes
  - Network risk analysis across a number of asset classes, topics and hazards.

– Asset classes which Transpower planned to further develop asset health models and asset life-extension models in line with the Commission's RCP3 decision.

– The asset and network risk-based decision-making frameworks that Transpower planned to develop.

– Maturity model with maturity level definition, target maturity level and maturity self-assessment by Transpower across.

– Progress milestone timeline.

The maturity model contained in the AHNR Roadmap detailed the maturity levels definition across all three workstreams and was independently developed for the purpose of assessing the progress made by Transpower. This maturity model is reproduced in the following table for ready reference as the remainder of this IV report will refer to this AHNR maturity level attained by Transpower in October 2022.

[8] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

Table 3-3 Asset health and network risk maturity model

AHNR maturity dimensions and workstreams	Maturity level			
	Level 1	**Level 2**	**Level 3**	**Level 4**
Asset health modelling [multiple asset classes]	**Age** Asset Health is projected based on age with adjustments made based on condition assessment by expert opinion.	**Condition** Asset Health is projected using modifiers based on expert generated asset class life analysis assessment.	**Multi-factor characteristics** Asset Health is projected using consistent frameworks and factors across asset classes.	**Multi-factor optimised characteristics** Asset Health is projected using multiple characteristics at an asset system level and is continually improved.
Impact modelling [multiple asset classes]	**Expert opinion** Consequence is determined in an ad-hoc qualitative way, using the corporate risk matrix as a guide.	**Cost to replace** Consequence is quantified to reflect financial impact to the economy from loss of service and direct costs to replace.	**Internal business impacts** Consequence quantified using a structured/repeatable framework with weighted economic impact for service and all internal business consequence.	**Holistic impacts** Consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
Network risk analysis [multiple asset classes, topics and hazards]	**Business rules** Asset investment is supported using network and asset class objectives (e.g., Reliability, Capacity, Safety), to identify if relative risk is increasing or decreasing. Decisions are based on expert opinion and qualitative assessments.	**Asset centric** Asset investment is informed and supported by summation of asset health risk from an agreed set of asset classes. It excludes wide area and long duration outages, natural hazards, cascade failures and future risks.	**Network interdependencies** Asset investment is informed and supported by summation of asset health and capability risks and opportunities at both asset and network levels. This includes wide area and long duration outages, natural hazards, cascade failures and future risks.	**System of systems** Asset investment is informed and supported by an integrated understanding of asset system, network, and wider societal risks and opportunities arising from our network and other contributors. Considers multiple internal and external factors including customer centric engagement on risk acceptability.

Both the GHD Advisory's Expert Opinion Progress Review report[9] and the AHNR Roadmap were prepared in response to 53ZD notice issued by the Commission in December 2019.

The Expert Opinion Progress Review report contained findings against the following:

– Transpower's progress against the targeted maturity positions outlined in the AHNR Roadmap (and using the maturity model, as shown above, as the assessment criteria) for asset health modelling, impact modelling, and network risk analysis workstreams. Transpower's progress was assessed for each workstream and across each asset classes, topics and hazards where maturity progress was targeted in the AHNR Roadmap.

– Transpower's practice was assessed for each workstream and across each asset classes, topics and hazards against the GEIP using the definition set in Part 1 of the Electricity Industry Participation Code 2010.

– Transpower's ability to use the developed asset health and impact models, criticality framework, network risk analysis and risk-based decision-making framework to inform and support its base capex need for RCP4 submission.

The Expert Opinion Progress Review report found that at an overall level Transpower's asset management system to be in a mature state that was well developed, governed, and practiced in achieving its business objectives. Progressing against the AHNR Roadmap plan assisted Transpower in strengthening various crucial elements of its asset management system.

[9] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

The Expert Opinion Progress Review report found that in general Transpower has progressed well and met most of the targeted maturity position outlined in its AHNR Roadmap except in two instances where Transpower could not demonstrate achieving the targeted maturity position. These pertained to the asset health models of two asset classes, namely revenue meters and substation management system, not meeting the targeted maturity position in the AHNR Roadmap. However, the observed maturity position was deemed reasonable given the nature of these two asset classes which does not easily lend itself to condition driven R&R intervention and have other more influential driver for R&R intervention decisions. Hence no improvement recommendation was made for these two asset classes health model.

The Expert Opinion Progress Review report also found that in general Transpower's existing asset management practices after considering the recent development in asset health modelling, impact modelling, criticality and risk-based decision-making frameworks demonstrated GEIP. When considering the entire range of asset management practices comprising of various elements, processes, tools and decisions holistically, it did not identify any evidence of Transpower not meeting GEIP. However, when individual elements, processes and tools of asset management practices were assessed in isolation without any regard to the entire asset management ecosystem, it found a total of 12 asset classes, topics and hazards across the three workstreams where Transpower could further improve its practice to with GEIP. These were identified across the following:

- Asset health models for reactors, capacitor (including filters), indoor switchgear, wall and roof bushings, and substation structures (5 asset classes in asset health modelling workstream).
- Impact models for reactor, converter transformers, wall and roof bushings, LV AC distribution systems, substation structures and building roofs (6 asset classes in impact modelling workstream).
- Network risk analysis pertaining to resilience criteria (1 topic in network risk analysis workstream).

Finally, the expert opinion report did not identify any gaps relating to Transpower's ability to use the developed asset health models, impact models, criticality framework and network risk-based decision-making framework to inform and support its base capex need for RCP4 submission.

We have been cognisant of these findings contained the GHD Advisory Expert Opinion Progress Review report[10] and have noted any change of status in the element of Transpower's grid asset management system since October 2022. In accordance with the ToR, we have leveraged the findings from the Expert Opinion Progress Review report when evaluating the proposed base R&R capex across the asset portfolios and have noted this at respective Sections of this IV report.

We note that while the AHNR modelling is an important indicator for R&R intervention expenditure and timing decision, it is not the only input to the decision. Depending on the nature of the asset portfolios and classes, other considerations such availability of market support, commercial contracts, synergy and optimisation of delivery program, workforce capability, compliance requirements etc. are also factored into such a decision. We have explained this individually within the relevant Sections and in the relevant expenditure categories and asset portfolios in this IV report.

[10] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

3.2.3 ICT asset management strategy and systems

This Section provides an overview of the strategy and processes in place to develop an ICT asset portfolio.

ICT strategy

Transpower's ICT strategy is set out in the ICT Strategy: Transpower's ICT Direction 2021 – 2030 document. The strategy is underpinned by three core principles:

- To use data and digital technology to accelerate organisational effectiveness.
- To enable the future workforce and services.
- To evolve ICT capability while maintaining reliable and secure services.

The ICT strategy supports the wider business by addressing key business drivers. The ICT strategy sets out six business drivers that its design is intended to address. These are summarised in the following table.

Table 3-4 Transpower business drivers

Business drivers	**Strengthen customer collaboration**	**Optimise asset decisions**	**Improve end-to-end grid works**	**Enable adaptive & proactive operations**	**Enable the future workforce**	**Asset industry and technology trends**
	Improve customer engagement across all aspects of connections, operation and investment through digital enablement.	Use data and analytics investments to do the right work efficiently by having access to accurate network asset information.	Improve identification and scheduling of work and how staff operate as a fully mobilized, digitally connected workforce.	Effectively integrate distributed and intermittent generation using more adaptive and proactive operations	Leverage opportunities created by advances in cloud services, automation, digital collaboration and comms. to enable the future workforce.	Cognisant of and application of data and digital technologies, to fundamentally change and improve how Transpower operates.

Source: Transpower IST IV Overview; 08-March-2023, page 3

To address these business drivers, five strategic ICT objectives have been established by Transpower. The strategic objectives are designed to ensure future investment in ICT focusses on addressing the business drivers. The ICT strategic objectives are summarised in the table below.

Table 3-5 Summary of ICT strategic objectives

ICT strategic objectives	**Enable a digital Transpower**	**Enable data driven insights**	**Adopt new ways of working**	**Drive cybersecurity by design**	**Maintain and modernise services**
	Experiment with disruptive technology to determine value. Where proven, adopt new value adding technology to advance business capabilities in strategic focus areas.	Use data and analytics for proactive business decision-making to improve asset management and network risk decisions. Use insights to deliver grid works efficiently and manage the grid of the future.	Adopt lean, agile and value driven approaches to improve and optimise the delivery of services to our internal customers and reduce service delivery timeframes and improve service quality.	Design and manage services for security. Enhance cybersecurity practices for mobile and cloud services and integrate security analytics into cybersecurity function.	Maintain and modernise reliable and resilience systems while delivering better customer engagement and experience. Deliver regulatory and compliance mandated investments.

Source: Transpower IST IV Overview; 08-March-2023, page 3

To deliver on its strategic objectives, Transpower has developed 19 ICT specific sub-strategies. These sub-strategies are summarised in the table below.

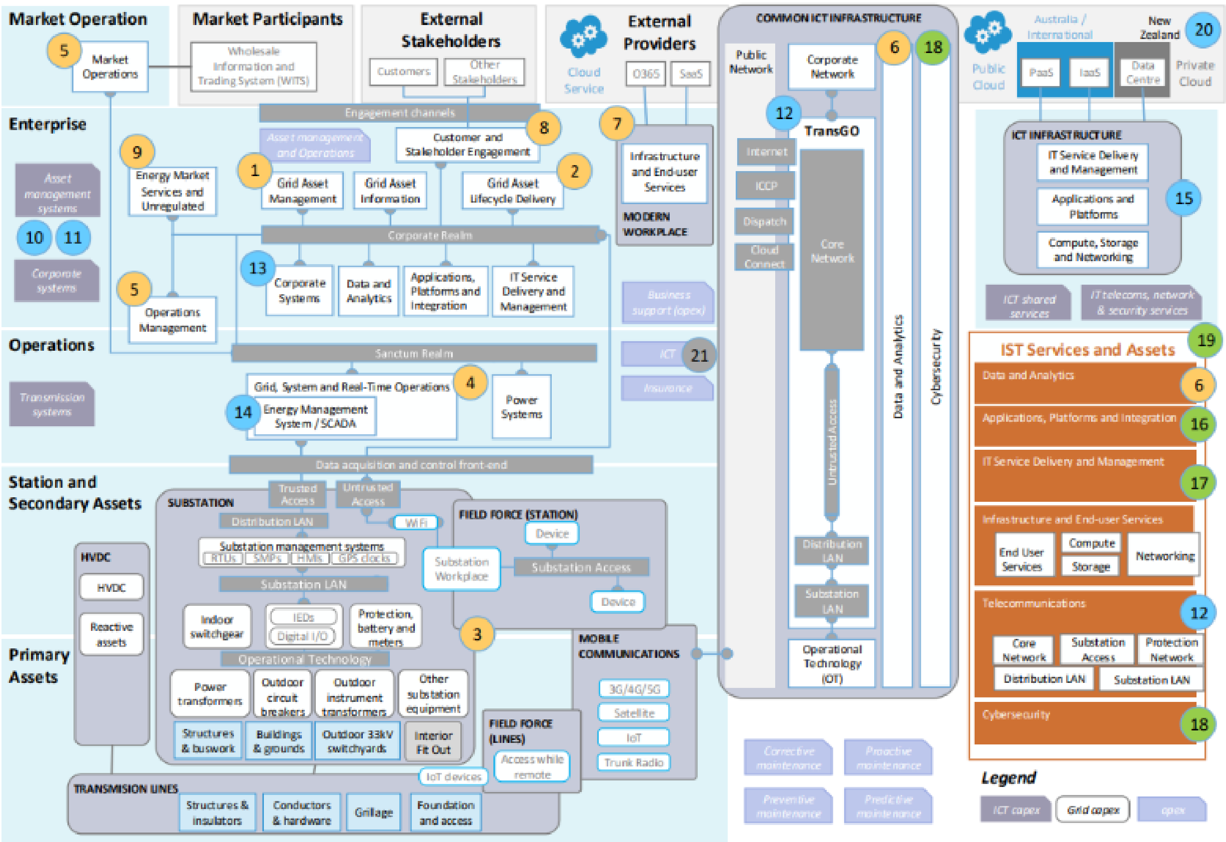
Table 3-6 ICT sub-strategies

Ref	Sub-strategy	Description
1	Asset management and Network Risk Systems	Consolidate asset information supporting grid network investment and risk assessment.
2	End to End Planning Systems	Provide a future view of end-to-end systems architecture aligned to end to end planning.
3	Field Force Management and Mobility	Decide approach to mobility platforms and how to publish asset condition data from various sources.
4	Transmission Systems (including network modelling and data acquisition)	Determine system strategy for the real time systems domain, for the ecosystem that includes SCADA, PI, network modelling and data acquisition.
5	Market Systems & EA/SOSPA	Support the System Operator Service Strategic Plan and initiatives by anticipating future technology needs.
6	Data and Analytics	Build an intelligent ecosystem for targeting value through data-driven decision making.
7	Digital Workplace	Continue to embed digital technologies into business to create a more efficient and productive organisation.
8	Customer Engagement Systems	Support customer strategy and determine how to enhance customer engagement systems.
9	Non-Regulated Business (EMS)	Support non-regulated business with a common understanding of future technology needs and how common ICT services and infrastructure can be leveraged.
10	Transmission Pricing	Implement the Transmission Pricing Methodology and pricing transmission services.
11	Compliance Obligations	Maintain compliance with other legislative and regulatory requirements.
12	Telecommunications (TransGo)	Determine the future needs in terms of services, capacity and capability for the TransGo network.
13	Enterprise Business Capability	Assess how the ecosystem of enterprise business capability systems including FMIS can be rationalised.
14	Energy Management Systems and SCADA	Improved power system analysis tools to manage in real time a more complex and constrained power system and the stability of new connections. Determine if business will continue with or change SCADA.
15	IT Infrastructure	Set the future direction for cloud, data centre, virtualisation, compute, storage, networking and associated services relating to management and operations to modernise ICT Infrastructure.
16	Applications, Platforms and Integration	Seek to rationalise and consolidate platforms and move to as-a-service models where appropriate.
17	IT Service Delivery & Management	Evolve service delivery and adopt lean, agile and value driven approaches to improve and optimise the delivery of services to internal customers.
18	Cybersecurity	Enhance cybersecurity practices for mobile and cloud services and understand how business can leverage advances in analytics as applied to cybersecurity.
19	ICT Recurrent and Lifecycle	Includes all recurrent spend to maintain services. The relevant investment case driven by policy. No sub-strategies required but approach to be defined.

Source: ICT Strategy Transpower's ICT Direction 2021 – 2030, page 18-19.

Each sub-strategy has been mapped onto the Transpower ICT landscape, as shown in the figure below.

Figure 3-5 Alignment of ICT sub-strategies to ICT landscape



Source: Transpower, ICT029 ICT Strategy.pdf

Table 3-7 Alignment of ICT sub-strategies and business drivers

Business driver	ICT sub-strategy
Strengthen customer collaboration	Customer engagement Digital workplace Data & analytics
Optimise asset decisions	Digital workplace Data & analytics Asset management and network risk systems TransGo
Improve end-to-end grid works	Digital workplace Data & analytics End to end planning systems Field works management and mobility
Enable adaptive & proactive operations	Energy management systems and SCADA Data & analytics Real time systems Outage and switching systems Market systems and EA/SOSPA
Enable the future workforce	Enterprise business capability Customer engagement Digital workplace Data & analytics TransGo

Source: Transpower, ICT029 ICT Strategy.pdf

The ICT sub-strategies are aligned to the defined business and ICT strategy and outcomes and are key to developing investment cases, as part of the long-term planning process, by identifying investments required in the forecast period. The ICT Sub-strategy Planning Approach sets out further details regarding how the sub-strategies are developed and the deliverables arising from them.

The ICT strategy summarised above is delivered under the overarching ICT investment framework.

ICT investment framework

The management of ICT assets and the need for ICT expenditure is underpinned by Transpower's ICT investment framework. The ICT Investment Framework describes Transpower's process for making ICT related investment decisions involving the allocation and management of financial capital to deliver specific and measurable business outcomes that achieve corporate objectives.

The aim of the framework and supporting systems is to:

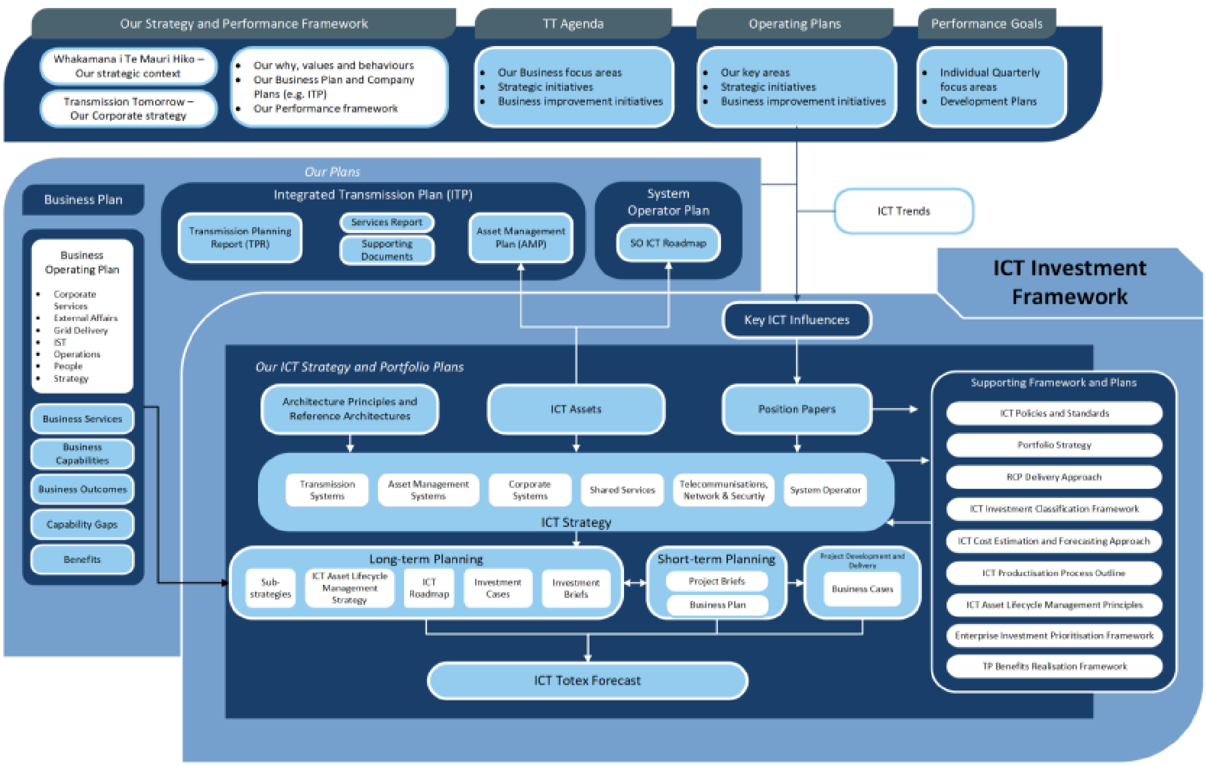
- Enable sufficient flexibility to adjust the ICT investment pathway as technologies and organisational needs change
- Providing confidence to internal and external stakeholders that investment decisions are made prudently and in line with regulatory obligations.

The framework is applicable to Transpower investments that are fully funded by the Commission or partly funded with the Electricity Authority (EA) under SOSPA. It is also a key component of Transpower's broader IST Operating Model and guides how Transpower converts its strategic objectives and priorities into a long-term plan which is subsequently used inform the annual business planning process.

Transpower has undertaken an assessment of how the framework meets its regulatory requirements and Good Electricity Industry Practice (GEIP) guidelines[11]. Transpower has recently been working to implement this across the asset base.

The framework is shown in the following figure.

Figure 3-6 Transpower ICT investment framework



Source: Transpower, ICT001 ICT Investment Framework V0.3_Final_endorsed.pdf

[11] Transpower, ICT Investment Framework Report, February 2023, Appendix 2: Regulatory Context and Evaluation.

Investment planning

Transpower has revised the ICT investment process following the RCP3 submission. The revisions include implementing a long-term investment plan, detailing top-down challenges to the long-term forecasts and revising the classification of the investment types and categories. This has also been supported with the creation of auditable trails of evidence for key investment decisions.

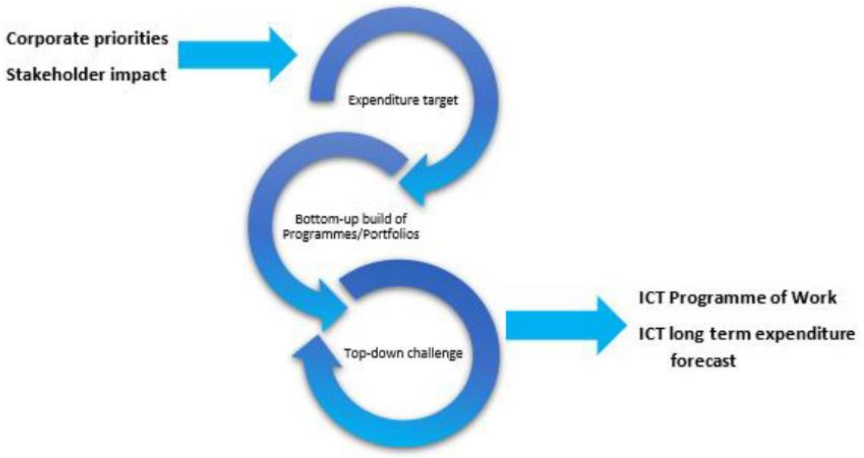
The investment planning period is divided into two:

– A long term 10-year plan and
– A short term 2-year plan.

The **long-term plan** is an ongoing process of updating the rolling plan based on recent investments and the most up-to-date intelligence as those projects are delivered. This also includes information on recent innovation and development that can impact the long-term ICT strategies.

The process is shown in the following figure.

Figure 3-7 ICT long term expenditure forecast development process



Source: Transpower, ICT001 Investment Framework V0_3_Final_endorsed.pdf

The long-term forecast commences with establishing an expenditure target, typically set by considering trend analysis and the overall corporate priorities. It is worth noting that the corporate priorities are driven by the impact on customers in that the expenditure target is linked back to providing customer services.

The long-term planning collateral produced includes:

– ICT sub-strategies - as set out above.
– ICT Asset Lifecycle Management Strategies - focus on ensuring Transpower proactively maintains ICT assets by upgrading them to remain supported and fit-for-purpose.
– Investment Cases - sub-strategies are consolidated based on the common theme into investment cases. Investment cases provide a challenge of prudency and efficiency of proposed expenditure identified by the sub-strategies and focus on the assessment of investment options available, specifically the analysis of costs and benefits for each option.
– Investment Briefs - captures information specific to an investment (usually a series of projects) required over the 10-year forecast period. It covers the scope of the investment and the outcomes it is trying to achieve. It is an input to short-term planning to inform project prioritisation, further estimation, and scheduling.

Through governance sessions and a variety of tools, the forecast and long-term plan is reviewed for prudence, cost efficiency, defensible and that it is deliverable plan.

Short-term planning is an annual process which aims to create and update a rolling-two-year plan of ICT investments that have been identified in the long-term plan. The short term planning process is designed to ensure planning of investments and investigations are undertaken at a project level and that there is strategic alignment between short-term and long-term priorities.

The key input to the short-term planning process are project briefs. Delivery teams review the investment briefs created in the long-term planning stage and establish a number of project briefs to optimise their delivery by separating investments into phases or combining multiple investment activities into single delivery projects.

There is a feedback mechanism from the short-term planning and project delivery back to the long-term plan, so that as relevant data is received, this can influence the long-term plans.

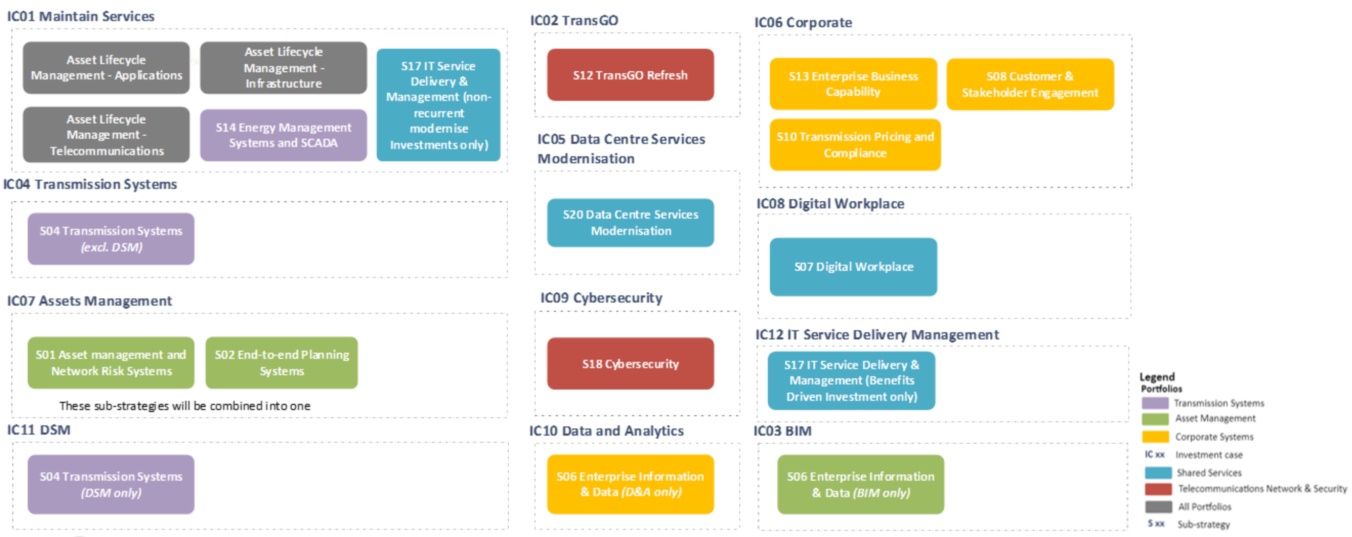
RCP4 investment plan

As per the long-term planning framework and ICT strategy outlined above, Transpower has shared twelve investment cases that make-up the ICT capex investment requirement across RCP3 and RCP4. These investment cases also include forecasts of new (additional) ICT related operating costs.

Eleven of these investment cases are associated with modernising Transpower's ICT infrastructure and are specific, one-off programmes which deliver a specific technical solution that will become business-as-usual going forward. A further investment case has also been developed to maintain a consistent level of service for Transpower by regularly replacing and repairing those ICT assets which are currently in service (such as computers, monitors, routers etc).

Each of the twelve investment cases have been mapped to the ICT sub-strategies to ensure investments are aligned to its strategic priorities. The mapping of the investment cases to the ICT sub-strategies is shown in the figure below. In most cases the investment case meets a single sub-strategy. However, there are a number of investment cases that encompass more than one ICT sub-strategy.

Figure 3-8 ICT sub-strategy themes and investment cases (RCP3 and RCP4)



Source: Transpower, IVP006 RCP4 IV ICT - Overview.pdf

The following figure shows how the investment case sets out both capex and opex within the context of the RCP4 expenditure requirement proposed by Transpower.

Figure 3-9 ICT expenditure development for RCP4

Source: GHD

3.3 Evaluation

3.3.1 Strategic context, priorities and policy

The Whakamana i Te Mauri Hiko is a scenario-based approach to consider what the future may look like, and the actions required now to get Transpower into that future. This then provides an organisational wide strategic context and give general direction to the remainder of Transpower's strategies, priorities and policies.

To understand the relevancy and appropriateness of the strategic context and the base case future scenario adopted by Transpower, we reviewed the most recent copy of six monthly monitoring report against the Whakamana i Te Mauri Hiko. It showed various market and industry movements and Transpower's progress or status against the selected base case scenario of 'accelerated electrification'.

We found the monitoring report thorough and objective providing detail comparison of industry indicators or themes (such utility scale renewable generation, emission reduction, process heat decarbonisation, electric vehicles, distributed energy resources, electricity affordability etc.) and Transpower expectation or status against them. This pulse check of Transpower strategic context and general direction towards the future scenario provides a reality check and regular feedback loop to gain external perspective. This monitoring report concludes that Transpower adoption of the 'accelerated electrification' base case scenario is relevant, and the chosen strategic direction is appropriate.

To further verify Transpower's approach, we compared the 'accelerated electrification' base case scenario against the latest 2022 Integrated System Plan (ISP) prepared by the Australian Energy Market Operator (AEMO) and the adopted 'step change' scenario in it. The 2022 ISP observed that the momentum towards the decarbonisation of Australia's National Electricity Market (NEM) has accelerated in recent years indicating their confidence with the adopted base case scenario. The adopted base case scenarios in both Whakamana i Te Mauri Hiko and the 2022 ISP are of similar nature accounting for the difference between the characteristics of New Zealand and Australian energy markets. This comparison further suggests a relevant and appropriate strategic context and direction chosen by Transpower. This provides a good basis for establishing relevant organisational strategies, priorities and policies to operate the business.

We reviewed Transpower's strategic context, its focus on performance areas, its asset management policy, future workforce and digital journey priorities contained in various corporate documents. The set of these strategic documents indicates clear alignment with the five strategic priorities and six performance measures identified in the Transmission Tomorrow report.

Review of these strategic documents covering both the grid strategy and ICT strategy that details the functions, processes, asset lifecycle decisions and other management frameworks indicates general alignment with the fundamentals of ISO 55000[12] and ISO31000[13] principles. Additionally, we also reviewed various documents pertaining to both grid strategy and ICT strategy separately in base capex and opex sections of this report to evaluate the relevant expenditure category and asset portfolios within them. We referred to the evaluation undertaken in those sections to arrive at our conclusion with respect to Transpower's strategy, priorities and policy.

Our review indicates that Transpower's organisational strategies, priorities, policies and the supporting processes demonstrate good asset management practices and a risk-based expenditure planning approach to achieve prudent outcome.

Further, we also noted that all Transpower employees are given their individual annual performance KPIs that are aligned to the six performance measures contained in the Transmission Tomorrow report. The employee performance KPIs are reviewed on a quarterly basis. This allows Transpower's overarching business direction to be embedded within individual staff performance metric. We consider this to provide a line of sight between the organisational strategic priorities and individual success measures allowing alignment of intent and actual practice.

[12] ISO 55000:214 Asset Management Framework
[13] ISO 31000 Risk Management Guidelines

3.3.2 Grid asset management strategy and systems

We reviewed various documents that described Transpower's grid asset management system, supporting strategies, management plans and frameworks that supports the intent of its asset management policy to provide safe, reliable, and cost-effective electricity transmission services for benefit of its customers. Transpower's grid asset management system is well placed to inform, develop and support its proposed expenditure, service measures, deliverability, and stakeholder engagement aspects of their RCP4 submission. In our opinion it reflects GEIP. In stating this, we observed the following characteristics of its Strategic Asset Management Plan and asset management system framework.

The objectives, approaches, functions and activities of the grid asset management system are detailed in grid Strategic Asset Management Plan and asset management framework documents, and they cascade down to various elements of Transpower's grid asset management system. The supporting asset management strategies (e.g., asset class strategy), models (e.g., AHNR model), processes (e.g., solution prioritisation) and frameworks (e.g., investment decision) have strong and visible alignment with the strategic intent.

We found that Transpower business objectives are aligned or cascades down to the asset management framework documents and elements. For example, the asset class objectives outlined within each asset class strategy are aligned with the Transmission Tomorrow strategic priorities. The asset class strategy describes the approaches required to meet those objectives (and challenges). Each asset class strategy describes Transpower's asset management strategy and planning, decision making, asset information, risk and review, and lifecycle delivery approach for that asset area. Such descriptions consistently refer to an associated asset health model, impact analysis model and investment decision framework. These alignments provide the 'line-of-sight' in various levels and elements of Transpower's grid asset management system.

We also evaluated the underlying processes, tools, models, data and assumptions separately within the respective expenditure categories and asset portfolios within them in base capex and opex sections of this report. The outcome of those evaluations also supports the above conclusion.

The development of Transpower's asset health and risk models, asset life-extension models, and risk-based decision-making frameworks against the AHNR Roadmap and in response to the Commission's 53ZD notice has enabled Transpower to have an advance visibility of their asset condition. This information can then be considered together with impact analysis to appreciate the criticality of failures or non-functional or under-performance of such assets. This asset status view can be aggregated to have a class or portfolio or network wide views. It has provided Transpower with the ability to project annual monetised risk values for different scenarios and level of expenditure interventions. This gives Transpower's management team timely insights and allows them to make better informed R&R intervention (replacement or refurbishment) and deferral decision compared to previous RCPs.

Stating the above, we understand that the modelling and analysis on some asset classes, topics and hazards are in more mature state and provide better asset management decision making insight than the others. We understand the quality of output information from these workstreams that influence the expenditure decision is dependent on the quality of input information and assumptions used. We encourage the reader of this report to familiarise themselves with the findings from the GHD Advisory Expert Opinion Progress Review report from October 2022[14] where each of these qualifications are documented in detail.

The 12 asset classes, topics and hazards across the three workstreams identified as not aligned to GEIP, its limitation and impact to expenditure decision, and the functioning of other grid asset management system processes to identify and counter those limitations are noted in our evaluation for the respective expenditure categories and asset portfolios. We have described them individually within the relevant Sections and in the relevant expenditure categories and asset portfolio in this IV report.

3.3.3 ICT asset management strategy and systems

We reviewed the various documents that describe how Transpower build up their ICT investment plan from their initial framing of the strategic objectives through to the final investment cases. Whilst Transpower's ICT investment plan initially appears complex (as there is a desire to align the investment plan with past expenditure pathways),

[14] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

Transpower do provide the necessary explanations and pathways that allow alignment with historical expenditure and how that will develop and support its future expenditure in the RCP4 submission.

In our opinion the ICT investment stages reflect GEIP for the following reasons:

– The ICT strategies align with the overall business objectives and provides a significant level of detail within the Framework to establish the connection.
– The strategies cascade down into sub-strategies which allows for these to be built into investment cases.
– Transpower have, which is also a reflection of GEIP, developed a long-term plan and a short-term plan, which interact and are adjusted as time progresses, technology adapts and the requirements of the business change. It is not expected that a ten-year plan will be fixed.

The underlying models, tools and assumptions used to build up the ICT investment portfolio, is reviewed in more details in in Sections 11 and 16 of this report. The outcome of those evaluations also supports the above conclusion.

3.4 Conclusion

Based on our evaluation, we consider that Transpower's strategic context, priorities and policy approaches as well as its grid and ICT asset management systems are consistent with GEIP. The application of the strategies and priorities, guided by asset management frameworks and practice meets all the relevant evaluation criteria.

The following tables describes our verification of Transpower's strategic context, priorities and policy and the grid and ICT asset management strategy and systems against the evaluation criteria. In reaching these positions, we considered that the context setting, priorities, and policy adopted by Transpower and their application and practice with respect to proposing expenditure budget for RCP4 meets all the relevant evaluation criteria.

Table 3-8 Strategy development and implementation conclusion

ToR Clause	Evaluation criteria	Meets criteria	Comment
4.2, 4.3	Policies and governance processes are consistent with good asset management practice, have been effectively implemented, and are directed towards achieving efficient and prudent expenditure outcome	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(b)	Weather policy regarding the need for, and prioritisation of, projects and programme demonstrate a risk-based approach consistent with good asset management practice and are directed towards achieving cost-effective and efficient solutions	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.

4. Cost estimation

Our evaluation of the following three cost estimation topics that dictates Transpower's forecast expenditure for RCP4 against the ToR is presented in this section as following:

– Cost estimation framework
– Cost escalation forecast
– Productivity forecast

The following sub-section describes the relevant ToR evaluation criteria and method, followed by our assessment of each of the three cost estimation topics.

4.1 Evaluation approach

The following table outlines the applicable evaluation criteria stipulated in the ToR to assess various cost estimation topics that informs the Transpower's RCP4 expenditure forecast. The evaluation method outlines our general approach in assessing the element of these topics against the stipulated criteria.

Table 4-1 Evaluation criteria and approach: Cost estimation

ToR clause	Evaluation criteria	Evaluation method
3.2	Whether Transpower's RCP4 proposed base capex, opex and key assumptions are consistent with expenditure which represents the efficient costs reflecting GEIP.	– Review the build-up of the forecast expenditure incorporate efficient cost estimate variables, i.e., the unit rate estimates are efficient/competitive or comparable against similarly described building block asset/work. – Review the build-up of the forecast expenditure incorporate efficient cost estimate variables, i.e., the quantities and types of asset components used to describe the building block assets are reasonable or comparable against similarly described building block asset/work. – Review the inputs, methods and impact of the cost escalation forecast and productivity forecast modelling as per the below checks.
A1(a)	Whether key assumptions are reasonable including: (i) the method & information used to develop them;	– Review the draft NZIER report titled 'Cost escalation forecasts: Frameworks, forecasts, and forecast methods' dated October 2022 to understand the cost escalation model inputs and assumptions. – Review the draft (dated July 2022) and final (dated July 2023) NZIER's report titled 'Opex productivity: Estimating a challenging but achievable target' to understand the productivity model inputs and assumptions. – Corroborate the information gained during the interviews with the inputs, assumption and method used detailed in TEES estimation framework and the above reports.
	(ii) how they were applied;	– Review the draft NZIER report titled 'Cost escalation forecasts: Frameworks, forecasts, and forecast methods' dated October 2022 to understand the application of the cost escalation model. – Review the draft (dated July 2022) and final (dated July 2023) NZIER's report titled 'Opex productivity: Estimating a challenging but achievable target' to understand the application of the productivity model. – Review the response to our request for information to better understand the estimation and forecasting process and model adjustments carried out in practice.
	(iii) their effect on the proposed base capex	– Review to identify volumetric vs customised scope of work within each asset portfolio and its cost estimate build-up for RCP4 forecast and link it back to the TEES (or alternate) sources. – Review the draft NZIER report titled 'Cost escalation forecasts: Frameworks, forecasts, and forecast methods' dated October 2022 to understand the output and its effect to Transpower's RCP4 expenditure forecast. – Review the draft (dated July 2022) and final (dated July 2023) NZIER's report titled 'Opex productivity: Estimating a challenging but achievable target' to understand the output and its effect to Transpower's RCP4 expenditure forecast.

ToR clause	Evaluation criteria	Evaluation method
A1(g)	Reasonableness and adequacy of models used to prepare the proposed expenditure including: (i) inputs to the model; and	– Review the productivity modelling/evaluation approaches adopted previously by the Commission, the AER and the Ofgem for electricity network businesses revenue reset, and compare the approach adopted by Transpower/NZIER. – Review the modelling logic, input parameters, types of input selected and their relevance and appropriateness for productivity and cost escalation forecast.
	(ii) methods used to check reasonableness of forecasts and related expenditure	– Compare the modelling approach to other similar methods adopted by regulated network entities and regulators. – Review the coherence of cost escalation method. – Clauses A1(m) and A1(n) of the Capex IM require Transpower to consider its previous efficiency improvements (i.e., productivity over RCP2 and RCP3), as well as the scope for efficiency improvements during RCP4 when proposing a productivity forecast.
A3(c)	Transpower's process is reasonable and cost effective	– Review the deduced average per project costs planned in RCP3 vs RCP4 (internal benchmarking of forecast costs against currents costs). – Review Transpower's expenditure build-up and check if it is based on a volumetric cost build-using the TEES building block unit rates and the proposed quantities and site-based factors. – Examine the cost estimation activities across the project development lifecycle from pipeline to concept to initiation to plan & design to build-to-commissioning-to-handover & closeout stages (process benchmarking). – Examine the cost accuracy range and the use of estimate at different stages of project development and its refinement as it progresses through various investment decision gates. These were observed from basis of estimate reports and estimate build-up calculation from the investigation and delivery business case stages (process benchmarking).
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	– Examine the use of variable generic allowance (vargen) in the cost estimate build-up and its basis, reason and prevalence in RCP4 (process benchmarking and high level governance and process review). Also review the proportion of project portfolio using vargen between RCP3 and RCP4 (trending or time-series analysis). – Review the building block breakdown to see base costs, service providers overheads, site specific allowance and exceptional extras within the cost estimate and the usage of TEES resource, cost items and assembly hierarchy structures (project and programme sampling). – Review the risk register records of various projects for risk workshop meeting outcomes, such as without and with risk treatment plans, delegation of control measure to responsible managers, and the use of consequence and likelihood values underpinning the risk values (high level governance and process reviews). – Review the TEES building block unit rates and observe changes to them between the RCP3 budgeting time (2017) and RCP4 budgeting time (2023). Focused review on those unit rates with a compounded annual growth rate of ≥10% between RCP3 and RCP4 (trending or time-series analysis). Also benchmarked a few common building block unit rates with alternatively sourced unit rates for similarly scoped building block (unit rate benchmarking). – Reviewed the budget vs actual analysis performed by Transpower management, documentary evidence to support budget re-prioritisation activity, delegated financial authority and escalation process flow, and business case adjustment approval process flow (high level governance and process reviews). – Live demonstration of TEES usage covering various asset portfolio/project types – transmission lines, substation primary and substation secondary. – Review of customised cost estimates within the delivery business case of five E&D re-opener projects and one major capital project from RCP3 that demonstrate capital costing method and formulation, the use of TEES building block unit rates and inclusion of allowance within such project estimates.

4.2 Cost estimation framework

The following table summarises our verification of Transpower's cost estimating framework used to budget a major portion of the RCP4 expenditures.

Table 4-2 Verification summary of Transpower's cost estimation framework

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Reasonable assumptions made	Yes
Reasonable and credible input data selected	Yes
Reasonable tool/software/method adopted	Yes
Is the generated output reasonable	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	None identified
Key issues that the Commission should focus on	None identified

4.2.1 Observations

Transpower has a dedicated cost estimation team that provides cost estimation and cost management support services internally to its asset planning and delivery teams.[15] This team is also the custodian of the Transpower Enterprise Estimating System (TEES), a database tool based on the common industry software Success Estimator platform with estimating functionality and asset build-up and configuration capability.

The cost estimates for most of the grid capex and a selected portfolio of maintenance work delivered as projects is developed by the cost estimation team using the TEES. It does not produce cost estimate for grid opex (predicative corrective, proactive maintenance, AM&O), ICT capex, ICT opex, business support capex and business support opex. The evaluation of the cost estimation process for such expenditure categories are included within the respective categories in Sections 8 and 11 of this report.

Once the grid capex and maintenance work projects are approved, its sanctioned expenditure amount is loaded into Transpower's Oracle Financial Management Information System (FMIS) to track delivery progress and to 'drawdown' approved money against the work.[16] IDC for capex delivery is calculated in the FMIS and the cost escalation (time value of money) is calculated in the TEES.[17] These are added to the capital project cost estimates.

Estimates developed using the TEES are classed as either volumetric or non-volumetric work.

Volumetric works are relatively low value high volume work, with repeatable scope and delivery method and do not usually require detail site investigations. They are based on building block method, i.e., it describes assumed or standardised scope of work that identifies quantities and unit rates of various asset types and activities. The breakdown of these volumetric work has a 1:1 relationship with FMIS records. This is a simple and efficient approach for building budgets for volumetric work where the P50 confidence level is maintained at the portfolio level.

Non-volumetric works are generally high value low volume work, with non-routine scope, site specific delivery method and requires investigation and risk workshop to define risk allowance. They can be based on building block method (usually at the initial stages of project development only and typically using either various generic or 'vargen' placeholder or a combination of building blocks and 'vargen' placeholder) but more likely are based on detailed customised estimation as the project is developed further. Customised estimate involves choosing the most closely matching asset and activity types and quantities in the TEES to describe the project scope based on

[15] Transpower, AM009 Cost Estimation Framework.pdf
[16] Transpower, AM009 Cost Estimation Framework.pdf
[17] Transpower, AM009 Cost Estimation Framework.pdf

investigation report. It also involves determining risk allowance based on risk workshop that follows Transpower's SCORED method. The P50 confidence level is maintained at individual project level.

For RCP4 forecast the predominant approach for cost estimation is the use of building block approach with some specific work programmes and portfolios being developed using the customised estimates.

The master cost library within the TEES is structured in the following fashion:

– Resource – the lowest level of costing information in the cost data hierarchy.
– Cost item – describes a specific item of work and is made up of one or more collection of resources.
– Assembly – describes a building block and is made up of a one or more collection of cost items.

The master cost library is refreshed annually based on completed projects (lesson learnt) and new knowledge as they become available (sourced internally and externally).[18] Cost data within TEES is informed by various sources such as project closeout cost report assigned to building blocks and deliverables, service provider pricing analysis (noting that there is no perfect 1:1 mapping with the TEES building blocks), median contracting data and actual contract outturn costs. In addition to these sources, Transpower also rely on OEM or escalation of historic project cost to formulate bespoke or non-routine cost estimate, for e.g., for HVDC technologies.

4.2.2 Evaluation

We examined various elements of Transpower cost estimation framework, TEES, its usage, associated processes and exclusions used in estimating the expenditures proposed in RCP4 using the evaluation criteria in sub-section 4.1 of this report. Our observations are outlined below.

Accuracy

The class of cost estimate used for RCP4 budgeting purpose is reasonable considering the various types of estimates (building block for volumetric work and customised estimate for non-routine work).

The P50 confidence estimate is aimed at portfolio level for volumetric work and P50 confidence estimate is aimed at individual projects level for non-routine work. As estimates progress through their 'classes' from investigation business case stage (Class 5) to delivery business case stage (Class 3/2) its corresponding accuracy range aligns to AACE International recommended practice notes[19] for this industry.

We reviewed the cost estimation details and their basis during the investigation business case and delivery business case for various major projects from RCP3.[20] We believe this cost estimation process is appropriate and likely to lead to reasonable cost estimates as the project or programme develops in scope during the course of time.

Allowance in unit vs portfolio

Transpower's unit rates formed part of volumetric asset portfolios thereby the comparison also tested the quantum of allowances for site specific activities included within individual asset building block unit rate.

We reviewed the quantum of the included allowances for site specific activities at individual building block level and its impact when viewed across larger volumetric portfolio when aggregated to programme level.[21] The TEES building block unit rates produced reasonable portfolio level volumetric cost estimates that considered the likelihoods of individual project/site/asset/activity expenditure performance to overrun/underrun against the unit rate estimate.

[18] Transpower, RFI012 TP Response.pdf
[19] AACE International, Recommended Practice 96R-18: Cost estimate classification system – As applied in engineering, procurement, and construction for the power transmission line infrastructure industries.
[20] Transpower, RFI012-03 CP_WKM_00L_0_00 CNI NZGP Substations - Build - Investigation Business Case (IBC) estimate.pdf, RFI012-04 CP_WKM_00L_0_00 CNI NZGP Substations - Build - Delivery Business Case (DBC) estimate.pdf, RFI012-01 WIR TEES Report A27 4Feb2019.pdf, RFI012-02 WIR TEES Report A42 1Oct2019.pdf, RFI012-05 CP_WKM_00L_0_00 CNI NZGP Substations-Build (Basis of Estimate).xlsx, RFI012-06 NZGP1 MCP ATTACHMENT E - COSTING REPORT.pdf
[21] Transpower, RFI 012 Cost Estimation Framework.docx

An annual feedback loop enables Transpower to update its TEES information with actual costs as portfolios of work are commissioned and closed off in FMIS thereby informing the allowance level with realised outturns at portfolio level.[22] This helps ensure the database remains relevant.

We consider Transpower's approach to cost estimating including the method for determining allowances for site specific activities reasonable. It's especially appropriate for volumetric asset portfolios as it restricts the individual asset building block unit rates to known cost experience at aggregated programme level instead of selecting specific examples of individual project/site/asset/activity expenditure. The approach thereby avoids overestimating the cost at portfolio level. We note that other electricity network utilities with good cost estimation framework in place also does the same.

Approved versus expected expenditure performance

Transpower regularly analyse approved expenditure versus expected expenditure performance across various asset portfolios and expenditure categories.[23] The following figure is an example of reporting that shows Transpower reporting on this cost performance.[24] In the figure, 'allowance' represents the RCP3 budget approved in 2018 and the 'forecast' represent a combination of actual delivery and Transpower's forecast of the remainder of RCP3 expenditure delivery as of November 2022. We consider this demonstrates a good governance process around expenditure recording and monitoring and note that it allows TEES to be informed by relevant inputs.

Figure 4-1 Allowance vs forecast base R&R capex comparison in RCP3

Source: Transpower, RFI012-13 BPR Pack Oct 2022.pdf

[22] Transpower, RFI012 TP Response.pdf
[23] Transpower, RFI012-14 Fcst vs RCP3 Allowance cost qty analysis May21 fcst (publ Aug21).pdf
[24] Transpower, RFI012-13 BPR Pack Oct 2022.pdf

We found several examples that demonstrate Transpower seeks to understand the drivers for any variations identified:

– Transpower is forecasting to replace lower quantities of substation primary assets but is experiencing higher cost in RCP3. They were able to explain the difference as being due to price escalation and change in site specific scope (for e.g., larger site, additional complexity, additional site enabling work, carried over quantities from RCP2 due to pandemic restrictions etc.).
– In contrast, Transpower is forecasting to replace more quantities of batteries and chargers and is experiencing lower cost in RCP3 due to the need to bring forward a number of battery replacements to align with associated switchgear and substation management systems work and also due to a lack of spares for the legacy chargers.

Analysis of approved versus expected expenditure should be read in the context of the fungibility of the base capex allowance set in each RCP. This approach reflects the real understanding that changes can materialise over time that affect actual expenditure. Example of changes that impact the actual expenditure delivery compared to any allowance set up to eight (8) years prior include:

– Changes in risk profile such as better or worse condition of assets or removal of market support.
– Changes in strategy such as tower to pole strategies and painting of structure approaches.
– Changes in costs driven by scope change and varied price escalation.
– Changes in schedule such as deferrals or accelerations.

Further, expenditure prioritisation affects the mix of actual expenditure delivery. An example of re-prioritisation in RPC3 is that lower quantities in transmission line and substation asset portfolios will be funding the increase costs in substation asset portfolios.[25]

We note that this analysis is limited to asset portfolios within the base R&R capex category where the volumetric deliverables are defined and can be measured. The analysis does not consider bespoke or non-defined and non-quantified deliverables such as HVDC work, warehouse buildings, substation structure and buswork. These bespoke deliverables can also be lumpy by nature. We consider this review tracking the performance of actual work versus allowance in terms of both quantities (where applicable) and unit cost to be appropriate in informing the input data to TEES that will likely lead to current and relevant cost estimates.

Risk treatment

Diversity of skills and perspectives were observed in an example of Transpower's SCORED register (Transpower's project risk register) documenting the content and decision of risk workshop discussions for selected projects.[26] This indicates Transpower has systematic approach to identifying and considering risks in cost estimates.

We also observed the reduction in risk profile (likelihood or/and consequence variables) through use of control measures and delegation to risk owners. We noted that the likelihood variables have remained unchanged since 2017. In the provided project examples, risk allowances were calculated using a deterministic process (chosen consequence value × chosen likelihood value) and not a probabilistic process (simulation run to generate a range of possible risk outcomes and associated probabilities they will occur). We consider this treatment and application of risk into the cost estimate to be reasonable given the level at which risks are being considered, and that it will likely lead to appropriate cost estimates. We have observed similar practices in Australian TNSPs approach to risk treatment within their cost estimation process.

[25] Transpower, RFI012-13 BPR Pack Oct 2022.pdf
[26] Transpower, RFI012-07 NZ1-12887087-Penrose Control Building Replacement Concept Design Report (CDR) rev 2 - combined (1).pdf, RFI012-08 #2 SCORED workshop agenda - PEN.pdf, RFI012-09 Appendix I - SCORED Register - Penrose Control Building Replacement.pdf, RFI012-10 Penrose Control Room Risk Allowance Schedule Rev1.xlsx

Governance

We sighted the business case adjustment policy[27] and the delegated financial authority policy[28]. We also sighted evidence of Transpower staff practicing such policies – for example in the Penrose asbestos remediation project.[29]

Evidence of the release of management reserve was also sighted (refer to the Wiri ODID conversion project[30]). This demonstrated the control measures and governance process in place at Transpower in handling of the budget, variation approval and its treatment within its systems. This indicates a mature organisation with well-established governance practices in relation to cost estimation, variation, treatment of contingency and escalation and approval processes.

Review of detailed cost estimate build-up[31] of various R&R projects from different asset portfolios indicates consistent application of Transpower's cost estimation framework and use of TEES where applicable. Evidence of both building block and detailed customised estimation approaches for various types of projects, the use of vargen, and the inclusion of risk allowance was sighted.[32] We consider this evidence demonstrated a reasonable cost estimation framework designed to produce reasonable cost estimates for both volumetric expenditures and bespoke expenditures.

Generic allowances

We reviewed commentary justifying the use of use of vargen in four project estimates for batteries and DC systems, disconnector and earth switches, grillage and power cable.[33] The PowerBI dashboard summary view of every base R&R asset portfolio, plus the enabling customer electrification and resilience programme being proposed using the UIOLI uncertainty mechanism, generated from the FMIS shows 27% of forecast expenditure value consisted of vargen.[34]

Justification for most of the vargen used in buildings and grounds, dynamic reactive power, other station equipment, power transformer, HVDC and conductor asset portfolios was evident. Vargen is being used as a placeholder in those instances where the scope description is not captured within the building blocks available in the project cost estimate. The use of vargen has reduced from the RCP3 submission period (30%) to RCP4 submission time (22%) when compared against the same basis, i.e., excluding the enabling customer electrification and resilience programme being proposed using the UIOLI uncertainty mechanism as it did not exist during RCP3 submission. This demonstrates the continual improvement of TEES library of cost information in terms of diversity of building blocks in it since the previous RCP submission.

Data organisation

Review of quantities included in the cost build-up, the choices of types of cost items, allocation of costs within external labour, equipment, internal labour, material, major plant, design, land and finance indicate reasonable cost estimation process. Details such as allocation of various commodities and cost groups to resource level, and their aggregate allocation to form cost items, and their aggregated allocation to form building block (for volumetric work), and their aggregated allocation to form assemblies (for non-volumetric work) were also sighted.[35] It showed a logical mapping of various disaggregated elements and the organisation of cost information within TEES. We note that other electricity network utilities with good cost estimation framework in place also organise their elementary cost information in similar fashion in their databases.

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[27] Transpower, RFI012-16 BCA Policy.pdf
[28] Transpower, RFI012-15 Delegated Authority Policy.pdf
[29] Transpower, RFI012-11 Penrose Control Room DBC Final Approved Sign.pdf
[30] Transpower, RFI012-19 CP_WIR_76_00_00 BCA Memo - WIR ODID.pdf, [RFI012-19]
[31] Transpower, various PMPs, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx
[32] RFI012-20 Proportion of vargens in RCP3 and RCP4.xlsx
[33] Transpower, RFI012-17 TL-Grillage 2021-22 - DBC.pdf, RFI012-23 Huntly-Otahuhu A (OTA-DRY) CP_637_006_0_00 Report Short.pdf, RFI012-28 198 - Battery Bank (Station Battery, Fuse Box, Spreader Frames, Scoping Study) - BBB17-mBAT Resource Extract.xlsm, RFI012-29 246 - Tower Painted Vinyl less than 230m2 avg - LBB-TP1 Resource Extract.xlsm, RFI012-30 101 - 66 50kV ES - Earth Switch - BBA4-dES Resource Extract.xlsm
[34] Transpower, RFI012 TP Response.pdf
[35] Transpower, RFI012-27 TEES master cost library and screenshots.pdf, RFI 012 Cost Estimation Framework.docx

Benchmarking against independent sources

We compared the unit rates of few common asset building blocks from TEES with similarly described asset building blocks adopted by Australian DNSPs and TNSPs. For this comparison we referred to:

– the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets.[36]

– the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets.[37]

We observed reasonable alignment between Transpower's and Australian DNSPs and TNSPs unit rates of asset building blocks considering the jurisdictional differences.

Benchmarking against RCP3

Comparison of the same set of building block unit rates used to develop the RCP3 submission (in 2017 with constant 2017/18 NZD) and RCP4 submission (in 2023 with constant 2021/22 NZD) indicted the following building block where the compounded annual growth rate of ≥10% was observed.[38] Additional justification[39] for these differences were obtained from Transpower which were deemed reasonable:

– 11kV 11/0.415kV 200kVA Local Service Transformer (rapid increase in design and equipment costs).

– Oil / Water separator (changes to standard design for oil spill angle, separator plate and pumping system, and stainless steel pipes).

– 7 Wire Stock Fence (scope change to include removal cost of existing stock fence and temporary fencing).

– 220 kV DS – Disconnector (large increase from service provider related to changes to work practice and inclusion of foundation to enable increased clearance and seismic performance).

– Tower Attachment Points-Small circuit set (large increase in material cost).

– EPR Mitigation - Tower per structure (scope change to include non-conductive fencing, site inspection etc.).

– GPS Clock (change in material and inclusion of antenna).

– Bus Coupler Protection Panel (scope change adding relay, cable, additional engineering effort etc.).

– NCT - Neutral Current Transformer (large increase from service provider related to changes to work practice).

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[36] Refer to repex models for:
Jemena (2021 to 2026 reset) available at: **https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/jemena-determination-2021-26/draft-decision**
Powercor (2021 to 2026 reset period) available at: **https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/jemena-determination-2021-26/draft-decision**
SA Power Networks (2020 to 2025 reset period) available at: **https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/sa-power-networks-determination-2020-25**

[37] AEMO, Transmission Costs for the 2022 Integrated System Plan. Available at: **https://aemo.com.au/en/consultations/current-and-closed-consultations/transmission-costs-for-the-2022-integrated-system-plan**

[38] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

[39] Transpower, RFI012 TP Response.pdf

4.2.3 Conclusion

Based on our evaluation, we considered that the cost estimation framework, its supporting tools and inputs adopted by Transpower and its practice to budget the expenditures proposed in RCP4 meets all the evaluation criteria having regard to GEIP.

The following table describes our verification of Transpower's cost estimation framework against the evaluation criteria.

Table 4-3 Evaluation criteria and approach: Cost estimation

ToR clause	Evaluation criteria	Meet criterion	Comment
3.2	Whether Transpower's RCP4 proposed base capex, opex and key assumptions are consistent with expenditure which represents the efficient costs reflecting GEIP.	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(a)	Whether key assumptions are reasonable including: (i) the method & information used to develop them;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed expenditure including: (i) inputs to the model; and	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) methods used to check reasonableness of forecasts and related expenditure	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.

4.3 Cost escalation forecast

The following table summarises our verification of Transpower's cost escalation forecast that influences the proposed RCP4 expenditures.

Table 4-4 Verification summary of Transpower's cost escalation forecast

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Reasonable assumptions made	Yes
Reasonable and credible input data selected	Yes
Reasonable tool/software/method adopted	Yes
Is the generated output reasonable	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	None identified
Key issues that Commission should focus on	None identified

4.3.1 Observations

As explained above, Transpower escalates costs in TEES at the resource level using escalators developed by NZIER. The report 'Cost escalation forecasts: Frameworks, forecasts and forecast methods' dated July 2023[40] provides the method and indices. This feeds into FMIS to forecast overall expenditure.

The table below shows the cost escalation categories and the respective indices used for the escalation.

Transpower's proposed approach for RCP4 is generally consistent with the approach that was used in RCP3.

Table 4-5 Cost escalation categories and the respective indices used for escalation

Category	Item	Index measure
Labour	Network opex labour	Labour cost index - All industries
	Network capex labour	Labour cost index - Construction
	ICT labour	Labour cost index - Professional and technical services
	Internal labour	Labour cost index - Electricity, Gas, and Water Industry
	Grid capex labour (design consultants)	Labour cost index - Construction
Metals	Copper	London metal exchange copper
	Aluminium	London metal exchange aluminium
	Steel	World Bank steel price index and Asia Hot-Rolled Coil
	Other metals	World Bank Metals and Mineral Price Index
Construction	Construction	Producer Price Index (Outputs for Heavy and Civil Engineering)
ICT	ICT software and hardware	All groups CPI
Maintenance	Maintenance opex	PPI All groups output

Source: NZIER, REG014 Cost escalation forecasts and methodology, July 2023.

[40] NZIER, Cost escalation forecasts and methodology, July 2023. [REG014]

4.3.2 Evaluation

We consider the cost escalation approach adopted by Transpower is reasonable, both in terms of design and implementation. In stating this, we note that we did not have access to, or review NZIER's underlying econometric models, although NZIER's report explained the modelling approach used.

In our view, the indices chosen as the basis of the escalation are reasonable and justified. While any forecast is subject to material uncertainty, NZIER applied a range of reasonable techniques such as futures prices, Consensus Economic forecasts, and forecasts by international agencies for commodities and econometric modelling for labour cost and producer price indexes.

Of importance, we note:

– NZIER provided commentary on caveats associated with each index, given the changing economic environment.
– NZIER ensured that all indices appropriately captured only price effects and not quality changes. This is a key principle of escalation that we agree with, i.e., escalation should generally only capture the changes to the price components of expenditure, not structural changes in the type of goods purchased, nor improvements in the quality of the goods.

Both NZIER (in recommending the escalation approach) and Transpower (in applying the escalation) have held to the above principle, with one exception. The sole exception was the ICT Software and Hardware expenditure category, where NZIER proposed (and Transpower accepted) the use of All Groups CPI to escalate non-labour ICT capex. NZIER argued that All groups CPI is a sensible compromise between the cost changes in:

– Quality adjusted computing equipment—this index decreases as computing equipment quality increases. However, increases in computing equipment quality do not necessarily decrease Transpower costs in practice. This is because Transpower is not likely to purchase lower quality equipment, which in any case becomes outdated and is removed from sale by vendors as they renew their model line ups.
– Non-quality adjusted computing equipment—this would reflect both quality changes and price changes.

We also note that for a period Transpower manually adjusted certain cost components (mostly for metal commodities and CPI) due to a recent review of building blocks in TEES, which had left some building blocks outdated. This has since been resolved and the RCP4 proposal will not include any manual adjustments.

4.3.3 Conclusion

Based on our evaluation, we considered that the cost escalation forecast, its supporting tools and inputs adopted by Transpower and its practice to budget the expenditures proposed in RCP4 meets all the evaluation criteria having regard to GEIP.

The following table describes our verification of Transpower's cost escalation forecast method against the evaluation criteria.

Table 4-6 Evaluation criteria and approach: Cost escalation forecast

ToR clause	Evaluation criteria	Meet criterion	Comment
3.2	Whether Transpower's RCP4 proposed base capex, opex and key assumptions are consistent with expenditure which represents the efficient costs reflecting GEIP.	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(a)	Whether key assumptions are reasonable including: (i) the method & information used to develop them;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed expenditure including: (i) inputs to the model; and	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) methods used to check reasonableness of forecasts and related expenditure	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.

4.4 Productivity forecast

The following table summarises our verification of Transpower's cost escalation forecast that influences the proposed RCP4 expenditures.

Table 4-7 Verification summary of Transpower's productivity forecast

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Reasonable assumptions made	Yes
Reasonable and credible input data selected	Yes
Reasonable tool/software/method adopted	Yes
Is the generated output reasonable	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	Additional cross-checks can be performed by examining, for example, the productivity of New Zealand's biggest distributors, or of First Gas, or by undertaking a more extensive comparison with overseas electricity transmission operators. However, given the analysis already performed by NZIER and Transpower, we consider that such additional cross checks are unlikely to support a change to the productivity forecast proposed by Transpower. While the Commission may choose to perform these additional cross-checks as part of its assessment of the regulatory proposal, we consider Transpower has provided sufficient analysis to support its proposed productivity forecast.
Key issues that Commission should focus on	Appropriate ways to decide on the productivity forecast figure, given that all available estimation techniques and comparator data sets have their own limitations and shortcomings.

4.4.1 Observations

Clauses A1(m) and A1(n) of the Capex IM require Transpower to consider its previous efficiency improvements (i.e., productivity over RCP2 and RCP3), as well as the scope for efficiency improvements during RCP4 when proposing a productivity forecast.

Transpower relies on NZIER's report titled 'Opex productivity, A report for Transpower' dated July 2023.[41] We reviewed multiple iterations of this report dating back to July 2022.as well as additional underlying information supplied by Transpower. We have also reviewed productivity evaluation approaches adopted previously by the Commission, the AER and Ofgem.

In RCP3, Transpower forecasted opex productivity of 0.2% using historical labour productivity in the professional, scientific, and technical services sector. The Commission accepted this target for RCP3. We did not review the work underlying the RCP3 productivity target because it is essentially a simpler version of Transpower's proposed approach for RCP4. Transpower has improved the relevance and granularity of the sectors for which productivity is assessed when developing a productivity forecast.

For RCP4, Transpower is proposing an opex productivity target of 0.5%, based primarily on NZIER analysis (NZIER estimates a range from 0.4% to 0.6%), which Transpower then cross-checked with a range of other estimation approaches. We agree with that the approach of relying on the NZIER figure as the most robust and

[41] NZIER, 'Opex productivity: A report for Transpower', July 2023.

relevant estimate, and then cross-checking it with other, less robust and relevant estimates, is appropriate given that Transpower is the sole electricity transmission operator in New Zealand.

4.4.2 Evaluation

While we would have preferred for Transpower to have performed more cross-checks, we consider that the cross-checks Transpower did perform are sufficient to demonstrate that its proposed productivity forecast of 0.5% is appropriate, and not understated. In our discussion in the rest of the section we suggest additional cross-checks that can be performed to further increase the Commission's confidence in the productivity growth figure. Should the Commission consider that these additional cross-checks are warranted, we suggest that, given the current point in the RCP4 process, the Commission should perform these cross-checks itself, rather than having Transpower perform them.

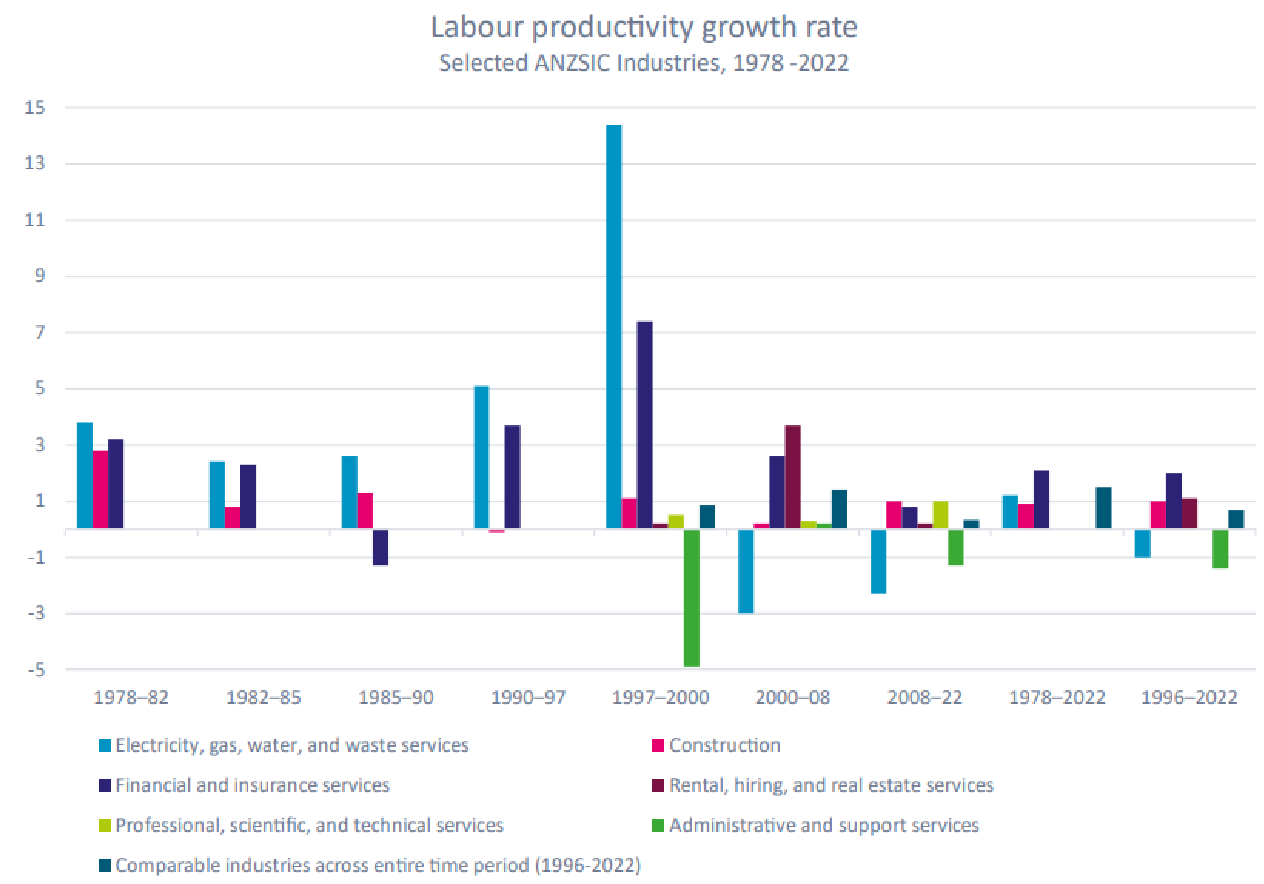
NZIER estimate of productivity target for Transpower

To develop its estimate, NZIER applies a weighted labour productivity approach to determine the productivity target. This is a composite of four comparable sectors (adjusted for the labour proportion in opex):

– Construction.
– Financial and insurance services.
– Professional, scientific, and technical services.
– Administrative and supportive services.

We find the selection of comparable sectors reasonable. NZIER did not include the electricity, gas, water, and waste services sector because that is largely made up of other regulated networks, which risks creating self-feedback. This sector is also highly volatile. NZIER also excluded the renting, hiring, and real estate sector to the sectors' high volatility. Notably, NZIER included data impacted by COVID-19 in its latest report, despite previously arguing that COVID-19 may have had temporary effects that should not feed into long-term productivity targets. We agree with this approach. The figure below shows the changes in labour productivity across the assessed sectors between 1996 and 2020.

Figure 4-2 Changes in labour productivity across comparable sectors (1978-2022)



Source: NZIER, 'Opex productivity: A report for Transpower', July 2023, Figure 1.

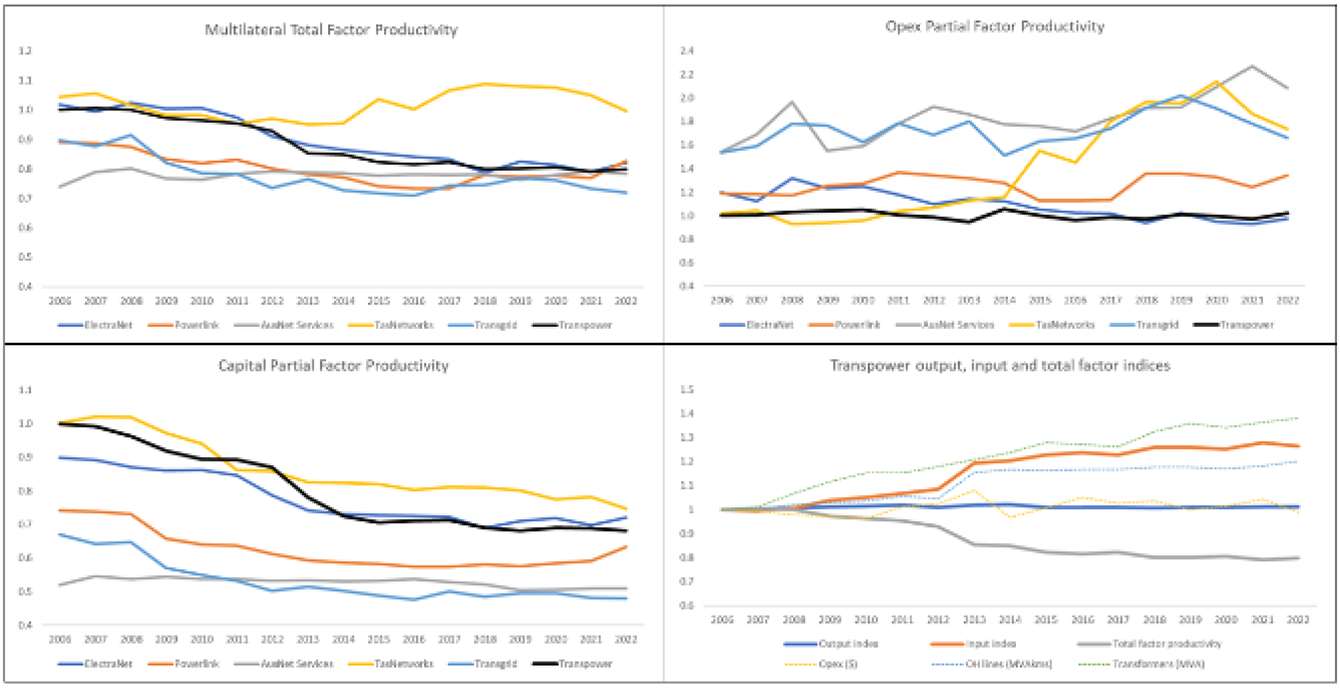
Additional cross-checks of NZIER's estimate

Transpower considered a range of additional approaches as cross-checks for the NZIER estimate and those cross-checks confirmed that the NZIER estimate is appropriate to rely on. We consider that a broader set of cross-checks may be useful, and we discuss some of these below. However, based on the evidence put forward by Transpower, we expect that these broader cross-checks are unlikely to result in a change to Transpower's proposed forecast of 0.5%. This figure is broadly in line with Transpower's past efficiency improvements, improvements seen in network operators overseas, and targeted improvements recently adopted by overseas regulators. This is why, should the Commission consider that additional cross-checks are required, we suggest these be performed by the Commission, rather than Transpower.

The following Figure shows how Transpower compares with Australian networks in terms of productivity. Transpower underperforms in opex partial factor productivity (PFP), but this is likely due to a different ratio of opex to capex costs, since Transpower performs well under total factor productivity (TFP) and capex PFP comparisons.

The RCP3 IV report identified ElectraNet (dark blue) and TasNetworks (in yellow) as being most comparable to Transpower. On the metrics used, Transpower performs similarly to ElectraNet but worse than TasNetworks. However, this does not necessarily imply that Transpower is less efficient. This is because TFP and multilateral total factor productivity (MTFP) metrics do not capture all the important features of a transmission network, such as resilience and security. Idiosyncratic factors may also contribute to differences. For example, TasNetworks also operates an electricity distribution network, which drives a somewhat different cost structure compared to a pure transmission business.

Figure 4-3 ***Productivity comparison between Transpower and Australian TNSPs***



Source: Transpower analysis including AER data.

Transpower's proposed target for RCP4 is broadly consistent with those in comparable overseas jurisdictions over similar time periods, as outlined in the table below. Caution is required when interpreting or comparing international benchmark results because Transpower and comparator TNSPs operate in different contexts and make different decisions, including different opex/capex trade-offs. Of the comparators UK TNSPs are less comparable to Transpower than Australian TNSPs, especially given the very different labour market (compared to the very closely linked New Zealand and Australian labour markets). Nevertheless, benchmarking provides useful cross-check evidence that Transpower's proposed target is likely to be appropriate.

Table 4-8 Comparison of latest opex productivity targets for select TNSPs in New Zealand, Australia, and the UK

Network	Jurisdiction	Economic regulator	Opex productivity target	Target years	Target status
Powerlink	Queensland	AER	0.50%	2022 to 2027	Final decision
ElectraNet	South Australia	AER	0.60%	2023 to 2028	Final decision
TasNetworks	Tasmania	AER	3.00% in 2024-25, and 0.50% afterwards	2024 to 2029	Proposal
AusNet	Victoria	AER	0.50%	2022 to 2027	Final decision
Transgrid	New South Wales	AER	0.60%	2023 to 2028	Final decision
Ofgem-regulated networks (1)	Great Britain	Ofgem	1.05%	2021 to 2026	Final decision
Transpower	New Zealand	Commerce Commission	0.50%	2025 to 2030	Proposal

Note: (1) This was originally set at 1.25% including a 0.2% innovation uplift. However, the Competitions and Markets Authority determined that the innovation uplift was not appropriate.
Sources:
Powerlink - AER (2022), Final Decision Powerlink Queensland Transmission Determination 2022 to 2027.[42]
ElectraNet - AER (2023), Final decision ElectraNet transmission determination 1 July 2023 to 30 June 2028.[43]
TasNetworks - AER (2023), Issues Paper TasNetworks Electricity Transmission and Distribution Determination 1 July 2024 to 30 June 2029.[44]
AusNet Services - AER (2022), Final Decision AusNet Services Transmission Determination 2022 to 2027 Overview.[45]
Transgrid - AER (2023), Final Decision Transgrid transmission determination 1 July 2023 to 30 June 2028.[46]
Ofgem – Competitions and Markets Authority (2021). Cadent Gas Limited, National Grid Electricity Transmission plc, National Grid Gas plc, Northern Gas Network Limited, Scottish Hydro Electricity Transmission plc, Southern Gas Networks plc and Scotland Gas Networks plc, SP Transmission plc, Wales and West Utilities Limited vs the Gas and Electricity Markets Authority—Final determination, Volume 2B.[47]; and Ofgem (2021), RIIO-2 Final Determinations Core Document (Revised)[48]

It is important to ensure that Transpower's opex productivity target is cross-checked by as much robust evidence as possible, which can be achieved by maximising the range of forecasting/estimation methods used for the cross-checks. This is because:

1. Productivity estimation involves a wide range of judgements on methodological and data matters, making the results quite subjective
2. Opex productivity is a material driver with a considerable impact across most opex categories.

Importantly, after considering several approaches (all with their own strengths and weaknesses), NZIER dismisses all but one approach using subjective judgements. NZIER then relies on just one approach—weighted labour productivity—to propose a productivity figure. While we agree that the approaches that NZIER dismisses (econometric modelling, labour and intermediates inputs productivity, overseas jurisdiction comparisons) are less robust than weighted labour productivity, they have in the past been used as relevant considerations by regulated utilities and regulators in setting productivity targets.

In our opinion these other approaches should be, to the extent possible, used as cross-checks for the main estimate derived from weighted labour productivity. Though these alternative approaches have real drawbacks, they can nonetheless provide insight into opex productivity. Transpower has performed a number of cross-checks using these alternative approaches, but further cross-checks could potentially be performed. Transpower has also explicitly stated that it is not relying on these cross-checks to set its proposed figure.

[42] Available at: **https://www.aer.gov.au/system/files/AER%20-%20Powerlink%202022-27%20-%20Final%20Decision%20-%20Final%20decision%20document%20-%20April%202022_1.pdf**
[43] Available at: **https://www.aer.gov.au/system/files/AER%20-%20ElectraNet%202023-28%20-%20Final%20Decision%20-%20Overview%20-%20April%202023_0.pdf**
[44] Available at: **https://www.aer.gov.au/system/files/AER%20-%20Issues%20Paper%20-%20TasNetworks%20-%202024-29%20Distribution%20and%20Transmission%20revenue%20proposal%20-%20March%202023.pdf**
[45] Available at: **https://www.aer.gov.au/system/files/AER%20-%20Final%20Decision%20-%20AusNet%20Services%20transmission%202022-27%20-%20Overview%20-%2028%20January%202022.pdf**
[46] Available at: **https://www.aer.gov.au/system/files/AER%20-%20Transgrid%202023-28%20-%20Final%20Decision%20-%20Overview%20-%20April%202023_1.pdf**
[47] Available at: **https://assets.publishing.service.gov.uk/media/617fd07ce90e07197483b8a9/ELMA_Final_Determination_Vol.2B.pdf**
[48] Available at: **https://www.ofgem.gov.uk/sites/default/files/docs/2021/02/final_determinations_-_core_document_revised.pdf**

Regulators in comparable overseas jurisdictions to New Zealand rely on a wide range of information to inform productivity targets. Overseas regulators acknowledged the strengths and weaknesses of each approach to inform their determinations. The range of results also helps regulators understand how confident and precise they can realistically be in setting productivity targets.

For example, in the AER's 2019 decision paper on forecasting productivity growth for electricity distributors , the AER stated that their decision "is based on our consideration of all information sources available, and their strengths and weaknesses against the factors we are using to establish the weight we place on each of them… We do not consider we can rely on a single information source to forecast opex productivity growth…relying on sensible judgment and various available information sources is reasonable." [49] In reaching its decision for distributors, the AER considered the following approaches:

– Electricity distribution opex partial factor productivity
– Electricity distribution econometric time trend
– Electricity distribution (undergrounding) econometric coefficient
– Gas distribution econometric time trend
– Labour productivity gross value added
– Electricity supply chain MFP
– Water efficiency target
– International electricity TFP

Notably, the AER currently largely relies on econometric benchmarking to set productivity targets for electricity TNSPs. The AER publishes annual benchmarking reports for electricity distribution and transmission. Certainly, benchmarking would provide valuable additional evidence to help determine an appropriate opex productivity target for Transpower. However, NZIER ruled out econometric benchmarking, citing various data and modelling difficulties.

In Ofgem's 2022 determination for electricity distribution (RIIO-ED2), Ofgem set the ongoing totex efficiency challenge at 1%[50]. Ofgem primarily relied on TFP modelling of comparable sectors.[51] Recognising the limits of applying data from comparable sectors directly onto electricity distribution, Ofgem also considered the following factors:

– Ambition of the sector to deliver transformational change
– Potential for embodied and disembodied technical change
– Distribution network operators' proposed productivity targets
– Regulatory decisions on other networks.

In Ofgem's 2020 determination for high-voltage electricity transmission and high-pressure gas transmission (RIIO-T2), Ofgem set the ongoing efficiency (OE) challenge at 1.25% for opex and 1.15% for capex from 2021 to 2026. CEPA, consultants to Ofgem in setting the RIIO-T2 OE challenge, recommended that Ofgem does not solely rely on labour productivity measures.[52]

In its analysis of frontier shift policy, CEPA stated that "setting the OE challenge requires consideration of multiple pieces of evidence to make an informed judgement on the frontier productivity improvements that could be achieved by energy network companies over RIIO-2."

Further, CEPA warned against relying exclusively on labour productivity, arguing "that rather than [labour productivity] being the sole or main source of information on where to set the OE challenge for opex, LP estimates

[49] AER (2019), Final decision paper: Forecasting productivity growth for electricity distributors, available: https://www.aer.gov.au/system/files/Opex%20productivity%20growth%20review%202018%20-%20Final%20decision%20-%208%20March%202019.pdf
[50] Ofgem (2021), RIIO-2 Final Determinations Core Document (Revised), available: https://www.ofgem.gov.uk/sites/default/files/docs/2021/02/final_determinations_-_core_document_revised.pdf
[51] Ofgem (2022), RIIO-ED2 Final Determinations Core Methodology Document, available: https://www.ofgem.gov.uk/sites/default/files/2022-11/RIIO-ED2%20Final%20Determinations%20Core%20Methodology.pdf
[52] EPA (2020), RIIO-GD2 and T2: Cost Assessment: Advice on Frontier Shift policy for Final Determinations, available under "Technical Annex part one" at: https://www.ofgem.gov.uk/publications/riio-2-final-determinations-transmission-and-gas-distribution-network-companies-and-electricity-system-operator

should be one of the factors taken into account alongside TPF measures and other pieces of evidence." Indeed, in its final determination, Ofgem considered the following methods:

- Total factor productivity (value add and gross output measures) across comparable sectors
- Labour productivity across comparable sectors
- Economy-wide productivity estimates
- Network companies proposed targets and past efficiencies achieved
- Specific drivers of potential productivity (such as energy-sector innovation funding in Great Britain).

In our discussions with Transpower there was a small but important difference in positions on how various types of evidence should be considered to arrive at an appropriate figure for the productivity growth parameter.

Transpower argued that, in practice, despite documenting a broader approach that considers multiple methods, overseas regulators have ultimately relied on a single labour cost-based information source to set productivity targets—the same approach adopted by Transpower.

We understand the argument that some regulators may have only used alternative evidence to provide a sense-check, but that this evidence was not essential and had limited impact on regulators' final calculations of the productivity growth figure applied in the determinations. However, we could not confirm this based on publicly available statements made by the relevant regulators. We maintain the view that the sense-checks are an essential part of the regulatory determination process for the productivity target.

For RCP4, this small, but important difference in approach does not result in conflicting outcomes. Despite explicitly staring that it is not relying on them, Transpower did perform a range of sense-checks, and the results of this analysis were in line with NZIER's proposed figure, which Transpower has adopted.

The real question, albeit theoretical for RCP4, is what happens should the sense-checks cast doubt on the main labour-productivity-derived figure. In our view, such a discrepancy would need further detailed investigation. Different evidence bases have different pros and cons that lead regulators to weigh them to greater or lesser extents. It is not surprising that regulators may heavily weigh certain pieces of evidence, while de-weighing others, given the specific context of each determination.

We agree that, in practice, examining additional alternative approaches (to those Transpower has already performed) would require further work that could ultimately have limited impact on the productivity target. This could risk violating proportionality. On balance, we consider that the work performed by Transpower is sufficient to present a credible proposed parameter for further review by the Commission, which may in turn choose to perform additional analysis using a wider range of approaches.

4.4.3 Conclusion

The following table describes our verification of Transpower's productivity forecast against the evaluation criteria.

Table 4-9 Evaluation criteria and approach: Productivity forecast

ToR clause	Evaluation criteria	Meet criterion	Comment
3.2	Whether Transpower's RCP4 proposed base capex, opex and key assumptions are consistent with expenditure which represents the efficient costs reflecting GEIP.	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(a)	Whether key assumptions are reasonable including: (i) the method & information used to develop them;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed expenditure including: (i) inputs to the model; and	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
	(ii) methods used to check reasonableness of forecasts and related expenditure	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier observation and evaluation sub-sections.

Based on our evaluation, we consider Transpower's proposed productivity forecast meets the evaluation criteria and GEIP. Additional cross-checks can be performed by examining, for example, the productivity of New Zealand's biggest distributors, or by undertaking a more extensive comparison with overseas electricity transmission operators. However, given the analysis already performed by NZIER and Transpower, we consider that such additional cross checks are unlikely to support a change to the productivity forecast proposed by Transpower. While the Commission may choose to perform these additional cross-checks as part of its assessment of the regulatory proposal, we consider Transpower has provided sufficient analysis to support its proposed productivity forecast. Below we discuss the potential cross-checks in more detail.

In our view, where possible, in setting the opex productivity target, Transpower and the Commission should consider sources that are robust, relevant, and realistic.

– Robust—the source should provide an objective estimate and be resistant to idiosyncratic factors
– Relevant—the source should reflect Transpower's operating context as much as possible
– Realistic—the source should rely on proven practices and have sufficient recent data available.

The table on the following page assesses various potential sources against these three criteria, in the context of RCP4. It shows that, in addition to the weighted labour productivity approach that NZIER has recommended (and Transpower has relied on with some cross-checking), the Commission could more explicitly consider more cross-checks when setting the productivity target. These additional sources should potentially include:

– Time trend forecasting (based on Transpower data)
– Total factor productivity (TFP)/partial factor productivity (PFP) benchmarking (of Transpower and overseas electricity transmission networks together, expanding the sample to UK utilities) or TFP/PFP benchmarking of overseas transmission networks only.
– Electricity distribution (ED) network productivity (of large NZ networks)

Transpower has provided us with TFP/PFP benchmarking of Transpower and Australian electricity transmission networks together). However, Transpower's proposal does not explicitly rely on this source, as Transpower considers that the results are not robust due to differences in operating environment, reporting and accounting. Transpower considers benchmarking results as a cross-check rather than an explicit input. Currently, it is not clear how Transpower would consider benchmarking were it to disagree with Transpower's preferred methods.

Further, in setting an opex productivity target, the Commerce Commission could consider regulatory precedent and Transpower's historical productivity growth[53].

[53] There are potentially other idiosyncratic factors that might inform the Commission's judgment, including the level of government funding, economy-wide productivity growth, and the impact of COVID-19. Overseas regulators have discussed these three sources in various determinations and supporting papers. Our high-level assessment is that these should not drive productivity adjustments in the context of RCP4. There is no NZ-equivalent of Great Britain's Innovation Funding that compelled Ofgem to uplift their ongoing efficiency challenge settings. Economy-wide productivity growth could trickle down to the energy sector, but current data are too volatile and uncertain. Much of this is due to COVID-19, which in theory could have long-term impacts but any long-term impact is currently too uncertain to apply an objective adjustment.

Table 4-10 Sources informing opex productivity targets for electricity transmission networks

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
Econometric modelling								
Time trend forecasting of Transpower only[54]	No (Yes for DNSPs)	No	No	Somewhat	Yes	Yes	Cross-check	Time trend forecasting is not fully robust on its own. It can add valuable context but is less useful than PFP benchmarking, which can adjust for additional factors influencing opex. AER and Ofgem do not consider this source. This is because they have more powerful tools, such as benchmarking, which would incorporate time trends in any case. Time trend forecasting does not consider catchup efficiency, making cross-comparisons challenging. Time trend forecasting is possible using Transpower data only, without the need for international comparators. It is also simpler than PFP benchmarking. There is no ready-made productivity estimate using this source, but the necessary data to produce one is available. The Commission could perform this analysis as an additional cross-check.
Productivity benchmarking including Transpower and overseas comparators	Yes (TFP and PFP)	Yes (TFP only)[55]	Cross-check	Yes	Yes	Somewhat	Cross-check	We share NZIER's concerns around benchmarking but disagree with their conclusion that benchmarking is not appropriate. Unlike the AER and Ofgem, Transpower is unable to limit the benchmarking sample to domestic comparators. Benchmarking would necessarily involve multiple networks. Since Transpower is NZ's only electricity transmission operator, the comparators must be overseas networks. On balance, we think the benefits of an additional comparator set outweigh the drawbacks of reduced comparability, provided that the results are used as a cross-check only and viewed in the context of the results produced from more robust sources. Transmission benchmarking is generally less mature than distribution benchmarking. However, transmission benchmarking is not unprecedented; the AER has undertaken such benchmarking since 2014 on an annual

[54] This refers to relying on time trend components of econometric modelling only without considering other explanatory drivers (such as network undergrounding).
[55] Note that Ofgem benchmarks networks against a comparator set of industries, not against each other.

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
								basis, while European regulators have done since 2005 on a periodic basis.[56] A more subjective consideration of overseas networks' TFP and PFP (without Transpower data) may be more suitable (outlined below). However, a risk is that model weights trained on overseas examples only may not generalise well to NZ. Transpower has performed this cross check using combined data from Australian electricity transmission networks and Transpower and estimates an opex PFP of 0.4–0.5%. This figure is consistent with the figure produced by NZIER. Transpower does not directly rely on this benchmarking analysis, though uses it as a cross-check on the NZIER number. A possible improvement would be to include the UK data in the sample, or to separately compare Transpower to UK TNSPs in addition to the comparison with the Australian TNSPs.
Weighted inputs								
Labour only	No (Yes for DNSPs)	Yes	Yes, main source (NZIER analysis)	Yes	Yes	Yes	Yes, high weighting / main source	We agree with Transpower that this is a highly relevant source. A key weakness is that labour is but one opex component. NZIER estimates a range of 0.4–0.6%.
Labour and intermediate inputs	No (Yes for DNSPs)	Yes	No	Yes	Yes	No	Not viable	Consider in principle, but not viable for RCP4 because NZ does not collect the growth accounting statistics required for intermediate inputs. If data were available, this method would be superior to the labour only approach because intermediate inputs also capture other opex components.
Cross-sectoral comparison								
Electricity distribution	No	No	Cross-check (All DNSPs, non-exempt DNSPs)	Yes	Somewhat	Yes	Cross-check (Biggest DNSPs)	Electricity distribution and transmission networks share similar opex inputs. They operate in similar contexts and are regulated under similar frameworks. Large electricity distribution businesses in NZ (such as Vector and Powerco) are not entirely comparable with Transpower, but they are not so dissimilar as to warrant complete dismissal. Small electricity distribution businesses are likely less comparable.

[56] AER (2022), Annual Benchmarking Report: Electricity transmission network service providers—November 2022. Available: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/annual-benchmarking-reports-2022

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
								AER and Ofgem did not consider this source. This is because they have sufficient data for multiple electricity transmission networks, so they did not have to rely on cross-sectoral comparisons. On balance, we think the benefits of an additional comparator set outweigh the drawbacks of reduced comparability, provided that the results are used as a cross-check only and viewed in the context of the results produced from more robust sources. NERA estimated electricity distribution businesses' opex PFP between 1996 and 2018[57], using the Economics Insights method previously adopted by the Commission[58]. At that point, from 2003 onwards, the changes in productivity were on average negative both for the distribution industry as a whole, and also for the non-exempt subset of distributors. Transpower has used these figures as a cross check. However, we consider a more targeted analysis of only the biggest distributors (Vector, Powerco, Orion) would be a more useful cross-check. The data needed for this analysis is publicly available. The Commission could perform this analysis as an additional cross-check.
Gas transmission and distribution	No (Yes for DNSPs)	Yes[59]	Cross-check	Yes	Somewhat	Yes	Cross-check	Gas network companies and electricity transmission companies share some opex inputs but operate in materially different contexts. First Gas operates New Zealand's gas transmission network. On balance, we think the benefits of an additional comparator set outweigh the drawbacks of reduced comparability, provided that the results are used as a cross-check only and viewed in the context of the results produced from more robust sources. There is no ready-made recent productivity estimate using this source, but the necessary data to produce one is available. In 2022 the Commission retained the GPBs' productivity factor of 0% (which was originally set in 2013), noting that there is still no evidence the GPBs improve their productivity faster or slower than the rest of the economy. Transpower's proposal is consistent with this cross-check.

[57] NERA (2019), Opex Partial Productivity for DPP3. Available: **https://comcom.govt.nz/__data/assets/pdf_file/0028/162469/NERA-Economic-Consulting-on-behalf-of-ENA-Submission-on-EDB-DPP-reset-draft-decisions-paper-18-July-2019.pdf**

[58] Economic Insights (2014), Electricity Distribution Industry Productivity Analysis: 1996—2014. Available: **https://comcom.govt.nz/__data/assets/pdf_file/0025/62764/Economic-insights-updated-productivity-analysis-electricity-distribution-1996-2014.pdf**

[59] Electricity transmission networks, gas transmission networks, and gas distribution networks share the same ongoing efficiency challenge under RIIO-T2.

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
Utilities sector	No	No	Cross-check	No	Somewhat	Yes	Do not consider	The utilities sector is too broad to be meaningful. The operating contexts differ significantly. It also risks self-feedback since electricity transmission is part of the utilities sector, creating perverse incentives. The Productivity Commission estimated an opex PFP of –1.7% in the utilities sector (electricity, gas, waste, and water) in 2021[60]. While Transpower has used this measure as a cross check, we consider it is not sufficiently robust or relevant.
Water sector	No (Yes for DNSPs)	No[61]	No	No	No	No	Do not consider	Water sector productivity is not reliable. Despite water services being monopolies, NZ lacks an economic regulator for water. Therefore, measured water sector productivity neither reflects competitive market pressure nor regulators' informed judgment. The water sector also materially differs from the electricity sector in terms of opex inputs and the operating context.
International comparison								
Overseas modelled productivity	No (Yes for DNSPs)	No	No	Yes	Somewhat	Yes	Cross-check	On balance, we think the benefits of a larger sample size outweigh the drawbacks of lower comparability. Overseas electricity transmission networks are not entirely comparable with Transpower, but they are not so different as to warrant complete dismissal. Indeed, the AER's electricity distribution econometric model includes data from NZ and Canadian networks. This is a possible alternative to a benchmarking model that combines data from Transpower and overseas comparators (outlined above). The difference is that this source would take outputs from models trained solely on overseas comparators, rather than including the Transpower data in the model. While this would be less relevant, it is also more realistic given the RCP4 timeline. The AER and Ofgem do not consider overseas data for electricity transmission networks because their respective jurisdictions have multiple transmission networks, allowing for a local comparator set. This is not true for NZ, where Transpower is the sole electricity transmission network operator.

[60] Productivity Commission (2021), Productivity by the numbers. Available: **https://www.productivity.govt.nz/publications/productivity-by-the-numbers-2021/**
[61] Ofgem discussed water network companies and the process used for determining their OE. However, water sector targets did not directly inform Ofgem's RIIO-T2 determination.

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
								On balance, we think the benefits of an additional comparator set outweigh the drawbacks of reduced comparability, provided that the results are used as a cross-check only and viewed in the context of the results produced from more robust sources. The AER produces PFP results for Australian networks. Ofgem produces TFP results for comparator industries, but we are not aware of publicly available results for individual networks, though the Commission may be able to source these from the AER and Ofgem. If possible, the Commission could perform this analysis as an additional cross-check.
Overseas productivity targets set by regulators	No	No	No	No	Somewhat	Yes	Do not consider	The productivity targets set by overseas regulators are not just a weighing of comparative evidence but also in part a policy choice that each regulator makes in the context of its own decision-making framework. Therefore, while it is useful to look at the data-points and underlying analysis considered by overseas regulators in making their decisions, the actual targets set by those regulators are less useful as a cross-check than the underlying data and analysis.
Other sources								
Other network operators' proposed targets	No	Yes	No	No	Yes	Yes	Do not consider	Helpful in a jurisdiction like Australia and the UK, where multiple transmission operators exist, and their proposals can provide an indirect sense-check—this is not possible in NZ.
Historical improvements achieved by operator[62]	No	No	No	No	Yes	Yes	Do not consider	This source is not robust because it risks creating perverse incentives. It also ignores changes in the operator's operating context. More robust econometric modelling techniques can in part capture this source. As part of electricity distribution businesses' DPP3 reset, the Commerce Commission disagreed that past performance is necessarily predictive of future performance[63]. However, we interpret the TOR evaluation criteria as potentially requiring the IV to consider Transpower's historical performance[64].

[62] As distinct from historical productivity trends or time trends. For example, if productivity has declined over time, a time trend approach would lower the productivity target, while there is leeway for the historic improvements achieved approach to hold the target at higher levels previously achieved.
[63] Commerce Commission (2019), Default price-quality paths for electricity distribution businesses from 1 April 2020—Final decision. Available: https://comcom.govt.nz/__data/assets/pdf_file/0020/191810/Default-price-quality-paths-for-electricity-distribution-businesses-from-1-April-2020-Final-decision-Reasons-paper-27-November-2019.PDF
[64] While this is not stated explicitly, the TOR states that "the evaluation criteria for the opex proposal are likely to be consistent with those for the base capex proposal where appropriate and include further criteria that are specific to assessing opex proposals." In turn, A1(m) of the Capex IM requires the Commission to consider "the type of efficiency improvements obtained in the current and previous regulatory periods."

Source	AER	Ofgem	Transpower	Robust?	Relevant?	Realistic?	IV opinion	Rationale
								Should the Commission opt to include this source as a cross check, in our view the Commission should not place high weight on it. The Commission must approach this source in the context of all other evidence.
Regulatory precedent	Yes	Yes	Yes	No	Yes	Yes	Cross-check	Important in principle. However, there is no clear precedent framework in place for Transpower and given the length of RCP periods, productivity trends can change in material ways. It is worth considering incrementally—that is, where the proposed figure is materially different from the historical regulatory precedent, this should be backed by new evidence. In this case, the regulatory precedent is a figure of 0.2% from RCP3, which Transpower is proposing to increase to 0.5% based on a similar, but improved, method. Transpower's proposal is therefore consistent with this cross-check.

5. Electricity demand forecast

We have applied a reasonable degree of scrutiny to Transpower's demand forecast that reflects the fact it only primarily impacts E&D capex, which is $98.5m of proposed expenditure.

Clauses A1(h) and A1(i) of the ToR apply for verifying the demand forecast:

– A1(h) requires consideration of the reasonableness of the key assumptions, key input data and forecasting methods used in determining demand forecasts; and
– A1(i) requires appropriateness of demand forecasts and other key assumptions in determining proposed base capex and opex.

The following table summarises our verification for this topic.

Table 5-1 Verification summary of Transpower's electricity demand forecast

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Reasonable assumptions made	Yes
Reasonable and credible input data selected	Yes
Reasonable modelling/forecasting method adopted	Yes
Generated forecast is reasonable	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	Treatment of distributor-provided step changes
Key issues that Commission should focus on	None identified

5.1 Overview of demand forecast

Transpower's demand forecast approach remains largely consistent with the RCP3 approach. Key improvements since RCP3 include:

– Improved depth of stakeholder engagement to gain better data.
– More sophisticated approach to consider the impact of industry electrification, batteries, and distributed generation.
– Process improvements in software development and governance.

Transpower's demand forecasting process has four main steps:

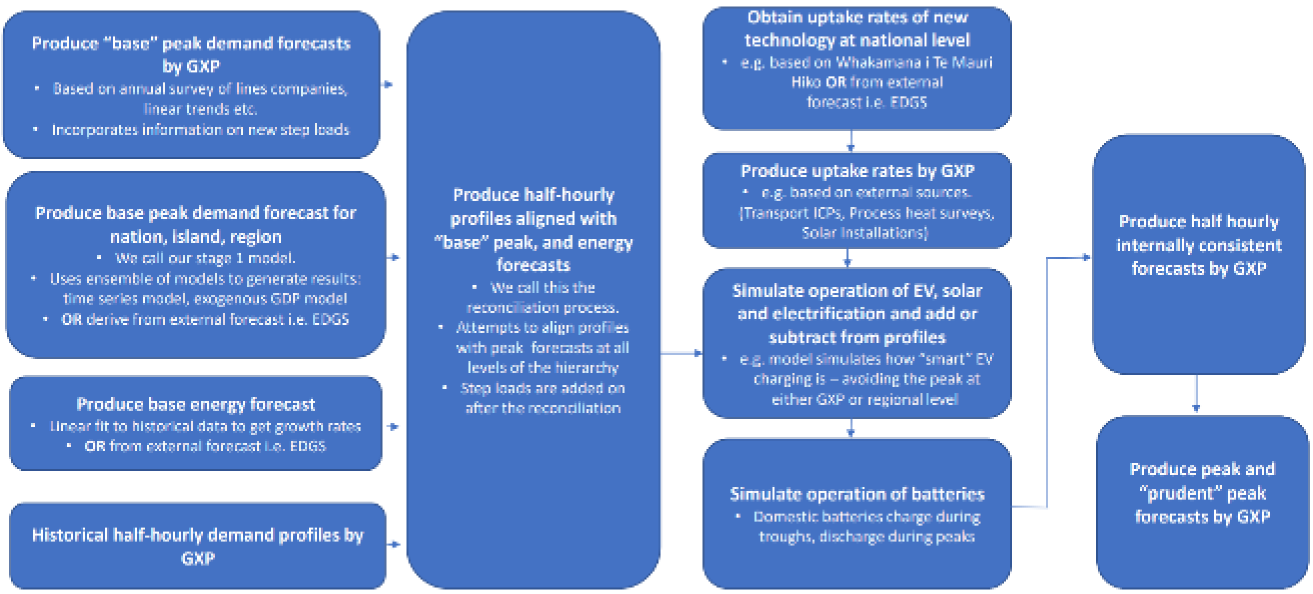
1. Forecast peak demand using:
   - Bottom-up base-step-trend model at the grid exit point level.
   - Top-down ensemble of regression models at the national, island, and regional levels. Also, possible to use electricity demand and generation scenarios.
2. Combine bottom-up results, top-down results, and historic demand profiles into forecast demand profiles at the grid exit point level.
3. Adjust demand profiles considering new technologies, such as electrification, electric vehicles, solar, and batteries.
4. Produce expected and prudent peak forecasts at the grid exit point level.

Voluntary information disclosure from distribution businesses is a key input to the bottom-up demand forecasting step. Where necessary, Transpower adjusts these inputs to improve comparability.

Demand forecasting is a key input into E&D capex investment decisions. However, the demand forecast does not on its own determine investment levels.

The following figure summarises the detailed steps in Transpower's demand forecasting process.

Figure 5-1 Demand forecasting process



Source: Transpower, RFI023-12 230322 Demand forecasting overview.pdf

5.2 Evaluation approach

We have taken a mixed approach to evaluate Transpower's demand forecasting. First, we assessed high level documents to verify the overall method. The 'Demand forecasting overview' document[65] was the key document outlining Transpower's high level approach. Secondly, we attended several explanatory and walkthrough sessions to verify that the high-level process described is embedded and functioning within the organization. These sessions took place on 23 March and 3 May 2023.

We further requested examples of Transpower's engagement with Electricity Distribution Businesses to verify Transpower's data collection approach for the bottom-up component of its demand forecast. We also asked Transpower to provide 1) the volume of non-major capital project growth driven capex, and 2) information on past predicted step changes and whether they have eventually occurred, though Transpower was unable to fully answer these two questions as they do not collect all the required information.[66]

We have not evaluated or replicated the programming code that powers the demand forecasts. The link between the demand forecast and the capex driven by that forecast is addressed in Section 10.

5.3 Evaluation

Our opinion is that Transpower's demand forecast satisfies the ToR Clause A1 evaluation criteria (specifically A1(h) and A1(i)). It largely relies on the well-established demand forecasting method applied in prior RCP submissions, while making a number of useful refinements.

The approach does not solely rely on Transpower's own data and analysis, but draws input data from a range of sources, including Transpower's customers and relevant publicly available information.

Transpower's method is robust. There are multiple checks throughout the process to identify and investigate errors or unusual results. However, there is always room for improvement, as described below.

[65] Transpower, Demand forecasting overview
[66] Transpower, RFI023-12 230322 Demand forecasting overview.pdf

5.3.1 Incorporating distributor-provided demand step changes

At the bottom-up stage of demand forecasting, Transpower currently effectively assumes that all steps identified by distributors will occur with absolute certainty and at the time estimated by the distributor providing the information. Distributors assign probabilities to their proposed step changes, which are often high but generally not one hundred percent.

Transpower argued that, from a planning perspective, it is not useful to probability-weight the step changes in the demand forecast. This is because, ultimately, a step usually either occurs or it does not, and so either all of the relevant capacity is needed, or none of it is. Scaling down the expected demand using probabilities is less useful than running sensitivities on the step change not occurring or occurring later. Probability estimates are also subjective. Transpower therefore adopts a sensitivity testing approach, as opposed to probabilistic scaling of the forecast.

At the margin, this approach is likely to overestimate demand from distributor-proposed step changes, and to assume that demand increases occur sooner than they actually do. This is because not all submitted step changes occur and, those that do, can occur later than originally proposed. However, Transpower has not historically systematically monitored data on which distributor-proposed step changes actually occur, nor the discrepancy in the timing proposed by the distributor compared to the actual timing. Nevertheless, from analysing overall demand, Transpower estimates that certain proposed steps almost certainly did not occur, such as for example the Hunter Downs Irrigation Scheme. Transpower also noted that it could not determine why peak demand reduced in certain grid exit points between 2017 and 2022, since it could not observe data at the ICP level.

On balance, while we think the area of demand forecasting can be improved, we do not consider this a sufficiently material issue because:

– The investment stage considers demand sensitivity scenarios, not just the base demand forecast.
– Transpower's process of reconciliation of top-down and bottom-up forecasts provides a check on the impact of distributor-provided step changes.
– Given the asymmetry of consequences of underproviding capacity compared to overproviding it, it is preferable at the margin to overestimate rather than underestimate demand.
– Major step changes in demand are likely to be funded by the major capital projects line item or directly by the customers paying for connection assets under Transmission Works Agreements, rather than base capex
– The approach has worked sufficiently well for Transpower in the past.

In its submission on the draft RCP4 plan, Fonterra provides a similar suggestion, calling for Transpower to "work with stakeholders to develop a probability of capacity increase for every [grid exit point] and then use this score to future proof the [grid exit point] for when that demand increase occurs."[67]

5.3.2 Dealing with the uncertain impact of emerging new technologies on demand

As new technologies or drivers emerge and mature, Transpower develops and refines more sophisticated approaches to forecasting the impact of these technologies.

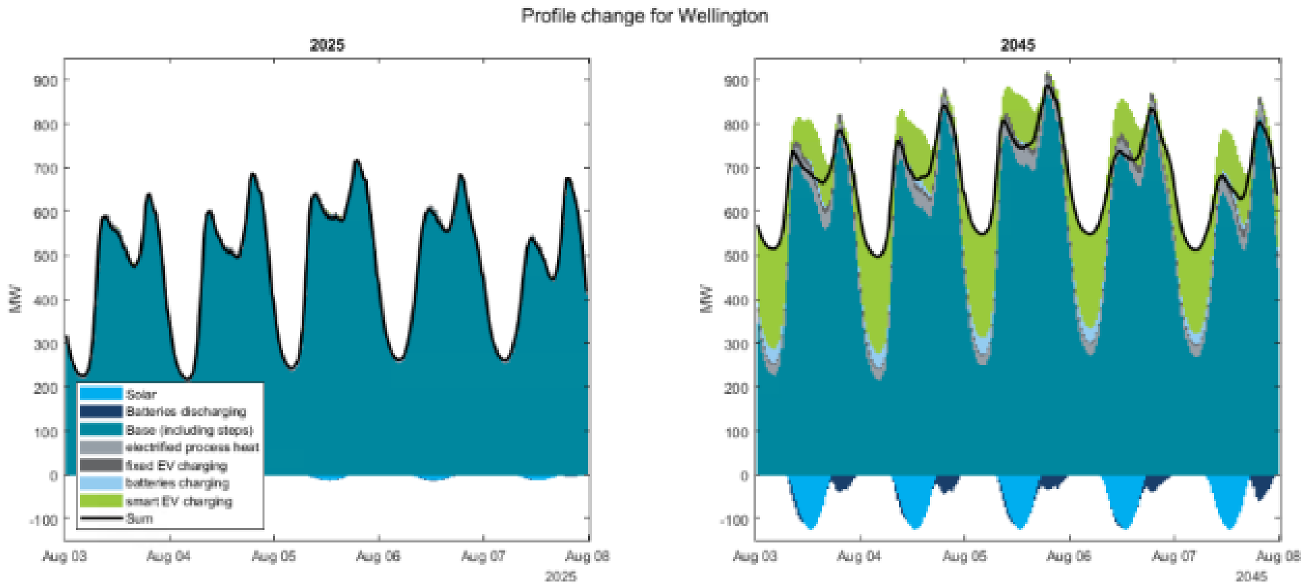
One key new driver is the expected increasing trend in electrifying industrial and other processes in the New Zealand economy, as the country seeks to reduce greenhouse gas emissions. Forecasting the pace and impact of this driver is highly uncertain. In recognition of this, Transpower is seeking an uncertainty mechanism to help deal with this driver.

While highly uncertain, the impact of electrification on the demand forecast, as a whole, is still expected to be relatively small until the end of RCP4. Also, major changes in the field (for example large-scale process heat electrification) would usually be funded under major capital projects, rather than base capex (the proposed allowance for which is driven by the demand forecast). Figure 5-2 below provides a hypothetical example of how electrification could impact the Wellington's electricity demand profile by 2045, assuming a high level of electric

[67] Fonterra, Submission on the draft RCP4 plan, November 2022. Available at: **https://tpow-corp-production.s3.ap-southeast-2.amazonaws.com/public/uncontrolled_docs/6.%20Fonterra%20Submission%20-%20Transpower%27s%20RCP4.pdf?VersionId=KJzcrOFEqsEHYlHN3_iqCLU1gFkNf4Lg**

vehicle charging smartness. It shows that electric vehicle charging is likely to increase total electricity demand, but smart electric vehicle charging could help spread the load and reduce the amount of grid investment needed.

Figure 5-2 Hypothetical demand profile change with electrification



Source: Transpower, RFI026 Transpower Response.pdf

5.4 Conclusion

We have verified Transpower’s demand forecasting approach against evaluation criteria ToR clause A1(h) and A1(i) and consider it sound. Nevertheless, we consider the bottom-up modelling that incorporates distributor-provided step changes could be further improved. A step in the right direction would be to undertake a review to understand any systematic trends that may show a predictable lag between the distributor-estimated timing of demand step changes compared to when those step changes tend to actually occur.

Part C

Stakeholder consultation and deliverability

6. Stakeholder consultation

Sections 4.6 and 4.7 of the ToR require the IV to “provide an opinion on the extent and effectiveness of Transpower’s consultation with its stakeholders” and to “provide an opinion on the extent to which Transpower has considered stakeholder feedback in developing its proposal.”

No specific criteria for assessing Transpower’s stakeholder consultation is provided. Therefore, our evaluation of Transpower’s proposed customer engagement process is informed by our understanding of GEIP and our assessment against the criteria used by SenateSHJ in November 2022.[68].

The following table summarises our verification of Transpower’s stakeholder consultation process for RCP4.

Table 6-1 Verification summary of Transpower’s stakeholder consultation process

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	None identified
Key issues that Commission should focus on	None identified

6.1 Overview of stakeholder consultation

As discussed below, Transpower takes a structured approach to stakeholder consultation. The consultation process is clear and clearly communicated to stakeholders in both written form and through presentations. The RCP4 consultation process complements an ongoing set of stakeholder engagement channels, including the Customer Advisory Panel, ongoing Individual Engagement Plans, and public communications (such as the online connections dashboard).

The RCP4 consultation process is occurring over multiple rounds:

– Between May and September 2022, Transpower consulted on a range of issues, including modified service measures, resilience, and asset management.
– In September 2022 Transpower formally published its draft RCP4 plan and invited submissions from its customers. This included explanatory material of key features of the draft plan and a response form for customers to complete.
– Transpower received eight submissions by November 2022 and published a summary of responses by December 2022.
– While Transpower considered a further round of industry-wide engagement in early 2023, Transpower opted against doing so as customers were broadly supportive of Transpower’s draft proposal.
– Transpower is continuing to engagement with customers on an individual basis where needed, including four regional EDB workshops in April and May 2023 to discuss regional expenditures.
– Transpower will submit its draft proposal to the Commerce Commission by December 2023, following which there will be further opportunity for engagement.

Stakeholders have so far provided a range of opinions in their submissions, both in support of and against specific aspects of the draft proposal. Generally, stakeholders were supportive of the draft proposal. The following concerns were noted by multiple stakeholders:

– Transpower did not fully address affordability and efficiency of supply—Transpower has acknowledged these concerns and responded to submitters through letters and meetings.

[68] SenateSHJ, SHE020 SSHJ RCP4 final expert opinion 1122.pdf

- Proposed service measures could be improved to better reflect performance—Transpower has made further changes to its proposed service measures (such as AH and CS2) and will continue to engage on points of service categorisation for GP2.
- Uptake of distributed energy resources (DER) remains uncertain and opaque—Transpower acknowledged these uncertainties and is strengthening engagement to better understand stakeholder views.
- Significant uncertainty and disagreement around pace of investment needed to support electrification—Transpower acknowledged these uncertainties and is strengthening engagement efforts to better understand stakeholder views.
- Improved outreach and communication are required to support resilience investments—Transpower has significantly improved its outreach and is committed to continuous improvement.
- Skills shortages are a risk to deliverability and require a coordinated response—Transpower acknowledged these risks in its deliverability review and is carrying out workforce planning and development initiatives.

6.2 Evaluation approach

We reviewed a broad range of documents to form our opinion. These include but are not limited to Transpower communication materials (consultation papers, slides, empty response forms, Transpower responses to stakeholder concerns), Transpower internal materials (Customer Engagement Plan, Customer Advisory Panel Meeting Minutes, internal feedback/action register), and stakeholder submissions. We did not engage directly with external stakeholders other than reviewing their responses to the RCP4 stakeholder consultation.

We visited Transpower on 22 March 2023 to better understand their approach, ask questions, and clarify issues. Following this workshop, we raised one RFI to gain a better understanding of how Transpower has considered issues raised to inform its proposal, both in terms of process and substantive changes made, to which we received a detailed satisfactory response.

6.3 Evaluation

We relied on the assessment criteria used by SenateSHJ to inform our assessment (used as subheadings in our analysis below) of Transpower's stakeholder consultation. Overall, we agree with the conclusions SenateSHJ reached in November 2022 and are satisfied that Transpower is continuing to engage at a similar standard.

We have introduced one additional criterion "Consideration of stakeholder feedback" to verify to what extent Transpower has taken stakeholder concerns on board, whether any changes (or lack whereof) to the RCP4 proposal are justified, and how Transpower has communicated with its customers on any changes (or lack thereof).

6.3.1 Proper allocation of resources

Based on the documentation sighted, we are satisfied that Transpower meets this criterion. This was also the conclusion reached by SenateSHJ. It is evident from the documentation and our discussions with Transpower that it has dedicated an extensive range of resources to stakeholder consultation across multiple channels and has used them effectively to drive the process.

6.3.2 Clearly defined scope

Based on the documentation sighted, we are satisfied that Transpower meets this criterion. This was also the conclusion reached by SenateSHJ. The RCP4 consultation process is clearly defined and self-contained. Systematic processes are in place to escalate or redirect issues towards other decision-making mechanisms, such as governance group meetings.

6.3.3 Clear method for identifying and prioritising stakeholders

Based on the documentation sighted, there is a clear method for identifying and prioritising stakeholders. The Customer Engagement Plan clearly identifies the most relevant stakeholders. The Individual Engagement Plans further detail Transpower's engagement with individual stakeholders. Individual Engagement Plans are dynamic documents that allow flexibility for engagement managers to tailor the amount and detail of engagement. Transpower demonstrated prioritization through its multiple channels of engagement, from broad public release of documents to regular one-on-one meetings with key customers. We understand that Transpower is exploring expanding engagement to more stakeholders through channels such as the Customer Advisory Panel, the Customer Representation Panel, its website, and indirect engagement with consumers through Transpower customers.

6.3.4 Fairness and accessibility to stakeholders

Transpower's consultation process is overall fair and accessible. Transpower's RCP4 communication materials are generally clear and easy to understand. Technical jargon was minimal and Transpower clearly highlight practical impact of its proposal. We understand that Transpower is conscious of its stakeholders' capacity (which may change over time) during consultations and tailors its engagement accordingly. According to Transpower, stakeholders agreed that that the materials provided were useful and fit-for-purpose. The consultation process occurred over a range of formats and mediums (such as written documents, interactive webinars, and one-on-one meetings). We are not aware of any stakeholder complaints in this area.

6.3.5 Clear and consistent narrative

In the context of RCP4, we consider that Transpower's narrative could be clearer, but acknowledge that Transpower is making significant progress. SenateSHJ considered this area a key shortcoming of Transpower's stakeholder consultation. However, SenatSHJ was evaluating Transpower's proposed approach to engagement as of October/November 2022, whereas this verification focuses on actual engagement carried out to date for RCP4.

Given the materials we have reviewed, we see evidence of a clear narrative focused on the changing needs of New Zealand's electricity sector, particularly in increasing resilience and meeting the challenge of increased electrification of the economy. There is a clear focus on better understanding and meeting customer needs, though Transpower has acknowledged that further work is needed to understand its customers. Stakeholders agreed that Transpower could further clarify its narrative and play a more strategic role in the electricity sector. During consultation, many submitters called for further leadership from Transpower, especially around DER, electrification, resilience, and workforce shortages.

6.3.6 Continuous improvement

This is a key strength of Transpower's stakeholder consultation approach. Transpower's documentation clearly shows a process of continuous improvement between RCP3 and RCP4. SenateSHJ scored Transpower 3.7 out of four for this criterion, citing improvements in:

– Increased resource commitment to communications and engagement teams and processes.
– Alignment of customer and communication plans.
– Updated Consumer Advisory Panel composition to include more stakeholder viewpoints.
– More accessible, proactive, and multi-channel engagement plans for RCP4.

Transpower customers appreciated Transpower's improved approach. The 2021 Customer Engagement Survey showed that over 70 percent of customers are satisfied, compared to 50 percent in 2020.[69]

We consistently see evidence that Transpower is committed to continuous improvement through further improvements, including quarterly updates to customers on its engagement progress. The proposed new CS1 service measure (focused on overall customer satisfaction) demonstrates Transpower's commitment to a high standard of stakeholder consultation.

6.3.7 Consideration of stakeholder feedback

Given the evidence we have seen so far, we are satisfied that Transpower has adequately considered stakeholder feedback in developing its RCP4 proposal. Transpower is actively developing its proposal so it is possible that our assessment may become outdated following the release of the final RCP4 proposal. Nonetheless we understand

[69] Transpower, 2021 Customer Engagement Survey, 2021.

that robust processes are in place to fully consider stakeholder feedback to inform Transpower's final RCP4 proposal.

While visiting Transpower, we raised a range of issues around stakeholder concerns across multiple topics. Transpower staff were clearly aware of these concerns and provided clear justification for any actions they have taken to address these concerns, or for deciding not to act. Transpower has a consultation feedback register that clearly assigns each concern raised to the relevant staff member to provide a response. The responses include actionable steps to address stakeholder concerns, including letter responses, one-on-one meetings, escalation to working groups, and references to work already in place to address concerns. While we did not necessarily trace each stakeholder concern to substantive changes to the final RCP4 proposal, we saw evidence across documents Transpower provided that Transpower is seriously and systematically considering stakeholder concerns and making changes to address these where warranted.

6.4 Conclusion

We are satisfied with Transpower's stakeholder consultation approach and consider it compliant with the relevant sections of the IMs and the verification TOR. Transpower's stakeholder consultation for RCP4 significantly improved upon that for RCP3. Though the consultation process is ongoing, we expect Transpower to continue engaging with stakeholders to a high standard as the RCP4 process continues.

7. Deliverability

The overall deliverability of the proposed base capex and opex during the regulatory period is an important consideration in the approval of expenditure allowances and forms a component of the ToR[70]. In this Section, we evaluate the extent to which Transpower has adequately addressed in its proposal its ability to deliver against proposed base capex and proposed opex during RCP4, taking into account the expected availability of Transpower and external resources required to deliver the proposed works.

While deliverability is an important component in the approval of base capex and opex, our analysis of the components of base capex and opex are outlined in separate Sections of this report and we have not sought to draw direct link between our deliverability assessment and the approval (or otherwise) or any particular programme.

The evaluation criteria used to assess deliverability was not specified in the ToR, so we have developed the set of criteria, and this is outlined in Section 7.2 of this report.

Our overall findings are summarised in the following table.

Table 7-1 Verification summary of deliverability of base capex and opex programmes

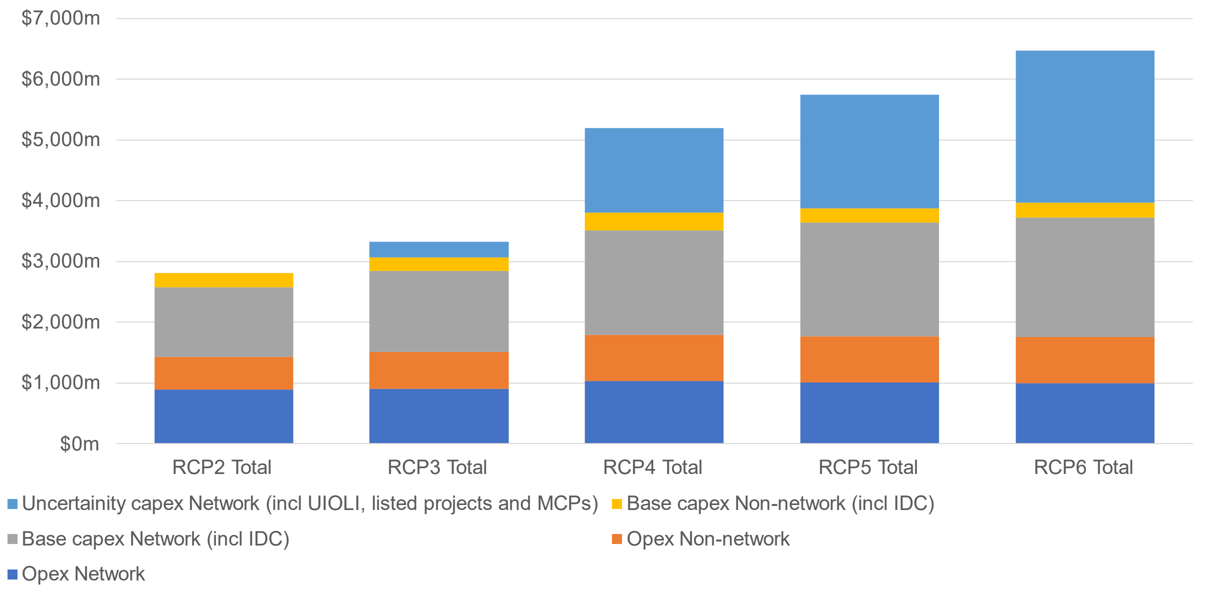
Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept
Potential scope for improvement	None identified
Key issues that Commission should focus on	Consider the ability for Transpower to recruit significant workforce (including approximately 200 additional people (often in specialised areas) over the next three years) to deliver expected programmes. Concerns are driven by the historically high demand for energy specialists.

[70] The ToR require the IV to “provide an opinion on the extent to which Transpower has adequately addressed in its proposal its ability to deliver against its proposed base capex and proposed opex during RCP4, taking into account the expected availability of Transpower and external resources required to deliver the proposed work”.

7.1 Proposed changes to base capex and opex

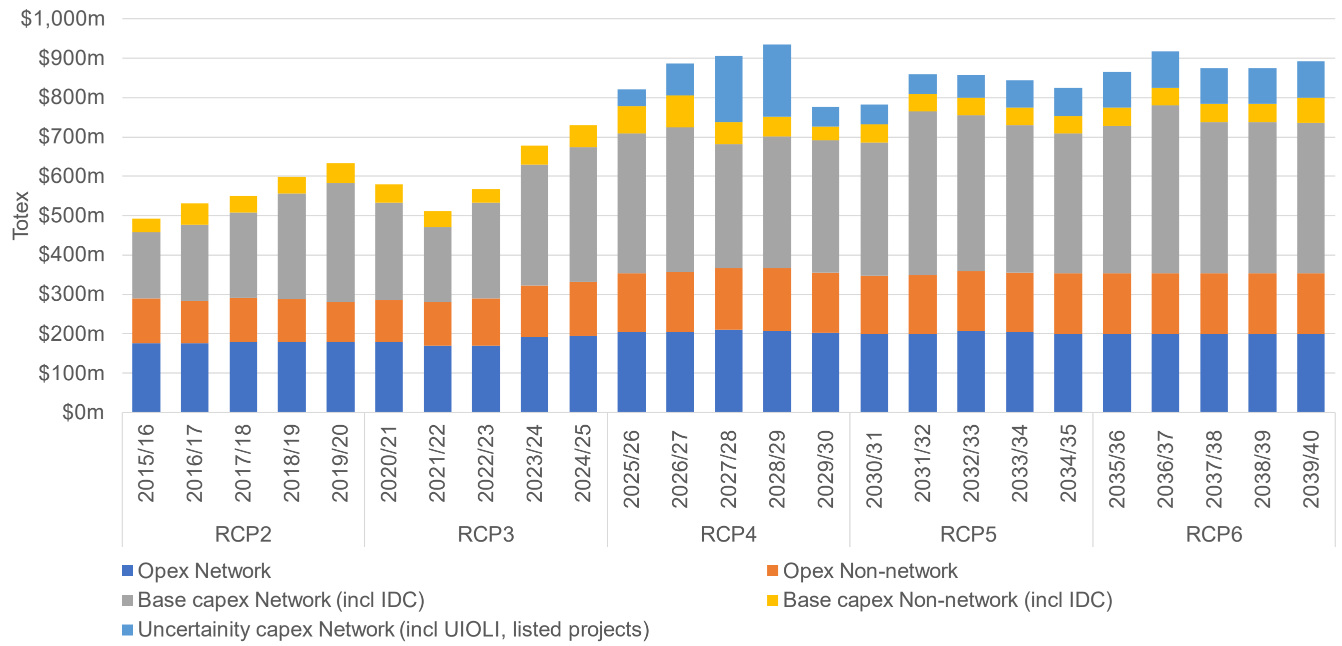
Based on their proposed expenditure, Transpower's base capex and opex programme is expected to grow by 26 percent (5% CAGR) between RCP3 and RCP4. Transpower are also forecasting increases in listed projects, major capital project and customer capex work (collectively Uncertainty capex in the figure below). As shown in the figures below, the RCP4 proposed expenditure level represents a step change from historical RCP2 and RCP3 levels and expenditure levels are expected to remain high in RCP5 and RCP6.

Figure 7-1 Total actual and forecast expenditure RCP2 to RCP6 (by RCP)



Source: GHD analysis of Transpower data

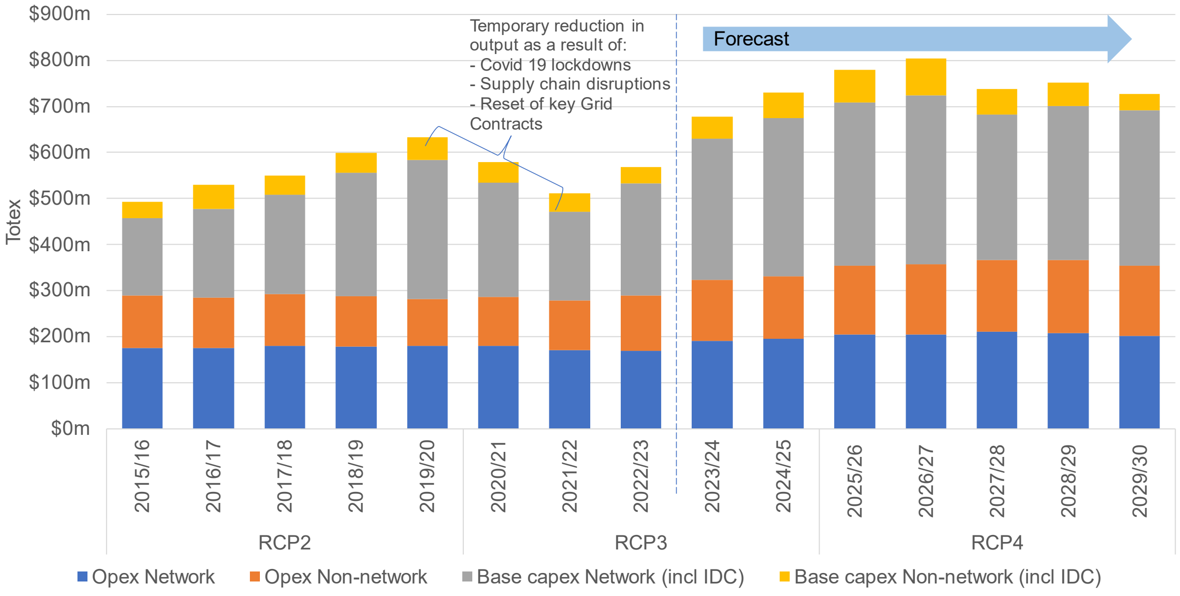
Figure 7-2 Total actual and forecast expenditure RCP2 to RCP6 (by year)



Source: GHD analysis of Transpower data

The total growth across all categories of expenditure (i.e., the opex, base capex, customer funded works and major capital project categories) between RCP3 and RCP4 is 54 percent (9 percent CAGR). The HVDC cable replacement listed project is a significant proportion of the potential listed projects expenditure, but largely draws from offshore resources for delivery and have a high material cost component. Excluding the HVDC cable replacement listed project, the growth across all other categories is 47 percent (8 percent CAGR)[71].

Figure 7-3 Total actual and forecast expenditure RCP2, RCP3 and RCP4



Source: GHD analysis of Transpower data

7.2 Evaluation approach

The ToR did not provide specific evaluation criteria for the assessment of deliverability. To evaluate the extent to which Transpower has adequately addressed in its proposal its ability to deliver against proposed base capex and proposed opex during RCP4, we considered the following:

1. Whether Transpower have historically been able to deliver the volume of expenditure required for RCP4.
2. Whether Transpower's internal workforce has sufficient capability and capacity.
3. Whether Transpower has sufficient contracted services to deliver the programme of works.
4. Ability to procure the necessary material and equipment to deliver the programme of works.
5. Whether outage constraints are likely to prevent Transpower from delivering the programme of works.
6. Whether Transpower's programme delivery approaches support the above elements to deliver the programme within the required timeframes, expenditure, safely and to an appropriate quality.

The following table summarises how we assessed each of these deliverability aspects.

[71] The listed project, MCP and customer components of the RCP4 work programme are subject to business case development and (for MCPs and listed projects) regulatory approval.

Table 7-2 Evaluation criteria and approach: Deliverability

	Deliverability criteria	Aspects reviewed	Key evidence sighted
1	Historic delivery performance	– Review of previous proposed expenditure against actual expenditure	– Previous RCP submissions – Previous IV reports
2	Internal workforce had sufficient capability and competencies	– Workforce Planning – Retention Rates – Training and Recruiting Plans – FTE growth in relevant areas	– RCP4 Deliverability Review – Transpower Workforce Plan - internal resource needs V2 – Business Support Opex Overview – Asset Management & Operations Opex Overview RCP4 – FTE uplift summary & Ratios
3	Ability to contract the necessary services	– Review effectiveness of new contracted services approach	– Grid Services Contract journey – RCP4 Deliverability Review
4	Procure necessary material and equipment	– Evidence of an effective procurement approach – Strategies to ensure long lead time items don't delay projects	– Procurement Methodologies for Identified Programmes
5	Outage constraints	– Review effectiveness of outage planning approach – Review whether service measure quality standards impact ability to undertake outages	– RCP4 Grid Service Measures Refresh Summary - March 2023 – Outage planning documentation
6	Programme Delivery Capability	– Review effectiveness of new programme delivery approach	– Programme Delivery Framework – RCP4 Deliverability Review – RCP4 IV Presentation - Asset Management System and Decision Framework

7.3 Historical delivery performance

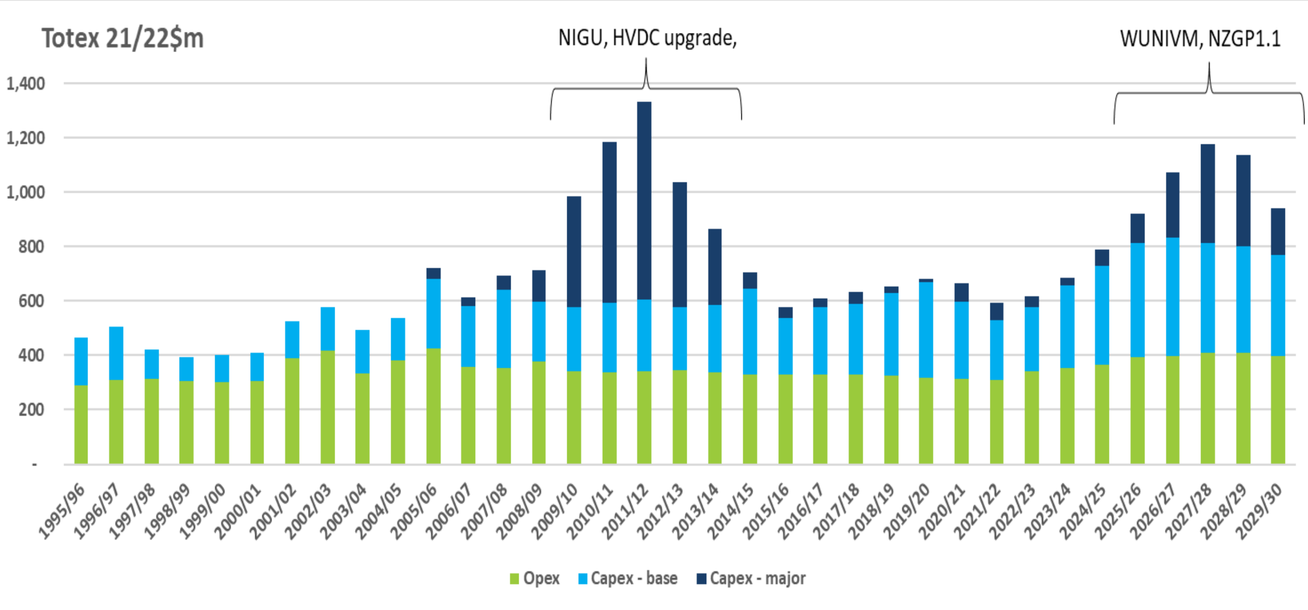
Historical delivery performance considers whether Transpower have previously been able to deliver the volume of expenditure required for RCP4.

Historically, Transpower have delivered between approximately $500m and $600m each year in RCP2 and similar levels of expenditure in the first two years of RCP3. To deliver its base capex and opex programme (as well as major capital projects, listed and customer projects) in RCP4, Transpower have forecast that they will have to ramp expenditure up to approximately $900m for 2027/28, which represents a significant increase.

Transpower have previously had periods of significantly higher levels of expenditure. As shown in the figure below, commencing in the early 1990s, there have been periods where expenditure has increased significantly from year to year as well as periods such as 2010 to 2013 where the expenditure has exceeded the forecast maximum RCP4 expenditure. It should be noted that a large percentage of expenditure during this period (as well as the increase in the expenditure from previous years) was due to undertaking two major projects, NIGU and the HVDC upgrade. Similarly, forecast totex for RCP4 is being driven by the WUNIVM and NZGP1.1, which are major projects (although smaller in size than previous major projects). We note a key implication of many smaller projects compared to few large ones (as is forecast to occur in RCP4) is that need for more FTEs to deliver the work.

The historical data indicates that previously Transpower has been able to expand its organisational capacity to deliver step changes in total expenditure equivalent to those expected in RCP4. Although Transpower will still be required to increase their base capex and opex to a greater level (up to $800m) than in previous periods.

Figure 7-4 Total expenditure 1995-2030



Source: Transpower, Deliverability response - Table 138 Capex and Opex.xlsx

7.3.1 RCP3 delivery performance

The following table shows Transpower's actual expenditure against the RCP3 allowances for opex and capex for year 1, 2 and 3 of RCP3.

Table 7-3 RCP3 Year 1 and 2 Forecast v Actual Expenditure ($m)

Expenditure Area	2020/21			2021/22			2022/23		
	Allowance	Actual	Difference (%)	Allowance	Actual	Difference (%)	Allowance	Actual	Difference (%)
Opex	294.7	286.3	-3%	292.7	279.0	-5%	297.0	310.7	+5%
Capex	236.9	282.1	+19%	279.3	221.2	-21%	276.7	267.3	-3%
Total	**531.6**	**568.2**	**+7%**	**572.0**	**500.2**	**-13%**	**573.7**	**578.0**	**+1%**

Source: Transpower, RCP4 Deliverability Review

The figures in the table, when aggregated over the three years, indicated Transpower's actual opex and capex were both slightly below the allowance amounts. Total actual opex was $884m compared with an allowance of $876m, and total actual capex was $793m compared with an allowance of $771m.

Reasons for differences in individual years are explained as follows:

– **Opex**

  - **2020/21**- Actual expenditure was 3% below allowance. This was achieved by actively driving efficiencies and rationalisation of licences and leases. The lower expenditure was partially offset by insurance industry premium increases and increases in maintenance expenditure.
  - **2021/22** – Actual expenditure was 5% below allowance. Actual CPI from 2021/22 of 6.29% increased the allowance for 2021/22. While Transpower experienced cost escalation in 2021/22 there is a lag between the higher 2021/22 CPI and when these costs will impact long term contracts. Supply chain and covid restrictions also resulted in lower cost in several areas. The lower expenditure was partially offset by an increase in insurance premiums.
  - **2022/23** – Actual expenditure was 5% above allowance driven by increased insurance costs as well as increased FTE needs ahead of additional works to be undertaken in opex and capex programs.

– **Capex**

- **2020/21**- Actual expenditure was 19% above allowance. The RCP3 allowance assumed that Transpower's service provider reset would occur in Year 1 and was reduced by a top-down adjustment and therefore forecast lower spend. However, the service provider reset was delayed by a year due to the Covid-19 lockdown restrictions, resulting in spend higher than the 2020/21 allowance.
- **2021/22** – Actual expenditure was 21% below allowance. The RCP3 allowance assumed that the service provider reset would have a smaller impact in Year 2. However, the service provider reset was delayed by a year to 2021/22 due to the Covid-19 lockdown restrictions that together with supply chain issues resulted in lower spend against the 2021/22 allowance. Additionally, the intelligent conductor management programme has enabled a change of strategy to the conductor portfolio which allowed Transpower to better consider alternative options and life extension options. This has enabled a reduction in the expected reconductoring volumes. Transpower have also adopted a Tower to Pole replacement programme for smaller towers resulting in a net reduction, to tower painting.

Differences in forecast versus actual expenditure in specific base capex and opex programs are discussed within their relevant sub-sections of this report.

7.3.2 Conclusion

Transpower have previously had periods of significantly higher levels of expenditure than the peak of RCP4, such as 2010-13 where the expenditure has exceeded the forecast maximum RCP4 expenditure (due to major projects). This demonstrates that historically Transpower has the organisational capacity to expand its total expenditure to the levels required in RCP4.

Transpower have broadly met their RCP3 allowances to date with differences in individual years due to covid and supply chain impacts as well as a delay in the new grid services contracts. Based on expenditure to date it is considered likely that Transpower will be able to deliver the remainder of its RCP3 programme.

7.4 Internal workforce capability and competencies

Transpower's internal workforce capability and capacity are maintained through a combination of workforce planning, turnover and recruitment.

7.4.1 Workforce planning

Transpower divides its workforce into the following regulatory categories[72]:

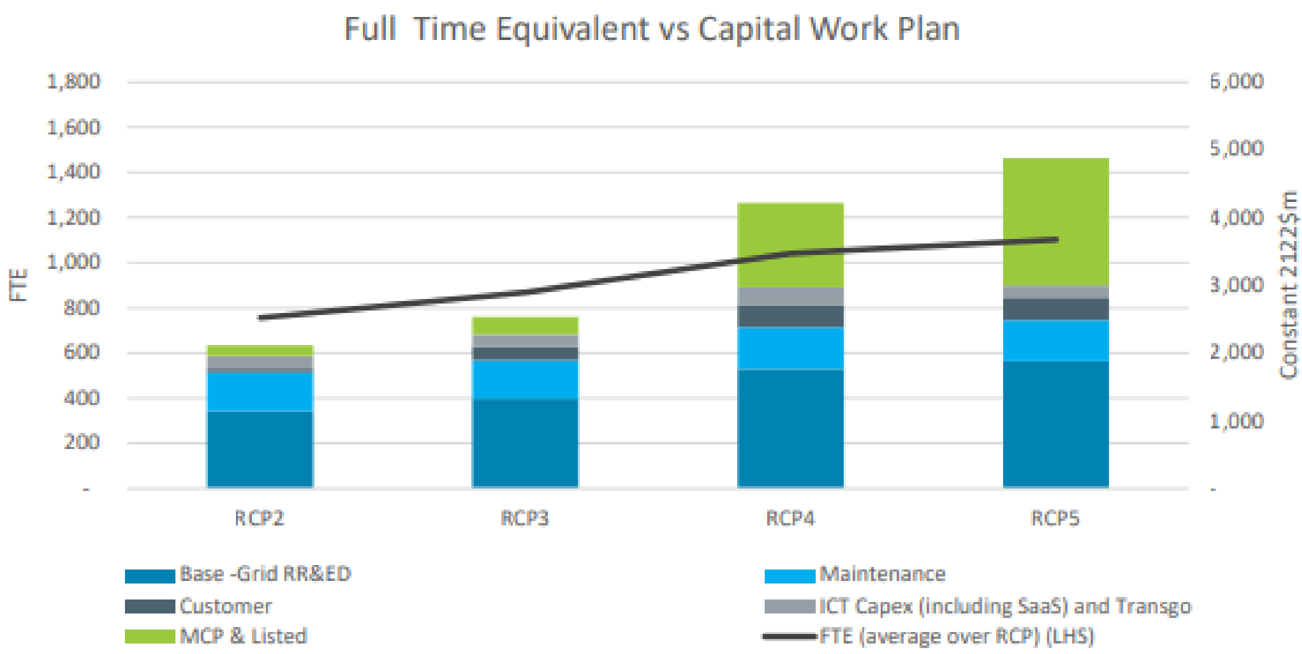
– Asset Management and Operations (AM&O) includes Grid Development, Grid Delivery, and the Grid Operations (excluding the System Operations function), as well as functions of Procurement and Supply, Landowner Relations, Property and Environment.

– Business Support includes Information Services and Technology, Customer and Strategy, People, Corporate Governance, External Affairs (excluding Landowner Relations and Property and Environment) and Corporate Services (excluding Procurement and Supply).

Transpower's existing workforce will be required to grow from its current level to deliver the RCP4 and RCP5 programs as shown in the figure below. Overall workforce capacity is forecast to grow by 45 percent from RCP2 to RP5, with a significant step up of 260 FTEs from 2021/22 to 2025/26.

[72] Transpower, DEL005 Transpower Workforce Plan – internal response needs v2

Figure 7-5 Actual and proposed FTE growth from RCP2 to RCP5



Source: Transpower, Transpower workforce plan – internal resource needs, March 2023, Figure 1. [DEL0005]

Transpower expected low growth in its capex and opex programmes when it submitted its RCP3 proposal. This led to a planned minimal workforce capacity growth through RCP3. However, a greater number of connection enquires and the need to recruit ahead of the increased RCP4 base capex and opex programs means the workforce is now required to significantly increase ahead of and as RCP4 commences. As a result, Transpower's regulated workforce is forecast to grow by 12 percent by the end of 2022/23 (from 752 to 845 people) since the submission of the RCP3 proposal, with most of that increase (62 of the 93 FTEs) expected to be engaged in 2022/23.[73]

Transpower's workforce capacity will need to grow further to deliver the remainder of RCP3 and then the RCP4 work programs. The drivers for this growth are[74]:

– The increase in base capex and ICT investment.
– The increasingly complex grid operations (for example as more intermittent generation is added) and it becomes harder to arrange planned outages.
– The planning and delivery of increasing major capital project and customer work for the remainder of RCP3.
– Preparing the RCP4 work programme by completing initial investigations including many during RCP3.
– Undertaking system planning and modelling for the major capital project investments for RCP4 and beyond.

The following table outlines Transpower's forecast workforce growth for the remainder of RCP3 and into RCP4 (before productivity gains). The forecast includes increased workforce capacity to deliver major capital project and customer work programs, which are is dependent on the timing of approvals, and which account for a significant proportion of proposed expenditure in RCP4.

The forecast was developed based on a workforce planning model that forecasts Transpower's organisational workforce needs into the future based on predicted volumes of grid work (including major capital projects and customer driven work), ICT work programs and any other activities. The model overestimated resource requirements in several areas so a bottom-up review of the future resourcing requirements was undertaken by each division. In most instances the bottom-up need has been used as the resource forecast.

[73] GHD analysis of data contained in Transpower, Transpower workforce plan – internal resource needs, March 2023, Figure 1. [DEL0005]
[74] Transpower, DEL005 Transpower Workforce Plan – internal response needs v2

Table 7-4 Actual and proposed FTEs RCP3

	Base year	RCP3				
	2017/18 Actual	2018/19 Actual	2019/20 Actual	2020/21 Actual	2021/22 Actual	2022/23 Forecast
AM&O	445	437	453	456	461	486
Total Business Support	307	303	323	326	322	359
Total	**752**	**740**	**776**	**782**	**783**	**845**

Source: GHD analysis of data contained in Transpower, DEL0005 Transpower workforce plan – internal resource needs, March 2023.

Table 7-5 Proposed FTEs RCP4

	RCP4				
	2023/24 Forecast	2024/25 Forecast	2025/26 Forecast	2026/27 Forecast	2027/28 Forecast
AM&O	541	583	616	617	627
Total Business Support	393	416	427	428	418
Total	**934**	**999**	**1043**	**1045**	**1045**

Source: GHD analysis of data contained in Transpower, DEL0005 Transpower workforce plan – internal resource needs, March 2023.

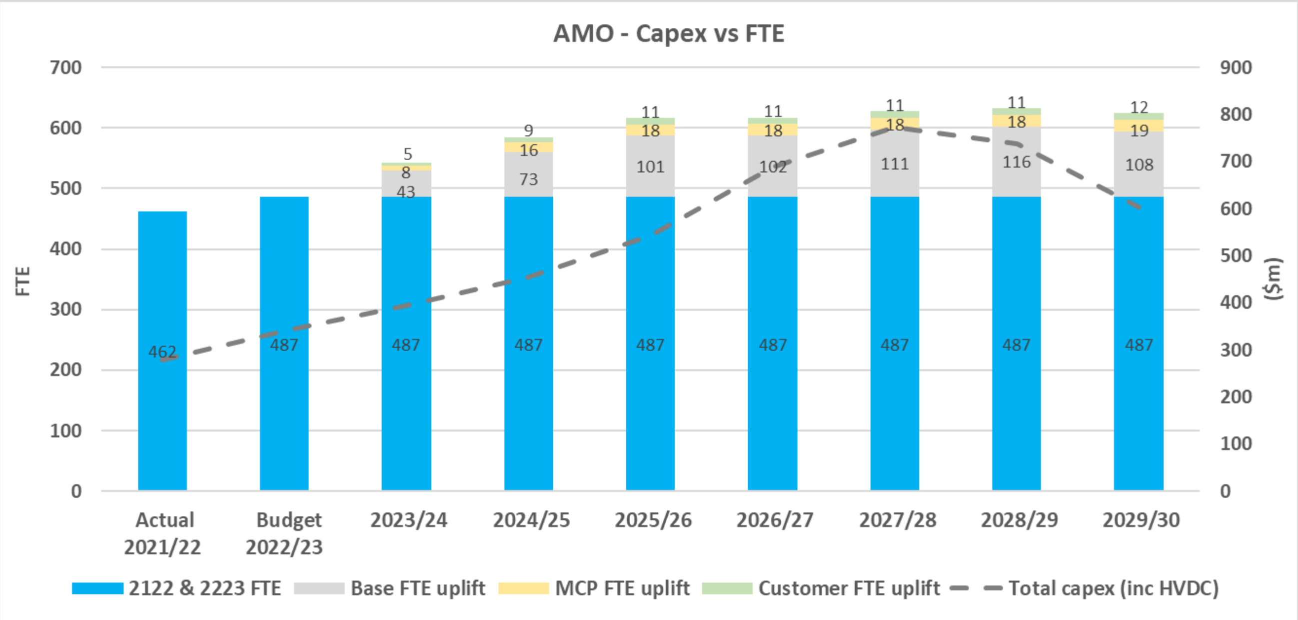
AM&O

The three core elements of Asset Management and Operations (AM&O) are:

- Grid Development,
- Grid Delivery, and
- Operations.

The workforce capacity requirements for the AM&O divisions are driven by the need to plan, build, maintain and operate the grid. Importantly, there is a requirement that this capacity be available prior to the capital build starting. AM&O also includes Procurement and Supply, Environmental, and the Landowner Relations and Property functions.

Figure 7-6 AM&O - Capex vs FTE



Source: Transpower, DEL0005 Transpower workforce plan – internal resource needs, March 2023.

The figure above outlines the growth in AM&O is required prior to the delivery of works. To understand the requirements, it's important to consider the role of each team in the delivery of works: [75]

- The Grid Development group typically work 2 to 3 years ahead of the capex work programme to investigate and plan. Transpower propose an additional 38 FTEs for this group.
- The Grid Delivery team is accountable for the delivery of the physical works associated with work programme. The 48 additional FTEs in this group are not required as early as the Grid Development team.
- Operations are accountable for outage planning, asset availability, real time communication and coordination with customers, Service Providers and the System Operator before during and after planned and unplanned outages. Transpower propose an additional 40 FTEs for this group.

Business support

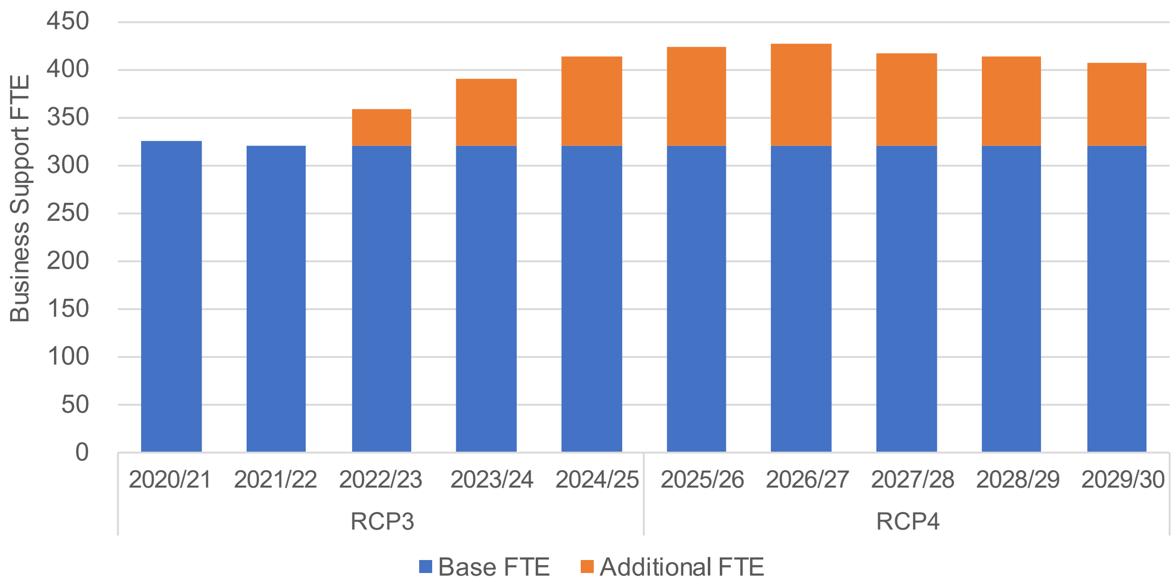
The core elements of Business Support are:

- Information Services and Technology (IST)
- External Affairs
- Corporate Services
- People
- Strategy and Customer
- Executive office

The workforce capacity requirements for the Business Support divisions are driven by the need to support a large base capex and customer connection programme, manage a more complex regulatory environment and address additional safety and environmental obligations.

The actual (last year of outturn) and forecast number of FTEs employed within business support is shown in the following figure. At its peak, Transpower forecast a total of 427 FTE in business support by 2026/27 - an additional 106 FTE over and above the 321 FTE in 2021/22. By the end of RCP4, this forecast falls to 408 FTE in total.

Figure 7-7 Number of FTE's and contractors under business support



Source: Transpower, EOP009 FTE Uplift summary & Ratios.xlsx, worksheet 'Ratios'

[75] Transpower, RCP4 Deliverability Review

7.4.2 Turnover and recruitment

The following table presents Transpower's turnover rates and average length of service for the last five years. The turnover rate was relatively stable for three years between 2017/18 and 2019/20 and then rose significantly from 7.5% in 2019/20 to 12.4% in 2020/21; a change that was sustained through 2021/22 at 15.5%. Year to date in February 2023, the retention rate remained high compared to historic levels and was 13.4%, with 57 staff having left between July 2022 and February 2023.

Discussions with Transpower indicated that the increased turnover rate is partly a result of covid related issues. Despite the increased turnover of staff in the last couple of years, the average length of service has been very consistent over the period 2017/18 to 2021/22.

Table 7-6 Transpower turnover rates and average length of service

Turnover	2021/22	2020/21	2019/20	2018/19	2017/18
Staff leaving	128	102	61	72	59
% of total staff	15.5%	12.4%	7.5%	9.0%	7.7%
Average length of service (years, permanent staff)	8.76	8.80	8.67	8.75	7.65

Source: Transpower, RFI013 Transpower Response.pdf

The effect of people turnover on overall deliverability depends, in part, on which groups in the business are most affected. The following table shows the staff turnover per division over the last several years. The most critical divisions for the delivery of the opex and base capex programme are Grid Delivery, Grid Development and Operations. As shown in the table, Grid Development and Operations have lower than average turnover rates whilst the Grid Development division has a slightly higher rate.

Table 7-7 Transpower turnover rates by division

Division	Sep-19	Mar-21	Oct-21	Dec-22	Feb-23
Corporate Services	17.3%	11.8%	20.6%	15.3%	17.0%
External Affairs	18.9%	7.1%	17.5%	19.1%	17.3%
Grid Delivery	**9.3%**	**14.1%**	**12.1%**	**16.1%**	**14.4%**
Grid Development	**7.4%**	**6.2%**	**13.0%**	**9.1%**	**9.2%**
ICT	9.9%	12.4%	19.5%	16.1%	13.7%
Operations	**7.1%**	**8.0%**	**11.7%**	**10.8%**	**10.5%**
People	2.1%	8.9%	20.9%	15.2%	20.5%
Strategy & Customer	4.3%	0.0%	16.7%	23.3%	17.1%
CEO	0%	8.0%	4.2%	16.0%	8.4%
Total	**9.3%**	**9.6%**	**14.9%**	**14.0%**	**13.2%**

Source: Transpower, RFI013 Transpower Response.pdf

Transpower recognise that the growth in required FTEs as well as the replacement of leaving FTEs will be challenging and have undertaken several initiatives to achieve the necessary growth.

Recruitment initiatives include:

– Market Transpower – refreshed employee value proposition for Transpower and sector including marketing campaigns.
– Internship – implementation of sponsorship for interns.
– International recruitment – steps change in the number offshore candidates.
– Workforce planning – building on the current practices to formalise and integrate workforce planning into the business planning processes.
– Accelerated onboarding – policy changes to support recruitment of additional candidates.

- Scaled up graduate programme to increase the pipeline of skilled employees into key engineering roles.
- Engaged an additional principal recruiter resource who has specialisation in search has been hired in anticipation of the growth in FTE.
- For roles that are difficult to recruiting for Transpower have a panel of recruitment agencies with international reach and networks that can source viable candidates.

7.4.3 Conclusion

Transpower have a well-developed workforce plan which identifies the internal resources needs as well as lead times required for different resources skills. The proposed additional resources across grid development, grid delivery, operations and business support are considered reasonable for the proposed ramp in expenditure and workforce volumes.

Transpower have commenced a range of initiatives to recruit and training addition people. Retention rates, allowing for the impacts of Covid-19, are considered reasonable. However, greater numbers of people leaving will increase the burden of recruitment to replace these individuals plus grow FTEs.

The demand for energy specialists is historically high and expected to remain high as the movements to decarbonise power systems occur throughout New Zealand and across the world. The current trend means Transpower is competing for increasingly scarce resources both locally and when seeking to attract (and retain) resources from overseas in some key areas of its business. While this challenge sits outside of Transpower's control, there is concern from the IV about the ability of Transpower to recruit approximately 200 additional people (often in specialised areas) into the business over the next three-year period necessary to deliver the expected programs.

7.5 Contracted services

7.5.1 Overview of Grid Services Contract

Transpower's Grid Service Contracts provide fault response, maintenance, and build services for the national grid.

Prior to 2022, there were 22 contracts across individual regions. In Transpower's Grid Services Contract Journey – January 2023[76], it was indicated that some of these where not commercially viable based upon the volume of work.

Based upon the expected growth in contracted services a new contract framework was adopted that includes mechanisms to support growth. These include:

- Forecasting of the two-year work programme forecasting, which articulates the projected non-contestable work programme for a service provider. This:
- Retain the flexibility to change the work program, whilst providing service providers greater certainty of Transpower work
- Incentivise service providers' continued investment in their people, specialist plant, equipment, and process improvement.
- Registration of Interest (ROI) process for large projects, which sets out the contestable work programme.

The new contract framework has reduced the number of regional service contracts, has created specialist services arrangements and has established a panel for contestable works. These elements of the Grid Services Contract are detailed below.

[76] Transpower, Grid Services Contract Journey, January 2023.

Regional Service Contracts

Transpower has established six regions for awarded contracts covering the provision of grid fault call-out response, operation, maintenance, and smaller project works for lines and substation assets. The six regions and contractors are shown in the figure below.

Figure 7-8 Map of new Gride Service Contract Regional Areas

Source: Transpower, IVP009 RCP4 IV Deliverability – overview.pdf

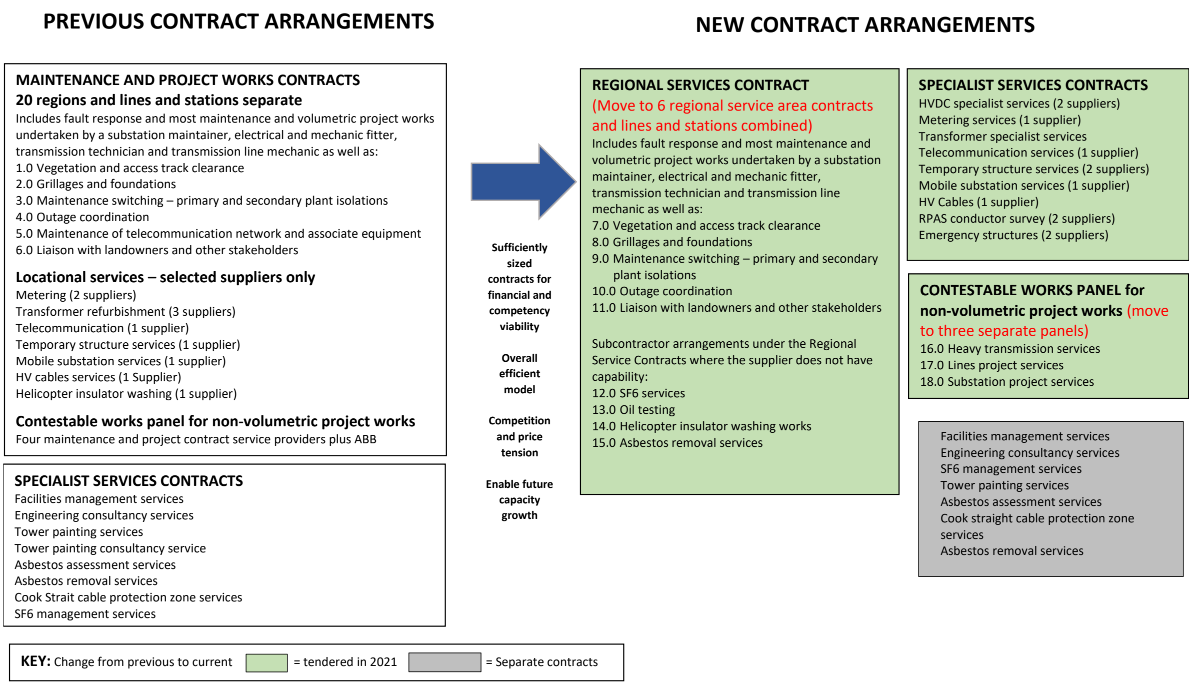
Specialist Service Contracts

Specialist Service Contracts are awarded to service providers on either a regional or national basis. These encompass emergency structure services, high voltage cables services, HVDC specialist services, mobile substation services, revenue metering services, and telecommunication services.

Contestable Works Panel

There are three Contestable Works Panels, one each for substation works, general lines work, and heavy wiring work. These panels do not restrict Transpower from considering other sourcing arrangements. The figure below displays the transition from the previous contract arrangement to the future contract arrangements.

Figure 7-9 Previous v future contract arrangements



Source: Transpower, DEL002 Grid Services Contract Journey

7.5.2 Initiatives to address deliverability

The changes to the Grid Services Contract will improve the ability of Transpower's service providers to deliver the remainder of the RCP3 programme and the RCP4 programme because of the following[77]:

- The forward visibility of the work programme has enabled longer-term work-force planning. The service providers have greater information to grow their workforce to meet the work programme in RCP4.
- The 'simplification' of the service provider base has enabled effective strategic communication. Service providers have easier access to senior Transpower executives, and Transpower has easier access to senior service provider executives. Delivery issues and challenges are easier to address and lead to earlier resolution.
- Consolidation of work into larger geographic regions enables more commercially viable work packages for service providers.
- Combining maintenance and project work drives efficiencies and can lead to greater throughput through better coordination of resources and outages with service providers.
- The newer contracts KPIs provide incentives for service providers to plan and deliver works safely and provide value for money.

The existing Grid Service Contracts were due to expire in 2021. Due to COVID-19, these were extended for a revised expiry date of 29 August 2022. The original RCP3 work plan allowed for a lower delivery year in year 2 to allow for the impact of the procurement process. The decision to extend a year during the covid lockdown affected the ability to ramp up as planned in the year (year 3) following award. The impact of the Covid-19 lockdowns, additional safety protocols, and ongoing increased level of sick leave has been managed by Transpower and their service providers to minimize the impact.

Despite this work, supply chain delays and lost productivity have affected delivery. The net result of these delays was a reduction in the work programme for the initial period of RCP3. Transpower have assessed the remaining RCP3 work programme and are confident of delivering the remainder of the programme.

[77] Transpower, Grid Services Contract Journey

7.5.3 Conclusion

Transpower have undertaken an update and streamlining of grid services contracts that provides a greater level of certainty regarding contractor work levels and forward work levels. This will enable service provides to grow their teams in line with the expected future work volumes. In addition, they have in place a range of contract KPIs, planning and training requirements for contractors to ensure that they integrated into Transpower's planning and workforce delivery approaches.

7.6 Procurement approach

7.6.1 Overview of procurement approach

Transpower has established procurement processes including the ability to tailor its sourcing strategies for larger projects. The Procurement Methodologies for Identified Programmes – December 2022[78] indicates an elevated period of supply chain risks due to Covid-19 and geopolitical events. This has been managed in the short term by monitoring the health of key suppliers with plans to improve supply chain resilience and procurement and supply chain digital systems capabilities chain digital systems capabilities in the future.

Transpower currently spends approximately $500m per annum on the procurement of goods and services across the company.[79] Approximately 85% is involved with grid services, Information and Communications Technology (ICT) services, or materials in support of the grid with the remaining 15% spent on other enabling services.

Procurement is centrally led with a mix of centralized and decentralized procurement activity. Organisational procurement functions include:

- Procurement Services that provide and promote procurement expertise, governance, policy and process improvements, and effective systems and tools.
- Category Management performs end-to-end supply chain management and strategic sourcing including assets and equipment, technical services, ICT, and Corporate indirect spend.
- Strategic Commercial Management ensures that key outsourced grid support and maintenance services and project works contracts are commercially sound and ensures the overall sustainability of Transpower's relationships with grid service providers.
- Inventory Management and Purchasing are responsible for the overall management of inventory levels, systems, and information, as well as the inventory purchasing activity.
- Logistics responsible for managing warehousing and logistics, ensuring materials are stored appropriately and delivered nationwide in support of grid project, fault restoration, and maintenance activities.

Consistent with other TNSPs, Transpower uses a combination of panels and outsourcing arrangements to deliver procurement outcomes. The range of panels are outlined in the following table.

[78] Transpower, Procurement Methodologies for Identified Programmes, – December 2022.
[79] Transpower, Procurement Methodologies for Identified Programmes, – December 2022.

Table 7-8 Panel arrangements

Panel	Panel description
Engineering Consultants	Outsourced design and advisory services for the efficient and effective operation of the grid. Approximately $45m per annum is procured through the EC panel and contracts, through a mix of sole-source and contestable work.
Grid Services	Grid Service Contract has recently been restructured with the introduction of 6 new regional service contracts, 13 specialist service contracts and the establishment of three contestable work panels. Further details are provided in Section 7.5 of this report.
Tower painting	Tower painting programme.
Facilities management	Regular maintenance of the grounds and buildings
Capital and line equipment	Period Supply Agreement or Panel Agreement approach for standard capital equipment and approved material purchases.
Transformers	Global supply panel.
ICT	Contract labour, outsourced services, technology, and telecommunications.

Source: Transpower, DEL002 Grid Services Contract Journey

For each panel, Transpower has established secondary procurement processes with a set of prequalified, contracted suppliers to ensure that goods and services are procured in a safe, compliant, efficient, value-focused, fair and transparent way to meet the needs of the business.

For Grid Services and Engineering Consultant panels, Transpower have introduced standard practices of the release of forward workplans utilising a modified Registration of Interest (ROI) process. These ROI processes help streamline procurement approaches, ensuring that there is commercial rigour applied to the project itself, while a strategic approach is applied to the panel management overall.

As part of the process, Transpower undertakes an optimisation approach using a combination of the following procurement approaches:

- Direct source – projects are directly allocated to a panel member, often to ensure the workforce is being maintained, and competency and capability retained.
- Selective source – competitively tender to a subset of the panel, based often on competencies with particular sites or equipment as well as provider interest and capacity.
- Closed competitive – full panel tender as there is interest in the project and to maintain competitive tension.
- Open competitive – tenders are openly published on GETS and not limited to existing suppliers/panel members.

To ensure value for money is maintained where direct sourced procurement approaches are used, Transpower uses methods such as benchmarking, quantity surveying, and open book pricing.

7.6.2 Long lead time items

Central to Transpower's delivery of its RCP4 capital programme is the ability to procure and deliver long lead time plant and equipment. The following table below sets out a list of current expected lead times for grid equipment and materials (noting that supply lead times vary regularly due to many factors).

Given the current expected lead times, it is worth noting that equipment and materials for year 1 of RCP4 will typically be procured in the preceding 1-2 years depending on the relevant lead times. The asset planning and grid works planning processes aim to build in appropriate procurement lead times to ensure equipment arrives on time.

Table 7-9 Expected Long Lead Time Plant and Equipment

	Front end Sourcing / RFQ (weeks)	Lead time from raising PO (weeks)	Total Weeks
Power transformers	13	62	**75**
Earthing transformers – non standard	13	55	**68**
Earthing transformers – standard	8	30	**38**
Local service transformers	4	54	**58**
Outdoor switchgear	3	38 - 68	**41 - 71**
Indoor switchgear	6	59	**65**
LVAC Switchboard	4	16	**20**
Neutral Earthing Resistor	4	26	**30**
Capacitor Bank	13	60	**73**
Dry Type (series and shunt)	13	65	**78**
Synchronous Condensers	13	52-104	**65-117**
Towers			
QEC Type C479 / 2DD Type HST	13	26	**26**
Other tower types	13	52	**52**
Conductors			
AAAC / ACSR/AC / SC/AC Earthwire	3	26	**29**
TACSR/AC (Curlew)	3	29	**83**
Insulators			
AC Composite / DC Composite	3	46	**49**
Glass	3	20	**23**
HVAC underground cables	3	30	**33**
Secondary systems			
Schneider Relays	3	52	**55**
Other Relays	3	12-30	**15-33**
Substation management system / RTU	3	45	**48**
Battery Charger	3	20	**23**
EnerSys Battery	3	18	**21**
Exide Battery	3	48	**51**
Communications & ICT			
Cisco switch	3	45	**48**
Cabinets	3	16	**19**

Source: Transpower, RFI013 Transpower Response.pdf

In response to the greater volumes of plant and equipment required for RCP4 Transpower have plans to increase supply chain throughput by increasing procurement and supply chain resourcing, improving systems and processes, and investing in warehouse capacity.

In response to extended lead times being experienced currently and increasing demand for electrification globally which is expected to continue to drive high global demand for transmission goods and services, Transpower have initiated several measures to de-risk long lead time equipment supply through initiatives to plan and order earlier.

The HVDC RCP4 plan has been prepared considering the lead times for procuring specialised HVDC equipment as in some cases equipment is only available through the OEM. Projects requiring significant OEM involvement such as the HVDC human machine interfaces replacement project are planned for mid to late RCP4 delivery allowing sufficient time for the discussions with the OEM and the procurement process. Projects with shorter lead times are planned for early RCP4 delivery. In general, the lead times for HVDC projects can be as short as 12 weeks and up to 2-3 years for complex projects that require extensive OEM engineering support. The majority of the HVDC assets have a 12-18 month's lead time subject to design and testing requirements. The procurement process for the listed HVDC cables project should start at least five years ahead of the installation date.

7.6.3 Initiatives and improvements

Transpower have sought to improve the resilience, efficiency and cost effectiveness of their procurement and supply chain processes with three main initiatives:

– prioritising supply chain resilience.
– continuous improvement.
– modernising procurement and supply chain systems.

Supply Chain Resilience

Transpower have recently undertaken a supply chain resilience review. The outputs include a roadmap to deliver supply chain resilience and other planned improvements over coming years.

The recent events of the pandemic and its effects on global supply chains necessitated closer management of the performance and sustainability of key suppliers due to increased supply risk. Transpower focused on ensuring the sustainability of key suppliers during this time including monitoring their health and aiding in their viability where it was deemed necessary.

Transpower worked with key outsource partners, such as service providers and engineering consultants. To ensure critical outsourced workforce was sustained through the pandemic, the volume of work directly allocated was increased to provide greater certainty of a continuous pipeline of work to help maximise resource utilisation and maintain a core workforce for the long term.

There is increased emphasis on supplier relationship management to reflect the need to be a 'customer of choice' to obtain the timely release of goods or to be able to gain a priority space in full manufacturing schedules. Transpower are enhancing their supplier relationships and management frameworks recognising that from a global perspective they are a small customer far away from most markets.

Transpower are also proposing to modernise digital procurement and supply chain systems to reduce risk, improve operational efficiency, and simplify supplier engagement. These system improvements will increase delivery timeliness and success by improving the monitoring and mitigation of supply chain risks and enabling near real time risk management, implementing new digital procurement tools, and improving collaboration with suppliers. To provide further resilience, warehouse capacity and inventory holdings are being increased to buffer for supply chain uncertainty.

Continuous Improvement

Transpower have undertaken several procurement continuous improvements including:

– Created a spend cube to analyse and report on spend data (for the last 7 years) – focusing on category activity that is providing information to allow for the management of categories and spend profiles.
– Standardised contract frameworks for use across several categories and have defined contract suites in place to enable efficient secondary procurement activity. Approximately 85% of Transpower's spend utilises documented secondary procurement practices. These include core grid services, ICT, and most equipment and materials procured in support of the grid.
– Improved management and visibility of inventory levels and practices and implementing system enhancements.
– Developed a warehousing strategy to outline how Transpower will develop and improve warehouses to cope with increasing storage demands, improving health and safety outcomes, and efficient and effective processes.

Modernising procurement and supply chain systems

During the remainder of RCP3 and RCP4, Transpower is seeking is to increase both their own and their supplier's efficiency, ability to plan collaboratively, respond to risks and changing needs rapidly, and ensure appropriate compliance across the end-to-end procurement and supply chain process. To achieve this, Transpower have four key investment areas outlined in ICT Corporate Systems and Asset Management investment cases:

– Implementation of a new modern, digital procurement and supply chain management solution outside the existing financial and asset management systems with appropriate integration back into those systems.
– Integration of the new modern, digital procurement and supply chain solution into the new Enterprise Business Capability system (which replaces the legacy FMIS system) to reduce manual integrations, improve controls, improve visibility of issues and risks, and create a single source of truth around these processes.
– Implementation of a new Contract Management system within an Enterprise Business Capability.
– An enhanced digital warehouse initiative to manage increasing pressure on warehouses as uncertainty drives higher holding volumes and higher turnover. The initiative will digitise and improve warehouse management processes and dispatch.

Overall, the new procurement and supply chain systems will be linked to improved asset planning tools that provide forward projection of procurement needs in real time and over longer planning windows (2 years and 5 years). This improves visibility of plans and procurement demand.

7.6.4 Conclusion

Transpower have a detailed procurement method that, while addressing compliance with principles, policies and procedures, is also designed to match the value, risk, criticality, and complexity of the purchase. The procurement method allows for different strategies for the type of procured good or service as well as flexibility of approach within a particular asset class. Several improvements have been implemented (or are in progress) to make the procurement process more efficient as well as improvement supply chain resilience, especially for longer lead time items.

7.7 Outage constraints

7.7.1 Overview of outage planning and management

The ability of Transpower to plan and manage outages is central to its ability to deliver its RCP4 capex and opex programs and grid output measures.

Transpower's outage planning process is outlined in the GL-OP-1024 Outage Planning Process document.[80] It includes all the steps necessary to plan an outage from creating a long-range plan and the Annual Outage Plan to handover to real-time control centres. The objective is to deliver the grid works plan, including maintenance and project works that require outages. This allows Transpower and service providers to schedule and resource work in a way that optimises asset availability.

The outage planning process must fulfil the requirements of the Electricity Industry Participation Code and the Outage Protocol. [81]

– The Electricity Industry Participation Code sets out the System Operator's outage coordination requirements for planned outages.
– The Outage Protocol sets the procedures and policies for Transpower to plan, consult on and carry out outages on the grid. This is required to be prepared as per Code requirements Part 12, Section 7. This includes preparing an outage plan to include all reasonably foreseeable connection and interconnection asset outages in the outage plan year.

The outage planning process is described in four activities:[82]

[80] Transpower, GL-OP-1024 Outage Planning Process
[81] Transpower, GL-OP-1024 Outage Planning Process
[82] Transpower, GL-OP-1024 Outage Planning Process

1. Outage Blocks: An outage block is the smallest group of primary equipment that can be isolated and worked on at any one time, and these need to be defined and managed in Transpower's systems to successfully carry out all outage planning and execution.
2. Make the Outage Plan: An Annual Outage Plan is created to provide a view of all outages of connection and interconnection assets for the next financial year. The creation of the plan starts in the last quarter of each year and finishes with the publication of the plan by 19 May, in accordance with the Outage Protocol.
3. Change the Outage Plan: The outage plan is continually updated to reflect changing window requirements and changing system conditions. These changes are made using Outage Variation Requests (OVRs). Any changes will be notified to other power system users.
4. Execute the Outage Plan: to execute the Outage Plan, a switching plan is created which specifies how equipment will be removed from service. A Short Time Planning Process (STPP) coordinates the submission, analysis, approval, and implementation of changes to the Outage Plan where they are required after 00:01 hrs of the current business day through to 23:59 hrs of the next business day.

The planning and delivery of outages involves coordination of the following teams:

– Grid Delivery: Planning and Scheduling team provides visibility of known grid projects via the Grid Works Plan (GWP) with provides an indication of future required outages.
– Grid Delivery: Project Delivery team: manages the delivery of programme and capital build projects resourced by Transpower roles, Engineering Consultants, Service Providers, and other suppliers. Delivery of capital build projects will also involve co-ordination with maintenance work managed by Regional Services Teams, and outages managed by Grid Operations to minimise the overall impact on the network.
– Operations: Outage Planning team coordinate with Service Providers, Project Managers and Programme Managers to create and optimise the outage plan and consult with connected parties and the system operator to review the plan. Outage Planners manage changes to the plan with outage variation requests (OVRs).
– Operations: Operations Planning engineers provide outage timing and scheduling advice, assess impact of planned outages on system security and recommend outage options to ensure system security.
– Operations: Grid and System Operations compile switching packs for the outage, coordinate short-term planning outage requests and manage real-time operation of the grid.
– Strategy and Customer – Customer and Commercial services provide interfaces between Grid Delivery, and external customers and connected parties on activities which include co-ordination of outages.

The documentation supplied indicates that Transpower has a systematic approach to the planning and management of outages which is integrated with in the programme delivery framework. This approach is consistent with the outage planning approach of other TNSPs.

7.8 Programme delivery capability

7.8.1 Overview of programme delivery framework

The Transpower programme delivery capabilities are detailed in the Programme Delivery Framework.[83] This sets out key roles and responsibilities and provides an overview of programme planning and delivery functions.

The objective of programme management is to enable coordinated management of a portfolio of projects to achieve Transpower's strategic priorities. This objective is achieved through a programme management approach, which enables and ensures:

– Co-ordinated oversight of works programming.
– Identification of grid delivery opportunities such as location-based grouping of works.
– Consideration of grid constraints such as weather, customers, outages, and localised resourcing.
– Consistencies and efficiencies in planning and delivery of programs.
– Assurance and confidence that Grid programs are being effectively monitored and controlled.
– Programme-wide improvements that would not be achieved through individually managed projects.

[83] Transpower, DEL004 Programme Delivery Framework

The key functions supporting delivery capability include:[84]

- **Programme Planning:** Programme Managers are responsible for development of a works schedule based upon applying the Asset Class Strategy and Decision Framework through active engagement with stakeholders in the end-to-end delivery chain so that works are grouped in the most efficient way to ensure deliverability. The forward view of forecast work and associated cost is captured in asset plans which are validated through internal processes and published via the Grid Works Plan. The planning horizon is 2-5 years.
- **Develop Delivery Strategies**: Programme Managers are also responsible for the development of delivery strategies to align work in the 2-5 year horizon to maximise efficiency of delivery programme through engagement with both internal and external stakeholders.
- **Delivery Phase:** Programme Managers maintain an oversight of project delivery progress via the National Delivery Managers and the overall delivery of programme progress. Investigation and Delivery Project Managers are responsible for delivery of their allocated investigation and build projects based on the relevant project management framework.

The programme delivery framework facilitates the deliverability of the projects by:

- Grouping work at a site where appropriate to:
  - improve efficiencies and/or reduce costs such as site establishment and administrative costs; and
  - manage risk e.g., using one Engineering Consultant (EC) to avoid multiple ECs working on multiple assets at a single site.
- Considering procurement governance principles for allocated and non-allocated works.
- Maintaining workforce capacity and capability.
- Factoring in; outage constraints, seasonal constraints; and impacts to landowners.
- Levelling work to support on-going viability of ECs and essential Service Providers.
- Accommodating customer issues and constraints.

Programme Governance

Depending upon the complexity of the project, governance can include steering group at a programme or project level and/or have boards tailored to suit programme need. Programme and project financials are monitored and controlled in accordance with Transpower's DFA Policy and procedures.

7.8.2 Initiatives and Improvements

In 2019/20, Transpower undertook an end-to-end review of delivery processes with Partners In Performance (E2E project). The key outcomes of this review included the establishment of a new management operating system (MOS) and governance structures (including programme delivery), which were used to manage meetings and performance relating to end-to-end delivery of grid work (from planning through to delivery of works on site). The new MOS is shown below.

Transpower's new management operating system provides overarching governance for their Grid Business Asset Management System and is outlined in Section 2.2 of AM002 AM-G 01 Grid Business Asset Management System Framework. The E2E project also drove a restructure of key delivery teams and implemented a range of wider improvements including a stage gate process for contestable projects, updated project management framework, health check process for projects, and integrated planning processes. Identified benefits from this programme have been reflected in the RCP4 forecast.

[84] Transpower, DEL004 Programme Delivery Framework

Figure 7-10 Management Operating System (MOS)[85]

Source: Transpower, Grid Business: Asset Management System – Framework, July 2021, page 6.

7.8.3 Conclusion

Transpower has a detailed Programme Delivery Framework that integrates planning and delivery functions. The objective of the framework is to enable coordinated management of a portfolio of projects to achieve Transpower's strategic priorities. Transpower have undertaken a range of programme delivery improvements after an end-to-end review in 2019. The key outcomes of this review included the establishment of a new management operating system (MOS) and governance structures, which are considered appropriate for a TNSP.

7.9 Evaluation

The following table summarises our evaluation of Transpower's ability to deliver its RPC4 program:

Table 7-10 Deliverability evaluation criteria

	Deliverability criteria	Meets criteria	Commentary
1	Internal workforce had sufficient capability and competencies	Partially meets criteria	Transpower have a well-developed workforce plan which identifies the internal resources needs as well as lead times required for different resources skills. The proposed additional resources across grid development, grid delivery, operations and business support are considered reasonable for the proposed ramp in expenditure and workforce volumes. Transpower have commenced a range of initiatives to recruit and training addition people. Retention rates, allowing for the impacts of covid, are considered reasonable. Despite a well-developed plan there is concern from the IV about the ability of Transpower to recruit approximately 200 people (often in specialised areas) in the business over a three-year necessary to deliver the expected programs.
2	Ability to contract the necessary services	Meets criteria	Transpower have undertaken an update and streamlining of grid services contracts which provides a greater level of certainty regarding contractor work levels and forward work levels. This will enable service

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	Deliverability criteria	Meets criteria	Commentary
			provides to grow their teams in line with the expected future work volumes. In addition, they have in place a range of contract KPIs, planning and training requirements for contractors to ensure that they integrated into Transpower's planning and workforce delivery approaches.
3	Procure necessary material and equipment	Meets criteria	Transpower have a detailed procurement method that, while addressing compliance with principles, policies and procedure, is also designed to match the value, risk, criticality, and complexity of the purchase. The procurement method allows for different strategies for the type of procured good or service as well as flexibility of approach within a particular asset class. Several improvements have been implemented (or are in progress) to make the procurement process more efficient as well as improvement supply chain resilience, especially for longer lead time items.
4	Outage constraints	Meets criteria subject to changes to RCP3 AP1 and AP2 quality limits	The documentation supplied indicates that Transpower has a systematic approach to the planning and management of outages which is integrated with in the programme delivery framework. This approach is consistent with the outage planning approach of other TNSPs. However, it should be noted that the planned outages needed to deliver the RCP4 programme will require the adjustments to the AP1 and AP2 service measures proposed by Transpower to avoid quality limits breaches.
5	Programme Delivery Capability	Meets criteria	Transpower has a detailed Programme Delivery Framework which integrates planning and delivery functions. The objective of the framework is to enable coordinated management of a portfolio of projects to achieve Transpower's strategic priorities. Transpower have undertaken a range of programme delivery improvements after an end-to-end review in 2019. The key outcomes of this review included the establishment of a new management operating system (MOS) and governance structures.
6	Historic delivery performance	Meets criteria	To deliver its base capex and opex programme, together with proposed uncertainty capex, listed projects and major capital projects, Transpower have forecast that they will need to ramp their delivery from nearly $600m per annum (in 2021/22) to approximately $1,100m per annum (in 2027/28). However, Transpower have previously had periods of significantly higher levels of expenditure, such as 2010-13 where the expenditure has exceeded the forecast maximum RCP4 expenditure (due to major projects). This demonstrates that historically Transpower has the organisational capacity to expand its total expenditure to the levels required in RCP4. Transpower have broadly met their RCP3 allowances to date with differences in individual years due to covid and supply chain impacts ss well as a delay in the new grid services contracts. Based on expenditure to date it is considered likely that Transpower will be able to deliver the remainder of its RCP3 programme.
7	IV Conclusion:	Transpower's workforce planning and programme delivery frameworks, service provider approach, procurement method and outage planning and management systems are all considered reasonable and at a standard of GEIP. It is the IV conclusion that Transpower has the organisational capability to deliver the remainder of the RCP3 and RCP4 base capex and opex programme, subject to adjustments to the AP1 and AP2 availability service quality limits (refer to Section 20 of this report). Our concern is Transpower's ability to ramp the capacity of its key teams over a three-year period to be able to deliver the programme. Transpower may face significant competition for skilled and experienced transmission resources from Australian and other country's TNSPs and resource companies that offer greater renumeration. As such in our opinion the Commission should request an update on Transpower's recruitment of specialised resources closer to the submission date as well as regularly reports throughout the remainder of RCP3 and in RCP4 on the status of its workforce.	

Part D

Capex

8. Summary of base capex

This section provides an overview of our evaluation of Transpower's proposed base capex for RCP4 against the ToR. Detailed evaluations are presented in the following sections organised by capex category as follows:

– Network capex containing:
  - Base R&R capex, refer to Section 9 of this report.
  - Base E&D capex, refer to Section 10 of this report.
– Non-network capex containing
  - ICT capex (excluding Software as a Service (SaaS)), refer to Section 11 of this report.
  - Business support capex, refer to Section 12 of this report.

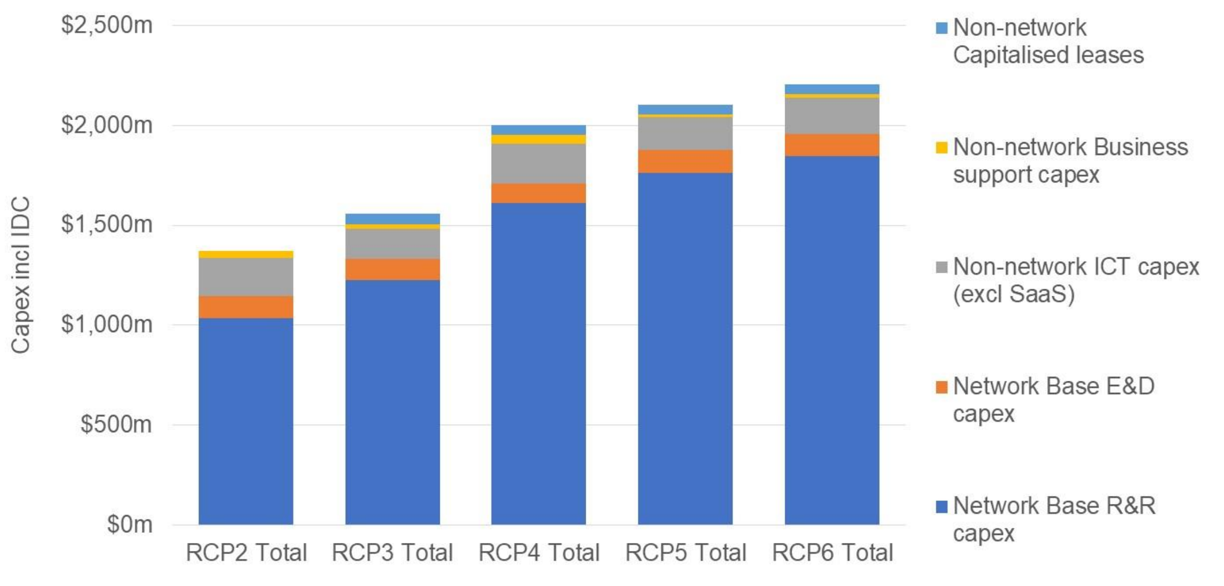
We have not reviewed the capitalised lease capex that is included in Transpower's RT01 expenditure schedule within the non-network base capex category, for which no information was made available to us nor have we interrogated its basis. We also did not review six (6) out of the total twelve (12) ICT investment cases that collectively constitute a minor portion of the total ICT expenditure and are all non-identified programmes.

Our verification of other capex categories which are being proposed using new and existing uncertainty mechanisms are presented in separately in Section 19 of this report. Therefore, the discussion and figures provided throughout this Section as well as Section 9 to Section 12 of this report, exclude capex categories proposed under the Use-It-Or-Lose-It (UIOLI) uncertainty mechanism and listed projects.

8.1 Summary of findings for base capex (overall)

The following figure shows Transpower's proposed overall base capex for historical, present and forecast RCPs.

Figure 8-1 Overall base capex RCP2 to RCP6



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The proposed overall base capex for RCP4 is 29% higher than the RCP3 base capex. The biggest contributor to this increase is the rise in the base R&R capex proposed in the RCP4.

We have examined all the capex categories shown in the above graph, and all the asset portfolios within them, in both network and non-network categories, except for the above stated exclusions, in greater detail and have analysed the drivers underpinning the growth in base capex to understand its prudency and efficiency. These are documented in detail in the Section 9 to Section 12 of this report.

The following table provides a high level summary of the overall base capex proposed by Transpower for RCP4, the extent of our verification and our conclusion. The drivers for base capex are as follows:

– **Base R&R capex** is driven by the need to maintain asset function or performance and manage risk of failure or non-service or non-compliance.
– **Base E&D capex** is driven by the need to meet the electricity demand forecast and generation development.
– **ICT capex (excluding SaaS)** consists of 12 investment cases around specific business needs; and
– **Business support capex** is driven by the need to maintain non-network assets and manage the risk of those assets failing, becoming non-compliant or otherwise impacting their ability to provide services.

Table 8-1 Proposed base capex and verification status

Expenditure category		RCP4 forecast	Verification	Verification status
Network base capex				
Base R&R capex[1]	Alternating current substation replacement and refurbishment	$441.5m	All amounts reviewed.	Accept: $416.1m Reject: $25.4m
	Buildings and grounds replacement and refurbishment	$121.0m		Accept: $108.0m Accepted but re-categorise: $13.0m
	Transmission lines replacement and refurbishment	$647.2m		Accept: $647.2m
	High voltage direct current and reactive assets replacement and refurbishment	$150.5m		Accept: $150.5m
	Secondary assets replacement and refurbishment	$251.1m		Accept: $251.1m
Base E&D capex	Enhancement and development (E&D) capex	$98.5m	All amounts reviewed.	Accept: $93.5m Accept but re-categorise: $5.0m
Non-network base capex				
ICT capex (excluding SaaS)		$198.5m	Reviewed: $180.3m Not reviewed: $18.2m	Accept: $180.3m
Business support capex		$43.1m	All amounts reviewed.	Accept: $27.1m Reject: $16.0m
Capitalised leases		$50.0m	Not reviewed: $50.0m	Not applicable
Total base capex		**$2,001.4m**	**Reviewed: $1,933.2m** **Not reviewed: $68.2m**	**Accept: $1,873.8m** **Accept but recategorise: $18.0m** **Reject: $41.4m**

Source: Transpower RCP4 forecast data and IV analysis
Note: [1] The base R&R capex excludes resilience workstreams that are being proposed using the UIOLI uncertainty mechanism as they are separately evaluated. There are however other resilience workstreams that are being proposed as part of base R&R capex programme embedded within various asset classes and hence are included within this amount.

8.2 Evaluation approach

The RCP4 proposed base capex consists of both identified and non-identified programmes across both network and non-network categories and asset portfolios within them. The evaluation criteria for them, based on the ToR, are different with identified programme having more onerous requirement consistent with the proportionate scrutiny principle.

8.2.1 Identified programme evaluation

The following table outlines the assessment requirements based on the ToR Appendix A1 and A3 evaluation criteria for the base capex identified programmes. The evaluation method outlines our general approach in assessing both network and non-network categories and asset portfolios within them that has been selected as identified programme against the stipulated criteria. This table has been referred across all the base R&R capex, base E&D capex, ICT capex and business support capex categories and asset portfolios within them, where applicable.

Table 8-2 Proposed base capex identified programmes evaluation criteria and method

ToR Clause	Evaluation criteria	Evaluation method
A1(i)	The appropriateness of using demand forecast and other key assumptions in determining the proposed base capex and opex	– Review peak demand forecasts, the profile of the peak demand, various forecast scenarios (prudent, expected, high bound, low bound) including the assumption of Tiwai aluminium smelter closure at the end of 2024. – Conclusion from the demand forecast review (Section 5 of this report) was drawn upon to assess the inputs and assumptions to the base E&D capex category.
A3(a)	Need for identified programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	– Check PMP includes investment need. – Check PMP and ACS are aligned. – Check the proposed programme is risk based supported by systematic approach to determine the likelihood of event occurring, consequences of those event and quantified risk value. – Where applicable, review choice of proposed project and nominated quantities in RCP4 for prioritisation based on risk (AHI score × impact). – Refer to GHD Advisory's Expert Opinion Progress Review to understand Transpower's AHNR modelling maturity to consider application of asset management policy and investment decision framework to justify the base R&R projects in RCP4 (findings from which are summarised within Section 3.2.2 of this report). Additionally, specific findings as applicable for each asset portfolio or asset class is described in the respective sub-sections. – Check prudency of deferring investment against Transpower's risk exposure level and its risk appetite/averseness.
A3(b)	Policies and planning standards were applied appropriately	– Process review to check if PMP and ACS have alignment or have line of sight to Network Strategy, Asset Management Plan, Strategic Asset Management Plan and Transmission Tomorrow. – Check whether outcomes of PMP forecast achieves the organisation goals, objectives with respect to people, safety, performance etc. – Review Transpower's annual transmission planning process including the type and quality of information documented in its Transmission Planning Report, customer technical request and concept assessment process, asset feedback and decision framework and options assessment approach against GEIP (process benchmarking). – Whether Transpower has demonstrated the ICT investment cases are in line with internal polices and that the investments are prioritised and directed to achieving a cost-efficient solution.
A3(c)	Transpower's process is reasonable and cost effective	– Governance and process review to check planning approach and activities listed in PMP are logical, and process is consistent as noted in ACS and asset management plan. – Determine whether investment activities are cost-effective.

ToR Clause	Evaluation criteria	Evaluation method
		– Compare average replacement/retirement age of asset class against Australian TNSPs in recently reported regulatory information notices (asset life cycle benchmarking). – Review the deduced average per project costs planned in RCP3 vs RCP4 (internal benchmarking of forecast costs against currents costs). – Review the build-up estimate for volumetric capex using TEES building block unit rates. – Review the nature of E&D solutions, its scope, need date and cost estimation proposed in RCP4 in the 2022 Transmission Planning Report. – Compare them to Grid Reliability Standards (N-1 requirements for core grid and economic requirements for others) in the Electricity Participation Code and the Grid Planning Technical Guideline (project and programme sampling, critique of project cost build-up).
A3(d)	Investment need is challenged, and alternative solutions considered	– Process review of Transpower's decision making including whether an options assessment is carried out that includes alternative solutions. – Review drivers, evidence of past mid-life extension strategies, alternatives and investment deferral options (high level governance and process review). – Review modelling of asset health, PoF, criticality and projection of annualised risk with and without investment scenario. – Review condition assessment data that provides input to asset health models (project and programme sampling). – Examine investment case for all resilience driven workstreams. – Examine where proposed capex or/and quantities significantly changed from RCP3. – Review the information available from the delivery business case stage of E&D re-opener project and major capital project from RCP3 to demonstrate the application and practicing of Transpower's investment decision framework and options assessment approach to justify the E&D projects. – Review referred regulatory requirements such as the Resource Management Act 1991 (especially clause 375) with respect to corridor management programme to better understand the need for expenditure.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	– Process Review of forecast to determine if expenditure is linked to key drivers, assumptions are reasonable, and expenditure linked to achieving grid outputs (measures) if relevant. – We note investigation business case (IBC) is prepared ~30 months in advance and delivery business case is prepared ~18 months in advance in lead up to the construction work. Hence there are no IBC available for any of the base E&D project presently identified in the Transmission Planning Report proposed during RCP4. The 2022 Transmission Planning Report that informed the RCP4 expenditure plan was reviewed.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	– Review of costing method, including the hierarchical build-up of cost resources and items to unit rates, its sourcing and feedback loop, and application of vargen. – Review of customised cost estimates within the delivery business case of five E&D re-opener projects and one major capital project from RCP3 that demonstrate capital costing method and formulation, the use of TEES building block unit rates and inclusion of allowance within such project estimates.
A3(g)	Effect of forecast capex on other cost categories, including relationship with opex	– Review impact of capex programme on opex and other programmes – have Transpower considered it and avoided double counting. – Review alternate options analysed as part of Transpower's investment decision process that considers capex-opex trade-off, intervention or investment deferral with risk and opex appetite. – Examine link between historic base R&R capex activity in various asset classes and its impact to grid opex. – Whether efficiency improvements and trade-offs are acknowledged between ICT investment cases which utilise similar assets / technologies and can leverage efficiencies. This also applies to opex trade-offs.

ToR Clause	Evaluation criteria	Evaluation method
A3(i)	Whether programme is appropriately linked with other projects or programmes	– Review whether PMP outlines linkages between programme and other expenditure programmes. (high-level governance and process review). – Examine scope of proposed base R&R capex and compare it against other proposed works for any duplication or overlap. – Examine non-like-for-like replacement to identify any capacity expansion element. – Examine cost allocation between the Transpower's system operator and grid owner/operator roles (high level governance and process review). – Examined the basis and scope of proposed base E&D capex and compared it against other proposed works (base R&R capex, enabling customer electrification capex and resilience capex being proposed using the UIOLI uncertainty mechanism) for any duplication or overlap.
A3(j)	Proposed procurement approach for associated goods and services	– Review how plant, materials and works are procured. – Review whether approach is efficient and whether there are deliverability risks caused by procurement.

Note: A3(h) is not applicable to base capex

8.2.2 Non-identified programme evaluation

The following table outlines the assessment requirements based on the ToR evaluation criteria for the base capex for non-identified programmes. Unlike identified programmes the ToR does not contain specific evaluation criteria for non-identified programmes. We have reviewed the general evaluation criteria in ToR Appendix A1 for the proposed base capex and included the individual criteria which are relevant to non-identified programmes. These criteria are included in the table below. This table has been referred across all the base R&R capex, base E&D capex, ICT capex and business support capex categories and asset portfolios within them, where applicable.

The evaluation method outlines our general approach in assessing those capex categories and asset portfolios within them that has been selected as non-identified programme against the stipulated criteria.

Table 8-3 Proposed base capex identified programmes evaluation criteria and method

ToR Clause	Evaluation criteria	Evaluation method
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier: reflecting GEIP.	– Review whether the proposed programme of works meets the investment need (e.g., the reason for the expenditure). – Review reasons for the proposed quantities and how they compare to RCP3. – Does the PMP have service, safety and cost performance goals which are considered reasonable and linked to key strategies to achieve these performance goals.
A1(a)	Whether key assumptions are reasonable including: (i) the method & information used to develop them	– Review the investment need and key drivers and then the effectiveness of asset health or other measures to assess condition as a driver for forecasting expenditure.
	(ii) how they were applied	– Examine how the key assumptions have been applied in developing the proposed base capex. – Check whether the PMP includes a logical decision-making process which is considered reasonable.
	(iii) their effect on the proposed base capex	– Check whether the impact of assumptions on capex are identified in the PMP. – Determine whether strategies are based on achieving a lower overall lifecycle cost.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	– Review Transpower's model for expenditure build-up and whether it is based on a volumetric cost build-using the TEES building block unit rates.

ToR Clause	Evaluation criteria	Evaluation method
		– Review how the volumes were developed, the maturity of such model used, limitation of any input data etc. – Review how the volumes were short listed and prioritised based on impact modelling, the maturity of such model used and limitation of any input data.
	(ii) methods used to check reasonableness of forecasts and related expenditure	– Review Transpower's methods for forecasting including trend analysis compare the levels to RCP3 as well as network risk modelling for the level of expenditure. – Check explanations for changes in nominated quantities in RCP4..

Note: A3(h) is not applicable to base capex.

9. Base R&R capex

Our evaluation of Transpower's proposed base R&R capex for RCP4 against the applicable evaluation criteria of the ToR is presented in this section. This section is divided into the following headings:

– Summary of findings
– Overview of base R&R capex proposal
– Evaluation of the 17 asset portfolios with sub-sections covering:
  - asset portfolio and strategy overview,
  - expenditure profile,
  - asset planning approach,
  - evaluation, and
  - conclusions.

9.1 Summary of findings for base R&R capex

The following table summarises Transpower's proposed RCP4 base R&R capex by portfolio and our conclusion with respect to the acceptance of the proposed expenditure.

All the base R&R capex values in the following table excludes resilience workstreams that are being proposed using the UIOLI uncertainty mechanism as they are separately evaluated in a Section 19 of this report. There are other resilience workstreams that are being proposed as part of base R&R capex embedded within various asset portfolios and hence are included within these values.

Table 9-1 Summary of findings – base R&R capex for RCP4

Network asset	Asset portfolios	Programme	Proposed base R&R capex	IV Conclusion
Substations	Power Transformers	Identified	$154.1m[1]	Accept: $144.1m Reject: $10.0m
	Indoor Switchgear	Non-identified	$46.7m	Accept: $46.7m
	Outdoor Switchgear	Identified	$106.5m	Accept: $106.5m
	Structures & Buswork	Non-identified	$32.6m	Accept: $32.6m
	Power Cables	Non-identified	$25.1m	Accept: $25.1m
	Other AC Substation Equipment	Non-identified	$46.2m[1]	Accept: $30.8m Reject: $15.4m
	Outdoor 33kV switchyards: Outdoor to Indoor Conversion	Non-identified	$30.2m	Accept: $30.2m
Buildings & Grounds	Buildings & Grounds	Identified	$121.0m	Accept: $108.0m Accept but recategorise: $13.0m
Transmission lines	Structures & Insulators (includes tower painting)	Identified	$421.6m[1]	Accept: $421.6m
	Conductor and hardware	Identified	$155.8m	Accept: $155.8m
	Foundations	Non-identified	$59.5m[1]	Accept: $59.5m
	Transmission Line Accessways	Non-identified	$10.3m	Accept: $10.3m
HVDC & reactive assets	HVDC	Identified	$78.1m	Accept: $78.1m
	Reactive Assets	Identified	$72.5m	Accept: $72.5m

Network asset	Asset portfolios	Programme	Proposed base R&R capex	IV Conclusion
Secondary assets	Protection, battery systems and Revenue Meters	Identified	$227.6m	Accept: $227.6m
	Substation Management Systems	Identified	$23.5m[1]	Accept: $23.5m
Total base R&R capex			**$1,611.3m**	**Accept: $1,572.9m** **Accept but recategorise: $13.0m** **Reject: $25.4m**

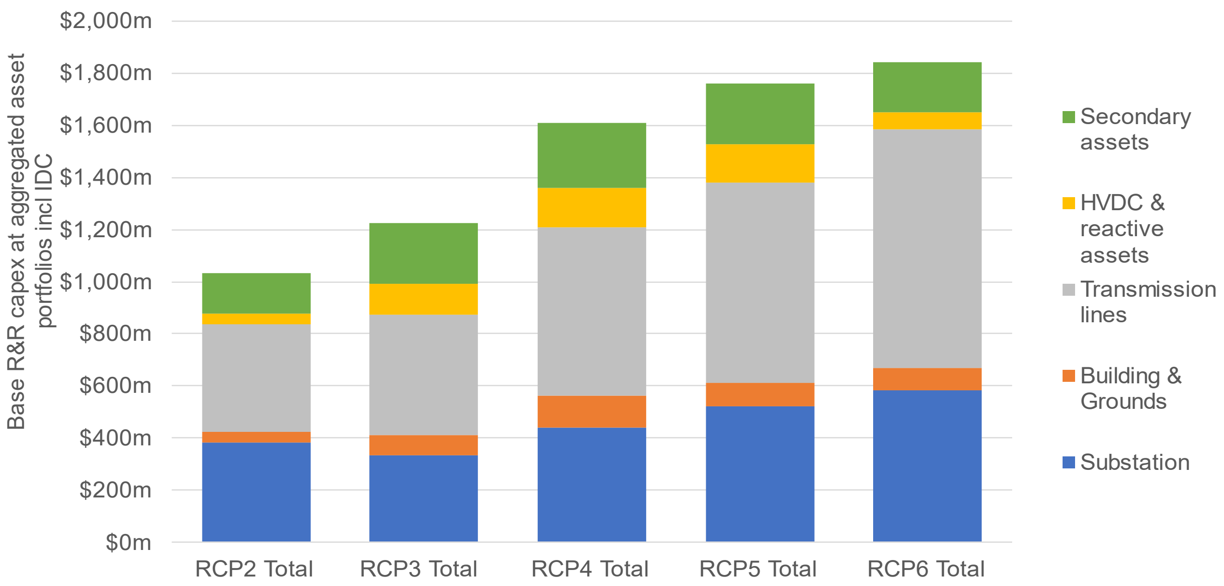
Note: [1] Capex totals for these asset portfolios exclude capex for resilience workstreams that they are being proposed using the UIOLI uncertainty mechanism.

9.2 Overview of base R&R capex

Base R&R capex refers to works that Transpower undertake to either replace or refurbish existing grid plant and equipment to address age, condition, performance, risk, regulatory and/or safety requirements. This network capex excludes capex that primarily addresses increased electricity demand or enabling customer electrification or resilience using uncertainty mechanism which are reviewed elsewhere is this report, as well as non-network capex.

Transpower's base R&R capex at aggregated asset portfolios for historical, present and forecast RCPs is shown below.

Figure 9-1 Base R&R capex RCP2 to RCP6 – showing asset portfolios at aggregate level

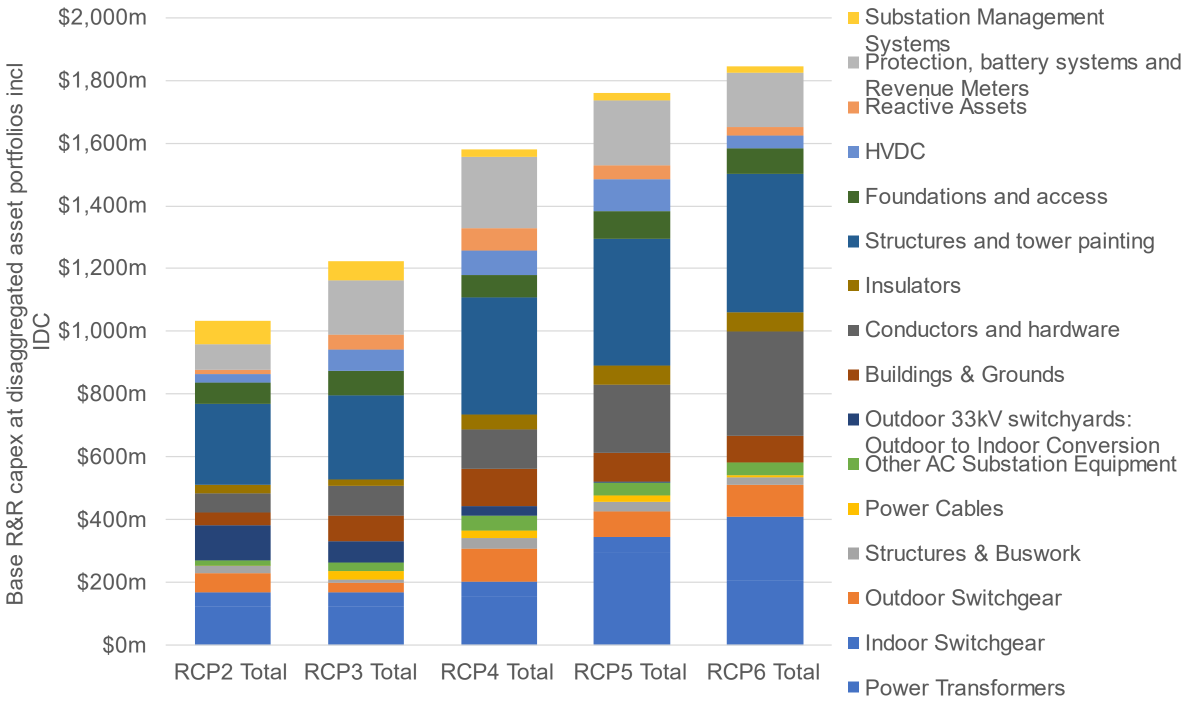


Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The proposed RCP4 total base R&R capex is 32% higher than the RCP3 total base R&R capex. The biggest contributors to this increase are due to the rise in the base R&R capex of the substation and transmission lines asset portfolios.

Disaggregating the same base R&R capex profile indicates that the power transformers, outdoor switchgear, buildings & grounds, structures & insulators, conductors & hardware, reactive assets, and protection asset portfolios are the biggest contributors to the increase in base R&R capex in RCP4 as shown in the following figure.

Figure 9-2 Base R&R capex RCP2 to RCP6 – showing asset portfolios at disaggregate level



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The following table summarises Transpower's proposed RCP4 base R&R capex year by year. It excludes resilience workstreams being proposed using the UIOLI uncertainty mechanism.

Table 9-2 Proposed RCP4 base R&R capex

Asset categories	2025/26	2026/27	2027/28	2028/29	2029/30
Substations	$115.7m	$88.6m	$79.9m	$94.1m	$63.2m
Buildings & Grounds	$28.5m	$24.9m	$23.7m	$22.4m	$21.6m
Transmission Lines	$120.3m	$141.5m	$117.5m	$123.4m	$144.6m
HVDC & reactive assets	$14.8m	$38.4m	$36.3m	$33.8m	$27.2m
Secondary Assets	$55.1m	$53.9m	$39.0m	$41.6m	$61.6m
Total	**$334.3m**	**$347.3m**	**$296.3m**	**$315.1m**	**$318.2m**

Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

9.3 Evaluation of base R&R capex proposal

The following sub-section details the respective scope of the individual asset portfolios, their strategies and planning approaches, annual capex profiles, capex drivers and our analysis in evaluating the prudency and efficiency of the proposed programme for each of the 17 asset portfolios that constitutes the base R&R capex being proposed for RCP4.

As part of its broader Grid Resilience Strategy, Transpower is proposing a number of resilience workstreams across multiple expenditure categories and asset portfolios in RCP4. Only some of these resilience workstreams are being proposed as the base R&R programme and hence their capex is embedded within the proposed base R&R capex of the respective asset portfolio. We have evaluated such resilience workstreams in this sub-section in each of the respective asset portfolio that they are included in.

For avoidance of doubt, we have evaluated Transpower's broader Grid Resilience Strategy and those resilience workstreams that are being proposed using the UIOLI uncertainty mechanism separately in Section 19 of this report.

9.3.1 Power transformers

The following table summarises our verification of the power transformer capex, which is selected as an identified programme, and forms part of the base R&R capex for RCP4.

Table 9-3 Verification summary of power transformer base capex

Verification element	Verification commentary
RCP4 proposed amount	$154.1m excluding resilience workstream[1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes, for the accepted capex. Does not satisfy the ToR clauses A3(a), A3(b), A3(c) and A3(d) evaluation criteria for rejected capex.
IV conclusion	Accept: $144.1m Reject: $10.0m
Potential scope for improvement	Consistent use of asset management systems and tools to justify all the proposed projects and expenditures. Given the mature state of the asset management system pertaining this asset portfolio, no exception is expected.
Key issues and areas that the Commission should focus	Proposing $10.0m budget for self-insurance within the fungible base R&R capex.

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the UIOLI uncertainty mechanism. Therefore, the resilience workstream capex is separately evaluated and not within this base R&R capex.

9.3.1.1 Asset portfolio and strategy overview

The scope of this asset portfolio encompasses major power transformers operating at 11kV and above. It includes supply and interconnector transformers in the main AC transmission network, traction transformers, small auxiliary earthing transformers and local service transformers. For avoidance of doubt, the HVDC converter station transformers are excluded from this asset portfolio.

The power transformer ACS[86] documents the challenges, objectives, fleet statistics, operational knowledge, asset management strategy and planning, asset management decision making, asset information, organization and people, risk and review and lifecycle delivery providing a detailed approach to manage this asset portfolio.

The power transformer PMP[87] provides the latest available snapshot of the state of this asset fleet, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base R&R capex forecast and associated quantities for power transformers and bushings.

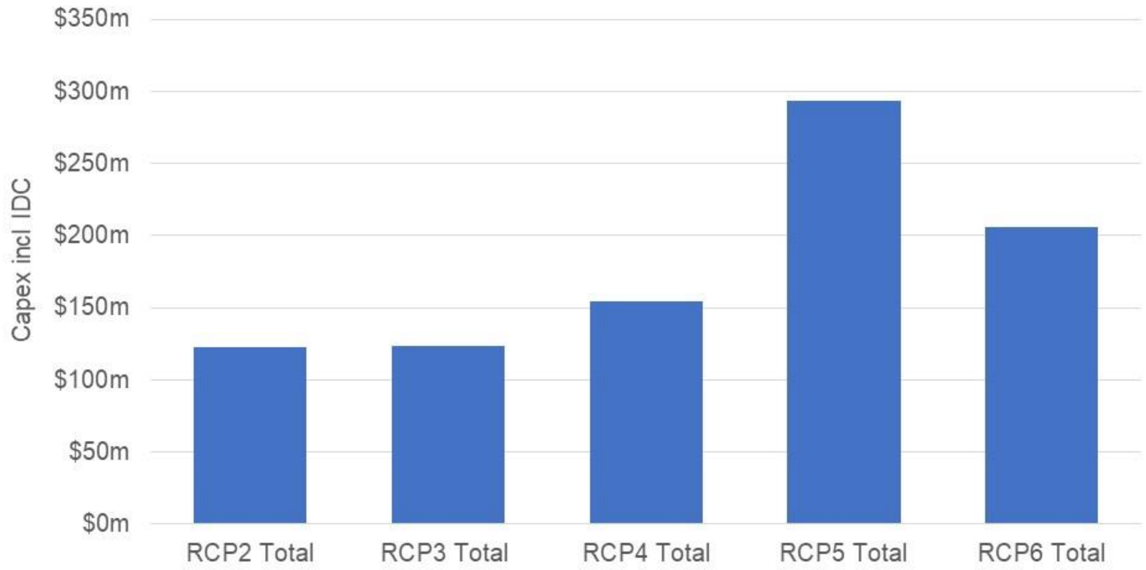
Transpower is also proposing a resilience workstream[88] within this asset portfolio which is the first time Transpower is separately identifying such activities or cost category in its RCP submission and forms part of its broader Grid Resilience Strategy[89]. This resilience workstream is being proposed using the UIOLI uncertainty mechanism. Therefore, it will be evaluated separately along with Transpower's broader Grid Resilience Strategy and other resilience workstreams being proposed using the UIOLI uncertainty mechanism in Section 19 of this report.

[86] Transpower, ERR009 FS 20.01 Power transformers asset class strategy.pdf
[87] Transpower, ERR026 ACS Power Transformer 2022 PMP.pdf
[88] Transpower, ERR028 Resilience 2022 PMP.pdf
[89] Transpower, ERR017 TG 10.03 Grid resilience strategy.pdf

9.3.1.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the power transformer asset portfolio including historical and forecast expenditures.

Figure 9-3 Power transformers base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is proposing to increase both the expenditure and the quantity of assets replaced or refurbished in this asset portfolio in RCP4, compared to the present RCP3 expenditure level. This increase is mostly due to asset/site quantities and increase in scope of R&R work in each site than the unit costs. We have evaluated changes in these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

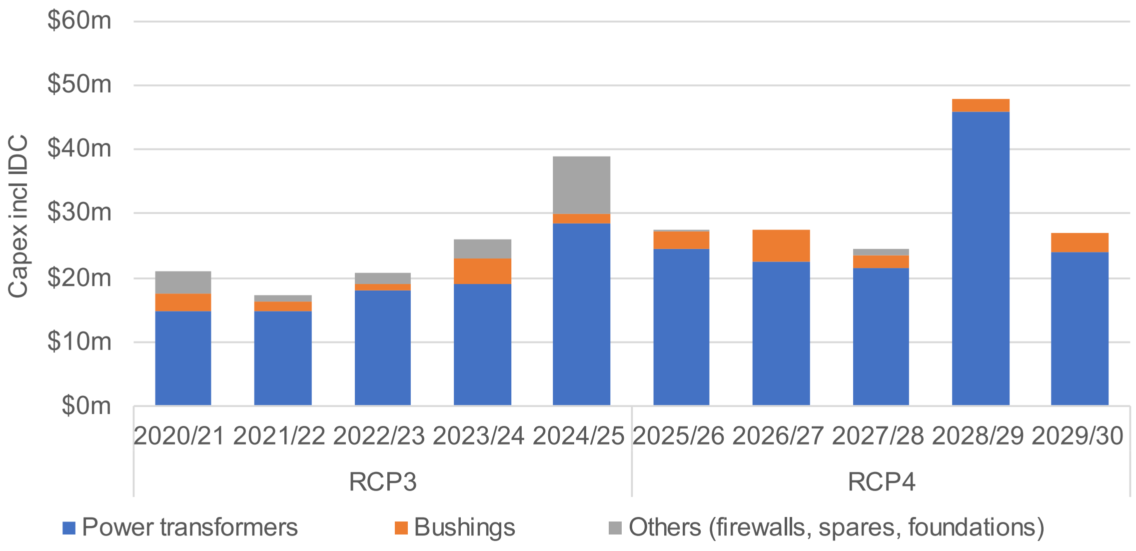
Table 9-4 Power transformers base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Power transformers	$123.6m	$154.1m	25%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure for power transformers, bushings, others and resilience categories.

Figure 9-4 Power transformer base R&R capex profile



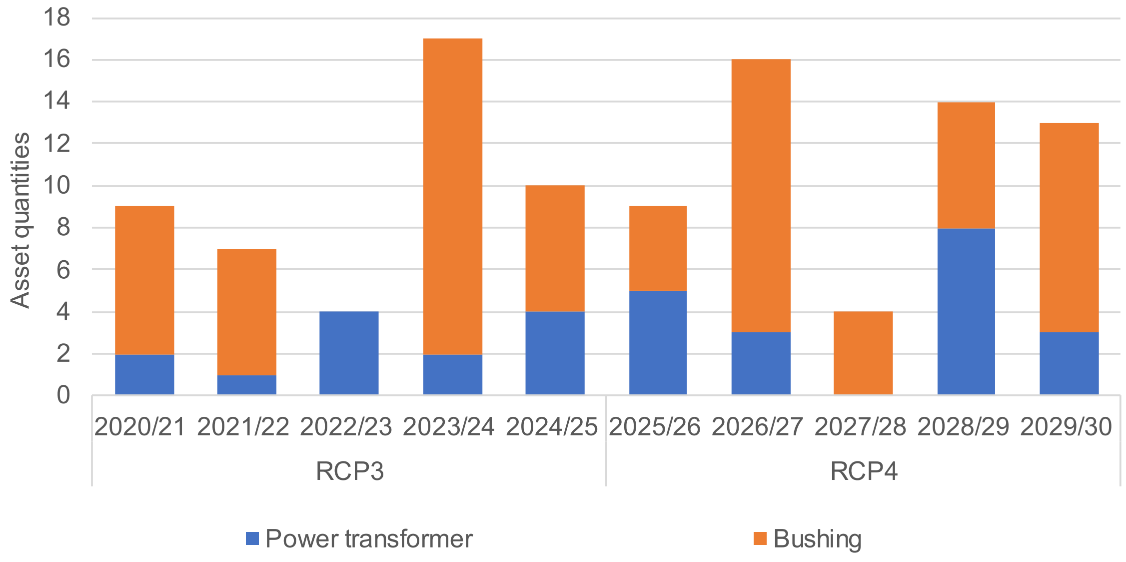
Source: Power transformer 2022 PMP, RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is planning to replace 13 transformers, including a transformer driven by GIDI funded project and a transformer replacement brought forward from RCP4 due to deteriorating asset condition issues coupled with growing electricity demand during RCP3. Transpower is also planning to replace 34 bushings during RCP3.[90]

Transpower is proposing to replace 19 transformers and 37 bushings during RCP4.[91] The annual quantity profile of the power transformers and bushings in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure. We note some delay or timing mismatch between the capex amounts and asset quantities due to long lead/delivery time for R&R projects of these nature. The asset quantities shown in the following figure are transformer and bushing replacements recorded in the year in which the replacement is completed or forecasted. The misalignment between quantities of replacements and timing of expenditure is due to long lead items may result in expenditure across years prior to the year in which the replacement is complete. Also, refurbishment expenditure will not have corresponding quantities of replacement.

[90] Transpower, Power transformers 2022 PMP
[91] Transpower, Power transformers 2022 PMP

Figure 9-5 Power transformer base R&R quantities profile



Source: Power transformers 2022 PMP

9.3.1.3 Asset planning approach

Transpower's ACS and PMP for this asset portfolio are informed by its organisational Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges faced in managing its existing fleet of power transformers (consisting of interconnecting, supply and traction power transformers) and its components (bushings, tap changers and tanks) and auxiliary transformers (consisting of local service, earthing and regulator transformers), their objectives and approaches to address them. The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The expected life of power transformers major components can range from 40-70 years. A large portion of Transpower's power transformer fleets is younger than 40 years, with some existing power transformers in service for over 60 years.[92]

Power transformers are bespoke equipment, have long manufacturing lead times, and are generally the most expensive assets in substations. In contrast, the local service transformers are relatively inexpensive and can be standard 'off-the-shelf' equipment.

Transpower's R&R capex planning approach for this asset portfolio is generally based on AHNR modelling consisting of asset health and impact modelling, monetised risk analysis and demand growth projection.[93]

Transpower's asset health model divides a power transformer into its three major components, namely – tank and windings, tap changers and bushings.[94] This allows Transpower to monitor and track the asset health scores for these components and has enabled it to clinically target piecemeal R&R interventions on specific asset components instead of wholesale replacement of the entire power transformer units. The asset health model for the local service transformer is relatively new.[95]

The impact modelling enables Transpower to obtain criticality ranking of all identified assets in poor health to prioritise R&R work and also explore the intervention timing. Collectively the AHNR modelling provides Transpower with an input to its R&R investment decision making.

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[92] Transpower, Power transformers 2022 PMP
[93] Transpower, RFI034-03 Power Tx Planning IV April 2023.pdf
[94] Transpower, Power transformers 2022 PMP and GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[95] Transpower, Power transformers 2022 PMP

The GHD Advisory Expert Opinion Progress Review report[96] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

– The asset health modelling for both power transformer and local service transformer meets the GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
– The impact modelling for power transformer meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios. The impact modelling for local service transformers meets the GEIP and aligns with Level 2 maturity that considers cost to replace, i.e., consequence is quantified to reflect financial impact to the economy from loss of service and direct costs to replace.
– The network risk analysis for both power transformer and local service transformer meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower assess the risk that unit of power transformer presents and into the future and compare this risk with the different investment options and the residual risk after each investment option on a Net Present Value (NPV) basis to find the lowest whole of life cost solution in order to determine the R&R intervention solution and its timing. Transpower applies site-specific monetised risk-based approach for investment decision for this asset portfolio. This approach is applied to each transformer unit with detailed analysis to create the long-term plan. It considers the cost benefit analysis of a range of R&R intervention options on each power transformer to find the pathway with lowest whole of life cost.

Transpower identify constraints and opportunities such as deliverability, optimisation between portfolios, and other influencing factors. It has identified synergies between this asset portfolio and other asset portfolios such as indoor/outdoor switchgear and secondary systems to align R&R activities where opportunities exist for project efficiencies.[97] Synergies with base E&D capex activity and also risks such as newly replaced transformers being stranded due to customer decision are appropriately identified.

Transpower's R&R focus for this asset portfolio also includes mid-life extension activities, such as replacing bushings, complete corrosion repaints, protection and instrumentation upgrades and maintenance activities which result in delaying full replacements. Transpower undertook these mid-life extension activities during RCP2 and RCP3 across its fleet of power transformers and hence moving forward its R&R projection for this asset portfolio involves increase in the number of full power transformer unit replacement.[98]

9.3.1.4 RCP4 capex drivers and solutions

The R&R need for this asset portfolio is based on risk and to maintain service performance. This need is informed by asset health scores (that incorporates asset condition status) and consequences of asset failure or non-performance to estimate the monetised risk value.

The investment process involves evaluating and optioning various alternate solutions to address the need, finding synergies with other proposed capital works (for e.g., switchgear R&R activities and/or power transformer E&D activities) on the same site or segment of grid related to the selected solution. Accordingly, the expenditure for this asset portfolio can includes complete replacement of transformer unit as well as piecemeal replacement. It also includes refurbishment activities that considers capex/opex trade-off (e.g., increase in opex to prolong the asset life in lieu of immediate replacement capex) on specific components that results in delaying full replacements.[99]

The RCP4 base R&R capex plan reflects the life extensions undertaken previously and the deferral of full unit replacements.

[96] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[97] Transpower, Power transformers 2022 PMP
[98] Transpower, Power transformers 2022 PMP
[99] Transpower, RFI034-03 Power Tx Planning IV April 2023.pdf

Transpower is also proposing to replace only the bushings of the transformer driven by strategy to phase out the population of resin bonded paper bushing and oil impregnated paper bushing to arrest increasing asset failure rates and failure risks within this make and model of bushings.[100]

9.3.1.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio is prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

This base R&R capex is volumetric programme. The RCP4 proposed budget was developed using customised cost estimates to account for bespoke associated site scope work and the corresponding asset quantities estimated for the R&R intervention as identified in this asset portfolio PMP. Transpower plans to develop and use standardised building block unit rate estimates for power transformer replacement projects to build its base R&R capex for RCP5 and RCP6.

The base R&R capex for bushing replacement was developed using the building block unit rate estimates and the corresponding asset quantities estimated for the R&R intervention as identified in this asset portfolio PMP.

We examined the prudency and efficiency of both variables, i.e., cost estimates and asset quantities, for both power transformers and bushings in this asset portfolio and observed the followings.

Prudency

We reviewed the provided high-level description of drivers, historic undertaking of mid-life extension strategies, consideration of alternative and investment deferral options for the proposed projects[101] in RCP4 and considered them to be reasonable. The data inputs, assumptions, design, and calibration of power transformers (including bushings) asset health and criticality models to inform the PoF curves and monetised consequence values are reasonable and appropriate to inform the R&R activities.

We analysed and enquired the reasons for any step change in quantities noticed between RCP3 and RCP4. The AHNR modelling tools and the underlying data, assumptions, their use for identifying and prioritising the proposed projects and nominated quantities in RCP4 is reasonable and demonstrated a risk-based approach in most instances.

We reviewed the modelling of the residual risk projection trends (forecast AHI score × criticality) with and without the proposed base R&R capex for this asset portfolio[102] and noticed that the projected risk level is generally consistent with proposed RCP3 risk level. For most part, the proposed power transformers replacement in RCP4 is driven by asset condition and risk. The proposed bushing replacement in RCP4 is driven by asset strategy of entirely phasing out two specific types of bushing from Transpower fleet. We considered this to be prudent approach.

Transpower is proposing to replace power transformers that will be 52-75 years old at the start of RCP4.[103] This replacement/retirement age is generally greater to what we have observed across the Australian TNSPs in recent times. [104] The replacement level being proposed in RCP4 (i.e., % proportion of power transformer against its population size), together with considering the asset average replacement age is reasonable level to sustain this fleet size.

Various randomly selected power transformers proposed for R&R projects were examined for their current operational status, AHI score, condition assessment data and site criticality values. [105] Most of them supported the RCP4 proposed R&R plan for being prudent. For example:

[100] Transpower, ERR009 FS 20.01 Power transformers asset class strategy.pdf
[101] Transpower, RFI034-03 Power Tx Planning IV April 2023.pdf and RFI034-04 AHI data for replacement works.xlsx
[102] Transpower, RFI034-05 RCP4 Asset health with and without investment.xlsx
[103] Transpower, RFI034-04 AHI data for replacement works.xlsx
[104] Transgrid revenue reset proposal for 2023-28 and Powerlink revenue reset proposal for 2022-27.
[105] Transpower, 20230502 Power Transformers – additional data.xlsx and 20230502 Power Transformers - additional information.pdf

– GFD-T5 80MVA unit failed in 2019 and is currently/temporarily replaced by a spare 60MVA unit. Transpower is proposing a like-for-like in-situ replacement.
– Both ISL-T3 and ISL-T7 suffers from moisture ingress in the motor drive unit in their on load tap changer which has heavier weightings in the AHI score calculation.
– 2 of the 3 single phase transformers of HAM-T5 have high moisture level in their oil. The DGA monitor shows an increase in moisture when T5 is highly loaded due to HAM-T4 being out of service.

Example of recent business cases[106] (from RCP3) demonstrated mature set of inputs (for e.g., spare capacity, back feed capability, use of standard VoLL, demand forecast, N/N-1 constraints, unserved energy, load duration curve etc.) informing the investment case. The inputs and outputs are consistent with the investment planning approach described in Transpower asset management system documentation. For e.g., option analysis considered life extension strategies vs. complete replacement vs. investment deferral etc. and selection of preferred solution. The definition and scoping of the preferred solutions and their delivery staging/bundling with other related work at the same site was deemed reasonable. Depending on the size of the investment, Transpower performed NPV analysis (for larger projects) or qualitative benefit analysis (for smaller projects) to select their preferred solutions. We consider this selection of option based on economic testing prudent.

The selection of 37 bushing, across 34 sites, is reasonable and is consistent with the strategies described in the ACS driven by historical safety concerns and operational performance. This is part of phasing out the last remaining resin bonded paper bushing and oil impregnated paper bushing. Also, these bushings will be 29-59 years old at the start of RCP4 when they will be retired. We consider this prudent.

We have not identified any overlaps or double counting between the base R&R capex for this asset portfolio and other asset portfolio or capex category. We examined the scope of each asset portfolio and their respective proposed base R&R capex for RCP4 to identify synergies and also duplication between them but could not find any overlaps. Evidence[107] to support non-like-for-like power transformer replacement, where there may be capacity expansion element, was also sighted and the approval process for such business case documented. We are reasonably satisfied that the evidence sighted demonstrate accurate recognition of R&R activity and Transpower is proposing a prudent level of base R&R capex in RCP4.

Nevertheless, we could not reconcile the justification[108] provided for proposing 2 power transformer replacement projects in RCP4 with Transpower’s asset management system and its AHNR modelling tools and investment decision making process. Instead of using the AHNR models and the investment decision making process in similar fashion to other 17 power transformers, the 2 power transformers are being proposed for replacement in RCP4 as a ‘self-insurance’ or ‘contingency’ fund to prepare for an eventuality of up to 2 power transformers failing during RCP4. We note that approximately 15% of the power transformer fleet are fully depreciated and hence uninsured and the remaining 85% fleet have insurance coverage with an excess of $0.1m.

Given the fungible nature of the base R&R capex, Transpower is proposing $10.0m budget for 2 power transformer replacement to cover ‘what-if-they-fail’ scenario without demonstrating this justification using its usual asset management systems and tools. Transpower claims that they have historically experienced 2 power transformer failures in 5-year period in average and hence is proposing to provision coverage for such eventuality during RCP4, however we note the following:

– There is no guarantee that the asset failure would occur within the uninsured fleet only.
– Given the fungible nature of the base R&R capex, customers should not be worse-off if no uninsured power transformers fail during RCP4. Also, customers should not be worse-off for Transpower’s inability to use its usual asset management systems to justify expenditure for these 2 power transformers.
– If Transpower is confident of historical failure trend repeating during RCP4, it should utilise its existing asset management systems, data and tools to identify power transformers likely to fail during RCP4.
– Transpower may want to explore this issue separately with respect to analysing how its consumers should pay for this in the most prudent and efficient manner while considering the risk.

[106] Transpower, RFI034-06 TMI Economic Assessment EDGS Scenarios.pdf, RFI034-01 CP_WAI_62_00_00 230322 waiotahe dbc signed.pdf and RFI034-02 CP_WRK_AK_00_00 220308 Wairakei T29 T30 Replacement DBC Mar2021.pdf
[107] Transpower, RFI034-01 CP_WAI_62_00_00 230322 waiotahe dbc signed.pdf
[108] Transpower, RFI034-03 Power Tx Planning IV April 2023.pdf

– Irrespective of the above arguments, the underlying calculation used to estimate the $10m budget is conservative in its risk assumption and calculation method. For e.g., the use of cumulative annual failure rates of individual components of power transformer and the use of rapidly increasing asset failure rates going forward.

Efficiency

The cost estimate allowed for the proposed power transformer and bushing replacement projects is deemed reasonable. The formulation of estimate using building block cost, quantities allowance, risk allowance, and the build-up of customised projects are found to be reasonable for the given scope of work within the randomly selected RCP4 projects. We compared this information, where applicable, against independently sourced costing information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets. [109] Similarly, we referred to the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets. [110]

When compared to the present RCP3 base R&R capex plan, the increase in the proposed RCP4 base R&R capex is mostly due to the increase in asset/site quantities and the scope of R&R work in each project. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.[111] In stating this we note that unit rate estimates for few power transformers, bushings, transformer tank painting and firewall retrofitting were unavailable during RCP3 submission.

9.3.1.6 Conclusion

We conclude that the proposed base R&R capex for 17 power transformers and 37 bushings totalling $144.1m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP. However, the proposed base R&R capex for 2 power transformers totalling $10m does not satisfy ToR clauses A3(a), A3(b), A3(c) and A3(d) of the evaluation criteria in the ToR.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-5 Power transformers base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	No	The need for replacing 2 power transformers is inconsistent with Transpower’s own asset management system and its investment decision making process. This is evident and documented in the earlier evaluation sub-section.
A3(b)	Policies and planning standards were applied appropriately	No	The policy and planning standard were not applied consistently in proposing to replace 2 power transformers. This is evident and documented in the earlier evaluation sub-section.
A3(c)	Transpower’s process is reasonable and cost effective	No	The process followed in proposing to replace 2 power transformers is not reasonable and not cost effective. This is evident and documented in the earlier evaluation sub-section.
A3(d)	Investment need is challenged, and alternative solutions considered	No	The investment need was not challenged, and alternative solution not considered in proposing to replace 2 power transformers. This is evident and documented in the earlier evaluation sub-section.

[109] The repex models are available in the draft decision folder within each DNSP’s determination page on the AER’s website. Refer to: **Determinations & Access arrangements | Australian Energy Regulator (aer.gov.au)**
[110] AEMO, Transmission costs for the 2022 Integrated System Plan, 20 July 2021, refer to: **AEMO | Transmission costs for the 2022 Integrated System Plan**
[111] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	This is evident and documented in the earlier asset planning approach sub-section.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	Proposed procurement approach for this asset portfolio is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy. Refer to our evaluation in Section 7 of this report.

Note: A3(h) is not applicable to base capex

9.3.2 Indoor switchgear

The following table summarises our verification of the indoor switchgear capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-6 Verification summary of indoor switchgear base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$46.7m including resilience workstreams [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes.
IV conclusion	Accept: $46.7m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

Note: [1] Transpower is proposing two capex workstreams driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, these two resilience workstreams capex are evaluated within this base R&R capex.

9.3.2.1 Asset portfolio and strategy overview

Indoor switchgear is an integrated assembly of circuit breakers, disconnectors, earth switches, instrument transformers and busbars that provide switching and control functions for the network. Transpower's indoor switchgear asset fleet is relatively young due to recent history of outdoor to indoor switchgear conversion programme and replacement of legacy switchboards. This asset portfolio is generally in good conditions and consists of the following:

– High voltage (HV) gas insulated switchgear using SF6 and installed indoor at 110kV and 220kV. These assets are expensive, with robust design and is performing at high level of reliability. They are installed at 9 different locations.
– Medium voltage (MV) switchgear using either SF6 or vacuum and installed indoor at 11kV, 22kV and 33kV predominantly protecting customer connection points. There are some legacy MV indoor switchgear using bulk oil filled and air-break. Worker exposed to arc flash safety hazards during routine asset maintenance, especially for older assets that does not have IEC62271-200FL and IEC62271-200FLR standard arc fault containment capabilities, is a key risk for this asset type in this industry. Most of Transpower's older MV indoor switchgear are withdrawable type with newer ones being fixed pattern type. The withdrawable type has higher unplanned outage rates compared to fixed pattern type.

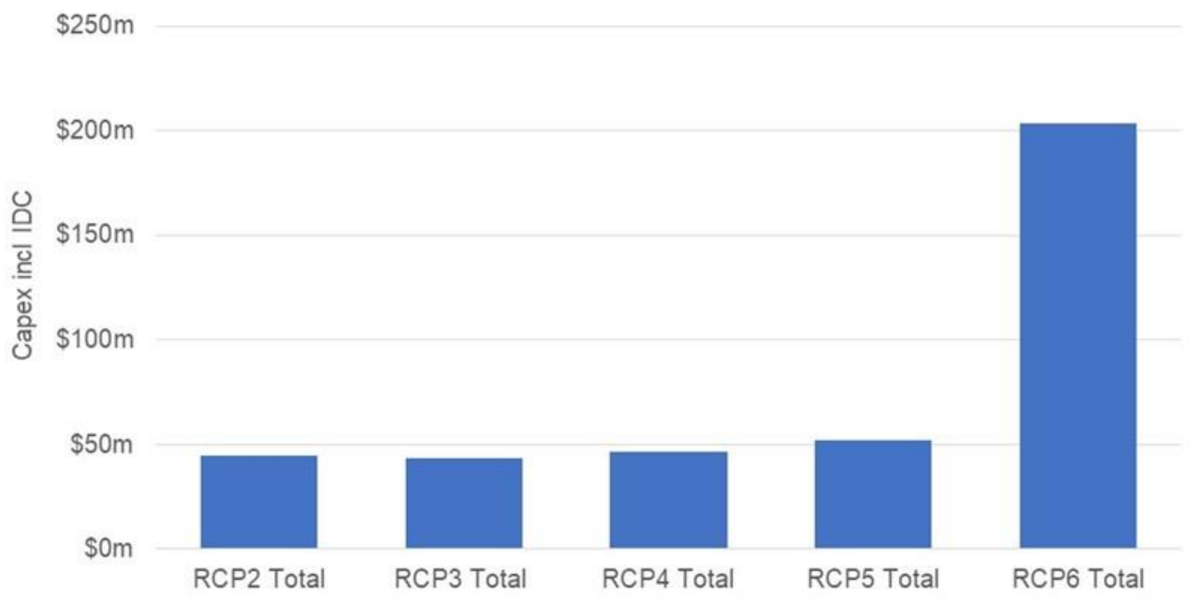
Transpower focus for this asset portfolio is on SF6 management[112] especially for the HV gas insulated switchgear and on safety, diversity of make-model and spare parts availability for MV switchgear.

The base R&R capex for this asset portfolio also includes resilience workstreams[113] that Transpower is specifically identifying within its RCP4 submission and forms part of its broader Grid Resilience Strategy[114]. There are two proposed resilience workstreams in this asset portfolio and pertains to non-air bushing pre-enabling works and for buying portable switchroom. These two resilience workstreams are being proposed using the base R&R capex and will be evaluated in this sub-section.

9.3.2.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the indoor switchgear asset portfolio including historical and forecast expenditures.

Figure 9-6 Indoor switchgear base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

Transpower is proposing to maintain a similar level of expenditure in RCP4 to RCP3.[115] While the asset quantities for replacement or refurbishment have decreased slightly, the sizes (or voltage levels) and scope of each R&R work in RCP4 has increased. We have evaluated changes in these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 9-7 Indoor switchgear base R&R capex for RCP3 and RCP4

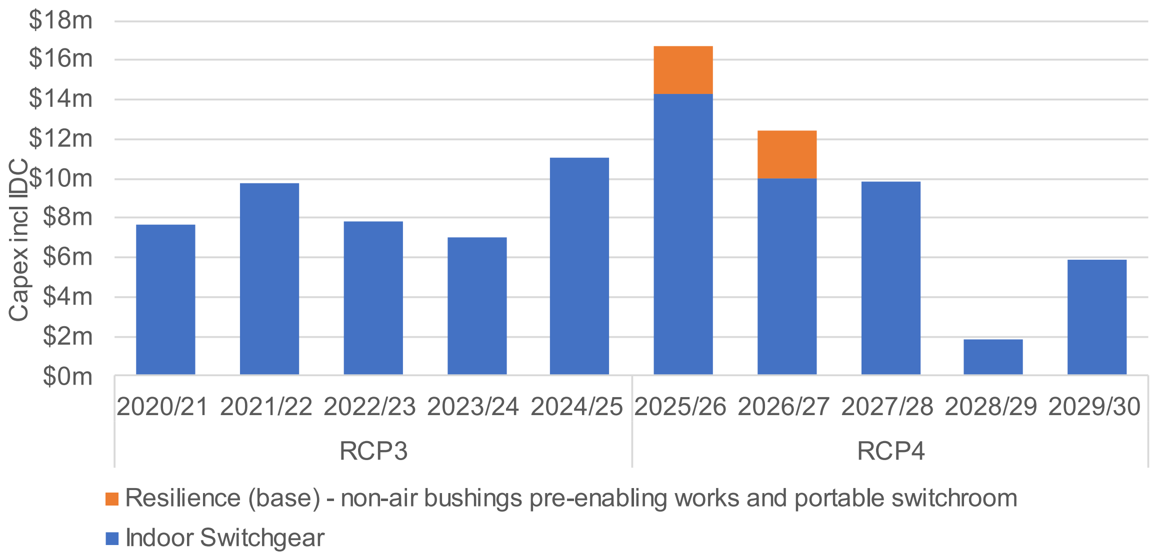
Asset portfolio	RCP3 total	RCP4 total	Change
Indoor switchgear	$43.3m	$46.7m	8%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure including for resilience workstreams.

[112] Transpower, ERR018 TS 55.01 SF6 Management Strategy.pdf
[113] Transpower, Resilience 2022 PMP
[114] Transpower, Grid Resilience Strategy
[115] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf

Figure 9-7 Indoor switchgear base R&R capex profile

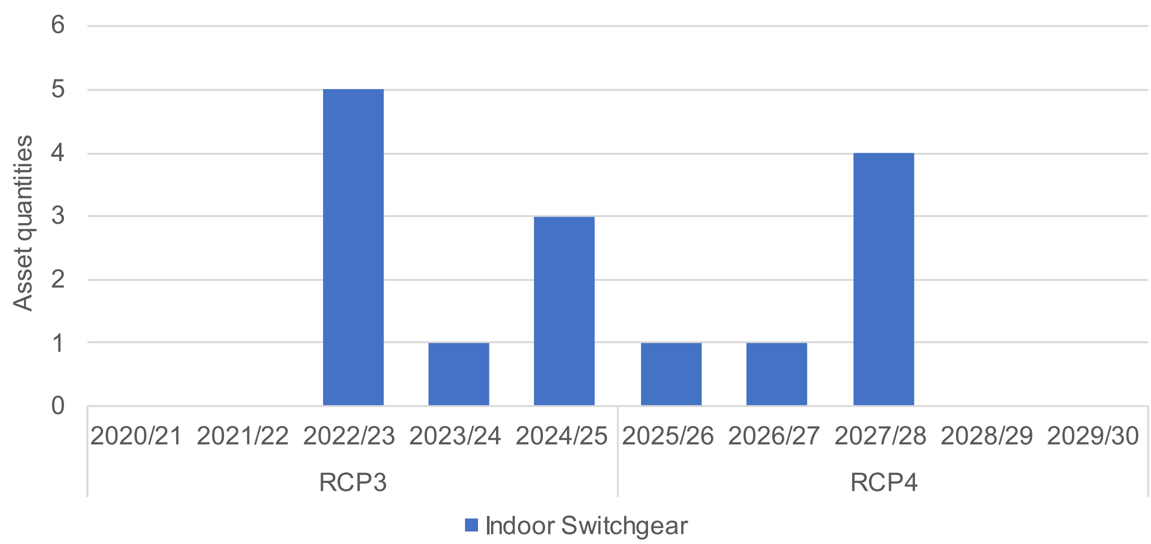


Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is planning to replace or refurbish 9 MV indoor switchboards and install building monitoring and online SF6 pressure monitoring systems on its HV gas insulated switchgear assets during RCP3.[116]

It is proposing to replace 6 MV indoor switchboard and undertake other indoor switchgear R&R activities during RCP4. The annual quantity profile of this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.[117]

Figure 9-8 Indoor switchgear base R&R quantities profile



Source: Indoor switchgear 2022 PMP

[116] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[117] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf

9.3.2.3 Asset planning approach

Transpower's ACS and PMP for this asset portfolio are informed by its organisational Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges faced in managing its existing fleet of indoor switchgear (consisting of various voltage level, interrupter type and withdrawable/fixed configuration), their objectives and approaches to address them. The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The life expectancy of well performing HV gas insulated switchgear indoor switchgear is approximately 60 years with timely maintenance and repair as needed. This depends on the ability to source critical spares and manufacturers support, which will no longer be available for all gas insulated switchgear models. The life expectancy for each type of MV indoor switchgear is generally 35-50 years depending on arrangement and usage or application in the substation.

While Transpower has developed AHNR models for this asset portfolio, it is relatively new and not as mature as others.[118] For example, the input data of asset health model for fixed configured and enclosed switchgear assets (such as condition assessment and testing data) is presently limited due to the nature of this type of assets. While the design set-up of asset health model for these assets are appropriate, they are not populated with actual input data. As such presently Transpower's R&R capex planning approach for MV indoor switchgear fleet is generally based on asset age with those assets being initially identified undergoing a more detailed review closer to the R&R intervention date. This review includes factors such as asset performance, potential consequence of major failure, obsolescence, availability of spare parts, known safety concerns and environmental impacts. Transpower's R&R capex planning approach for HV gas insulated switchgear indoor switchgear fleet is generally based on seeking to obtain maximum possible life by identifying and managing operational defects.[119]

The impact modelling enables Transpower to obtain criticality ranking of all identified assets in poor health to prioritise R&R work and also explore the intervention timing.

The GHD Advisory Expert Opinion Progress Review report[120] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

– The asset health modelling for this asset portfolio does not align with GEIP.
– The impact modelling for this asset portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
– The network risk analysis for this asset portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

While the Expert Opinion Progress Review report[121] identified gaps in the maturity of asset health model for this asset portfolio when assessed in isolation, it also commented that Transpower's overall asset management system, tools and decision frameworks collectively provides capability in understanding their network risk to inform and support its base R&R capex for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset portfolio.

Transpower identify constraints and opportunities such as deliverability, optimisation between portfolios, and other influencing factors. It has identified synergies between this asset portfolio and other asset portfolios such as secondary systems and also customer plans to align R&R activities where opportunities exist for project efficiencies.[122]

[118] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf and GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[119] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[120] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[121] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[122] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf

9.3.2.4 RCP4 capex drivers and solutions

The R&R need for this asset portfolio is primarily based on risk management such as safety (arc flash) concerns, addressing asset performance/condition/reliability/SF6 leakage concerns and addressing strategic/obsolescence/spare part availability concerns.[123]

The AHNR modelling for this asset portfolio has limitation as noted in the earlier paragraphs. Transpower uses asset age as a proxy for condition to initially identify likely candidate assets for R&R activities for those indoor switchgear that has not been identified having any safety, performance or strategic concerns.

The last of the oil filled MV indoor switchgear is planned for replacement during RCP3.[124] Transpower is focusing to replace air-break magnetic interrupter and early generation SF6 metal-clad indoor switchgear in RCP4.[125]

Transpower undertakes life extension activities for its HV SF6 filled indoor switchgear, and also as part of its SF6 Management Strategy, undertakes seal replacement to minimise SF6 leaks where possible. These activities are planned to continue until non-SF6 solutions are available at HV levels.

Transpower estimated the RCP4 base R&R capex for this asset portfolio by considering the AHNR modelling (with its limitation), SF6 Management Strategy and site-by-site review of each candidate indoor switchgear site because of low volume of this asset fleet. We understand that some of the proposed projects (in CYD and WIL substations) within this base R&R capex will be reviewed and refined after OEM investigation are carried out.

To achieve efficiencies and minimise outages, Transpower integrate indoor switchgear replacements with other works at the same site, and supply point upgrades undertaken by customers.[126]

Transpower is also proposing two workstreams driven by resilience concerns amounting to $4.8m total during RCP4 which is included within the proposed base R&R capex of this asset portfolio. These are pre-enabling works to response to major failures of non-air bushings/gas insulated switchgear and buying portable switchroom for South Islands.[127]

9.3.2.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio is prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

This base R&R capex is volumetric programme. The RCP4 proposed budget was developed using the building block unit rate estimates (from TEES) and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this asset portfolio and observed the followings.

Prudency

We appreciated the limitation of the asset health model of this asset portfolio and the data quality issues (asset granularity, classification/meter hierarchy structure in Maximo and single vs three phase data entry record) and inputs to the model (absence of actual duty factor value and observed condition data).[128] Given this, we examined the impact of these issues on the proposed base R&R capex. Other elements of Transpower's asset management systems identifies and addressed this shortcoming by undertaking detailed review of initially identified deteriorating assets. We observed that the absence of mature asset health model does not generally impact the ability of Transpower's asset management system to forecast the base R&R capex for RCP4 given the low volume of asset fleet and site-by-site review of each candidate indoor switchgear project.

[123] Transpower, RFI015-10 FS 17.01 Indoor switchgear asset class strategy.pdf
[124] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[125] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[126] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[127] Transpower, Resilience 2022 PMP
[128] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

The investment need of this asset portfolio is primarily based on risk, replacing MV switchboards that have strategic (such as obsolescence) or safety concerns. In stating this, we have considered the characteristics of the switchgear population, Transpower's average life expectancy of these assets, limitation with the asset health model, identification of common asset failure modes (internal ageing disconnectors), asset performance records, the application of asset criticality framework, option assessment and solution prioritisation approach which demonstrate a risk based approach.

Analysis of the proportion of the MV indoor switchgear proposed for replacement during RCP3 and RCP4 considering the population size, its age profile, diversity of interruption technology and Transpower existing strategies indicates a well-managed renewal of asset portfolio consistent with the expected average asset life.

Transpower's average life expectancy of MV indoor switchgear was considered comparable against the Australian DNSPs' MV indoor switchgear. [129]

The following two proposed resilience workstreams amounting to $4.8m are included within the proposed base R&R capex:

– Pre-enabling works at Wilton substation to facilitate easy instalment of air bushing transformer in the event of major asset failure incident. Considering the criticality of the 9 HV gas insulated switchgear sites, the choice of Wilton substation is prudent.
– Procuring a portable switchroom for South Island. This will assist Transpower in timely recovery after an HILP event and will mitigate the dependency of transporting the existing switchroom via ferry. We consider this proposed capex to be prudent.

We did not find any evidence of double counting between this proposed base R&R capex and other portfolio or expenditure categories. However, to achieve efficiencies and minimise outages, Transpower integrate indoor switchgear replacements with other works at the same site.

Historic base R&R capex related to the removal of air-break magnetic MV indoor switchgear and its impact to the ongoing grid opex was examined and links sighted. [130] It showed a reduction in the historical grid opex trend from about the time of removal of air-break magnetic MV indoor switchgear to modern equivalent indoor switchgear due to lower maintenance requirements.

We sighted the use of life extension strategies, SF6 Management Strategy, phasing out of old legacy switchgear and issue of stranded make-model of indoor switchgear asset[131], and consider them to be reasonable and prudent.

Efficiency

Comparison of the TEES building block unit rates[132] of 11kV and 33kV indoor switchgear indicate comparable cost against a set of independently sourced estimate information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations.

Similar comparison of TEES building block unit rates of HV gas insulated switchgear assets could not be performed given the lack of description/specification in TEES.

The proposed base R&R capex for RCP4, when converted to cost per MV switchboard project, is similar to RCP3 project cost. [133] Any discrepancy is attributed to proposed life extension works on HV gas insulated switchgear assets, inclusion of customised scope, and site specific allowance.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in. [134]

[129] AER Category Analysis RIN, Tab 5.2 Asset Age Profile, reported by various Australian DNSPs. This information is available in the AER website.
[130] Transpower, RFI015 Transpower response.pdf
[131] Transpower, RFI015-10 FS 17.01 Indoor switchgear asset class strategy.pdf
[132] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx
[133] Transpower, RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf
[134] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

9.3.2.6 Conclusion

We conclude that the proposed base R&R capex for indoor switchgear asset portfolio totalling $46.7m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this non-identified programme against the evaluation criteria.

Table 9-8 Indoor switchgear base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections.

9.3.3 Outdoor switchgear

The following table summarises our verification of the outdoor switchgear capex which is categorised as an identified programme and forms part of the base R&R capex for RCP4.

Table 9-9 Verification summary of outdoor switchgear base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$106.5m including resilience workstream [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $106.5m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

Note: [1] Transpower is proposing a capex workstreams driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, the resilience workstream capex is evaluated within this base R&R capex.

9.3.3.1 Asset portfolio and strategy overview

The outdoor switchgear portfolio consists of outdoor circuit breakers, outdoor instrument transformers and outdoor disconnectors and earth switches. The portfolio also includes the support structures for ground mounted disconnectors and earth switches. For avoidance of doubt, all outdoor switchgear in HVDC converter stations or associated with synchronous condensers or dynamic reactive power facilities are excluded from this asset portfolio.

The ACSs of the three asset classes in this portfolio documents their respective asset class challenges, objectives, fleet statistics, operational knowledge, asset management strategy and planning, asset management decision making, asset information, organization and people, risk and review and lifecycle delivery providing a detailed approach to manage this asset portfolio.

The PMPs of the three asset classes in this portfolio provides the latest available snapshot of the state of the respective asset fleet, describes the planning approach and recent and proposed operational activities. They also provide the RCP4 base R&R capex forecast and associated quantities for:

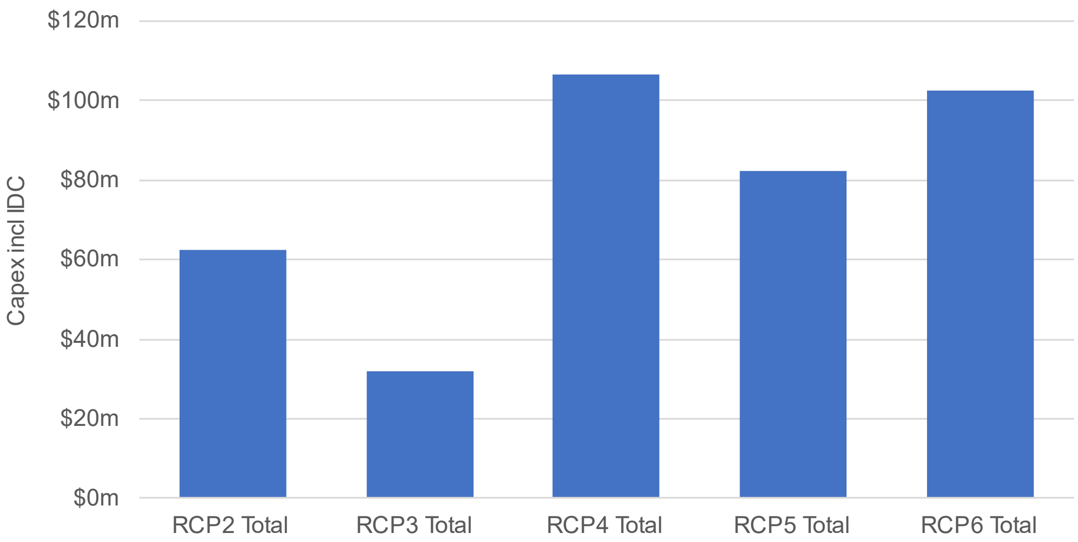
– Outdoor circuit breakers.
– Current transformers, voltage transformers, capacitive voltage transformers, neutral current transformers.
– Disconnector and earth switch, disconnector headgear and disconnector remote switching.

The base R&R capex for this asset portfolio also include a resilience workstream that Transpower is specifically identifying within its RCP4 submission and forms part of its broader Grid Resilience Strategy. This resilience workstream pertains to buying spare equipment to mitigate against the seismic risks identified using a new seismic hazard model. This resilience workstream targets mitigating risks at sites identified in the model with a high seismic risk after considering relevant the design standard (IEEE693). This resilience workstream is being proposed using the base R&R capex and will be evaluated in this sub-section.

9.3.3.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the outdoor switchgear asset portfolio including historical and forecast expenditures.

Figure 9-9 Outdoor switchgear base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

Transpower is proposing to increase both the expenditure and the quantity of assets replaced or refurbished across all three asset classes within this portfolio in RCP4, compared to the present RCP3 expenditure levels.[135] This increase is mostly due to asset quantities than the unit costs and we have evaluated changes to these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 9-10 Outdoor switchgear base R&R capex for RCP3 and RCP4

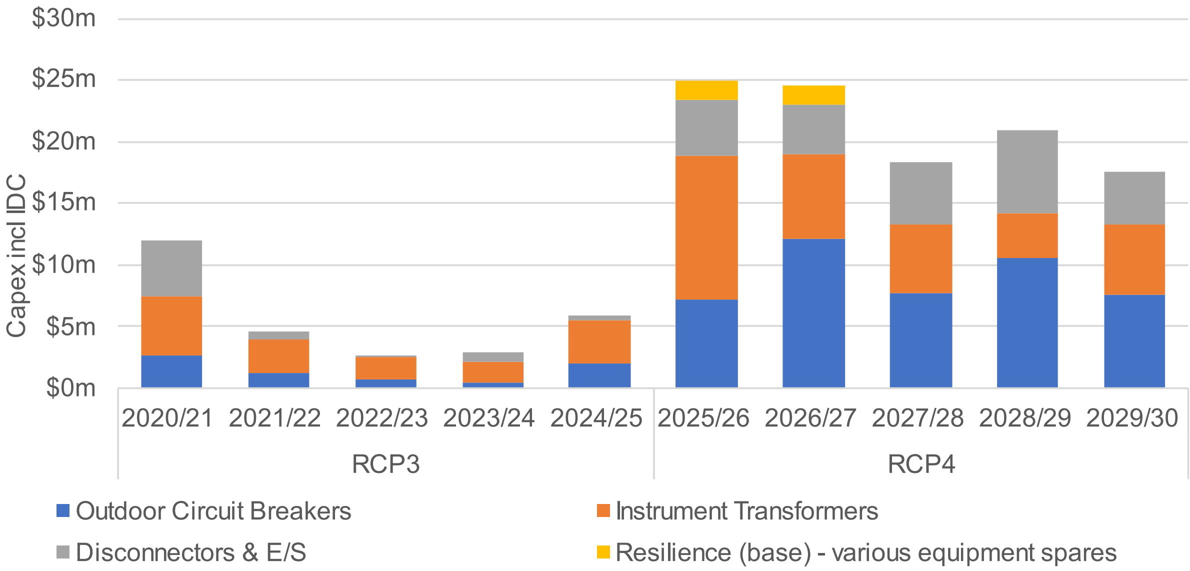
Asset portfolio	RCP3 total	RCP4 total	Change
Outdoor switchgear	$31.9m	$106.5m	234%

Source: Transpower, RT01 expenditure schedule

[135] Transpower, ERR025 ACS Outdoor Circuit Breakers 2022 PMP.pdf, ERR024 ACS Outdoor Instrument Transformers 2022 PMP.pdf, ERR023 ACS Disconnectors and Earth Switches 2022 PMP.pdf

The annual base R&R capex profile for all three asset classes within this asset portfolio in the stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-10 Outdoor switchgear base R&R capex profile

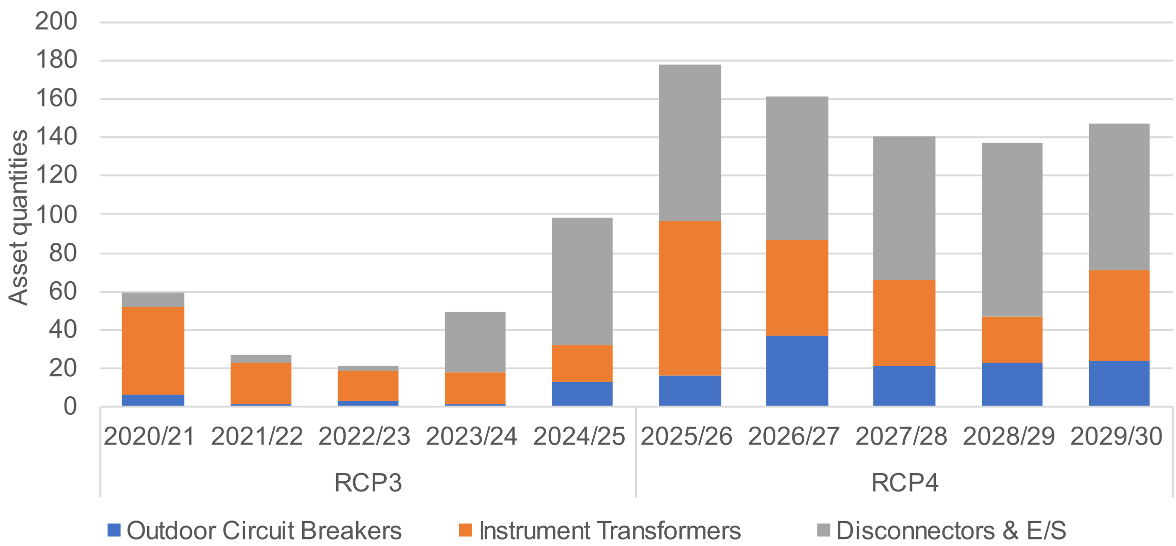


Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is presently planning to replace or refurbish 24 outdoor circuit breakers, 120 outdoor instrument transformers, and 110 outdoor disconnectors and earth switches in RCP3.

Transpower is proposing to replace or refurbish 121 outdoor circuit breakers, 247 outdoor instrument transformers, and 396 outdoor disconnectors and earth switches in RCP4. The annual quantity profile for all three asset classes within this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-11 Outdoor switchgear R&R quantity profile



Source: Outdoor Circuit Breaker 2022 PMP, Instrument Transformers 2022 PMP and Disconnector and Earth Switch 2022 PMP

9.3.3.3 Asset planning approach

The three asset classes within this portfolio all have their own respective ACS and PMP. Transpower's ACSs and PMPs for this asset portfolio are informed by its organisational Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges faced in managing its existing fleet of outdoor circuit breakers, current transformers, voltage transformers, capacitive voltage transformers, neutral current transformers, disconnector and earth switch, disconnector headgear and disconnector remote switching, their objectives and approaches to address them.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies, better asset makes and models, need for investigation and intervention priorities. Based on these they guide Transpower's R&R approach in managing these asset classes.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACSs and PMPs. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for all three asset classes in this portfolio in RCP4 is predominantly based on risk i.e., asset health scores and criticality modelling to prioritise R&R work.[136] These are based on respective asset class asset health model producing health score/probability of failure and asset class impact model producing criticality ranking. Collectively the AHNR modelling provides Transpower with an input to its R&R investment decision making.

The GHD Advisory Expert Opinion Progress Review report[137] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

- The asset health modelling for all three asset classes in this portfolio meets the GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
- The impact modelling for all three asset classes in this portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
- The network risk analysis for all three asset classes in this portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower also consider other information, such as suppliers' offerings (or lack thereof), compliance requirements, workforce capabilities etc. to complement the AHNR modelling in its R&R investment decision making.

Life extension strategies are applied to most of the outdoor disconnectors and earth switches asset class most of the time, mainly focusing on disconnector headgear component.[138]

[136] Transpower, ERR015 FS 51.01 Outdoor circuit breakers asset class strategy.pdf, ERR008 FS 03.01 Outdoor disconnectors and earth switches asset class strategy.pdf, ERR010 FS 22.01 Outdoor instrument transformers asset class strategy.pdf
[137] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[138] Transpower, ERR008 FS 03.01 Outdoor disconnectors and earth switches asset class strategy.pdf

Transpower has identified synergies between this asset portfolio and other asset portfolios such as power transformers and secondary systems to align R&R activities where opportunities exist for project efficiencies. The R&R programme for this asset portfolio is linked to associated secondary system, related structures and busworks, potential for indoor conversion and power cable R&R programs. Synergies are identified and these R&R programs are also linked to enabling customer electrification capex being proposed using the UIOLI uncertainty mechanism.[139]

The resilience workstream reflects the holding of additional spares of outdoor circuit breakers and outdoor instrument transformers in strategic locations to enable quick recovery after a seismic event. According to New Zealand GNS Science's updated National Seismic Hazard Model estimates the likelihood of future earthquake shaking hazard to have increased throughout most of the country, ranging from almost no change to more than doubling in some areas. We understand this body of knowledge is developing especially its interaction with IEEE693 design standard and there is presently no definitive solution, but we consider the planning approach to be appropriate.

9.3.3.4 RCP4 capex drivers and solutions

The base R&R capex drivers for all three asset classes in this portfolio in RCP4 is predominantly based on risk informed by asset health score and impact modelling information that allows Transpower to prioritise the investment based on asset performance and service criticality. The base R&R capex of these three asset classes during RCP3 and RCP4 is also partly driven by the benchmark agreement, i.e., minimum reliability standard prescribed by the Electricity Authority which is a seven-year long remediation programme.[140]

Transpower is proposing one workstream driven by resilience concern amounting to $3.2m during RCP4 which is included within the proposed base R&R capex of this asset portfolio. This is for purchasing 10 spare equipment of each circuit breaker, current transformers and voltage transformers at various voltage level and in strategic locations.

Outdoor circuit breakers

The base R&R capex for the outdoor circuit breaker asset class during RCP4 is also driven by Transpower's greenhouse gas emission reduction target, net zero commitment and its SF6 Management Strategy. Transpower is trying to avoid installing SF6 circuit breakers where possible, as SF6 circuit breaker inherently have natural leakage rates. While non-SF6 technology is available at 66kV and below level, there are very limited alternatives available at 110kV or above level at present.

The outdoor circuit breaker asset class R&R activities is also driven by the bulk oil circuit breaker phasing out strategy. Transpower is trying to phase out old bulk oil circuit breaker due to inefficient base opex and operational safety concerns and expects to complete this by 2030 as per its strategic objective.

Outdoor instrument transformers

The base R&R capex for the outdoor instrument transformers asset class during RCP4 is also informed by Transpower's recent experience with a specific make/model of current transformer (pre 2000 Nissin FGCH model) suffering from extensive corrosion of the stainless-steel bellows leading to the replacement of a number of this current transformer due to oil leaks. This experience with the pre 2000 Nissin FGCH model is very similar to the failure mode exhibited by the Arteche CH-123 failures which has resulted in explosive asset failures in past. So far the affected Nissin model has not exploded and failed.

[139] Transpower, ERR025 ACS Outdoor Circuit Breakers 2022 PMP.pdf, ERR024 ACS Outdoor Instrument Transformers 2022 PMP.pdf, ERR023 ACS Disconnectors and Earth Switches 2022 PMP.pdf
[140] Transpower, RFI015 Transpower response.pdf, ERR029 SA Protection and Revenue Metering 2022 PMP.pdf

Outdoor disconnectors and earth switches

The R&R approach to the fleet of outdoor disconnector and earth switch is to maintain them indefinitely, where possible, through targeted refurbishment and component replacement, based on condition (life extension strategy).

Transpower is planning to continue to target the disconnector headgear restorations, in lieu of replacement, during RCP4 which will return this component to as new condition. Transpower has also experienced a manufacturing issue with a small subset of this asset class which prevents this subset from being suitable for a life extension strategy.

Transpower is also proposing to trail remote switching arrangements of this asset class to enable future grid functionality and operational efficiency in RCP4.

9.3.3.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

This base R&R capex is volumetric programme. The RCP4 proposed budget was developed using the building block unit rate estimates of constituent asset class (from TEES) and the corresponding asset quantities estimated for R&R intervention as identified in the respective PMPs. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this programme and observed the following.

Prudency

We analysed and further breakdown the different types of asset class and enquired the reasons for any step change in quantities noticed between RCP3 and RCP4. We reviewed the investment drivers as identified in the previous sub-section to be reasonable in informing the proposed base R&R capex for RCP4. We found them to be risk-based drivers informing the development of prudent quantity of R&R activity.

We reviewed the supporting condition assessment data for a sample of individual equipment, assumptions, and the use of the asset health and network risk modelling tools for identifying and prioritising the proposed projects and nominated quantities in RCP4 and consider them to be reasonable.[141] It demonstrated a risk-based approach in most instances.

The average replacement/retirement age of these asset classes in this asset portfolio proposed by Transpower was considered comparable against the Australian DNSPs and TNSPs annual regulatory reporting in recent past considering the environmental differences. We referred to the average asset life reported in the annual Category Analysis RIN within the Asset Age Profile tab of the reporting template[142] for this comparison. We understand that while the age is not the absolute determinant for replacement, but it can provide an indication or proxy for asset conditions and hence the AHI score or the probability of failure. On this assessment, we consider that Transpower's proposed asset replacement volumes are prudent.

We queried the modelled projection of annualised risk levels for outdoor instrument transformers and outdoor circuit breakers asset classes with and without the proposed RCP4 base R&R capex and tested the level of risk averseness or otherwise (risk appetite) from Transpower management team in managing this portfolio. We consider the risk level at the end of RCP4 with the proposed base R&R capex to be generally similar to the current asset health across these asset classes.[143] This demonstrated a prudent volume of R&R work in RCP4.

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[141] Transpower, RFI015-02 AHI and Annualised Risk.pdf
[142] AER, 'Performance reporting', accessed August 2023, refer to: **Performance reporting | Australian Energy Regulator (aer.gov.au)**
[143] Transpower, ERR025 ACS Outdoor Circuit Breakers 2022 PMP.pdf, ERR024 ACS Outdoor Instrument Transformers 2022 PMP.pdf, ERR023 ACS Disconnectors and Earth Switches 2022 PMP.pdf

We reviewed recent business cases from RCP3 involving this asset portfolio.[144] They demonstrate consistent application of TEES building block unit rates, consideration of alternate options, identification of potential synergies with other work and improvements to the definition and scope of proposed solutions as the business case progresses from Investigation Business Case (IBC) stage to delivery business case stage. The inputs and outputs of this process are consistent with the asset planning decision framework. The definition and scoping of the preferred solutions were deemed prudent.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

We consider the effect of the proposed base R&R capex on other asset portfolios and other cost categories, including opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACSs and PMPs of the associated asset classes.

Efficiency

Comparison of the TEES building block unit rates of few randomly selected asset types from all three asset classes indicate acceptable alignment against independently sourced costing information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets. Similarly, we referred to the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the increase in the proposed RCP4 base R&R capex is mostly due to the increase in asset quantities. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.[145]

We reviewed the cost estimate process used in developing the resilience workstream budget of $3.2m embedded in this asset portfolio and consider it to be reasonable and consistent with its volumetric budget build-up. We also consider this workstream being proposed as base R&R capex to be reasonable.

[144] Transpower, RFI015-04 RCP3 Circuit Breaker Clearance Investigation - IBC.pdf, RFI015-05 RCP3 Circuit breakers Business Case - Approved.pdf, RFI015-06 Outdoor Instrument Transformers RCP3 DBC.pdf, RFI015-07 CP_VAR_1EA_0_00 - DS headgear refurbishment 23-24 DBC.pdf, RFI015-08 CP_MDN_BW_00_00_DBC_230328_SIGNED.pdf
[145] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

9.3.3.6 Conclusion

We conclude that the proposed base R&R capex for the outdoor switchgear asset portfolio totalling $106.5m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-11 Outdoor switchgear base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	This is evident and documented in the earlier asset planning approach and RCP4 capex drivers sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	This is evident and documented in the earlier asset planning approach sub-section.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and evaluation sub-sections.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and evaluation sub-sections.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	This is evident and documented in the earlier asset planning approach sub-section.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	Proposed procurement approach for this asset portfolio is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy. Refer to our evaluation in Section 7 of this report.

Note: A3(h) is not applicable to base capex

9.3.4 Structures and buswork

The following table summarises our verification of the substation structures and buswork capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-12 Verification summary of structures and buswork base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$32.6m including resilience workstream [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes.
IV conclusion	Accept: $32.6m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, the resilience workstream capex is evaluated within this base R&R capex.

9.3.4.1 Asset portfolio and strategy overview

The substation structures and buswork asset portfolio consists of:

– Lattice gantries and tie line towers
– Earthpeaks and lightning rods
– Steel and concrete support posts (including concrete posts supporting disconnectors). For avoidance of doubt, support structures for ground mounted disconnector/earth switch is included in a separate asset portfolio – outdoor switchgear.
– Baseplates, holding down arrangements and foundations
– Busbar structure, conductors, droppers, insulator posts
– Aerial earthwires and associated clamps and attachment hardware.

These structures operate from 11kV to 220kV level at AC substations, but in recent time with the 33kV outdoor switchyard conversion strategy, bulk of these structures are operating at 66kV to 220kV level.

We note the drone based visual asset inspection and condition assessment is relatively recent activity adopted by Transpower and historically there has been a lack of regular condition assessments and information from such activity informing a well-functioning asset health model.[146] Transpower is expecting to improve in this area during the remainder of RCP3 and it is expecting benefits from having a well informed and functioning asset health model. With this expectation they have adjusted their base R&R capex forecast for future RCPs from RCP5 onwards.[147]

Transpower plan for RCP4 continues to be refurbishment of concrete posts and steel lattice gantries as they reach the required intervention point and replacement of insulators and hardware. Transpower is also including a resilience workstream within its base R&R capex for this portfolio which is the first time Transpower is separately identifying such activities or cost category in its RCP submission. The proposed resilience workstream pertains to removing overhead station earth wire to mitigate common failure mode and is evaluated in this sub-section.

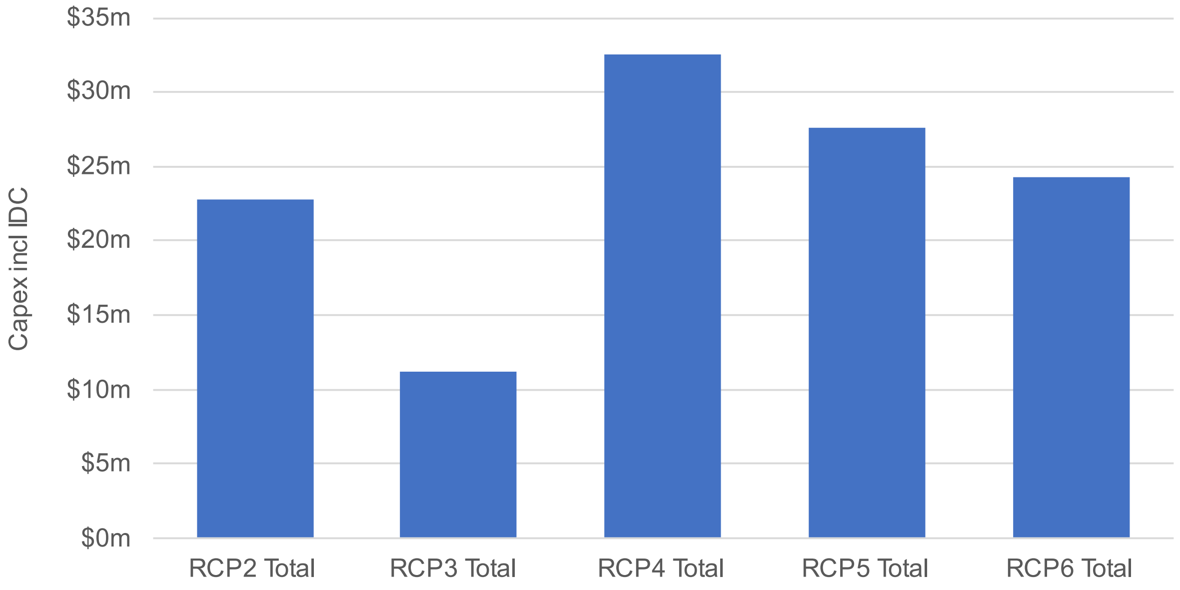
We reviewed this portfolio alongside the outdoor switchgear and building and ground asset portfolios and the 33kV outdoor switchyard conversion strategy.

[146] Transpower, RFI015-17 ACS Structures and Buswork 2022 PMP.pdf
[147] Transpower, RFI015-17 ACS Structures and Buswork 2022 PMP.pdf

9.3.4.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the substation structure and buswork asset portfolio including historical and forecast expenditures.

Figure 9-12 Structures and buswork base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

Transpower is proposing to increase the expenditure in RCP4 compared to the present RCP3 expenditure level. This increase is due to increase in asset quantities (more sites, greater scope of work) than the unit costs and we have evaluated changes to these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

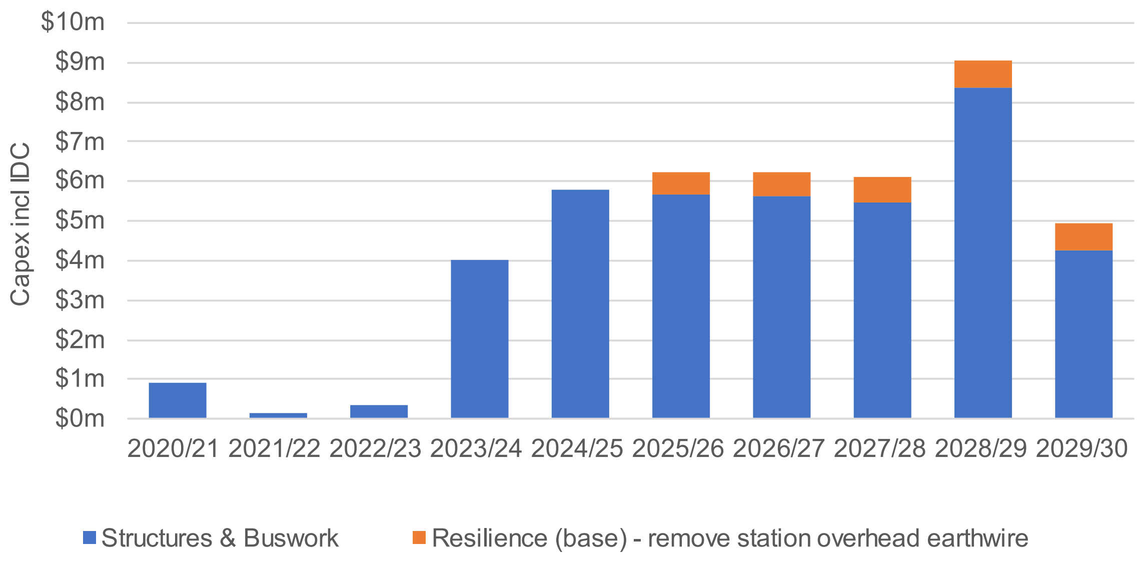
Table 9-13 Structures and buswork base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Structures and buswork	$11.2m	$32.6m	190%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure including for resilience workstream.

Figure 9-13 Structures and buswork base R&R capex profile



Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

This increase in RCP4 base R&R capex is mostly due to increase in lattice gantry painting programs. This increase in structure and buswork base R&R capex in RCP4 is also related to the increase in outdoor switchgear asset portfolio base R&R capex in RCP4 when compared to RCP3.

Transpower is planning on asset life extension work on 18 sites with painting lattice gantries and on 39 sites with refurbishing bus support posts, and planning on insulator and hardware replacement at 1 site in RCP4 totalling to $29.4m. It is also planning to proactively replace the overhead earth wire and replace them with lighting masts in 13 sites driven by resilience concerns in RCP4 totalling to $3.2m.

Given the nature of disparate variety of assets and the nature of base R&R capex projects, the base R&R quantity profile of this asset portfolio is not available.

9.3.4.3 Asset planning approach

Transpower's ACS and PMP for this asset portfolio are informed by its organisational Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges faced in managing its existing fleet of various varieties of structure and buswork assets, their objectives and approaches to address them.

The GHD Advisory Expert Opinion Progress Review report[148] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

– The asset health modelling for this asset portfolio does not align with GEIP. Transpower has paused progressing the maturity of this asset health model and it is presently not fully functional.
– Transpower has not yet developed the impact modelling for this asset portfolio to determine criticality.
– The network risk analysis for this asset portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also stated that any shortcomings identified within the individual asset class models or analysis within each workstream is based on assessment of those elements in isolation without any regard to the entire asset management ecosystem. Otherwise, the Expert Opinion Progress Review did not identify evidence that Transpower is not meeting GEIP when the entire range of asset management practices comprising of various elements, processes, tools and decisions are considered holistically.

For example, Transpower relies on site-based asset condition assessments to inform its investment decision for this asset portfolio. It has started to transition to drone based visual inspection activity for condition assessment of

[148] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

substation structure and buswork. It has developed an asset health model for steel lattice gantries and prototype condition forecasting methods for insulator and concrete support posts. It has also started to define and improve its asset health input data parameters and structures for this asset portfolio. It relies on the criticality assessment of associated substation assets (such as outdoor switchgear and power transformers) to infer prioritisation for R&R intervention work.

Evidence sited during the verification process confirmed this previous finding regarding the risk assessment process for this asset class.

Therefore, the investment need for this asset portfolio is primarily based on condition and coordination with other works or other asset portfolio expenditure programme.

Replacement intervention is the most viable option for insulators, conductor and bus hardware, substation earthwire, earthwire hardware and associated attachments. Whereas refurbishment intervention option is usually considered for lattice gantries with protective coating of galvanized surfaces, recoating of previously painted surfaces, steel and bolt replacements, staged refurbishment including addition or bypass of structure bays. Transpower has noted that site specific constraints and condition characteristics of the structures have a significant influence on the preferred options, estimated expenditure and outage coordination effort needed to safely access different areas of the structure and buswork.

9.3.4.4 RCP4 capex drivers and solutions

The substation structures and buswork usually tend to have a long asset life. Corrosion is the most significant degradation factor within this asset portfolio. The rate of degradation due to corrosion varies significantly depending on location or geography where they are installed. The same asset type may need to be intervened to prolong its life or to replace it much sooner than another one installed in a different corrosion zone.

The performance of this asset portfolio is largely dependent on external environmental factors such as bird dropping, hitting, nesting. Otherwise, the unplanned outage rate is performing well in recent years compared to the set performance target.

The investment need is initially identified by considering the asset condition at each specific site (based on 2016 condition assessment survey and the newly established drone based visual inspection activity), asset degradation curves and corrosion zones. Transpower presently does not perform criticality modelling for this asset portfolio. Hence when determining the final investment need or prioritising the intervention need, these drivers are collectively considered together with the seismic zone's information, the need of associated outdoor switchgear and power transformer asset portfolios and potential synergy in coordinated capital work.

Transpower considers various types and mix of intervention solution ranging from asset life extension strategies (painting, recoating of previously painted surfaces, steel and bolt replacement etc.) to complete in-situ asset replacement. The preferred option takes into consideration of site-specific constraints, operational outage restriction, asset condition itself and the whole of asset life cost estimate. Transpower plans its works for these assets for when other works are required to use the same outages.

9.3.4.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

This base R&R capex is volumetric programme. The RCP4 proposed budget was developed using the building block unit rate estimates of constituent asset class (from TEES) and the corresponding asset quantities estimated for R&R intervention as identified in the respective PMPs. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this programme and observed the following.

Prudency

We appreciated the limitation of both asset health and impact modelling of this portfolio to assess criticality. We understand the newly established drone based visual inspection activity is now providing asset condition assessment data and confirming/updating the previous 2016 condition assessment survey.

Given this, we examined the impact of these issues on the proposed base R&R capex. We reviewed the process for site based condition assessment, unmanned drone inspection program, corrosion zones factor etc. that informs and drives the asset remediation solution in this asset portfolio. We note the low confidence level in prioritising the capex project sites early on, but this is overcome closer to the need date given the nature of assets (associated with other portfolios), project investigation (site-by-site review), consideration of seismic zones, intervention solution (life extension strategies vs replacement) and recent roll out of condition assessment activities using drone technology. Adjustment made to the RCP4 budget to reflect these factors. We consider this reasonable and prudent approach in demonstrating a risk based approach.

Analysis of Transpower's average life expectancy of different asset types within this asset portfolio, which are considered reasonable, and their respective age profiles suggest a proportion of asset population needing intervention in every 5 years band. This quantum of asset population is not dissimilar from the proposed projects during RCP4.

Transpower is forecasting to continue with a programme of refurbishing concrete posts and steel lattice gantries and replacing insulators and hardware as they reach the required intervention point driven by asset condition assessment. The increase in forecast capex in RCP4 is primarily focused on the management of concrete posts, bus insulators and life extension activities for steel lattice gantries. This forecast quantities in RCP4 have included condition based investment deferral decisions based on recent drone inspections of various substation sites. We consider this prudent.

With respect to the proposed resilience workstream, Transpower is proposing to replace overhead earth wires in 13 sites with lighting masts after prioritising it down from an initial 26 sites where a threat of overhead earth wire falling down on energized switchyard equipment exists. Considering the low value solution, the consequence of such asset failure, Transpower's experience with 2006 Otahahu overhead earth wire failure, the prioritisation of sites is considered prudent.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Efficiency

The average project cost cannot be compared between RCP3 and RCP4 due to the diversity of project scope, asset types and activities.

We could not benchmark the asset or activity building block rates documented in the PMP in informing the RCP4 budget given the bespoke nature of building block description. While these unit rates are of low value, the quantities or scope of activities or assets is the main cost driver in each project. Using these unit rates, we deduced the type and quantities of activities in the highlighted projects documented in the PMP and consider them to be reasonable given the size and scale of Transpower average substations.

Furthermore, we reviewed the asset building block unit rates used during the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD). We noted the increase in the building block unit rates between the RCP3 and RCP4 is generally very modest when CPI is factored in. [149]

[149] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

9.3.4.6 Conclusion

We conclude that the proposed base R&R capex for substation structure and buswork asset portfolio totalling $32.6m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified** programme against the evaluation criteria.

Table 9-14 Structures and buswork base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.

9.3.5 33kV outdoor to indoor switchgear conversion

The following table summarises our verification of the 33kV outdoor to indoor switchgear conversion capex which is categorised as a **non-identified programme** and forms part of the base R&R capex for RCP4.

Table 9-15 Verification summary of 33kV outdoor to indoor switchgear conversion base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$30.2m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes.
IV conclusion	Accept: $30.2m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

9.3.5.1 Asset portfolio and strategy overview

This asset portfolio is considered and evaluated alongside the outdoor switchgear portfolio and indoor switchgear portfolio. This asset portfolio consists of all main primary asset types within the outdoor 33kV switchyards that includes the support structures, buswork, circuit breakers, disconnectors and earth switches, and other associated equipment such as instrument transformers, surge arrestors and local service supply components. These assets were designed and installed before 40 years ago and presently there is a significant gap between those designs and current design standards, especially spacing and safety clearance distances.

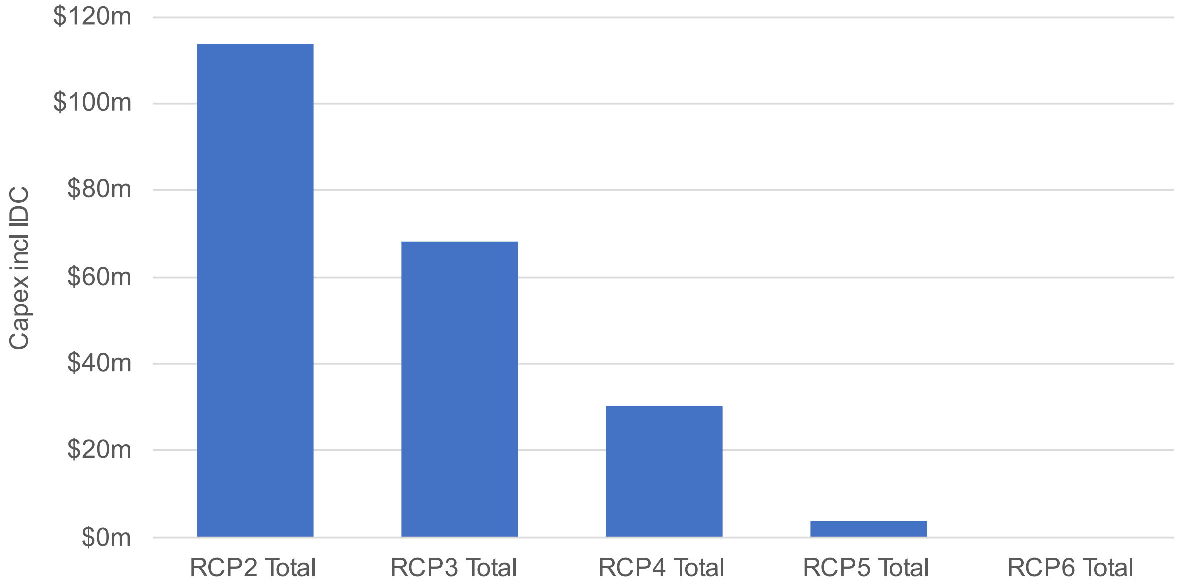
Transpower also have a number of tragic worker safety accidents, serious injuries and near misses in past due to the presence of these safety hazards and the need for operational maintenance. Outdoor switchyard is also exposed to the elements resulting in unplanned outages.

This outdoor-to-indoor conversion is an ongoing strategy and Transpower is expecting to complete this strategy by RCP5 when the last of the identified sites will be converted to indoor facility. We note that there will still be some outdoor 33kV switchyard sites will be remaining after this strategy, but they do not pose the same level of safety hazard (because of wider safety clearance and are N-1 sites where maintenance work can be done in a deenergized environment).

9.3.5.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the 33kV outdoor switchyard to indoor conversion programme including historical and forecast expenditures.

Figure 9-14 33kV outdoor to indoor switchgear conversion base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

As this conversion strategy will be nearing the tail end of its programme in RCP4, Transpower is forecasting reducing expenditure compared to the present RCP3 expenditure level. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels

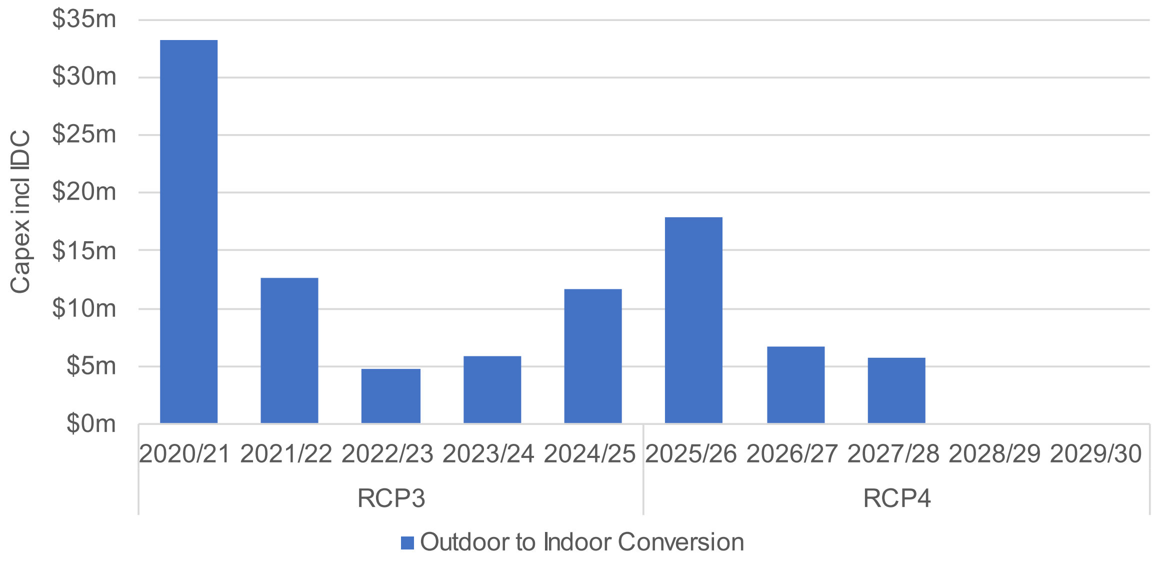
Table 9-16 33kV outdoor to indoor switchgear conversion base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
33kV outdoor to indoor switchgear conversion	$31.9m	$106.5m	234%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for all three asset classes within this asset portfolio in the stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-15 33kV outdoor to indoor switchgear conversion base R&R capex profile

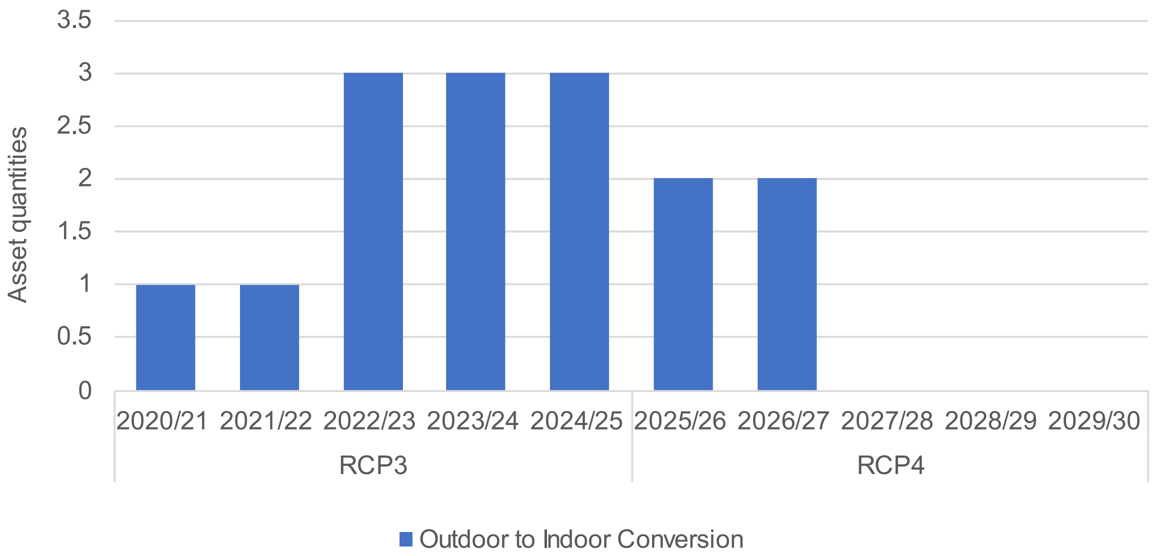


Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is planning to convert 11 sites to indoor 33kV switchboards during RCP3 at an estimated cost of $68.2m.

It is proposing to replace 4 sites to indoor 33kV switchboards during RCP4 at an estimated cost of $30.2m. The forecast quantity profile for this asset portfolio is shown in the following figure.

Figure 9-16 33kV outdoor to indoor switchgear conversion base R&R quantity profile



Source: Indoor circuit breaker 2022 PMP Appendix A

9.3.5.3 Asset planning approach

Transpower has identified all the outdoor 33kV switchyard that does not meet current safety-in-design standard, especially for maintaining the required safety clearance distances while working on those assets during the switchyard maintenance activities at its N-1 security sites.

These constrained N-1 security sites together with the AHNR information of those 33kV outdoor switchyard equipment is analysed to identify their R&R intervention timeline. Refer to our evaluation of the outdoor switchgear asset portfolio to appreciate the AHNR modelling maturity level and note that it is a collection of multiple asset classes. Reliability history of such installation to identify any poor performance issue is also considered.

Other factors such as indoor switchgear design flexibility for future development, compliance to seismic standard, flood level and update to associated substation equipment are also taken into consideration when planning and prioritising such asset replacement/conversion.

Cost to convert the site to indoor switchboard facility is considered for analysing and ranking site in terms of risk reduction vs cost trade-off. The highly ranked sites are further prioritised if it provides synergies with other planned works on the same site. The AHNR of the 33kV outdoor circuit breaker is considered as a starting proxy for the entire 33kV switchyard outdoor asset configuration.

Outdoor switchyard at small sites with N security and with poor safety clearance distances can generally be retained as it is because the safety concerns are largely eliminated by complete de-energisation of the switchyard for maintenance activity. Also, the reliability service risk of such small sites with N security are relatively small and hence do not warrant the costs of ODID switchyard conversion.

9.3.5.4 RCP4 capex drivers and solutions

The drivers for an ODID 33kV switchyard conversion are to provide a safe working environment through removal of inadequate safety clearances and to improve operational reliability by targeting N-1 security sites and assets with poor reliability performance.

Transpower is guided by its compliance obligation to meet the health and safety jurisdictional regulation which requires them to eliminate the health and safety risk, if not then to minimise them so far as is reasonably practicable. The ongoing 33kV ODID conversion programme allows Transpower to largely eliminate this risk progressively at selected N-1 security sites.

The outdoor switchyard are exposed to environmental factors and are vulnerable to outages and interruptions. This conversion programme therefore also addresses unplanned outages and reliability issues. Finally, the 33kV switchyard with outdoor equipment is an old technology and many of these installations are reaching the end of its useful life. Converting them to indoor switchgear addresses multiple issues.

9.3.5.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

This base R&R capex is volumetric programme. The RCP4 proposed budget was developed using the building block unit rate estimates of constituent asset class (from TEES) and the corresponding asset quantities estimated for R&R intervention as identified in the respective PMPs. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this programme and observed the following.

Prudency

We reviewed the historical track record of Transpower delivering this conversion strategy considering the outstanding proportion of 33kV outdoor switchyard sites, asset design and technologies in them, their asset age profile and the usual 36 months lead time from inception to commissioning of such conversion projects indicates a well-managed R&R conversion programme.

We reviewed the R&R investment drivers, primarily the safety concerns and secondarily the operational constraints and poor asset reliability performance and consider them to be reasonable and prudent. In stating this we also noted that not all 33kV outdoor switchyard sites are candidate for this R&R conversion if they have ample safety clearance distance or are N-1 security sites.

The average conversion/replacement/retirement age of the 33kV outdoor switchyard assets (focusing on Takaoka 33kV outdoor circuit breakers) are mostly greater than 50 years old and are bulk oil-filled types. We also noted Transpower strategy to re-use/sale/recovery of relatively modern and reliably functioning assets if such instances arises. The asset health and network risk modelling tools and the underlying data, assumptions and approaches used in preparing and forecasting capex for this conversion programme is reasonable.

We did not find any instance of double counting between this proposed base R&R capex and other portfolios or expenditure categories.

Efficiency

The proposed base R&R capex for RCP4, when converted to cost per site, is much greater than the RCP3 site cost. We understand that any discrepancy is attributed to inclusion of customised scope (for e.g., more quantities of indoor panels in each site) and site specific allowance. Given the low volume of work in RCP4 at the tail end of this conversion programme, we believe this is reasonable.

Furthermore, we reviewed the asset building block unit rates used during the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD). We noted the increase in the building block unit rates between the RCP3 and RCP4 is generally very modest when CPI is factored in. [150]

9.3.5.6 Conclusion

We conclude that the proposed base R&R capex for the 33kV outdoor switchyard to indoor conversion programme totalling $30.2m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

[150] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

Table 9-17 33kV outdoor to indoor switchgear conversion base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.

9.3.6 Power cables

The following table summarises our verification of the power cables capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-18 Verification summary of power cables base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$25.1m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept $25.1m
Potential scope for improvement	Not identified
Key issues and areas that the Commission should focus	Not identified

9.3.6.1 Asset portfolio and strategy overview

This asset portfolio consists of High Voltage (HV) and Medium Voltage (MV) cables, the cable accessories, specialised cable testing and jointing equipment, distributed temperature sensing, online cable monitors and supporting civil infrastructure. Most of Transpower cable population is relatively young and generally they have not yet reached the asset intervention age. For avoidance of doubt, the Cook Strait ±350kV HVDC submarine cables and low voltage (LV) cables are separate to this asset portfolio and are included within their respective asset portfolios – HVDC PMP and LVAC PMP.

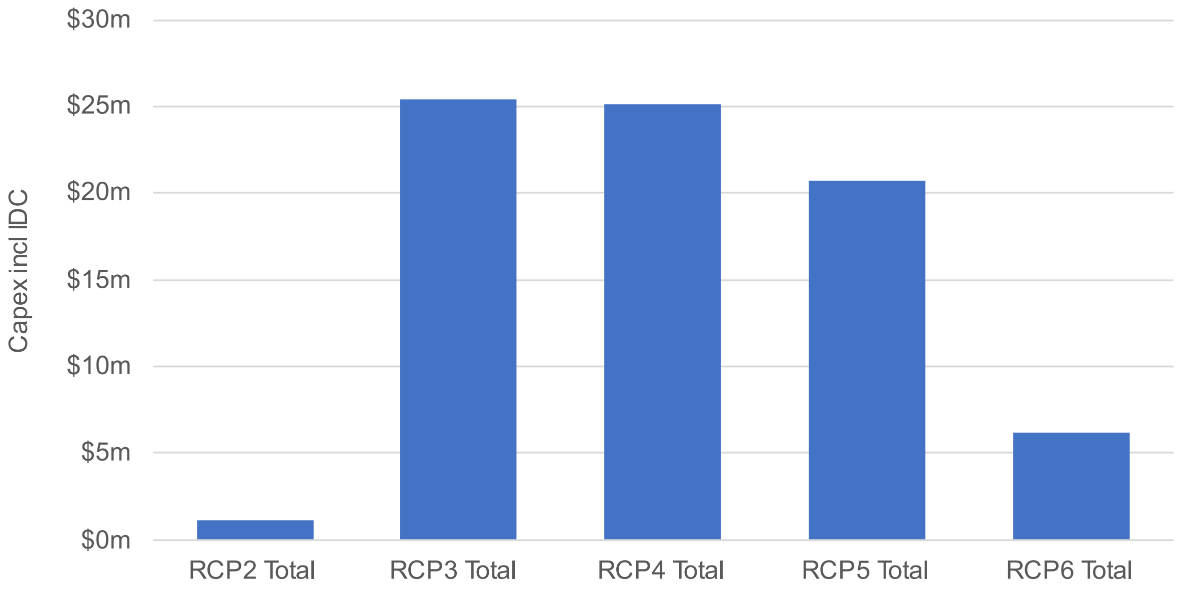
The HV cables operating at 66kV, 110kV and 220kV are either paper insulated oil filled cables or cross linked polyethylene cables and are usually in an urban environment outside the substation premises. The MV cables operating at 11kV, 22kV and 33kV are either paper insulated lead sheathed (PILC) cables or cross linked polyethylene cables and usually within the substation premises connecting power transformers to indoor switchgear.

We reviewed this portfolio alongside the 33kV outdoor switchyard conversion strategy and the power transformer asset portfolio.

9.3.6.2 Expenditure profile

The following figure shows the longer terms base R&R capex profile of the power cables asset portfolio including historical and forecast expenditures.

Figure 9-17 Power cables base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

Transpower is proposing to maintain a similar level of expenditure in RCP4 to RCP3. The asset quantities (or scope) of R&R work and the unit rates of few asset types are similar in both RCPs. We have evaluated both these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

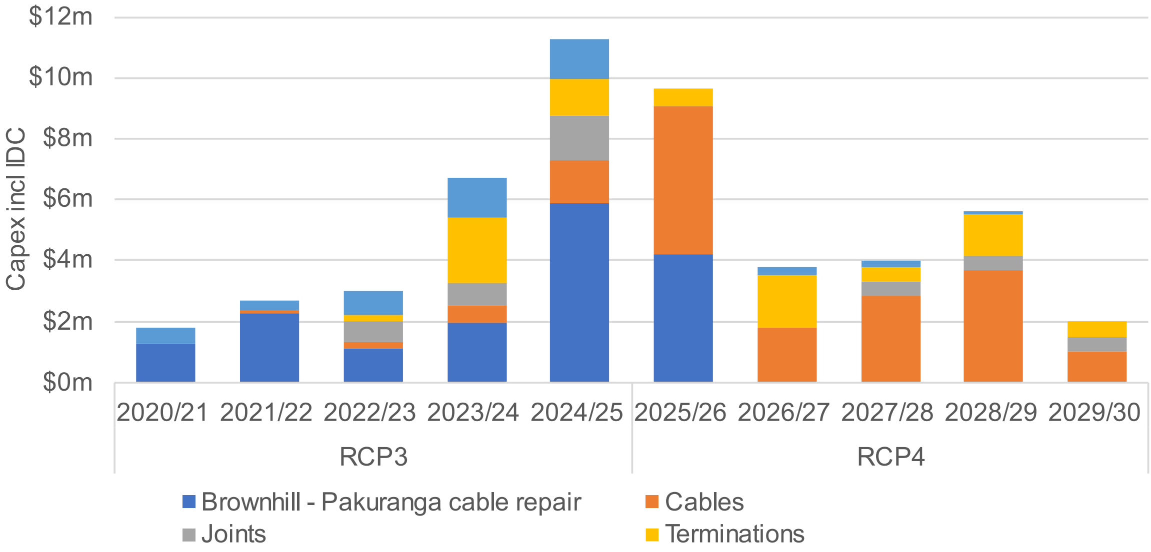
Table 9-19 Power cables base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Power cables	$25.5m	$25.1m	-1%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-18 Power cables base R&R capex profile

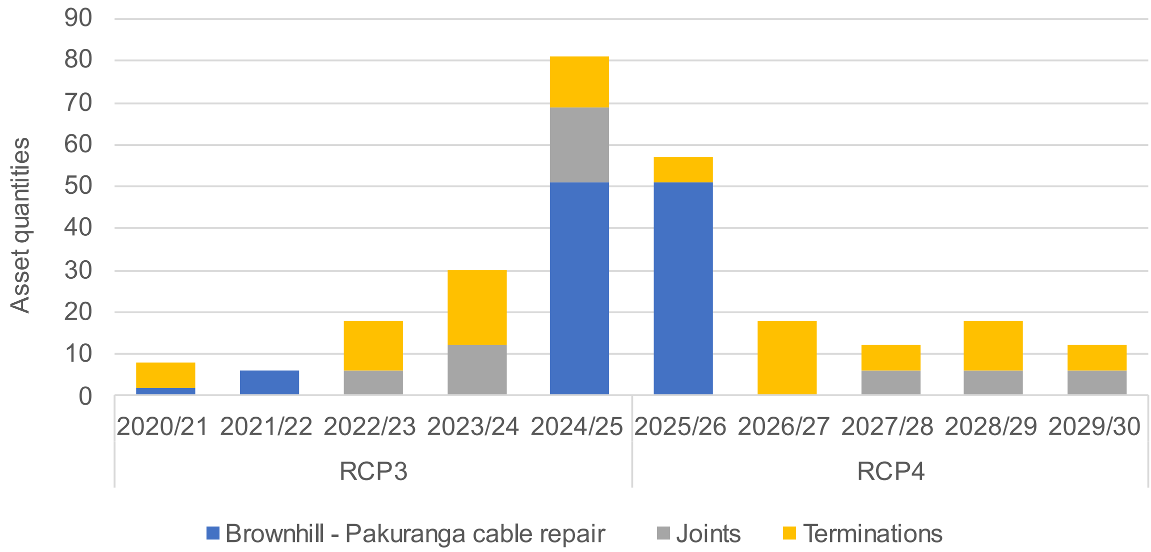


Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Transpower is replacing 36 HV joints and replacing 48 HV fluid filled termination along with repairing the Brownhill-Pakuranga cable which is in the initial phase in RCP3.

Transpower plan for RCP4 involves replacing 18 HV joints, replacing 48 HV fluid filled terminations, and completing the Brownhill-Pakuranga cable repair project. Transpower is also progressively replacing its PILC and oil filled cables with cross linked polyethylene cables and the MV cable population is growing due to the 33kV outdoor switchyard conversion strategy. The forecast quantity profile for this asset portfolio is shown in the following figure.

Figure 9-19 Power cables base R&R quantity profile



Source: Transpower, Power cables 2022 PMP.

9.3.6.3 Asset planning approach

Transpower utilises its AHNR modelling and defect indicators to identify the need for R&R interventions in this asset portfolio. The risk-based approach takes into account the drivers of poor health, known failure modes, the consequence of failure, whole of life cost and effectiveness of the options.

The GHD Advisory Expert Opinion Progress Review report[151] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

- The asset health modelling for this asset portfolio meets the GEIP, albeit with some limitation on input data because of the relatively young asset population.
- The impact modelling for this asset portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
- The network risk analysis for this asset portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The R&R intervention options considered for this asset class, especially the power cable assets are either:

- The planning approach for this asset portfolio is to monitor assets physical and electrical condition, carry out regular patrols of cable routes in public areas, maintain cable mechanical support systems, regularly inspect or in some cases retrofit the fluid- filled terminations, replace deteriorated accessories, maintain the integrity of sheath bonding systems and ensuring sufficient spares (cable, joints and terminations) to repair major faults in timely fashion.
- This asset portfolio is not analysed in isolation and the R&R intervention planning is made in conjunction with other interconnected asset portfolios. This may sometime lead some component of this asset portfolio being replaced ahead of their expected lifespan if driven by another interdependent asset.

The Expert Opinion Progress Review report[152] also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower also consider other information, such as suppliers' offerings (or lack thereof), compliance requirements, workforce capabilities etc. to complement the AHNR modelling in its R&R investment decision making.

Transpower has five underground circuits made up of older 220kV oil-filled cables technology in service at three sites. This technology is now considered obsolete with limited spare parts holdings and risk of long lead time to undertake major repair in these assets. While there have been no major failures in these 220kV underground circuits, Transpower is aware of this situation and their current planning approach is to continue to refurbish these oil-filled cables until such time that associated gas insulated switchgear or the connected transformer is planned for replacement.

Transpower is also planning to replace the Rangipo oil filled cables as part of the wider site works associated with a listed project (Rangipo gas insulated switchgear replacement which is separately evaluated in this IV report). The cost estimate for the Rangipo oil filled cable is included within the listed project cost estimate.

[151] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[152] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

9.3.6.4 RCP4 capex drivers and solutions

The investment driver for this asset portfolio is based on asset condition observation, experienced asset failures, and also incorporates asset criticality modelling for investment prioritisation. While most of the asset population are in good health, the poor performing assets are mainly due to moisture ingress in fluid filled HV terminations, early failure of HV joints and high failure rate of MV cable termination especially in the early years of the asset life. [153] The need for base R&R capex is also being informed by the Brownhill-Pakuranga B circuit cable joint failures and its investigation. Given the relatively young asset population, the asset health model presently does not have a very rich input data set to completely inform the investment requirement.

In recent years Transpower has not always met its unplanned outage rate performance target for MV underground cables. Most of the historic unplanned outages in HV and MV underground cables are attributed to cable joint failures and poor workmanship during installation respectively.

The usual R&R solution for this asset portfolio is complete in-situ asset replacement or piecemeal asset replacement (targeting only joints, terminations etc.).[154] The preferred option takes into consideration the purpose or the ongoing need of the assets, investment deferral and the whole of asset life cost estimate.

Transpower plans its capital work for this asset portfolio usually with the power transformer and indoor switchgear asset portfolios within the same outage site or outage window. [155]

9.3.6.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team.

We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

The proposed base R&R capex is a collection of quantities of various asset types (cables, joints, terminations) and their building block unit rates from TEES. Vargen is also included in this capex build-up to estimate few projects or bespoke scope of work not yet described within the standard set of building blocks within TEES. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this programme and observed the following.

Prudency

Given the age profile shape of this asset portfolio where majority of the asset quantities are relatively young and considering the quantities at the tail-end portion of this profile (i.e., older assets), the proposed R&R capex is reasonable.[156] The majority of the R&R capex at initial year of RCP4 is for repairing the Brownhill-Pakuranga circuit and replacing it joints after the cable failures in 2020 and 2021.

Transpower has identified the quality of workmanship in installing the cable joints and terminations to be a crucial determinant of the R&R intervention and its need timing and has mitigating strategies in place to control potential asset performance issues or failures.[157] We consider this a prudent practice.

The analysis of the average life expectancy of different asset types proposed by Transpower together with the respective asset type age profile indicated a quantum of projects/sites which was deemed consistent with the RCP4 base R&R capex proposal.[158]

The need identification process is reasonable and demonstrating a risk based approach in proposing the base R&R capex. Asset condition and the asset health model identifies the potential need for R&R investment. We also note the limitation of the asset health model for this asset portfolio such as absence of cable joints, terminations

[153] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf
[154] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf
[155] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf
[156] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf
[157] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf
[158] Transpower, RFI015-13 ACS Power Cables 2022 PMP.pdf

and HV oil filled cables. Given this we reviewed the PoF curve along with the recent years asset performance (annual unplanned outage rates) of this asset portfolio and we understand the existence of investigation business case and delivery business case gates as part of the funding approval process. We consider this a prudent practice.

We did not find any instance of double counting between this proposed base R&R capex and other portfolios.

Efficiency

The base R&R capex in RCP4 for few of the asset types within this asset portfolio is volumetric and is aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, both the unit rate and quantity variables are similar across both periods. For few asset building block unit rates that were available both during RCP3 (in constant 2017/18 NZD) and RCP4 (in constant 2021/22 NZD) submissions in TEES, the difference are negligible when CPI is factored in.[159]

Those building block unit rates that were not available during the RCP3 submission in TEES and hence could not be compared to the present-day TEES information, were compared with other sources. Such building block unit rates are considered reasonable and efficient when compared to similar cost estimates information sourced from Australian DNSPs and TNSPs. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤132kV level assets. For >132kV level assets, we scaled up the cost estimates of 132kV assets using our engineering judgement to compare that to higher voltage level assets.

9.3.6.6 Conclusion

We conclude that the proposed base R&R capex for power cables asset portfolio totalling $25.1m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

Table 9-20 Power cables base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) how they were applied;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(iii) their effect on the proposed base capex	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.

[159] Transpower, RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx

9.3.7 Other AC substation equipment

The following table summarises our verification of the other AC substation equipment capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-21 Verification summary of AC substation equipment base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$46.2m excluding resilience workstream [1]
Appropriate and sufficient information available for IV	Yes, for the accepted capex. The 'other station equipment' asset class in this portfolio lacks supporting information.
Meets GEIP and ToR evaluation criteria	Yes, for the accepted capex. Does not satisfy the ToR clauses 3.2, A1(a)(ii), A1(a)(iii), A1(g)(i) and A1(g)(ii) evaluation criteria for rejected capex.
IV conclusion	Accept: $30.8m Reject: $15.4m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the UIOLI uncertainty mechanism. Therefore, the resilience workstream capex is separately evaluated and not within this base R&R capex.

9.3.7.1 Asset portfolio and strategy overview

This asset portfolio covers the following three asset classes:

- Low voltage AC or LVAC distribution systems consisting of LV switchboards, LV distribution boards, main/submains/LV distribution cabling and AC junction boxes.
- General.
- Other station equipment consisting of oil containment and interception systems, cable trenches, air compressor systems, cranes and lift gear, earth grids, neutral earthing resistors, outdoor lighting, outdoor fire hydrant, roof and wall bushings, surge arrestors and washing systems. For avoidance of doubt, similar assets on HVDC substation sites are excluded from this asset portfolio.

For GHD's initial assessment Transpower provided one ACS that described 'LVAC distribution systems' asset class and two PMPs that describe 'LVAC distribution systems' and the 'other station equipment' asset classes. Similar documents on the 'general' asset class have not been provided for assessment. These available ASC and PMPs summarise the state of the respective asset fleet, strategic objective and measures, approach to planning, risk factors driving decisions and proposed work volume.

The LVAC distribution systems asset class forecast work plan is primarily, but not only, determined by observed asset condition assessments. This is not unusual, considering the risk posed by these asset failures, simplicity of assets, and type of asset failure modes.

The assets within the 'other station equipment' asset class consist of a diverse range of asset types which do not warrant an individual portfolio or fit coherently within any other asset portfolios or classes.[160] Due to the diverse nature of assets in this portfolio and the comparably smaller expenditure, understandably the data structures and quality for this portfolio is not as mature as other substations portfolios.

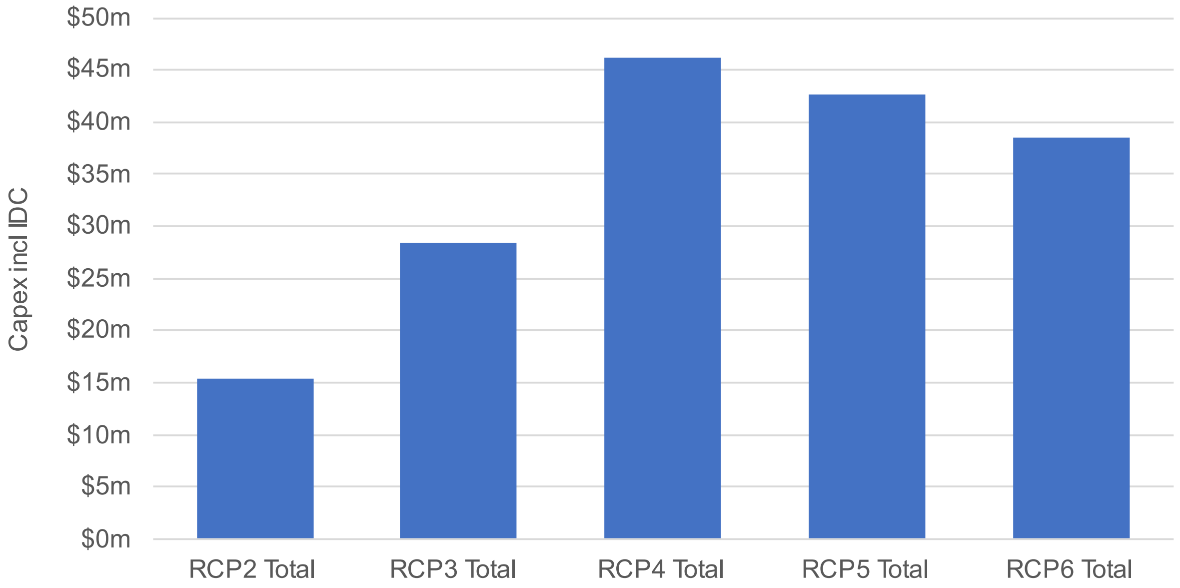
The breadth of asset types covered in 'other station equipment' asset class, requires a varied set of approaches to managing these assets.[161] From specific asset testing, to certification, diagnostic assessments, and asset servicing. These are seen to be applicable for the types of assets within this asset class. The drivers of managing oil containment are to achieve safe and reliable operation over the whole-of-life cost, minimising impact to the environment and mitigation of oil fire risk. This has not changed from RCP3.

[160] Transpower, 20230612 ACS Other Substation Equipment 2022 PMP.pdf
[161] Transpower, 20230612 ACS Other Substation Equipment 2022 PMP.pdf

9.3.7.2 Expenditure profile

The following figure shows the longer terms base R&R capex profile of other AC substation equipment asset portfolio including historical and forecast expenditures.

Figure 9-20 Other AC substation equipment base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

Transpower is proposing to increase the expenditure in RCP4 compared to the present RCP3 expenditure level. This increase is due to significant increase in the 'other station equipment' asset class. The cost increases are evaluated in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels (excluding resilience work).

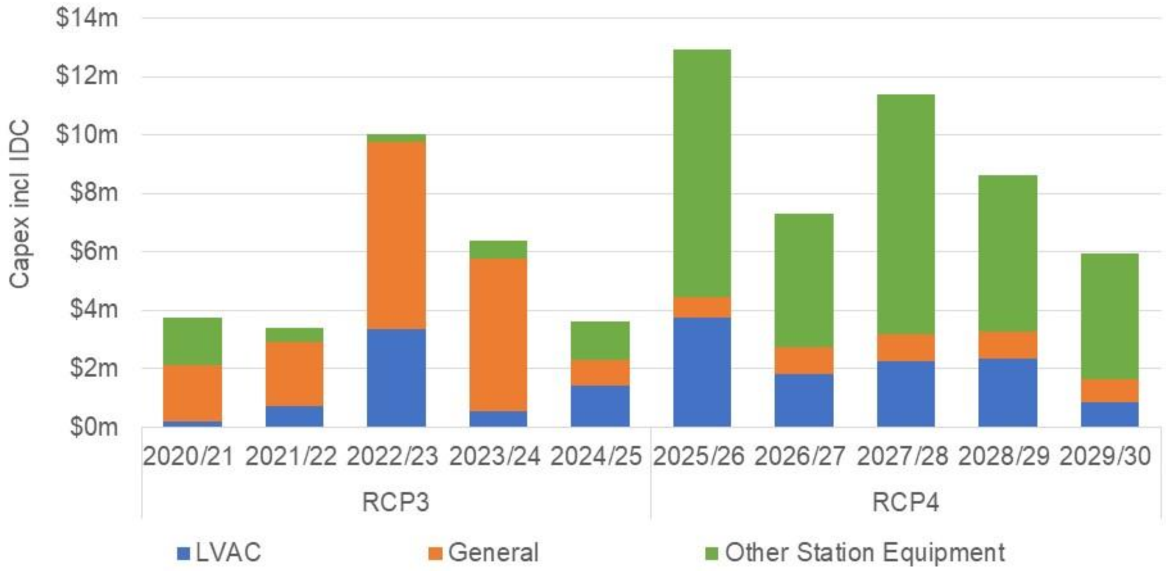
Table 9-22 Other AC substation equipment base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Other AC substation equipment	$28.3m	$46.2m	63%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for all three asset classes within this asset portfolio in the stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-21 Other AC substation equipment base R&R capex profile



Source: RT01 expenditure schedule, LVAC 2022 PMP, Other substation equipment 2022 PMP, Resilience 2022 PMP and GHD analysis.

The forecast for RCP4 involves spending $46.2m in base R&R capex. We note that Transpower has proposed a resilience workstream to develop flood solution at few substation sites which is being proposed using the UIOLI uncertainty mechanism and therefore is separately evaluated in Section 19 of this report.

Transpower is proposing $4.3m capex in 'general' asset class within this asset portfolio. Additional information, after our draft IV report, was provided on 3 August 2023 explaining the proposed capex in this asset class to fund operational teams to support fault response activities where the required action should be capitalised rather than a maintenance expense. As there is a drop in proposed amount in RCP4, limited time was spent assessing this asset class in greater detail.

The 'other station equipment' asset class proposes 710% increase in funding for RCP4 compared to RCP3. We note that this increase would be for the oil containment and cable trough replacement projects. However little supporting information was originally provided for this asset class for evaluation.[162] Subsequently additional information[163], after our draft report was provided on the 3 August 2023. Assessment of this additional information is discussed in the following evaluation section.

9.3.7.3 Asset planning approach

The asset health modelling, impact modelling and network risk analysis are done for only the 'LVAC distribution systems' asset class in this asset portfolio. The GHD Advisory Expert Opinion Progress Review report[164] on Transpower AHNR modelling indicates the following maturity status for this asset class within this asset portfolio:

– The asset health modelling for the 'LVAC distribution systems' asset class meets the GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
– The impact modelling for the 'LVAC distribution systems' asset class does not align with GEIP and is at Level 2 maturity that considers cost to replace, i.e., consequence is quantified to reflect financial impact to the economy from loss of service and direct costs to replace. Presently workplace safety impact is not modelled.
– The network risk analysis for the 'LVAC distribution systems' asset class meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

[162] Transpower, 20230612 ACS Other Substation Equipment 2022 PMP.pdf
[163] Transpower, Other AC Substation Equipment RCP4 Breakdown.pdf
[164] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

While the Expert Opinion Progress Review report identified gaps in the maturity of impact model for 'LVAC distribution systems' asset class in this asset portfolio when assessed in isolation, it also commented that Transpower's overall asset management system, tools and decision frameworks collectively provides capability in understanding their network risk to inform and support its base R&R capex for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

We have been provided with the PMP of the 'other station equipment' asset class documenting the planning approach and activities for this asset subcategory. It details that assets are identified and prioritised based on site inspection on condition and its R&R activities and timeline is influenced by other asset portfolio work programme. This asset class does not dictate the R&R intervention project on a substation site, rather is integrated into a larger work programme. We consider this reasonable given the nature of this asset class.

From the additional information provided on the 3 August 2023 we understand the proposed capex in the 'general' asset class includes contingency allowance alongside the corrective maintenance program. It funds the fault response activities, where the required action is capitalised rather than a maintenance expense.[165] For example, replacement of relays, pole structures and instrument transformers. Due to the limited scope of this asset class, it is understandable that there is no ASC or PMP documenting the asset planning approach for this asset class.

9.3.7.4 RCP4 capex drivers and solutions

Within the 'LVAC distribution systems' asset class, Transpower plans to replace 20 main switchboards including replacement project at OTA site that involves multiple main switchboards and complex outage requirement and therefore forecasting higher than usual average cost per site in 'LVAC distribution systems' asset class in RCP3.[166]

Transpower is proposing to replace 15 main switchboard and 7 distribution board in the 'LVAC distribution systems' asset class in RCP4.[167] Additionally, 6 minor distribution boards are forecasted to be replaced annually during RCP4.[168] The proposed capex for the 'LVAC distribution systems' asset class in RCP4 steadily increases when compared to RCP3. This is based on asset condition and age information and the investment decision will be refined closer to the time as more mature information are available.

The proposed capex in the 'other station equipment' asset class is understood to be driven by capital works to retrofit existing oil containment systems, cable trough replacements, associated transformer replacement works, wall and roof bushing replacements, and various remedial work at various substation sites.

9.3.7.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

This involved reviewing the provided initial tranche of asset management and strategy documentation relevant to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information provided to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

We also reviewed the additional information provided on the 3 August 2023[169] which attempted to substantiate funding requested for the 'general' and the 'other station equipment' asset classes.

Prudency

The approaches for identifying and remediating assets within the 'LVAC distribution systems' asset subcategory is considered to be GEIP. The application and use of assumptions, health models, risk analysis and other inputs (such as site inspection to compensate for shortcoming in the impact modelling) in the case of 'LVAC distribution systems' asset subcategory is considered reasonable. The average cost for asset replacement in RCP4 in the

[165] Transpower, Other AC Substation Equipment RCP4 Breakdown.pdf
[166] Transpower, RFI015-15 ACS LVAC 2022 PMP.pdf
[167] Transpower, RFI015-15 ACS LVAC 2022 PMP.pdf
[168] Transpower, RFI015-15 ACS LVAC 2022 PMP.pdf
[169] Transpower, Other AC Substation Equipment RCP4 breakdown.pdf

‘LVAC distribution systems’ asset subcategory are lower than in RCP3. This will be due to several factors such as work complexity, location etc. Due to the low value of this asset subcategory, this was not investigated further.

We note that the ‘general’ asset class does not have a standalone ASC or PMP and therefore presently unsure about its planning approach for identifying and remediating assets. However due to the small size and reduced funding requested compared to RCP3 level, a detailed evaluation was not considered valuable.

Insufficient evidence was a provided for the ‘other station equipment’ asset class to explain the steep increase in funding requested. In particular, the information is unclear on the quantum of asset and cost estimate basis for the proposed solutions.

The additional information[170] did not provide sufficient information to assess the forecast expenditure against Transpower’s asset planning decision framework considering the 4 stages – need identification, options assessment, prioritise solutions and develop plan.

We acknowledge the additional information provided a breakdown of the requested capex, however we could not trace back all the used asset building block unit rates to the TEES information. We also could not corroborate the stated drivers of the capex such as discrepancy of the existing transformer bunds with Transpower standard TP.DS.20.03, the performance criteria applied to oil containment system, and the allocation of placeholder projects in this asset class.

Therefore, we are unable to attest to the prudency for the total requested funding for the ‘other station equipment’ asset class, especially when considering the large step change proposed compared to RCP3. We therefore accept only the $15.5m for the ‘other station equipment’ asset class. We believe this amount should cater for the works proposed in Opunake, Otahuhu, Clyde, SEPA, and the roof and wall bushings replacements.

Efficiency

With respect to the ‘LVAC distribution systems’ asset class we noticed a range of asset building block unit rates (corresponding to different size, rating, built specification etc.) in the TEES and compared them to similarly described asset building block from the Australian DNSPs. We referred to the inputs in the recent AER repex models used for the latest rounds of DNSP revenue determinations. We consider them to be efficient. There were no building block unit rates for this asset subcategory in TEES during the RCP3 submission.

The efficiency of the provided cost estimates for the ‘general’ asset class could not be evaluated given the qualitative nature of the work being proposed in RCP4. Given the proposed amount in this asset class is lower than the RCP3 level and the amount is very small, we did not query the efficiency of the cost in this asset class any further.

With respect to the ‘other station equipment’ asset class we noticed a range of asset building block unit rates in the TEES. We could not trace the use of the TEES building block rates to the budget breakdown detail provided in the additional information on 3 August 2023.[171]

9.3.7.6 Conclusion

We conclude that the base R&R capex for the other AC substation equipment asset portfolio totalling $30.8m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The proposed base R&R capex for the ‘other station equipment’ asset class which rapidly increases compared to RCP3 currently lacks supporting justification for all the proposed amount with clear links back to Transpower asset management system such as the asset planning decision framework and hence half of the proposed amount, i.e., $15.4m is not accepted.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

[170] Transpower, Other AC Substation Equipment RCP4 breakdown.pdf
[171] Transpower, Other AC Substation Equipment RCP4 breakdown.pdf

Table 9-23 Other AC substation equipment base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	No	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) how they were applied;	No	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(iii) their effect on the proposed base capex	No	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	No	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	No	This is evident and documented in the earlier asset planning approach, capex drivers and solution and evaluation sub-sections.

9.3.8 Buildings and grounds

The following table summarises our verification of the buildings and grounds capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-24 Verification summary of building and grounds base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$121.0m including resilience workstreams [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $108.0m Accept but re-categorise: $13.0m drinking water supply sanitation compliance programme.
Potential scope for improvement	Re-categorise and propose the capex associated with meeting the potential applicable drinking water supply compliance standard using the uncertainty mechanism.
Key issues and areas that the Commission should focus	For the drinking water supply sanitation compliance programme – focus on the drivers, needs, available options, solutions and costs.

Note: [1] Transpower is proposing two capex workstreams driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, these two resilience workstreams capex are evaluated within this base R&R capex.

9.3.8.1 Asset portfolio and strategy overview

This asset portfolio includes substation buildings, warehouses, training facilities and National Grid Operating Centers (NGOCs), National Coordination Center (NCC), building services (access control, fire protection, heating and air-conditioning), and site infrastructure (roads, water supply, drainage services, switchyard security and boundary fencing).

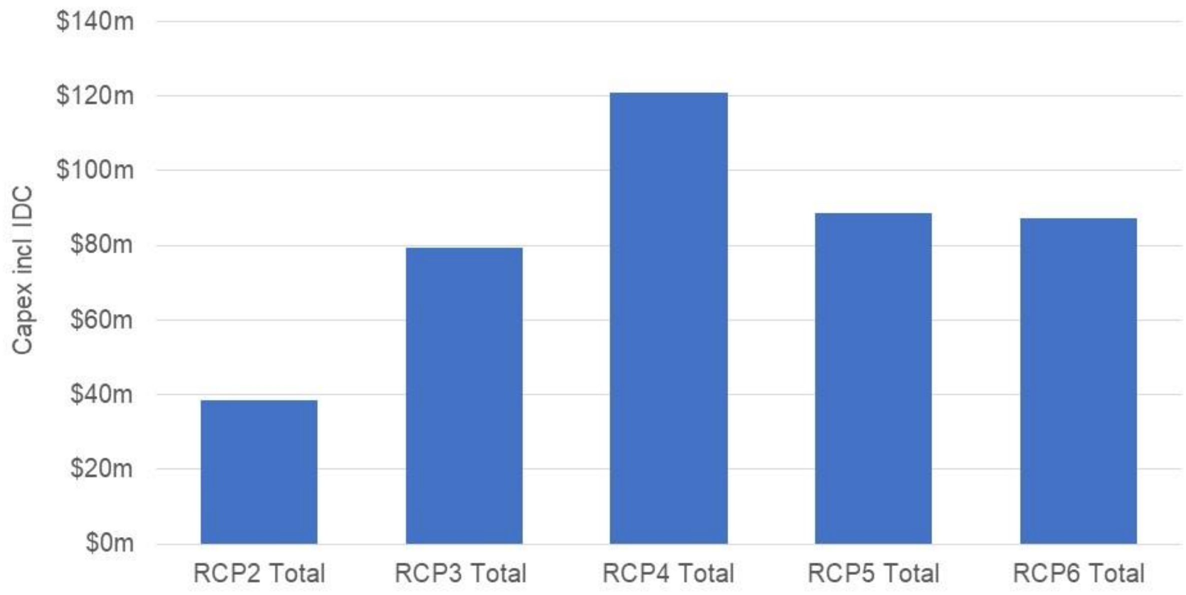
This asset portfolio provides accommodation, services and physical security for important grid equipment and systems. Depending on the nature of the asset and the type of work being proposed, the capex programme within this asset portfolio can be volumetric work (e.g., air conditioning R&R work) or bespoke work (e.g., warehouse construction).

Transpower outsource most components of asset management function of this asset portfolio to Facilities Maintenance (FM) service providers. [172] It however retains the function of reviewing and validating the draft plan developed by the FM service providers in-house before formal approval to deliver the base R&R work in this asset portfolio.

9.3.8.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the buildings and grounds asset portfolio including historical and forecast expenditures.

Figure 9-22 Building and grounds base R&R capex long term profile



Source: RT01 expenditure schedule, Buildings and grounds 2022 PMP, Resilience 2022 PMP and GHD analysis

The proposed base R&R capex profile for RCP4 is similar to RCP3 except for the following two proposed works which drives the difference between the RCP3 and RCP4 expenditure levels:

– addition of new resilience driven works (seismic strengthening of buildings to comply with building standards and fire stopping and detection upgrades to comply with building standards). This resilience workstream is being proposed as a base R&R capex and is evaluated in this sub-section in the following paragraphs. [173]
– addition of new drinking water supply infrastructure works to comply with potential new Taumata Arowai drinking water reform compliance requirement.[174] This is work is evaluated in this sub-section in the following paragraphs.

The remaining areas of capex proposed in RCP4 is very similar to the historical trend and consists of the following:

– Transpower is planning to invest on new warehousing facilities in RCP3 and will experience some tail end of this capex delivery in the early part of RCP4.
– Transpower is planning to invest in replacing security, boundary and stock fencing to meet its site security performance requirements. It has also recently updated the design standard for its fencing so that all its sites have consistent assets.
– Transpower is planning to replace flat roof on its building with pitched roof to eliminate water ingress.

[172] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf
[173] Transpower, ERR028 Resilience 2022 PMP.pdf
[174] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

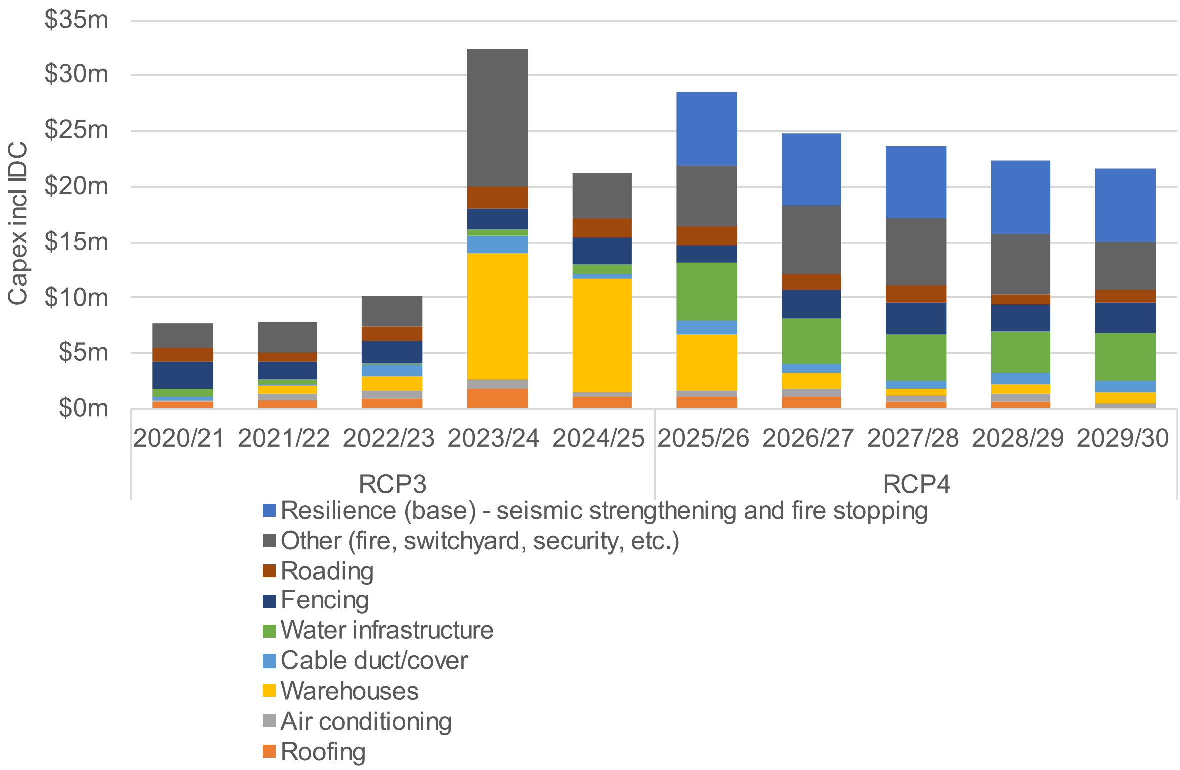
Table 9-25 Buildings and grounds base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Buildings and grounds	$79.4m	$121.0m	52%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile within this asset portfolio is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-23 Buildings and grounds base R&R capex profile



Source: RT01 expenditure schedule, Building and grounds 2022 PMP, Resilience 2022 PMP, GHD analysis

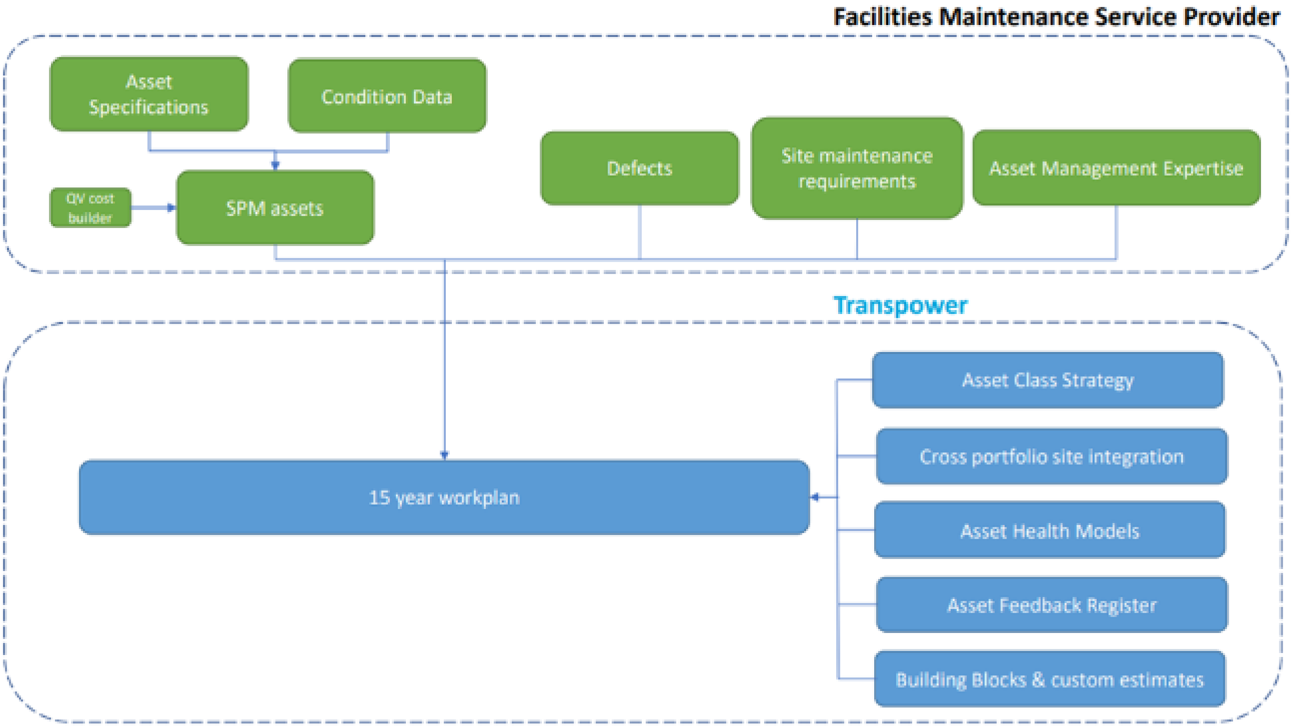
9.3.8.3 Asset planning approach

Unlike network assets, Transpower does not directly undertake these routine asset management functions for this asset category. The FM service provider uses industry standard software project management asset management tool to analyse this asset category. It captures the specifications, asset condition data, costing information (formerly Rawlinsons handbook, now the QV Cost Builder), defect findings, maintenance requirement etc. of various asset types within this category in order to generate 15 years workplan.[175] This forward-looking view from the software project management asset management tool is challenged, cross-checked and adjusted by Transpower using its own asset information, synergies with other network expenditure program, asset class strategy, cost knowledge, operational experience and commercial negotiation.[176]

Transpower manages the delivery of this asset category through its business as usual project management and outsourced project delivery mechanisms. This arrangement is shown in the below figure.

[175] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf
[176] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf

Figure 9-24 software project management informing Transpower future workplan



Source: Transpower, IVP012 RCP4 IV Buildings & Grounds - Overview.pdf

The condition assessment and asset health modelling of this asset category is based on the International Infrastructure Management Manual (IIMM) and hence the ranking and scale (C1…. C5) follows a slightly different style. This is considered together with the site criticality (importance) ranking to determine the investment priority.

Internally, Transpower's ACS and PMP for this asset portfolio documents the planning approach and identified sequence of activities to manage and mitigate the risks in this fleet. Each of the elements shown in the above figure within the Transpower system is described in detail in these documents, with the PMP documenting the various capex work programme (e.g., roofing, fencing, roading, air conditioning, security systems etc.) that it is proposing in RCP4.

The GHD Advisory Expert Opinion Progress Review report[177] on Transpower AHNR modelling indicates the following maturity status for some of the asset class within this broad and diverse asset portfolio:

- The asset health modelling for outdoor switchyard fence and building roofs asset classes both meets the GEIP, and both aligns with Level 2 maturity that considers condition, i.e., asset health is projected using modified based on expert-generated asset class life analysis assessment.
- The impact modelling for outdoor switchyard fence asset class meets the GEIP and aligns with Level 3 maturity that considers internal business impacts, i.e. consequence is quantified using a structured/repeatable framework with weighted economic impact for service and all internal business consequence. However, the impact modelling for building roofs asset class does not meets the GEIP and aligns with Level 1 maturity that considers expert opinion, i.e., consequence is determined in an ad-hoc qualitative way, using the corporate risk matrix as a guide.
- The network risk analysis for outdoor switchyard fence and building roofs asset classes both meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The GHD Advisory Expert Opinion Progress Review report[178] also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

[177] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[178] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

The resilience workstream being proposed in base R&R capex in RCP4 involves building seismic strengthening programme and is an ongoing risk management work. Transpower is undertaking this programme to meet its national building occupancy compliance standard and also to meet its obligations as a national lifeline utility. We have evaluated the merits of this resilience workstream in this sub-section in the following paragraphs.

Transpower is also proposing drinking water supply infrastructure capital works in base R&R capex in RCP4 to comply with the new Taumata Arowai drinking water reform that may potentially involve installation of water sanitation and mitigation solutions to ensure safe drinking water supplies in all its sites. We have evaluated the merits of this capex work in this sub-section in the following paragraphs

9.3.8.4 RCP4 capex drivers and solutions

The two main drivers for investment within this asset category are condition based replacement of major asset types and to continue to maintain assets to ensure safety, reliability and performance requirements are met. This is further explained below as the type of assets within this category consist of diverse range of assets, asset lives, functions, costs with varied drivers for investment.

– Replacement of security fences based on condition assessment and the ongoing maintenance opex is no longer economic, compared with total replacement.
– Replacement or augmentation of switchyard crushed rock aggregate based on analysis of condition, risk, cost and the recommendations included in any associated earthing studies for the site in question.
– Replacement or refurbishment of underground infrastructure such as potable, sewage and wastewater supplies when localised maintenance is no longer an effective or an economic solution.
– Provision and installation of fiber-reinforced plastic cable trench covers in public places, substation access ways, and at designated vehicle crossing points in switchyards.
– The repainting of coated metal roofing to preserve the life of the asset, using condition based intervention points and expected coating lifetimes that are adjusted based on corrosion zone. The metal roofing and guttering will be replaced when repainting is no longer an adequate solution.
– Replacement of Butynol flat roofs with pitched roof and colour steel finish.
– Resealing of substation roads and access ways when localised maintenance is no longer an effective or an economic solution.
– Identification, prioritisation, and mitigation of remaining seismic risk exposures for both grid critical and occupied buildings.
– Mitigation and removal of asbestos containing materials in all components of the asset class when other works need to interface with the inert asbestos risk.
– Enhancement of fire protection and essential infrastructure systems (uninterruptible power supply, batteries, generators, and HVAC) at critical sites.

The condition assessment and asset health modelling of this asset category is based on the International Infrastructure Management Manual (IIMM) and hence its asset health ranking or scorecard (C1…. C5) follows a slightly different style. This is considered together with the site criticality (importance) ranking to determine the investment priority.

Generally, the investment process for this asset category involves need identification, option assessment, solution prioritisation and plan development.

Asset performance, condition data, asset age, and corrosion zones are used to identify needs and associated need dates in the software project management asset management tool.[179] Transpower develop options to address the identified needs that achieves the acceptable level of performance considering risk level and whole of life cost.

Solutions are prioritised based on the date by which they need to be resolved.[180] Prerequisite activities in a site are linked in a plan so that activities are completed/amended/sequenced/deferred at the right time considering various

[179] Transpower, RFI022 Transpower Response.pdf
[180] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf

planned work in other asset class portfolios. Like-for-like replacement projects such as HVAC asset replacement are grouped regionally

9.3.8.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable. This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team.

We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.[181]

This base R&R capex is a combination of volumetric programme and also bespoke works. The RCP4 proposed budget was developed using unit rates within the software project management asset management tool. Specific asset quantities have not been provided for this asset portfolio. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, where possible, in this asset portfolio and observed the following.

Prudency

We examined various elements of Transpower's asset management system, tools, decisions, proposed RCP4 base R&R capex for this asset portfolio, including assessment of drivers and solutions and observed GEIP being followed.

Transpower's ACS and PMP are being informed by its network strategy, Strategic Asset Management Plan and eventually the Transmission Tomorrow. They describe the source of risks facing this asset category, its functional objective, performance requirement and approaches to address them. It also describes the relationship, gaps and duplication between the Transpower internal Maximo and gas insulated switchgear asset information and the software project management asset management tool used by the FM Service Provider. We observed the alignment within its asset management documentation and the ACS and PMP taking carriage of its organisational objectives. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The proposed R&R work plan is based on condition assessment and incorporating corrosion zone factors that adjusts the estimated life of the assets based on its location (geothermal exposed, seashore, salinity level, arid/inland/rural etc.), building function, and other operational and environmental factors (painting, proximity to traffic movement etc.) to optimize investment over the assets' lifecycles.[182] We note that this asset portfolio does not follow the business-as-usual AHNR model approach as rest of the network asset portfolios and instead follows the service provider managed software project management asset management tool that ranks the assets according to its state. This information is available at individual asset class level (i.e., roof, fence, doors etc.).[183] This information is then considered alongside the criticality assessment to determine risk-based priority for RCP4.

The use of software project management asset management tool is suited to this asset category especially for building, fences, road and accessways, cable trenches, retaining walls and bridges as it maintains and records asset characteristics and condition details down to individual component level thereby providing this information that is not available within Transpower Maximo and/or gas insulated switchgear.

We found that Transpower proposed base R&R capex budget in RCP4 to be lower than the forward looking workload view generated by the software project management asset management tool.[184] This comparison excludes the proposed budget for resilience and drinking water supply infrastructure driven works. This demonstrated the internal challenge, cross-checking and adjustment process. The delivery framework, operational knowledge, contract management and commercial negotiation process mitigates potential conflict of interest for the service provider in identifying defects and delivering planned solutions.

[181] Transpower, RFI022 Transpower Response.pdf
[182] Transpower, ERR022 ACS Buildings and Grounds 2022 PMP.pdf
[183] Transpower, RFI022 Transpower Response.pdf
[184] Transpower, RFI022 Transpower Response.pdf

Recent business cases[185] (from RCP3) showed mature set of inputs (need statement, external design report and cost estimates, option analysis, risk assessment, cost-benefit analysis, preferred solution scope etc.) informing the investment case. The inputs and outputs are consistent with the investment planning approach described in Transpower's ACS. For e.g., warehousing building option analysis considered leasing, new construction, relocation and do-nothing strategies and the selection of preferred solution.

We reviewed the building fire detection and fire stopping upgrade programme as part of the resilience driven base R&R programme.[186] It is based on a recent survey that has identified a number of sites that presently does not meet its standard. Transpower has identified around 15 vulnerable buildings with varying level of criticality based on its functions and occupancy and has prioritised strengthening work on 8 of them in RCP4 under the resilience programme. This prioritisation is based on risk and aligned with the Transpower asset investment and decision framework.

The building seismic strengthening programme is a resilience workstream being proposed as a base R&R capex and is an ongoing risk management work.[187] Transpower is identifying any buildings classified as IL4[188], together with any high occupancy buildings classified as IL2[189], that are found to have an ultimate structural capacity of less than 75% of the New Building Standard (Building Code Schedule 1 of the Building Regulation 1992) must be strengthened to not less than 75% NBS. Transpower has identified a number of buildings with varying level of criticality based on functions and occupancy and has prioritised strengthening work on a subset of those buildings in RCP4 under the resilience programme.

The prioritisation of the proposed seismic strengthening work is based on risk and aligned with the Transpower asset investment and decision framework. This relates to risk reduction aspect of resilience and is aimed at reducing loss of life and injury to occupants. We also tested this programme against Transpower insurance arrangements which can be treated as a recovery aspect of resilience. Insurance premium is not impacted by this proposed capex, rather the insurance provider expects to see assets adhering to Building Regulation 1992. We consider this proposed base R&R capex work to be prudent.

Evidence of cost splitting between Transpower roles as a transmission grid and a system operator indicated it presently splits its cost for Auckland and Christchurch NGOCs and Hamilton NCC to 48% to transmission grid and 52% to system operation based on FTE occupancy proportion. [190] This proportion is also applied to NCC seismic strengthening design business case being proposed for RCP4. This proportion has historically changed depending on the occupancy rate at the time. During most of RCP2 100% of the NCC base R&R capex were allocated to system operator role. In 2016 the NCC building was extended to include office space to accommodate transmission grid staff and at this point the split between the transmission grid and system operator changed to 48% and 52% based on the occupancy proportion. This is forecast to continue at this occupancy rate during RCP3 and RCP4. [191]

Buildings and grounds asset portfolio base R&R programme is linked and synergies are explored with associated indoor switchgear, other AC substation equipment and business support capex portfolios.

Nevertheless, we believe the drinking water supply sanitation compliance programme amounting to $13m should not be proposed as a base R&R capex. We reviewed the Water Service Act and the related regulatory materials in the Taumata Arowai register in relation to potential impact to Transpower to follow a new set of drinking water sanitation compliance requirement in the future. We understand that Transpower is proposing $13m base R&R capex on the basis that it will need to comply with the Taumata Arowai drinking water requirements by installing appropriate mitigations to ensure safe drinking water supplies. Transpower believes that it fits the new definition of an entity that owns and operates infrastructures that supplies drinking water to consumers.

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[185] Transpower, RFI022-01 CP_ADD_BR_00_00-ADD Warehouse New Storage Building-DBC.pdf, RFI022-02 WHI - Control Building Roof Maintenance - DBC.pdf
[186] Transpower, ERR028 Resilience 2022 PMP.pdf
[187] Transpower, ERR028 Resilience 2022 PMP.pdf
[188] Clause A3 of the Building Code defines the significance of a building by its importance level (IL), which is related to the consequences of failure. There are five levels of importance, considered by the importance of the building to society. Level 4: Buildings that must be operational immediately after an earthquake or other disastrous event, such as emergency shelters and hospital operating theatres, triage centres and other critical post-disaster infrastructure.
[189] Level 2: Normal structures and structures not covered by other categories, such as timber-framed houses, car parking buildings or office buildings.
[190] Transpower, RFI022 Transpower Response.pdf
[191] Transpower, RFI022 Transpower Response.pdf

Transpower has assumed approximately 100 sites that may not meet the proposed drinking water quality compliance standard. However, the identification of sites, the actual work needed, the options considered, cost involved etc. presently has high degree of uncertainty.[192] It is based on a desktop estimate using the following variables:

- 60 sites with potential roof water issue with an estimated $15,000 per supply site solution
- 20 sites with potential groundwater supply issue with an estimated $100,000 per supply site solution
- 20 sites with potential problematic supply connections with an estimated $200,000 per supply site solutions.[193]

We consider that presently the full implication of the proposed Water Service Act to Transpower is uncertain and the proposed solutions and its cost estimate is also uncertain. As such we consider this base R&R capex to be re-categorised and proposed using uncertainty mechanism.

Efficiency

Transpower has historically relied on the software project management asset management tool that contains QV Cost Builder rates (formerly Rawlinson's Handbook) to derive its project cost estimates. These rates are reviewed annually. These rates along with FM Service Providers market knowledge and historical trend are predominately used to build-up the forecast budget for RCP4.

Transpower is presently adding/revising a few building block unit rates within the TEES for air conditioning, cable duct, fencing, painting etc. however cost estimate for volumetric works did not use the TEES building block unit rates for RCP4.

At the project investigation stages a detailed site scoping is completed prior to delivery business case approval to define the scope of work and identify any site-specific costs that may be incurred. Once approved the project budget are loaded to FMIS. We sighted evidence for Albany and Frankton sealing projects cost estimate build-up. We also sighted the estimate for roofing projects (change over from flat roof to pitch roof) indicated that in average it costed $389k in RCP3 compared to $350k in RCP4.

The review of changes in the substation security fencing design standard shows the updated definitions of security functional requirements and the types of fences.[194] Consistent application of this design standard is expected to upgrade the security performance or access restriction across Transpower substation sites and also have some implication to the base R&R capex.

Given the above examples and analysis, Transpower's capital costing method and formulation, including unit rate sources and the quantum of include contingencies are reasonable.

Further, we also compared, where available, the increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) and noticed they are generally modest when CPI is factored in. Where this was not the case, we noticed the changes were due to different specification of asset (for e.g., fence and water/oil separator) or market commercialisation of asset (for example, air conditioning is now cheaper than in the past). Overall, we consider the cost information used in this asset portfolio to be efficient.

9.3.8.6 Conclusion

We conclude that the proposed base R&R capex for this asset portfolio totalling $108.0m satisfied the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

However, the proposed capex for the drinking water supply sanitation compliance programme amounting to $13.0m in this asset portfolio should not be proposed as base R&R capex given the high degree of uncertainty of its need, scope of work, solution and costs. This programme should recategorized and proposed using the uncertainty mechanism.

The following table describes our verification of this **identified programme** against the evaluation criteria.

[192] Transpower, RFI022 Transpower Response.pdf
[193] Transpower, RFI022 Transpower Response.pdf
[194] Transpower, RFI022-04 Updated definitions for fencing standard.pdf

Table 9-26 Buildings and grounds base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	This is evident and documented in the earlier asset planning approach and RCP4 capex drivers sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	This is evident and documented in the earlier asset planning approach sub-section.
A3(c)	Transpower's process is reasonable and cost effective	No	There is a high degree of uncertainty of need, scope of work, solution and costs with respect to the drinking water supply sanitation programme. Therefore, this programme should not be proposed using the base R&R capex. This is evident and documented in the earlier evaluation sub-section.
A3(d)	Investment need is challenged, and alternative solutions considered	No	There is a high degree of uncertainty of need, scope of work, solution and costs with respect to the drinking water supply sanitation programme. Therefore, this programme should not be proposed using the base R&R capex. This is evident and documented in the earlier evaluation sub-section.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	This is evident and documented in the earlier asset planning approach sub-section.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The proposed procurement approach for this portfolio is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy, especially in relation to the use of external FM service provider and software project management asset management tool. Please refer to our review in Section 7 of this report.

Note: A3(h) is not applicable to base capex

9.3.9 Transmission line structures

The following table summarises our verification of the transmission line structures capex which is categorised as a identified programme and forms part of the base R&R capex for RCP4.

Table 9-27 Verification summary of transmission line structures base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$78.7m excluding resilience workstream [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $78.7m
Potential scope for improvement	Further development of tower to pole replacement programme (as it's a new programme commencing at the end of RCP3) especially the investigation phase.
Key issues and areas that the Commission should focus	None identified.

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the UIOLI uncertainty mechanism. Therefore, the resilience workstream capex is separately evaluated and not within this base R&R capex.

9.3.9.1 Asset portfolio and strategy overview

This asset portfolio includes transmission line towers and poles operating at 11kV up to 220kV[195]. The tower and pole asset portfolio includes approximately 13,000 poles and 26,000 towers[196]. Pole structures are made from concrete, wood and steel with wooden poles being gradually replaced by concrete. Attachments for conductors or insulators are considered part of the structure. The structure portfolio also includes HVDC line structures.

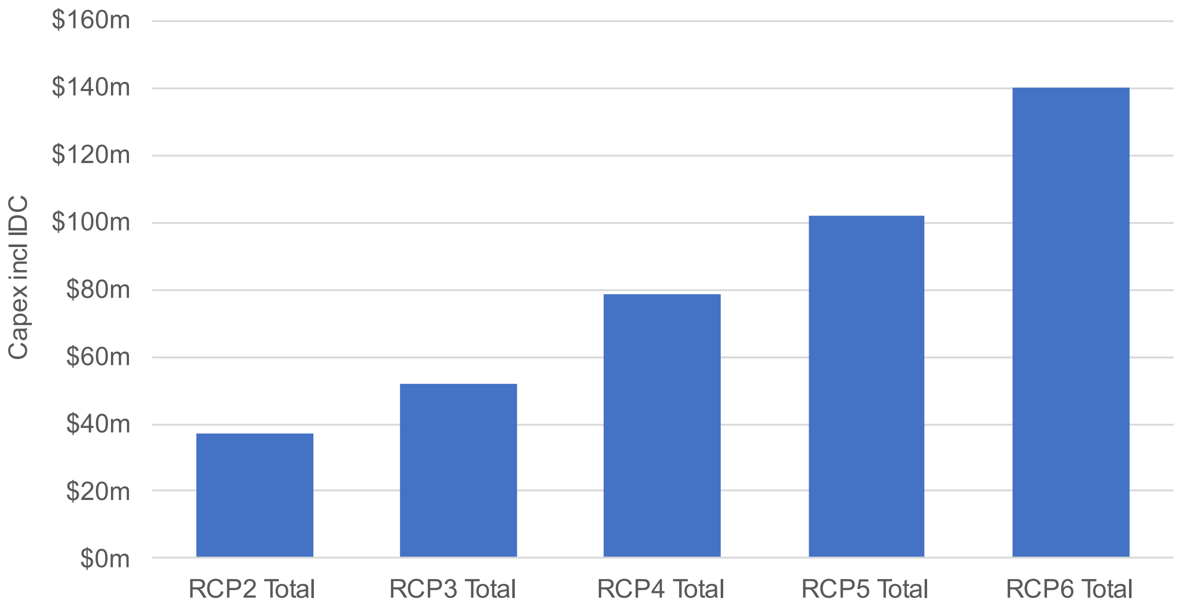
The transmission line – Towers and Pole ACS documents the challenges, objectives, fleet statistics, operational knowledge, asset management strategy and planning, asset management decision making, asset information, organization and people, risk and review and lifecycle delivery providing a detailed approach to manage this asset portfolio. The structures PMP provides the most recent view on the state of this asset class, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base capex forecast and associated quantities for tower and line R&R activities. This capex also includes resilience expenditure for R&R activities, structures for HVDC flood and wind resilience interventions, within this asset portfolio.

The annual trend of the base R&R capex for this asset portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule.

9.3.9.2 Expenditure profile

The following figure shows the longer-term base R&R capex profile of the transmission line structures asset portfolio including historical and forecast expenditures.

Figure 9-25 Transmission line structures base R&R capex long term profile



Source: RT01 expenditure schedule and GHD analysis.

Transpower is proposing to increase structures expenditure significantly from $51.9M in RCP3, to $78.7M (excluding resilience workstream being proposed using UIOLI uncertainty mechanism) in RCP4 and further proposed increased expenditure in RCP5 and RCP6. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 9-28 Transmission line structures base R&R capex for RCP3 and RCP4

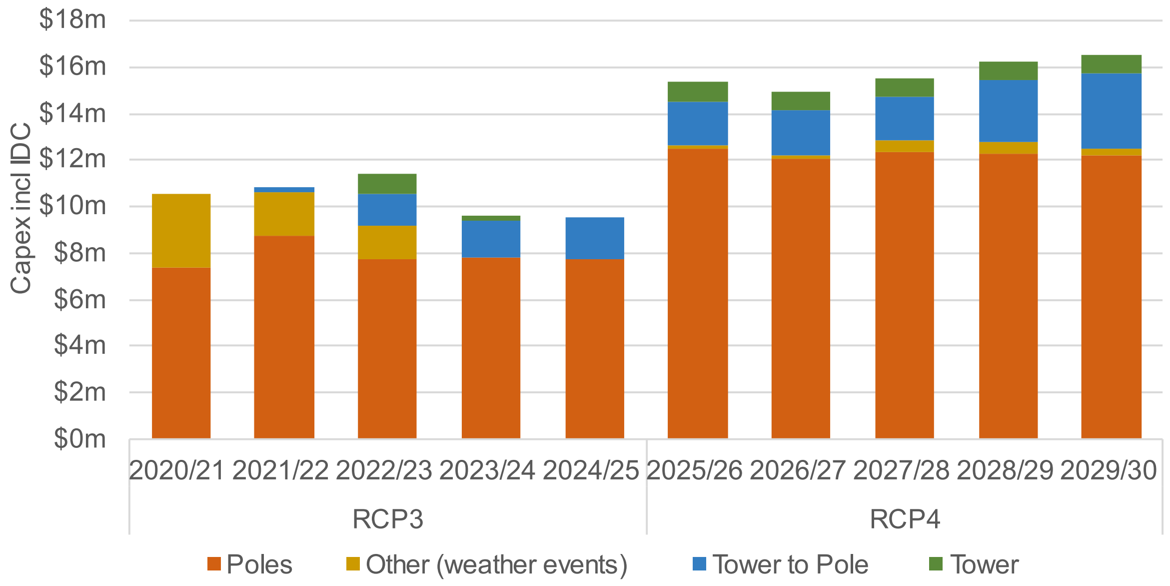
Asset portfolio	RCP3 total	RCP4 total	Change
Transmission line structures	$51.9m	$78.7m	51%

[195] These structures are designed to 400kV but operates at 220kV.
[196] Transpower, Transmission Lines Structures PMP

Source: Transpower, RT01 expenditure schedule and GHD analysis.

The planned expenditure for RCP3 and RCP4 per year are shown in the figure below broken down into poles, towers, and resilience expenditure. As this figure shows there is a large increase in expenditure from 2024/25 to 2025/26, mainly because of increased pole replacements and then relatively stable expenditure each year in RCP4.

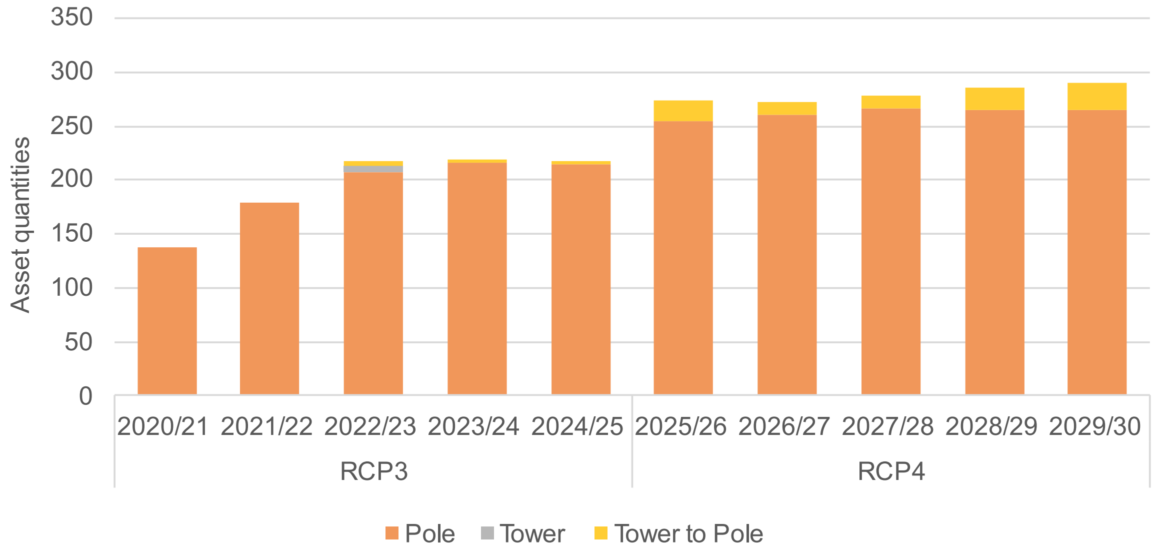
Figure 9-26 Transmission line structures base R&R capex profile



Source: RT01 expenditure schedule, Structures 2022 PMP, GHD analysis

Similarly, the forecast quantity profile of these asset types is shown in the following figure, which also shows an increase from 2024/25 to 2025/26 and then relatively stable level of structure replacements in RPC4.

Figure 9-27 Transmission lines structures base R&R quantity profile



Source: Structures 2022 PMP.

Transpower prioritised some investment during RCP3 because of restrictions caused by covid in 2021 and 2022. This was the case with poles where only 137 were replaced in 2021 and 179 in 2022 below the expected 190 per year. Transpower are planning to ramp this rate up in 2023 to 2025 in anticipation of higher rates required in RCP4 to maintain the asset fleet below the AH8 level[197]. Other works undertaken during RCP3 have included several tower replacements due to weather and geotechnical events.

Transpower plan to undertake 10 tower to pole replacements in RCP3 as part of a structured plan to enable identification and correction of any delivery issues before ramping up the programme and forecast to undertake 89 in RCP4[198]. This is potentially a deliverability risk for Transpower in RCP4 because the programme is new, although pole installation and restringing onto poles are existing activities that service providers are very familiar with.

9.3.9.3 Asset planning approach

Transmission line structures has its own respective ACS and PMP. The ACS and PMP for this asset portfolio are developed based on the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges, objectives and approaches to managing Transpower's poles, towers and insulator attachment points.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies or strategies (such as tower to pole replacement), better asset makes and models, need for investigation and intervention priorities. These elements guide Transpower's R&R approach in managing this asset class.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for transmission line structures is based on risk and lifecycle cost management i.e., asset health scores, criticality modelling and lifecycle cost models to prioritise R&R work. These are based on respective asset class asset health model producing health score/probability of failure and asset class impact model producing criticality ranking. The AHNR modelling is an input to Transpower's R&R investment decision making.

The GHD Advisory Expert Opinion Progress Review report[199] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

- Asset health modelling for this portfolio meets GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
- The impact modelling for towers, poles and attachment points in this portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
- The network risk modelling for transmission line towers, poles and attachment points meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Life extension strategies are applied to most transmission line towers through tower painting and steel and bolt replacement to manage corrosion.[200]

Transpower has identified synergies between this asset portfolio and other asset portfolios such as tower painting, insulators and foundations to align R&R activities where opportunities exist for project efficiencies. This R&R

[197] Transpower, Transmission Lines Structures PMP
[198] Transpower, Transmission Lines Structures PMP
[199] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.
[200] Transpower, Transmission Lines Structures PMP

programme is also linked to associated opex in the form of the steel and bolt replacement, especially for towers due for paint intervention that are planned to be replaced with poles in the future.

The resilience workstream reflects the importance of the HVDC lines withstand flood and high wind events. In addition, there is an investment in emergency exercises for tower restorations to minimise the restoration time post-event for tower failures. The resilience component is aligned with the investment description outlined in the Resilience Portfolio Management Plan.

9.3.9.4 RCP4 capex drivers and solutions

The asset management approach is to maintain structures in perpetuity, whilst achieving least lifecycle cost. The following key strategies have been adopted by Transpower to achieve this approach:[201]

– Paint towers based on optimal condition assessment scores for each corrosion code
– Repair or replace structures that have degraded to a point where they can no longer support their design loads. This includes replacing towers with poles where appropriate.
– Replace insulator attachment points at onset of section (CA20) or before fastener threads seize up (CA30).

The R&R investment need is based on the condition of the structure, the risk of failure and the criticality of the structure[202]. The forecast expenditure is based on asset health model scores which use condition assessment data and degradation rates.

Transpower’s asset health model captures the condition assessment information of structures for each of the following three areas: towers, structures and attachment points. Attachment points are components of both towers and poles.

The investment process involves evaluating and optioning various alternate solutions to address the need, finding synergies with other proposed capital works (such as replacing conductor when carrying out structure repairs or replacement). Accordingly, the expenditure for this asset portfolio can include attachment point replacement, replacement of steel and bolt work, painting of the structure (covered under a separate portfolio management plan) or complete structure replacement.

In RCP4 Transpower is proposing the following R&R activities for this asset portfolio[203]:

– Pole structures to be replaced based on a condition assessment score of 20 to ensure it meets the requirements of their Safety Management Systems under the Electricity Act.
– Pole and attachment point works are bundled with other works (reconductoring, insulator replacement, under clearance works) where possible to improve efficiencies. The asset health model for attachment points has recently been developed and will undergo further refinement over the next several years.
– In certain corrosion zones maintain the asset health of the tower structures by either painting or replacing steel and bolts (or both). There is no individual health model for steel and bolt members, as they are replaced once they reach replacement criteria based on condition assessment inspections.
– Conversion of some smaller towers where feasible to poles to reduce the whole of lifecycle costs compared to the traditional painting and maintenance requirements of a tower.
– Resilience workstream for critical towers located in flood and high wind areas.

9.3.9.5 Evaluation

To assess whether Transpower’s proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

This involved reviewing relevant asset management and strategy documentation and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

[201] Transpower, Transmission Lines Structures PMP
[202] Transpower, Transmission Lines Structures PMP
[203] Transpower, Transmission Lines Structures PMP

This base R&R capex is largely a volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across the asset class.

Prudency

We analysed the different elements of this asset class and investigated the reasons for any step change in quantities noticed between RCP3 and RCP4. We reviewed the investment drivers described above and determined that they are reasonable as a basis for developing the proposed base R&R capex.

We reviewed the use of the asset health and network risk modelling tools for identifying and prioritising the proposed projects and nominated quantities in RCP4 and consider them to be reasonable.

We observed that there is a strategy for how to address each structure type based on whether it requires life extension, partial replacement or complete replacement. The plan provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken. These assumptions and values are considered reasonable and appropriate.

The average replacement/retirement age for transmission structures are generally longer than those of comparable Australian DNSPs and TNSPs based on available annual regulatory reporting information. We referred to the average asset life reported in the annual Category Analysis RIN within the Asset Age Profile tab of the reporting template for this comparison. Whilst age is not the absolute determinant for replacement, but it can provide an indication or proxy for asset conditions and hence the AHI score or the probability of failure. To extend the life of transmission structures Transpower has developed life extension strategies, tower painting and steel and bolt replacement, as well as a corrosion degradation model. Therefore, we consider Transpower's planning around asset lives and replacement approaches for transmission line structures is prudent.

We queried the modelled projection of annualised risk levels for transmission structures with and without the proposed RCP4 base R&R capex and tested the level of risk averseness or otherwise (risk appetite) from Transpower management team in managing this portfolio. We consider the risk level at the end of RCP4 with the proposed base R&R capex to be generally similar to the current asset health. This demonstrated a prudent volume of R&R work in RCP4.

We reviewed a delivery tower to pole programme business case (for RCP3)[204]. It demonstrated that Transpower's approach to expenditure approval is considered at a GEIP standard. The business case includes:

– identification of the investment need,
– option analysis,
– selection of preferred option based on defined criteria such as whole of life costs and safety,
– identification of key risks and mitigations,
– project and outage schedule, and
– cost estimate.

The inputs and outputs of this process are consistent with the asset planning decision framework as described in Section 3 of this IV report. The definition and scoping of the preferred solution is considered prudent.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

The impact of the proposed base R&R capex on other asset portfolios, such as tower painting and foundations as well as opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACSs and PMP.

[204] Transpower, BPE-WGN towers to pole Delivery Business Case.pdf

Efficiency

We compared the TEES building block unit rates of few randomly selected asset types and checked where possible these rates against independently sourced costing information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets. Similarly, we referred to the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the large increase in the proposed RCP4 base R&R capex is mostly due to the increase in asset quantities (such as pole replacements increasing by 37% and tower to replacements going from 10 to 89)[205]. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.

We reviewed the cost estimate process used in developing the resilience workstream budget and consider it to be reasonable and consistent with its volumetric budget build-up. We also consider this workstream being proposed as base R&R capex to be reasonable.

9.3.9.6 Conclusion

Based on the reviewed information, we consider that proposed base R&R capex for transmission line structures of $78.7M meets all the evaluation criteria and reflects GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-29 Transmission line structures base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	This is evident and documented in the earlier asset planning approach, capex drivers and solutions, and evaluation sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	The Structures PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process which includes asset health and condition, detailed condition assessment, determination of asset-specific management strategy and then implement either monitoring, repair or replacement. This is evident and documented in the earlier evaluation sub-section.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower undertake an options assessment process that includes alternative solutions. This includes consideration of options such as like-for-like replacement, capacity upgrades and downgrades, dismantling, system reconfiguration and continued maintenance.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section. The primary grid output measures relevant to this capex programme are network risk, asset health and GP standards.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	Changes in volumes of structures replacements and unit rate changes are outlined in the PMP and are considered reasonable. Separate contingencies are not provided.

[205] Transpower, RFI020-10 Deliverable quantities for transmission lines volumetric work.exlsx

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
			This is evident and documented in the earlier evaluation sub-section.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	This is evident and documented in the earlier asset planning approach and evaluation sub-sections. The structures resilience expenditure is included in the portfolio plan however is separately evaluated within the UIOLI uncertainty mechanism.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is a combination of contracted services as well as direct purchase of poles and steel towers. This approach is consistent with the procurement strategies of other TSNPs.

Note: A3(h) is not applicable to base capex

9.3.10 Transmission line tower painting

The following table summarises our verification of the transmission line tower painting capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-30 Verification summary of transmission line tower painting base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$293.9m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $293.9m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

9.3.10.1 Asset portfolio and strategy overview

This asset portfolio consists of the protective coating of transmission line steel structures where environmental conditions are forecast to reduce the mechanical capacity of the structure.

Not all 26,000 steel towers require paint, it is based on the condition of the tower steel and the corrosion zone. Both transmission HVAC as well as the HVDC towers are painted. Transmission poles are not painted. The painting of transmission structures is divided into two areas:

1. structure areas within the minimum approach distance of conductors (MAD) requiring outages and additional training, and
2. the remainder of the tower structure.[206]

The transmission line tower painting ACS documents the objectives, statistics, operational knowledge, asset management strategy and planning, decision making, asset information, organization and people, risk and review and lifecycle delivery information to manage this asset portfolio. The transmission line PMP provides the most recent view on this asset class, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base capex forecast and associated quantities for tower and power R&R activities.

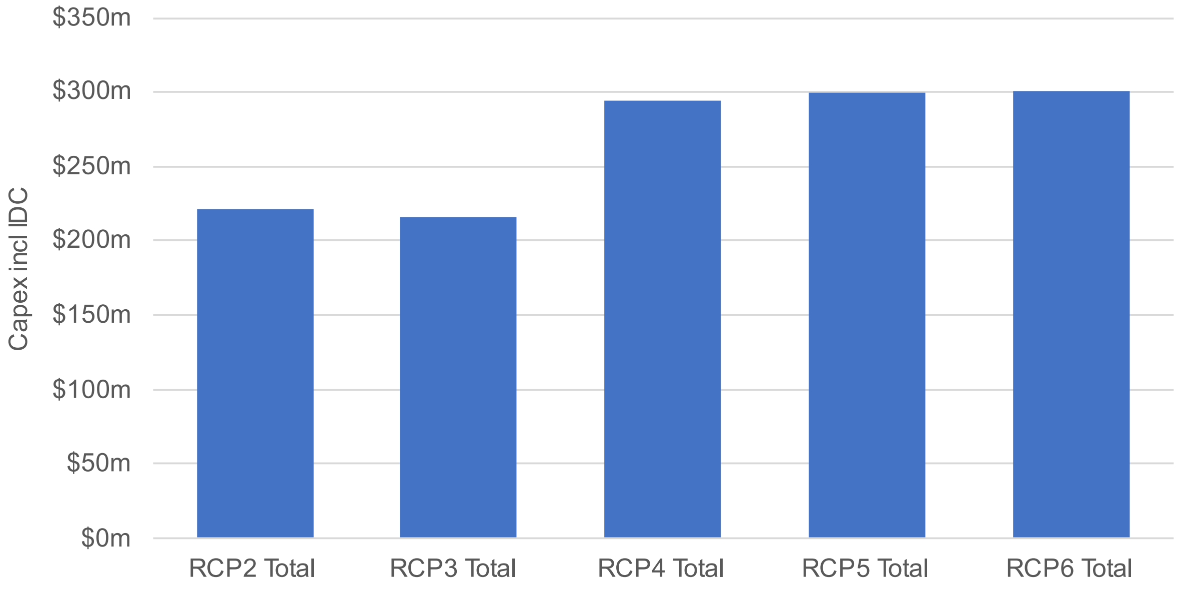
The annual trend of the base R&R capex for this asset portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule in 2021/22 real dollar term.

[206] Transpower, Transmission Lines Tower Painting PMP

9.3.10.2 Expenditure profile

Transpower is proposing to increase the transmission line tower paint R&R expenditure significantly from $215.5m in RCP3, to $293.9m[207] in RCP4 and then similar expenditure in RCP5 and RCP6 as shown in the following figure

Figure 9-28 Transmission line tower painting base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The following table shows the change in proposed expenditure levels in RCP4 compared with RCP3 expenditure levels.

Table 9-31 Transmission line tower painting base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Transmission line tower painting	$215.5m	$293.9m	36%

Source: Transpower, RT01 expenditure schedule and GHD analysis.

The following figures show the RCP3 and RCP4 MAD painting and tower painting expenditure and quantities. The key elements to note are:

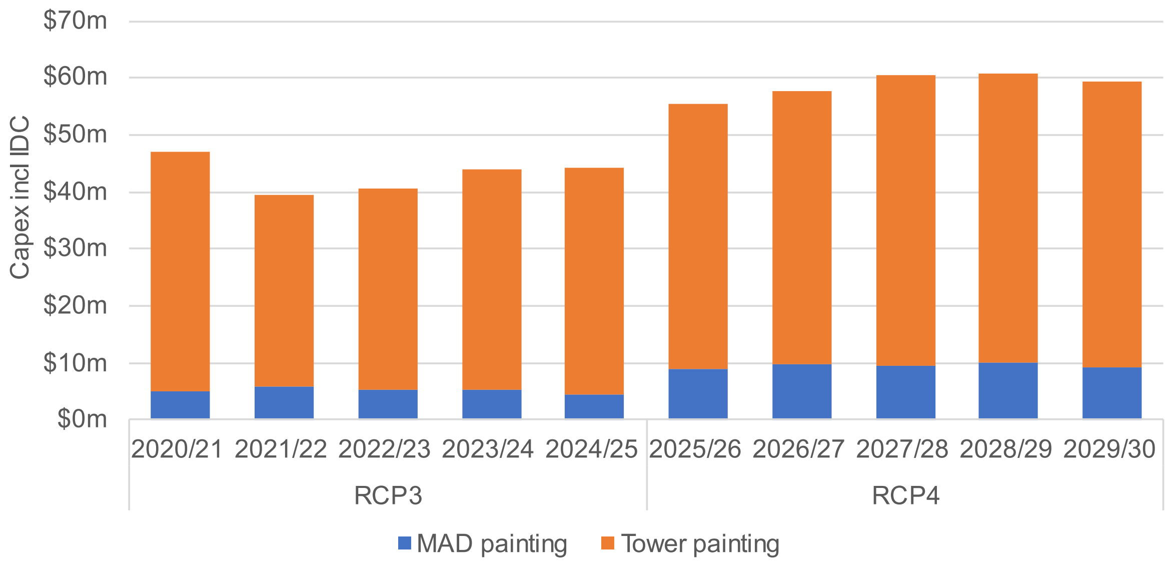
– Tower painting expenditure and quantities grow from about 2022/23 to about 2027/28 and then expenditure remains stable. This stabilisation of expenditure towards the end of RCP4 is because by this point in time a greater proportion of painting becomes recoating which is less costly.

– MAD painting expenditure and quantities grow significantly from RCP3 to RCP4 due to a greater focus on reducing steel and bolt replacement costs in the MAD area.

– Most of the expenditure is associated with tower painting is because the MAD painting area is only a small percent of the overall tower structure to be painted.

[207] Transpower, Transmission Lines Tower Painting PMP

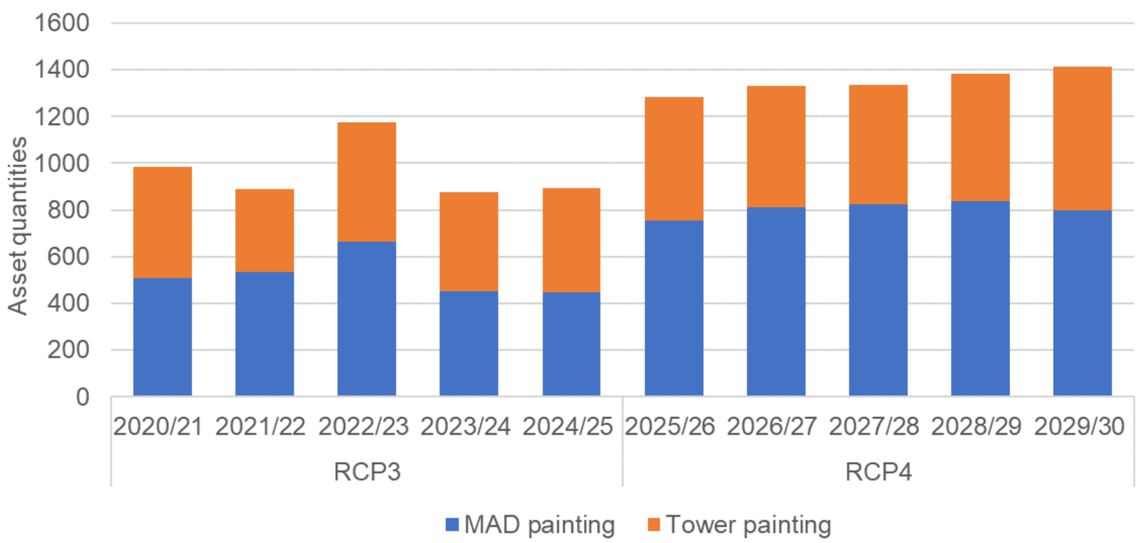
Figure 9-29 Transmission line tower painting base R&R capex profile



Source: Transpower, RT01 expenditure schedule and GHD analysis

Similarly, the forecast yearly quantity profile is shown in the following figure.

Figure 9-30 Transmission line tower painting R&R quantity profile



Source: Transpower, Tower painting 2022 PMP, GHD analysis.

Transpower prioritised investment during RCP3 because of restrictions caused by covid in 2021 and 2022. This was the case with both tower and MAD painting where the quantities in 2021 (478 towers and 506 MAD areas) and 2022 (355 towers and 534 MAD areas) are lower than the expected quantities to be painted from RCP4 onwards[208].

The following table shows the percentage quantity increases for regular tower painting and for the MAD tower painting. As the table indicates, the quantities of both tower painting and the MAD painting are growing substantially in RCP4.

[208] Transpower, Transmission Lines Tower Painting PMP

Table 9-32 Transmission lines tower and MAD painting areas RCP3 and RCP4

Activity	RCP3 quantities	RCP4 quantities	Change
Tower painting	2,215	2,725	23%
MAD painting	2,602	4,024	55%
Total	**4,817**	**6,749**	**40%**

Source: Transpower, RT01 expenditure schedule, Tower painting 2022 PMP, GHD analysis

9.3.10.3 Asset planning approach

Transmission line tower painting has an ACS and PMP. The ACS and PMP for this asset portfolio are developed base on the requirements of the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. These documents describe the challenges, objectives and approaches to managing Transpower's tower painting programme.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies or extension life strategies (of which tower painting is one), the need for investigation and intervention priorities. These guide Transpower's R&R approach in managing this asset class.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for transmission tower paint is based on risk and lifecycle cost management i.e., asset health scores, criticality modelling and lifecycle cost models to prioritise R&R work. These are based on respective asset class asset health model producing health score/probability of failure and asset class impact model producing criticality ranking. Collectively the AHNR modelling provides Transpower with an input to its R&R investment decision making.

The GHD Advisory Expert Opinion Progress Review report[209] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

- The asset health modelling for this portfolio meets GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
- The impact modelling for this portfolio meets the GEIP and aligns with Level 2 maturity that considers the financial impact from loss of service and the direct costs to replace.
- The network risk modelling for this portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower has identified synergies between this asset portfolio and other asset portfolios in particular tower structures. The tower structure lifecycle plan, condition and criticality, outlined in the structures PMP will influence which towers are painted and their frequency. The R&R programme for this asset portfolio is also linked to associated opex in the form of the steel and bolt replacement which tower painting delays or offsets.

[209] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

9.3.10.4 RCP4 capex drivers and solutions

The key asset management objective is to undertake tower painting to ensure the structural integrity of all transmission towers that are not identified for alternative strategies such as pole replacement. The intention is that painting occurs prior to significant rusting and then to repaint prior to paint failure. The approach is to extend the life of the towers indefinitely to lower the lifecycle cost.

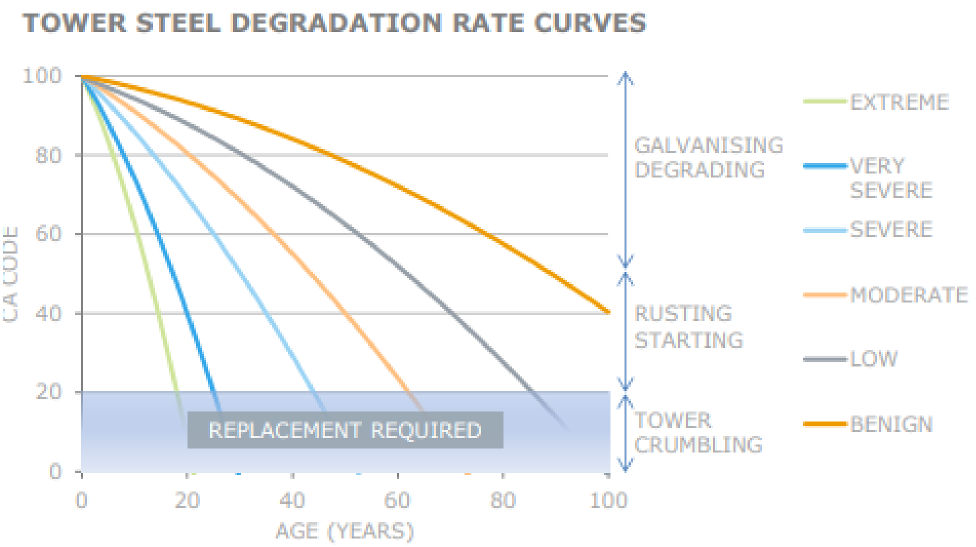
The key paint objectives to achieve this are[210]:

– Paint towers based on optimal condition assessment scores for each corrosion code
– Repaint when the intermediate coat shows through the topcoat
– Use the asset heath model to indicate the likely intervention timeframe
– Replace small towers with poles in preference to painting the tower, where practical and cost-effective.

The investment need for this asset portfolio is based on the condition of the structure, the risk of failure of the structure and whether the tower is designated to be replaced with another tower or a pole. The forecast expenditure is based on asset health scores which reflect the remaining life of the tower steel for unpainted structures or the life of the paint coating for painted structures.

Unpainted structures use degradation rates for each corrosion zone based on observed condition codes, whereas painted structures use time-based forecast per corrosion zone from last paint date. The objective is to paint or recoat towers with AH of 8 or greater.[211] Asset health forecasts for unpainted towers uses steel condition code values from an overview condition assessment (OVCA), the corrosion zone, and the expected degradation profile for that corrosion zone.[212] Modelling of the available codes for each structure using corrosion zone degradation rates establishes the asset health profile for unpainted towers, as shown in the figure below.

Figure 9-31 Unpainted galvanised steel tower degradation curves



Source: Transpower, Transmission lines tower painting PMP

Painting is preventive and is undertaken before any potential failure event. As such, Transpower does not currently use criticality in the tower painting forecast and prioritisation models. Delays in painting towers beyond the optimal window impacts the cost to complete the works rather than increasing failure likelihood.

In RCP4 Transpower is proposing the following R&R activities for this asset portfolio[213]:

– Tower painting programme to continue to align with the strategy to paint towers where this delivers the least whole of lifecycle cost, effectively maintaining towers in perpetuity.
– A focus on MAD painting to complete 100% of MAD areas.

[210] Transpower, Transmission Lines Tower Painting PMP
[211] Transpower, Transmission Lines Tower Painting PMP
[212] Transpower, Transmission Lines Tower Painting PMP
[213] Transpower, Transmission Lines Tower Painting PMP

– Inclusion of approximately 100 towers on the BRK-SFD-B line to be painted where a previous decision to dismantle the line was deferred due to increased generation/load interest in the area, the maintenance of these towers have been included into the RCP4 programme.
– Commence a higher volume of recoating previous painted towers compared to the RCP3 quantities.

9.3.10.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

This involved reviewing asset management and strategy documentation and interviewing relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

This base R&R capex is largely a volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across the asset class.

Prudency

We analysed the different elements of this asset class and investigated the reasons for quantity step changes between RCP3 and RCP4. We reviewed the investment drivers described above and determined that they are reasonable as a basis for developing the proposed base R&R capex.

We reviewed the assumptions, and the use of the asset health and network risk modelling tools for identifying and prioritising the proposed projects and nominated quantities in RCP4. The tower painting plan provides a summary of the current asset health levels and future asset health levels if the proposed works are not undertaken. It reveals that that asset health of transmission towers drops significantly without any investment resulting it more costly repairs or tower replacements in later regulatory periods. These assumptions and values are considered reasonable and appropriate.

The average replacement/retirement age for transmission structures are generally longer than those of comparable Australian DNSPs and TNSPs based on available annual regulatory reporting information. We referred to the average asset life reported in the annual Category Analysis RIN within the Asset Age Profile tab of the reporting template for this comparison. Age is not the absolute determinant for replacement, but it can provide an indication or proxy for asset conditions and hence the AHI score or the probability of failure. To extend the life of transmission structures Transpower has developed life extension strategies including tower painting as well as a corrosion degradation model to more accurately determine the optimal intervention points. We consider Transpower's tower painting approach is a prudent life-extension technique for its transmission towers.

The transmission line tower painting PMP, unlike other PMPs does not contain a modelled projection of annualised risk levels with and without the RCP4 investment. This is because painting is undertaken at the optimal economic intervention point, not at the condition assessment level necessary to avoid asset failure.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

We consider the impact of the proposed base R&R capex on other asset portfolios such as transmission line structures as well as opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACSs and PMP.

Efficiency

Transpower have defined building block unit rates for each tower type, informed by the actual cost of completed equivalent historic projects. Each structure to be painted is assigned building blocks, and the sum of these is the estimated cost included in delivery business cases. Eighteen building blocks are currently used, reflecting combinations of tower size, MAD areas, whether the tower is painted or unpainted, the paint product to be used, and whether the structures are standard or high preparation.

We attempted to compare the TEES building block unit rates for painting of a few randomly selected asset tower types and check these rates against independently sourced costing information. However, the Australian NEM median unit cost information for transmission towers did not include tower painting costs. We did compare the tower painting unit costs between service providers using the Transpower's price book which aligned with the TEES building blocks.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the large increase in the proposed RCP4 base R&R capex (36%) is mostly due to the increase in asset quantities (23% for tower painting and 55% for MAD painting) as outlined in the sub-sections above. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.

9.3.10.6 Conclusion

Based on the reviewed information, we consider that proposed base R&R capex for tower painting of $293.9m meets all the evaluation criteria and reflects GEIP.

The following table describes our verification of this identified programme against the evaluation criteria.

Table 9-33 Transmission line tower painting base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	The Tower Painting PMP outlines the investment need and key drivers for tower and MAD painting expenditure workstreams. The programme is prioritised based on economic life extension of tower structures rather than a pure risk-based approach.
A3(b)	Policies and planning standards were applied appropriately	Yes	The Tower Painting Structures PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower undertake an options assessment process that includes alternative solutions.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section. The primary grid output measure most relevant to this capex programme is asset health.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	The cost estimate allowed for the volumetric painting expenditure is based on the TEES estimating system. Separate contingencies are not provided. This is evident and documented in the earlier evaluation sub-section.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. This is evident and documented in the earlier asset planning approach and evaluation sub-sections.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	The tower paint programme is related to the structures programme and is impacted by the tower to pole program. These linkages are outlined in the PMP and reflected in the expenditure proposal.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is primarily through the grid services contract for service providers. This approach is consistent with the procurement strategies of other TSNPs. Refer to our evaluation in Section 7 of this report.

Note: A3(h) is not applicable to base capex

9.3.11 Transmission line insulators

The following table summarises our verification of the substation structures and buswork capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-34 Verification summary of transmission line tower insulators base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$49.0m including resilience workstream [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes.
IV conclusion	Accept: $49.0m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, the resilience workstream capex is evaluated within this base R&R capex.

9.3.11.1 Asset portfolio and strategy overview

This asset portfolio includes transmission line insulators and fittings and earthwire hardware. There are approximately 53,000 glass, porcelain or composite insulators across Transpower's network[214]. Both transmission HVAC as well as the HVDC transmission line insulators are included in this asset portfolio.

The transmission line insulator ACS documents the objectives, statistics, operational knowledge, asset management strategy and planning, decision making, asset information, organization and people, risk and review and lifecycle delivery information to manage this asset portfolio. The transmission line insulator PMP provides the most recent view on this asset class, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base capex forecast and associated insulator quantities for R&R activities.

Transpower's asset management approach for insulators, as with other transmission line assets, is to maintain them in perpetuity, whilst achieving least lifecycle cost. The strategy is to replace them based on a condition assessment (CA) score of 20, and wherever it is economical to do so with other works[215]. To achieve an overall least lifecycle cost, the current strategy is to replace the insulators in blocks or bundles of work. To improve efficiency, re-insulation work is also bundled with any works where conductor lifting is done.

[214] Transpower, Transmission Lines Insulators PMP
[215] Transpower, Transmission Lines Insulators PMP

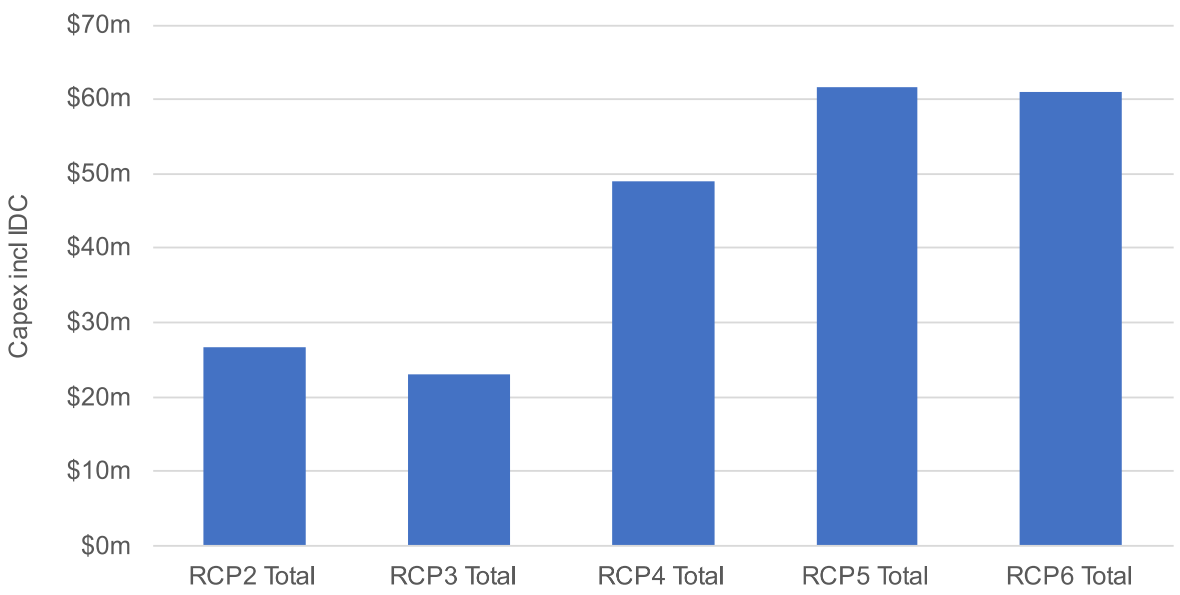
The key investment activities Transpower will undertake are:

- Replace glass and porcelain insulators and fittings when condition assessment shows that they have reached their replacement criteria (i.e., at condition assessment 20).
- Replace composite insulators and fittings based on age, prior to their normal expected life, or sooner where condition dictates.
- Install composite insulators in extreme and very severe corrosion areas, and in sensitive areas where audible noise is an issue. Install glass cap and pin insulators in all other areas.

9.3.11.2 Expenditure profile

Transpower is proposing to significantly increase insulator R&R capex from $22.1m in RCP3 to $49.0m in RCP4, to $61.7m in RCP5 and then maintaining a similar expenditure in RCP6.

Figure 9-32 Transmission line insulators base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 9-35 Transmission line insulators base R&R capex for RCP3 and RCP4

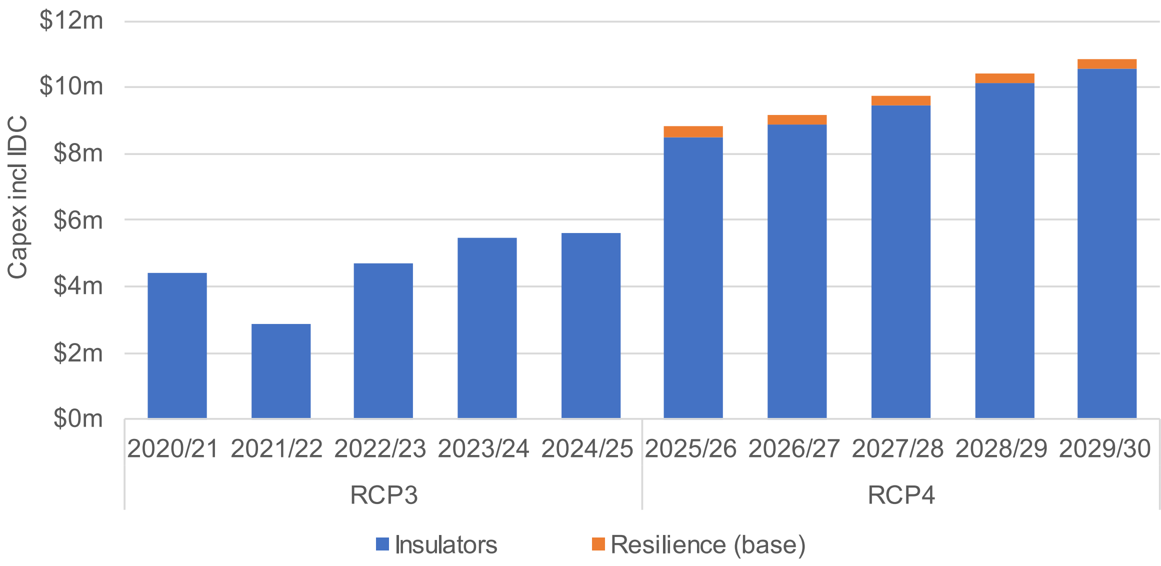
Asset portfolio	RCP3 total	RCP4 total	Change
Transmission line insulators	$23.1m	$49.0m	112%

Source: Transpower, RT01 expenditure schedule

The yearly expenditure and quantities for RCP3 and RCP4 is shown in the figures below. The tables and graph are broken into insulator replacements and resilience expenditure. The key trends are:

- The insulator replacement quantities nearly double between RCP3 and RCP4
- The expenditure increase grows at a faster pace that the increase in quantities reflecting a higher cost of insulator replacement. This is especially the case between RCP3 and RCP4 where the average cost per insulator goes from $6.5k to $8.3k. This increase in cost per insulator is due to revised TEES rates and a change in the ratios of the type of insulators replaced (as shown in the following table).
- There is a small level of resilience expenditure (for volcanic ash event) growing slightly from $1.6m in RCP4 which is expected to increase to $1.9m in RCP6.

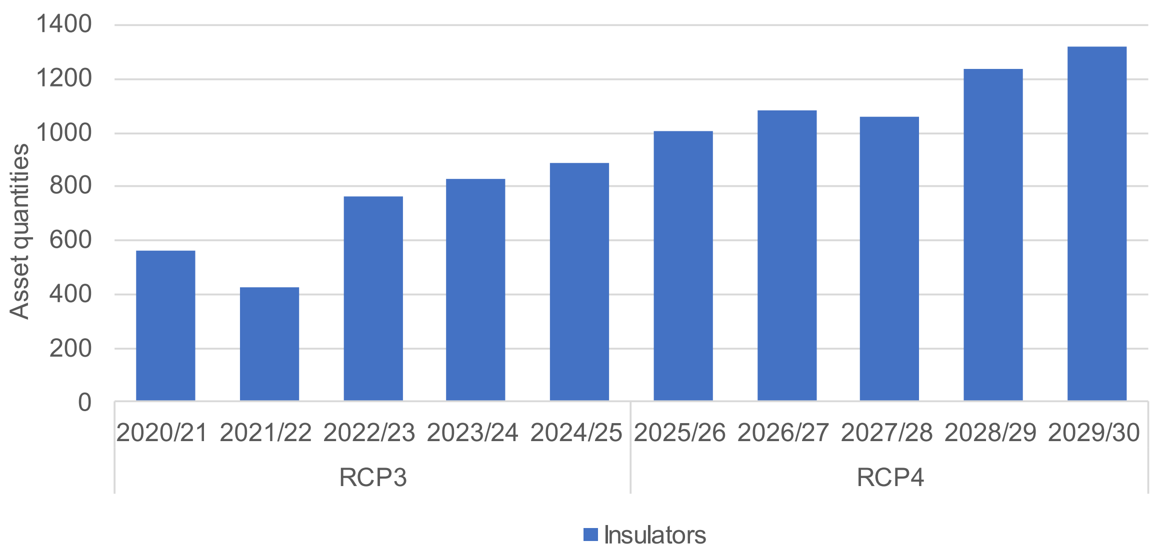
Figure 9-33 Transmission line insulators base R&R capex profile



Source: RT01 expenditure schedule, Resilience 2022 PMP, GHD analysis

Similarly, the forecast quantity profile of this asset portfolio is shown in the following figure.

Figure 9-34 Transmission line insulators R&R quantity profile



Source: Outdoor Circuit Breaker 2022 PMP, Instrument Transformers 2022 PMP and Disconnector and Earth Switch 2022 PMP

Transpower's insulator replacement is much lower in RCP3 (approx. 400 to 900 per year) relative to RCP4. In the two RCP3 covid impacted years, 2021 and 2022, Transpower replaced quite a small volume of insulators, 564 and 424. The number of insulators to be replaced for the remainder of RCP3 are higher but not as high as average of the RCP4 replacement levels. The remaining RCP3 works consist of standalone re-insulation work, a small amount of earthwire hardware replacement and re-insulation work associated with the pole replacement programme. Transpower undertook a recalibration exercise of its asset model and new degradation rates which have reduced the work volume in RCP3 compared to their RCP3 submission.

The following table shows the percentage changes in the quantities of each insulator type from RCP3 to RC4. The total percentage change of 65% is much less the expenditure change of 112%. Part of this difference is due to the higher percentage change for the more expensive strain insulators set (110%, 118% and 110% as shown in the table) relative to lower growth of suspension tower insulator replacements. The remainder of the difference is due to an increase in insulator unit rates for each of these types.

Table 9-36 Transmission line insulators quantities by type for RCP3 and RCP4

Insulator type	RCP3 quantity	RCP4 quantity	Change
110/66kV Strain insulator cct set	154	364	136%
110/66kV Strain insulator cct set replacement aligned to pole replacement	50	109	118%
110/66kV Suspension insulator cct set	1,276	2,146	68%
110/66kV Suspension insulator cct set replacement aligned to pole replacement	370	390	5%
220kV Strain insulator set	220	461	110%
220kV Suspension insulator set	1,335	2,238	68%
HVDC Strain insulator set	18	0	-100%
HVDC Suspension insulator set	44	0	-100%
Total	**3,467**	**5,708**	**65%**

Source: Transpower, Insulators 2022 PMP, RFI020-10 Deliverable quantities for transmission line volumetric work.xxlx

9.3.11.3 Asset planning approach

Transmission line insulators has an ACS and PMP. The ACS and PMP for this asset portfolio are developed based on the requirements of the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. These documents describe the challenges, objectives and approaches to managing Transpower's insulators programme.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies, better asset makes and models, need for investigation and intervention priorities. Based on these they guide Transpower's R&R approach in managing this asset class.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for transmission line insulators is based on risk and lifecycle cost management i.e., asset health scores, criticality modelling and lifecycle cost models to prioritise R&R work. These are based on respective asset class asset health model producing health score/probability of failure and asset class impact model producing criticality ranking. Collectively the AHNR modelling provides Transpower with an input to its R&R investment decision making. The October 2022 Expert Opinion Progress Review report on Transpower AHNR modelling by GHD indicates the following maturity status:

– The asset health modelling for this portfolio meets GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
– The impact modelling for insulators in this portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
– The network risk modelling for this portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The October 2022 Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding their network risk to inform and support its base R&R capex for this asset portfolio for RCP4 submission. Evidence sited (such as the insulator PMP) during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower has identified synergies between this asset portfolio and other asset portfolios such as conductor and hardware and tower structures to align R&R activities where opportunities exist for project efficiencies. The R&R program for this asset portfolio is also linked to associated opex such as insulator washing and line patrols and condition assessments.

9.3.11.4 RCP4 capex drivers and solutions

The insulator investment need is based on the condition of the insulator which is influenced by age and environment. Glass and porcelain insulators are planned for replacement when their condition reaches the intervention point at CA20[216]. Composite insulators differ from glass and porcelain with respect to their degradation modes and rates. Transpower is undertaking further analysis of composite degradation rates and replacement requirements. Currently, replacements are based on age or observed condition. Composite insulators have superior pollution and noise performance so are installed in high pollution areas or certain areas where noise is perceived to be an issue[217].

Transpower also makes investment decisions to replace insulators prior to reaching intervention points, age or observed conditions. This occurs when other works are undertaken on the transmission line such as tower to pole changeovers or attachment point replacements.

Transpower utilise its asset health model to forecast future insulator replacement volumes and expenditure. The insulator asset health model is influenced by condition assessment, corrosion zone, insulator type and asset age. The asset health model, based on condition information and degradation modelling has enabled Transpower to extend the asset life beyond a tradition time-based replacement. Due to the high variance in degradation zones, Transpower believe there is substantial value in managing insulators as a condition-based program.

Earthwire hardware has historically not been included in health models, thereby making forecasting work packages difficult. It has now been included in the health model for the insulator portfolio. This has been made possible by data cleansing exercises to remove erroneous data.

In RCP4 Transpower is proposing the following R&R activities for this asset portfolio[218]:

– Increase in re-insulation replacement volumes compared to RCP3 levels.
– Increase in re-insulation as part of other work such as tower to pole changeovers or attachment point replacements.
– Undertake some resilience improvements by installing insulators that are less susceptible to the build-up of volcanic ash in the event of an eruption.
– Earthwire hardware replacements will be undertaken as opex works in RCP4. Therefore, there is an uplift in the maintenance spend forecast to account for this change.

9.3.11.5 Evaluation

To assess whether Transpower’s proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and evaluation methodologies described in section 8.2 where applicable. This involved reviewing asset management and strategy documentation and interviewing relevant Transpower management team members. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

This base R&R capex is largely a volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R

[216] Transpower, Transmission Lines Insulators PMP
[217] Transpower, Transmission Lines Insulators PMP
[218] Transpower, Transmission Lines Insulators PMP

intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across the asset portfolio.

Prudency

We analysed the different elements of this asset class and investigated the reasons for quantity step changes between RCP3 and RCP4. We reviewed the investment drivers described above and determined that they are reasonable as a basis for developing the proposed base R&R capex.

We reviewed the use of asset health data for asset health and network risk modelling tools for identifying and prioritising the proposed projects and nominated quantities in RCP4 and consider them to be reasonable. The insulator PMP including planning information which provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken. These assumptions and values are considered reasonable and appropriate.

The average replacement/retirement age for transmission line assets are generally longer than those of comparable Australian DNSPs and TNSPs based on available annual regulatory reporting information. We referred to the average asset life reported in the annual Category Analysis RIN within the Asset Age Profile tab of the reporting template for insulator comparison. Unfortunately, the RIN includes expected asset lives for conductors and towers but not for insulators. Therefore, a direct comparison with Australian DNSPs or NTSPs is not possible. The insulator PMP outlines the expected life for different insulator types which is based on corrosion degradation rates. We consider this as an appropriate basis for Transpower's planning around asset lives and replacement.

We queried the modelled projection of annualised risk levels for transmission line insulators with and without R&R works in RPC4 and tested the level of risk averseness or otherwise (risk appetite) from Transpower's management team. The level of RCP4 investment will maintain the current level of asset failure risk and is necessary to avoid a significant increase in insulators with a very poor asset health rating. This demonstrated a prudent volume of R&R work in RCP4.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

We consider the effect of the proposed base R&R capex on other asset portfolios such as transmission line structures and conductor and hardware, including opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACSs and PMP.

Efficiency

We compared the TEES building block unit rates of few randomly selected asset types and checked where possible these rates against independently sourced costing information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets. Similarly, we referred to the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the large increase in the proposed RCP4 base R&R capex is due to both the increase in asset quantities and the increase in the TEES rates. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) has largely been due to the increase in material costs as well as smaller increase do to labour rate changes. The increase in quantities to maintain asset health levels and the increase in unit costs are considered reasonable.

Whilst the majority of the cost build up was for volumetric activities this is not the case for earthwire hardwire where effective TEES rates do not currently exist. This element of the insulator asset class is costed as a predictive maintenance project where there is a bottom-up cost estimate.

We reviewed the cost estimate process used in developing the resilience workstream budget and consider it to be reasonable and consistent with its volumetric budget build-up. We also consider this workstream being proposed as base R&R capex to be reasonable.

9.3.11.6 Conclusion

We conclude that the proposed base R&R capex for the transmission line tower insulators asset portfolio totalling $49.0m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this identified programme against the evaluation criteria.

Table 9-37 Transmission line insulators base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	Transpower's ACS and PMP are aligned with each other as well as related PMPs such as the Conductor and Hardware PMP. The plan provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken. These assumptions and values are considered reasonable and appropriate to inform the R&R activities.
A3(b)	Policies and planning standards were applied appropriately	Yes	The Insulator PMP is aligned with Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier evaluation sub-section.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower undertake an options assessment process that includes alternative solutions.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section. The primary grid output measures that are relevant to this capex program are network risk, asset health and the GP standards.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier evaluation sub-section. Separate contingencies are not provided.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	The insulator program is related to the conductor and hardware program and is impacted by the tower to pole program. These linkages are outlined in the PMP and reflected in the expenditure proposal.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is primarily through the grid services contract for service providers. Insulators are procured as part of period order contracts. This approach is consistent with procurement strategies of other TSNPs and procurement is not expected to create deliverability risks.

Note: A3(h) is not applicable to base capex

9.3.12 Conductor and hardware

The following table summarises our verification of the conductor and hardware capex which is categorised as an identified programme and forms part of the base R&R capex for RCP4.

Table 9-38 Verification summary of conductor and hardware base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$155.8m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $155.8m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

9.3.12.1 Asset portfolio and strategy overview

This asset portfolio includes transmission line conductors, earthwires, joints, spacers and dampers. There are approximately 52,400 circuit spans of conductor (16,400 circuit kilometres), and 9,800 spans of earthwire (3,400 kilometres) in the Transpower transmission network[219]. Both transmission HVAC as well as the HVDC transmission line conductors and hardware are included in this portfolio.

The transmission line conductors ACS documents the objectives, statistics, operational knowledge, asset management strategy and planning, decision making, asset information, organization and people, risk and review and lifecycle delivery information to manage this asset portfolio[220]. The transmission line conductor and hardware PMP provides the most recent view on this asset class, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base capex forecast and associated quantities for conductor and hardware R&R activities.

Transpower's asset management approach for conductors is to achieve a high level of reliability, to mitigate safety hazards, and to achieve least lifecycle cost. The main strategy is to repair conductors and hardware when analysis shows that localised sections have reached end of life and replace where ongoing management costs and risk are unacceptably high, including sub-span, span or section replacement approaches[221].

The key investment activities Transpower will undertake are[222]:

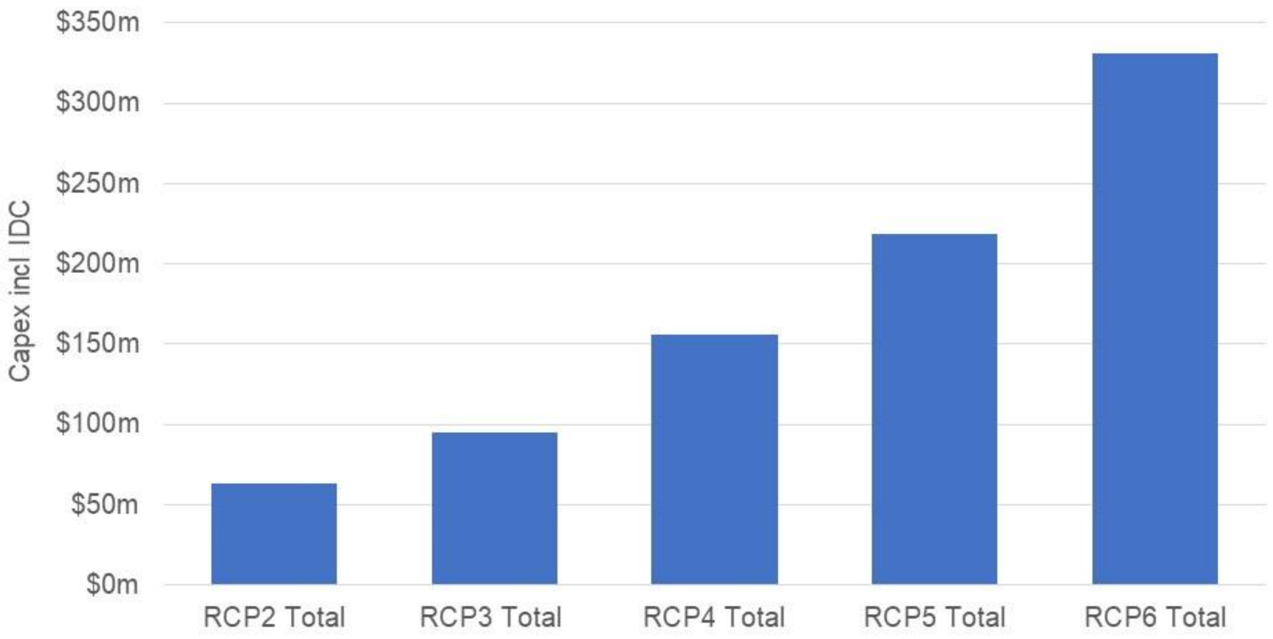
- Replace degraded conductors, earthwires, and hardware as they reach end of useful life.
- Increase inspection, testing, and repairs above RCP2 and RCP3 levels to increase the accuracy of the future forecasts and manage the condition and operational risk associated with aging infrastructure.
- Reduce the risk of joint failure by reducing the incidence of joints in critical spans, and by testing and repairing joints as required.
- Continue to manage and rectify spans where there are insufficient clearances to conductors.

[219] Transpower, Transmission Lines Conductor and Hardware PMP
[220] Transpower, Transmission Lines Conductor and Hardware PMP
[221] Transpower, Transmission Lines Conductor and Hardware PMP
[222] Transpower, Transmission Lines Conductor and Hardware PMP

9.3.12.2 Expenditure profile

Transpower is proposing to significantly increase conductors and line hardware R&R capex from $95.0m in RCP3, to $155.8m in RCP4, to $218.5m in RCP5 and then $330.7m in RCP6 as shown in the following figure.

Figure 9-35 Conductor and hardware base R&R capex long term profile



Source: RT01 expenditure schedule, GHD analysis

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 9-39 Conductor and hardware base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Conductor and hardware	$95.0m	$155.8m	64%

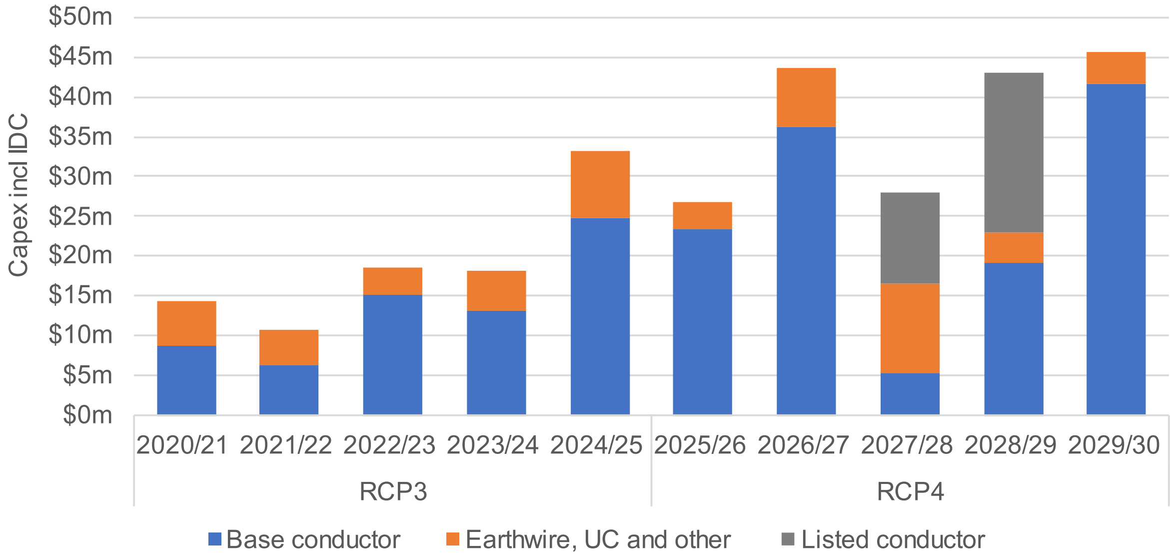
Source: Transpower, RT01 expenditure schedule

The yearly proposed capex and quantities for RCP3 and RCP4 is shown in the following figures. The key trends are:

- The overall increase in conductor and hardware base R&R expenditure as well as conductor quantities is growing significantly from RCP3 to RCP4. The change from year to year is uneven due to the expected timing of projects.
- The growth in earth wire and non-conductor expenditure is growing at a faster rate than conductor expenditure. The change from year to year is uneven due to the expected timing of projects.
- Transpower have identified a reconductoring project, HLY-OTA-A, that is a listed project forecast to be completed in RCP4[223]. This project is separately reviewed in the Listed Projects sub-section below. We have included its proposed capex profile in the below figures for completeness only.
- The under-clearance capex is to be completed by the end of RCP4 and is a minor component of capex.

[223] Transpower, Transmission Lines Conductor and Hardware PMP

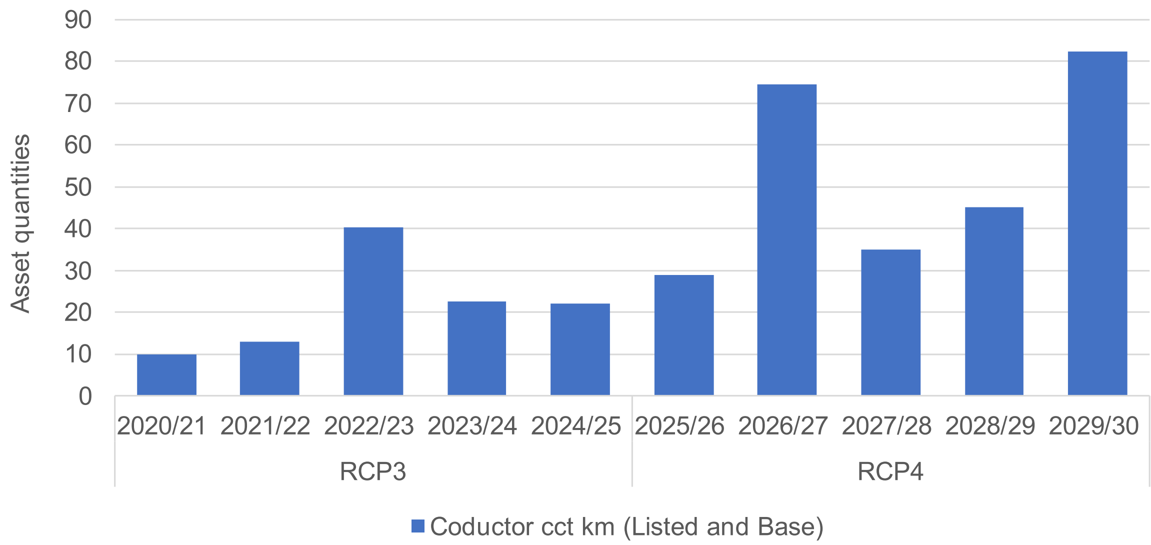
Figure 9-36 Conductor base R&R and listed project capex profile[224]



Source: RT01 expenditure schedule, Conductor and Hardware PMP, GHD analysis

Similarly, the forecast quantity profile of this asset portfolio is shown in the following figure.

Figure 9-37 Conductor and hardware R&R quantity profile



Source: Conductors 2022 PMP, GHD analysis

Transpower has and is undertaking a small volume of base capex conductor projects in RCP3 relative to RCP4, 5 and 6, however they have done significant Major Capital Project reconductoring work during this time. Base capex reconductoring projects are based on condition assessments rather than age. In the two RCP3 covid impacted years, 2021 and 2022, Transpower replaced quite a small volume of conductors and hardware. The amount of conductor and hardware to be replaced for the remainder of RCP3 are higher but not as high as average of the RCP4 replacement levels.

The following table shows the quantities and percentage changes for the main conductor categories.

[224] Only base R&R capex is reviewed in this sub-section.

Table 9-40 Transmission line conductor and hardware quantities for RCP3 and RCP4

Insulator type	RCP3 quantity	RCP4 quantity	Change
Base conductor & EW replacement cct km	163.2	244.5	50%
Listed Conductor Replacement cct km	-	45	N/A
Under-clearance capex (instances of towers with UC spans)	184	206	12%
Aerial laser surveys	5,694	6,000	5%

Source: Transpower, Conductor and Hardware PMP, GHD analysis

As outlined in the above table the growth in RCP4 quantities is mostly for base conductor and earthwire replacements. This also reflects the expenditure growth where this category represents all the expenditure growth.

9.3.12.3 Asset planning approach

Transpower's ACS and PMP for this asset portfolio is influenced by and aligns with the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. These documents describe the challenges, objectives and approaches for managing Transpower's conductors and lines hardware.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies, better asset makes and models, need for investigation and intervention priorities. These documents guide Transpower's R&R approach in managing this asset class.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for conductor and lines hardware is based on risk i.e., asset health scores, criticality modelling to prioritise R&R work. These are based on the asset health model producing health score/probability of failure and asset class impact model producing criticality ranking. The AHNR modelling provides Transpower with an input to its R&R investment decision making. The October 2022 Expert Opinion Progress Review report on Transpower AHNR modelling by GHD indicates the following maturity status:

- Conductor asset health modelling meets GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
- Impact modelling for conductors meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
- Network risk modelling for conductors meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The October 2022 Expert Opinion Progress Review report also states that Transpower is mature and capable in using these models and understanding network risk. Therefore, the use of these models is considered reasonable as basis for the development of its base R&R capex. Evidence sited, such as the conductors and hardware PMP as well as conductor condition assessments) during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower has identified synergies between conductors and line hardware and other asset portfolios such as insulators and tower structures which allows alignment of R&R activities where opportunities exist. The R&R program for this asset portfolio is also linked to associated opex such as condition and earthwire sampling, testing and repairs.

9.3.12.4 RCP4 capex drivers and solutions

The R&R conductor and hardware investment need is based on the condition of the conductor, especially with respect to signs of bulging and corrosion, the risk of failure of the conductor or hardware and on regulatory compliance to address under-clearances. Transpower currently have condition assessment data for approximately 65% of the line and visual off the tower condition assessments for 100% of the network[225]. The forecast expenditure is based on asset health scores for conductor and earthwires. The conductor and earthwire asset model were updated in 2021[226].

Transpower's replacement forecast volumes have reduced from the volumes anticipated at the time of their RCP3 submission. This was due to investment in improving condition assessment and forecasting techniques such as high-quality imagery from close aerial surveys using drones and extensive laboratory testing[227].

Transpower utilise its asset health model (replacing a previous CBRM approach) to determine the expected remaining conductor asset life. The model introduced in 2021 builds upon the previous model incorporating conductor defect information, Cormon test results, finite effects analysis (FEA) modelling, conductor sample results and factors in conductor mechanical loadings[228]. This model is more reliable than the visual inspection condition used in previous models. Conductor and earthwire condition information used in the model is captured from close aerial surveys. Interventions in the 2–7 year period are based on condition assessment data. Earthwires are included together with Conductors in the CBRM health model[229].

There is no asset health model required for spacer and dampers which are targeted for replacement prior to seizure of the bolts (CA30), as these are defect replacements. There is no asset health model for joints which have a longer expected life than conductors. Joints are managed through an annual programme of testing and repairs, with testing prioritised by public safety and service performance criticality.

In RCP4 Transpower is proposing the following R&R activities for this asset portfolio[230]:

- Undertake eleven reconductoring projects. Each of these lines has a conductor condition report which outlines the assessment results that required inclusion in the RCP4 works.
- Undertake the listed reconductoring project (the OTA-DRY section in the HLY-OTA-A line) subject to submission by Transpower and approval by the Commission.
- 24km of earthwire replacement either as part of reconductoring projects or as standalone projects.
- Aerial laser surveys (3,700kms of topographical and 2,300 kms of full conductor surveys).
- Under-clearance span management.

9.3.12.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and evaluation methodologies described in section 8.2 where applicable. This involved reviewing asset management and strategy documentation and interviewing relevant Transpower management team members. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

This base R&R capex is largely a volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across the asset class.

[225] Transpower, Transmission Lines Conductor and Hardware PMP
[226] Transpower, Transmission Lines Conductor and Hardware PMP
[227] Transpower, Transmission Lines Conductor and Hardware PMP
[228] Transpower, Transmission Lines Conductor and Hardware PMP
[229] Transpower, Transmission Lines Conductor and Hardware PMP
[230] Transpower, Transmission Lines Conductor and Hardware PMP

Prudency

We analysed the different elements of this asset class and investigated the reasons for quantity step changes between RCP3 and RCP4. We reviewed the investment drivers described above and determined that they are reasonable as a basis for developing the proposed base R&R capex.

We reviewed the supporting condition assessment data from several conductor condition reports and the use of the asset health and network risk modelling tools for identifying and prioritising proposed projects and nominated quantities in RCP4 and consider them to be reasonable.

The conductor and hardware PMP including planning information which provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken. These assumptions and values are considered reasonable and appropriate.

The average replacement/retirement age for transmission line conductors and hardware assets are generally longer than those of comparable Australian DNSPs and TNSPs. We referred to the average asset life reported, of 50 years in the annual Category Analysis RIN within the Asset Age Profile tab of the reporting template. Transpower's expected life of conductors and earthwires ranges between 17 and 100+years, depending on the type and construction of the conductor or earthwire, and the environment the asset is installed in (primarily the corrosiveness of the environment)[231]. We consider this as an appropriate basis for Transpower's planning around asset lives and replacement.

We queried the modelled projection of annualised risk levels for transmission line conductors and hardware with and without R&R works in RPC4 and tested the level of risk averseness or otherwise (risk appetite) from Transpower's management team. The level of RCP4 investment is necessary to reduce the volume of conductors that will be at their intervention point (0.67% with the investment and 1.45% without it)[232]. This demonstrated a prudent volume of R&R work in RCP4.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

We consider the effect of the proposed base R&R capex on other asset portfolios such as transmission line structures and insulators, including opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACS and PMP.

Efficiency

TEES cost estimates are used to estimate work in the conductors and hardware portfolio. Estimates for simpler work generally use the standard TEES building block rates where available. The larger reconductoring and dismantling projects in this portfolio use a different TEES cost estimation method, with different high-level building blocks (HLBBs)[233].

We compared the TEES building block unit rates of few randomly selected asset types and checked where possible these rates against independently sourced costing information. For this comparison we referred to the Australian NEM median unit cost information of similarly described asset type contained in the recent AER repex models used for the latest rounds of DNSP revenue determinations for ≤66kV level assets. Similarly, we referred to the unit cost estimate information of similarly described asset type in the latest AEMO transmission cost database for ≥132kV level assets.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the large increase in the proposed RCP4 base R&R capex is mostly due to the increase in asset quantities. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in. Some TEES rates have decreased.

[231] Transpower, Transmission Lines Conductor and Hardware PMP
[232] Transpower, Transmission Lines Conductor and Hardware PMP
[233] Transpower, Transmission Lines Conductor and Hardware PMP

9.3.12.6 Conclusion

We conclude that the proposed base R&R capex for the conductor and hardware asset portfolio totalling $155.8m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-41 Conductor and hardware base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	The conductor and hardware PMP outline the investment need and key drivers.
A3(b)	Policies and planning standards were applied appropriately	Yes	The ACS and PMP are aligned with each other as well as related PMPs such as the structures PMP. The plan provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The conductor and hardware PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower undertake an options assessment process that includes alternative solutions.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier evaluation sub-section. The primary grid output measures that are relevant to this capex program are network risk, asset health and the GP service measures.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier evaluation sub-section. Separate contingencies are not provided.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. This is evident and documented in the earlier asset planning approach and evaluation sub-sections.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	The conductor and hardware program is related to the insulator and structures program and is impacted by the tower to pole program. These linkages are outlined in the conductor and hardware PMP and reflected in the expenditure proposal.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is a combination of contracted services as well as direct purchase of conductor and hardware which is generally not long lead time. This approach is consistent with the procurement strategies of other TSNPs and procurement is not expected to create deliverability risks.

Note: A3(h) is not applicable to base capex

9.3.13 Transmission line grillage, foundations and accessways

The following table summarises our verification of the transmission line grillage, foundations and accessways capex which is categorised as a non-identified programme and forms part of the base R&R capex for RCP4.

Table 9-42 Verification summary of transmission line grillage, foundations and accessways base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	Grillage and foundations: $59.5m including land stability for towers and poles resilience workstream[234] but excluding flood hardening for HVAC towers in braided rivers resilience workstream[235]. Accessways: $10.3m including resilience workstream[236].
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $59.5m for grillage and foundations and $10.3m for accessway
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

9.3.13.1 Asset portfolio and strategy overview

The grillage and foundation asset portfolio includes foundations for steel lattice towers as well as a small number of larger steel poles with engineered foundations. There are two main types of foundation categories mass concrete (non-grillage) and direct buried steel (grillage) foundations. These foundations consist of two components, the buried part and the connection interface components between the buried part and the above ground structure. There are approximately 23,700 transmission line foundations of which over half (13,600) are grillage or concrete over grillage with a further 9,400 are mass concrete foundations[237].

Transmission line accessways provide routes to transmission lines and structures from readily accessible areas such as local roads to more remote locations via private or public land. They are critical to enable Transpower to respond to faults or events quickly and safely on their transmission lines. Accessways consist of approximately 15,400km of sealed and unsealed roads, spur tracks, walking tracks and unformed accessways. They often include water crossing structures such as bridges, culverts, and fords[238].

The transmission line grillage, foundation and accessways ACSs and PMPs outline the portfolio description, strategies, objectives, performance requirements, lifecycle management, risk management and proposed expenditure. The PMPs also provide the RCP4 base capex and opex forecasts and associated quantities for these asset classes. R&R capex including historical and future RCPs is presented in the RT01 Expenditure Schedule.

Transpower's asset management strategy for foundations is to maintain them in perpetuity, at least lifecycle cost, and to ensure the integrity and reliability of the overhead structures and conductors they support[239]. Given the criticality of foundations to the integrity of transmission structures Transpower's portfolio approach is an intervention programme to refurbish or replace foundations before degradation has reached a point where failure is possible.

[234] Transpower is proposing a capex workstream (land stability works for towers and poles) driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, this resilience workstream capex is evaluated within this base R&R capex.
[235] Transpower is proposing capex workstream (flood hardening of HVAC towers in braided rivers) driven by resilience concern within this asset portfolio using the UIOLI uncertainty mechanism. Therefore, this resilience workstream capex is separately evaluated and not within this base R&R capex.
[236] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the base R&R capex submission. Therefore, the resilience workstream capex is evaluated within this base R&R capex.
[237] Transpower, Transmission Line Foundations PMP
[238] Transpower, Transmission Line Foundations PMP
[239] Transpower, Transmission Line Foundations PMP

The key investment activities Transpower will undertake are to prevent foundation failure are[240]:

– Refurbish grillage foundations with concrete over grillage, based on the condition of the connection, considering structure type and criticality. Carry out concrete over grillage when the grillage is at CA40 for all structures except low to medium level criticality suspension structures, where the intervention point shall be CA30.
– Cathodic protection (CP) (at CA50) as the primary intervention for foundations where the structure is to be dismantled, divested or replaced. Intervention by CP is dependent on soil resistivity, proximity to substations and buried services at each site.
– Non-Grillage foundations will be monitored and proactively managed based on risk, with the concrete to steel leg interfaces refurbished based on condition prior to the onset of significant rusting (at CA50).

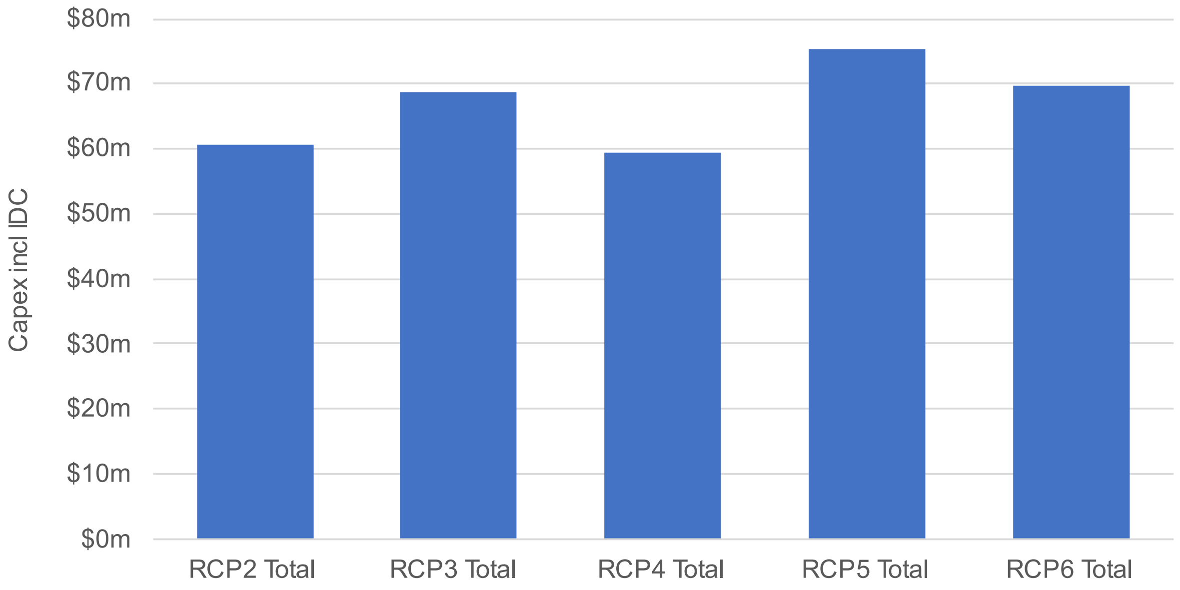
Transpower's strategy to manage existing accessway assets is at least lifecycle cost and develop better knowledge of assets to enable cost-effective management[241]. This includes management of access tracks, bridges, culverts and fords. This strategy allows accessways to degrade until Transpower are unable to access structures at all, or an upgrade is required for project requirements.

This approach is not being taken on all access routes, especially major access routes such as those through the Rainbow, Molesworth and St James Stations.[242]

9.3.13.2 Expenditure profile

Transpower is proposing to maintain a fairly stable expenditure for transmission line grillage and foundations from RCP3 to RCP6 whilst accessway expenditure is expected to grow, although from a low base as shown in the following figures.

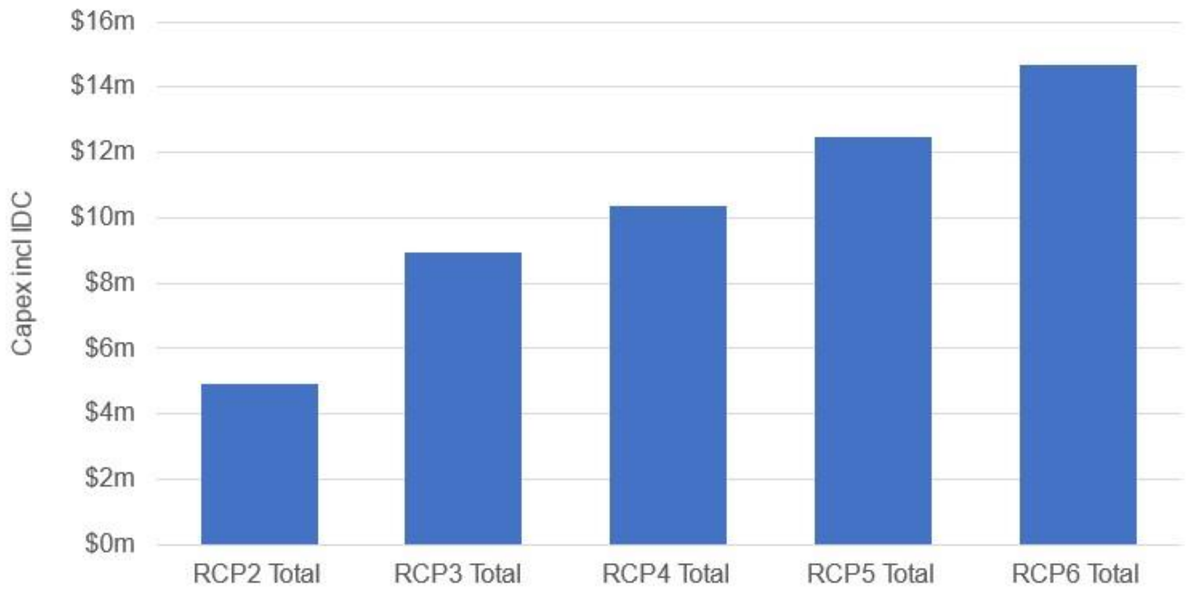
Figure 9-38 Transmission line grillage and foundations base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

[240] Transpower, Transmission Line Foundations PMP
[241] Transpower, Transmission Line Accessways PMP
[242] Transpower, Transmission Line Accessways PMP

Figure 9-39 Transmission line accessways base R&R capex long term profile



Source: RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Transpower is proposing to increase both the expenditure and the quantity of assets replaced or refurbished.

Table 9-43 Transmission line foundations and accessways base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Transmission line foundations	$68.7m	$59.58m	-13%
Transmission line accessways	$8.9m	$10.3m	16%

Source: Transpower, RT01 expenditure schedule

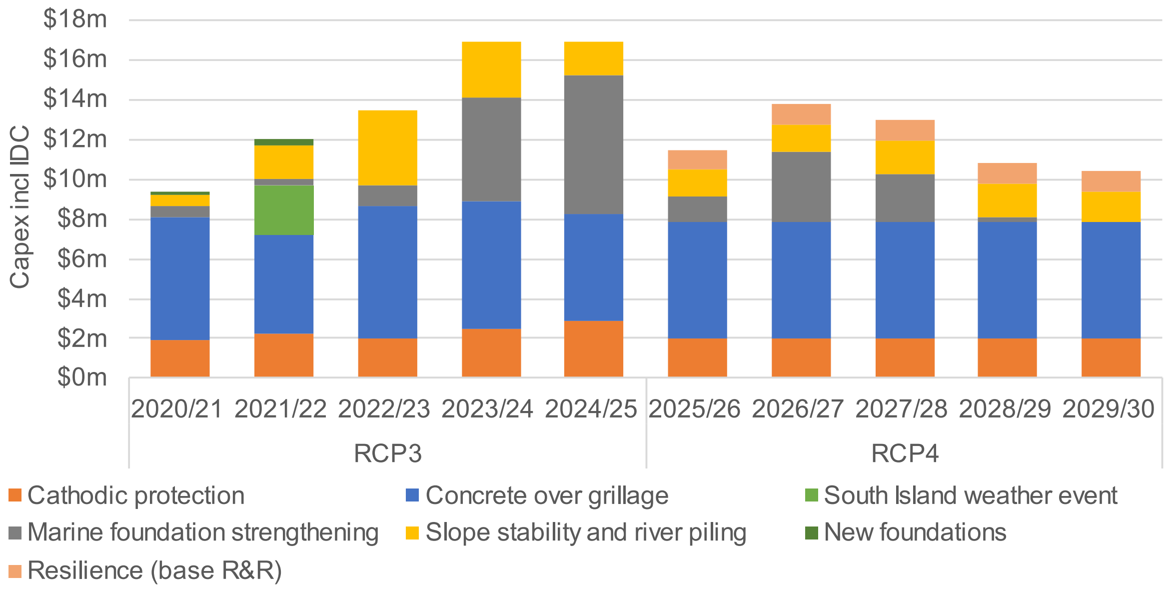
The yearly proposed expenditure and quantities for RCP3 to RCP4 is shown in the figures below. The key trends are:

– Fairly uniform forecast cathodic protection and concrete over grillage interventions across the RCP3 and RCP4.
– Very few new foundations to be constructed.
– Ongoing but decreasing quantities of slope stability and river piling foundation works.
– Some marine foundation replacements across RCP3 and RCP4.
– Resilience expenditure in RCP4 of $17.4m (consisting of $5.1m of land stability work for towers and poles capex intervention being proposed as base R&R programme and $12.3m of flood hardening of critical and vulnerable HVAC towers in braided rivers being proposed using UIOLI uncertainty mechanism)[243].

The annual base R&R capex profile for the grillage and foundation asset portfolio in the stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

[243] Transpower, Transmission Line Foundations PMP, Resilience 2022 PMP

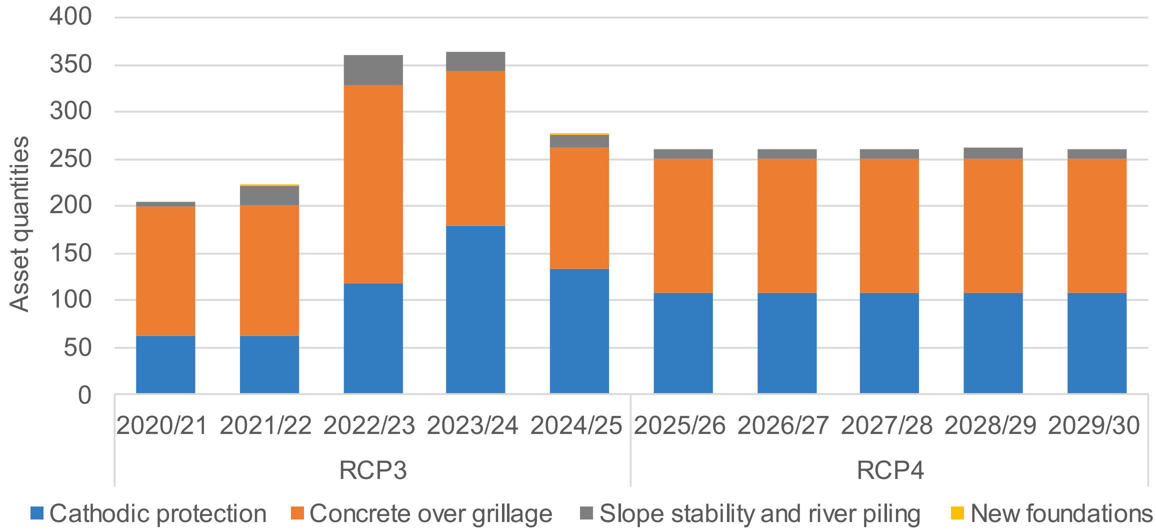
Figure 9-40 Transmission line grillage and foundations base R&R capex profile in RCP3 and RCP4



Source: RT01 expenditure schedule, Resilience 2022 PMP, TL Grillage 2022 PMP, TL Foundation 2022 PMP, GHD analysis

Similarly, the forecast quantity profile of this asset portfolio is shown in the following figure.

Figure 9-41 Transmission line grillage and foundations R&R quantity profile in RCP3 and RCP3

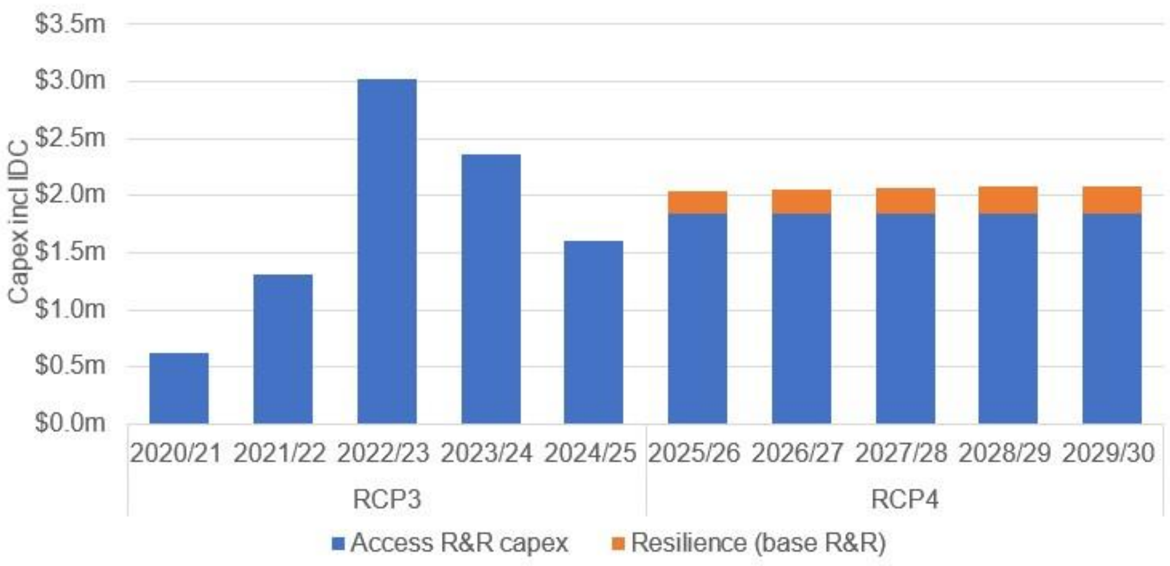


Source: TL Grillage 2022 PMP, TL Foundation 2022 PMP

Compared with other transmission line asset portfolios Transpower is not required to ramp as significantly the volume of foundation interventions for the remainder of RCP3 and into RCP4. For non-grillage foundations the focus has been on works associated with the South Island weather event, slope stability and nine major marine foundation life extension repairs.

The annual base R&R capex profile for the accessway asset portfolio in the stacked columns are shown for the present RCP3 and proposed RCP4 in the following figure.

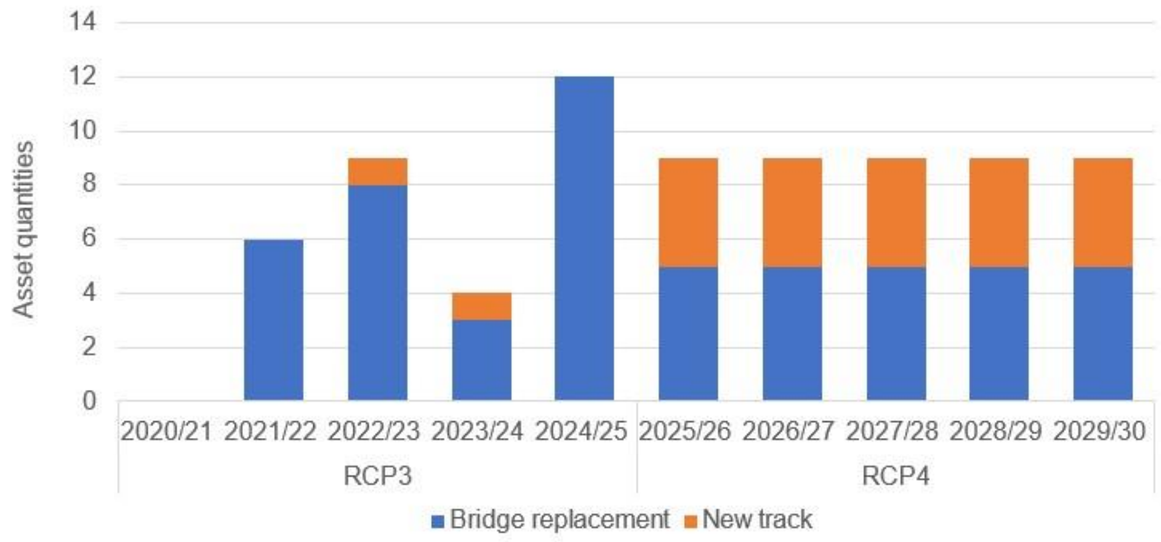
Figure 9-42 Transmission line accessway base R&R capex profile in RCP3 and RCP4



Source: TL Access 2022 PMP, Resilience 2022 PMP, RT01 expenditure schedule, GHD analysis

Similarly, the forecast quantity profile of this asset portfolio is shown in the following figure.

Figure 9-43 Transmission line accessway R&R quantity profile in RCP3 and RCP3



Source: TL Access 2022 PMP

Compared to other transmission line asset portfolios the investment in transmission line accessways is relatively small with the ramp in expenditure mainly in opex rather than capex.

9.3.13.3 Asset planning approach

Transpower's ACSs and PMPs for these asset portfolios are influenced by and align with the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. These documents describe the challenges, objectives and approaches for managing these assets.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies, the need for investigation and intervention priorities. Based on these they guide Transpower's R&R approach in managing these asset classes.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACSs and PMPs. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

Foundation asset health information is used in combination with asset criticality data to determine needs and associated need dates. This is primarily the function of the asset health models. The October 2022 Expert Opinion Progress Review report on Transpower AHNR modelling by GHD indicates the following maturity status with respect to grillage and foundations:

– Asset health modelling meets GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
– Impact modelling meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.
– Network risk modelling meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

There is no asset health model for transmission line accessways given the much smaller nature of the expenditure required, the variability of the asset and that the consequence of “asset failure” is less significant than for other asset classes. Asset health and remaining life for water crossings are based on general inspections from Chartered Professional Engineer’s (CPEng) with bridge expertise which is considered reasonable.

The October 2022 Expert Opinion Progress Review report also states that Transpower is mature and capable in using these models and understanding their network risk. Therefore, the use of these models is considered reasonable as basis for the development of its based R&R capex.

Transpower has identified synergies between these asset portfolios and the other transmission line portfolios which allows alignment of R&R activities where opportunities exist.

9.3.13.4 RCP4 capex drivers and solutions

The foundation investment need is based on primarily based on asset health. Timely refurbishment of grillages is required to avoid deteriorating to a point where higher cost tower propping and major steel replacement is required. Other key drivers are replacing poor condition foundations, undertaking waterway protection work on foundations in or adjacent to riverbeds, and remediating slope stability issues.

concrete over grillage and cathodic protection are now the preferred grillage intervention options. Where an asset is forecast to remain in perpetuity, Transpower will consider concrete over grillage as the preferred option, with cathodic protection as an alternative where concrete over grillage cannot be delivered in a cost-effective manner[244].

For grillage foundations the forecast asset health aligns with the strategy of intervening prior to major steel deterioration but with slight differentiation by asset criticality. Grillage assets beyond intervention in ‘Very Poor’ and ‘Poor’ will be reduced at the end of RCP4, with a small increase in assets approaching intervention in ‘Fair’ condition[245].

The asset health profile for non-grillage concrete foundations is overall very good given the age profile and the normal expected life for most foundation types is 120 years[246]. A small portion of assets will require interventions such as strengthening and refurbishment of buried foundation structures.

Foundation connection components (or foundation interfaces) are a small part of the overall foundation and tower structure, but their failure has the potential to result in a structure collapse, with significant implications for safety and network performance. This intervention point is at the point of steel corrosion and well before any loss of steel cross-section.

[244] Transpower, Transmission Line Foundations PMP
[245] Transpower, Transmission Line Foundations PMP
[246] Transpower, Transmission Line Foundations PMP

In RCP4 Transpower is proposing the following R&R activities for foundations[247]:

– Similar level of grillage foundations to RCP4 (approximately 250 per annum)
– Slope stability ($0.5m per annum) and river piling (6 per annum) at a forecast rate based on historical need
– HVAC resilience work programme for towers in braided rivers and hardening towers and poles for ground stability threats.
– HVDC tower resilience works to wind and floods in rivers.

Transpower's strategy is to manage existing accessway assets at least lifecycle cost and develop better knowledge of these assets to enable cost-effective management. This includes management of access tracks, bridges, culverts and fords.

The main objectives for accessways relate to ensuring that safety and accessibility targets, which help Transpower maintain and operate the grid, are achieved at least lifecycle cost. To achieve these, the key objectives are:

– Safety performance: Reduced public safety risk by Accessway issues.
– Manage existing accessway assets at least lifecycle cost and develop better knowledge of assets to enable cost-effective management. This includes management of access tracks, bridges, culverts, and fords.

9.3.13.5 Evaluation

To assess whether Transpower's proposed base R&R capex for these asset portfolios was prudent and efficient, we followed the evaluation criteria and methodologies described in section 8.2. for non-identified programmes. This involved reviewing asset management and strategy documentation and interviewing relevant Transpower management team members. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

These base R&R capex areas are largely volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across these asset classes. The level of review was less substantial than for other transmission line asset classes because the level of expenditure was less and they are not identified programmes.

The transmission line foundations asset class has well defined drivers and investment need. Timely refurbishment of grillages is required to avoid deteriorating to a point where higher cost tower propping and major steel replacement is required. Other key drivers are replacing poor condition foundations, undertaking waterway protection work on foundations in or adjacent to riverbeds, and remediating slope stability issues. The asset health model which forecasts expenditure is mature and appropriate for this asset class.

Foundation and grillage refurbishment is categorised as volumetric works for estimation purposes, as they are reasonably repetitive with largely similar scope. The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in. The RCP4 proposal for this asset class is considered reasonable.

Transmission line accessways capex is driven by the expected future transmission lines projects and which require suitable accessways in time for the commencement of transmission line projects and the ability to access transmission lines for maintenance and emergency response. Access replacements are volumetric with TEES building block rates used to forecast budgets. Actual delivery rates per project vary from the TEES building blocks depending on the scope and location of the work. Given the nature of the asset class and the level of expenditure it is considered reasonable that there is no asset health model and that upgrade works are determined by SME based on condition reports. The RCP4 proposal for this asset class is considered reasonable.

[247] Transpower, Transmission Line Foundations PMP

9.3.13.6 Conclusion

We conclude that the proposed base R&R capex for the transmission line grillage and foundations asset portfolio totalling $59.5m and the transmission line accessways asset portfolio totalling $10.3m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this non-**identified programme** against the evaluation criteria.

Table 9-44 Transmission line grillage, foundations and accessways base R&R base capex evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier: (GEIP) reflecting appropriate planning and performance standards	Yes	The proposed program of works meets the investment needs (e.g., the reason for the expenditure). Review of changes and reasons for the proposed quantities and how they compare to RCP3. The PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure. These strategies are considered at GEIP
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	We reviewed the investment needs and key drivers and then the effectiveness of asset health and the inspection program to assess condition as a driver for forecasting expenditure. The method and information used to develop them is considered appropriate.
	(ii) how they were applied;	Yes	We examined how the key assumptions have been applied in developed the proposed base capex proposals. The PMPs outlined logical decision-making processes which is considered reasonable and cost effective.
	(iii) their effect on the proposed base capex	Yes	The assumptions are used to develop these capes programmes as outlined in the sub-sections above.
A1(g)	Reasonableness and adequacy of any models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	We reviewed Transpower's model for expenditure build-up of these asset class which was based on a volumetric cost build-using the TEES building block rates. The cost estimate allowed for the volumetric expenditure is considered reasonable. The cost estimate used the build-up for the PMP forecast expenditure based on the scope, cost elements, delivery constraints is considered reasonable.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	We reviewed Transpower's methods for forecast checking which consisted of trend analysis is conducted to compare the levels to RCP3 as well as network risk modelling (for foundations) for the level of expenditure. The trend analysis (and explanations for changes in expenditure) and network risk modelling tools and the underlying data, assumptions, and their development and use for nominated quantities in RCP4 is reasonable and demonstrated a risk-based approach in most instances.

9.3.14 HVDC

The following table summarises our verification of the HVDC capex which is categorised as **an identified programme** and forms part of the base R&R capex for RCP4.

Table 9-45 Verification summary of HVDC base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$78.1m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $78.1m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

9.3.14.1 Asset portfolio and strategy overview

The two HVDC systems connect the North and South Islands of New Zealand to enable energy transfer between the islands, providing network support and connectivity to the national electricity market. These links provide North Island consumers with access to South Island hydro generation and South Island consumers access to North Island thermal generation. This link a critical asset within the Transpower network, and its importance cannot be overstated.

The key components of the HVDC systems considered are:

- HVDC converter stations at Haywards and Benmore,
- converter transformers,
- cable stations located at Fighting Bay and Oteranga Bay,
- subsea Cook Strait cables (38km per cable),
- electrode stations, sea and land electrodes,
- power electronics,
- communication systems connecting the HVDC system to control centres,
- harmonic filters.

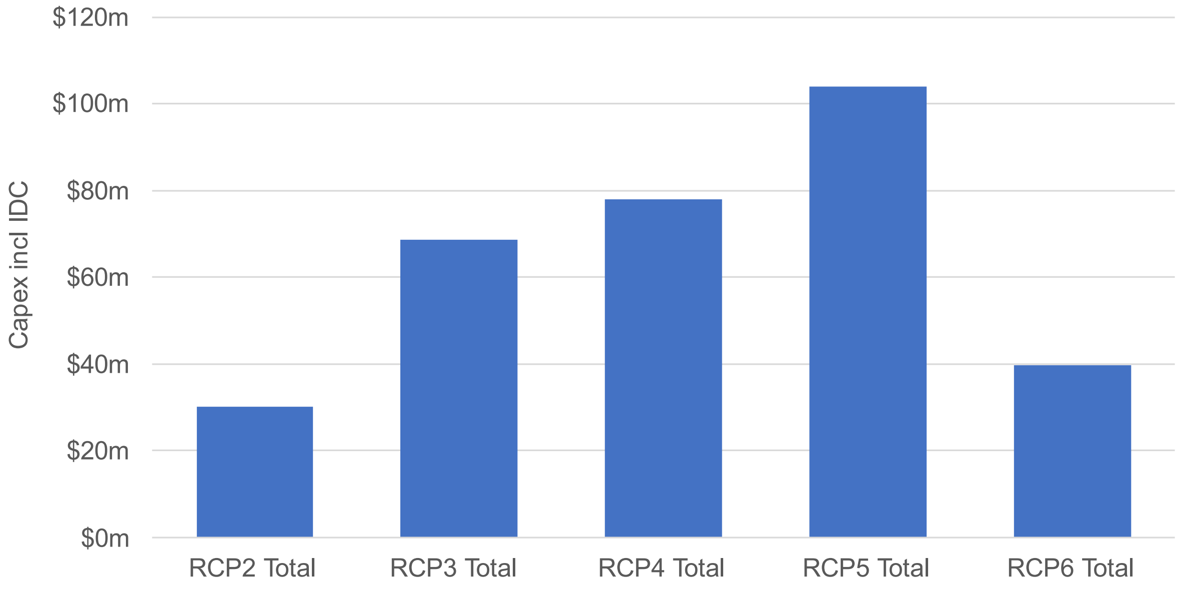
The overhead HVDC transmission line is assessed within the overhead transmission line asset portfolio.

The HVDC Assets 2022 PMP provides the latest view of the state of two HVDC systems (Poles). The two systems (Poles) were installed in different periods. Pole 2 and associated AC assets (commissioned in 1992), and Pole 3 and associated AC assets (commissioned in 2013). Pole 2 is 30 years old, now requiring the usual expected major mid-life refurbishment. Pole 3 is 10 years old and is not driving any significant or unexpected expenditure.

9.3.14.2 Expenditure profile

The figure below shows the longer term base R&R capex profile of the HVDC asset portfolio including historical and forecasted expenditures.

Figure 9-44 HVDC base R&R capex long term profile



Source: Transpower, RT01 expenditure schedule

The forecast expenditure for RCP4, presented in the RCP3 IV report[248], indicated expenditure for RCP4 would drop to below $20.0m (2017/18 value). The current forecast for RCP4 is $78.1m. Also, under RCP3, Transpower started its mid-life refurbishment of key components on Pole 2.

Based on this, our interpretation is that at the time of the previous RCP submission, it was expected that virtually all of Pole 2's mid-life refurbishment would be completed during RCP3. Approximately 50% of the work and expenditure on Pole 2 will now be carried out in RCP4. This assessment of pervious planning/ forecasts of Transpower's HVDC work plan is valuable, as it provides a view on the level of confidence that can be placed on the forecast and delivery of the RCP4 work plan.

Table 9-46 HVDC base R&R capex for RCP3 and RCP4

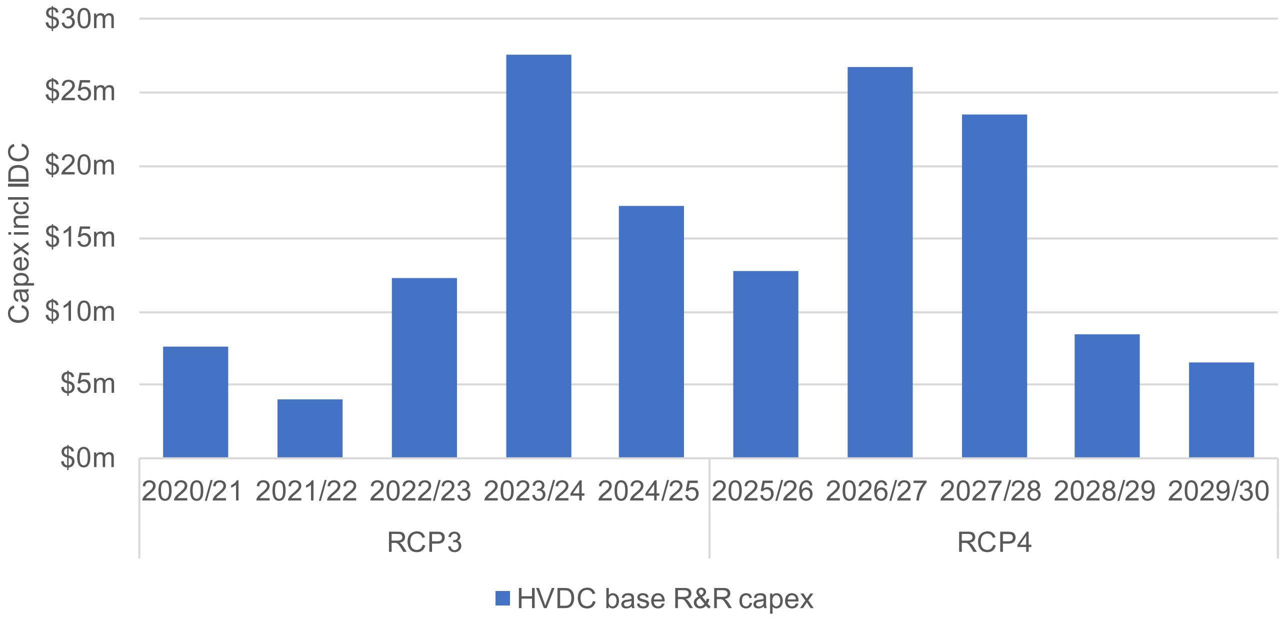
Asset portfolio	RCP3 total	RCP4 total	Change
HVDC	$68.6m	$78.1m	14%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio is shown for the present RCP3 and proposed RCP4 in the following figure.

[248] Source: Independent Verification Report - Transpower's RCP3 Expenditure Proposal (2020-25)

Figure 9-45 HVDC base R&R capex profile



Source: RT01 expenditure schedule.

It is recognised that the refurbishment of HVDC systems is complex. Also, new information would have become evident since the RCP3 submission. It is therefore understandable that some variation, to the view presented five years ago, will occur as new asset condition information becomes available.

However, the current RCP4 forecast is a significant increase. As a result, the mid-life refurbishment of Pole 2 will continue into RCP4, with ~48% of expenditure to be on Pole 2, ~39% on common assets (mostly Pole 2 era), and the remainder ~13% on Pole 3.

In the first two years of RCP3 Transpower has spent $14.0m on both reactive and HVDC assets. However, $16.4m worth of planned work for RCP3 has so far been deferred on HVDC. Over $15.0m of this is due to assets being identified in better condition than expected. This is an example of how Transpower has been able to use its asset management systems to defer capex based on updated or more accurate asset condition information.

In discussions, Transpower noted that HVDC work planned for RCP3 delivery is progressing well with the first stage of the converter transformer refurbishment programme commissioned in March 2023. This is the largest programme of work, and the remainder of the projects are coordinated around this programme. Majority of the other larger components such as HVDC and AC primary asset replacements were indicated on be track for RCP3 commissioning. Assets on order or at late-design stages are on track for on-time delivery during annual planned HVDC outages.

9.3.14.3 Asset planning approach

This asset portfolio population is relatively small, highly diverse and highly technical. With different asset conditions, redundancy levels, and expected live spans. HVDC systems are bespoke installations, with key components typically supported by the two or three OEMs who designed, supplied, and built these systems. Requiring access to specialist resources, locally and internationally. This makes finding alternative suppliers challenging, which can make it difficult to ensure competitive pricing.

Consequently, determining the cost of key asset replacements cannot often rely on Transpower's building block costs, and bottom-up estimates are usually used. Where possible, historically similar projects appear to be used as a source of comparison for Transpower. However, as Transpower has not carried out a mid-life refurbishment recently, comparisons of relevant historical spend on mid-life refurbishment is not possible.

To manage the supply and cost of key components, Transpower engages with its major OEM suppliers to maintain long term support. It is valuable to note that due to the distance from European OEM suppliers, Transpower may find additional premiums being charged. Nonetheless, Transpower recognizes the importance of maintaining open and constructive relationships with its OEM suppliers to ensure the continued reliability and optimal performance of its HVDC systems.

A major driver for managing integral components of HVDC interconnectors, such as electronics and software, is the issue of obsolescence. OEMs do not support electronics and software for the 40–50-year life of interconnectors. Therefore, mid-life refurbishment costs include replacing or refurbishing of these expensive components.

The GHD Advisory Expert Opinion Progress Review report[249] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

- The asset health modelling for the subsea cable and converter transformers asset classes in this portfolio meets the GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
- The impact modelling for the subsea cable in this portfolio meets the GEIP and aligns with Level 3 maturity that considers internal business impacts, i.e., consequence quantified using a structured/repeatable framework with weighted economic impact for service and all internal business consequence. The impact modelling for the converter transformers in this portfolio does not align with GEIP and aligns with Level 3 maturity that considers internal business impacts, i.e., consequence quantified using a structured/repeatable framework with weighted economic impact for service and all internal business consequence.
- The network risk analysis for the subsea cable and converter transformers asset classes in this portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also stated that any shortcomings identified within the individual asset class models or analysis within each workstream is based on assessment of those elements in isolation without any regard to the entire asset management ecosystem. Otherwise, the Expert Opinion Progress Review did not identify evidence that Transpower is not meeting GEIP when the entire range of asset management practices comprising of various elements, processes, tools and decisions are considered holistically.

9.3.14.4 RCP4 capex drivers and solutions

As indicated above, the older HVDC system, namely Pole 2 (commissioned in 1992) is the major driver for expenditure in RCP4, requiring a mid-life refurbishment. For HVDC systems to perform reliably over their 40-50 year, a mid-life refurbishment is necessary. Remediation is also driven by OEM's recommendations when equipment reach manufacturer's recommended operating/duty limits. Such a programme is essential to ensure the system's continued reliability and optimal performance. This is standard practice for managing an asset life cycle of HVDC systems.

The converter transformers and subsea cables are the two most expensive assets, normally expected to last the forecast 40-50-year life cycle of a HVDC system. Other major assets such as the overhead transmission lines and buildings will also meet this 50-year life cycle, with minor intervention. As noted, the HVDC overhead line is covered within the transmission line asset portfolios.

HVDC mid-life refurbishment normally requires significant components to be upgraded, replaced or refurbished, such as:

- Smoothing reactors,
- Converter transformers,
- Thyristor valves,
- HVDC control and protection,
- Circuit breakers,
- Cooling systems

[249] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

– Auxiliary systems
– Other DC equipment – includes DCCT, VDR, disconnects and breakers and switches, and
– Miscellaneous (e.g., security, fire protection, human machine interface).

Transpower's is refurbishing Pole 2 over RCP3 and RCP4. Transpower confirmed Pole 2's mid-life refurbish programme would to be completed during RCP4. Pole 3 is now 10 years old, with no systematic, material, or inherent issues identified by Transpower. Confirming that only conventional maintenance activities, for a 10-year-old interconnector, will be required for Pole 3 during RCP4.

The breakdown of the total $78.1m in expenditure for the two poles supports the descriptions provided for planned work in RCP4[250], noting:

– Pole 2 makes up ~48% of forecast expenditure (~$37.5m)
– Pole 3 makes up ~13% of forecast expenditure (~$10.2m)
– Common assets (mostly Pole 2 era) make up ~39% of forecast expenditure (~$30.5m).

9.3.14.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

The review looked for alignment between the RCP4 work plan with the HVDC Asset Class Strategy and HVDC Assets 2022 PMP. In addition, we reviewed approximately ~20% of the work plan, that drives ~80% of the forecast $78.1m capex. The evidence provided[251] demonstrated that key assets forecast to be remediated, reason for addressing and examples of quotations. Overall, no material discrepancies were identified between the asset strategies and work plan.

This base R&R capex is not a volumetric program. Each interconnector is bespoke and highly technical system. The asset portfolio PMP describes the state of the major components driving the work plan. In considering the age of the two interconnectors, no material discrepancies were identified in the work proposed for the two individual interconnectors. The list of condition monitoring tests and inspections described in the asset portfolio PMP, also reflects GEIP.

As unique remediation work, specifically on Pole 2, is required, the RCP4 proposed budget was developed using customised cost estimates based on OEM or specialist suppliers' quotes.

This evaluation found that the AHNR modelling maturity reflected what was determined during the 2022 Expert Opinion Progress Review.

Prudency

As indicated above, the major driver for expenditure is the mid-life expansion work on Pole 2, which we concluded is appropriate practice for HVDC interconnectors the age of Pole 2. In addition, the importance of the two interconnectors to the Transpower system, would not support pushing out extending the mid-life extension by a few years for possible financial gain. The condition and remediation of common area equipment, such as secondary and auxiliary assets, described in the asset portfolio PMP, typically reflect degradation levels expected for assets their age.

Efficiency

Due to the unique nature of HVDC interconnectors (bespoke and highly technical systems), the subject matter expertise and spare parts required to maintain the interconnector, are usually provided by a handful of the OEM or a small group of specialist suppliers. This makes the ability to create a competitive environment limited or even impossible. Understandably doing comparisons of unit rates, to assess increases in price, is not possible for this asset portfolio.

[250] Transpower, 20230510 – HVDC and reactive – additional information v1.pdf
[251] Transpower, RFI030 Transpower Response.pdf

Some HVDC operators have been successful in setting up contracts that limit the mark-up of OEMs local agencies. However, we acknowledge that these contracts are not always offered by OEMs.

Key components being remediated as part of the mid-life extension for Pole 2, are regularly long lead items or sub-systems. However, our view is that Transpower has sufficient time to effectively manage these long lead items and should not cause delays to implementation.

Transpower indicated their intent to use opportunities to align planed work, including work on the HVDC overhead lines, to limit the number and duration of outages planned for this asset class.

9.3.14.6 Conclusion

We conclude that the proposed base R&R capex for the HVDC asset portfolio totalling $78.1m satisfies the evaluation criteria and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-47 Indoor switchgear base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	PMP outlines the investment need and key drivers. ACS and PMP are aligned with each other. The plan provides a summary of the asset health.
A3(b)	Policies and planning standards were applied appropriately	Yes	The PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process management of HVDC which includes asset health and condition, condition assessment, determination of asset-specific management strategy and then implement either monitoring, repair or replacement. As intervention timeframes have been forecast within the 5 year RCP4 window. Specific intervene dates need to be determined to optimise risk/cost/performance.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	No documented options papers were presented for the proposed work plan however the PMP does outline the decision process that Transpower undertakes for HVDC investment. Transpower presented options when providing responses to RFI's.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	The key drivers and assumption for this capex programme are OEM recommendations, operating/duty limits, asset condition and obsolescence management.
A3(f)	Capital costing method and formulation, including unit rate sources and the quantum of included contingencies	Yes	The cost estimation approach is a combination of building block costs (minority), but primarily bottom-up estimates. Where possible reference checks were made to previous similar work.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. The PMP decision making process considers the overall lifecycle costs and the relationship between opex and capex.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	Planning and timing around remediation of HVDC overhead line has been considered.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is a primarily done through requesting one-off bespoke quotes from OEM's or specialists. Limited suppliers exist for HVDC assets, limiting competitive comparisons.

9.3.15 Reactive assets

The following table summarises our verification of the reactive assets capex which is categorised as an identified programme and forms part of the base R&R capex for RCP4.

Table 9-48 Verification summary of reactive assets base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$72.5m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $72.5m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

9.3.15.1 Asset portfolio and strategy overview

This asset portfolio comprises of several asset classes, all providing forms of network support /strengthening, depending on the voltage and frequency conditions. These asset classes require different strategies in how they are managed, to ensure they operate as required to safeguard network compliance with regulations and standards.

The risk due to asset failure is distinct for different asset classes, as well as their locations. No locational criticality assessment was carried out in this review, to quantify and prioritise locational risks, required to optimise delivery work. Each asset class was reviewed as a portfolio.

Like most transmission networks worldwide, there is an increasing impact from asynchronous generators connecting to the network. The way in which Transpower’s reactive assets fleet will need to adapt to manage this change would be funded through enhancement and development portfolio where required. Therefore, all expenditure in this asset portfolio is assessed from a replacement and refurbishment perspective.

This asset portfolio consists of the following assets classes:

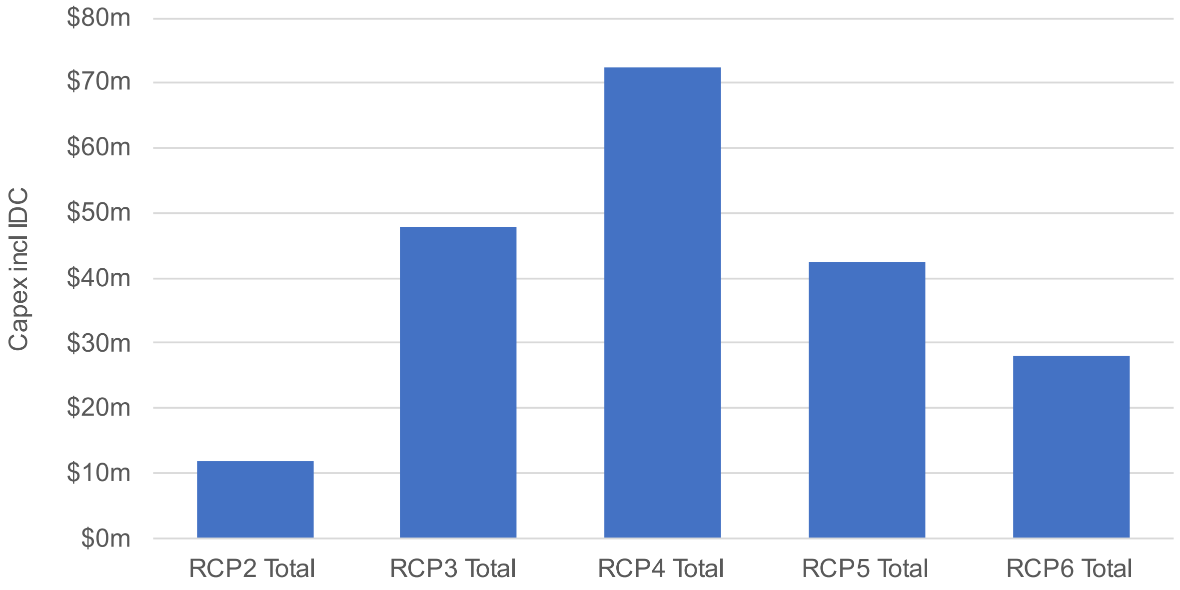
- Capacitor banks
- Reactors
- Synchronous condensers
- Static Var Compensators (SVCs)
- Static Synchronous Compensators (STATCOMs) including those located at the HVDC converter stations.
- Control and protection systems, auxiliary systems, and primary assets directly related to the operation of synchronous condensers, SVCs, and STATCOMs.
- Reactive power controllers associated with the SVCs, capacitors and reactors that are within the scope of this are portfolio are considered.

Excluded from the above are reactive power equipment directly related to the operation of the HVDC systems at Benmore filter banks, Haywards filter banks, Hayward and Benmore DC yard filters, and power line carrier filter components.

9.3.15.2 Expenditure profile

The following figure shows the longer-term base R&R capex profile of reactive assets portfolio including historical and forecast expenditures.

Figure 9-46 ***Reactive assets base R&R capex long term profile***



Source: RT01 expenditure schedule

Transpower is proposing to increase the expenditure and refurbished across all asset classes within this portfolio in RCP4, compared to the present RCP3 expenditure levels. This increase is mostly due to refurbishment of synchronous condenser and SVC. We have evaluated changes to these variables in this sub-section in subsequent paragraphs. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

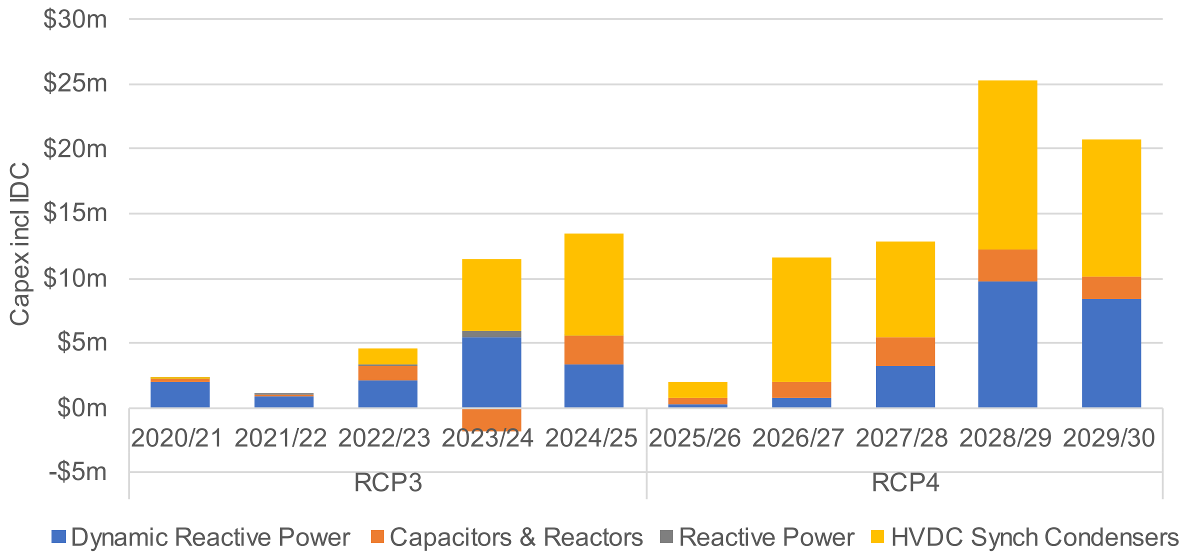
Table 9-49 ***Reactive assets base R&R capex for RCP3 and RCP4***

Asset portfolio	RCP3 total	RCP4 total	Change
Reactive assets	$47.9m	$72.5m	51%

Source: Transpower, RT01 expenditure schedule

The annual base R&R capex profile for this asset portfolio in is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 9-47 ***Reactive assets base R&R capex profile***



Source: RT01 expenditure schedule.

9.3.15.3 Asset planning approach

The PMP for this asset portfolio covers the planning period from RCP3 and through to RCP6. Providing a long-term view of Transpower's current expectations. This asset portfolio specifically excludes reactive power equipment, and controls directly related to the operation of the HVDC system.

Our review of the PMP indicates the information collected and analysed to drive the work plan for RCP4 substantiates the drivers justifying the work plan. These are summarised below.

Due to the relatively small number of assets within this asset portfolio the defect/failure history, quantity, manufacturer, and ages of the assets are well recorded. Maintaining accurate asset information is critical to inform the asset strategies described in the PMP. There is an acknowledgement that better and granular asset information needs to be gathered on capacitors to improve modelling of asset health.

Performance targets and measures exist for capacitor banks, SVC's, STATCOMS and synchronous condensers. We recognise and encourage such measures being in place. As it helps monitor and assess how effectively Transpower manages these assets.

The expected life cycles for SVCs, STATCOMs and their respective control and protection components is captured in the PMP. These life cycles reflect typical industry life cycles expected from these assets. Ignoring local influences such as environmental or utilisation factors. The RCP4 work plan reflects the work needed to achieve the life cycles reflect in the PMP.

The GHD Advisory Expert Opinion Progress Review report[252] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

– The asset health modelling for reactors and capacitors (including filters) in this portfolio were not aligned to GEIP and were aligned with Level 2 maturity that considers condition, i.e., asset health is projected using modifiers based on expert-generated asset class life analysis assessment. The asset health modelling for synchronous condensers in this portfolio meets the GEIP and aligns with Level 3 maturity that considers multi-factor characteristics, i.e., asset health is projected using consistent frameworks and factors across asset classes.
– The impact modelling for reactors in this portfolio was not aligned to GEIP and aligns with Level 1 maturity that considers expert opinion, i.e., consequence is determined in an ad-hoc qualitative way, using the corporate risk matrix as a guide. The impact modelling for capacitors (including filters) in this portfolio meets the GEIP and aligns with Level 1 maturity that considers expert opinion, i.e., consequence is determined in an ad-hoc qualitative way, using the corporate risk matrix as a guide. The impact modelling for synchronous condensers in this portfolio meets the GEIP and aligns with Level 3 maturity that considers internal business impacts, i.e., consequence is quantified using a structured/repeatable framework with weighted economic impact for service and all internal business consequence.
– The network risk analysis for reactors, capacitor (including filters) and synchronous condensers in this portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The Expert Opinion Progress Review report also stated that any shortcomings identified within the individual asset class models or analysis within each workstream is based on assessment of those elements in isolation without any regard to the entire asset management ecosystem. Otherwise, the Expert Opinion Progress Review did not identify evidence that Transpower is not meeting GEIP when the entire range of asset management practices comprising of various elements, processes, tools and decisions are considered holistically.

Major refurbishments on the synchronous condensers' main machines are planned for RCP4 and is supported by the associated health model to ensure that these units remain operational until at least 2042 (the expected life of Pole 2). Our review acknowledges that the detailed scope of these interventions is difficult to fully assess while the synchronous condensers remain in operation. Transpower therefore look to perform intensive scoping investigation during RCP3 to better understand the scope and costs of the refurbishment work. Transpower confirmed sufficient funding has been requested in absence of this certainty.

Risk is a key driver for managing assets within Transpower's asset management framework. Transpower uses Bowties to analyse the most likely causes of asset failure, and the most effective control measures to incorporate

[252] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

into their investment plans. Bowtie assessment have been carried out for capacitor failures, synchronous condenser failures, STATCOM failures and SVC failures.

Obsolescence management is a key driver for managing control and protection assets. The PMP identifies assets that need to be remediated during RCP4 because of obsolescence. Our review does not identify any issues with the general timing needed to address obsolescence, as it reflects typical asset life cycle for such assets.

9.3.15.4 RCP4 capex drivers and solutions

The PMP for this asset portfolio identifies the following as drivers for the investment plan:

- Risk of capacitor can failures on aging and deteriorating capacitor banks.
- Obsolescence and high risk of failure due to aging SVC control systems.
- Availability of spares and lack of manufacturer support for SVCs.
- Minimising the risk of synchronous condenser failures.
- Maintaining high availability of the reactive plant that supports the HVDC.
- Control and auxiliary assets reaching end of life.
- Deferral of asset replacements with life extension of reactive power assets by carrying out timely intervention.

The asset strategies presented[253] support the management of these drivers and are in line with GEIP. Each asset class's generic practices were assessed against the management of each asset class as a whole. Optimal delivery of these strategies will need to consider individual health assessments, failure rates, network locational risks, obsolescence etc to ensure efficient delivery of asset class strategies.

9.3.15.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

Synchronous Condensers

The large increase in expenditure for this asset class is to carry out refurbishments on SC1, SC2, SC7, SC8, SC9, SC10. Major refurbishments were carried out on these synchronous condensers in RCP1, while partial refurbishments were completed on SC3 and SC4 in RCP1.

The full scope of the required remediation work cannot accurately be determined until the synchronous condensers are taken offline and opened for inspection. Inspections are needed on SC7-10, while SC3-4 had internal inspections in 2020, as such information will determine the expected scope. SC1-2 were rewound within the last 20 years and no major refurbishment work is expected in RCP4.

The HVDC listed project seeks to replace one or all the subsea HVDC projects. An option to be considered under this project, is the increase in subsea cable transfer capacity to 1,400MW. The risk of this change on synchronous condenser asset class was discussed in relative detail.

The risk assessed is whether unnecessary major refurbishment of synchronous condenser would be done before the future requirement of the synchronous condenser asset class can be confirmed due to an increase in subsea transfer capacity. Transpower confirmed that should the subsea cable transfer capacity increase to 1,400 MW no additional synchronous condensers would be needed at Hayward.

SVCs & STATCOMs

Refurbishment of SVC3 and SCV7 will be completed during RCP3, while SVC9 is planned to undergo its mid-life refurbishment during RCP4. The cost for SVC3 is expected to be ~$8.0m and SVC7 is expected to be ~$7.0m. The forecast for SVC9 is expected to be ~$12.0m. The mid-life refurbishment of SVCs is standard practice, however optimal timing of such work can be varied depending on performance of each asset. Currently SVC9 is indicated to be in good condition with sufficient spares coverage and manufacturer support.

[253] Transpower, ERR011 FS 31.01 Capacitors and reactors asset class strategy.pdf, ERR012 FS 32.02 Synchronous condensers asset class strategy.pdf, ERR013 FS 45.01 Static var compensators asset class strategy.pdf

STATCOM's are indicated to be relatively new and in good condition and most STATCOMs are presently under OME's warranty. Minor concerns such as air conditioning unit failures and corrosion issues need to be addressed.

The current work plan indicates that the STATCOM's Windows XP-based control system need to be upgraded in RCP4 as it is no longer supported by Microsoft and cybersecurity improvements would be carried out to address this concern. Discussions with Transpower confirmed this work was completed in RCP3, at a cost of $0.6m.

The total forecast budget for the dynamic active power assets in RCP4 is over ~$22.0m. This is similar to the current RCP3 forecast (~$22.0m). Additional information[254] provided on the 15 June 2023 provides evidence of Transpower's summary plan of work, per location, for this asset class.

Capacitors

The current capacitor health model, with its limitations, indicate this asset class is in relatively good health.[255] The PMP for this asset class indicates the capacitor fleet consist of 5,274 individual cans.

The first two-years of actual expenditure in RCP3 has been $0.3m indicating a low replacement rate of failed or problematic assets. The last two years of RCP3 forecasts an expenditure is $5.5m, a large increase. Additional information[256] provided on the 15 June 2023 provides evidence of Transpower's plan of work, per location, in RCP3 and RCP4. It indicates phasing for the bulk expenditure in RCP3 to occur in the later part of the cycle.

The forecast expenditure for RCP4 is of similar magnitude to the capex in RCP3.

Reactors

The current reactor health model, with its limitations, indicate this asset class is in relatively good health.[257] The PMP of this asset class indicates the reactor fleet consist of 378 individual reactors. Most appear to have minor issues such as paint damage.

Prudency

We analysed and further breakdown the four asset classes in this asset portfolio and enquired the reasons for any step change in quantities noticed between RCP3 and RCP4. We reviewed the investment drivers as identified in the previous sub-section to be reasonable in informing the proposed base R&R capex for RCP4. We found them to be risk-based drivers informing the development of prudent quantity of R&R activity.

We reviewed the supporting data for a sample of individual equipment, assumptions, and the use of the asset health, with its limitations, for identifying and prioritising proposed work for reactors and capacitors. We consider them to be reasonable as it demonstrates a risk-based approach.

Most expenditure in RCP4 is driven by the refurbishment of synchronous condensers and dynamic reactive power. The age profiles of these specific assets and the RCP4 planned remediations are considered comparable to industry practices. We understand that while the age is not the absolute determinant for replacement, it can provide an indication or proxy for asset conditions and hence the AHI score or the probability of failure. On this assessment, we consider that Transpower's proposed work plan to be prudent.

No Investigation Business Case (IBC) or Delivery Business Case were presented for these assets for review. The expectation is these will be produced, for business approval, closer to delivery timeframe.

In the absence of business cases, evidence of options analysis was provided. [258] Though the options analysis presented was at a high level, it provided sufficient evidence for us to support the proposed work plan.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

We consider the effect of the proposed base R&R capex on other asset portfolios and other cost categories, including opex is mapped and understood. This effect can be on the timing and/or the quantum of the cost.

[254] Transpower, 20230615 - HVDC and reactive - additional information first and second session .pdf
[255] Transpower, ERR030 SA Reactive Power Assets 2022 PMP.pdf
[256] Transpower, 20230615 - HVDC and reactive - additional information first and second session .pdf
[257] Transpower, ERR030 SA Reactive Power Assets 2022 PMP.pdf
[258] Transpower, RFI041-01 Evidence for work plan.xlsx

Efficiency

Our assessment confirms that due to the unique nature of reactive assets portfolio, the use of building blocks for cost estimation is not possible. Most of the estimates rely on customised quotations. We did observe that historical cost estimates are used were possible, such as reactors and capacitors.

The uniqueness of large reactive assets project requires individual cost estimates with inputs from specialist suppliers. Larger projects would also generally require design work, which we understand is often undertaken externally. Refurbishment and other minor projects have a relatively small design component, which is primarily carried out by Transpower engineers or service providers, as part of the delivery phase. We agree it is typical for major projects within this portfolio to be design-build contracts which are often delivered by major (overseas) vendors. Were possible the use of TESS building blocks in the cost estimation was evident. This is typical for capacitors or 'smaller' components relating to synchronous condensers refurbishment.

We reviewed the cost estimate process and cost from quotations were provided. A detailed review of each refurbishment projects scope was out of this review's terms. Neither did we seek to test pricing with alternative suppliers. We therefore cannot comment on the cost competitiveness of individual quotations and quoted prices were taken on face value. We have noted Transpower's standard tendering and negotiation process that is designed to achieve cost efficient procurement outcomes.

9.3.15.6 Conclusion

We conclude that the proposed base R&R capex for the reactive assets portfolio totalling $72.5m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-50 Reactive assets base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	PMP outlines the investment need and key drivers. ACS and PMP are aligned with each other. The plan provides a summary of the asset health.
A3(b)	Policies and planning standards were applied appropriately	Yes	The PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process management of Reactive Assets which includes asset health and condition, condition assessment, determination of asset-specific management strategy and then implement either monitoring, repair or replacement.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	No documented options papers were presented for the proposed work plan. However, Transpower presented options when providing responses to RFI's[259]. The PMP outlines the decision-making process which includes option assessment.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	The key drivers and assumption for this capex programme are OEM recommendations, asset condition and obsolescence management.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	The procurement approach is a combination of building block costs and bottom-up estimates. Were possible reference checks were made to similar previous work.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. The PMP decision making process considers the overall

[259] Transpower, 20230510 - HVDC and reactive - additional information v1.pdf, 20230510 - HVDC and reactive - additional information v2.pdf, 20230510 - HVDC and reactive - additional information v3.pdf, 20230510 - HVDC and reactive - additional information.pdf

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
			lifecycle costs and the relationship between opex and capex.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	Potential impact of HVDC listed project was reviewed. Confirmation was provided that unnecessary remediation of current synchronous condensers would not occur if the HDVC listed project were to proceed.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is a combination of building block costs and bottom-up estimates. Were possible Reference checks were made to previous similar work.

Note: A3(h) is not applicable to base capex

9.3.16 Secondary assets

The following table summarises our verification of the secondary assets capex which is categorised as an identified programme and forms part of the base R&R capex for RCP4.

Table 9-51 Verification summary of secondary assets base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$227.6m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes.
IV conclusion	Accept: $227.6m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

9.3.16.1 Asset portfolio and strategy overview

The scope of this asset portfolio encompasses secondary assets including protection equipment, DC systems and revenue meters. Substation management systems are excluded from this asset portfolio and are reviewed in the sub-sequent sub-section. The assets in this portfolio are[260]:

- Protection schemes.
- Outdoor junction boxes and the secondary wiring.
- Feeder protection.
- Line protection for clearing faults on transmission lines.
- Bus zone protection
- Other types of protection include transformer, capacitor, and reactor protection.
- Special protection schemes that are required to control the stability of the transmission system
- Station DC systems required to provide power to protection schemes
- Revenue meters to record electricity usage for wholesale market reconciliation and billing.

Transpower's asset strategy and RCP4 expenditure forecasts for secondary assets are detailed in ERR029 SA Protection and Revenue Metering 2022 PMP, the ERR031 SA Station DC Systems 2022 PMP, and the corresponding Protection, Metering, and Protection DC Supplies asset class strategies (ACSs).

The Protection ASC documents a summary update and the challenges, objectives, asset statistics, operational knowledge, asset management strategy and planning, asset management decision making, asset information,

[260] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP.

organization and people, risk and review and lifecycle delivery providing a detailed approach to manage this asset portfolio.

The PMPs provides the latest available snapshot of the state of this asset group, describes the planning approach and recent and proposed operational activities. It also provides the RCP4 base capex forecast and associated quantities for R&R activities. This asset portfolio does not include resilience capex for R&R activities.

The annual trend of the base R&R capex for this asset portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule dated February 2023.

Transpower's objective for protection, revenue metering and DC systems is that they operate reliably and meet their operational needs, at least life cycle cost. Transpower's primary strategy is to replace assets based on age and where either the increased probability of failure, or technical obsolescence, poses an unacceptable operational risk.

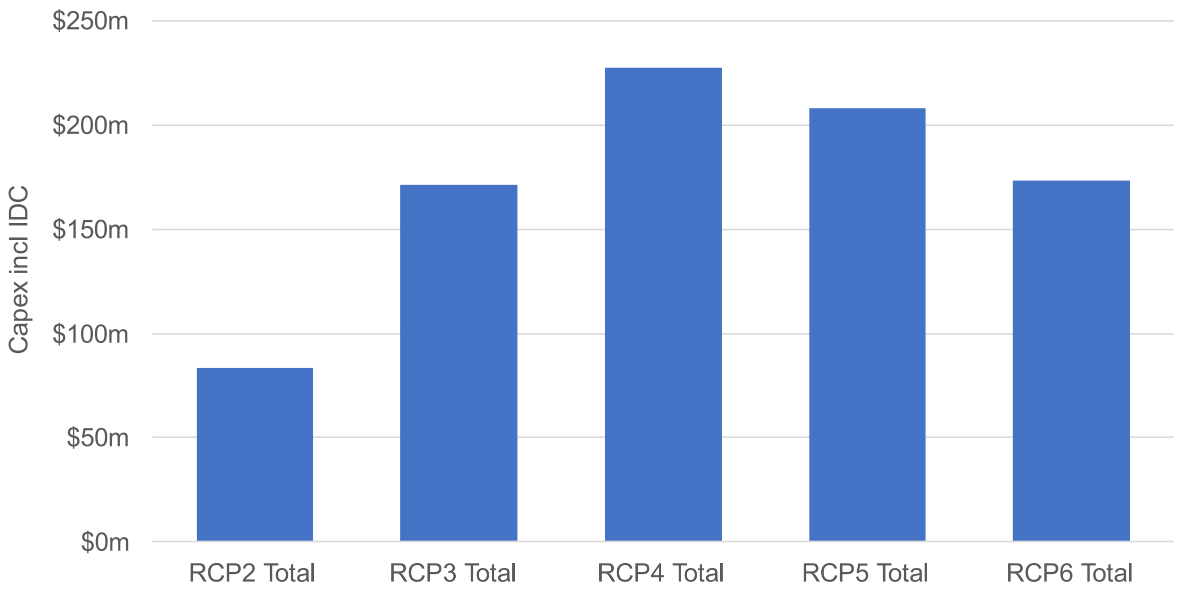
The key investment activities and strategies Transpower will undertake are[261]:

- Replace station batteries based on condition subject to expected life of 8 years for existing and 12 for new.
- Ensure new DC supplies meet future requirements, including sizing batteries for new carryover requirements.
- Replace relays on obsolescence or endemic failure: Replace relays based on unavailability of spares, or where a model shows signs of endemic failure, subject to a maximum life expectancy of 20-35 years.
- Replace outdoor junction boxes based on an estimated life expectancy of 40 to 50 years then refine the plan based on condition, closer to the time of replacement.
- Replace meters based on age.

9.3.16.2 Expenditure profile

Transpower is proposing to increase secondary assets R&R expenditure from $171.6m in RCP3, to $227.6m in RCP4, before reduction to $208.2m in RCP5 and further reductions in RCP6.

Figure 9-48 Secondary system assets base R&R capex long term profile



Source: Transpower, RT01 expenditure schedule

[261] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP.

The following table shows the change in proposed expenditure levels from RCP3 to RCP4 in expenditure levels.

Table 9-52 Secondary assets base R&R capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Secondary assets	$171.6m	$227.6m	33%

Source: Transpower, RT01 expenditure schedule, GHD analysis

Most of the protection works are protection schemes coming to the end of expected life and require replacement before failure rates increase. There is the need to bring protection schemes up to standard, including the need to meet the Benchmark Agreement fault clearance times. Transpower is aiming to complete this work by the end of RCP4. Other protection upgrades include replacement of old bus blocking schemes, legacy arc flash schemes, bus zone (BZ) protection and cabling, and the upgrade of line protection schemes.

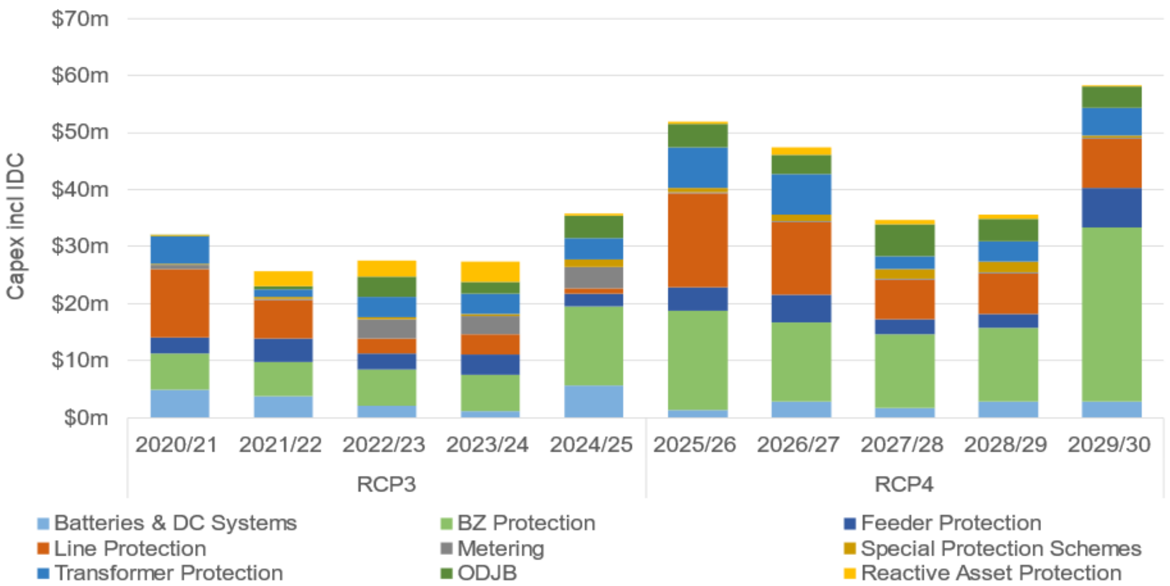
There are approximately 116 outdoor junction boxes to be replaced in RCP3[262]. Condition information on many units were captured from inspections instigated during RCP2. The outdoor junction boxes will be replaced as part of other programs of works. In RCP4 approximately 298 outdoor junction boxes will need to be replaced at a cost of $15.8m[263].

In RCP3, the forecasted expenditure is $23.1m for the station DC portfolio[264]. Transpower is forecasting an RCP4 spend of $11.8m. There are approximately 150 batteries and chargers being replaced in this period and this is driven by these assets coming to the end of their expected life.

A full replacement of all main revenue meters was completed in RCP1, so they are now all the same type and configuration. The revenue metering fleet is currently being replaced in RCP3. Metering replacements will significantly decrease in RCP4 with a reduction in expenditure in RCP4 to $0.9m compared to RCP3 of $13.5m. The next lifecycle replacement for these meters is expected again in late RCP5 and early RCP6[265].

The following figure shows a breakdown of expenditure by asset classes.

Figure 9-49 Secondary system assets base R&R capex profile for RCP3 and RCP4

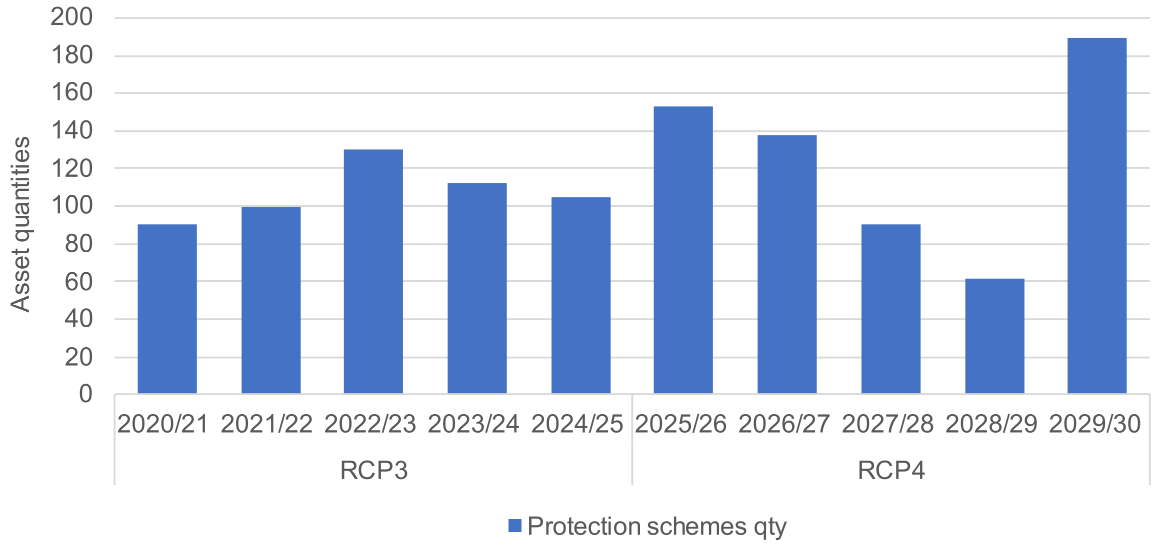


Source: Transpower, ERR029 SA Protection and Revenue Metering 2022 PMP, SA Station DC Systems PMP, RT01 expenditure schedule, GHD analysis

Similarly, the forecast quantity profile of this asset portfolio is shown in the following figure.

[262] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP
[263] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP
[264] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP
[265] Transpower, SA Protection and Revenue Metering PMP, SA Station DC Systems PMP

Figure 9-50 Secondary system assets base R&R quantity profile for RCP3 and RCP4



Source: Transpower, ERR029 SA Protection and Revenue Metering 2022 PMP, SA Station DC Systems PMP, GHD analysis

The volume of replacement works fluctuates across RCPs and this variability provides the opportunity to stagger asset replacements more evenly across the RCPs. RCP4 total protection asset quantities per year vary from 153 in 2025/26, down to 62 in 2028/29, then up to 189 in 2029/30.

9.3.16.3 Asset planning approach

Secondary assets have several ACSs and PMPs. The ACSs and PMPs for this asset portfolio are developed based on the requirements of the Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. These documents describe the challenges, objectives and approaches to managing Transpower's insulators programme.

Transpower identify constraints such as asset condition and performance data, deliverability, risk, optimisation between portfolios, and other influencing factors. They also identify opportunities such as the use of new technologies, better asset makes and models, need for investigation and intervention priorities. Based on these they guide Transpower's R&R approach in managing this asset class.

The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

The investment need for this asset portfolio is based on risk and maintaining service performance. This need is informed by asset health scores that incorporate asset condition and consequences of asset failure or non-performance to estimate the monetised risk value. Many of the secondary assets are electronic devices where asset condition is not able to be monitored visually, so they must be replaced based on forecasted reliable working life, failure rates, and/or system requirements such as to meet expected fault clearance times.

Transpower's AHNR modelling provides Transpower with an input to its R&R investment decision making. The October 2022 Expert Opinion Progress Review report on Transpower AHNR modelling by GHD indicates the following maturity status for secondary assets:

– The asset health modelling meets GEIP and aligns with Level 3 maturity for protection relays (multi-factor characteristics) and Level 2 for batteries and chargers and revenue meters (condition based).
– The impact modelling meets GEIP and aligns with Level 4 maturity for protection relays (holistic impacts), Level 2 for batteries and chargers (cost to replace) and Level 1 for revenue meters (expert opinion).
– The network risk analysis for this asset portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

The October 2022 Expert Opinion Progress Review report also commented that Transpower is mature and capable in using their above models and in understanding network risk to inform and support its base R&R capex RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset class.

Transpower has identified synergies between this asset portfolio and other asset portfolios such as substation primary plant asset classes in terms of substation asset replacement projects.

9.3.16.4 RCP4 capex drivers and solutions

Transpower's overall strategy for secondary assets, especially protection assets, is to replace relays on obsolescence or endemic failure, replace relays based on unavailability of spares or where a model shows signs of endemic failure, subject to a maximum life expectancy of 20-25 years[266]. This approach has determined the input values for RCP4.

A key point that impacts on the investment forecast for this portfolio is that generally these assets cannot be maintained or inspected. Any intervention is typically the replacement of the asset or the scheme at the end of its life. Because of the criticality of protection relays and DC battery systems, these replacements are likely to be conservative as the risk of allowing the assets to enter into periods of high rates of failure is not tolerable. An issue generally internationally with a replacement of age strategy is that failure rate data on ageing protection relays is limited and this makes determining an asset health model difficult.

In RCP4 Transpower is proposing the following R&R activities for this asset portfolio[267].

Protection

- Replace protection schemes, outdoor junction boxes and metering assets at end of their expected life.
- Bring protection schemes up to standard to meet the Benchmark Agreement fault clearance times.
- Increase reliability and resilience to the grid by:
  - Enabling or enhancing auto-reclose functionality on circuits.
  - Voltage transformer selection scheme installations and modifications.
- An increase in the number of bus zone installations on distribution buses due to the need to replace the old fast bus blocking schemes, when feeder protection comes due for replacement.
- Secondary cabling costs allocated based on the number of protection schemes being installed and as a percentage of protection schemes being replaced. Lessons learnt from RCP3 have shown that secondary cabling costs especially between the relay room and outdoor junction boxes have not been allowed for in protection installation works and protection replacement works (where new secondary cabling is required).
- Upgrade of line protection schemes on circuits with old protection signalling equipment (PSE) have been allowed for as part of line protection replacements.

Station DC systems

- A lower number of station batteries and chargers being replaced in RCP4 as compared to RCP3 due to the black start capability program that ran in RCP3.

Revenue, local service, and power quality meters

- The revenue metering fleet is being replaced in RCP3. Metering replacements will significantly decrease in RCP4.

[266] Transpower, ERR029 SA Protection and Revenue Metering 2022 PMP
[267] Transpower, ERR029 SA Protection and Revenue Metering 2022 PMP

9.3.16.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and evaluation methodologies described in section 8.2 where applicable. This involved reviewing asset management and strategy documentation and interviewing relevant Transpower management team members. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex.

This base R&R capex is largely a volumetric program. The RCP4 proposed budget was developed using the building block unit rate estimates from TEES and the corresponding asset quantities estimated for R&R intervention as identified in the PMP. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, across the asset class.

Prudency

We analysed the different elements of this asset class and investigated the reasons for quantity step changes between RCP3 and RCP4. We reviewed the investment drivers described above and determined that they are reasonable as a basis for developing the proposed base R&R capex.

We reviewed the use of asset health data for asset health and network risk modelling tools for identifying and prioritising the proposed projects and nominated quantities in RCP4 and consider them to be reasonable. The PMPs including planning information which provides a summary of the asset health and criticality model assumptions as well as monetised consequence values if the proposed works are not undertaken. These assumptions and values are considered reasonable and appropriate.

We queried the modelled projection of annualised risk levels for with and without R&R works in RPC4 and tested the level of risk averseness or otherwise (risk appetite) from Transpower's management team. The level of RCP4 investment will maintain the current level of asset failure risk and is necessary to avoid a significant increase in insulators with a very poor asset health rating. This demonstrated a prudent volume of R&R work in RCP4.

We did not find any instance of double counting between this proposed base R&R capex and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the base R&R capex for this asset portfolio for RCP4.

We consider the effect of the proposed base R&R capex on other asset portfolios including opex is mapped and well understood. This effect can be on the timing and/or the quantum of the cost and Transpower has considered this relationship in its ACSs and PMPs. Substation program work often involves combining plans for work by site, scheme, or by circuit. For example, protection works may be combined with Substation Management System replacements, Outdoor to Indoor conversions, and replacement of primary equipment. Battery and charger replacement work is mostly grouped by service area as they are largely independent of other works and do not require outages for replacement work.

Efficiency

The replacement of protection relays is generally repeatable and Transpower uses a volumetric cost estimating approach based on standard building blocks for a given asset type and equipment rating. Standard building block estimates are based updates from historic costs.

We attempted to compare the TEES building block unit rates of few randomly selected secondary asset types and against independently sourced costing information. Unfortunately, publicly available Australian NEM median unit cost information for these secondary assets does not exist for the DNSPs or TNSPs.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities cost building-up calculation. When compared to the present RCP3 base R&R capex plan, the increase in the proposed RCP4 base R&R capex is due to both the increase in asset quantities and the increase in the TEES rates.

Transpower carried out a building block review in 2022 in preparation for the RCP4 submission. This review was based on actual cost data from completed projects. This has mainly seen an increase in costs across the majority of portfolios due to factors such:

– Increase costs in materials and freight.
– Increase in charge out rates due to a lack of resources.
– Introduction of new standard design packages (transformer protection, capacitor bank protection, etc) that provided the benefit of consistency and redundancy across these asset types, rather than the previous bespoke designs with the associated the risks.

The increase in quantities to maintain asset health levels and the increase in unit costs are considered reasonable.

9.3.16.6 Conclusion

We conclude that the proposed base R&R capex for the secondary assets portfolio totalling $227.5m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this identified programme against the evaluation criteria.

Table 9-53 Secondary assets base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	PMP outlines the investment need and key drivers. ACS and PMP are aligned with each other. The plan provides a summary of the asset health, where available. The proposed secondary assets replacement in RCP4 is driven by asset age and functionality requirements.
A3(b)	Policies and planning standards were applied appropriately	Yes	The PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process management of secondary assets which includes asset health and condition, and we believe provides cost effective results. The asset health and network risk modelling tools and the underlying data, assumptions, and their development and use for identifying and prioritising the proposed projects and nominated quantities in RCP4 is reasonable and demonstrated a risk-based approach in most instances.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	The proposed R&R capex scenarios for the secondary asset population is generally consistent with the proposed RCP3 and RCP4 expenditure plan.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	The key drivers and assumption for this capex program are OEM recommendations, asset condition and obsolescence management. The current state of protection, station DC systems and revenue metering is generally good. Reliability performance and critically reviews have led to the subsequent extension of some types of protection relays from 20 to 25 yrs.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	The procurement approach is a combination of building block costs and bottom-up estimates. Where possible reference checks were made to similar previous work.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	No evidence of double counting was found. Impact of forecast capex on other cost categories considered as part of PMPs.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	Within the secondary asset portfolio, the capital expenditure appears to be reasonable and well balanced with respect to cost outcomes. Links to other programs appear to be sound.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The procurement approach is a combination of building block costs and bottom-up estimates. Were possible reference checks were made to previous similar work.

Note: A3(h) is not applicable to base capex

9.3.17 Substation management systems

The following table summarises our verification of the substation management systems capex which is categorised as an identified programme and forms part of the base R&R capex for RCP4.

Table 9-54 Verification summary of secondary assets base R&R capex

Verification element	Verification commentary
RCP4 proposed amount	$23.5m excluding resilience workstream [1]
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $23.5m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	Resourcing level of specialist substation technicians to deliver the proposed expenditure programme.

Note: [1] Transpower is proposing a capex workstream driven by resilience concern within this asset portfolio using the UIOLI uncertainty mechanism. Therefore, the resilience workstream capex is separately evaluated and not within this base R&R capex.

9.3.17.1 Asset portfolio and strategy overview

The substation management system refers to the systems that enable real-time monitoring and remote control of substation equipment. They communicate directly with Transpower's Supervisory Control and Data Acquisition (SCADA) and/or Energy Management System (EMS).

The substation management system contains the telemetry systems based on computers and local area networks (LANs) that have been specifically designed to operate in electricity utility environments.[268] Therefore, substation management system reliability is essential to maintaining visibility and control of the power system. The substation management system asset portfolio includes:

- Remote Terminal Units (RTUs)
- Substation Management Platforms
- Human machine interfaces
- GPS clocks
- SCADA junction boxes

The objective of this asset portfolio is the safe and reliable operation at least lifecycle cost. Investment need is primarily based on asset age and technology and market support obsolescence. Life expectancy for each asset

[268] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf

type is based on manufacturer's recommendations, adjusted for factors such as measured mean time between failure (MTBF) statistics and real-world failure rates information.

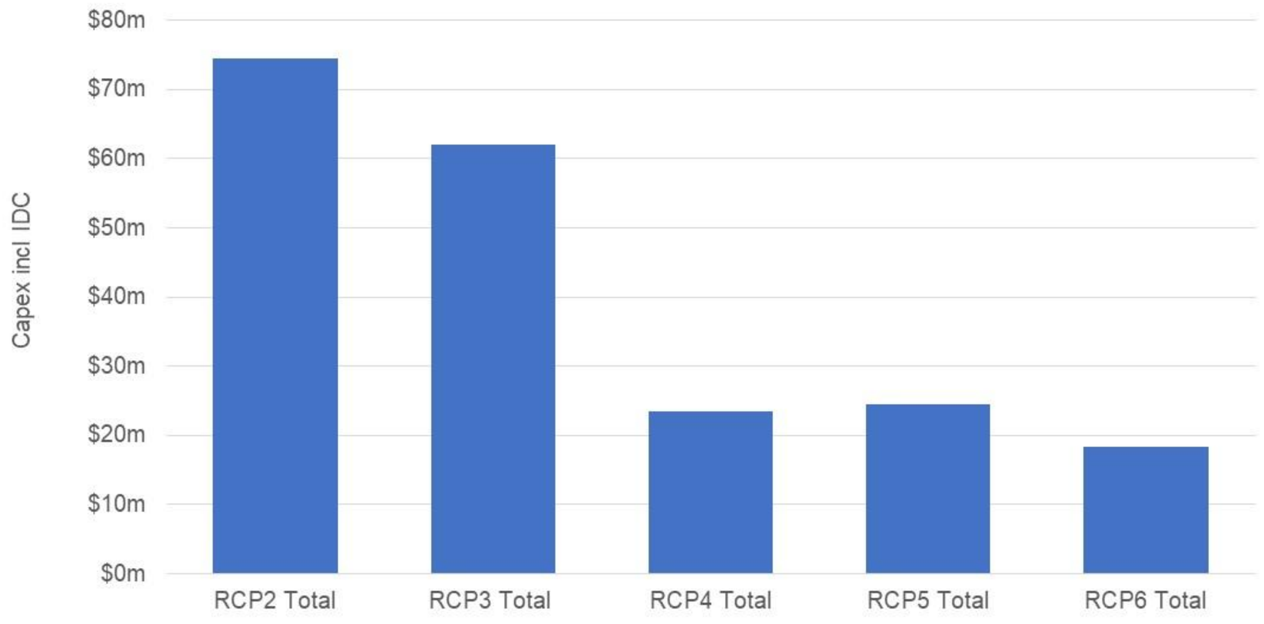
Transpower's main strategies for the substation management system asset portfolio are:

- Replace legacy RTUs and Input/Output (I/O) modules with substation management system equipment when they reach 15 years of age.
- Implement remote engineering access (REA) while deploying substation management system. The REA installation work is carried out at the same time as substation management system deployment or legacy I/O replacements, to reduce overall costs by avoiding double handling and rework.
- Replace GPS clocks based on obsolescence drivers subject to a maximum age of 15 years.
- Upgrade sites with hybrid substation management system and legacy I/O modules when they reach 15 years of age, by replacing the I/O modules with substation management system equivalent.
- Implement remote engineering access while deploying substation management system.
- Centrally manage the configuration and substation intelligent electronic devices (IEDs) using a suite of vendor-provided tools.
- Reduce whole-of-life costs and procurement risk by using a sole system vendor with detailed substation management system specifications and managing the relationship with the sole system vendor to encourage long-term technical support and cost control.

9.3.17.2 Expenditure profile

The following figure shows the longer term base R&R capex profile of the substation management system asset portfolio including historical and forecast expenditures.

Figure 9-51 Substation management system base R&R capex long term profile



Source: Transpower, RT01 expenditure schedule, Resilience 2022 PMP and GHD analysis.

In RCP1 and RCP2 Transpower upgraded a large number of sites to substation management system.[269] Presently within RCP3 to date 138 sites have been fully upgraded to substation management system (no legacy RTU on site) and 42 sites are still fully or partially dependent on legacy GE or Foxboro units that can no longer be obtained and/or are unsupported.[270] There are 16 sites currently being upgraded to the new substation management platform system.[271]

[269] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf
[270] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf
[271] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf

Transpower has forecast the base R&R capex for substation management system in RCP4 of $27.9m which is a significant reduction in expenditure from RCP3 level. This is because from 2025 onwards the deployment of new substation management system-based system changes to simple age-based device refreshes.[272]

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure level.

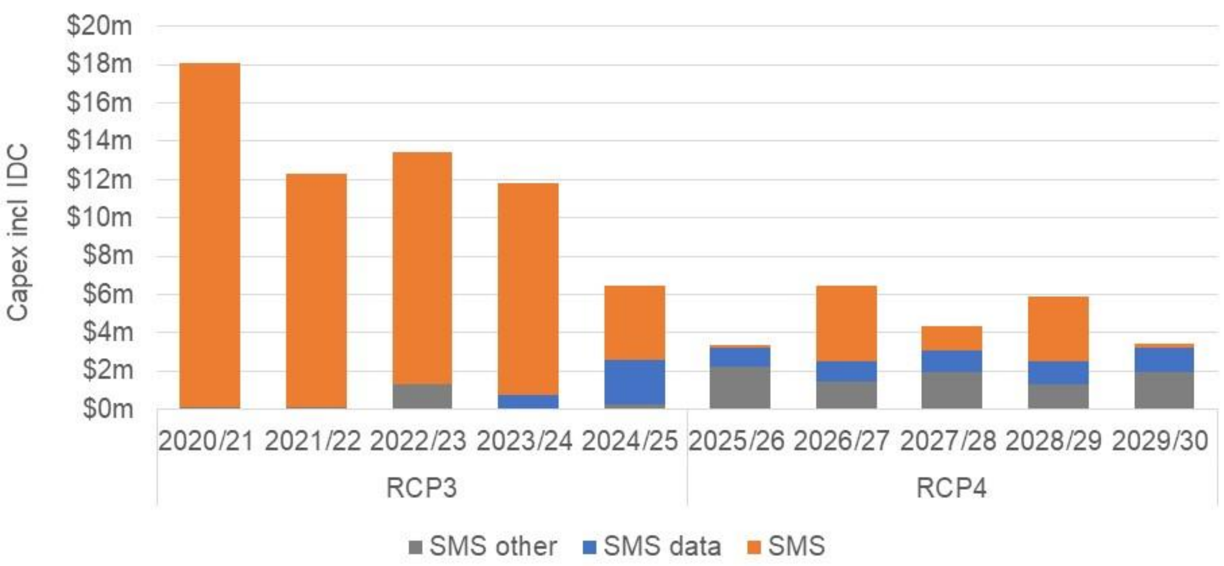
Table 9-55 ***Substation management system base R&R capex for RCP3 and RCP4***

Asset portfolio	RCP3 total	RCP4 total	Change
Substation management system	$62.1m	$23.5m	-62%

Source: Transpower, RT01 expenditure schedule

Transpower have refined the scope and costs for the R&R work with the savings resulting from this rationalization, offsetting the costs resulting from the decommission of legacy mimic panels. The volume of substation management system upgrades will significantly increase in longer future as the RCP1 upgrades reaches end of life and requires device refreshes. The following tables shows the RCP3 and RCP4 the actual and forecast expenditure and quantities.

Figure 9-52 ***Substation management system base R&R capex profile***

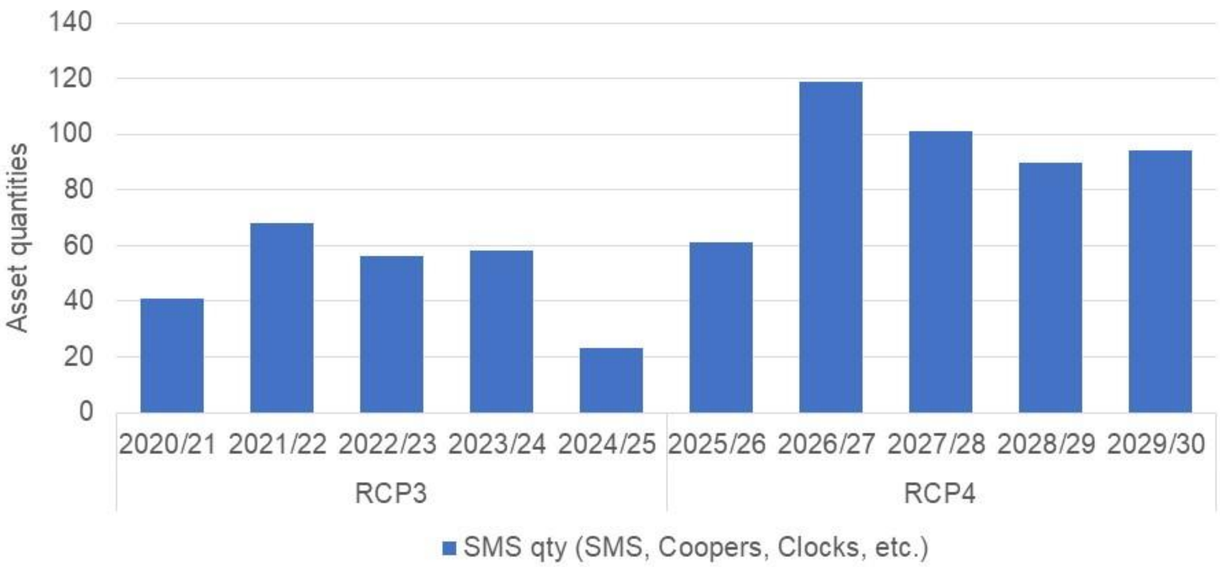


Source: Transpower, RT01 expenditure schedule, Resilience 2022 PMP, and GHD analysis

The forecast quantity profile of this asset portfolio is shown in the following figure.

[272] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf

Figure 9-53 Substation management system base R&R quantity profile



Source: Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf, GHD analysis

9.3.17.3 Asset planning approach

Transpower's ACS and PMP for this asset portfolio are informed by its organisational Transmission Tomorrow strategy, Strategic Asset Management Plan and eventually the Network Strategy. Collectively they describe the challenges faced in managing its existing fleet of Substation management system equipment, their objectives and approaches to address them. The focus areas, challenges, and proposed actions to address them are aligned to the strategic priorities stated in the Transmission Tomorrow. We observed the alignment within its asset management documentation and the ACS and PMP. This asset management system is directed towards identifying and developing prudent and efficient R&R solutions.

Efficient condition assessment of this asset portfolio poses challenge. We note that measuring, observing and recording the condition of the equipment (and its sub-components) within this asset portfolio can be economically prohibitive as such activities will require a substantial amount of effort for the value (risk mitigation) it will return.[273] Also, such inspection activities may not entirely yield useful condition information to contribute into asset health modelling. For e.g., tests on microprocesses or digital assets may only yield binary results.[274] Further technology obsolescence and market support is more influential driver for R&R intervention decisions.[275]

The GHD Advisory Expert Opinion Progress Review report[276] on Transpower AHNR modelling indicates the following maturity status for this asset portfolio:

– The asset health modelling for this asset portfolio meets the GEIP and aligns with Level 1 maturity that considers age, i.e., Transpower's substation management system asset health model is based solely on age and as such no condition data is used in its derivation of asset health score or probability of failure. Each component has their respective expected age. The report noted that the nature of this asset portfolio does not easily lend itself to condition driven interventions. In stating this, the report considered the consequence of substation management system failure.
– The impact modelling for this asset portfolio meets the GEIP and aligns with Level 4 maturity that considers holistic impacts, i.e., consequence is quantified using a structured/repeatable framework that includes monetised impacts for societal, environmental, direct cost, safety and customer impacts over a range of scenarios.

[273] GHD Advisory, Expert Opinion Progress Review report on Transpower AHNR modelling
[274] GHD Advisory, Expert Opinion Progress Review report on Transpower AHNR modelling
[275] GHD Advisory, Expert Opinion Progress Review report on Transpower AHNR modelling
[276] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

– The network risk analysis for this asset portfolio meets GEIP and aligns between Level 2 maturity (asset centric) and Level 3 maturity (network interdependencies).

While the Expert Opinion Progress Review report identified lower levels of maturity of asset health model and impact model for this asset portfolio when assessed in isolation, it also commented that Transpower's overall asset management system, tools and decision frameworks collectively provides capability in understanding their network risk to inform and support its base R&R capex for RCP4 submission. Evidence sited during the verification process confirmed this previous finding regarding AHNR maturity for this asset portfolio.

Once substation LAN equipment is installed, these assets are then managed under the ICT portfolio who monitor, maintain, and replace the assets at the end of their life. The human machine interface assets lifecycle management is a joint effort with IST team within Transpower.[277] Having said this, we also note that this asset portfolio has limited opex as most works are capex work.[278] The key preventive controls are replacing assets in a timely manner or increasing system redundancy. Transpower monitors international data on component failure rates to assist in informing these preventive controls.[279]

At present, Transpower's main programme of work is focused on phasing out legacy serial-based RTUs and I/O modules and replacing these with new ethernet-capable substation management system platform. This new technology also includes Remote Engineering Access (REA), which allows interrogation and management of secondary systems without needing to be on site.

9.3.17.4 RCP4 capex drivers and solutions

Transpower plans to complete the substation management system implementations at the remaining 71 sites and with the intention to maintain the delivery momentum achieved in the preceding RCP3 period. The completion of the RTU replacement programme in RCP3 is reflected in the lower forecast investment requirements for RCP4.

Transpower's overarching driver for substation management system is that the assets operate reliably and meet operational needs, at least lifecycle cost. A second driver for expenditure is for the replacement of assets that are at the point where either the probability of failure, or technical obsolescence, poses an unacceptable operational risk. Often replacement is based on age before these issues become an issue for the safe and reliable operation of the network.

The investment plan is based on the result of age-based replacement policies.[280]

Due to the systems consisting of modular electronic components there is a view that there is no meaningful way of determining the health of the units other than by age. Hence, there is a reliance on manufacturer recommendations, measured in Mean Time Between Failures (MTBF) statistics, and real-world failure rates.[281]

Transpower have stated the criticality of the substation management system assets is based on the criticality of the site at which they are located. Site criticality ratings are determined by the amount of sustained load or generation lost after an event experienced at the site, the amount of load that is transferred through the substation, strategic importance (e.g., black start capability), and the GXP's long-term performance targets (if applicable). We consider the above approach reasonable for these assets.

At the end of RCP3 Transpower is expecting to address the old and unreliable legacy RTU and I/O module assets by completing the final five years of the 15-year substation modernisation programme. Following the completion of this program, the substation management system investments are primarily refreshes of the equipment deployed early in the modernisation programme. The current plan also stabilises the human machine interface age profile and maintains the current GPS clock age profile.

The new substation management system gateways are proving to be reliable with few recorded failures. The substation management platform units have an expected useful life of 15 years so lifecycle replacements for these will commence in RCP4.

At the end of RCP3 we have addressed the old and unreliable the legacy RTU and I/O module assets by completing the final five years of the 15-year substation modernisation programme. Following the completion of

[277] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf
[278] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf
[279] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf
[280] Transpower, ERR006 FP 12.01 Substation management systems asset class strategy.pdf
[281] Transpower, ERR032 SA Substation Management Systems 2022 PMP.pdf

this program, the substation management system investments are primarily refreshes of the equipment deployed early in the modernisation programme. The current plan also stabilises the human machine interface age profile and maintains the current GPS clock age profile. The new substation management platform gateways are proving to be reliable with few recorded failures. The substation management platform units have an expected useful life of 15 years so lifecycle replacements for these will commence in RCP4.

9.3.17.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

This involved reviewing the provided initial tranche of asset management and strategy documentation pertaining to this asset portfolio and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the proposed RCP4 base R&R capex for this asset portfolio.

Transpower estimate the cost of R&R intervention by undertaking detailed site investigations prior to finalising cost for substation management system projects, applying volumetric cost estimates (from TEES) where applicable and using customised project estimates for substation management system installations at very large sites. We examined the prudency and efficiency of both variables, i.e., unit rates and asset quantities, within this asset portfolio and observed the followings.

Prudency

We consider Transpower's current asset management practice of the portfolio is valid. It is generally based on replacing systems on age and prior to the assets failure rates becoming problematic, or components becoming obsolete and unsupported by OEMs. Transpower has an age-based profile for assets that are part of the substation management system. We consider this a prudent approach.

Given the above approach, we also examined the expected life of various components of this asset portfolio that Transpower has adopted, and we consider them to result in prudent R&R intervention decision. We also examined the age profile (in the form of age range) of various components of this asset portfolio, and when considered together with the average life expectancy, we observed that the proposed quantum of this asset portfolio in RCP4 to be prudent.

The PMP outlines the investment need and key drivers, and the solution is aligned with the Transpower's policies and planning standards. We also did not find any evidence of overlap of this base R&R capex with other asset portfolios, especially the ICT investment cases.

Efficiency

The cost estimate of R&R work is a combination of volumetric building block bottom-up estimates and also customised cost estimates.

The proposed base R&R capex for RCP4 is generally aligned to TEES building block unit rates × quantities proposed in PMP of this asset portfolio for RCP4. However, we only reviewed this cost build-up calculation at a portfolio level, and not at individual component level as the quantity breakdown is not provided in the PMP. Nevertheless, some of the building block unit rates being used for proposing the RCP4 base R&R capex for this asset portfolio are generally deemed reasonable based on engineering judgement.

We note that apart from the GPS clock, there were no other building block unit rates available during the RCP3 submission and hence could not be compared against the unit rates used for RCP4 submission.

9.3.17.6 Conclusion

We conclude that the proposed base R&R capex for substation management system asset portfolio totalling $23.5m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 9-56 substation management systems base R&R base capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	This is evident and documented in the earlier asset planning approach, RCP4 capex drivers and solutions, and evaluation sub-sections.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The approach is dependent on manufacturer's recommendations, adjusted for factors such as measured mean time between failure (MTBF) statistics and real-world failure rates information. This is documented in the earlier capex driver and solution sub-section. Proposed procurement approach for this asset portfolio is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy. Refer to our evaluation in Section 7 of this report. Nevertheless, the resourcing level of specialist substation technicians to deliver the proposed expenditure programme should be of focus. Ability of Transpower to ramp up and recruit such resources and retain them for the required time period is important.

Note: A3 (h) is not applicable to base capex

10. Base E&D capex

Our evaluation of Transpower's proposed base E&D capex for RCP4 against the applicable evaluation criteria of the ToR is presented in this section. This section provides an overview of this capex category and details the capex profile, network planning approach, capex drivers and solution, and our analysis in evaluating the prudency and efficiency of the proposed capex for RCP4.

The following table summarises our verification for the base E&D capex which is selected as an identified programme for RCP4.

Table 10-1 Verification summary of base E&D capex

Verification element	Verification commentary
RCP4 proposed amount	$98.5m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes, except for corridor management programme which does not satisfy ToR evaluation criteria A3(g) and A3(i).
IV conclusion	Accept: $93.5m Accept but re-categorise: $5.0m for corridor management programme to opex.
Potential scope for improvement	Re-categorisation and propose the corridor management programme costs as opex.
Key issues and areas that the Commission should focus	Treatment of corridor management programme expenditure.

10.1 Overview of base E&D capex

The Capex IM defines the base E&D capex as base capex that is **not** one of the following:

- base R&R capex
- business support capex
- ICT capex
- funded under network investment contract.

By deduction, this means that the base E&D capex is the capex needed to augment and expand the network by increasing its capacity and capability.

The development of the base E&D capex being proposed by Transpower for RCP4 involves identifying the network constraints and opportunities to change network capability and investigating options to resolve them through a decision an asset planning decision framework. This process is informed by Transpower's annual transmission planning exercise, Transmission Planning Report (TPR), and the latest Whakamana i Te Mauri Hiko report. They collectively review and models electricity demand forecast, multiple scenarios of New Zealand's decarbonization journey and likely speed of electrification which are then used to develop the base E&D capex budget for RCP4.

This activity considers the trend in connection enquiries (both generators and loads), peak national demand forecast and electricity supply requirements and future plans at each regional GXP level.[282] The national peak demand forecast is developed based on information from respective electricity distribution businesses.[283]

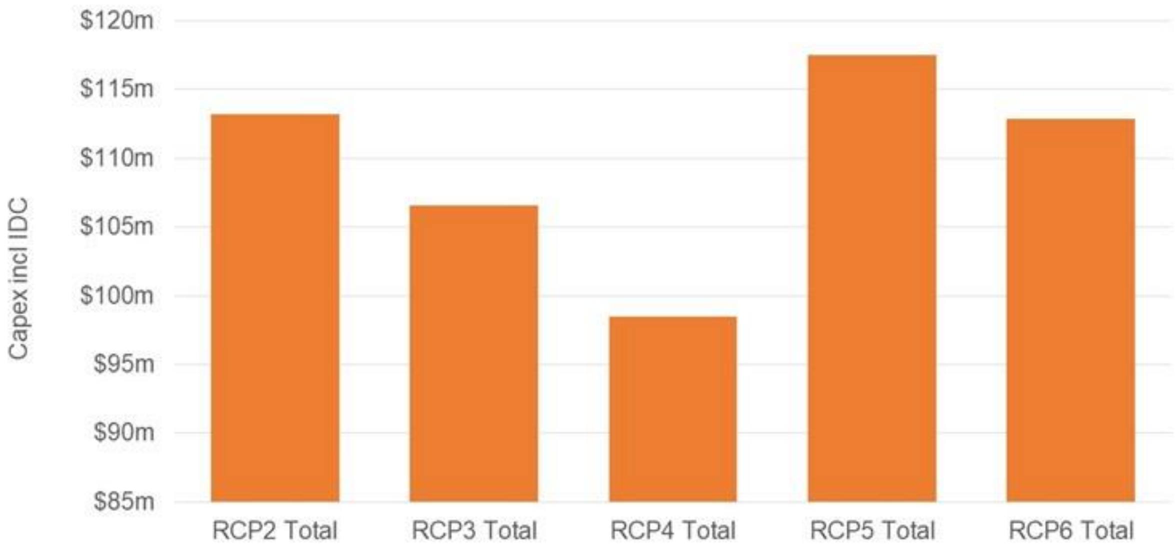
This process allows Transpower to identify, investigate and progress grid enhancement and development needs and provides a decision framework and options assessment approach. The decision framework allows for grouping of various needs across multiple asset portfolio and drivers, to prioritise and collectively consider them. The option assessment approach analyses need, timing of need, various alternate options and identify the preferred solutions that build-up the base E&D capex portfolio.

[282] Transpower, EED001 Transmission Planning Report 2022.pdf
[283] Transpower, EED001 Transmission Planning Report 2022.pdf

10.2 Expenditure profile

The following figure shows the longer term profile of base E&D capex including historical and forecast expenditures.

Figure 10-1 Base E&D capex long term profile



Source: Transpower, RT01 expenditure schedule

Transpower is proposing a budget of $98.5m base E&D capex in RCP4 with approximately $20.0m profiled evenly across the period. This is slightly less than the RCP3 in real monetary term.

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

Table 10-2 Base E&D capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Base E&D capex	$106.6m	$98.5m	-8%

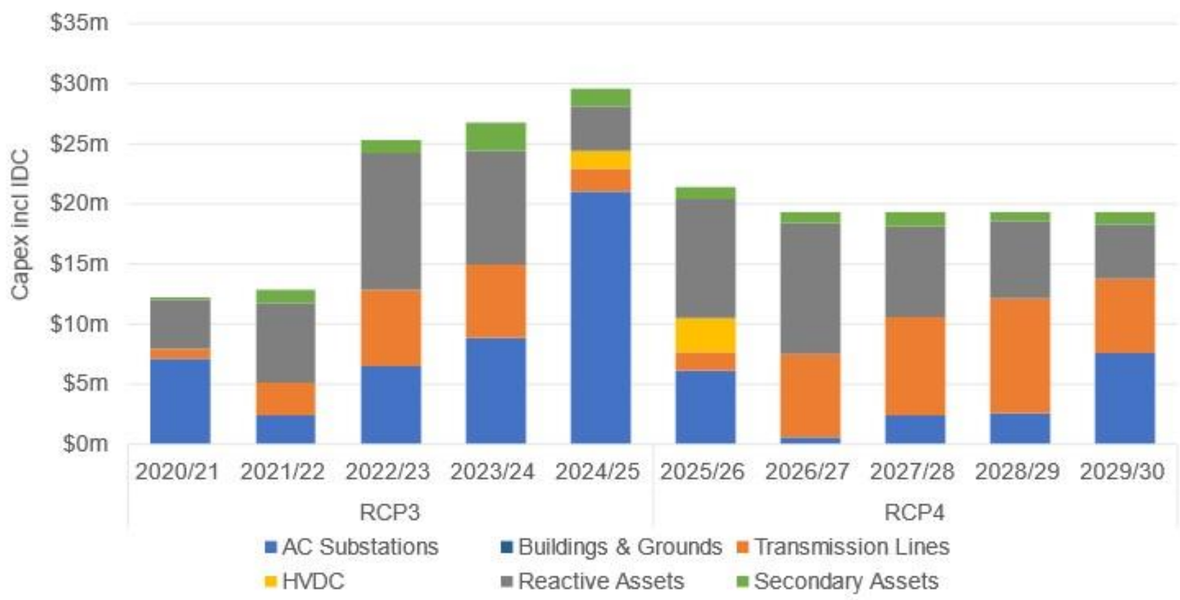
Source: Transpower, RT01 expenditure schedule and GHD analysis.

Transpower has reported its base E&D capex category against each individual asset portfolio in the RT01 expenditure schedule regulatory template and the expenditure profile in the following figure is based on the same reported information. However, we note that **reporting base E&D capex categories against each individual asset portfolios is not accurate**. Given the formation process of the base E&D capex portfolio (such as adding allowance for presently unknown system need and reducing the total estimated portfolio), the resulting total capex will not exactly match to the collection of discrete individual projects. The defined scope, asset types and quantities breakdown of these collection of projects cannot be mapped perfectly to various asset portfolios.

Our analysis is therefore based on the base E&D capex portfolio formation process, its total amount but also testing the basis of few sample projects from the 'extremely likely' and 'highly likely' scenario categories.

The annual base E&D capex profile in stacked columns is shown for the present RCP3 and proposed RCP4 in the following figure.

Figure 10-2 *Base E&D capex profile*



Source: Transpower, RT01 expenditure schedule.

The above figure shows that the total base E&D capex proposed for RCP4 is slightly less than RCP3 proposal. The majority of the proposed amount is within the transmission lines and reactive asset deliverable portfolios. The base E&D capex for the HVDC asset portfolio in 2025/26 is associated with the need to investigate WLG resilience and HVDC black start after loss of AC event.

10.3 Network planning approach

The development of the base E&D capex being proposed by Transpower for RCP4 follows the four inter-related processes: [284]

– Asset feedback process.
– Annual transmission planning process.
– Customer technical requests including concept assessment process.
– Asset planning decision framework.

The first three processes provide information on the capability of the grid to provide the system capacity, reliability and security required to meet future customer and grid needs. Where the capability of the grid is insufficient, or changes in load or generation require a reassessment of system requirements, a problem or opportunity is passed to the decision framework for further investigation. This assessment utilises an industry standard power flow modelling analysis software tool called PowerFactory (DigSilent). This becomes an E&D system need. The decision framework provides a mechanism for grouping system need and asset need (i.e., need identified in base R&R capex asset portfolios) to prioritise and collectively consider them.

The decision framework incorporates the options assessment approach, which specifies how needs are investigated, the level of analysis being commensurate with the complexity of the issue, likely level of expenditure and timing of the need. The outcome of the delivery-level option assessment approach is selection of a preferred solution.

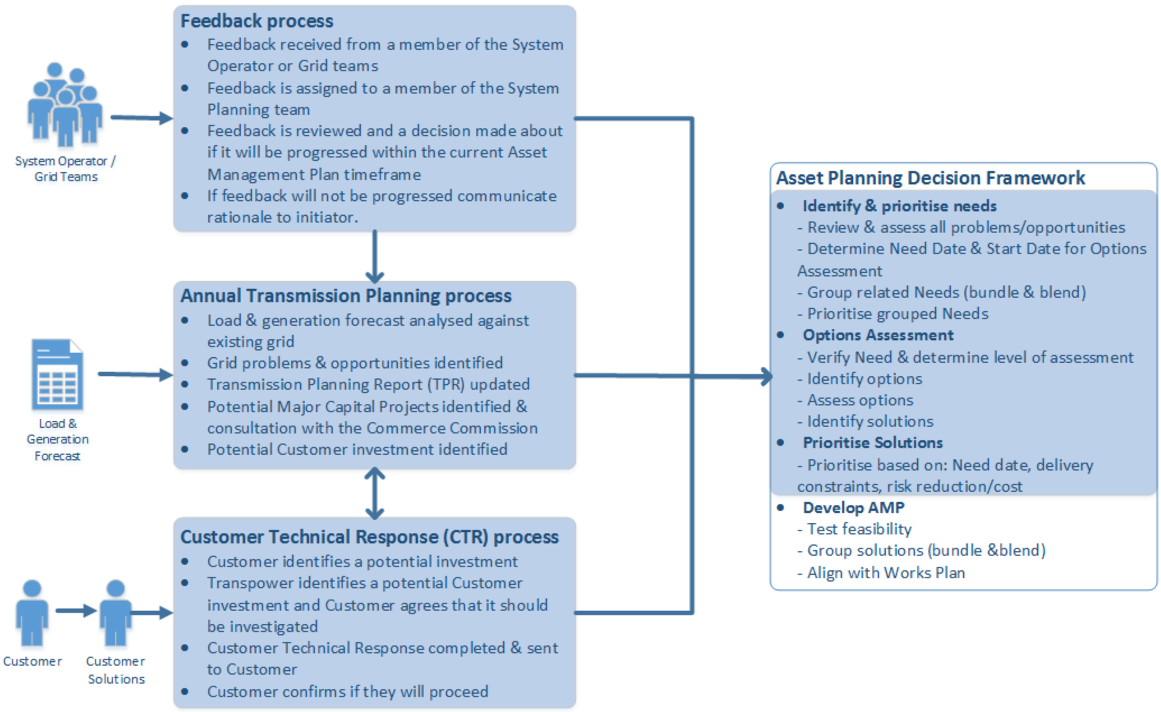
The network enhancement approach is detailed in the Transmission Planning Report and comprises both current system planning knowledge relating to system needs, and the progress of system needs through the decision framework. The network enhancement approach discusses investment drivers, investment uncertainties, collective needs, options for resolution and indicative investment costs. The accuracy of information in the network

[284] Transpower, EED001 Transmission Planning Report 2022.pdf

enhancement approach is commensurate with level of certainty of investment, timing of the system need and level of option assessment approach investigation completed.

The following figure shows a high-level overview of the inter-related processes and information flow that comprises the formation of base E&D capex.

Figure 10-3 E&D base capex development process



Source: Transpower, EED001 Transmission Planning Report 2022.pdf

Transpower analyses project uncertainties and considers the maturity of their need, timing and solution definition and categorises them as 'extremely likely', 'highly likely' and 'likely'. These categories are used to build up the base E&D capex portfolio across various likelihood scenarios.

Transpower have selected projects deemed 'extremely likely' and 'highly likely' and have also included an allowance for presently unidentified system needs that may arise during RCP4. It has also challenged itself (reduced the portfolio amount) to reflect cost savings, investment deferral and use of new technologies. As a result, the proposed base E&D capex portfolio is not based on collection of specific projects. This portfolio build approach is similar with RCP3 approach.

10.4 RCP4 capex drivers and solutions

The drivers for this capex portfolio reflect electricity demand changes and generation development, use and retirement. Various electricity distribution businesses have forecast a step change to their load growth.[285] Transpower is also observing that overall national peak demand increasing with forecast step-changes (such as new generation, generation retirement and new loads) in specific regional GXP.[286]

Connection enquiries (both generators and loads), which are often a leading indicator of growth, has grown significantly since 2019.[287] Transpower is also observing an increase in the number of embedded generator connections or connection enquires.[288]

[285] Transpower, EED001 Transmission Planning Report 2022.pdf
[286] Transpower, EED001 Transmission Planning Report 2022.pdf
[287] Transpower, EED001 Transmission Planning Report 2022.pdf
[288] Transpower, EED001 Transmission Planning Report 2022.pdf

Drivers of base E&D capex are varied and often complex with multiple influencing factors and uncertainty. As time progresses and these drivers and factors gets better defined and scoped, the specification of the need starts to form. Some of the drivers of base E&D capex need are:

– To provide more capacity to generators or connected loads.
– To match reliability or security of supply to the required standard or agreed service levels.
– To maintain or improve power quality measures.
– To manage the dynamic response of the power system to disturbance.

The base E&D capex is driven by the high level of uncertainty in the external environment. Transpower decision framework aims to deliver the 'least regrets' outcome. The inter-related processes explained earlier also allows Transpower to invest, defer expenditure or quickly change credible solutions. This is also the reason that Transpower explain why the base E&D capex portfolio is not itemised into specific asset portfolios or project sites in RCP4.

Transpower has used the latest knowledge of their system needs as of 2022 Transmission Planning Report to size the portfolio capex with the expectation that some projects within this portfolio may be deferred, other will have different credible solutions, and new system needs may arise that are not yet foreseen.

The inter-related processes is a continuous review process as new information becomes available. This continuously influences the size of capex portfolio. For RCP4 Transpower has consider the drivers of the system need, the stages of decision framework completed to date, credible options and cost to resolve the issue, along with whether the investment will meet the requirements of the option assessment approach for approach to inform its view of the certainty of the base E&D capex.

The following table identify projects categorised as 'extremely likely' that Transpower expected in its 2022 Transmission Planning Report to progress through the option assessment approach and to meet the approval stage gates. These projects are those that are already well into the design process, where Transpower is confident in projected generation or load changes, and/or that have other certain drivers such as asset condition.

Table 10-3 Extremely likely projects for E&D system needs in 2022 Transmission Planning Report

Project description	Driver for issue	Total capex in RCP4
Minor limit projects to resolve metering or protection limits. Low cost, simple projects.	Load growth	$0.5m
Bunnythorpe – Woodville special protection scheme upgrade	Dispatch constraints	$0.6m
Bus the Arapuni – Bombay circuit at Hamilton	Lower system losses Security and operational flexibility	$1.8m
Hororata and Kimberley thermal capacity protection	Load growth	$0.6m
Tauranga transmission capacity – short term	Load growth	$0.9m
Western Bay of Plenty voltage support	Load growth	$9.3m
Tarukenga 220 kV bus security	Security of supply	$2.8m
Gore – Roxburgh overload management	Dispatch constraints	$3.1m
Invercargill – Gore capacity – short term	Load growth	$0.6m
Corridor Management Programme. It is a multidisciplinary strategic programme of activities to seek and advocate for provisions in statutory planning documents under the Resource Management Act 1991.	National Policy Statement	$5.0m
Minor limit projects to resolve metering or protection limits. Low cost, simple projects.	Load growth	$0.5m
Total		**$25.2m**

Source: Transpower, EED001 Transmission Planning Report 2022.pdf

The following table identifies projects categorised as 'highly likely' that Transpower expected in its 2022 Transmission Planning Report to progress through the option assessment approach and to meet the approval stage gates, but which have a less certain identified solution and associated cost. These projects have less certain drivers, or those that would occur later in the period when Transpower is more certain about the costs of the project.

Table 10-4 Highly likely projects for E&D system needs in 2022 Transmission Planning Report

Project description	Driver for issue	Total capex in RCP4
Generation connection driven grid investments. The 2022 Transmission Planning Report identified several areas where there is generation interest and connection would result in constraints and inefficient dispatch.	Generation connections Maintenance outages	$17.0m
Generation/demand change driven investments. The 2022 Transmission Planning Report identified areas where changes in generation and grid support from existing generation result in the need to invest to manage voltages	Voltage management	$10.1m
Henderson – Wellsford backup capacity – Stage 2	Load growth	$3.3m
Hororata Kimberley voltage quality	Voltage management	$12.1m
Kaitimako interconnection capacity	Load growth	$15.3m
Bunnythorpe – Wanganui B line thermal upgrade	Load growth	$9.1m
Edgecumbe interconnecting transformer	Generation dispatch Load growth	$4.3m
Total		**$71.2m**

Source: Transpower, EED001 Transmission Planning Report 2022.pdf

Finally, the following table list projects categorised as ‘likely’ that Transpower expected in its 2022 Transmission Planning Report to require some capex, but the scope of the need is less certain, solution detail is very high level based on the option assessment approach principles.

Table 10-5 Highly likely projects for E&D system needs in 2022 Transmission Planning Report

Project description	Driver for issue	Total capex in RCP4
Fernhill – Redclyffe – A and B line reconductoring	Load growth	$12.9m
Lower South Island shunt reactor	Load changes	$5.1m
Timaru voltage support (stage 2)	Load growth	$7.3m
Total		**$25.3m**

Source: Transpower, EED001 Transmission Planning Report 2022.pdf

Collectively these three categories of potential E&D projects amount to $121.7m in total. In addition to these projects, Transpower also considered allowance for presently unidentified system needs that will require base E&D capex in RCP4. It also went through a top-down expenditure challenge process to account for investment deferrals or the use of new technology to reduce investment. Given the uncertainty of the inputs and assumptions within each of the identified projects, Transpower has rationalise the total amount for the base E&D capex to $98.5m for RCP4.

In summary, the examples of solution being proposed by Transpower within the portfolio of ‘extremely likely’ and ‘highly likely’ categorises to augment the upstream interconnected grid involves:

– Special protection scheme upgrade to address dispatch constraints.
– Reconfiguration of circuit to address system losses.
– Install capacitor to address voltage quality issues.
– Reconductoring to address thermal capacity constraints.

10.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

This involved reviewing the provided 2022 Transmission Planning Report, the latest Whakamana i Te Mauri Hiko report[289] and interviewing the relevant Transpower management team. We also requested and reviewed further information[290] to test, corroborate and challenge the assumptions and supporting framework and decisions that informed the proposed RCP4 base E&D capex.

Transpower has analysed the available forecasted project uncertainties and maturities of input information to formulate the proposed base E&D capex for RCP4 as explained in earlier paragraphs. The proposed base E&D capex are collection of various groups of diverse projects across various likelihood scenarios. It is with this context we examined the prudency and efficiency of the proposed base E&D capex for RCP4.

10.5.1 Prudency

The Transmission Planning Report documents the outcome of Transpower's annual planning process considering the customer technical request and concept assessment process, asset feedback and decision framework and options assessment approach identifying the issues, demand forecast, available capacities/constraints, opportunities, solutions, need time and scope definition at each regional GXP level. This is aligned to GEIP when compared to annual transmission planning process and reporting of mature TNSPs in other jurisdictions.

The process flow involved in the connection process as described in Transpower's website[291] corroborates with commentary in the 2022 Transmission Planning Report.

We reviewed the peak demand forecasts, its inputs, assumption and approach (refer to Section 5 of this report) and conclude its appropriateness to driving the need and hence the base E&D capex in this category.

We reviewed the proposed solutions documented in the various extremely likely and highly likely projects in the 2022 Transmission Planning Report for RCP4. We consider the proposed solutions to be prudent and reasonable and are consistent with the Grid Reliability Standards and the Grid Planning Technical Guideline[292]. Additionally, we also requested and reviewed five E&D re-opener projects[293] and one major capital project[294] from RCP3 to corroborate the network planning approach undertaken and the details of system need and proposed solution, scope and costs of those projects. We consider the solution opted to be prudent and reasonable and were consistent with the Grid Reliability Standards and the Grid Planning Technical Guideline.

The nature of information available, assumptions used, and decisions formed from RCP3 delivery businesses underwent the same planning process, investment decision framework and options assessment approach to justify the E&D projects. This suggests consistent application of Transpower's frameworks and processes thereby indicating a well-established planning and base E&D capex development function within Transpower.

We note that the Grid Reliability Standards has not changed since RCP2. Depending on the maturity of defining the system need, timing, solution and scope of work, projects are prioritised based on likelihood scenarios and need date to compile the base E&D capex budget. This planning process is directed towards identifying and developing prudent and efficient base E&D solutions.

Uncertainty within inputs and assumptions, especially pertaining to customer connection requests have been identified and separately estimated and being proposed using the UIOLI uncertainty mechanism.

We reviewed the corridor management programme which is categorised as an extremely likely scenario outcome in the portfolio of base E&D capex closely. The corridor management programme is a multidisciplinary strategic

[289] Transpower, COR003 Transpower Whakamana i Te Mauri Hiko.pdf
[290] Transpower, RFI014 Transpower response.pdf
[291] Transpower, 'Our connection process' webpage, accessed August 2023, refer to: **Our connection process | Transpower**
[292] Transpower, RFI014-13 DG 25.02 Grid Planning Technical Guidelines.pdf
[293] Transpower, RFI014-01 CP_ISL_002_0_00 USI Voltage Management Prepurchase Delivery Business Case.pdf, RFI014-02 CP_ISL_01K_0_00 Delivery Business Case - USI Voltage Norwood ISL Reactor.pdf, RFI014-03 CP_VNN_27_00_00 220406 Delivery Business Case - UNI Reactor CAPEX.pdf, RFI014-04 CP_KAW_006_0_00 Initial business case KAW Interconnector.pdf and RFI014-05 CP_VTL_85_00_00 - Delivery Business Case - WRK Ring Reactor.pdf
[294] Transpower, RFI014-10 Net Zero Grid Pathways 1 major capex proposal.pdf

programme of activities to seek and advocate for provisions in statutory planning documents of respective territorial authorities/owners under the Resource Management Act 1991. We make the following observation:

– Transpower has been annually undertaking this advocacy engagement in RCP3 and is proposing to continue to do the same in RCP4. Clause 375 of the Resource Management Act 1991 stipulates that traversing of the transmission line >110kV and >100MVA capacity is discretionary activity and is only allowed by the regional territorial authority if they are satisfied that the existing/proposed location is suitable.
– We appreciate the need for Transpower to continue to advocate and influence applicable landowners and jurisdictional authorities to ensure that their transmission assets are recognized, provided for and protected within their respective regional territorial authority plans and documents. This expenditure involves contracting specialist legal, environmental and stakeholder engagement consultants. It is a recurring exercise where the benefit gained is expected to last until the next exercise is undertaking periodic maintenance activities. This activity is needed once every few years on a given span of the transmission line corridor.
– This activity does not renew or extend the life of Transpower assets beyond its average life. Capitalising such activity would lead to creation of assets which will need to be depreciated over the estimated life.
– Further, Transpower has also highlighted that the Resource Management Act 1991 is being repealed and new laws will be enacted, and the impact to Transpower's operation is presently unknown. Transpower has identified a potential regulatory change event and is proposing to reduce the threshold amount and using the re-opener uncertainty mechanism for it.

Given the above observations, we believe the proposed corridor management programme estimated at $5.0m in RCP4 should be re-categorised as opex.

10.5.2 Efficiency

The proposed cost estimates for base E&D capex documented in the 2022 TPR for RCP4 and also sighted in five E&D re-opener projects and one major capital project from RCP3 are reasonable and efficient.

As expected, early-stage project definition has high level cost estimates mostly based on using similar scoped building blocks from TEES and/or engineering judgement from previous experience. As project definition matures (for e.g., in the case of major capital project submission) its cost estimate firms up and are based on discussion with suppliers and/or using TEES and workshopping with SMEs to allow for risk allowance. We consider this to be a reasonable approach in developing capital cost estimate of projects and consistent with our observation made in section 4 regarding cost estimation framework.

10.6 Conclusion

We conclude that the proposed base E&D capex totalling $93.5m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

However, we believe the proposed base E&D capex for corridor management programme amounting to $5.0m is an opex activity and should be re-categorised as opex.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 10-6 Base E&D capex evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	This is evident and documented in the earlier network planning approach and evaluation sub-sections.
A3(b)	Policies and planning standards were applied appropriately	Yes	This is evident and documented in the earlier network planning approach, capex drivers and solutions and evaluation sub-sections.
A3(c)	Transpower's process is reasonable and cost effective	Yes	This is evident and documented in the earlier network planning approach and evaluation sub-sections.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	This is evident and documented in the earlier network planning approach, capex drivers and solutions and evaluation sub-sections.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	This is evident and documented in the earlier network planning approach, capex drivers and solutions and evaluation sub-sections.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	This is evident and documented in the earlier network planning approach, capex drivers and solutions and evaluation sub-sections.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	No	This is evident and documented in the earlier evaluation sub-section.
A3(i)	Whether programme is appropriately linked with other projects or programmes	No	This is evident and documented in the earlier network planning approach, capex drivers and solutions and evaluation sub-sections.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	Proposed procurement approach for this asset portfolio is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy. Refer to our evaluation in Section 7 of this report.

Note: A3 (h) is not applicable to base capex

11. ICT capex

This section evaluates Transpower's proposed ICT capex requirement for the RCP4 period. ICT capex is categorised across five ICT asset portfolios, namely asset management systems, corporate systems, ICT shared services, IT telecoms, network & security services and transmission systems.

Overall, Transpower's ICT expenditure for RCP4 is being proposed in twelve investment cases. Of these only eight of the investment cases have ICT capex associated with them. We reviewed five of these investment cases that have ICT capex associated with them. We also note that we reviewed a sixth investment case (i.e., IC08 – Digital Workplace), which does not have any ICT capex associated with it in RCP4.

11.1 Summary of findings

The table below sets out Transpower's proposed ICT capex requirement for the RCP4 and our conclusion. Of the total proposed capex of $198.5m, we have reviewed the investment cases for $180.3m of capex and accept $180.3m. The remaining investment cases, all of which are non-identified programmes and accounting for $18.2m of capex, have not been reviewed.

Details pertaining to these conclusions can be found in the following sub-sections.

Table 11-1 Summary of findings – ICT capex programme

Investment Case	Programme	Proposed RCP4 ICT capex	IV Conclusion
IC01 – Maintain assets	Identified	$67.6m	Accept: $67.6m
IC02 – TransGO refresh	Identified	$93.7m	Accept: $93.7m
IC04 – Transmission system	Non-identified	$9.9m	Accept: $9.9m
IC05 – DCSM	Non-identified	$1.8m	Accept: $1.8m
IC06 – Corporate IST	Non-identified	$2.1m	Not reviewed
IC07 – Asset management	Non-identified	$8.1m	Not reviewed
IC09 – Cyber security	Non-identified	$7.3m	Accept: $7.3m
IC11 – Digital switch management.	Non-identified	$8.0m	Not reviewed
Total		**$198.5m**	**Accept: $180.3m** **Not reviewed: $18.2m**

11.2 Overview of ICT capex

The RT01 expenditure schedule provided by Transpower sets out a total ICT capex requirement of $198.5m for the RCP4. This expenditure is categorised across five ICT asset portfolios, namely:

– Asset management systems,
– Corporate systems,
– ICT shared services,
– IT telecoms, network & security services, and
– Transmission systems.

As noted in Section 3 of this report, Transpower's ICT strategy and investment framework underpins its proposed ICT capex and opex requirements for RCP4. Within that framework, Transpower has developed a series of ICT sub-strategies to ensure its investments in ICT are aligned to its strategic priorities. Transpower's ICT investments are grouped into a number of investment cases (projects) that are mapped to the sub-strategies with costs ultimately apportioned across the ICT capex asset portfolio.

The investment cases are at the heart of Transpower's proposed expenditure plan. They set out the proposed solutions to meet ICT strategic objectives, evaluate costs and benefits and subsequently set out the investment decision made and a resulting forecast of expenditures. Each investment case contains projections of capex, step up opex, investigation expenditure (invex) and software as a service (SaaS) expenditure for the investment options considered and the investment decision taken forward.

Our evaluation of Transpower's ICT capex requirement focusses on the content of these investment cases, the process that they follow and their alignment to the defined ICT strategy, framework and GEIP.

A total of twelve investment cases have been identified and shared by Transpower. Eleven of these investment cases are associated with modernising Transpower's ICT infrastructure and are specific, one-off projects which deliver a specific technical solution that will become business-as-usual going forward. A further investment case has also been developed to maintain a consistent level of service for Transpower by regularly replacing and repairing those ICT assets which are currently in service (such as computers, monitors, routers etc).

The total ICT capex requirement identified within the investment cases is $215.0m, some 8.3% higher than the expenditure set out in the RT01 expenditure schedule.

We understand that the sum of expenditure set out in the investment cases is greater than the amount proposed in the RT01 expenditure schedule for a number of reasons:

– The RT01 expenditure schedule is based on the view of costs held in February 2023, whereas the investment cases were completed and approved at various times prior to that date. There has been some movement in costs across some of the projects as a result.
– There has also been some reclassification of costs between what is considered 'capex' and what is considered 'opex'.
– Some costs identified in the investment cases have been re-allocated to other asset categories within the RT01 expenditure schedule.

Transpower has provided a reconciliation worksheet which provides line of sight between the costs included in the investment cases and the costs set out in the RT01 expenditure schedule. Transpower has also provided some explanations and reasons for the variances witnessed.

The following table presents Transpower's proposed ICT capex for the RCP4 period as per the RT01 expenditure schedule, broken down by the twelve investment cases. Eight of the twelve investment cases have ICT capex associated with them in the RCP4 period.

Table 11-2 Proposed RCP4 ICT capex by investment case

Investment case	RCP4 ICT capex	Associated ICT capex
IC01 – Maintain assets	$67.6m	Yes
IC02 – TransGO refresh	$93.7m	Yes
IC03 – BIM	$0.0m	No
IC04 – Transmission system	$9.9m	Yes
IC05 – DCSM	$1.8m	Yes
IC06 – Corporate IST	$2.1m	Yes
IC07 – Asset management	$8.1m	Yes
IC08 – Digital workplace	$0.0m	No
IC09 – Cyber security	$7.3m	Yes
IC10 – DA Analytics	$0.0m	No
IC11 – Digital switch management (DSM)	$8.0m	Yes
IC12 – IT Service, Delivery & Management (ITSM)	$0.0m	No
Total	**$198.5m**	

Source: Transpower, IV recon RT01_IC.xlsx; worksheet 'reconciliation', GHD Analysis

For the purposes of this IV report, when discussing the proposed ICT capex requirement in total, we present the proposed ICT capex based on the data contained within Transpower's RT01 expenditure schedule. However, our evaluation of the prudency and efficiency of the proposed investments is centred on the content of the investment cases shared by Transpower.

Our evaluation of the investment cases is undertaken at a macro level such that we review the investment case as a whole (rather than just focussing on the ICT capex element). In doing so, we are ultimately commenting on the prudency and efficiency of all costs identified within the investment cases – capex, ICT step opex, ICT SaaS opex and invex – regardless which asset category the costs ultimately sit within the RT01 expenditure schedule. Within this evaluation, and where necessary, we map the cost differential between the investment case expenditures and the proposed RT01 expenditure schedule and set out the reasons for the variance (as provided by Transpower) and comment on them where appropriate.

Our evaluation of the investment cases is set out in Section 11.5 of this report.

11.2.1 Software as a Service

SaaS are cloud-based IT applications. SaaS is becoming a more common platform for the provision of software across many businesses and industries where users subscribe to the software instead of buying it. Common forms of SaaS include Microsoft 365 and SAP. SaaS is not a business initiative or a condition specific to the electricity industry, rather this is a business-as-usual function.

The advantages to Transpower of SaaS are that the software vendor is responsible for ensuring that the software is up-to-date and available for all the recorded users. There are operational advantages for Transpower in that they no longer need to own / maintain servers and manage upgrades when released by the manufacturer.

Traditionally software procured by the business has been capitalised and as such, costs relating to SaaS have historically been reported as capex and embedded within one of the five ICT capex asset portfolios - namely asset management systems, corporate systems, ICT shared services, IT telecoms, network & security services, and transmission systems.

However, the International Financial Reporting Standards (IFRS) Interpretations Committee (IFRIC) published a decision[295] in March 2021 on how entities are to account for the costs of configuring or customising a supplier's application in SaaS arrangements. The implication of this decision is that SaaS costs need to be expensed instead of capitalised.

As of 2021/22, Transpower has re-categorised SaaS expenditures from capex to opex and report SaaS as part of its ICT opex requirement for the purposes of the RCP4 submission. That is to say that SaaS costs incurred in 2020/21 and earlier continue to be reported by Transpower as ICT capex and remain embedded within the five ICT capex asset portfolios within the historical ICT capex data.

We do not consider SaaS any further as part of the ICT capex section of this IV report, except within our evaluation of the investment cases set out in Section 11.5 of this report. Please refer to Section 16 of this report for a discussion of Transpower's proposed ICT opex, which includes sub-sections dedicated to the reporting of SaaS.

11.2.2 System Operator Service Provider Agreement

SOSPA (System Operator Service Provider Agreement) is a mechanism for Transpower, as the System Operator, to receive a fee for both operating the network and a capital fee for the administrative settlement for the grid owner (Transpower – Transmission) business. As with any system operator / asset owner there are services which are integrated, however financially they need to be separated.

We have examined IT services costs submitted as part of the ICT capex to confirm that the SOSPA ICT capex are separated out. Within IC05 Data Center Service Modernisation and IC10 Data Analytics investment cases we can see the expected SOSPA capex, and that these costs have been apportioned and separated out of the ICT capex.

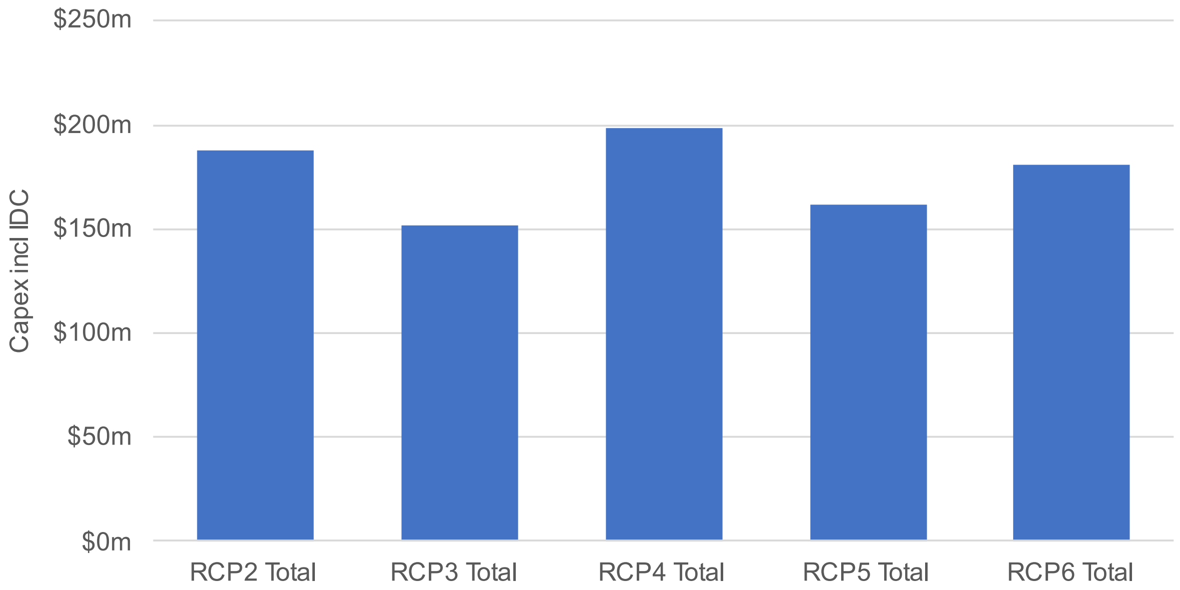
We are confident that there are no SOSPA associated costs within Transpower's ICT capex request for RCP4.

[295] https://www.ifrs.org/news-and-events/updates/ifric/2021/ifric-update-march-2021/

11.3 Expenditure profile

ICT capex refers to all capital investments that are required to deliver on Transpower's ICT strategy via its ICT investment framework. The following figure presents the long-term cost profile of ICT capex from RCP2 to RCP6.

Figure 11-1 ICT capex profile



Source: Transpower, RT01 expenditure schedule.

From 2021/22 onwards SaaS has been recategorized as ICT opex, however, due to the way the data is captured and reported by Transpower, SaaS expenditures were accounted for as capex and included in the RCP2 totals and for the first year of RCP3 in the chart above.

Transpower is proposing a substantial increase in ICT capex in RCP4 compared to the RCP3. The following table shows the change in proposed expenditure levels in RCP4 compared to the RCP3. Average annual capex in RCP3 is anticipated to be $30.4m per annum. In RCP4, capex is expected to increase to an average of $39.7m per annum.

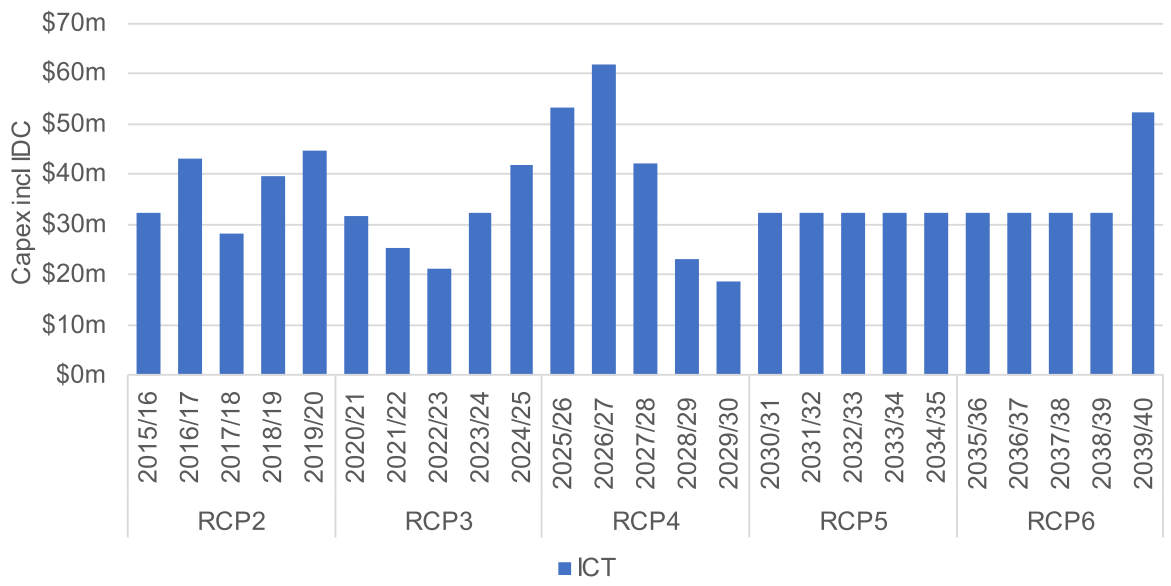
Table 11-3 ICT capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
ICT capex (excluding SaaS)	$151.9m	$198.5m	30.7%

Source: Transpower, RT01 expenditure schedule and GHD analysis.

The above does not tell the whole story, however. The following figure sets out the ICT capex profile from RCP2 to RCP6 on an annual basis. Noting the inclusion of SaaS expenditures up to an including 2020/21, it is apparent that Transpower is forecasting a significant increase in ICT capital expenditures from 2023/24 onwards, peaking in 2026/27 before reducing through the remainder of the RCP4.

Figure 11-2 RT01 RCP2 to RCP6 annual ICT capex



Source: Transpower, RT01 expenditure schedule and GHD analysis.

We can see in the first part of RCP3 (2020/21 to 2022/23) that there has been a drop off of ICT capex. This is subsequently forecast to ramp up significantly through the remainder of RCP3 and into the start of RCP4.

11.4 Deliverability assessment

Transpower undertook an ICT deliverability assessment in early 2023[296]. This assessment of the delivery challenges within the ICT portfolio was instigated as Transpower were not able to deliver the planned works for the RCP3[297]. This was based on experience of the prior two years, where Transpower were aware that they were not delivering to the planned works.

There is no single clear reason for the deliverability issue identified by Transpower, rather a reflection of similar issues across multiple projects. As an example, the ability for Transpower to secure expert resources was challenging and when considered for one single project would not be an issue, but when multiplied across several projects, led to delays. In a similar fashion, procurement and supply chain delays were incurred, which then impacted on the individual project.

In summary, there is not a clear event that caused widespread delay in the projects, rather the compounding of small issues, leading to the larger impact.

We note that Transpower do not list Covid-19 directly as a cause for the deliverability issues witnessed to date in RCP3. In our opinion, the well documented restrictions on global, national and local travel and supply chains is likely to have also played a role to some degree.

11.4.1 Resolution of the deliverability issues

To address the deliverability issues seen in the early part of RCP3, Transpower assessed all the projects under the ICT portfolio, looking specifically to address deliverability and to propose modifications to the RCP3 plan to successfully ensure delivery.

The assessment identified deferrals and cancellations against specific projects, and a summary of these actions is provided in the table below.

[296] Assessment summarised in the following report. ICT Delivery Approach RCP3 / RCP4; Approved 02-03-2023
[297] ICT Delivery Approach RCP3 / RCP4; Approved 02-03-2023; Section 6; RCP3 / RCP4 Deliverability Assessment by Portfolio; page 15

Overall, Transpower, has deferred or cancelled around $13.9m of ICT capex in RCP3 to date. This is equivalent to 10%[298] of the proposed RCP3 capex.

Table 11-4 Proposed deferrals following deliverability assessment

Solution	Project	RCP3 impact (reduction)
Reduction in RCP3 capex	DSM Phase 3	$1.0m
Start later in RCP3	AMPS lifecycle refresh	$0.5m
Defer to RCP4	Advanced digital workflow	$0.6m
	Enhanced data acquisition	$0.3m
	TEES replacement	$1.5m
	Consolidate H&S systems	$0.5m
	Technology lifecycle refresh	$0.6m
	Substation LAN refresh	$3.7m
	BIM digital twin	$0.6m
	AM automation refresh	$0.3m
	Grid operator intelligence	$0.6m
	Digitise telemetry data	$1.0m
Sub total deferrals		**$10.6m**
Cancellations	SRAM	$1.0m
	Lightning detection refresh	$1.5m
	SCADA operator usability	$0.8m
Sub total cancellations		**$3.3m**
Total		**$13.9m**

Source: ICT Delivery Approach RCP3 / RCP4; Approved 02-03-2023; Figure 8; page 15 and Figure 9; page 16.

11.4.2 RCP3/RCP4 ramp up

Transpower's RCP4 proposal shows a ramp up in expenditure, starting in 2023/24 and increasing into RCP4 before tailing off in the latter years of RCP4. Whilst the ramp appears to be partially driven by picking up deferred capex, it is worth noting the impact that the TransGo Refresh project (IC02) has on the overall ICT capex profile.

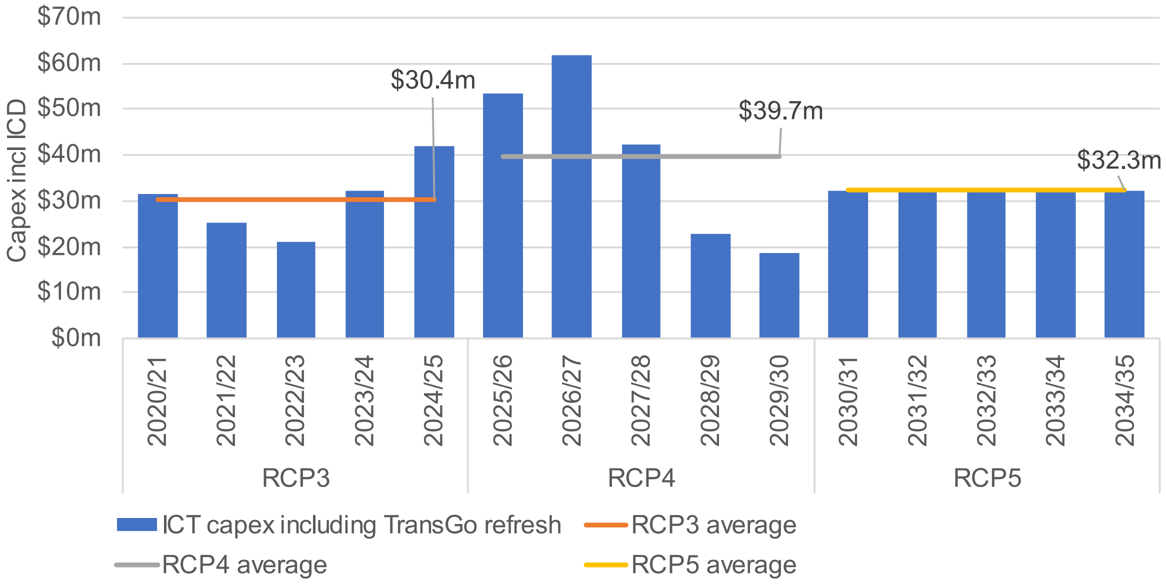
The TransGo Refresh project is a significant capex project, with a total forecast capex of $116.6m[299] across RCP3 and RCP4. The project accounts for around 47% of the proposed ICT capex forecast in RCP4.

The TransGo Refresh project is a one-off project, where the project capex is expected to reach a total of $19m by the end of the RCP3 period, of which Transpower anticipate nearly $15m will be spent in 2024/25 itself. A further $93.7m of capex is forecast through RCP4, with nearly two thirds incurred in the first two years (2025/26 and 2026/27). The project is scheduled to be complete (from a capex perspective at least) by the end of 2029/30.

To see the impact of TransGo Refresh on the ICT capex forecast, the figure below, presents annual ICT capex for the RCP3 to RCP5 period, with and without the capex relating to the TransGo Refresh project.

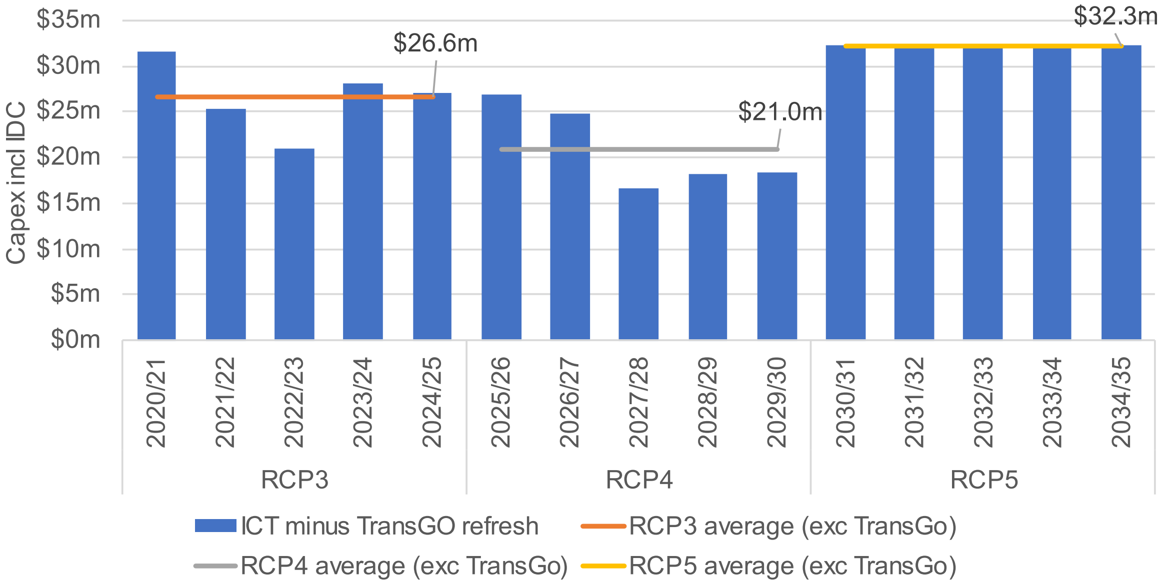
[298] 13.9 / 146.3 = 0.95. Synergies GHD Independent Report Transpower RCP3 Expenditure Proposal; Table 73; page 236
[299] IV recon RT01_IC.xlsx; IC individual worksheet (RT01 total for TransGo Refresh)

Figure 11-3 RCP3 to RCP5 annual ICT capex with TransGo refresh Project



Source: RT01 expenditure schedule; IV recon RT01_IC.xlsx; IC individual worksheet

Figure 11-4 RCP3 to RCP5 annual ICT capex without TransGo Refresh Project



Source: RT01 expenditure schedule; IV recon RT01_IC.xlsx; IC individual worksheet

Transpower is projecting the average annual ICT capex to increase by 31% between RCP3 and RCP4 (from an average of $30.4m per annum to an average of $39.7m per annum). This is followed by a drop of 19% from RCP4 to RCP5 (to an average of $32.3m per annum). Removing the TransGo Refresh project from the ICT capex portfolio changes the profile of expenditure significantly. Without the TransGo Refresh project, the average annual ICT capex in RCP3 reduces to $26.6m per annum, whilst the average annual capex in RCP4 falls from $39.7m to $21.0m.

The TransGo Refresh is a key driver of Transpower's forecast for ICT capex across RCP3 and RCP4. It is evaluated in detail as an identified programme in Section 11.5 of this report.

11.5 Evaluation

To assess whether Transpower's proposed base R&R capex for this asset portfolio was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

Our assessment has involved reviewing the provided initial tranche of documentation pertaining to ICT capex and interviewing the relevant Transpower management team and subject matter experts. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting evidence that informed Transpower's proposed RCP4 ICT capex.

We also considered the ICT strategy and investment framework discussed and evaluated in Section 3 of this report.

Our evaluation of the prudency and efficiency of Transpower's ICT capex forecast focusses on the content of the investment cases, the process that they follow and their alignment to the defined ICT strategy, framework and GEIP. Six investment cases have been selected to be evaluated in detail. These are:

- IC01: Maintain Services (Maintain Assets)
- IC02: TransGO Refresh
- IC04: Transmission Systems
- IC05: DCSM
- IC08: Digital Workplace
- IC09: Cybersecurity

Collectively those projects account for around 91% of the proposed ICT capex for RCP4. All investment cases that make up the identified programme have been evaluated (IC01 - Maintain Services and IC02 - TransGo Refresh), whilst we have also evaluated investment cases that make up a large proportion of the non-identified programme too.

However, as noted below, the sum of expenditures set out in the investment cases differ to the expenditures set out in Transpower's RT01 expenditure schedule. As only six investment cases are evaluated in detail, to assist the reader in understanding the costs set out in the investment cases and how they relate to Transpower's overall proposed expenditure requirement, an overview of the investment case costs and Transpower' reconciliation to the RT01 expenditure schedule is provided below.

11.5.1 ICT expenditure summary

The twelve investment cases shared by Transpower include costs for the chosen investment option, broken down by capex, step-up opex (only), SaaS opex and invex for each year of RCP3 and RCP4. The costs are summarised in Table 11-5. The table shows a total ICT capex requirement in RCP4 of $215.0m and additional opex step change costs of $51.3m, SaaS opex of $46.5m and total invex costs of $11.0m.

The reconciliation worksheet provided by Transpower which provides a breakdown of costs by investment case but aligns with the RT01 expenditure schedule is presented in Table 11-6. The table shows a total ICT capex requirement in RCP4 of $198.5m and additional opex step change costs of $43.5m, SaaS opex of $55.8m and total invex costs of $12.9m.

On first appearance, the numbers appear to be significantly different, with significant changes in total portfolio costs as well as within projects. As noted in the introduction to this section of the report, there are a number of drivers for the differences observed, including:

- The RT01 expenditure schedule is based on the view of costs held in February 2023, whereas the investment cases were completed and approved at various times prior to that date. There has been some movement in costs across some of the projects as a result.
- There has also been some reclassification of costs between what is considered 'capex' and what is considered 'opex'.
- Some costs identified in the investment cases have been re-allocated to other asset categories within the RT01 expenditure schedule.

Table 11-5 Investment case costs ($m)

	RCP3					RCP4				
Investment Cases	**ICT capex**	**ICT opex (step)**	**SaaS opex**	**AM&O and ICT Invex**	**Totex**	**ICT capex**	**ICT opex (step)**	**SaaS opex**	**AM&O and ICT Invex**	**Totex**
IC01 – Maintain assets	42.0	2.0	0.0	5.2	**49.1**	67.7	0.0	0.0	5.0	**72.7**
IC02 – TransGO refresh	19.0	0.0	0.0	0.7	**19.7**	93.7	0.0	0.0	0.0	**93.7**
IC03 – BIM	5.2	2.5	0.0	0.5	**8.1**	4.8	3.5	0.0	0.5	**8.8**
IC04 – Transmission system	5.2	0.1	1.5	1.1	**7.8**	7.1	1.5	2.8	0.9	**12.3**
IC05 – DCSM	14.0	7.1	0.0	0.0	**21.1**	7.8	29.9	0.0	1.8	**39.5**
IC06 – Corporate IST	1.0	1.7	6.0	3.0	**11.8**	2.1	2.2	32.1	0.9	**37.3**
IC07 – Asset management	2.3	0.0	1.8	0.8	**4.9**	8.2	0.5	7.4	1.6	**17.7**
IC08 – Digital workplace	0.0	0.0	0.0	0.0	**0.0**	0.0	2.9	0.6	0.1	**3.7**
IC09 – Cyber security	10.2	0.5	0.7	0.0	**11.4**	7.3	5.9	3.2	0.0	**16.4**
IC10 – DA Analytics	16.1	0.0	0.0	0.0	**16.1**	10.0	4.4	0.0	0.0	**14.4**
IC11 – Digital switch management	11.3	0.0	0.0	0.0	**11.3**	6.5	0.0	0.0	0.0	**6.5**
IC12 – ITSM	0.4	0.1	0.5	0.0	**1.1**	0.0	0.4	0.3	0.1	**0.7**
Total	**126.8**	**13.9**	**10.6**	**11.1**	**162.4**	**215.0**	**51.3**	**46.5**	**11.0**	**323.7**

Source: Transpower, IV recon RT01_IC.xlsx.

Table 11-6 ICT expenditure by investment case – reconciled to RT01 expenditure schedule ($m)

	RCP4				
Investment Case	**Capex**	**ICT Step opex**	**SaaS opex**	**Invex (ICT and AM&O)**	**Totex**
IC01 – Maintain assets	67.6	0.0	0.0	4.4	**72.0**
IC02 – TransGO refresh	93.7	3.0	0.0	0.2	**96.9**
IC03 – BIM	0.0	2.1	0.8	0.6	**3.4**
IC04 – Transmission system	9.9	1.5	0.0	0.9	**12.2**
IC05 – DCSM	1.8	20.0	1.4	2.2	**25.4**
IC06 – Corporate IST	2.1	2.2	32.1	1.5	**37.9**
IC07 – Asset management	8.1	0.5	7.5	1.6	**17.7**
IC08 – Digital workplace	0.0	2.9	0.6	0.1	**3.7**
IC09 – Cyber security	7.3	5.9	3.2	1.1	**17.7**
IC10 – DA Analytics	0.0	4.9	10.0	0.1	**15.0**
IC11 – Digital switch management.	8.0	0.0	0.0	0.3	**8.3**
IC12 – IT Service, Delivery & Management	0.0	0.4	0.3	0.1	**0.7**
Total	**198.5**	**43.5**	**55.8**	**12.9**	**310.7**

Source: Transpower, IV recon RT01_IC.xlsx

When considering the differences between the capex values, for the purposes of the investment cases capex and SaaS opex are inter-changeable as the treatment of SaaS is driven by accounting only. On this basis:

- Whilst the difference between capex identified in the investment case ($215.0m) and the expenditure schedule ($198.5m) is $16.5m, the total difference between the capex and SaaS opex costs identified in the investment cases ($261.5m) and the RT01 expenditure schedule ($254.3m) is much reduced at $7.1m. This equates to around a 2.2% difference. There are three key drivers behind this difference of $7.1m.
- The capex (capex + SaaS opex) of IC03 is unchanged within the investment case, but $4.0m has now been allocated to network capex and so does not appear in the RT01 expenditure schedule under ICT capex.
- The capex (capex + SaaS opex) of IC05 is also unchanged within the investment case, but $4.6m has now been allocated to capitalised leases and so does not appear in the RT01 expenditure schedule under ICT capex.
- IC11 has experienced an increase in costs (capex + SaaS opex) of +$1.6m.
- These three changes account for nearly all of the variance from a capex perspective.
- There are minor changes in capex (capex + SaaS opex) in IC01, IC04, IC06 and IC07 (each less than $0.1m).
- The capex (capex + SaaS opex) of IC02, IC08, IC09, IC10 and IC12 are the same in both the investment cases and the RT01 expenditure schedule. It can be noted that whilst IC10 remains unchanged from a capex + SaaS opex perspective, the entirety of the ICT capex amount set out in the investment case has been reclassified as SaaS opex.

Based on the above, we are comfortable that from an ICT capex perspective and SaaS opex perspective, we have a line of sight between the investment case RCP4 capex value of $215.0m and the proposed RCP4 ICT capex forecast of $198.5m set out in the RT01 expenditure schedule. The costs proposed in the expenditure schedule and the variances observed have been explained.

When considering ICT step opex, we note:

- For IC02, Transpower has added $3.0m of step opex which is not detailed in the investment case, but this change is identified in the opex documentation provided by Transpower.

– The step opex in IC03 is $1.5m lower in the expenditure schedule than in the investment case. We have been informed that the costs have been reclassified as Business Support opex rather that ICT opex as the cost relates to FTE increase. As such, the total step opex is in the investment case remains unchanged.
– The $29.9m of step opex identified in the investment case of IC05 remains unchanged. The reduction shown in the expenditure schedule is due to $9.9m being reallocated to the base year opex, with the remaining $20m continuing to be considered as step ICT opex.
– The step opex of IC10 has increased costs of +$0.5m compared to the investment case.
– The step opex of IC01, IC04, IC06-IC09 and IC11-12 are the same in both the investment cases and the RT01 expenditure schedule.

When considering ICT invex, we note:

– Invex has increased by $1.9m from the investment cases to the RT01 expenditure schedule.
– The most significant increase is $1.1m for the IC09 which is offset by a significant reduction (-$0.6m) in IC01. Less significant increases occur across most investment cases.
– Of the $12.9m of opex identified in the expenditure schedule, $7.0m has been identified as AM&O invex. The remainder ($5.9m) is identified as ICT opex.

On the basis of capex and opex reconciliation summarised above, we are comfortable that the integrity of the investment cases is maintained such that although the costs in the investment cases differ to those in the RT01 expenditure schedule, these have been explained and can be followed. As such, the processes, the content and the findings of the investment cases can be used as the basis for our evaluation of the prudency and efficiency of the Transpower ICT capex and opex forecasts.

In the following sub-sections we set out our evaluation of the six chosen investment cases and state our opinion on the proposed ICT capex value of $180.3m. Whilst the evaluation of the investment cases considers the costs in their entirety (capex, opex and invex), our analysis of how these costs are applied by Transpower in their opex forecasts are discussed in the appropriated opex sections (Section 15 of this report for AM&O opex and Section 16 of this report for ICT opex).

11.5.2 IC01 – Maintain Services (Maintain Assets)

The following table summarises our verification of the IC01 – Maintain Services which is categorised as an **identified programme** and forms part of the base ICT capex for RCP4.

Table 11-7 Verification summary of IC01 – Maintain Services

Verification element	Verification commentary
RCP4 proposed amount	$67.6m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $67.6m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

Overview

The Maintain Services investment case focuses on the ICT assets deployed by Transpower to ensure that they provide a reliable and secure service for the critical transmission network and enterprise functions. The IC01 investment case considers investments into the ICT assets which are coming to, or are at, the end of their life. Transpower maintain asset lifecycle management strategies for all the classes within this category and this covers the assets needing replacement across RCP3 and RCP4.

There are three types of assets captured in the maintain services investment case (telecommunications, infrastructure and applications). A summary is provided in the following table.

Table 11-8 Asset segments relating to Maintain Services investment case

Asset segment	High-level asset summary	Services supported
Telecommunications	6,500 km fibre 560 multiplexors 38 routers 2,000 switches	Provides connectivity to substations, offices and data centres and provides Transpower with critical infrastructure support 24/7.
Infrastructure	1,600 virtual servers (instances) 270 physical servers 1,700 TB of storage 1,200 corporate desktops	Supporting connectivity, the operational environment, workplace productivity services, and equipment for the business activities.
Applications	Applications to deliver business critical or enterprise functions.	Applications supporting activities across Transpower. Planning, commissioning, maintenance on a 24/7 service.

Source: ICT022 IC01 Maintain Assets ICT Investment Case.pdf; page 8

The total proposed expenditure in the investment case across RCP3 and RCP4 is shown in the following table.

Table 11-9 IC01 - Maintain Services expenditure ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	20.8	12.1	13.1	11.7	19.1	**76.8**	14.8	15.5	9.0	13.5	14.7	**67.7**
Step opex[1]	-	-	-	-	-	**-**	-	-	-	-	-	**-**
SaaS opex[2]	-	-	-	-	-	**-**	-	-	-	-	-	**-**
Invex[3]	0.1	-	1.6	2.5	1.0	**5.2**	1.0	1.0	1.6	1.0	0.4	**5.0**
Total	**20.9**	**12.1**	**14.7**	**14.2**	**20.1**	**82.0**	**15.8**	**16.5**	**10.6**	**14.4**	**15.1**	**72.7**

Source: Transpower, ICT022 IC01 Maintain Assets ICT Investment Case.pdf
Notes:
[1] In the latest reconciliation worksheet provided by Transpower, some step opex is identified in the RCP3 period but is not evident in the investment case documentation shared. For the purposes of our review of the investment case, the table above focusses on the costs identified in the original investment case. There is no ICT opex identified in the RCP4 period in any of the documentation and reconciliation files received.
[2] SaaS opex is not separated out from the capex expenditure.
[3] includes AM&O and ICT opex.

The investment case contains identified expenditure in both capex and opex. The capex is further broken down into two sub-categories – recurrent expenditure and non-recurrent expenditure. Recurrent expenditure relates to investments that are repeatable across a five-year rolling period whilst non-recurrent expenditure relates to one-off investments to modernise existing equipment.

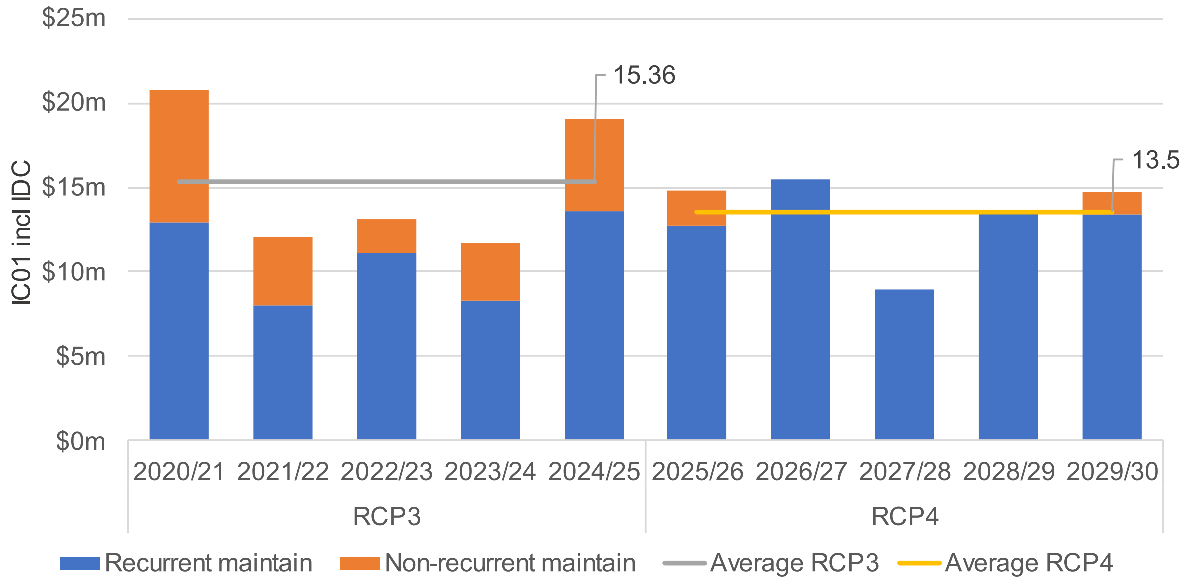
The breakdown of capex by recurrent and non-recurrent expenditure is shown in the following table.

Table 11-10 IC01 - Maintain Services capex by category ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Recurrent maintain	12.9	8.0	11.1	8.3	13.6	53.9	12.7	15.5	9.0	13.5	13.4	64.3
Non-recurrent maintain	7.9	4.1	2.0	3.4	5.5	22.9	2.1	-	-	-	1.3	3.4
Total capex (inc SaaS opex)	**20.8**	**12.1**	**13.1**	**11.7**	**19.1**	**76.8**	**14.8**	**15.5**	**9.0**	**13.5**	**14.7**	**67.7**

Source: Transpower, ICT022 IC01 Maintain Assets ICT Investment Case.pdf, page 16

Figure 11-5 IC01 - Maintain Services: capex across RCF3 and RCP4 by category



Source: ICT022 IC01 Maintain Assets ICT Investment Case; table on page 8.pdf

The annual average expenditure for RCP4 ($13.5m per annum) drops by about 12% from RCP3 ($15.4m per annum). However, we note that there is considerable variability between the years, with expenditure ranging between around $9m and $21m in any given year. This is driven by the recurrent capex element which is based on the lifecycle of the specific assets and ranges from 2, 3, 4 and 5 years.

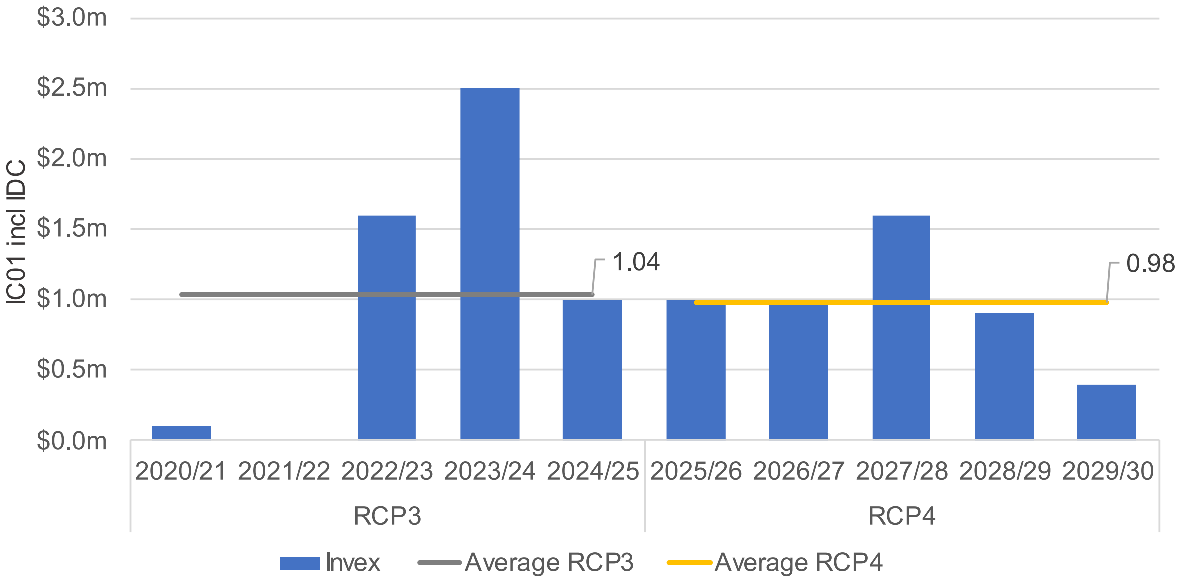
ICT opex

The opex identified in the investment case relates to Invex. Invex in this investment case relates to expenditure that allows exploration and investigation into alternatives or upgrades to current systems which are coming to their end-of-life and to explore potential alternatives or solutions to future needs. This can take the form of procuring newer, alternative technologies for review and comparison on how it performs compared to existing assets.

For IC01, it should be noted that opex to maintain the assets is zero as once the assets are capitalised, the cost of maintaining them is captured under one of the six opex categories.

The profile of invex is shown in Figure 11-6. We can see that Transpower intend to spend more on investigations in 2023/24 as Transpower has identified a programme under 'Management Systems Modernisation' as the current ICT management systems are expected to need updating, upgrading, or replacing in RCP4.

Figure 11-6 IC01 - Maintain Services: Invex (opex) across RCF3 and RCP4



Source: ICT022 IC01 Maintain Assets ICT Investment Case; table on page 8.pdf
#ICT opex is zero

Expenditure drivers and solutions

The driver of this investment case can be captured in two main factors for capex and one for opex, in line with the expenditure plan. The three sections are summarised below.

- **Recurrent capex:** Recurring Investments aimed at maintaining and updating existing ICT services, functionality, capability and/or market benefits through a regular upgrade programme.
- **Non-recurrent capex:** One-off, non-recurring investments driven by the want/need for the newer capability offered by a replacement system or by the need to replace an existing asset at the end of life.
- **Invex opex:** has been developed to examine potential alternatives or solutions to future needs. This can take the form of procuring newer, alternative technologies for review and comparison on how it performs compared to existing assets. The expenditure is an opex element.

The driver for this investment case focuses on the replacement of end-of-life assets with solutions reviewed to see if a modern equivalent asset would enhance the current services. The decision on the end-of-life, or extension to end-of-life assets, for the case of ICT equipment, is driven by maintaining a low risk to the business, which is captured in Transpower's guide to risk[300].

There is an interaction between opex and capex as where assets or services are coming to the end-of-life, Transpower are able to explore alternative solutions through opex, which will also include a review if the capex will stay as recurrent, or non-recurrent.

The investment case identifies several ICT related works which potentially overlap with other ICT investment cases. Transpower has resolved the overlaps by only allocating expenditure to the Maintain Services investment case that are not captured by other investment cases. We were able to identify in the investment case for Maintain Services and for similar other investment cases, areas of overlap and where one had been deducted from the other. The remaining expenditure was reviewed to see if there was any duplication between this programme of work and other investments, and we did not identify any crossover.

As Transpower has a low-risk appetite, this results in differences in replacement cycles for critical and enterprise asset categories and guidelines to match the risk profile to the service levels. The ICT assets are categorised according to the critical level of services they support, and replacement cycles defined in the asset lifecycle management strategies.

[300] Transpower's ICT Risk and Assurance Policy.

Evaluation

There are twelve investment cases associated with modernising the ICT infrastructure. These are a mix of specific, one-off projects which deliver a specific technical solution that will become business-as-usual. There is a second category of ICT assets which are currently part of the business-as-usual and need repairing or replacing on a regular basis, such as computers, monitors, routers. The investment case is designed to maintain a consistent level of service for Transpower by replacing and repairing those ICT assets which are currently in service.

An important factor in maintaining the current assets is acknowledging that there is both an opex/capex trade-off and a capex/capex trade-off, such that as investments are made in ICT the existing portfolio is considered. An example would be the introduction of Software as a Service (SaaS). SaaS removes the need for in house servers to maintain copies of software as this is managed by the manufacturer, as are updates to the software. This requires less infrastructure to be owned by Transpower. In this case, Transpower has identified a capex saving by moving to SaaS – which is now classified as opex.

Within this investment case, Transpower has identified three investment segments:

– Telecommunications,
– Infrastructure, and
– Applications.

The expenditure within each segment is established by applying a three-step process:

– Identity the asset / application that needs replacement.
– Review if the asset / application crosses over into another investment case and conversely confirm that the proposed intervention is sufficiently separate from other investment cases that it falls into this investment case.
– Confirm the proposed solution is appropriate. This includes assessing the option of replacing recurrent expenditure with non-recurrent expenditure. The preferred solution should offer a lower cost whilst maintaining the level of exposure to risk.

The three-step approach is followed across the three segments, as noted in the following table.

Table 11-11 Process for identifying expenditure within each investment segment

Step	Process	Commentary
1	Identity the asset / application that needs replacement.	In the case of Maintain Services, across all three investment segments, the asset life is known and there is an expected replacement date. As the assets reach their end of life, they are assessed to see if the replacement can be delayed and for how long. Transpower has delayed the replacement of assets, especially where a larger investment case can be the replacement. Transpower has also shown that replacement is initially based on like-for-like, however they also review the modern equivalent, which may offer additional services that the original equipment did not offer. This is considered as the replacement is due.
2	Review if the asset / application crosses over into another investment case.	As much of the Maintain Services is ongoing replacement, staggered to manage workload and interruptions to the services, Transpower do review the assets when larger investment cases are proposed, for example TransGo Refresh. As a process, the investment cases align with the strategies, which also interact with Maintain Services. There are long term plans and strategies in place examining the overall condition of the assets and the services they provide. An example is TransGo Refresh, where existing routers will be replaced now with like-for-like assets. The timing of TransGo Refresh means that the current obsolete routers need replacing now, and by the time TransGo Refresh is delivered, the replacements will be towards their end of life and there should be sufficient 'life' if there is a delay. We view this as the correct approach to asset management.
3	Confirm the solution is appropriate.	As with any asset replacement, there is a need to confirm that the replacement is still needed, that is an asset is not just being replaced as there was one there before. In many cases, modern replacements have higher capacities, and the number of units can be reduced. Transpower has demonstrated that the replacement assets are assessed for additional functionality that was not available in the original asset. We see that Transpower has a strategy that looks at the future needs of the business and if the current

Step	Process	Commentary
		assets deliver that need. With ICT, the change is more step change to a newer standard than gradual growth. We are of the view that this is captured in the strategy.

Establishing the cost of Maintaining Services

The Maintain Services investment case provides for the replacement of a range of asset segments with the adoption of two different types of capex investments (recurrent and non-recurrent) and one opex – investigation. As a result, there are several different cost estimation techniques that are used to arrive at an estimate. The method used is based on the investment type and available information.

In summary:

– **Recurrent capex:** A comparative approach is adopted in which the replacement cost is expected to be consistent with historical costs as the assets are readily available from suppliers. The most recent actual cost (or an average if available) is extrapolated forward to develop the expected recurrent capex forecast.

– **Non-Recurrent:** Transpower use an expert judgement approach using estimation input from subject matter experts with experience and understanding of the project requirements and costs to develop the expected non-recurrent capex forecast.

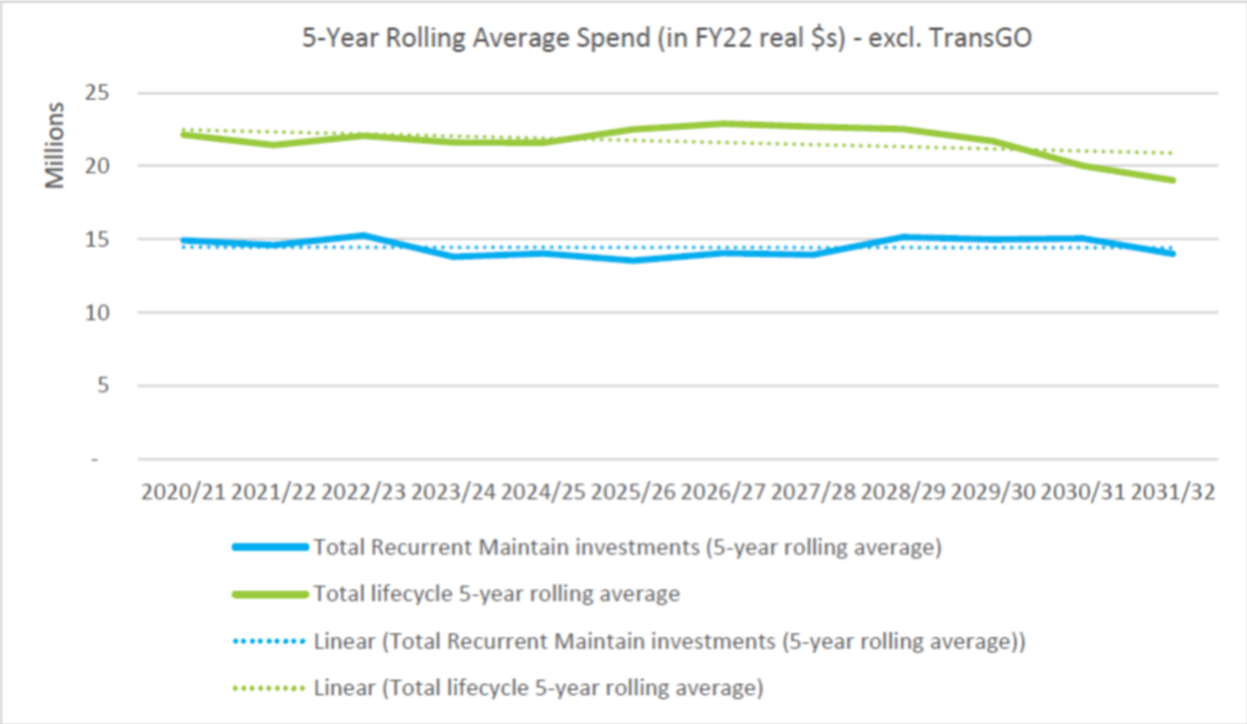
– **Invex (opex):** Transpower use a base-step-trend and a bottom-up approach to derive the Invex (opex) forecast. The base is 2021/22 years with steps and trends. As IC01 – Maintain Assets is replacement of end-of-life assets, the only opex element relates to investigations.

When coupled with the identified need, these cost estimation techniques lead to the RCP4 programme of works.

The costs are built up from recent projects and replacements. For Maintain Services, there is a continual replacement of assets, and the costs should be well understood, even when it comes to modern equivalents. The Maintain Services can be defined as is a continual replacement of existing assets, the cost profile is based on a bottom-up assessment and does fluctuate through the years.

The following figure shows two lines, the green line which is based on the forecast lifecycle replacement period – that is without any life extension due to condition or manufacturer support, and the actual replacement undertaken by Transpower who actively look to extend the life of the assets where it is feasible. We can see that life extension is reducing the costs, which we agree is the correct approach.

Figure 11-7 IC01 - Maintain Services: Invex (opex) across RCF3 and RCP4



Source: ICT022 IC01 Maintain Assets ICT Investment Case.pdf; figure 4, page 18

Delivery of the investment case

As part of the investment case, a roadmap has been provided showing the individual investments and the cycle of refresh. An example of the telecommunications investment roadmap is provided in the figure below. There are also roadmaps for infrastructure and applications.

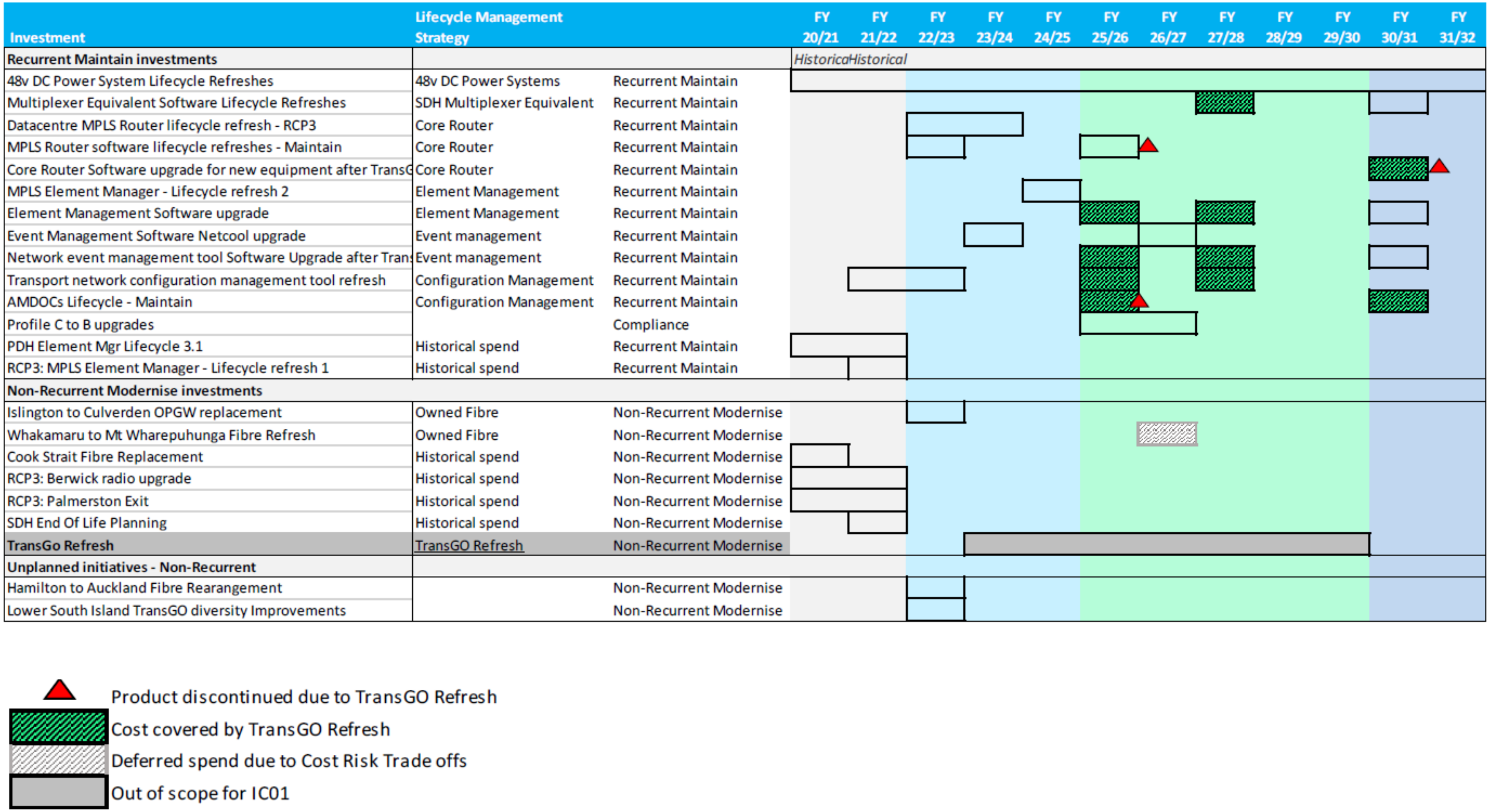
The roadmap allows us to identify a number of key good industry practices, namely:

– Reduction in cost due to an alternative – in this case the cost is covered due to TransGo Refresh.
– Out of scope costs, that any cost associated with TransGo Refresh should not be captured under IC01.
– Alternatives are considered, including removal – product discontinued due to TransGo Refresh.
– The cyclic nature of the assets shows the ongoing need for the IC01 investment case.

In terms of deliverability, this capital programme has been running throughout RCP3 and will also continue through RCP4. There is an interaction with TransG Refresh, however deliverability of TransGo Refresh is captured under that particular investment case and the maintain services is separate and should not be affected through RCP4.

Overall, Transpower has a delivery plan supported with a roadmap, and the plan in RCP4 is similar that applied in RCP3, and the number of FTEs is also maintained.

Figure 11-8 Snapshot of telecommunication investment roadmap



Source: ICT022 IC01 Maintain Assets ICT Investment Case.pdf; page 29

Optimisation of the capex

As part of the assessment of the assets and if the asset is still appropriate, consideration is given to the alternatives, this may be an opex/capex trade off, or a capex/capex trade-off. Importantly the roadmap also identifies where services will be transitioned - for example to the cloud as an '…as a service' offering. This also shows that there is consideration regarding integrating new technologies and managing the cost between opex and capex.

An example of the optimisation process is shown within the Applications assets and summarised in Table 55 below.

Table 11-12 Key variances in recurrent maintenance investment for Applications (Example from IC)

Investments driving the variance	Change from RCP3 to RCP4	Rational for variance
Financial Management and Information System (FMIS) Refreshes	-$2.3m	FMIS will be modernised in RCP4, replacing the regular FMIS upgrades as justified by the IC06 Corporate investment case. The modernisation is driven by the product going EOL.
Habitat Refreshes (Part of SCADA Programme)	-$0.7m	Variance is due to the timing of the refreshes in the two regulatory periods. The timing is driven by the vendor roadmaps. RCP3 included the tail-end of one habitat refresh and the full refresh of another. RCP4 has only one refresh.
Payroll Lifecycle Refreshes	-$0.7m	There is one less refresh cycle in the RCP4 period for payroll system. This is due to the lifecycle refreshes being needed every three years as per vendor roadmap.
EMP Refreshes (Part of the SCADA Programme)	-$1.7m	This variance is due to the synergy of delivering this project with the Habitat project which saves circa $1.1 million (10% efficiency due to the tight coupling of the functions of the two products). The remainder of the reduction is due to removal of one-off investments from previous project and timing of the next upgrade spanning RCP3 and RCP4. The timing of investments is aligned to the vendor roadmap.
Transmission Pricing System (TPS) System Lifecycle Refreshes	-$0.8m	The plan utilises synergies by doing the upgrades for TPS system in combination with benefits driven projects as they are not complex and can be combined. However, if these investments are not undertaken then the refreshes will need to be done as standalone projects.
Investments done in RCP3 (FY20-23) but not repeated in our forecast (FY23-30)	$1.6m	These projects include: – CRM platform technology refresh – moved to cloud ($0.5m) – Lightening Detection Servicer and software lifecycle refresh – to be operated as a service ($0.3m), – Remote Systems Test Environment refresh – aligned to the infrastructure assets ($0.4m)
Total	-$7.4m	

Source: ICT02 IC01 Maintain Assets ICT Investment Case.pdf; table 7; Page 22

What we can see is where refresh cycles, timings of replacements or alignments with other investment cases has allowed reductions in the RCP4 over the RCP3 expenditure, which is then captured as a saving.

Conclusion

Overall, the requirement for Maintaining Services is set out over RCP4, and Transpower has shown that they have examined where this investment case interacts with other investment cases. We are satisfied that Transpower had appropriately allocated costs to investment cases avoiding any duplication.

The interaction with other investment cases is also demonstrated where current services are being transitioned, which includes applications being transferred over to cloud services, thus reallocating the cost from capex to opex to deliver a prudent and efficient solution.

The investment case indicates that Transpower undertakes a review of each asset when it reaches its end-of-life to assess whether a replacement is needed, consider whether the investment need is addressed by works proceeding under another investment case, and assess whether any additional services provided by the modern equivalent asset can be leveraged.

There are several different approaches to the cost build up, with the majority based on recent historical costs and forecast forward. This is reasonable, as in most cases, the technology is readily available and thus reflective of the market.

Accepted RCP4 costs

Based on our evaluation of the IC01 investment case, we accept the investment case and the costs identified are prudent and efficient, and consistent with GEIP.

As noted in Section 11.5.1 of this report, the costs set out in the investment cases do not align exactly with the costs set out in the RT01 expenditure schedule. The following table compares the RCP4 costs identified in the IC01 investment case against those costs assigned to the IC01 investment case from the RT01 expenditure schedule.

Table 11-13 IC01 – Maintain Services: Cost comparison for RCP4

IC01 – Maintain Services	Investment case	RT01 expenditure schedule	Difference
ICT capex	$67.7m	$67.6m	-$0.1m
ICT Step opex	-	-	-
ICT SaaS opex	-	-	-
Invex (ICT and AM&O)	$5.0m	$4.4m	-$0.6m
Total	**$72.7m**	**$72.0m**	**-$0.7m**

Source: ICT02 IC01 Maintain Assets ICT Investment Case.pdf, IV recon RT01_IC.xlsx; worksheet 'Reconciliation'

The difference is capex in negligible whilst the invex forecast has reduced. We believe these changes do not alter the integrity and findings of our assessment of the investment case set out above. As such, based on the principle of proportionate scrutiny, that the change is negligible, an acknowledgement that costs change over time, we accept a IC01 totex value of $72.0m, including $67.6m of ICT capex and $4.4m of Invex.

We are comfortable, based on the principles above, that these costs are consistent with the RT01 expenditure schedule which drives its stated request for capex and opex.

Verification assessment

We conclude that the IC01 Maintain Services capex of $67.6m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 11-14 IC01 – Maintain Services evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	We reviewed the investment case, which includes a roadmap for replacement of ongoing assets, and demonstrated that programs were reviewed prior to replacement, in line with good asset management.
A3(b)	Policies and planning standards were applied appropriately	Yes	ICT framework and policies are in place and were applied.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The processes are complex, and therefore do need a structure, which is evident in the investment case.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Alternatives are examined, this is also supported with the invex option to examine alternative solutions within a controlled environment.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	Cost modelling is the most prevalent as differing elements use differing approaches (recurrent = comparative costs; non-recurrent = expert judgement and market testing; invex = bass-step-trend) to determine the total forecast expenditure.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	Comparative cost analysis is used extensively for recurrent replacements which is baselined against the options / services received. Contingencies are minimal as it is maintaining existing assets at the current level of services, which with ICT is a fast progression scenario.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	Capex and opex trade-off is reviewed, along with review of trade off with other investment case plans for RCP3 and RCP4. Evidenced with removal of IC01 costs when IC02 would 'go live'.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	Clear links with other programs of works is demonstrated within the investment case, and the reciprocating investment case.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	Goods are continually procured, no change to the procurement process has been proposed.

Note: A3 (h) is not applicable to base capex

11.5.3 IC02 – TransGo Refresh

The following table summarises our verification of the IC02 – TransGo Refresh which is categorised as an **identified programme** and forms part of the base ICT capex for RCP4.

Table 11-15 Verification summary of IC02 – TransGo Refresh

Verification element	Verification commentary
RCP4 proposed amount	$93.7m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $93.7m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Overview

Transpower owns and operates a private telecommunications network throughout New Zealand which is known as TransGo (Transpower network to support Grid Operations). The network is primarily used to monitor and control the substation and network assets providing electricity via the transmission system. It is also used to run the wholesale electricity market, which Transpower are also the facilitator of that market.

The TransGo network commenced in 2008 and the legacy network was fully decommissioned in 2015. Since 2015, TransGo has been extended to provide connectivity to Northland and the West Coast and new sites that have since been added to the grid.

TransGo underpins all the network services used to operate Transpower's business. These include industry specific critical services, such as protection signalling, Supervisory Control and Data Acquisition (SCADA) and operational voice, as well as enterprise IT services. TransGo is predominantly a privately owned and managed network, utilising optical fibre between substations and Transpower sites.

TransGo assets were expected to last between 10 and 15 years. With the build of the current network starting in 2007 it was initially anticipated the need to refresh the network during RCP3. During the planning for RCP3, Transpower were able to defer the refresh until RCP4 given the ongoing support commitments from their vendors at the time.

Currently, the assets embedded in the network are expected to reach their end of life and technical support from the manufacturers is expected to be withdrawn[301] during the next price control period. The required investment was originally identified in RCP3 and during RCP3 there was a period of 'trade-off' where investment was deferred as the assets were expected to still be fit for purpose.

The usual option is a replacement for a like-for-like technology however the existing technology is no longer readily available, hence a transition to a more modern platform where the equipment is readily available and uses modern fibre protocols is required.

Transpower has examined the use of the network and, unsurprisingly the need for additional services has increased over recent years. This is partly due to development in technologies which were not readily available 10 years ago. Transpower has mapped out 34 services which would use the TransGo network.

– **Move to IP:** Internet Protocol (IP) is now the standard for all network services. The legacy time division multiplex protection services are expected to start moving to IP during the next 10 years. The current network will not be able to meet a number of these future services.
– **Digitalisation:** There is a move towards more services and processes being digitalised. Many of these enhancements require increased network capacity in more physical locations than in the past. The current network design and equipment has the potential to constrain the adoption of these enhancements.
– **Adoption of 'as a service' capabilities:** Across the industry there is a move away from owned and operated infrastructure in favour of '…as a service' applications and infrastructure. This is driving a change in the network away from owned, high capacity, fixed network paths to a more flexible model where network connectivity is consumed on an as needed basis.

The sub strategy considers the balance between Transpower continuing to own the TransGo assets, or procuring access to third party assets who would provide the infrastructure service. In essence, as is seen in many of the ICT projects, there is a move to Infrastructure as a Service (IaaS). The sub-strategy recommends a hybrid model where Transpower own and operate the infrastructure connecting their substations but increase the amount of third-party infrastructure assets where the service can be considered a backbone service.

The total proposed expenditure in the investment case across RCP3 and RCP4 is shown in the following table.

Table 11-16 IC02 – TransGo Refresh expenditure ($m)

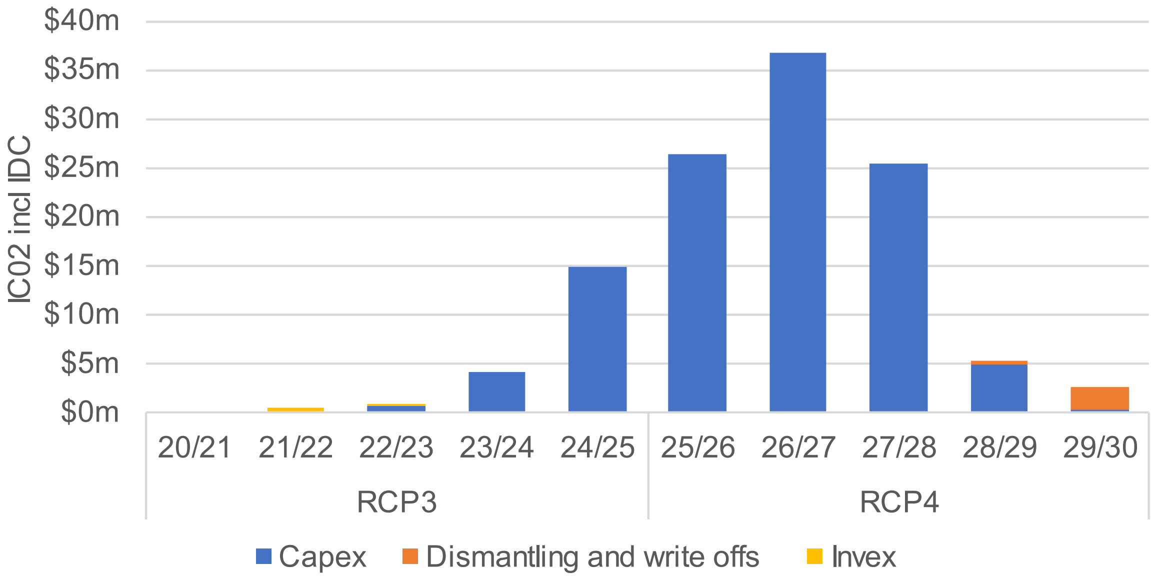
	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	-	-	0.6	4.2	14.9	19.7	26.4	36.8	25.4	4.8	0.2	93.7
Dismantling and write-offs										0.4	2.4	2.7
Step opex	-	-	-	-	-	-	-	-	-	-	-	-
SaaS opex	-	-	-	-	-	-	-	-	-	-	-	-
Invex	-	0.5	0.2	-	-	0.7	-	-	-	-	-	-
Total	**-**	**0.5**	**0.8**	**4.2**	**14.9**	**20.4**	**26.4**	**36.8**	**25.4**	**5.2**	**2.6**	**96.4**

Source: RFI 038-02 TransGo categorisation V3.0 MASTER.xlsx worksheet 'Dashboard'

The costs are also shown in the figure below.

[301] ICT023 IC02 TransGo ICT Investment Case.pdf; section – proposed network approach, list item 1; page 1

Figure 11-9   IC02 – TransGo Refresh: Expenditure across RCP3 and RCP4



Source: RFI 038-02 TransGo categorisation V3.0 MASTER.xlsx worksheet 'Dashboard'

There are investigations in the early stages of the project, in 21/22 and 22/23 at a total of $0.7m, these are programmed to ensure that the TransGo Refresh will proceed with the correct technology. The expenditure starts in the latter part of RCP3 and ramping up into RCP4.

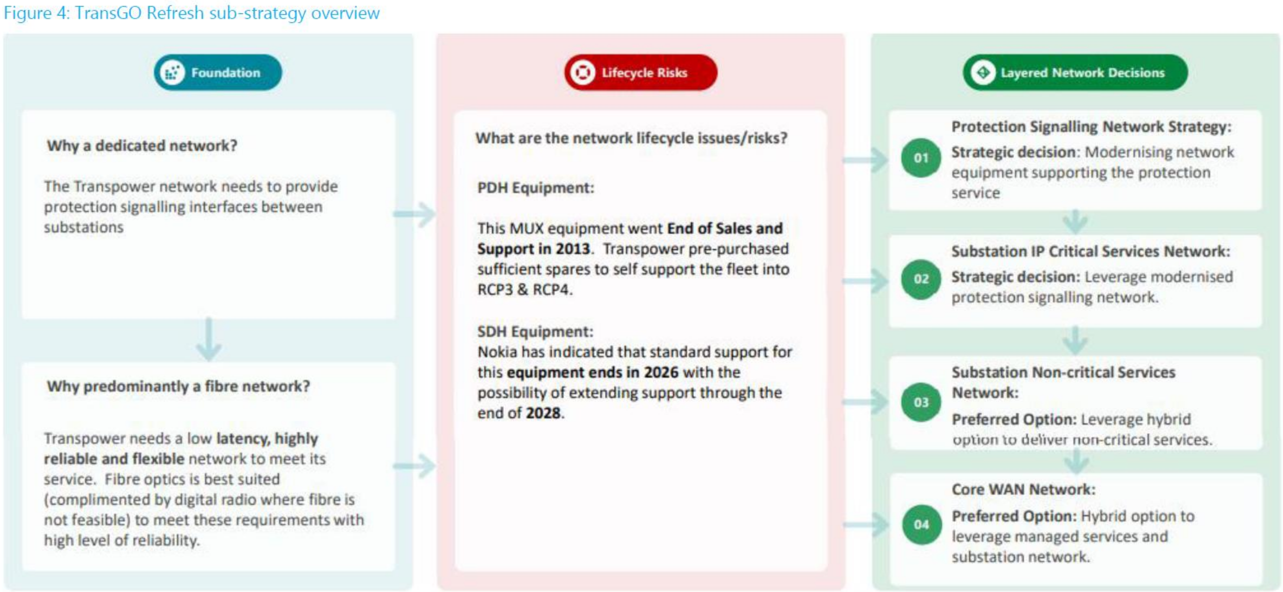
Capex significantly ramps up in 2023/24, peaking in 2026/27 at $36.8m, although the expenditure starts to ramp down following that peak, there is still $33.0m to be spent in the latter three years of RCP4. The expenditure is all planned to be spent in RCP4 and that there is no expenditure planned for RCP5.

Expenditure drivers and solutions

TransGo Refresh program of works has been planned since 2008, as the name infers, this is a refresh of the existing TransGo network. Transpower are aware that the current assets and infrastructure are coming to the end of their useful life. As this is a significant expenditure, Transpower has developed it as a separate investment case and sub-strategy. The approach followed a structured method to evaluate the need - that is identify the drivers and address the absolute need for Transpower to own and operate its own fibre network.

The sub-strategy overview, which set the framework for establishing the drivers and solutions, is shown in the following figure.

Figure 11-10 TransGo Refresh sub-strategy overview

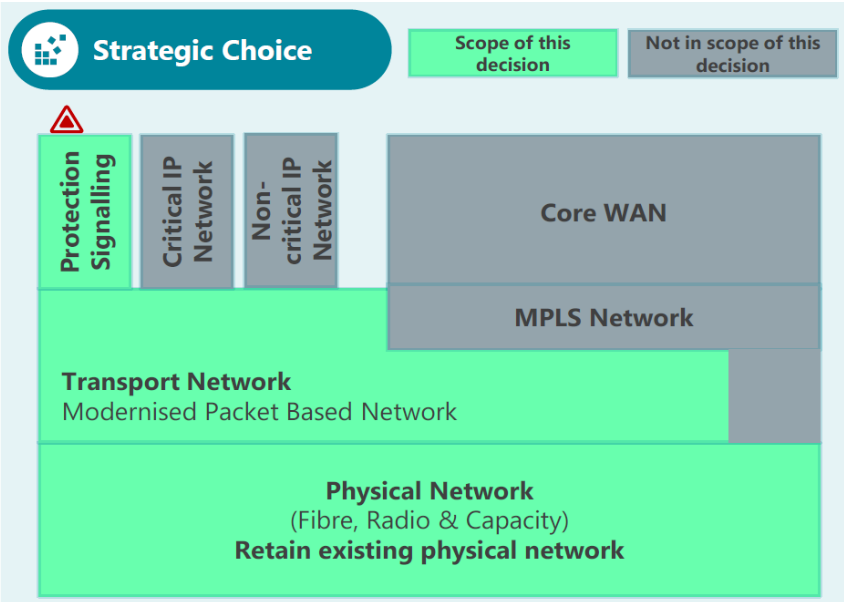


Source: ICT023-IC02 TransGO ICT Investment Case.pdf, page 15

We can see in the sub-strategy that the foundation question addresses the need for a dedicated network, which moves onto the technical aspects of the services such as protection signalling and IP critical services. The process was governed through a cross organisational management advisory group and a General Manager level Governance Team. The network decisions were further expanded to review potential need and options, which were agreed as strategic choices.

An example of the protection signalling strategic choice is shown in the following figure.

Figure 11-11 TransGo Refresh Network decision – protection signalling (example)



Source: ICT023-IC02 TransGO ICT Investment Case.pdf, page 16

There are four network decisions which align with the network decisions shown in the sub-strategy.

Following on from the strategic choice, this set the scope for the investment options. The investment was then articulated into physical programmes that identified:

- Site infrastructure
- Radio link
- Inter site fibre and capacity
- Long range optics
- Protection signalling equipment
- Network clocks
- Core network
- Management tools
- Optical transport equipment.

These solutions were then developed into the investment case that also includes a spreadsheet to develop the expenditure.

After reviewing the strategy and the sub-strategies and how they are built up, we are of the opinion that the expenditure drivers have been correctly identified and has the correct level of review and authorisation to provide confidence that it delivers a robust and economic solution.

Evaluation

The Transpower approach is to address the need to invest in TransGo and derive what would be an optimal business outcome to deliver required services to the level of quality needed for the least total cost of ownership.

There has been an informal market exploration with suppliers to inform on some high-level assumptions and to gauge the range of potential costs.

To establish the extent of the TransGo refresh, Transpower has provided a cost build up using a bottom-up approach, and in these early stages, provide a P50 and a P90 cost estimate. In terms of the option provided in the investment case, Transpower has used the P50 estimate as its basis.

The evaluation of the costs uses a multitude of sources, including:

- Recent projects completed by Transpower.
- Soft market testing by existing suppliers to understand if the cost is reasonable.
- Alterative cost and scope assessment to understand if the investment case is reasonable.

Transpower has provided these documents as part of our assessment of this investment case.

The project build-up also includes optimistic, most likely, critical and pessimistic options, basically proving a range for the potential costs. The driver between the differing scenarios is the quantity of work rather than the price. That is the pessimistic opportunity looks to deliver connections to 380 substations where the optimistic delivers connections to 500 substations. The unit cost is the same. This does not really deliver a range of costs, rather a reflection on ability to deliver the programme, and the costs would be extended into the latter years.

The driver of the costs can be split into two:

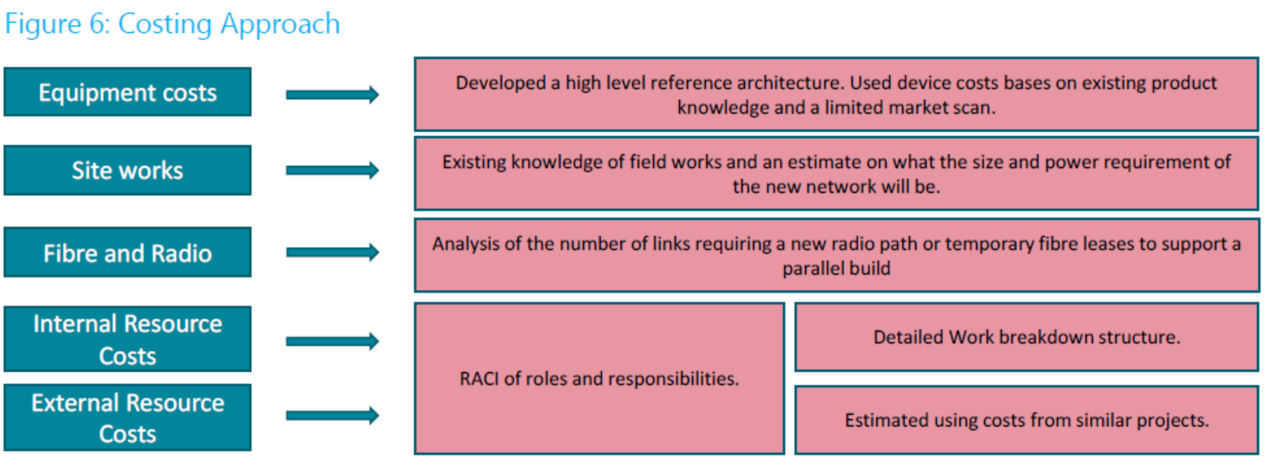
- Where assets of a similar specification have been procured by Transpower, the unit price is based on these prior procurements.
- Where the assets are readily available in the market but have not been procured by Transpower, industry knowledge and advice from market participants is used to establish a base cost.

Establishing the cost of TransGo Refresh

The expenditure drivers and solutions for this investment case have been captured as a single capitalised plan – capex. A small amount of cost ($0.7m) has been spent in 2021/22 and 2022/23 for investigations, which is captured in opex. The dominant approach for the expenditure driver is a bottom-up cost.

For each capex area, Transpower developed a three-point (Pessimistic, Realistic & Optimistic) cost estimates. These estimates were then used as inputs into a monte-carlo cost simulation model which ultimately produced the P50 and P90 costs. The approach is summarised in the following figure.

Figure 11-12 TransGo Refresh costing approach



Source: ICT023-IC02 TransGO ICT Investment Case.pdf, page 24

To verify that the costing approach was producing reasonable answers, Transpower engaged Deloitte New Zealand to perform an independent review of the costing approach and key assumptions. The primary objective was to validate the process and rationale used to develop the costs and specifically:

- Review whether the approach taken to develop the cost estimation is reasonable.
- Review the reasonableness of the key costing assumptions and identify areas where assumptions have not been adequately documented or validated; and
- Assess whether the level of risk quantified in the costing is reasonable and whether any key risks have not been considered.

Deloitte made ten observations which Transpower actioned and incorporated into the costing approach.

Along with the expert review, Transpower also benchmarked the costs internally. The exercise was completed using the original TransGo build costs inflated to FY21/22 dollars. The benchmark costs are in the range of $125 million (15% efficiency) - $132 million (10% efficiency) of the proposed costs and may indicate that the costs are understated.

In conclusion, a bottom-up approach has been adopted to estimate the cost. Unit costs have been established, some from equivalent recently procured assets and the remaining using input from market participants.

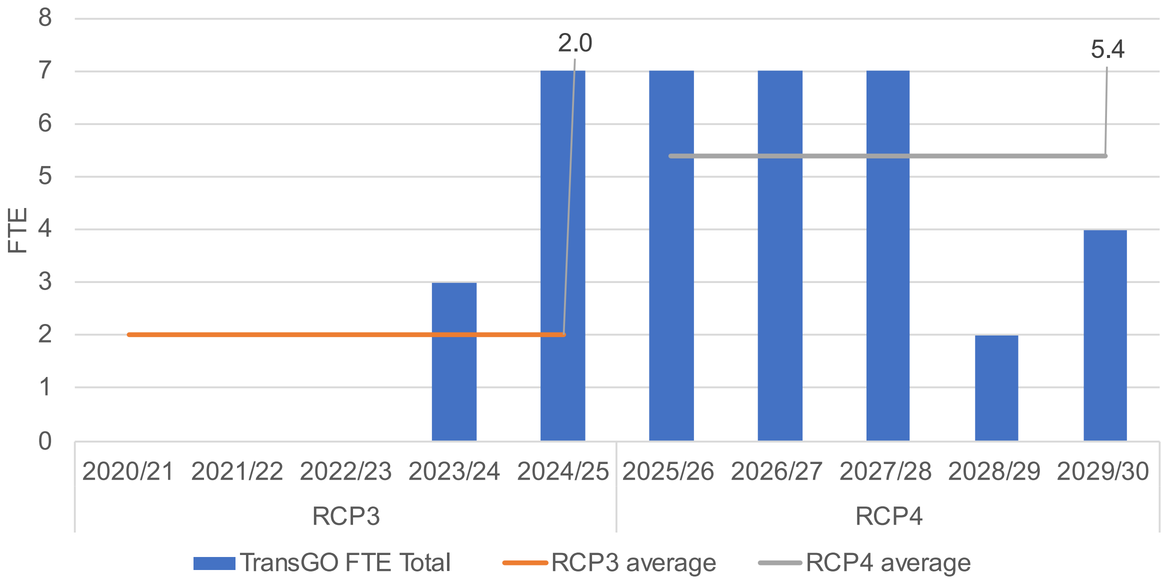
There has been a robust approach to establish a base cost, which has then been checked against independent expert and a benchmarking exercise. There are some differences, but this is to be expected as first and foremost it is a forecast and costs are not being locked down at this stage. This does introduce an element of uncertainty regarding the project cost as the complete cost of the project is yet to be fully market tested.

We are of the view that the evaluation and methodology is reasonable, and the costs are accurate, making this investment prudent and efficient.

Business support capitalised FTEs

Transpower has identified additional staff requirements under business support opex section discussed in Section 17 of this report. In this case, the number of staff required to meet the TransGo Refresh, is shown in the following figure.

Figure 11-13 Number of FTE's associated with TransGo Refresh under business support opex



Source: Business Support business case; Version 0.5; Dated 31-March-23; Table 6; drivers; page 11

The additional FTE requirements will be 100% capitalised[302] as part of the TransGo Refresh. The cost of those staff are therefore accounted for in the ICT capex requirement and there is no impact on the business support opex requirement. The TransGo Refresh investment case describes the requirement for additional staff[303].

The investment case for the development of TransGo covers the same period over which the additional staff are needed, and we also recognise that the scope of the refresh is country wide. We are of the view that the additional staff, for the period of the project is reasonable.

Delivery of the investment case

As part of the investment case, a high-level programme schedule has been provided showing the phases and the approximate delivery times. An example of the TransGo high-level programme schedule is provided in the figure below. The schedule covers the entirety of the TransGo Refresh.

The schedule allows us to identify a number of key good industry practices, namely:

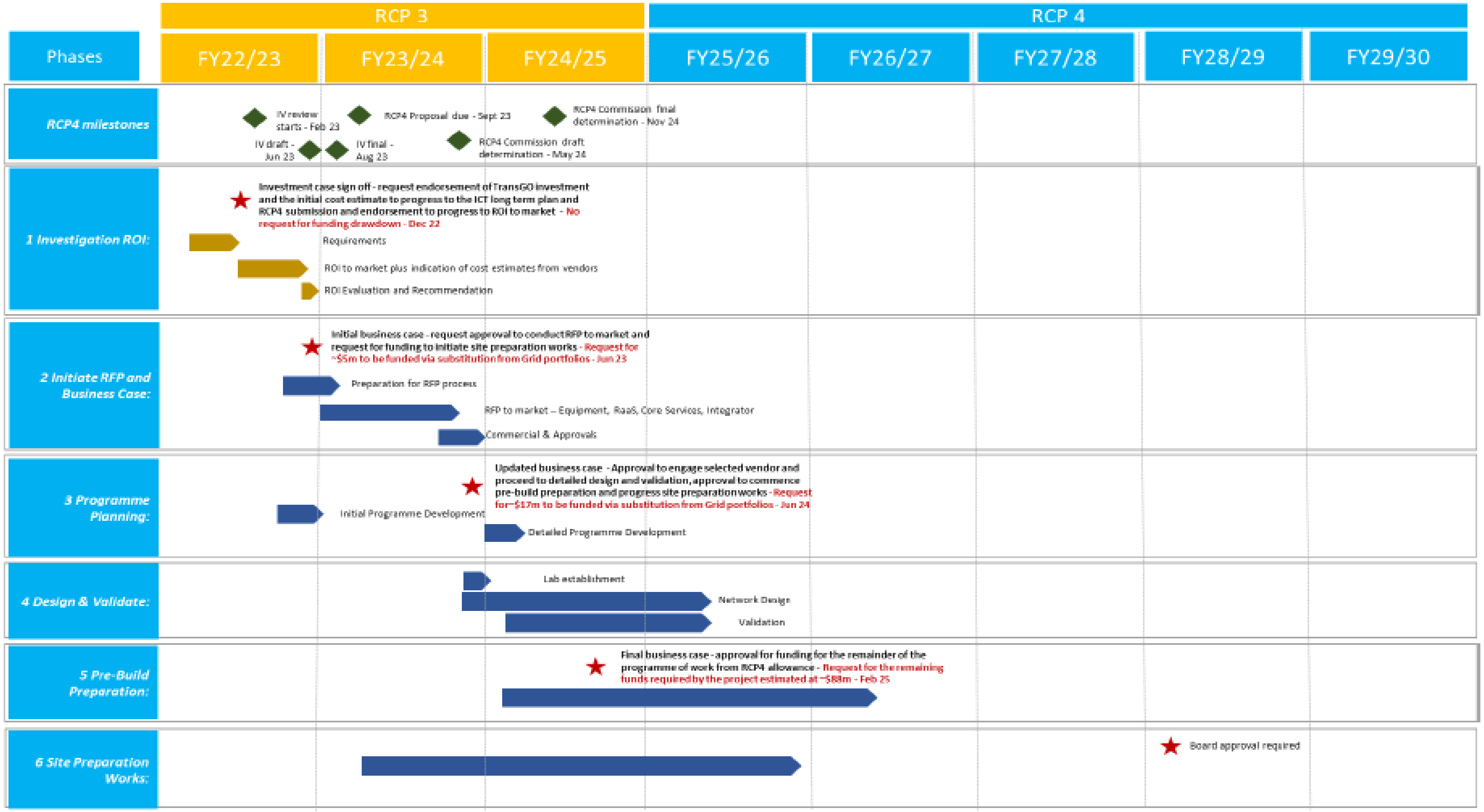
- Lock down dates for review and submission.
- Critical path dates for investment case sign off.
- Funding drawdown to allow for procurement stages to commence, including funding values.
- Project development to a more detailed plan, in advance of next stages.
- A critical path to delivery.

In terms of deliverability, this capital programme has started in RCP3 and will also continue through RCP4.

Overall, Transpower has a delivery plan supported with a schedule, and the plan in RCP4 is similar that applied in RCP3, and the number of FTEs is also maintained.

[302] Transpower, Business Support business case; Version 0.5; Dated 31-March-23; Table 5, page 10
[303] Transpower, RFI 0338-02 TransGO Categorisation V3.0 MASTER for IV.xlsx

Figure 11-14 TransGo Refresh – example of the phases for delivery of the TransGo Refresh



Source: ICT023-IC02 TransGO ICT Investment Case.pdf, page 29

TransGo Refresh as a low incentive rate base capex

Transpower has proposed that the TransGo Refresh programme has a high level of uncertainty with regards to the cost and has proposed that this becomes part of the low incentive rate uncertainty mechanism. The TransGo Refresh programme has been reviewed against the low incentive rate base capex requirements set out in the ToR (Appendix A8).

A project can be treated as low incentive rate base capex where the project is likely to require capital expenditure greater than the base capex threshold. The current threshold is $20m. We note that the ToR states that the base capex threshold applies to Transpower's RCP4 proposal.

The following criteria also need to be considered in evaluating whether the base capex project or base capex programme should be specified by the Commission as a low incentive rate base capex project:

– Whether there are viable alternatives that meet the same investment need; and
– The magnitude of cost uncertainty of the base capex project or base capex programme.

We consider the first condition is met if there are no viable alternatives in a technical sense that meet the same technical project need. We understand that the second condition is met if there is potential for a large variation in the capex associated with the project.

Is the project is likely to require capital expenditure greater than the base capex threshold?

The current base capex threshold is $20m and TransGo Refresh is estimated to cost a little under $100m in RCP4. We agree that this project meets this requirement.

Are there viable alternatives to meet the same investment need?

Transpower proposed three options and two were discounted as they did not deliver the technical necessity. Within the preferred option, three cost alternatives were proposed, summarised in the following table below. The preferred option, 3.3 is highlighted.

Table 11-17 Cost options for TransGo Refresh

Options	Estimated cost	
	P50	P90
3.1 Source all from the open market	Not considered feasible	
3.2 deliver critical assets themselves, everything else sourced from the open market	$136.0m	$199.0m
3.3 deliver all substations themselves, except WAN, sourced from the market	**$111.0m**	**$130.0m**
3.4 Deliver all themselves, only use market where there are no other options	$119.3m	$142.2m

Source: ICT023-IC02 TransGO ICT Investment Case.pdf, page 23

Although there are three options presented, the solution is the same technical solution with variants in terms of who has ownership and who installs the assets. We are of the view that these solutions are similar. We are of the view that there are no viable alternatives that meet the needs of this investment.

Magnitude of cost uncertainty of the base capex project or programme

The current TransGo Refresh project is estimated to be $116.1 million across the remaining part of RCP3 and the whole of RCP4.

Based on the expected range of expenditure proposed by Transpower[304] the higher P90 value of $130.0m has been calculated by Transpower as the upper limit of risk for delivering the TransGo Refresh project. This suggests the cost of the project has an uncertainty in the order of 17% of the P50 forecast cost.

We are of the view that at this stage of planning the project, where the costs have not been market tested that an upper limit of $130.0m does not constitute a large magnitude of uncertainty around the base case cost of $111.0m. That is, we are of the view that the magnitude of cost uncertainty is not excessive.

[304] ICT023-IC02 Transgo ict Investment Case.pdf, page 6

Summary

Based on our evaluation, we considered that two of the three criteria for determining a project can be declared a low incentive base capex project have been met but that the level of costs uncertainty in the base capex may not be sufficient. We conclude that TransGO Refresh does not meet all the criteria to be declared a low incentive base capex project.

Conclusion

This investment case is a significant investment in fibre technology which is used to provide network security in the form of protection timings and response. Traditionally, the fibre network are owned exclusively by the transmission business as ensuring latencies and security of the fibre network is paramount. As communications technology has developed, the required level of security can be established through alternative methods, and third-party services can meet the technical requirements. This is the case with Transpower.

The proposed solutions in the TransGo Refresh investment case looks to balance the needs of the business with the currently available technologies, which are at the end of their useful life and there is a need to develop a network for the future. This means that Transpower are at a point where they need to invest, and delaying is no longer an option.

We are of the opinion that the investment case sets out the necessary plan and expenditure and presents a prudent and efficient plan.

Accepted RCP4 costs

Based on our evaluation of the IC02 investment case, we accept the investment case and the costs identified are prudent and efficient, and consistent with GEIP.

As noted in Section 11.5.1 of this report, the costs set out in the investment cases do not align exactly with the costs set out in the RT01 expenditure schedule. The following table compares the RCP4 costs identified in the IC02 investment case against those costs assigned to the IC02 investment case from the RT01 expenditure schedule.

Table 11-18 IC02 cost comparison for RCP4 ($m)

IC02 – TransGo Refresh	Investment case	RT01 expenditure schedule	Difference
ICT capex	$93.7m	$93.7m	-
Dismantling and write-offs	$2.7m	$0.0m	-$2.7m
ICT Step opex	-	$3.0m	$3.0m
ICT SaaS opex	-	-	-
Invex (ICT and AM&O)	-	$0.2m	$0.2m
Total	**$96.4m**	**$96.9m**	**$0.5m**

Source: ICT023 IC02 TransGo ICT Investment Case.pdf, IV recon RT01_IC.xlsx; worksheet 'Reconciliation'

Across RCP4, the RT01 capex ($93.7m) aligns with that in the original investment case capex, however RT01 expenditure schedule includes additional ICT opex ($3.0m) and additional invex ($0.2m) this offsets the absence of the allowance for dismantling and write-offs ($2.7m) which appears in the investment case and is not specifically visible in RT01 expenditure schedule. These changes in total amount to a revision of $0.5m which is insufficient to alter the integrity and findings of our assessment of the investment case set out above. As such, we accept a IC02 totex value of $96.9m, made up of $93.7m of ICT capex and $3.2m of opex.

We are comfortable, based on the principles above, that these costs are consistent with the RT01 expenditure schedule which drives its stated request for capex and opex.

We further conclude that TransGO Refresh does not meet all the criteria to be declared a low incentive base capex project.

Verification assessment

We conclude that the IC02 TransGo Refresh capex of $93.7m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **identified programme** against the evaluation criteria.

Table 11-19 IC02 – TransGo Refresh evaluation (identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management	Yes	We reviewed the investment case, which includes a roadmap for replacement of ongoing assets, and demonstrated that programs were reviewed prior to replacement, in line with good asset management.
A3(b)	Policies and planning standards were applied appropriately	Yes	It is developed as its own Investment Case and due to its size and value, a cross organisational sub strategy was developed which included GM level governance team.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The process is extensive as it is a significant programme and the structure in place is evident in the investment case.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Alternatives were examined through the optioneering and sub-strategy cross department groups introduced at different stages, plus external review has been included to ensure overall approach meets the business objectives.
A3(e)	How grid outputs, key drivers, assumptions, and cost modelling were used to determine its forecast capex	Yes	Cost modelling is based on the most appropriate approach (comparative costs for similar assts, and expert judgement and market testing for new assets), to determine the total forecast.
A3(f)	Capital costing methodology and formulation, including unit rate sources and the quantum of included contingencies	Yes	Overall, cost contingency approaches used in the form for P50 and P90 costing whilst the programme is developed, which is further refined as programme starts to be delivered.
A3(g)	Effect of forecast capex on other cost categories, including opex relationship	Yes	Capex and opex trade-off is reviewed, along with review of trade off with other investment case plans for RCP3 and RCP4. Evidenced with removal of costs from other Investment Cases planned when IC02 would 'go live'.
A3(i)	Whether programme is appropriately linked with other projects or programmes	Yes	Clear links with other programs of works is demonstrated within the investment case, and the reciprocating investment case.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	Proposed approach is included as Transpower will go to the market for most of the assets. Soft market testing has occurred and has been used in the cost build up.

Note: A3 (h) is not applicable to base capex

11.5.4 IC04 – Transmission systems

The following table summarises our verification of the IC04 – Transmission systems which is categorised as a **non-identified programme** and forms part of the base ICT capex for RCP4.

Table 11-20 Verification summary of IC04 – Transmission systems

Verification element	Verification commentary
RCP4 proposed amount	$9.9m
Appropriate and sufficient information available for IV	Yes

Verification element	Verification commentary
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $9.9m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Overview

The Transmission System investment case is not a single activity or service for delivery, rather it is a collection of individual initiatives collated under the one heading with common goals. It consists mainly of initiatives around modernising functions used in the management of the transmission system. There are seven initiatives for RCP4:

– Digitalise operational switching
– Grid operator situational intelligence
– Grid operator role flexibility and work distribution (Resilience)
– Integrate and optimise outage management process
– Digitalise telemetry data management
– Improve protection systems management
– DER enablement – to manage emerging Distributed and Renewable Energy Resources (DER)

Each of these seven initiatives is an incremental change focussed on improving the ability for Transpower employees to manage the changing state of the transmission system.

The total expenditure profile for the Transmission System investment case is shown in the following table.

Table 11-21 IC04 – Transmission Systems expenditure ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	0.1	0.1	0.2	1.6	3.3	**5.2**	2.0	1.8	1.6	0.5	1.4	**7.1**
Step opex	-	-	-	0.1	0.1	**0.1**	0.1	0.4	0.4	0.4	0.4	**1.5**
SaaS opex	-	0.3	0.4	0.8	-	**1.5**	1.2	-	0.4	0.4	0.9	**2.8**
Invex[1]	-	-	0.2	0.4	0.6	**1.1**	0.2	0.4	0.1	0.2	0.1	**0.9**
Total	**0.1**	**0.4**	**0.7**	**2.8**	**3.9**	**7.8**	**3.4**	**2.5**	**2.4**	**1.3**	**2.7**	**12.3**

Source: ICT031 IC04 Transmission Systems.pdf
Note: [1] includes AM&O and ICT opex

A more detailed breakdown of the Transmission System expenditure is given in the following table, sourced from the options analysis detailed in Appendix 3 of the IC04 investment case. The detail in the investment case did not report expenditure for 2020/21, and while the total expenditure for RCP4 aligns with that shown in table above there are some differences in the distribution of costs over time.

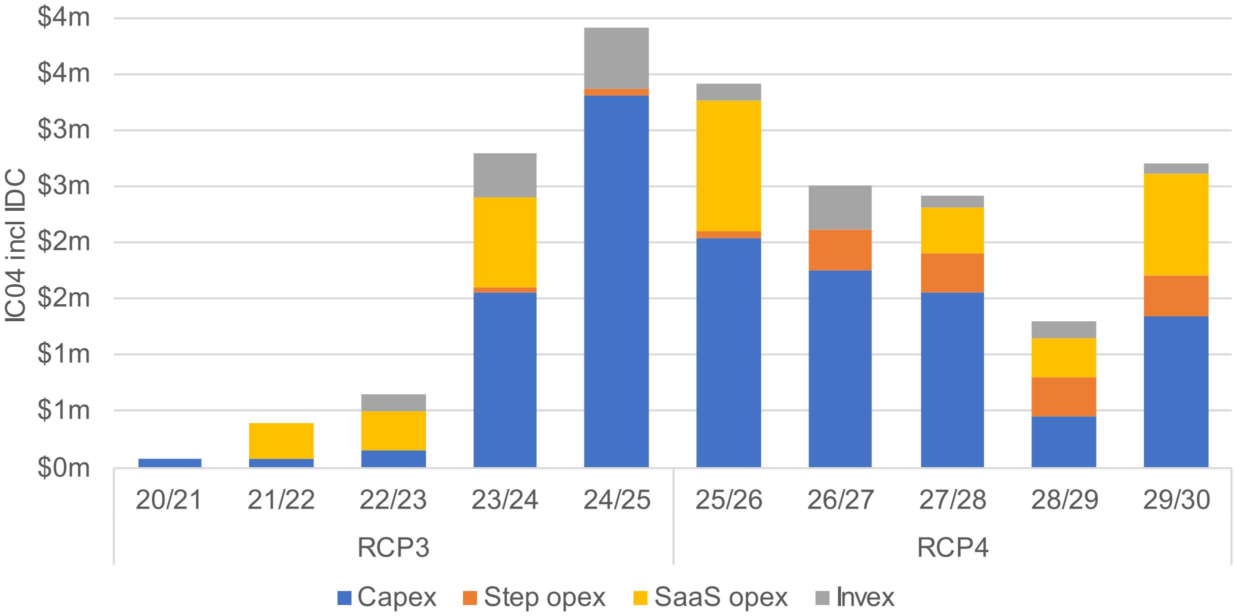
Table 11-22 Detailed Transmission Systems proposal by category summary ($000's)

Total Costs: Option 2: Resilient - Proactive	RCP3					RCP4					
	2021/22	2022/23	2023/24	2024/25	Total	2025/26	2026/27	2027/28	2028/29	2029/30	Total
RCP capex											
S04.4.2 Grid Operator Situational Intelligence	-	-	-	-	0	600	300	600	-	900	2,400
S04.4.4 Integrate & Optimise Outage Mgmt Process	71	-	-	1,000	1,071	1,200	450	450	450	450	3,000
S04.4.51 Real time systems technology changes	-	-	-	-	-	-	750	500	-	-	1,250
S04.4.52 Telemetry change efficiency	-	-	151	265	416	239	-	-	-	-	239
S14.14.2 SCADA Operator Usability	11	83	-	286	380	-	256	-	-	-	256
Subtotal: RCP capex	**82**	**83**	**151**	**1,551**	**1,867**	**2,039**	**1,756**	**1,550**	**450**	**1,350**	**7,145**
RCP SaaS opex											
S04.4.3 Grid Operator Role (Resilience)	-	309	-	405	714	405	405	-	405	-	1,215
S04.4.52 Telemetry change efficiency	-	-	350	389	739	-	-	-	-	-	-
S04.4.53 Telemetry quality & assurance	-	-	-	-	-	761	-	-	350	500	1,611
Subtotal: RCP SaaS opex	**--**	**309**	**350**	**794**	**1,453**	**1,166**	**405**	**0**	**755**	**500**	**2,826**
RCP OPEX											
S04.4.2 Grid Operator Situational Intelligence	-	-	-	-	-	-	300	300	300	300	1,200
S04.4.52 Telemetry change efficiency	-	-	-	55	55	55	55	55	55	55	275
Subtotal: RCP opex	**-**	**-**	**-**	**55**	**55**	**55**	**355**	**355**	**355**	**355**	**1,475**
RCP invex											
S04.4.2 Grid Operator Situational Intelligence	-	-	-	-	0	-	-	-	-	-	0
S04.4.3 Grid Operator Role (Resilience)	-	-	50	-	50	-	50	-	50	-	100
S04.4.4 Integrate & Optimise Outage Mgmt Process	-	-	-	250	250	-	250	-	-	-	250
S04.4.51 Real time systems technology changes	-	-	-	-	0	-	100	100	-	-	200
S04.4.52 Telemetry change efficiency	-	-	100	100	200	50	-	-	-	-	50
S04.4.53 Telemetry quality & assurance	-	-	-	-	0	50	-	-	100	100	250
S14.14.2 SCADA Operator Usability	-	-	-	50	50	50	-	-	-	-	50
Subtotal: RCP invex	**0**	**0**	**150**	**400**	**550**	**150**	**400**	**100**	**150**	**100**	**900**
Total RCP Costs	**82**	**392**	**651**	**2,800**	**3,925**	**3,410**	**2,916**	**2,005**	**1,710**	**2,305**	**12,346**

Source: ICT031 IC04 Transmission Systems.pdf

The expenditure is broken down by category in the following figure.

Figure 11-15 IC04 – Transmission System expenditure across RCP3 and RCP4



Source: ICT031 IC04 Transmission Systems.pdf

We can see that most of the cost is in capex around 2024/25 and onward into RCP4,

Expenditure drivers and solutions

The key drivers presented for this investment is risk reduction, increasing efficiencies, and reducing health and safety, and reputational risk. Transpower has reviewed three options, of which one is maintaining the existing assets in their current state and modernising at the end of life.

The three options are summarised in the following table.

Table 11-23 Options for delivering IC04 - Transmission System investment

1 Maintain	This would limit the investment to maintaining the existing ICT assets and modernising at the End of Life. Transpower have identified that some critical systems require additional capability and capacity to respond to change and complexity in future years, this option would not facilitate this.
2 Reactive	This minimal option would be retrospectively reacting to localised impacts. It supports shorter restoration times for known scenarios and provides the initial steps for integrating the outage management process, enables functionality for situational intelligence guidance and enables more efficient management of our telemetry data to provide quality data for decision making. The key risk is that this option assumes the environment does not change and it does not allow for increased workload or future changes in workforce. This option contributes to partial realisation of Value of Lost Load (VOLL), opex efficiency and capex reduction benefits gained from better tools, data and improved speed to competency for new personnel.
3 Proactive	This option combines Option 1 and Option 2. It enhances resiliency and enables proactive response to change and complexity (including ability to adapt). This option will provide situational intelligence using advanced AI/ML based decision models to guide operators based on predictions of future events, improve productivity, agility and quality of our outage planning processes, enable better workforce management, enable efficiencies, improved quality & assurance and technology changes to Transpower's telemetry systems and provide additional improvements to Transpower's SCADA systems. It will enable the full realisation of VOLL, opex efficiency and capex reduction benefits gained from better tools, data and improved speed to competency for new personnel.

Source: ICT031 IC04 Transmission Systems.pdf, table on page 5

The differentiator for Option 1 is that it does not provide any modernisation to the current suite of tools, in that it maintains the current services and does not look to risks if requirements change in future years.

Of the three options, Transpower has identified that the proactive option is preferred as it will enable the full realisation of VoLL, opex efficiency and capex reduction benefits gained from better tools, data and improved speed to competency for new personnel.

These solutions are looking to leverage new technologies and new ways to respond to the changes in the business. The transmission systems investment case is focussed on facilitating advances in software and addressing the management of business data. There are seven challenges identified:

– Information and data.
– Human error incidents and near misses.
– Changing work force.
– Discrete tools.
– Leveraging technology.
– Increased workloads.
– Consistently meeting customer expectation.

The challenges are framed to set out the requirements that Transpower see that they need to respond to in the remainder of RCP3 and forthcoming RCP4 period. These seven challenges have then been mapped to the seven sub strategies, listed at the beginning of this chapter.

In the case of ICT opex, the assessment of the expenditure is built up in the same way as the capex. The ICT opex which includes: opex, SaaS opex and invex, is considered further in the ICT opex section.

Investment initiatives

The Investment Case outlines seven initiatives to respond to the transformational period identified in the scoping exercise. The key scope initiatives for Transmission Systems are:

– **Initiative S.04.4.2 Grid Operator Situational Intelligence** to reduce risk and improve responsiveness by providing a wider field of situationally relevant operational data to support decision making.
– **Initiative S.04.4.3 Grid Operator Role Flexibility and Work Distribution (Resilience)** to reduce risk and improve operator efficiency by improved logging, and to provide workload management to safely and efficiently prioritise and allocate work in line with skills of available resources.
– **Initiative S.04.4.4 Integrate and Optimise Outage Management Processes** to improve process productivity and agility, and to enable plan optimisation across multiple dimensions, such as reducing risk, customer impacts and operator and service provider workload.
– **Initiative S04.4.51 Real time systems** technology changes ensuring systems and tools for telemetry data management remain current as grid technologies, telemetry collection assets and protocols evolve over time.
– **Initiative S04.4.52 Telemetry** change efficiency to optimise telemetry data management systems improving efficiency in applying changes to configurations and management of the telemetry collection assets. This will ensure pace of change is matched with increase in modelling activity as the grid becomes distributed and the volume of connections increase.
– **Initiative S04.4.53 Telemetry** quality & assurance ensures that telemetry configurations and collection assets continue to provide timely and accurate data critical to Transpower's operations and investment decisions.
– **Initiative S14.14.2 SCADA Operator Usability** to provide additional improvements, not delivered during the lifecycle upgrade, including the improved performance of the modelling system, enhanced management of operational notes and creation of predictive alerting.

The initiatives are then used to establish the costs.

Evaluation

Each of the seven initiatives has the main options, of maintain the current assets, minimal intervention in a reactive fashion and a final proactive approach. The scope of work proposed to address the seven challenges addressed by this investment case introduce several interdependencies with other investment cases including TransGo sub strategy, data centre services modernisation and data and analytics to name three. There are six interdependencies in all.

Although we can see from the cost breakdown that there is no overlap in costs, there is a delivery risk where the dependencies may introduce delays in the transmission systems investment case if other investment cases are delayed. That may be an acceptable solution, in that we would expect Transpower to delay these programmes of work if the deployment of the facilitating technology is also delayed.

Transpower has also identified where costs are captured elsewhere and hence set to zero for these initiatives.

The investment case identifies expected benefits from the proposed scope of work and assumptions underpinning those benefits. Transpower has also included the expected improvements by implementing the programme of works.

When the business case is coupled with a bottom-up assessment of the costs, which are based on historical purchases, the proactive solution is expected to deliver benefits that outweigh the higher investment costs.

Establishing the cost

To establish the expenditure profile for each of these initiatives, each initiative is evaluated separately using an initial comparative approach where the replacement cost is expected to be consistent with existing assets and readily available from suppliers. Where the option is not available, Transpower has used expert judgement approach using estimation inputs from subject matter experts.

The comparative base for the cost estimation is also included as a refence in the cost spreadsheet, thus allowing direct reference to the source. An example is shown in the following figure.

Figure 11-16 Example of cost approach for IC04 transmission systems

Costing Approach:	Comparative estimation based on historical development costs similar projects in this business area		
Scope:	This initiative will streamline the process for managing telemetry data across end-to-end systems including SMS, SCADA, PI, Situational Intelligence and the Data Lake.		
Opex		**FULL**	**Description**
			Eaton system upgrades (SMS 5000) and modelling instruction integration within M.I. incl. Model
			61850 phase 2 and backlog campaign modelling integrator enhancements
		$739,202	61850 Impl & Auto Roadmap Ph2
	Overall:	**$739,202**	
Capex	Implementation Cost	$754,907	Eaton system upgrades (SMS 5000) and modelling instruction integration within M.I. incl. Model propagation minor enhancement
	Implementation Cost	$750,000	61850 phase 2 and backlog campaign modelling integrator enhancements
	Implementation Cost	$500,000	61850 Impl & Auto Roadmap Ph2
	Overall:	**$2,004,907**	

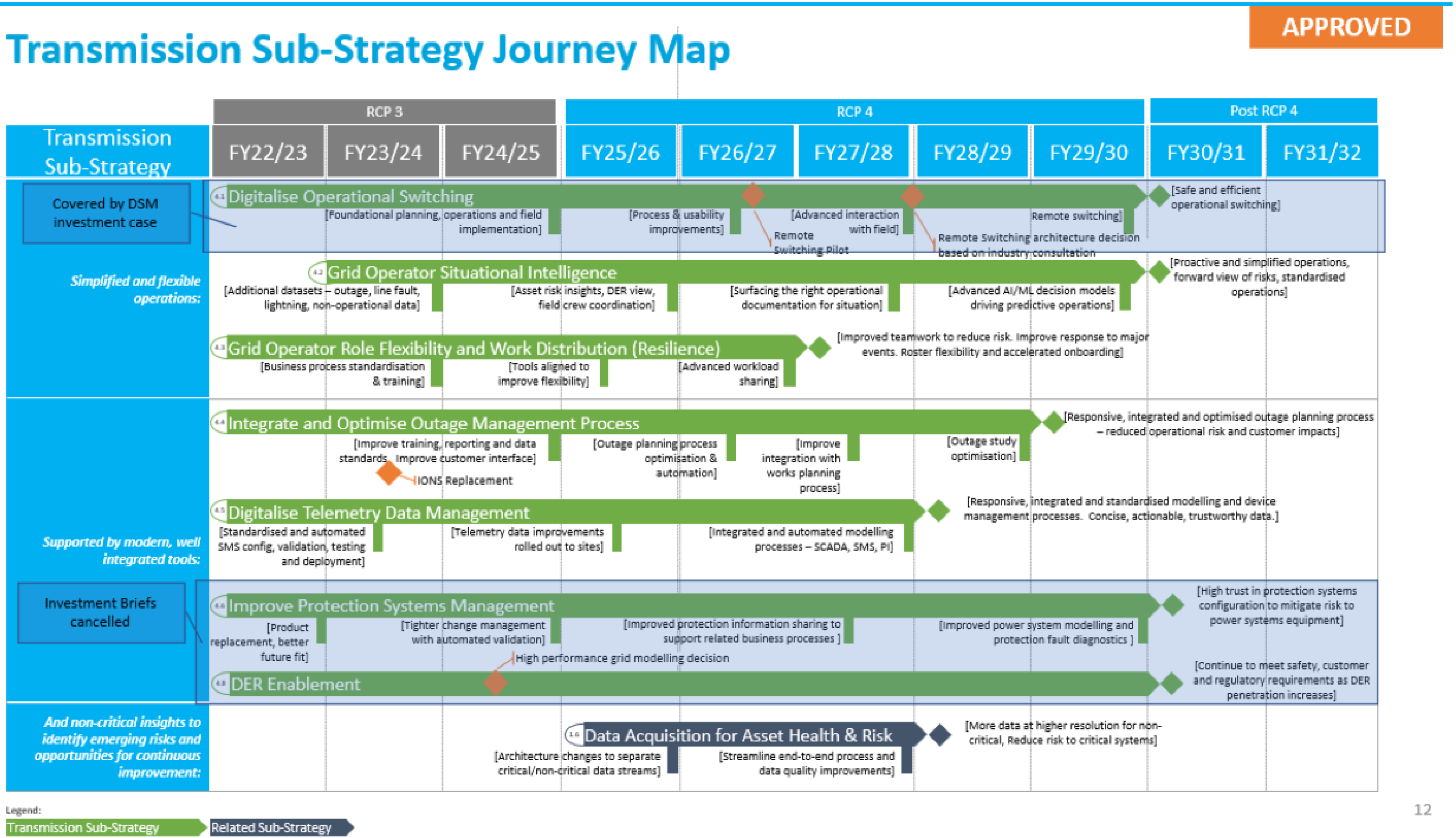
Source: RFI039-01 Transmission System Imitative cost summary.xlsx; worksheet 'Init 4.51

The costs are broken down in the relevant categories, namely capex, opex and invex and can be traced back to the comparative source. We can see how and where the costs have been built up and we agree that this is a reasonable approach.

Delivery of the Investment Case

As part of the Investment Case, a transmission system sub-strategy journey map has been provided showing the individual investments and the cycle of refresh. The transmission system sub-strategy journey map is provided in the following figure.

Figure 11-17 Transmission system example of the sub-strategy journey map



Source: ICT031 IC04 Transmission Systems.pdf; appendix 3; page 12

The journey map allows us to identify a number of key good industry practices, namely:

– Expected completion dates and also what constitutes the sub-strategy to be delivered.
– Approximate dates for pilots (invex) allowing for triggers to be placed which will drive expenditure.
– Critical path for interacting deliverables and an approach to ensure delivery.
– Trade-offs between similar programmes of work and mutual advantages can be leveraged.

Overall, Transpower has a delivery plan supported with a journey plan, and the plan in RCP4 is similar that applied in RCP3. We are of the opinion that the program can be delivered,

What we can see is where assets are to be replaced, timings of replacements and alignments with other investment cases has allowed reductions in the RCP4 expenditure over the RCP3 expenditure, which is then captured as a saving.

Conclusion

The Transmission System investment case is a concatenation of several projects into a single investment case that is required over the RCP4 period. Transpower has shown that they have examined where this investment case interacts with other investment cases and we are satisfied that Transpower had appropriately allocated costs to investment cases avoiding any duplication.

The investment case shows that Transpower reviews each asset of the assets classes and creates investment initiatives for each of the particular ICT streams. This supports good industry practice as it naturally leads to consolidation of technologies, and with the advancement of technology, Transpower are able to leverage these advantages. Transpower do consider whether the investment need is addressed by works proceeding under another investment case, and assess whether any additional services provided by the modern equivalent asset can be leveraged.

The cost build up is based on a comparative approach, as the predominant driver relates to existing assets and a majority based on recent historical costs and forecast forward. This is reasonable, as in most cases, the technology is readily available and thus reflective of the market.

Based on our evaluation of the IC04 investment case, we accept the investment case and the costs identified are prudent and efficient.

Accepted RCP4 costs

Based on our evaluation of the IC04 investment case, we accept the investment case and the costs identified are prudent and efficient, and consistent with GEIP.

As noted in Section 11.5.1 of this report, the costs set out in the investment cases do not align exactly with the costs set out in the RT01 expenditure schedule. The following table compares the RCP4 costs identified in the IC04 investment case against those costs assigned to the IC04 investment case from the RT01 expenditure schedule.

Table 11-24 IC04 – Transmission systems: Cost comparison for RCP4

	Investment case	RT01 expenditure schedule	Difference
ICT capex	$7.1m	$9.9m	$2.8m
ICT Step opex	$1.5m	$1.5m	-
ICT SaaS opex	$2.8m	-	-$2.8m
Invex (ICT and AM&O)	$0.9m	$0.9m	-
Total	**$12.3m**	**$12.3m**	**-**

Source: ICT031 IC04 Transmission Systems.pdf, IV recon RT01_IC.xlsx; worksheet ‘Reconciliation’

Although the total capex increases in the RT01, we can see that this is a transfer from SaaS opex to capex and that the total expenditure (totex) does not change. We believe these changes do not alter the integrity and findings of our assessment of the investment case set out above. As such, based on the principle of proportionate scrutiny, any change in cost is negligible and an acknowledgement that costs may change over time, we accept a IC04 totex value of $12.3m in RCP4, and specifically the proposed ICT capex of $9.9m.

We are comfortable, based on the principles above, that these costs are consistent with the RT01 expenditure schedule which drives its stated request for capex and opex.

Verification assessment

We conclude that the IC04 Transmission Systems capex of $9.9m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

Table 11-25 IC04 – Transmission system evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	The base capex and assumptions are set out in the investment case and the cost build up can be traced. We are of the opinion that it is a prudent and efficient approach. The approach follows a framework and strategy as set out within Transpower ICT strategy. This does reflect good industry practice.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	Comparative approach is used to develop the assumptions. The assumptions are set out along with the historical comparative data within the same spreadsheet. The method is also set out.
	(ii) how they were applied;	Yes	Application is also set out in the same spreadsheet allowing tracing of costs.
	(iii) their effect on the proposed base capex	Yes	It is clear the effect as the model allows for the assumptions to change, however the model shows the reasoning.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	Inputs to the model are provided along with how these are applied.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	Checks are based on recent costs incurred along with comparative assessment for the future development.

11.5.5 IC05 – Data centre service modernisation

The following table summarises our verification of the IC05 – Data centre service modernisation which is categorised as a **non-identified programme** and forms part of the base ICT capex for RCP4.

Table 11-26 Verification summary of IC05 – Data centre service modernisation

Verification element	Verification commentary
RCP4 proposed amount	$1.8m
Appropriate and sufficient information available for IV	No
Meets GEIP and ToR evaluation criteria	No
IV conclusion	Accept: $1.8m There has been a reduction in totex cost of 36% ($14.1m) from the issuance of the investment case ($39.5m in RCP4 excluding SOSPA) to the provision of the latest RT01 figures ($25.4m for RCP4). This does not invalidate the investment case. The bulk of the changes reflect reallocation of $4.6m from ICT capex to capitalised leases and a reduction in the ICT opex step change with a corresponding increase in the base ICT opex.
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Overview

Transpower maintains a significant amount of data for the planning and operation of the transmission network. This can range from detailed network asset data through to corporate and personnel data.

Transpower currently has two data centres which house physical Transpower ICT assets. That is servers, routers, and other associated hardware to ensure that Transpower staff can access the data in an acceptable fashion. The Data Centre Services Modernisation (DCSM) sub-strategy sets out a future where the requirement to have physical data centres is significantly reduced and the data transitions into a cloud environment. The costs for implementing this strategy are shared between the system operator and the asset owner. The analysis below excludes the costs allocated to the system operator.

The move to a cloud-based architecture / provision of servicers is generally referred to as an '…as a service'. For example, 'software as a service' or 'infrastructure as a service'. With the premise that there are third party service providers who can provide ICT software or access to infrastructure more cost effectively, and more reliably than Transpower as the sole procurement entity.

The expenditure profile for DCSM is shown in the following table. From the table we can see that in RCP3 capex is expected to be $14.0 million with $7.8 million of capex in RCP4. The drop from RCP3 to RCP4 specifically relates to the expenditure being transferred to opex from capex as per the IFRS decision. This is driven by the move away from physical servers to Infrastructure as a Service.

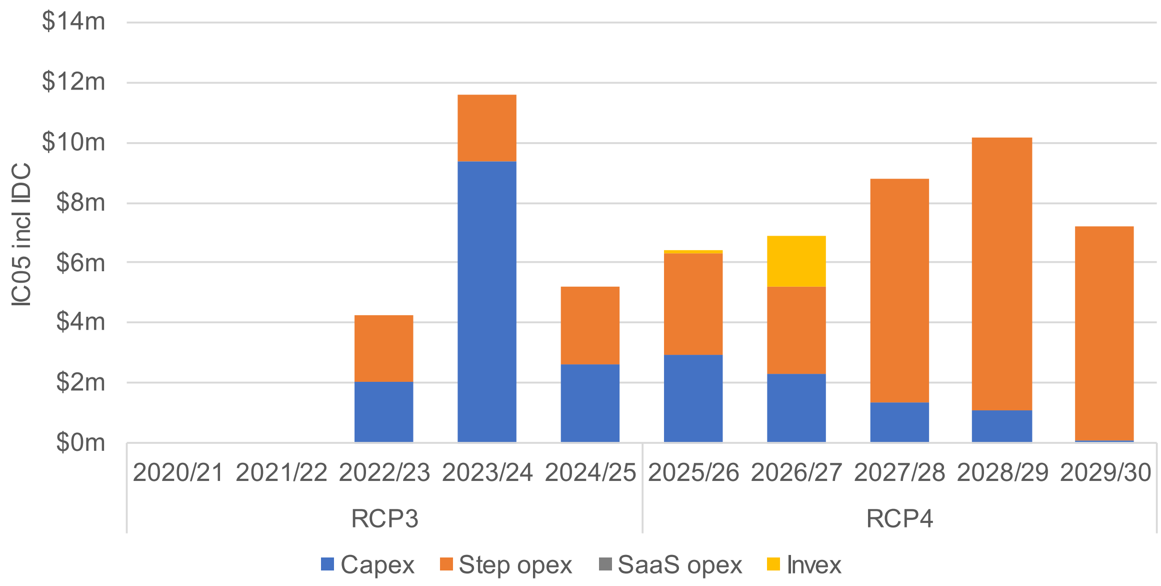
Table 11-27 IC05 – Data centre service modernisation expenditure ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	-	-	2.0	9.4	2.6	14.0	3.0	2.3	1.4	1.1	0.1	7.8
Step opex	-	-	2.2	2.3	2.6	7.1	3.3	2.9	7.4	9.1	7.1	29.9
SaaS opex	-	-	-	-	-	-	-	-	-	-	-	-
Invex	-	-	-	-	-	-	0.1	1.7	-	-	-	1.8
Total	**-**	**-**	**4.3**	**11.6**	**5.2**	**21.1**	**6.4**	**6.9**	**8.8**	**10.2**	**7.2**	**39.5**

Source: ICT031 IC04 Transmission Systems.pdf

The overall expenditure is further illustrated in the following figure, which reveals that across RCP4 capex is projected to taper off and be replaced by opex.

Figure 11-18 DCSM expenditure across RCP3 and RCP4

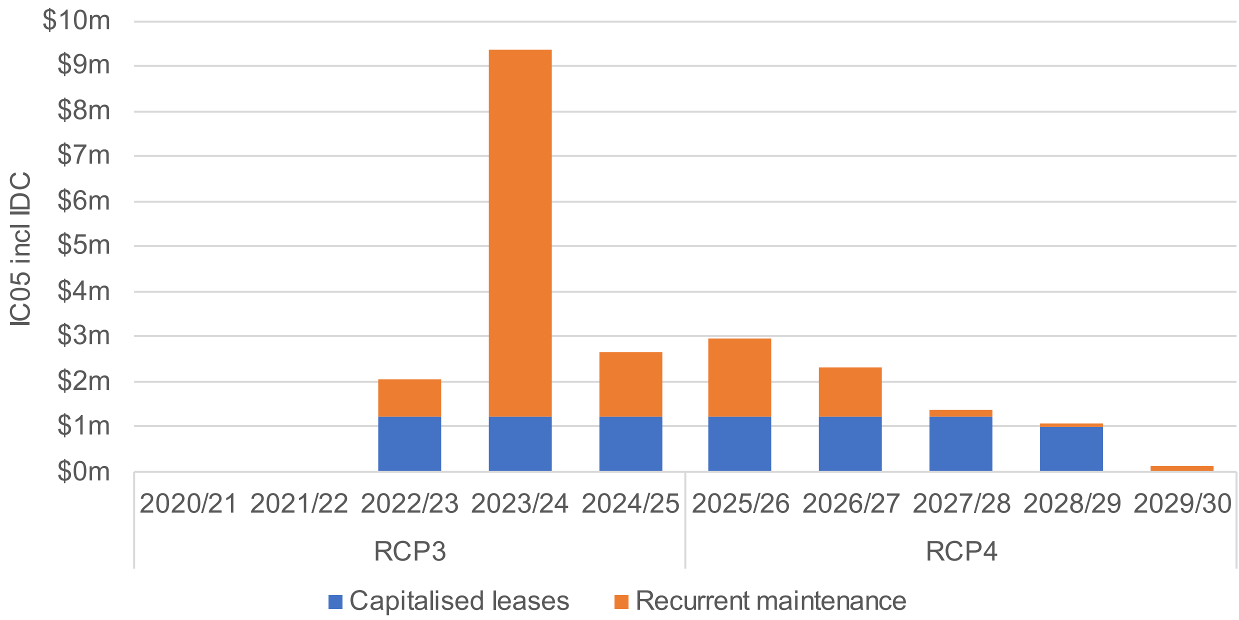


Source: ICT025 IC05 DCSM ICT Investment cases.pdf
Note: the 20/21 and 21/22 figures were not provided in the investment case.

We can see that there is a large, capitalised expenditure expected in 2023/24, which then drops off to a more stable value of between $1m and $3m per annum up to 2028/29. In reflection there is a steady increase in opex starting in 2024/25 and moving forward, peaking in 2028/29 at just over $9m.

The capex applied in this investment case is categorised into two sub sections – capitalised leases and recurrent maintenance, shown in the following table.

Figure 11-19 DCSM capex expenditure across RCP3 and RCP4



Source: ICT025 IC05 DCSM ICT Investment cases.pdf

It is apparent that there is a planned maintenance activity in 2023/24 which accounts for 63% of the total capital expenditure in RCP3. Following that event, the overall capex tapers off throughout RCP4.

Transpower define ICT opex in two areas, opex to maintain the assets and opex for investigations. The planned expenditure is shown in the following table.

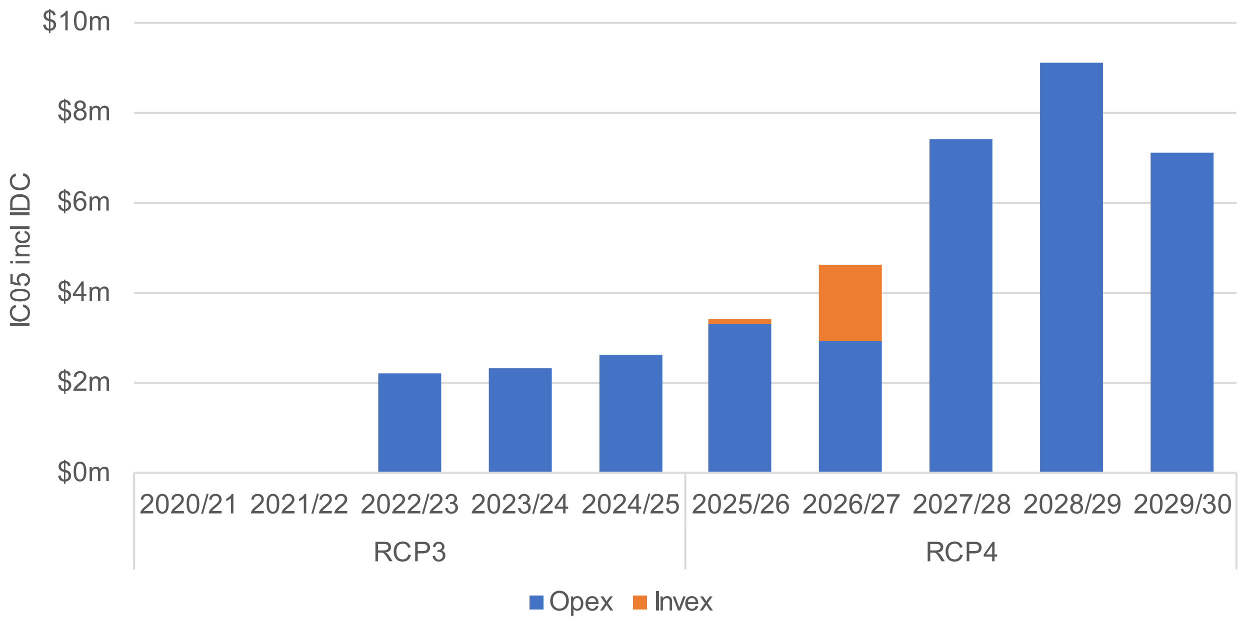
Table 11-28 IC05 – Data centre service modernisation opex by category ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Opex	-	-	2.2	2.3	2.6	**7.1**	3.3	2.9	7.4	9.1	7.1	**29.9**
Invex	-	-	-	-	-	**-**	0.1	1.7	-	-	-	**1.8**
Total opex	**-**	**-**	**2.2**	**2.3**	**2.6**	**7.1**	**3.5**	**4.6**	**7.4**	**9.1**	**7.1**	**31.7**

Source: Transpower, ICT025 IC05 DCSM ICT Investment cases.pdf

For IC05, opex to maintain the assets is approximately $2.2m to $2.6m per annum through RCP3 and between $2.9m and $3.3m into the first two years of RCP4. There is then a large step increase towards $10m in the next two years and then dropping to just above $7m in the final year of RCP4. This is also shown in the figure below.

Figure 11-20 DCSM opex expenditure across RCP3 and RCP4



Source: ICT025 IC05 DCSM ICT Investment cases.pdf

Opex for investigations relates to investigations into replacement assets or systems that may be an option as the current assets get to the end of their life, recorded under ‘invex’. Approximately $1.7m has been allocated to invex, with $4.6m forecast for 2026/27.

Expenditure drivers and solutions

The expenditure drivers for this Investment Case are captured in three main factors, two being capex and one being opex, which is the largest expenditure of the three. Each is briefly discussed below:

- **Capitalised leases:** refers to the expenditure associated with the lease of current data centre racks that are capitalised. The cost of capitalised leases is steady across RCP4 at $1.2m per annum, then dropping off in the final two years.
- **Recurrent maintenance:** relates to maintaining the core systems in operation and mitigating the risks associated with these systems being unsupported in the future. There is an expected large cost, due to refresh activity, in 2023/24, and then the cost is tapers off towards the end of RCP4.
- **Opex:** is simplistically the current ongoing annual cost of operating the data centre facilities.

The main driver for the ICT expenditure is to mitigate the risks associated with maintaining ICT infrastructure. This is then further enhanced with the driver to optimise ICT infrastructure which in certain cases can be driven by the available market services. To date, the most optimised option was to own the physical infrastructure and maintain the assets. As technology has changed, there is a move towards the '…as a service' provision, which allows the third-party service providers to maintain their assets, which you 'rent' access. This is now the more common method for software and is starting to be seen more often in the form of infrastructure services and is apt name 'infrastructure as a service - IaaS.

The investment case identifies two strategic options:

– Option 1 – Keep the existing Data Centres and continue to invest in Transpower owned infrastructure.
– Option 2 – Move to new Data Centre infrastructure – this is a transition to Infrastructure as a Service / Platform as a Service (IaaS/PaaS).

Regardless of the option, there is a need for investment. The two options are evaluated in the Investment case with option 2 selected as the preferred option.

Evaluation

Transpower currently own the infrastructure in the data centres through leased spaces. The assets / infrastructure that is housed in the data centres are upgraded / replaced at between five to ten years of age. The strategy to move to an IaaS has certain benefits in that, the requirement to upgrade the infrastructure will be the responsibility of the third party for an associated fee. In this case the original capex cost will become an opex cost.

There are several benefits to using a third-party supplier for ICT infrastructure:

– The third-party supplier is an expert in managing the infrastructure and should have access to the required level of expertise and knowledge. Whereas, in the case of Transpower, ICT infrastructure is an enabler and not a core activity.
– Third parties will provide ICT services to a multitude of businesses, and therefore can leverage size and service provision. This also has downsides, covered below.
– Transpower can reduce the requirement for buildings to support infrastructure as any third-party assets will be hosted elsewhere.

The option does have some potential challenges, namely:

– Procuring the necessary infrastructure, at a reasonable price may be difficult, as more organisations adopt cloud services and the corresponding market supply to provide infrastructure shrinks.
– The provision of a service within New Zealand is still to be affirmed. For example, Amazon Web Service (AWS) are in the process of establishing a base within New Zealand but their servers are currently in Australia. This may not present a problem, as one of the major advantages of '…as a service' is that the risk of a single failure is avoided as data is 'spread' across the infrastructure.
– The use of the '..as a service' option generally means that the customer does not have control over the physical location of their data. The construction of a AWS in New Zealand does not mean Transpower's data will reside within New Zealand, but it may facilitate that outcome. The distributed nature of storage offered by IaaS systems is usually a selling point for these services in that they are not exposed to a single location failure. We highlight that there may be implications with storing infrastructure data overseas, which we did not see addressed in the business case.

Transpower has also linked the drivers in the investment plan to the strategic drivers for the business, namely:

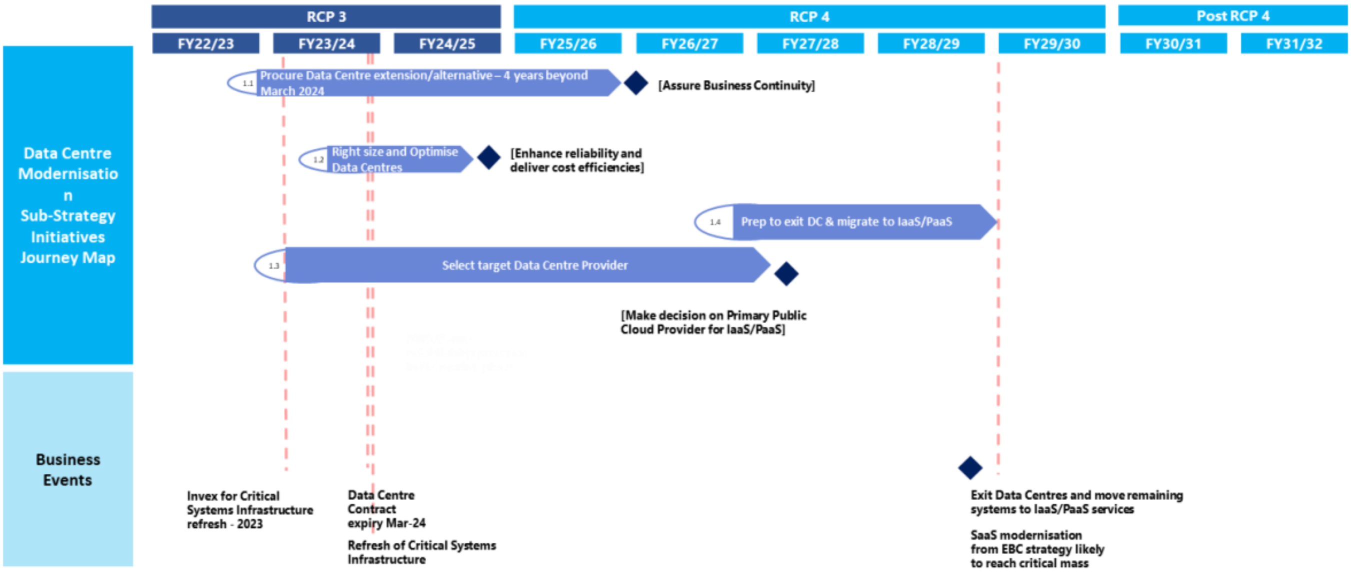
– A long-term strategy for infrastructure, platforms and software - will provide an opportunity to ensure maintain and modernisation investments.
– Cost control – an opportunity to reduce costs, eliminate hidden costs and simplify the infrastructure.
– Increased efficiency – The approach means there is opportunity for continuous improvement of people, process and technology to optimise future investments.
– Access to technology and resources – Adopting a modernised infrastructure will provide access to skilled resources and technology/services at a reasonable price point.

A key factor is that this Investment Case has also been aligned with the Corporate Strategy, namely:

- Transpower's "Transmission Tomorrow – Our Strategy" and "Te Mauri Hiko – Energy Futures" are the key strategic drivers for the ICT Strategy and the supporting sub-strategies.
- These strategies outline a rapidly changing electricity environment in New Zealand. Substantial growth in demand for grid supplied energy, more connections and complexity, technology changes with battery and home automation systems, and a shift from carbon energy sources are driving the need for increased network reliability and resilience.

To further understand the plan, a journey map has been developed and is shown in the following figure.

Figure 11-21 DCSM high level journey map to IaaS / PaaS



Source: ICT025 IC05 DCSM ICT Investment cases.pdf

Establishing the cost of Maintaining Services

In terms of establishing a cost for the investment case, Transpower has undertaken a bottom-up assessment of the current services and is of the view that there are services that can be transferred to IaaS / PaaS services. For clarity, there will be a subset of services which Transpower will prefer, for now, to maintain their own servers, especially around operations and control of the network.

The bottom-up costing exercise has two elements:

- Established costs, for example Project Management, are based on historical costs incurred in past projects. These assets are readily available in the marketplace, and Transpower able to procure these assets.
- The current service costs are based on the provision of services for the current Australian service provision.

The costs provided in the excel sheet are referenced back to the source, which is based on market pricing, and therefore we consider this a reasonable approach for the investment case.

Conclusion

The Investment Case and associated documents have been reviewed, and we conclude that Transpower has adequately supported the proposed investments. The investment in this case, is a move away from the traditional data centre ownership through a transfer the services to a third party.

There is a clear expectation that certain services, predominantly linked to the control system will not be transferred to third party providers, so the requirement to maintain servers will be ramped down, but not eliminated. We agree with this approach.

Based on our evaluation of the IC05 investment case, we are satisfied that the proposed expenditure is prudent and efficient, and consistent with GEIP.

Accepted RCP4 expenditure

Based on our evaluation of the IC05 investment case, we accept the investment case and the costs identified are prudent and efficient, and consistent with GEIP.

As noted in Section 11.5.1 of this report, the costs set out in the investment cases do not align exactly with the costs set out in the RT01 expenditure schedule. The following table compares the RCP4 costs identified in the IC05 investment case against those costs assigned to the IC05 investment case from the RT01 expenditure schedule.

Table 11-29 IC05 – Data centre service modernisation: Cost comparison for RCP4

IC05 - DCSM	Investment case	RT01 expenditure schedule	Difference
ICT capex	$7.8m	$1.8m	-$6.0m
ICT Step opex	$29.9m	$20.0m	-$9.9m
ICT SaaS opex	$0.0m	$1.4m	$1.4m
Invex (ICT and AM&O)	$1.8m	$2.2m	$0.4m
Total	**$39.5m**	**$25.4m**	**-$14.1m**

Source: ICT025 IC05 DCSM ICT Investment cases.pdf

The most significant factor is that the totex has reduced from $39.5m to $25.4m, a drop of 36%. This does not invalidate the investment case. The bulk of the changes reflect reallocation of $4.6m from ICT capex to capitalised leases and a reduction in the ICT opex step change with a corresponding increase in the base ICT opex ($9.9m).

Based on our assessment of the investment case we accept the proposed expenditure on the basis that the investment case and supporting information demonstrates that the evaluation criteria are satisfied and the proposed expenditure is prudent and efficient, and consistent with GEIP.

Verification assessment

We conclude that the IC05 Data centre service modernisation capex of $1.8m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

Table 11-30 IC05 – Data centre service modernisation evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	We reviewed the investment case, which includes a journey map for move to IaaS / PaaS, and demonstrated that programs were reviewed prior to replacement, in line with good asset management. Based on our evaluation of the IC05 investment case, we are satisfied that the proposed expenditure is prudent and efficient, and consistent with GEIP

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	ICT framework and policies are in place and were applied in identifying the need and the preferred solution.
	(ii) how they were applied;	Yes	The application is clean and logical and follows the ICT framework
	(iii) their effect on the proposed base capex	Yes	The assumptions set out the effect on the proposed base capex.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	The inputs and the models underpinning the Investment Case have been made available for review. The inputs are credible the model allows reasonable interrogation of the proposed expenditure.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	The methods used to check the Investment Plan are based on recent incurred costs.

11.5.6 IC08 – Digital Workplace

The following table summarises our verification of the IC05 – Digital Workplace which is categorised as a **non-identified programme** and forms part of the ICT expenditure for RCP4.

Table 11-31 Verification summary of IC05 – Data centre service modernisation

Verification element	Verification commentary
RCP4 proposed amount	$0.0m
Appropriate and sufficient information available for IV	No
Meets GEIP and ToR evaluation criteria	No
IV conclusion	Accept: $0.0m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Overview

The Digital Workplace ICT strategy sets out the plan to provide Transpower with tools and processes that facilitate a change in the dynamic of the workforce, namely the move to multi-locational workforce rather than an office-based workforce.

Traditionally staff have been in an office for most of their work time, with limited options of working remotely, or from different locations. There has been a move to a more flexible option of working, where staff can work from home, or offices that that are more convenient. At the same time, on a technical level, there has been a move away from businesses maintaining software on a server to be rolled out to their workforce, towards the scenario where the software manufacturer manages the updates directly – known as Software as a Service (SaaS),

To facilitate this type of working, several changes are needed, namely:

– Common Digital Workplace Portal – A modern Intranet, more content and experience driven, with improved mobility and access controls.
– Blended Workplaces – To enhance Microsoft Teams with tools that support immersive collaboration.

On a more technical level, to facilitate these services, changes are needed in the ICT infrastructure that become a facilitating function, for example.

– Innovation Sandpit – To simplify the evaluation of digital workplace technologies and prototyping.
– Digital Workplace Governance – To uplift our governance processes.

– Digital Workplace Resilience – To ensure new initiatives are resilient.
– Workplace Analytics – To provide a view of productivity and usage data regarding digital workplace tools.

When looking to the future options, Transpower has considered that an augmented/Virtual Reality (AR/VR) Training Environment - To support an increase in capacity for training/competency assessments.

In the drive to provide a digital workspace Transpower has acknowledged that there are limitations with the current technology, and as such has scaled back the implementation of Digital Workspace until those functions can be delivered at the correct time, this is expected to be in RCP4.

Expenditure profile

The total expenditure across RCP3 and RCP4 is shown in the following table.

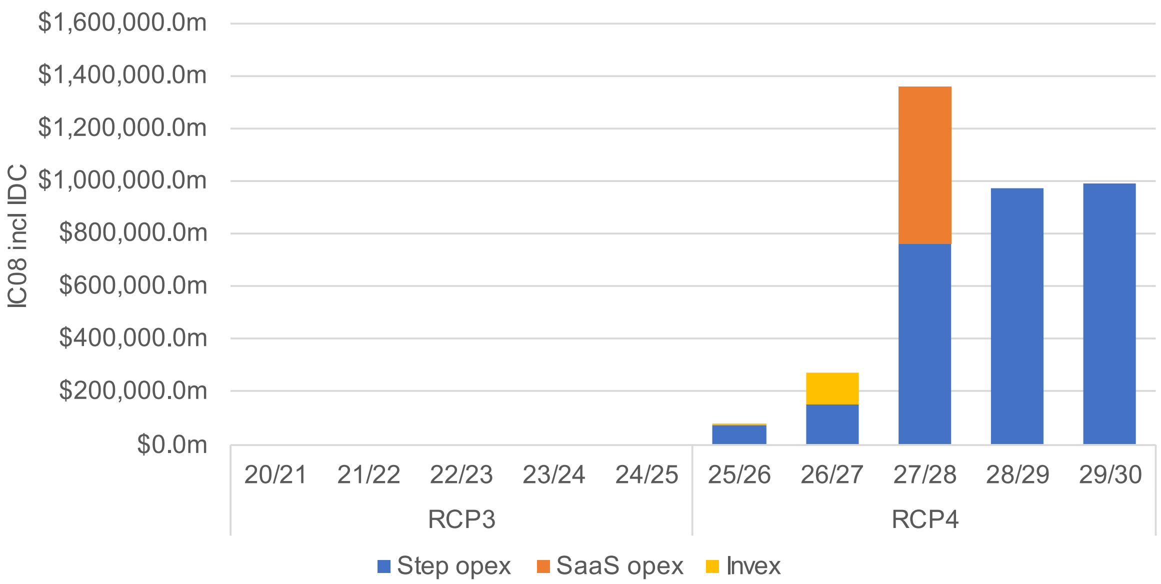
Table 11-32 IC08 – Digital Data centre service modernisation expenditure ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	-	-	-	-	-	**-**	-	-	-	-	-	**-**
Step opex	-	-	-	-	-	**-**	0.1	0.1	0.8	1.0	1.0	**2.9**
SaaS opex	-	-	-	-	-	**-**			0.6			**0.6**
Invex	-	-	-	-	-	**-**	-	0.1	-	-	-	**0.1**
Total	**-**	**-**	**-**	**-**	**-**	**-**	**0.1**	**0.3**	**1.4**	**1.0**	**1.0**	**3.7**

Source: ICT027 IC08 Digital Workplace Investment cases.pdf and IV recon RT01_IC.xls

The expenditure for each category is shown in the following figure.

Figure 11-22 ICT Digital workspace expenditure across RCP3 and RCP4



Source: ICT027 IC08 Digital Workplace Investment cases.pdf and and IV recon RT01_IC.xls

The expenditure for Digital Workspace is predominantly opex in nature with some SaaS opex in 2027/28 and a small amount for investigations (invex) in 2026/27.

Expenditure drivers and solutions

The driver for the expenditure is focussed on keeping the current workforce on pace with developing technology to ensure that the workforce has access to the most up to date software, including the ‘behind the scenes’ infrastructure that facilitates the employee experience.

This includes a multitude of packages, which are not necessarily interconnected, for example:

- modernising the Transpower intranet
- providing a project environment to enable evaluation of digital workplace technologies.
- enable rapid prototyping,
- introducing AR/VR training environment and other supporting investments (governance, resiliency, analytics).

Each item individually can have its own drivers, but it is the overall benefit to Transpower employees that will be seen.

Transpower has offered two options, the first option is a ‘do nothing’ option, that maintains the current status-quo, and does not enhance the services on offer to the employees.

The second option recommends seven actions in the digital workplace, each action is summarised below:

- **Common Digital Workplace Portal** – facilities the option to ‘work anywhere’ for staff.
- **Innovation Sandpit** – An environment to evaluate digital workplace technologies and enable rapid prototyping.
- **Blended Workplaces** - Enhance Microsoft Teams with tools that support collaboration.
- **Digital Workplace Governance** – Strengthening the governance processes to ensure that the appropriate technology, processes, procedures, controls and standards are in place.
- **Digital Workplace Resilience** – To provide confidence to handle disruptions by developing mechanisms/processes to protect against events that could adversely impact the digital workplace
- **Workplace Analytics** - Provides Transpower and employees with data regarding the engagement and adoption of the digital workplace tools and their impact on the organisation. Any dashboards required will be treated as data products under Data Analytics (D&A) programme, and not this investment case.
- **Augmented/Virtual Reality (AR/VR) Training Environment** to support an increase in capacity for training/competency assessments.

Transpower has identified several elements as out of scope, specifically:

- Artificial intelligence (AI) & Machine Learning (ML) based virtual assistants.
- Digital Literacy.
- Desktop Virtualisation (Desktop as a Service).
- Desktop Virtualisation (Virtual Desktop infrastructure).
- Availability and Presence.
- Bring your own Technology (BYOT).

These services are not considered as options for the current and next price control. However, they may be an option in future developments.

Evaluation

Transpower has identified the following limitations with their existing digital workspace:

- The current intranet is a home-grown solution which has several barriers to adoption (static intranet, minimum automation and integration) and multi-touch manual processes (rather than automated and digitised workflows with visibility of performance indicators).
- Information sits across multiple, disconnected systems requiring context switching and resulting in a loss of productivity.
- It does not support the anticipated growth for grid training/field competency assessments resulting in increased costs in the future.

Transpower has identified that loss of experience is a key concern for their future workforce and the ability to innovate is a key differentiator in capturing and retaining industry talent. The proposed digital workspace investment delivers a common experience to all employees, enabling staff to be accountable for their learning opportunities and have access to codified knowledge that can be trusted and re-used in context. The following key consideration are addressed by the investment case:

– Staff, in part due to COVID-19 impacts, expect enhanced capabilities to collaborate in hybrid meetings and workshops (both virtual and physical audience) and the ability to seamlessly work remotely.
– There is a well-advertised “war on talent” where competition for highly skilled resources has become increasingly competitive and heightened by the COVID-19 pandemic.

We accept that providing a digital environment that fosters collaboration and efficient sharing of knowledge is consistent with GEIP and likely to aide with staff development and retention.

The investment case indicates that the preferred option delivers benefits across RCP4 and RCP5 that exceed cost. Implementing the first 6 of the 7 actions is projected to deliver an IRR of 17.2% with the 7th action is projected to deliver an IRR of 17.3%. We are therefore are satisfied with the prudency of the proposed investment.

Establishing the cost of Digital Workspace

To establish the RCP4 cost of the Digital Workplace, separate costings were developed for each of the 7 action items addressed by the preferred option. Transpower has advised that the costs basis consists primarily of known and estimated software licence costs and the costs of personnel training. GHD has reviewed the cost build up and confirmed the basis for the cost estimate is reasonable[305].

Delivery of the Investment Case

Transpower has aligned this investment case with the corporate business goals and developed sub-strategies that eventually lead to the planned investments. The stage investment path can be seen with the roadmap shown contained in the IC08 Digital Workplace investment case document.[306]

The roadmap of initiatives has several inter-relationships and dependencies that will need to be managed to ensure Transpower gets the full benefit from all the investments. They are:

– Building Information Modelling (BIM) investments provide inputs for the Grid training materials in the form of 3D models of our assets.
– Enterprise Business Capability investment case may include Learning Management. This investment case incorporates the use of AR/VR training which may require some integration. Whilst there are no overlaps between the investment cases, there are areas of close alignment, as they are all contributing towards similar efficiency benefits. Transpower does not anticipate any material overlaps in costs or benefits between these areas.

The proposed delivery plan appears to be reasonable.

Conclusion

The proposed investment in the digital workspace addresses a legitimate need. Transpower has demonstrated that the preferred option will provide an acceptable IRR delivering benefits which exceed costs.

Based on our evaluation of the IC08 Digital Workspace investment case, we accept the investment case and find that the costs identified are prudent and efficient and consistent with GEIP.

Accepted RCP4 expenditure

The costs set out in the investment cases correlate with the costs set out in the RT01 expenditure schedule.

Verification assessment

We conclude that the IC08 Digital Workplace capex of $0.0m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

[305] RFI040-01 Digital Workplace Cost Breakdown.xls
[306] ICT027 IC08 Digital Workplace Investment cases.pdf

Table 11-33 IC08 – Digital Workplace evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	The assumptions are set out in the investment case and the cost build up can be traced. We are of the opinion that it is a prudent and efficient approach. The approach follows a framework and strategy as set out within Transpower ICT strategy. This does reflect GEIP.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	The investment case includes a cost benefit assessment demonstrating that benefits are expected to exceed cost and deliver a reasonable IRR. Transpower has provided a spreadsheet presenting the basis for the estimated expenditure.
	(ii) how they were applied;	Yes	Key assumptions are set out in the same spreadsheet allowing tracing of costs.
	(iii) their effect on the proposed base capex	Yes	The model allows the impact of adjusted assumptions to be assessed.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	Inputs are defined in the spreadsheet model which demonstrated how those inputs effect the assessed costs and benefits.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	Checks are based comparison with relevant historical costs and market insights for the costs for new applications.

11.5.7 IC09 – Cybersecurity

The following table summarises our verification of the IC09 – Cybersecurity which is categorised as a **non-identified programme** and forms part of the base ICT capex for RCP4.

Table 11-34 Verification summary of IC05 – Data centre service modernisation

Verification element	Verification commentary
RCP4 proposed amount	$7.3m
Appropriate and sufficient information available for IV	No
Meets GEIP and ToR evaluation criteria	No
IV conclusion	Accept: $7.3m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus	None identified

Overview

Cybersecurity sub strategy is a single strategy focussed on Transpower maintaining a reliable and secure service. Cybersecurity is constantly evolving, as the threats of cyber-attacks on the business evolve, the business needs to respond. Transpower need to manage the risk exposure to cyber-attacks as the worst-case impact of a successful attack could lead to the loss of ability to operate the electricity system.

Transpower abide by two significant processes and procedures, namely:

– ISO27001:2012 – Information Security Management
– VCSS-CSO – Voluntary Security Standards for Control System Operators[307]

We assume that Transpower meet the ISO and VCSS standard.

Rather than a new expenditure, this is a continuous expenditure to maintain the current level of security and enable new capabilities in response to evolving threats as the technology evolves.

Expenditure profile

The total expenditure across RCP3 and RCP4 is shown in the following table.

Table 11-35 IC09 – Cybersecurity expenditure ($m)

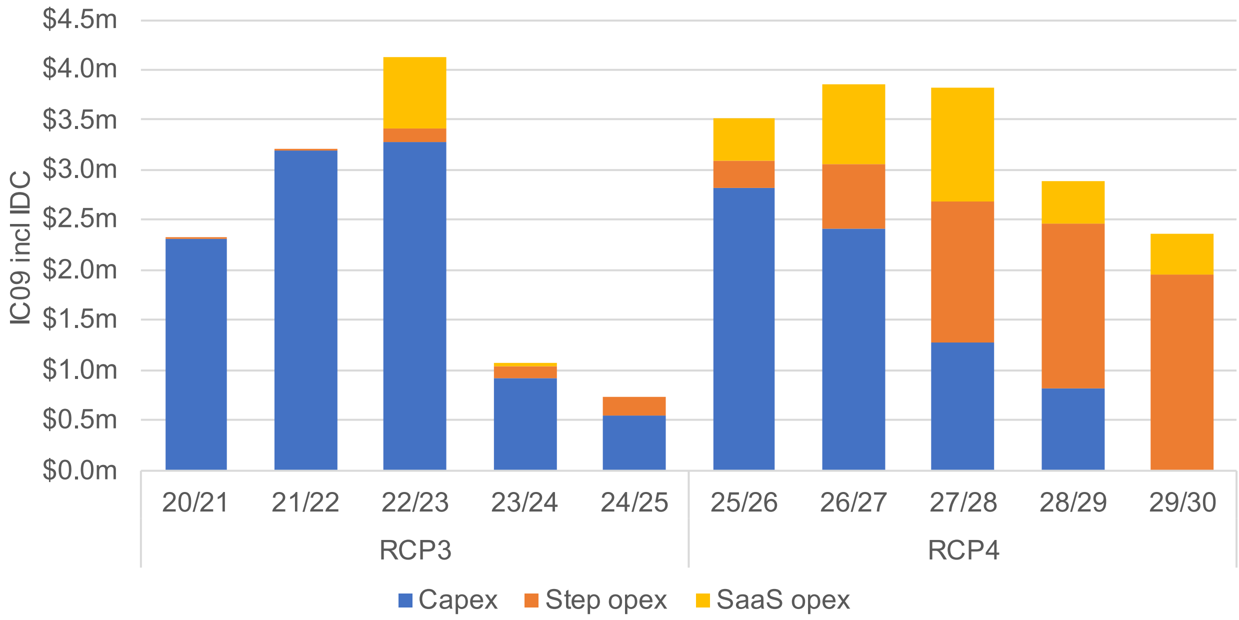
	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex	2.3	3.2	3.3	0.9	0.5	**10.2**	2.8	2.4	1.3	0.8	-	**7.3**
Step opex	0.0	0.0	0.1	0.1	0.2	**0.5**	0.3	0.6	1.4	1.6	1.9	**5.9**
SaaS opex	-	-	0.7	0.0	-	**0.7**	0.4	0.8	1.1	0.4	0.4	**3.2**
Invex	-	-	-	-	-	**-**	-	-	-	-	-	**-**
Total	**2.3**	**3.2**	**4.1**	**1.1**	**0.7**	**11.4**	**3.5**	**3.9**	**3.8**	**2.9**	**2.4**	**16.4**

Source: ICT027 IC08 Digital Workplace Investment cases.pdf and IV recon RT01_IC.xls

The expenditure for each category is shown in the following figure.

[307] Document produced by National Cyber Security Centre and the Control System Security Information Exchange.

Figure 11-23 Cybersecurity expenditure across RCP3 and RCP4



Source: ICT028 IC09 Cybersecurity ICT Investment case.pdf

The investment case contains expenditure in both capex and opex. The capital expenditure is further broken down into four sub-categories, plus one category relating to TransGo firewalls. The sub-categories can be approximated into maintaining the existing services at the current level followed with new capabilities specifically for new threats not seen before.

These four main sub-categories are duplicated for both opex and SaaS opex. A breakdown of the expenditure is shown in the following table below.

Table 11-36 ICT Cybersecurity capex and opex expenditure by sub-category ($m)

	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Capex												
Maintain & modernise existing capabilities	1.4	2.8	2.1	0.5	0.0	6.8	1.5	1.0	1.3	0.7	0.0	4.4
TransGo firewall	0.5	0.0	0.0	0.0	0.0	0.5	1.3	1.3	0.0	0.0	0.0	2.7
Sustain security control	0.4	0.4	0.4	0.4	0.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
New capabilities to threat	0.0	0.0	0.8	0.0	0.1	0.9	0.0	0.1	0.0	0.1	0.0	0.2
New capabilities to business change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	**2.3**	**3.2**	**3.3**	**0.9**	**0.5**	**10.2**	**2.8**	**2.4**	**1.3**	**0.8**	**0.0**	**7.3**
SaaS opex												
Maintain & modernise existing capabilities	0.0	0.0	0.7	0.0	0.0	0.7	0.0	0.4	0.7	0.0	0.0	1.1
Sustain security control	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	2.1
New capabilities to threat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New capabilities to business change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	**0.0**	**0.0**	**0.7**	**0.0**	**0.0**	**0.7**	**0.4**	**0.8**	**1.1**	**0.4**	**0.4**	**3.2**
Opex												
Opex - maintain	0.0	0.0	0.1	-0.1	-0.1	0.0	0.0	0.3	1.1	1.3	1.6	4.3
Opex - benefits	0.0	0.0	0.0	0.2	0.3	0.5	0.3	0.3	0.3	0.4	0.4	1.7
Subtotal	**0.0**	**0.0**	**0.1**	**0.1**	**0.2**	**0.5**	**0.3**	**0.6**	**1.4**	**1.6**	**1.9**	**5.9**
Total	**2.3**	**3.2**	**4.1**	**1.1**	**0.7**	**11.4**	**3.5**	**3.9**	**3.8**	**2.9**	**2.4**	**16.4**

Source: ICT028 IC09 Cybersecurity ICT Investment case.pdf

Cybersecurity capex

The breakdown of the capex profile show that there are distinct areas of expenditure in that most of the RCP3 capex expenditure is related to maintaining and modernising the current services ($6.8m, 66% of RCP3 capex) and this continues into RCP4 ($4.4m, 60% of RCP4 capex) for the same services. It should also be noted that the capex drops in RCP4 ($7.3m) compared to RCP3 ($10.2m).

Cybersecurity opex

Opex is generally low in RCP3, with $0.5m allocated to opex, this is also the case for SaaS opex which is also low in RCP3 ($0.7m). there is a significant uplift in both opex and SaaS opex in RCP4, which coincides with the reduction of capex. Where SaaS opex increases by $3.2m in RCP4 and opex also increases to $5.9m in RCP4.

Expenditure drivers and solutions

The Cybersecurity sub-strategy sets out the latest business and technology trends impacting Transpower. These have a potential to increase the vulnerability and increase the need to invest into new capabilities resulting from the business, threat and technology change. Not mitigating these changes would increase our risk significantly above the band of acceptable risk exposure.

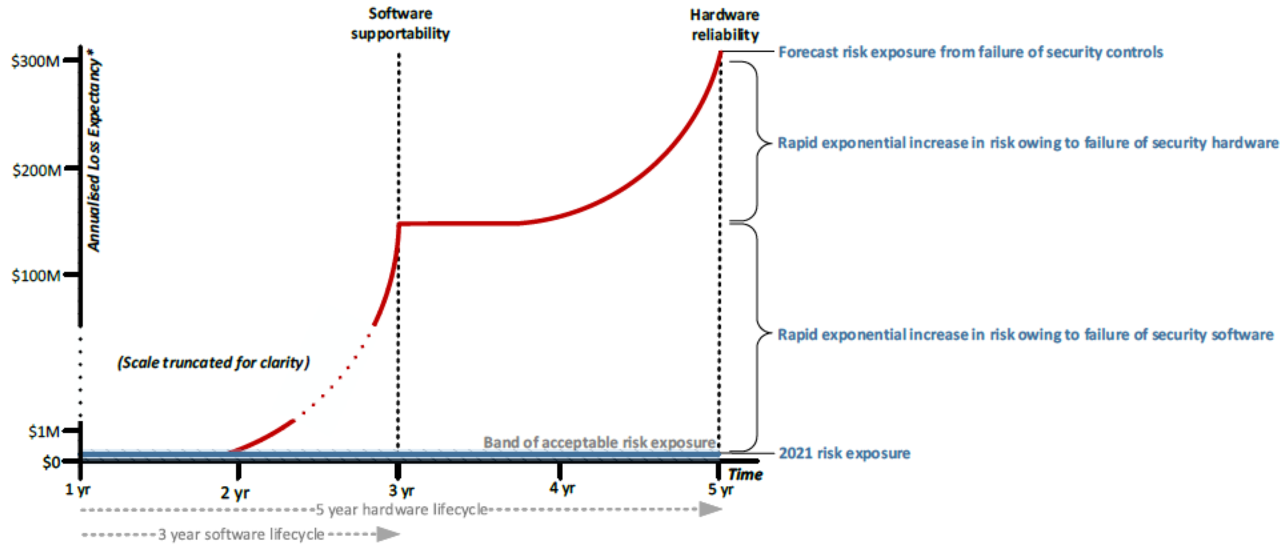
Transpower use an ‘avoided risk’ approach to identify the avoided risk associated with investing in cybersecurity capabilities. The starting point is a “do nothing” scenario which assumes that there are no new investments. Ceasing new investment implies no upgrade software, firmware, and hardware.

It is expected that in the ‘do nothing’ approach, eventually the controls will fail and a high-impact cybersecurity event such as a ransomware attack may be successful. In this scenario, Transpower has estimated that that the full cost-of-consequence, would be in the region of $320m.

This full cost-of-consequence reflects modelled Annualised Loss Expectancy (ALE) on Transpower but does not reflect the wider impact on the New Zealand economy.

An output of the modelling is shown in the figure below. This shows the expected annualised loss expectancy for the ‘do nothing’ scenario.

Figure 11-24 Estimated Loss expectancy – do nothing scenario



Source: ICT028 IC09 Cybersecurity ICT Investment case.pdf

The costs are built up to ensure that the risk associated with delivering the scope is addressed.

The cost is built up on both a comparative cost of existing assets, with input from third parties for the next generation of technology and software.

As the replacements are cyclical, it can be seen that in 2024/25 there is a replacement planned to maintain the existing infrastructure in its current form. There is then a move in technology in RCP4 to a different approach, which transfers the costs over to opex.

This investment case does not calculate the financial return using NPV or IRR metrics. This is because the associated risk mitigation benefits are only measurable utilising the Transpower Risk Framework's semi-quantified annualised loss expectancy approach. The annualised loss expectancy is an annualised metric that can't be discounted. Therefore, the key means to assess the appropriateness of this investment is provided by the comparison of available options against the acceptable risk exposure.

Evaluation

Critical infrastructure organisations such as Transpower are actively targeted by malicious actors. Increased use of data sharing and cloud-based services and connected Operational Technologies have the potential to further increase exposure to cyber threats.

Threat actors seek to leverage organisations' dependence on information and systems for their own financial or political gain, which in turn, can disrupt customer service delivery, threaten core operations, and impact the realisation of strategic objectives.

The key driver of cybersecurity is risk mitigation. An increasing number of significant high profile cyberattacks internationally (such as attacks on oil pipelines, supply chains and Microsoft core technologies) and in New Zealand (including RBNZ and Waikato DHB) reinforce cybersecurity as one of the key risks for Transpower.

Transpower's Risk Appetite Statement 2020 stipulates that Transpower has a low-risk appetite for actions not consistent with the long-term interests of NZ consumers as determined by the Regulators in the Service Delivery exposure category. From the cybersecurity perspective, this translates to Transpower taking a risk-based approach towards management of its ICT assets and to actively manage cyber threats.

In terms of risk, Transpower has a low-risk appetite, which is quantified through an annualised loss expectancy approach. To establish the ALE, Transpower has carried out a risk mapping and mitigation assessment which aims to capture the potential loss, in monetary form associated with cybersecurity controls failing.

This is further supported with modelling controls which Transpower has introduced to reduce the likelihood of certain threats (which erode the security stages in place) and the potential impact. As there are multiple stages of control, which would have to be disabled to realise a successful attack, this approach is useful for mapping potential points of weakness.

The drivers for the cybersecurity strategy are listed in five key activities:

– Maintain and modernise existing capabilities.
– Sustain security control effectiveness.
– New capabilities in response to threat change.
– New capabilities in response to business change.
– New capabilities in response to technology change.

The drivers for this strategy do not cover new technologies or processes brought around by the change to data centres. The drivers are seen to maintain a similar level of ICT infrastructure and solutions within the scope of the existing assets.

Transpower's risk-based management approach to cybersecurity investments integrates four key elements:

– Risk-based identification and quantification of threats reported as an annualised loss expectancy to the organisation.
– Transpower use a 'bowtie' risk analysis and Semi-Quantitative Risk Assessment (SQRA) to assess the areas requiring investment in the Benefits driven category. annualised loss expectancy demonstrates an expected monetary loss to Transpower associated with a risk of our current cybersecurity controls failing in a single year. It is the product of the annual rate of occurrence (ARO) and single loss expectancy (SLE) (annualised loss expectancy = ARO x SLE).
– A security controls framework driven by our policies and aligned to the threat landscape.

- Key areas of cybersecurity risk are modelled as bowties, including the controls designed to either reduce the likelihood of a threat occurring, or to mitigate the impact if it does occur. These controls describe the tools, processes and operating procedures of our cybersecurity management.
- A security programme aligned to adding or changing security controls effectiveness to maintain or lower its risk position (ALE).
- Continual reporting of security controls effectiveness and the impact to the overall risk position and ALE.

The definition of the need, to manage the risk of cyber-attacks is well understood. The threat is constantly evolving, and infrastructure businesses have, at times, been a focus of these attacks. It is understood and recognised that there is a clear need to mitigate the risk.

Establishing the cost of Cybersecurity

To establish the RCP4 cost of cybersecurity, a comparative approach is adopted in which the replacement cost is expected to be consistent with historical costs as the assets are readily available from suppliers. The most recent actual cost (or an average if available) is extrapolated forward to develop the expected recurrent capex forecast.

Delivery of the investment case

Transpower has aligned this Investment Case with the corporate business goals and developed sub-strategies that eventually lead to the planned investments. A stage of that path can be seen with the roadmap shown in the IC09 Cybersecurity investment case.[308]

When reviewing the options analysis, we are of the view that, in the case of cybersecurity, the option of ‘do nothing’ and maintain the current infrastructure is not an appropriate response. Rather, as set out by Transpower, the preferred option is business wide and influences other Investment Cases. We agree with the Transpower approach to Cybersecurity which also encompasses other sub-strategies such as TransGo which is expected to progress with certainty across RCP4.

In the case of cybersecurity, the options are incremental, in that to complete Option 2, the actions in Option 1 also need completing, and the same for Option 3, in that the activities; listed in Option 2 and Option 1 are also required.

In terms of alternative options, the choice is limited as cybersecurity is heavily dependent on the existing infrastructure and the path set at that time.

At a business level, our view is that Transpower has established an acceptable level of risk, based on the nature of the business and how the system can be accessed. The current level meets the requirements of the VCSS-CSO and the ISO standard. We do not see any reason that the level of risk should be lowered or increased. This naturally leads to the conclusion that the second option – maintain the level of risk – is the most appropriate.

We have reviewed the activities that are proposed in option 2, such as:

- Maintain the core systems as installed in RCP3.
- Invest in controls including SaaS based solution.
- Add new capabilities in response to the threat change.
- Add new capabilities in response to the changes in Transpower.
- Add new capabilities in response to new / change in technologies.

We are satisfied that the proposed investments are appropriate as they sufficiently maintain the desired level of risk.

Transpower has conducted a risk assessment under an approach known as a Semi-Quantitative Risk Assessment, which allows areas of investment to be identified. Delivering Option 2 should maintain the risk profile within the bounds of the assessment.

Establishing the cost

As noted above, the options are incremental such that the cost of Option 2 includes the work required to deliver option 1 plus the additional work required to deliver the expanded scope of Option 2. Transpower provided an

[308] Source: ICT028 IC09 Cybersecurity ICT Investment case.pdf, Figure 7.

excel sheet[309] where the costs were based on historical deployments to which these became the basis of the forecast cost.

The costs are formed based on three elements:

– Bottom up cost
– Comparative assessment
– Expert judgement

To establish the cost, the scope of the new equipment is based on existing specifications – for example providing a new connection to a substation will follow the current designs, and the individual components are selected based on the appropriateness and a view to their suitability in the future. The latter is to assure that the 'latest' proven technology is used rather than older equipment which may become obsolete quicker or not have the latest security specifications. The assets are then confirmed that they will meet the required functionality.

By using existing technology as the basis of the cost is a reasonable approach as those assets are procured from the market, the more modern equipment should be of a similar cost as they are providing a similar function. There is a need for expert judgement to ensure that those assets are 'future proofing' in a way that is reasonable for Transpower, especially in ICT where the life of the assets is relatively short.

Conclusion

The need to, at a minimum, maintain the existing level of cybersecurity, is a well understood requirement in the current climate. Transpower follow two major processes for cybersecurity, namely the ISO 27001 standard and the New Zealand VCSS-CSO standards. Both set a level of cybersecurity.

Transpower have proposed expenditure across the remaining part of RCP3 and for RCP4, which will deliver the same level of risk. The cost to meet this is built up from different sources, but where costs can have been incurred, these are used.

Based on our evaluation of the IC09 Cybersecurity investment case, we accept the investment case and find that the costs identified are prudent and efficient and consistent with GEIP.

Accepted RCP4 expenditure

Based on our evaluation of the IC09 investment case, we accept the investment case and the costs identified are prudent and efficient, and consistent with GEIP.

As noted in Section 11.5.1 of this report, the costs set out in the investment cases do not align exactly with the costs set out in the RT01 expenditure schedule. The following table compares the RCP4 costs identified in the IC09 investment case against those costs assigned to the IC09 investment case from the RT01 expenditure schedule.

Table 11-37 IC09 – Cybersecurity: Cost comparison for RCP4

	Investment case	RT01 expenditure schedule	Difference
ICT capex	$7.3m	$7.3m	-
ICT Step opex	$5.9m	$5.9m	-
ICT SaaS opex	$3.2m	$3.2m	-
Invex (ICT and AM&O)	-	$1.1m	$1.1m
Total	$16.4m	$17.6m	$1.1m

Source: ICT028 IC09 Cybersecurity ICT Investment case.pdf, IV recon RT01_IC.xlsx; worksheet 'Reconciliation'

The difference is an additional expenditure in invex that is not mentioned in the investment case, this equates to 7% of the total expenditure in RCP4.

We believe these changes do not alter the integrity and findings of our assessment of the investment case set out above. As such, based on the principle of proportionate scrutiny, the change is negligible, an acknowledgement

[309] RFI017-01 Cybersecurity cost build up and historical trends.xlx; Cost inputs worksheet

that costs change over time, we accept a IC09 totex value of $17.6m, including $7.3m of ICT capex. We are comfortable, based on the principles above, that these costs are consistent with the RT01 expenditure schedule which drives its stated request for capex and opex.

Verification assessment

We conclude that the IC09 Cybersecurity capex of $7.3m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification of this **non-identified programme** against the evaluation criteria.

Table 11-38 IC05 – Data centre service modernisation evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	The assumptions are set out in the investment case and the cost build up can be traced. We are of the opinion that it is a prudent and efficient approach. The approach follows a framework and strategy as set out within Transpower ICT strategy. This does reflect good industry practice
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	Comparative approach is used to develop the expenditure. The assumptions are set out along with the historical comparative data within the same spreadsheet. The method is also set out.
	(ii) how they were applied;	Yes	Application is also set out in the same spreadsheet allowing tracing of costs.
	(iii) their effect on the proposed base capex	Yes	It is clear the effect as the model allows for the assumptions to change, however the model shows the reasoning.
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	Inputs to the model are provided along with how these are applied.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	Checks are based on recent costs incurred along with comparative assessment for the future development.

12. Business support capex

This section evaluates Transpower’s proposed business support capex requirement for the RCP4 period. Business support capex is categorised as non-network capex and includes capital expenditure on:

– Vehicles,
– Office equipment, and
– Office buildings and facilities.

In RCP3, business support capex included a fourth category of expenditure labelled ‘AC substations’. Transpower has advised expenditure was for work related to putting systems in place for the grid service provided contract reset including digital engineering, engineering consultants and service provider support, site digitisation. No expenditure in this category is proposed for RCP4.

12.1 Summary of findings

The following table summarises Transpower’s proposed RCP4 business support capex by category and our conclusions with respect to verification and acceptance of the proposed expenditure. Of a total proposed expenditure of $43.1m, we accept $27.1m and do not accept $16.0m.

Details pertaining to these conclusions can be found in the following sub-sections.

Table 12-1 Summary of findings – ICT capex programme

Capex category	Programme	Proposed RCP4 ICT capex	IV conclusion
Vehicles	Non-identified	$3.8m	Accept: $4.2m[1] Reject: $0.0m
Office equipment	Non-identified	$30.1m[2]	Accept: $13.7m Reject: $16.0m
Office Buildings and Facilities	Non-identified	$9.2m	Accept: $9.2m Reject: $0.0m
Total		**$43.1m**	**Accept: $27.1m** **Not reviewed: $16.0m**

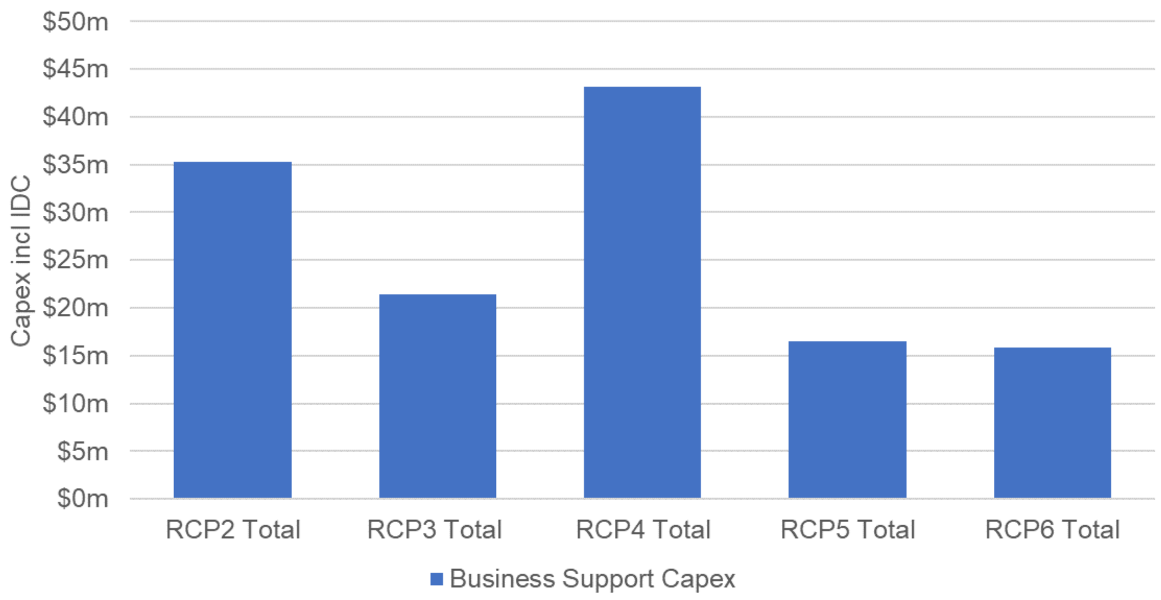
Notes:
[1] Accepted expenditure for vehicles includes $0.4m related to forklifts reallocated from office equipment.
[2] Proposed expenditure for office equipment includes $0.4m for forklifts.

12.2 Overview of business support capex proposal

The following figure shows the longer term business support capex profile including historical and forecast expenditure. Increased expenditure is proposed for RCP4 compared to RCP3 and RCP2 with expenditure for RCP5 and RCP6 projected to reduce below RCP3 levels.

The main reason for the increased expenditure in RCP4 is the additional expenditure associated with the Wellington Street Building ($16m) and development of the grid skills training facility at Bunnythorpe ($9.2m).

Figure 12-1 Business support capex long term profile



Source: Transpower, RT01 expenditure schedule.

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3 expenditure levels.

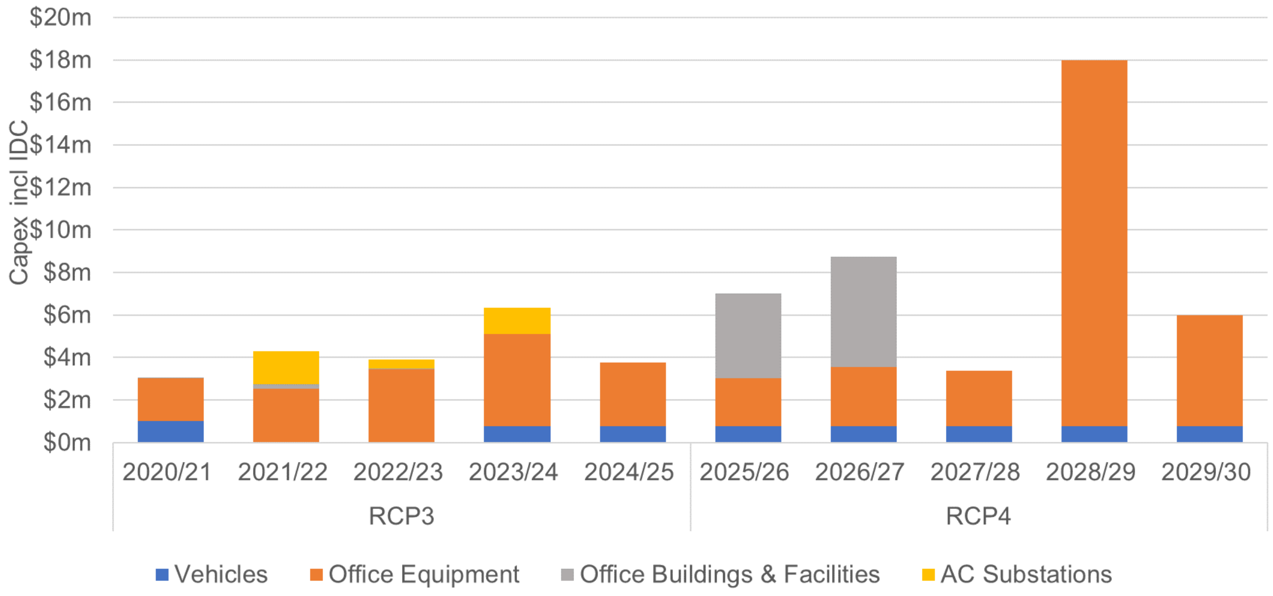
Table 12-2 Business support capex for RCP3 and RCP4

Asset portfolio	RCP3 total	RCP4 total	Change
Business support	$21.7m	$43.1m	192%

Source: Transpower, RT01 expenditure schedule and GHD analysis.

The annual business support capex profile for all categories within this asset portfolio is shown as stacked columns in the following figure, which includes capex across RCP3 and RCP4.

Figure 12-2 Business support capex profile



Source: Transpower, RT01 expenditure schedule.

The following table summarises Transpower's proposed RCP4 base business support capex by year.

Table 12-3 Proposed RCP4 overall base business support capex

Category	2025/26	2026/27	2027/28	2028/29	2029/30
Vehicles	$4.0m	$5.2m	$0m	$0m	$0m
Office Equipment	$0.8m	$0.8m	$0.8m	$0.8m	$0.8m
Office Buildings and Facilities	$2.3m	$2.8m	$2.6m	$17.2m	$5.2m
Total	**$7.0m**	**$8.8m**	**$3.4m**	**$18.0m**	**$6.0m**

Source: Transpower, RT01 expenditure schedule.

12.3 Evaluation

To assess whether Transpower's proposed business support capex was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 8.2 of this report as applicable.

Vehicles, office equipment and office buildings and facilities are non-identified capital expenditure programmes and as such we have followed the non-identified programme evaluation criteria. The criteria and method have been applied to each category of business support capex individually.

Our assessment has involved reviewing the provided initial tranche of documentation pertaining to business support capex and interviewing the relevant Transpower management team and subject matter experts. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting evidence that informed Transpower's proposed RCP4 base business support capex.

To support our evaluation of Transpower's proposed capex we reviewed the relevant business support asset class plan[310] and supporting documentation to understand how Transpower has established the required capex forecast. Specifically, we considered:

- Key assumptions made and the basis for those assumptions.
- Whether Transpower has demonstrated the proposed capex is in line with internal polices and that the investment is prioritised and directed to achieving a cost-efficient solution.
- Whether efficiency improvements and trade-offs are acknowledged. This also applies to opex trade-offs.
- The ability for Transpower to deliver the expenditure in the remaining RCP3 period and into RCP4.
- The reasonableness of any models used to prepare the cost base.
- The reasonableness of any forecasts and the assumptions behind the forecasts.

Our evaluation of each business support capex component is presented in the following sub-sections.

[310] Section 6.1 of AM003 2022 Asset Management Plan.pdf

12.3.1 Vehicles

The following table summarises our verification for the business support (vehicles) base capex which is selected as an identified programme for RCP4.

Table 12-4 Verification summary of business support capex - vehicles

Verification element	Verification commentary
RCP4 proposed amount	$3.8m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept $4.2m. This is comprised of the $3.8m proposed by Transpower and recorded in the vehicles category and $0.4m associated with forklifts but allocated to the office equipment category
Potential scope for improvement	Consistently allocate vehicle related expenditure to the vehicle category within business support capex.
Key issues and areas that the Commission should focus	None identified.

Overview

Vehicles covers a variety of different types and classes, with the majority being used by grid delivery and associated with Field Operations staff when maintaining and repairing the network assets.

This capex category also covers trailers, trucks, a forklift, and a minibus. The types and quantities of vehicles assigned to different business departments are shown in the table below.

Table 12-5 Types and quantities of different vehicles procured by Transpower

Variant / Group	Auckland	Corporate Services	Grid Delivery	Land owner Relation	Pool car	Operations	People	Total
Forklift		1						1
Fuel Card		1						1
Minibus							1	1
Station Wagon			47	4	6	1	3	61
Trailer			16				4	20
Truck							1	1
Utility	1	3	21	1			3	29
Total	**1**	**5**	**84**	**5**	**6**	**1**	**12**	114

Source: Transpower, RFI042-02 Master vehicle list, GHD Analysis

We can see from the list in the table above that most of the vehicles are utilities, station wagons and trailers and are linked to the Grid Delivery part of the business with the remaining vehicles spread across different business departments and are different type of vehicles, for example forklift allocated to corporate services.

Expenditure profile

The expenditure profile for vehicles is shown in the following table. Transpower is projecting similar levels of expenditure across RCP4, RCP5 and RCP6. The average expenditure across the first three years of RCP3 is $0.68m per annum.

Table 12-6 Business support capex – vehicles ($m)

Component	RCP3 (base and 3 forecast years)						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Vehicles	1.0	0.5*	0.5*	0.8	0.8	3.6	0.8	0.8	0.8	0.8	0.8	**3.8**
Total	**1.0**	**0.5***	**0.5***	**0.8**	**0.8**	**3.6**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**3.8**

Source: Transpower, Business services categories.xlsx and RT01 expenditure schedule
Note: 2021/22 and 2022/23 expenditure has been transferred from office equipment as that expenditure relates to vehicles.

Asset planning approach

Section 6 of the 2022 Asset management Plan[311] sets out the business support capex asset class plan (ACP). The asset class plan specifies that Transpower plans to replace vehicles when replacement criteria are met. The replacement criteria include steps necessary to meet commitments to change all passenger vehicles to hybrid or electric vehicles. Transpower participates in the All of government contract for the supply of motor vehicles to achieve the best available price for new vehicles. The vehicles asset class plan applicable for RCP4 is unchanged from that applicable for RCP3.

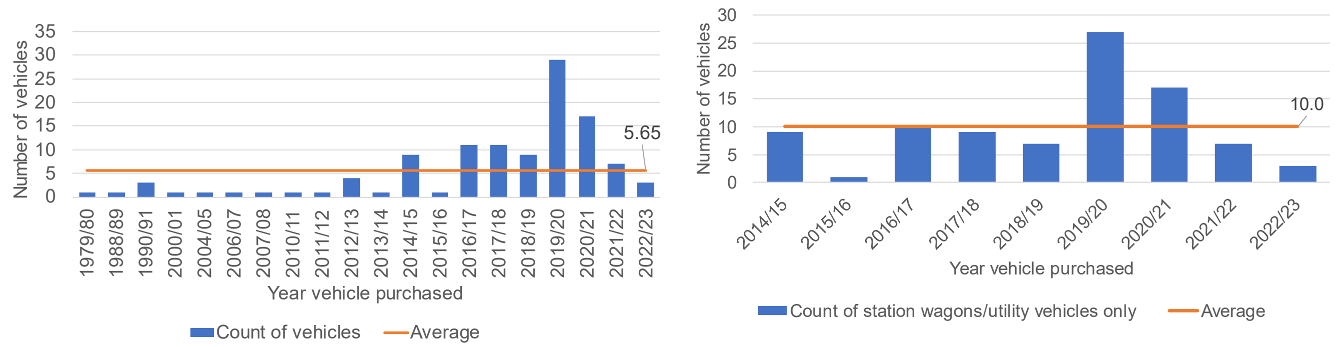
Expenditure drivers and solutions

The expenditure driver for vehicles is linked to the replacement plan. Transpower has advised that the proposed expenditure for the RCP4 period is based on the average historic expenditure. The replacement and disposal policy for Transpower is set out in their motor vehicle policy and states that, generally vehicles will be replaced after 4 years or 120,000 kms travelled for petrol and 5 years or 150,000 kms travelled for diesel and electric vehicles, whichever occurs first. There is a formal approval for a vehicle replacement by the GM of People prior to it occurring.

Evaluation

Transpower provided a list of all the vehicles along with details of their age, use and ownership. The age profile of all the vehicles is shown in the following figure.

Figure 12-3 Age profile of all vehicles owned by Transpower



Source: Transpower, RFI042-02 master vehicle list.xlsx

We note the following:

– The more specialist vehicles such as forklifts, trailers and trucks are not replaced on a cyclic basis, rather these will be replaced on a condition assessment. This approach is reasonable.

– The more common vehicle, station wagons and utilities, appear be replaced on distance driven / condition rather than age. Although the average age is three years, this means that about half of the vehicles are older, and it can be seen that some are significantly older.

– There is no forecast of additional vehicles to account for the potential increase is staff, specifically for increased Grid Delivery FTEs.

[311] Cross referent to document AM003 2022 Asset management plant in Appendix E

Conclusion

Transpower's based the RCP4 expenditure ($0.76 million per annum 21/22 NZD) on historical average expenditure. A review of the expenditure for the first three years of RCP3 indicates the average annual expenditure of $0.68 million (constant 21/22 NZD). The proposed expenditure of RCP4 is slightly higher than this average which is reasonable given the projected growth in FTEs in the last two years of RCP3 and RCP4.

The expenditure of vehicles can be compartmentalised into two areas.

– Specialist, low volume vehicles, for example, forklift truck are procured intermittently and are replaced as needed. This is shown that there are some vehicles that are 30 to 40 years old.

– Grid Delivery vehicles, which covers 74% of the fleet, are replaced on a 4-year or 150,000km basis. More companies are moving to condition only, rather than a pre-set value. However, the age profile shows that this discrete threshold is not strictly adhered to as 41 of the 97 (i.e., 42%), station wagons / utilities are older than 4 years. The age profile suggests that Transpower is also considering condition when assessing the need for replacement.

Overall, our opinion is that the approach to replacement cost estimation, that is taken from the historical average, is reasonable. There is evidence of a condition-based approach, which is reasonable and in line with GEIP.

The approach to replacement cost estimation, that is project the RCP4 expenditure using the historical average, is reasonable. There is evidence of a condition-based approach to vehicle replacement as 42% of Grid Delivery vehicles and all the specialist vehicles are older than 4 years, which is in line with GEIP.

We accept the expenditure for business support capex – vehicles shown in the following table. This table show the reallocation of expenditure on Forklifts to the vehicle category (from the office equipment category).

Component	RCP3 (base and 3 forecast years)						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Vehicles	1.0	0.5*	0.5*	0.8	0.8	3.6	0.8	0.8	0.8	0.8	0.8	**3.8**
Forklifts									0.1	0.1	0.1	**0.4**
Total	**1.0**	**0.5***	**0.5***	**0.8**	**0.8**	**3.6**	**0.8**	**0.8**	**0.9**	**0.9**	**0.9**	**4.2**

Source: Transpower, Business services categories.xlsx and RT01 expenditure schedule
Note: 2021/22 and 2022/23 expenditure has been transferred from office equipment as that expenditure relates to vehicles.

We conclude that the proposed base business support capex totalling $3.8m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP. We also accept $0.4m associated with forklifts once reallocated from the office equipment category to the vehicle category.

The following table describes our verification against the evaluation criteria.

Table 12-7 Business support capex (vehicles) evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	The replacement of vehicles is consistent with GEIP as it combines condition information and the age and distance drive guidance provided in the motor vehicle policy. Participation in the All of Government should ensure an efficient price for replacement vehicles.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	The approach for using the average RCP3 expenditure to project RCP4 expenditure is considered appropriate as the asset class plan is unchanged from that which applied during RCP3.
	(ii) how they were applied;	Yes	
	(iii) their effect on the proposed base capex	Yes	

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	Our review of vehicle age profile information indicates replacements are being undertaken consistent with the motor vehicle asset class plan and considering vehicle condition where appropriate to extend asset life.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	

12.3.2 Office equipment

The following table summarises our verification for the business support (office equipment) capex which is selected as an identified programme for RCP4.

Table 12-8 Verification summary of business support capex – office equipment

Verification element	Verification commentary
RCP4 proposed amount	$30.1m
Appropriate and sufficient information available for IV	Insufficient information has been provided to demonstrate that the $16m expenditure associated with the Wellington office meets the evaluation criteria.
Meets GEIP and ToR evaluation criteria	Yes, except for $16.0m allocated to the Wellington office
IV conclusion	Accept $14.1m, with $0.4m associated with forklifts reallocated to the vehicles category. Not Accept $16.0m
Potential scope for improvement	Consistently allocate vehicle related expenditure to the vehicle category within business support capex.
Key issues and areas that the Commission should focus	Whether Transpower is able to provide sufficient justification for the proposed $16m expenditure during RCP4 on the Wellington office.

Overview

The business support capex proposed by Transpower for RCP4 for the office equipment category provides expenditure to address the following:

– Provide necessary upgrades to facilities generally tied to leases for office space.
– Provide general facilities upgrades, for example kitchen, bathrooms, desks, chairs and meeting rooms.
– Provide necessary upgrade, replacement or repair of minor fixed assets across the business.
– Provide ICT equipment, namely laptops, phones and peripheral devices.
– Upgrades to blended workplaces.
– Following the transition of warehouse forklifts to electric forklifts in 2023/24 provide annual repairs and replacement of the forklifts.

As noted in section 12.3.1 of this report, the vehicle category within business support is intended to hold the allowance for vehicle related expenditure. We therefore believe the expenditure on forklifts would be better allocated to the vehicles category rather than the office equipment category. This would result in a reallocation of $0.4m of capex from the office equipment to vehicles category.

Expenditure profile

The expenditure associated with office equipment as proposed by Transpower is set out in the following table. The RCP4 expenditure labelled other in this table is the $0.4m associated with forklifts.

Table 12-9 Business support capex – office equipment ($m)

Component	RCP3						RCP4					
	Base 20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Office equipment	0.2	-	-	3.6	3.0	**6.8**	2.3	2.8	2.5	17.1	5.1	**29.8**
Other	1.8	2.1*	2.9*	0.8	-	**7.5**	-	-	0.1	0.1	0.1	**0.4**
Total	**2.0**	**2.0**	**2.9**	**4.4**	**3.0**	**14.4**	**2.3**	**2.8**	**2.6**	**17.2**	**5.2**	**30.1**

Source: Transpower, Business services categories.xlsx and RT01 expenditure schedule.
Note: 2021/22 and 2022/23 expenditure has been transferred from office equipment as that expenditure relates to vehicles.

A significant expenditure is proposed towards the end of RCP4 which relates to Wellington office facilities upgrade of $16 million in 2028/29. The timing of this expenditure is aligned with the expiry of the current lease Wellington office.[312] Office leases are capitalised in accordance with the IFRS Accounting Standard.

Aside from the $16m allowance for the Wellington office the average expenditure across RCP3 and RCP4 is very similar.

Asset planning approach

Section 6 of the 2022 Asset management Plan[313] sets out the business support capex asset class plan. The asset class plan specifies that Transpower undertake an annual process to review the office equipment needs and budget for necessary replacements which are then implemented in the following year.

The asset class plan for the ICT assets covered under the office equipment category specifies policies guiding the replacement of these minor fixed assets. This group of assets comprises numerous low-value IT items. The proposed expenditure provides equipment for new staff and for the replacement of existing equipment which has reached the end of its useful life.

Expenditure drivers and solutions

The following table identifies the key components of expenditure that build up the proposed allowance for RCP4.

Table 12-10 Business support capex – office equipment

Expenditure driver	RCP4 capex
Facilities upgrades aligns with term of lease: Christchurch office Wellington office	 $0.3m in 2026/27 $16.0m across 2028/29 and 2029/30
General facilities upgrades (kitchens, bathrooms, desks, chairs and meeting rooms)	Approximately $0.35m annually
General minor fixed assets	Approximately $0.3m annually
General minor fixed ICT assets (laptops, phones peripherals)	Approximately $1.85m annually
Blended workplaces and office collaboration	$0.6m in 2028/29 and 2029/30
Warehouse forklifts – annual replacement to maintain fleet of electric forklifts	$0.13m in 2027/28, 2028/29 and 2029/30
Total	**$30.1m**

Source: Transpower, Business Service Categories.xlsx

Evaluation

Excluding the large expenditure associated with the Wellington office the proposed allowance for RCP4 is $14.1m, which is similar to the level of expenditure for RCP3 of $15.4m for this category of business support capex. Transpower is therefore proposing a very similar expenditure allowance for RCP4 for this asset class (excluding

[312] Section 6.1 of AM003 2022 Asset Management Plan.pdf
[313] Cross referent to document AM003 2022 Asset management plant in appendix E

the Wellington office component) as it expects to require during RCP3. Given this asset class is comprised of expenditure on many low value fixed assets it is reasonable that the allowance for RCP4 should align with that in RCP3.

The allowance for the Wellington office in 2028/29 and 2029/30 at a total of $16 million results in is a significant increase from the RCP3 expenditure. This allowance appears to be associate with significant expenditure tied to the end of the existing office lease. GHD would expect that expenditure of this magnitude should be captured in its own investment plan and business case. As we have not been provided with such documentation, we cannot verify that the allowance for the Wellington office meets the evaluation criteria.

Expenditure related to vehicles and forklifts appears to be better aligned with the vehicles capex category. We would not expect to see infrastructure of this type considered as office equipment.

Conclusion

Office equipment is classified to cover specific assets, namely, laptops, screens, phones, peripherals, desks, chairs, kitchen appliances etc. we can see that there is a basic budget allocated for these activities.

There are two expenditure items that we recommend be reconsidered:

– Wellington office upgrade in 2028/29 and 2029/30 at a total of $16 million. This proposed capex should have its own investment plan and business case its own Investment Case. We have not been provided with sufficient information to verify the prudency of this proposed expenditure at this time.
– Warehouse forklifts – should be allocated to ‘vehicles’ category.

The table below shows the allowance for office equipment capex if the expenditure associated with the Wellington office and expenditure related for forklifts and other vehicles is removed.

Table 12-11 Adjusted business support capex – office equipment ($m)

Component	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Office equipment	0.2	-	-	3.6	3.0	**6.8**	2.3	2.8	2.5	1.1	5.1	**13.7**
Other	1.8	2.1*	2.9*	0.8	-	**7.5**	-	-	-	-	-	**-**
Total	**2.0**	**2.0**	**2.9**	**4.4**	**3.0**	**14.4**	**2.3**	**2.8**	**2.6**	**1.1**	**5.2**	**13.7**

Source: Transpower, Business services categories.xlsx and RT01 expenditure schedule
Note: 2021/22 and 2022/23 expenditure has been transferred from office equipment as that expenditure relates to vehicles.

We conclude that the proposed base business support capex totalling $14.1m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP. We also accept $0.4m associated with forklifts. However, we consider this should be reallocated from the office equipment category to the vehicle category.

We reject $16.0m associated with the Wellington office upgrade.

The following table describes our verification against the evaluation criteria.

Table 12-12 Business support capex (office equipment) evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	Aside from the $16.0m sought for the Wellington office the remainder of the propose RCP4 capex allowance is consistent with the expenditure during RCP3. This is reasonable and consistent with GEIP given the expenditure addresses the upgrade and replacement of many low value assets. Insufficient information has been provided to verify that the proposed allowance for Wellington office is prudent.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	The expenditure allowance is consistent with the asset replacement and upgrade guidance provided in the relevant asset class plan.
	(ii) how they were applied;	Yes	
	(iii) their effect on the proposed base capex	Yes	
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	We have reviewed the high level build-up of RCP4 allowance and believe that aside from the Wellington office component the RCP4 allowance is reasonable.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	

12.3.3 Office buildings and facilities

The following table summarises our verification for the business support (office buildings and facilities) capex which is selected as an identified programme for RCP4.

Table 12-13 Verification summary of business support capex – office buildings and facilities

Verification element	Verification commentary
RCP4 proposed amount	$9.2m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept $9.2m
Potential scope for improvement	None identified.
Key issues and areas that the Commission should focus	None identified.

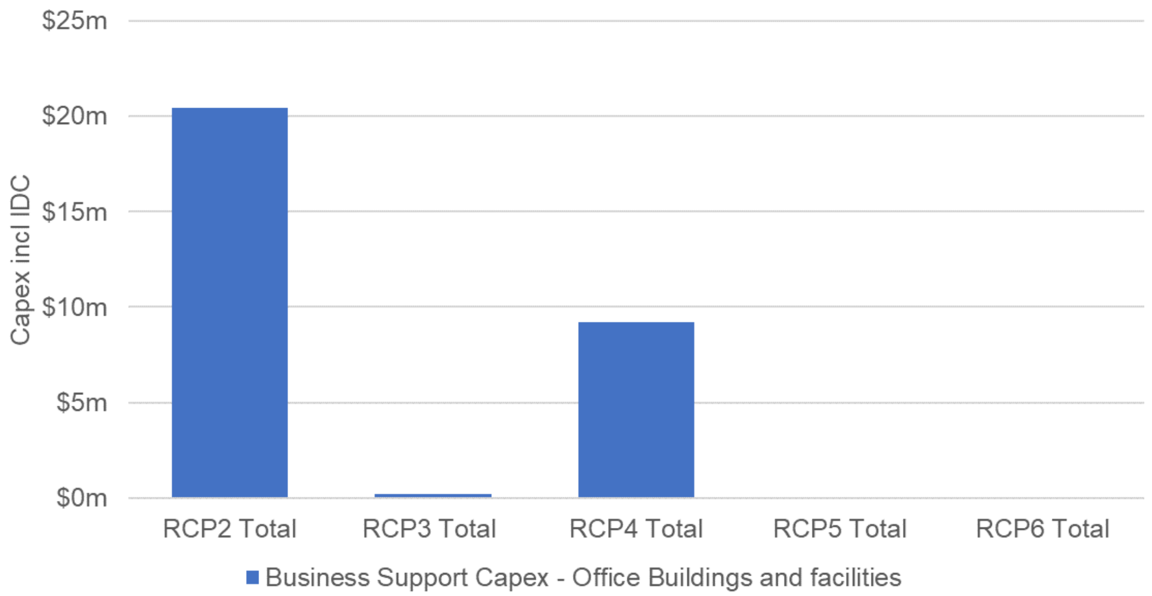
Overview

This capex category address expenditure on buildings and grounds that is not captured within the buildings and grounds R&R asset class reviewed in Section 9.3.8 of this report. For RCP4 the proposed allowance for business support capex (office buildings and facilities) is $9.2m. This entire amount is associated with the development of Grid Skills training facilities at Bunnythorpe during 2025/26 and 2026/27.

Expenditure profile

The expenditure profile for this asset class varies between RCPs and depends on the bespoke projects targeted for delivery in each period. As such there is little corelation between the expenditure profiles across RCPs. The figure below shows the variation in expenditure on this asset class across RCP2 to RCP6.

Figure 12-4 Business support – office buildings and facilities capex long term profile



Source: Transpower, Business services categories.xlsx and RT01 expenditure.

The table below shows the RCP3 and RCP4 expenditure for the office buildings and facilities asset class.

Table 12-14 Business support capex – office buildings and facilities ($m)

Component	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Office buildings and facilities	0.01	0.19	0.00	0.2	0.0	**0.2**	4.0	5.20	0.0	0.0	0.0	**9.2**
Total	0.01	0.19	0.00	0.2	0.0	**0.2**	4.0	5.20	0.0	0.0	0.0	**9.2**

Source: Transpower, Business services categories.xlsx and RT01 expenditure schedule.

Asset planning approach

As the entire allowance for RCP4 for this asset class is associated with the upgrade of the Grid Skills facility at Bunnythorpe, a specific RFI was raised seeking information on the investment case for this project. The information provided in response to that RFI included evidence of the need for the investment options considered and recommended solution. We have based our verification on the investment case provided by Transpower.[314]

Expenditure drivers and solutions

The Transpower investment case identifies that to facilitate the delivery of the increased work volume across RCP4 and beyond there is a need to upgrade the Grid Skills training facilities.

Grid Skills is a registered with the New Zealand Qualifications Authority as a Private Training Establishment and provides compliance training and transmission trade qualifications for all workers on Transpower's physical assets. Much of the work undertaken on Transpower's assets is prescribed electrical work as defined by the Electricity Act, and as such workers must hold a registration class with the Electrical Workers Registration Board relevant to the

[314] RFI042 Business support capex – Additional information .docx

work being undertaken. Grid Skills is the only provider of qualifications required for transmission work such as Line Mechanic and Power Technician.

The material step-up in service provider resource required to deliver the capital plan requires an increase in the number of trainees going through the Grid Skills facilities. Transpower's workforce plan for RCP4 sees a step up in the number of trainees in four core roles:

– Substation Mechanic,
– Electrical fitter,
– Power technician,
– Power Technician, and
– Line Mechanic

The step up in requirements and average training is shown in the table below.

Table 12-15 Trainees and training for core roles (per annum)

Role	Current leaners	Current weeks of training per annum	Average annual number of trainees in RCP4	Expected annual weeks of training in RCP4
Substation Maintainer	12	6 weeks	48	24 weeks
Electrical fitter[2]	0		30	8 weeks
Power technician	12	51 weeks	16	68 weeks
Line Mechanic[3]	42	18 weeks	90	45 weeks

Source: Transpower.
Notes:
[1] Growth figure allows for uplift over a 5-year period and turnover of 15% per annum.
[2] Training for Electrical Fitter (a major capital project focussed role) is currently carried out in the workplace by the service provider, but an intensive classroom-based training course is part of the 24/25 Grid Skills workplan for development as current sources of workers for this role become constrained.
[3] This training is currently delivered at the Omaka Lines training facility near Blenheim.

The table demonstrates a need to increase training capacity.

Transpower plans to support the growth in workforce by increasing the capacity for training delivery. An assessment of the current training facilities was undertaken, which identified capacity issues at the Huntly location currently used for Power Technician training, gaps in the equipment available to train on, and a preferred solution.

The assessment considered a number of options including the upgrade of facilities at Bunnythorpe and identified the Bunnythorpe option as the preferred alternative with a project cost of $9.2m. The upgrade at Bunnythorpe extends the current facilities by adding:

– the ability to run multiple training courses concurrently at one site covering all substations courses.
– the capability to undertake substations training on equipment that is representative of the equipment in live substations. Costing includes $6.4m of cost to purchase or move from Huntly, substation equipment for dedicated training.
– a central North Island location with training and accommodation in same location and good transport connections.
– a modern training center of excellence.

Evaluation

The investment case provided by Transpower demonstrates that there is a clear need for the upgrade of Grid Skills facilities and that the proposed upgrade at Bunnythorpe is the preferred means of addressing this need. The proposed investment seeks to provide the training facilities needed to provide an adequately trained workforce. Having access to an appropriately trained workforce is necessary to deliver the RCP4 work programs and consistent with GEIP.

The investment case describes the scope of work required to deliver the preferred solution and the estimated costs for each scope item. The cost is divided between developing training facilities including classrooms and their fit-out and building the grid training equipment which involves relocating substation equipment to the site. Of the total budget of $9.2m, $2.7m is associated with the training facilities and $6.5m is associated with the relocation and development of grid training equipment. Given the scope of work the budget appears to be reasonable.

Conclusion

The investment case demonstrates that the upgrade of Bunnythorpe is required to expand the Grid Skills training capacity necessary to support the delivery of the proposed increase in work volumes across RCP4 and beyond and the costs appear to be a reasonable reflection of the scope of work. We are therefore satisfied that the proposed expenditure is prudent and efficient and meets the evaluation criteria in the ToR.

We conclude that the proposed base business support (office buildings and facilities) capex totalling $9.2m satisfies the evaluation criteria in the ToR and is therefore prudent and efficient having regard to GEIP.

The following table describes our verification against the evaluation criteria.

Table 12-16 Business support capex (office equipment) evaluation (non-identified programme)

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
3.2	Base capex and key assumptions consistent with expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier reflecting GEIP	Yes	The IC demonstrates that the expanded Grid Skills training facilities are required to deliver the increased work volumes across RCP4 and beyond. Providing appropriate training facilities is consistent with GEIP. Furthermore, the IC documents the rationale for selecting the Bunnythorpe upgrade as the preferred solution.
A1(a)	Whether the key assumptions are reasonable including: (i) the method and information used to develop them;	Yes	The IC shows a clear need for expanding existing Grid Skills training capacity to keep pace with the projected increased in workforce across RCP4 and beyond.
	(ii) how they were applied;	Yes	
	(iii) their effect on the proposed base capex	Yes	
A1(g)	Reasonableness and adequacy of models used to prepare the proposed base capex including- (i) inputs to the model; and	Yes	The cost breakdown provided in the IC demonstrates the basis for the RCP4 capex allowance providing a clear link between the scope of work required to upgrade the Bunnythorpe facilities and the proposed allowance. The allowance is reasonable considering the scope of work proposed.
	(ii) the methods used to check the reasonableness of the forecasts and related expenditure	Yes	

Part E

Opex

13. Summary of opex

This section provides an overview of our evaluation of Transpower's proposed opex for RCP4 against the ToR. Detailed evaluations are presented in the following sections organised by opex category as follows:

– Grid maintenance opex (Section 14 of this report)
– AM&O opex (Section 15 of this report)
– ICT opex (Section 16 of this report)
– Business support opex (Section 17 of this report)
– Insurance opex (Section 18 of this report)

In this section we also outline the evaluation approach used for the opex categories and the base step trend method used in Transpower's estimation of many of the opex forecasts.

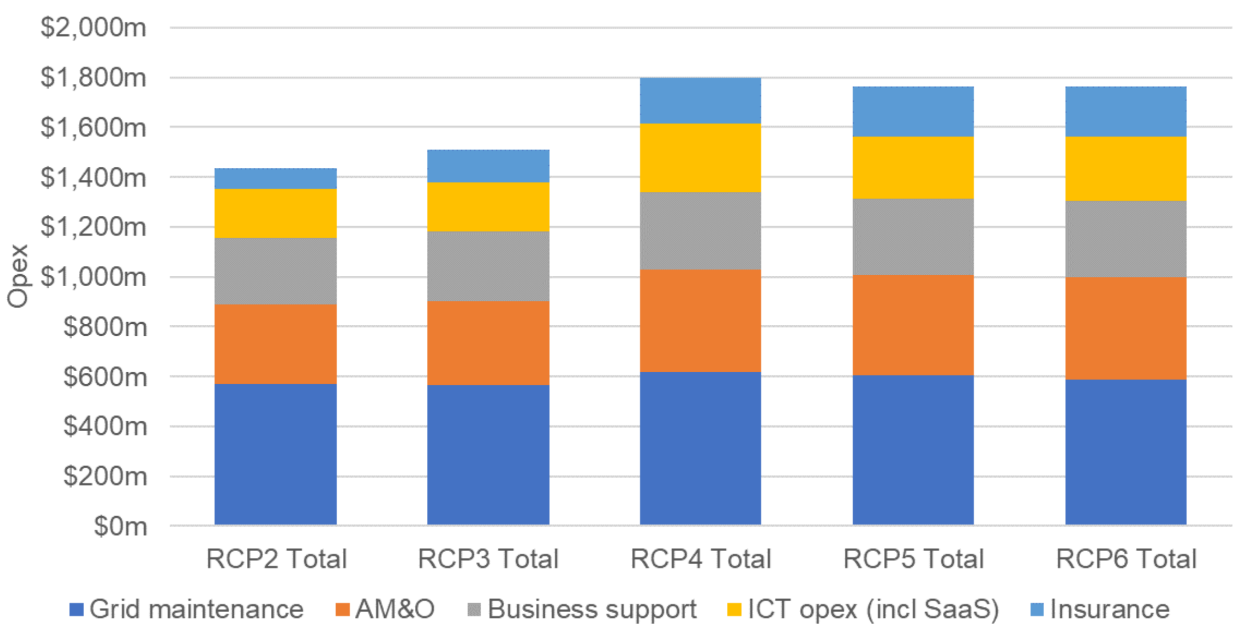
13.1 Overview of opex proposal

Transpower's opex proposal covers the works that Transpower undertake to:

– maintain existing networks assets in an appropriate condition,
– achieve required network performance,
– meet regulatory and/or safety requirements,
– conduct investigations,
– perform planning activities,
– provide operational support, and
– deliver non-network expenditure associated with support functions.

The following figure shows Transpower's proposed opex broken down into the major opex categories for RCP2 to RCP6.

Figure 13-1 Overall opex RCP2 to RCP6



Source: Transpower, RT01 expenditure schedule

The follow table summarises Transpower's proposed RCP4 opex compared with RCP3 expenditure for the main opex categories.

Table 13-1 Opex for RCP3 and RCP4

Opex portfolio	RCP3 total	RCP4 total	Change
Grid maintenance	$566.6m	$619.1m	9%
Asset Management and Operations (AM&O)	$338.0m	$408.9m	21%
Business Support	$278.9m	$310.4m	11%
ICT	$196.9m	$276.5m	40%
Insurance	$128.3m	$183m	43%
Total	**$1,508.7m**	**$1,797.6m**	**19%**

Source: Transpower, RT01 expenditure schedule

As the table illustrates Transpower is proposing to increase opex from $1,509m to $1,798m a 19% increase. The largest contributors to this increase for each of the major categories are:

– **Grid maintenance:** growth and step change in a range of predictive maintenance projects.
– **AM&O:** growth in grid development, grid delivery, operations, procurement and supply, landowner relations and property, and environment FTEs to deliver a much larger capex programme and Service Provider assistance to enable sufficient development of trainees.
– **Business Support:** growth in the number of business support FTEs to support the increased work force required for the larger capex programme and to support a number of initiatives being pursued across RCP4.
– **ICT:** reflects increases in both SaaS expenditure and underlying ICT opex. Increased underlying ICT opex is predominantly driven by the projected increase in FTEs and contractors consistent with the 12 ICT investment cases reviewed in Section 11 of this report.
– **Insurance:** projected increases in insurance premiums mainly due to the need to adjust coverage in line with changing asset value and additions, and increased cost of covering material damage/business interruption and submarine cables

We have examined each of these opex categories in detail and analysed the drivers underpinning these increases to understand the reasonableness of them. These are documented in detail in the respective sub-sections. The following table provides a high-level summary of the opex proposed by Transpower for RCP4 and our conclusion with respect to this opex.

Table 13-2 Summary of findings – opex proposal

Opex type	Opex category	Programme	Proposed opex	IV conclusion
Network opex	Preventive Maintenance	Identified	$206.9m	Accept: $206.9m
	Predictive Maintenance	Identified	$383.9m	Accept: $383.9m
	Corrective Maintenance	Non-identified	$23.8m	Accept: $23.8m
	Proactive Maintenance	Non-identified	$4.6m	Accept: $4.6m
	Asset Man. & Operations	Identified	$408.9m	Accept: $408.9m
Non-network opex	Business Support	Identified	$310.4m	Accept: $310.4m
	ICT opex (including SaaS)	Identified	$275.8m	Accept: $275.8m
	Insurance	Non-identified	$183.5m	Accept: $183.5m
Total			**$1,797.6m**	**Accept: $1,797.6m**

13.2 Evaluation approach

The following table outlines the applicable ToR criteria and our approach to assessing Transpower's proposed opex. The shad grey rows indicate the application of the ToR to all opex categories, only identified programmes and to the overall opex programme as appropriate.

Table 13-3 Opex evaluation criteria

ToR Clause	Evaluation criteria	Aspects reviewed
All opex categories		
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Review PMP and other supporting information for drivers and whether proposed expenditure addresses these drivers
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Process review of method used tp develop opex proposal: – Base-step-trend approach – Cost benchmarking or internal historic cost trending – Review of key assumptions – Comparison of base capex PMPs against Maintenance PMPs – Evidence of consideration of opex-capex trade-offs
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Evidence of RCP3 opex reduction initiatives & planned for RCP4. Review of current effectiveness of RCP3 measures. This measure is reviewed globally for opex.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Evidence of planned opex efficiencies in RCP4. Link between planned opex efficiencies and previous investments. This measure is reviewed globally for opex.
Identified programmes only		
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	Check PMP or supporting documentation includes investment need. Check PMP or supporting documentation align with relevant AM processes. Check programme is risk based.
A3(b)	Policies and planning standards were applied appropriately	Process review to check if PMP or other supporting documentation is aligned with Transpower policies & standards.
A3(c)	Transpower's process is reasonable and cost effective	Governance and process review to check planning approach and activities listed are logical, and process is consistent. Determine whether investment activities are cost-effective for achieving asset class objectives.
A3(d)	Investment need is challenged, and alternative solutions considered	Process Review of Transpower's decision making including whether an options assessment is carried out that includes alternative solutions (to the extent that it is applicable to the opex category).
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Review of impact of opex programme on capex and other programmes – have Transpower considered it and avoided double counting.
A3(i)	Programme is appropriately linked with other projects or programmes	Review of whether PMP outlines linkages between programme other expenditure programmes (high level governance and process review).
A3(j)	Proposed approach to procurement of associated goods and services	Review how plant, materials and works are procured. Review whether approach is efficient and whether there are deliverability risks caused by procurement.

ToR Clause	Evaluation criteria	Aspects reviewed
Overall opex programme		
A1(j)	Efficiency improvements obtained in the RCP3 and previous regulatory periods?	Evidence of previous efficiency improvements Review of effectiveness of efficiency improvements This measure is reviewed globally for opex
A1(k)	Scope for efficiency improvements	Whether Transpower have identified efficiency improvements This measure is reviewed globally for opex

Note: A3(e), A3(f) and A3(g) are not applicable to opex proposal categories.

13.3 Base step trend forecasting

Unlike the forecasting techniques utilised to develop the various capex programme a significant amount of Transpower's overall opex proposal has been developed utilising a base-step-trend cost estimation approach. This estimation approach consists of:[315]

– **Base expenditure**, i.e., a 'revealed cost' amount that represents the ongoing, efficient expenditure requirement over the forecast period. Transpower approach is to select a base year and then make adjustments to the base amount to remove any atypical costs in that year add recurring costs that were absence in that year.
– **Step changes** required to meet the needs of the network or to allow for external requirements. These can be one-off or ongoing changes and involve a change in the scope of work delivered.
– **Trends** that reflect expected changes in cost due to outputs and productivity. The trend can also include real price effects. These are applied separately.

The steps and trends are unique to each area of opex forecast using a base-step-trend technique. As such we evaluate their reasonableness in our review of those sections.

Where Transpower have used the base-step-trend method they have selected 2021/22 as the base year.

The use of a base-step-trend approach is a reasonable approach for the estimation of opex categories. There are two key elements that Transpower must demonstrate with respect to the base year for an estimate to be considered reasonable and in align with GEIP:

1. The base year must be representative of the level of effort and expenditure expected in a normal or average year. As such Transpower has to make adjustments for non-recurring costs or adding in expected costs that did not occur in that year. We consider whether the base year is representative in our review of each opex area that uses a base-step-trend method for part or all of Transpower's forecast.
2. The base year should represent a year where there was efficient and prudent expenditure.

The base year approach presented by Transpower does not have a clear mechanism for confirming that it is an 'efficient' year. Instead Transpower have put forward the following rationale as justification for the selection of 2021/22 as the base year:

– **Use of actual costs and not estimated costs.** To establish that 21/22 is an efficient year Transpower wanted to use a complete set of actual cost data. Transpower has confirmed that the 21/22 is actual data[316], which means that there are no cost estimates used in the base year.
– **The most up to date costs**. As the cost of goods and materials fluctuates over time, it is important that actual costs are the most up to date. The reason for this is to capture movement in prices. Therefore, the costs represent 'normal' costs.
– **Cost savings in RCP2.** By selecting the most recent year with complete data the base year by definition will incorporate any efficiencies realised by previous initiatives. The identification of previous cost savings is a demonstration of a focus on minimising costs across opex portfolios. However, to recognise that previous

[315] Transpower, EOP008 Asset Management & Operations Opex Overview RCP4, page 6
[316] Transpower, 'ICT Delivery Approach RCP3/RCP4. "The base year for the model is FY21/22 as this is the latest year for which we have a full year of actual data", refer to section 8, page 22

initiatives have reduced costs or improved efficiencies the expenditure changes from these initiatives need to be quantified.

– **Historical trending.** To get an appreciation of the base year, the total opex in that year is compared to prior years (usually the previous five years). This provides a relative comparison of the base year and recent history. Where Transpower has used the base-step-trend method they have compared the actual base year costs to the previous five to seven years to demonstrate that the actual base year costs are not materially different from the average previous expenditure.

The above arguments are both logical and reasonable. As a result, we consider that 2021/22 is an appropriate base year for Transpower to select and use for base-step-trend forecasting. However, with the information presented to us we are not able to verify that the 2021/22 year is an efficient year. However, given the previous years that Transpower could have used were either in RCP2 or more significantly impacted by covid, this year is on balance the most suitable to use as the base year.

13.4 Overall programme evaluation

As further elaborated in the following sections we conclude that the RCP4 opex satisfies the overall programme evaluation criteria in the ToR.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 13-4 Evaluation summary of overall opex programme

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
Overall opex programme			
A1(j)	Efficiency improvements obtained in the RC3 and previous regulatory periods?	Yes	Generally, the choice of 2020/21 for the base year captures efficiency improvements made during RCP2 and the early part of the RCP3. Where specific examples of efficiency improvements have been identified they are noted in the following sections presenting our evaluation of the specific opex categories
A1(k)	Scope for efficiency improvements	Yes	Transpower has applied a productivity adjustment to reflect expected on going productivity improvements. The assumed rate is an annual improvement of 0.5 percent in productivity based on independent advice, from NZIER, using historical changes in New Zealand's labour productivity in industries undertaking similar activities as Transpower. The adjustment for productivity improvements reduces Transpower's RCP4 opex forecast. Where additional efficiency improvements have been identified they are discussed in the following section evaluating specific opex categories.

14. Grid maintenance opex

This section provides an overview of our evaluation of Transpower's proposed grid maintenance opex for RCP4 against the ToR. Detailed evaluations are presented in the following sub-sections organised by opex category as follows:

– Preventive Maintenance
– Predictive Maintenance
– Corrective and proactive maintenance

In this section we also provide an outline of maintenance activities by main asset categories, the maintenance planning approach, the relationship between maintenance and base capex and opex reduction and efficiency initiatives.

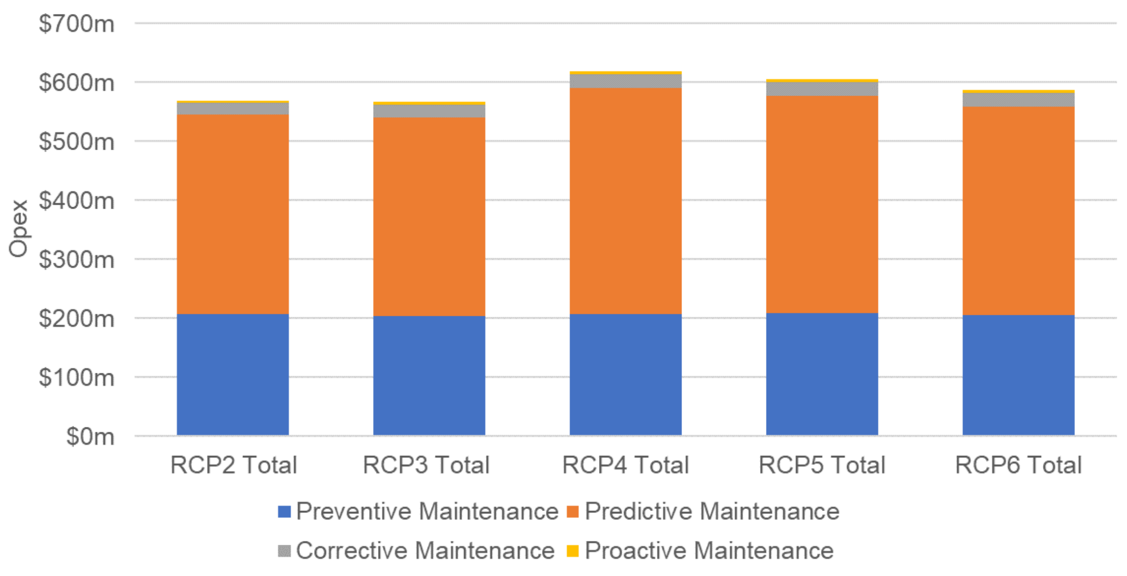
14.1 Grid maintenance overview

Grid maintenance work covers all HVDC and HVAC transmission line and substation assets, and communication-site and services assets (but excluding communications bearer and network assets). It is undertaken to address in-service deterioration of assets, respond to transmission faults, proactively improve the assets, and implement projects to replace asset components. Grid routine maintenance work is categorised into four main work types: preventive, predictive, corrective, and proactive maintenance work.

Transpower's long-term goal is to proactively maintain assets using risk-based maintenance. This approach establishes maintenance tasks for each specific asset where the intervention and the timing are optimised based on factors such as current asset condition, historical reliability, and criticality of the asset. A risk-based or reliability informed approach reduces risk, for a given expenditure amount, compared with a simpler time-based approach.

A more risk-based approach can only optimise expenditure to a certain point. Transpower has stated that as their assets get older, they expect some maintenance to increase, combined with some opex to capex trade-offs, and cost increases reflective of current market conditions. As a result, Transpower is forecasting a small step increase in grid maintenance during RCP4 that can be seen in the figure below.

Figure 14-1 Maintenance expenditure by regulatory period (RCP2 to RCP6)



Source: Transpower, RT01 expenditure schedule

The following table summarises proposed RCP4 maintenance expenditure per year.

Table 14-1 Proposed RCP4 maintenance expenditure opex

Major categories	25/26	26/27	27/28	28/29	29/30	RCP4
Preventive Maintenance	$41.6m	$40.2m	$42.0m	$40.7m	$42.3m	**$206.9m**
Predictive Maintenance	$76.6m	75.4m	$80.1m	$78m	$73.7m	**$383.9m**
Corrective Maintenance	$4.8m	$4.8m	$$4.8m	$4.8m	$4.8m	**$23.8m**
Proactive Maintenance	$0.9m	$0.9m	$0.9m	$0.9m	$0.9m	**$4.6m**
Total	**$123.9m**	**1$21.3m**	**$127.8m**	**$124.4m**	**$121.7m**	**$619.1m**

Source: Transpower, RT01 expenditure schedule

14.2 Maintenance activities by main asset categories

This section provides a brief overview of the maintenance activities by main asset portfolio. It covers transmission Lines, AC Substations, and HVDC assets.

14.2.1 Transmission lines

Transpower maintain transmission line corridors with a wide range of transmission line types, age profiles, components and environmental conditions. There is a strong emphasis on preventive maintenance for line assets. The maintenance regime consists of a combination of annual routine patrols and less frequent condition assessments.

The main types of routine maintenance activities are: Line patrols: all lines are subject to routine patrols. Where a critical line or sections of a critical line are identified as being in a high-risk location Transpower schedule patrols more frequently.

- **Condition assessment:** these assessments involve a detailed inspection of all transmission line components, foundations and conductors to record asset condition. The default intervals, from July 2023 are 12 years for lines supported by towers or concrete or steel poles in low corrosion environments with shorter intervals for other types or structures in more corrosive environments.
- **Corrective maintenance:** Transpower initiate corrective maintenance because of faults and defects identified during patrols or condition assessments.
- **Vegetation control:** Transpower manage this work using tree growth modelling techniques. Measurements taken during annual routine patrols inform the plan, but it also considers exception reporting such as landowner advice and fault reports where vegetation clearance is a factor.
- **Access tracks:** Transpower maintain access ways, made up of sealed and unsealed roads, spur tracks, bridges and walking tracks. The general maintenance standard is that vehicle access ways should be designed to 4WD utility vehicle standard operating under normal weather conditions. Transpower inspect bridges and culverts in accordance with NZ Transport Agency inspection criteria.

Transmission Lines maintenance projects include:

- Attachment point replacement
- Foundation refurbishment
- Conductor joint repairs and analysis
- Tower steel and bolt replacement

14.2.2 AC substations

Transpower's substations comprise of a wide variety of equipment ages and types. Routine maintenance at AC substations incorporates a wide range of assets, including power transformers, indoor and outdoor switchgear, reactive equipment, and protection equipment. Specific approaches vary between asset types, but will generally include the following activities:

Inspections: inspection of substation assets aims to ensure that facilities and equipment are in a safe and serviceable condition and that any abnormalities that represent a risk to grid reliability, safety of personnel or the security of the site are identified and rectified.

– **Condition assessments:** these provide a standard assessment of the condition and expected remaining life of the assets.
– **Diagnostic testing:** this involves measuring electrical and mechanical parameters such as insulation, mechanism timing checks and clearances.
– **Servicing:** this involves periodic servicing, aligned with inspections and condition assessments, to maintain asset condition.
– **Corrective maintenance:** this is work initiated because of faults, identified defects or condition assessments. The work also includes responding to remote monitoring (SCADA) alarms.

14.2.3 HVDC

Maintenance is particularly important for HDVC assets due to the criticality of the asset and the inherent difficulty in undertaking remedial work. However, prudent levels of redundancy in some components of the HVDC assets, the control systems, mean that failures of some components may not necessitate urgent corrective work.

HVDC routine maintenance programme covers thyristor valves, synchronous condensers, converting power transformers, circuit breakers and other switchgear, and reactance and protection equipment dedicated to the HVDC system. The programme includes the following activities:

– **Inspections:** these are undertaken at intervals appropriate for the equipment type and technology in use and can range from 1 month to 12 years. HVDC station assets (for example, electrodes) undergo visual inspections, servicing and condition/diagnostic testing in accordance with the asset’s characteristics.
– **Special inspections:** these focus on the submarine cables and include patrols of the HVDC Cable Protection Zone and annual inspections of the cable using a submersible remote operating vehicle and divers.
– **Corrective maintenance:** this includes minor repairs of HVDC station equipment identified during site inspections and condition assessment.

HVDC submarine cable management covers a range of contracted activities including:

– Maritime patrol and shallow water response.
– Remotely Operated Vehicle (ROV) availability (for deep water response).
– Maritime markers and lights maintenance.
– Spares maintenance.

The range and types of maintenance undertaken by Transpower on its assets is consistent with the approaches we have observed from other TNSPs.

14.3 Maintenance planning approach

Transpower maintain the grid to meet network operational and security requirements, taking into account safety, statutory compliance, sustainable operations and overall cost.

In general, maintenance is completed to avoid the consequences of asset failure and ensure the grid remains safe and reliable. The Maintenance Planning Framework (MPF) sets out Transpower’s approach to achieving these objectives through planning, scheduling and delivery. The MPF has varying levels of influence over the core functions across the asset management value chain and aligns with Transpower’s strategic objectives for the grid business and with the Asset Management System outlined in Section 3 of this report.

The MPF sets out the approach to implementing the “Maintain” stage of the 2021 Strategic Asset Management Plan, the Reliability Management Strategy and individual asset-specific maintenance strategies. These strategies are reflected in the service specifications and standard maintenance procedures, which are used to configure Maximo, where work plans are assigned to individual assets. The standard maintenance procedures are used in the field by Service Providers to deliver the asset-specific maintenance strategies.

Maintenance planning translates the maintenance strategies into implementable works programs delivered by Transpower employees or Service Providers. This translation consists of two main activities:

– **Maintenance specification** of the maintenance to be delivered, the skills and resources required, and inventory practices to be applied. This involves analysis of work history, asset and performance data, and the application of reliability processes to improve maintenance and supply requirements. Support from engineering teams is required to ensure that all asset design, servicing, and compliance requirements are considered.
– **Maintenance delivery** of all maintenance work by qualified workers in a controlled manner that ensures the safety of all stakeholders, and the timely provision of all necessary materials and parts. This includes the medium-range planning and scheduling of the work programme, together with the detailed planning of grid and land access, resources and work scope for each job.

14.4 Key maintenance planning information systems

Transpower's information systems and those of their Service Providers, are fundamental to maintenance work planning and work management. These include Maximo, Mātai, Work Order Risk Prioritisation, Asset Management Planning Solution (AMPS), Financial Management Information System (FMIS) and Integrated Outage Notification System (IONS). A description of the key systems outlined in the following table and figure.

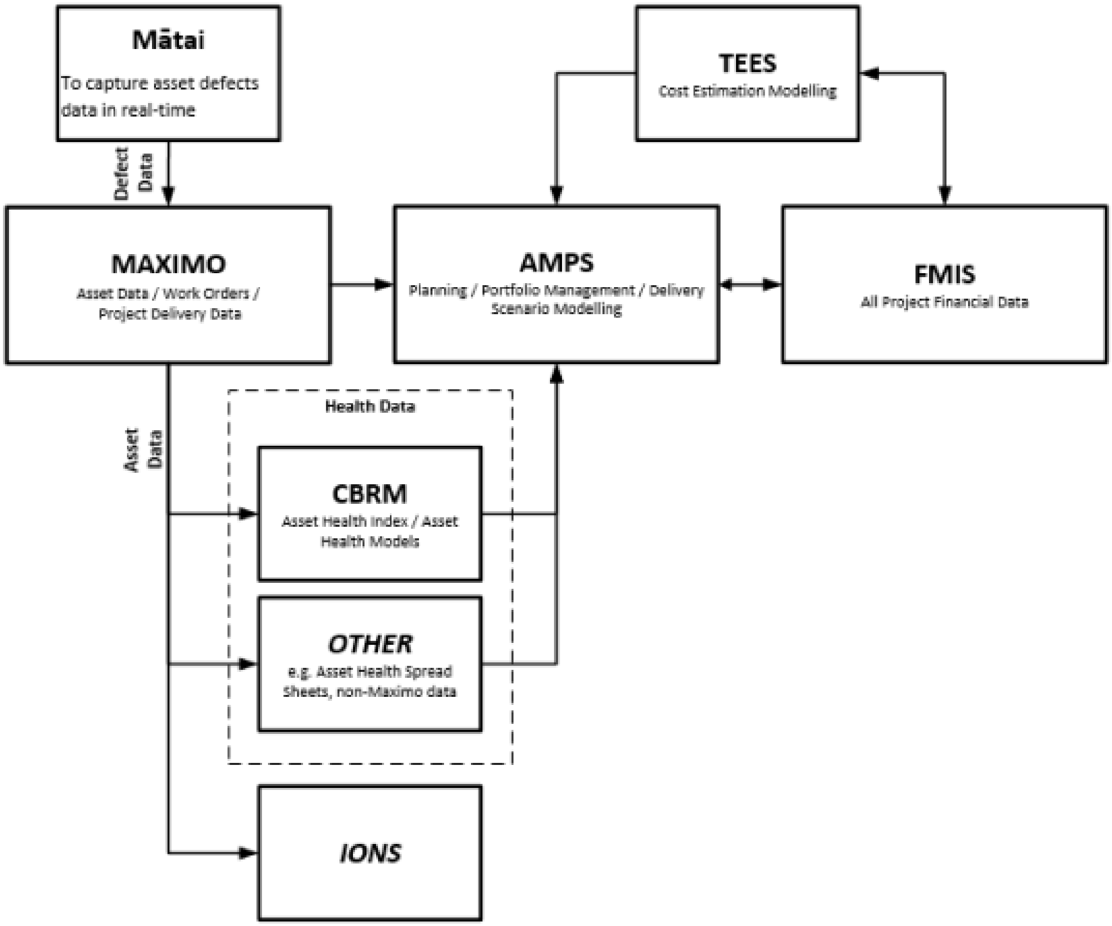
Transpower's maintenance planning approach, including its asset information systems is considered appropriate and consistent with approaches of other TNSPs.

Table 14-2 Information systems to support work management

System	Description
Maximo	Core asset management information system for all grid assets. Used as the asset register, to manage the maintenance programme and work orders and to manage incidents.
Mātai	New application that enables Service Providers to complete several of their tasks, such as condition assessments, raise and manage defects, verify defects, add landowner notes, capture photos, and then upload directly to Maximo.
Work Order Risk Prioritisation	Machine learning tool that scans the defect data recorded by field staff. It recognises key terms and is used to scan the description of defect work orders to categorise them into work clusters. It calculates the frequency and relevance of terms in each work cluster and then sorts and ranks the data with a risk profile based on likelihood and consequence. Work Order Risk Prioritisation is paired with the criticality framework to allow for risk prioritisation of defect work.
Asset Management Planning Solution (AMPS)	AMPS enables Transpower to make more effective asset planning decisions balancing risk, service levels, and investment in asset management planning. The data inputs into AMPS come from Maximo, CBRM, the asset feedback register, and the condition assessment spreadsheets. AMPS applies the asset class strategy for each asset class. The output from AMPS is used for forecasting future work activity and expenditure. For maintenance planning AMPS is used to predict future work for PDML and maintenance projects work.
Financial Management Information System (FMIS)	FMIS is the financial management, forecasting, and reporting system.
Integrated Outage Notification System (IONS)	IONS is the master system for all grid outages. It is used to raise, process, and approve outage variation requests to the annual outage plane. IONS is used by service providers to identify equipment outage opportunities to programme maintenance works.

Source: Transpower, AM010 Maintenance Planning Framework.pdf

Figure 14-2 Integration of asset information systems for maintenance planning



Source: Transpower, AM010 Maintenance Planning Framework.pdf

14.5 Relationship between maintenance and base capex

Transpower's proposed maintenance is interdependent with its proposed base capex and its asset strategies for replacement.

As outlined above, Transpower maintain the grid to meet network operational and security requirements, taking into account safety, statutory compliance, sustainable operations and overall cost. It's maintenance requirements are developed as part of their design making framework that is applied to each asset class that considers relevant asset data, asset performance requirements, intervention points and life cycle options. From this framework the operational requirements, such as inspections, condition assessments and routine maintenance activities are developed. At the same Transpower develops it capital requirements for each class.

The capital requirements of assets influence grid maintenance volumes and expenditure in a number of types of ways. These include:

- When an asset is replaced with an asset with different parameters the level of maintenance or the time taken for maintenance items may change. This could result in a lower maintenance cost where the new asset is quicker to inspect or undertaken routine maintenance however the level of maintenance could increase where the asset has additional maintainable items.
- Where asset replacement is driven by the condition of the assets there may be an increase in condition assessments of those assets closer to the expected replacement age of the asset. The purpose is to both more accurately define when the works are required by and for linear assets, time conductors, whether the whole or parts of the assets need to be replaced at that time.

– Additional grid skills training (which is a component of preventive maintenance) would need to be undertaken because both Transpower and its Service Providers will grow the size of their workforces to deliver an increase in capex forecast in RCP4.
– Although not related to base capex, where major capital projects or customer funded works increase the size of the transmission network, such as new substations, the volume of maintenance that Transpower must undertake increases.
– Some assets close to the end of their expected lives require more maintenance to ensure they remain at an appropriate service level. Replacement of such assets will therefore reduce the maintenance requirement.
– There are some asset classes where Transpower is able to defer capital replacement which has resulted in additional opex as the life of those assets are extended. The following table outlines the three largest capital deferments which will result in additional opex for RCP4.

Table 14-3 Capital deferment resulting in addition RCP4 opex

Portfolio	Description of trade off	$ impact on maintenance (RCP4 total)	Estimated capex reduction (RCP4)
TL Tower	Transpower have developed a programme to replace some 110kV towers with poles to reduce the lifecycle cost of these structures (through eliminating tower painting capex). These towers to be replaced will now not be painted but will require maintenance interventions such as steel and bolt section replacements to extend their lives until they are replaced with poles.	$6.4m	$57.3m of capex deferral. Based on the expected RCP4 volume of 3292 towers painted (at the time of the RCP3 proposal), versus 2725 Towers planned now for the same period. Average tower painting cost of $101k
ACS General, ACS Indoor Switchgear and ACS Circuit Breakers	Transpower have a SF6 Management Strategy[317] which includes reducing SF6 emissions (through proactive management) and replacement of SF6 circuit breakers with SF6 free or low-leakage breakers in the future. To achieve these objectives Transpower is undertaking the following maintenance activities: – SF6 gas testing on high operation circuit breakers and other circuit breaker types as required. – SF6 pipework. Proactively replacing pipework that has reached a condition assessment score of 40 before it leaks. – Undertaking proactive pole replacements on poor performers, mainly out AEG S1 circuits breakers – Investigating SF6 monitoring of high volume SF6 outdoor circuit breakers – High voltage gas insulated switchgear switchgear mid-life seal replacements	$5.0m	The primary focus is to mitigate the release of SF6. In terms of capex trade off, the proactive pole replacements for AEG S1 breakers, could extend the current life expectancy from 35 to 40 or 45 years. There is currently ~$4m capex replacement for these type of breakers in RCP4. However, there are other factors driving these replacements thus Transpower expect the capex benefit to commence in RCP5.
TL Conductor, TL Structures	Transpower increased their maintenance activity to extend the life of conductors, but also as a method of increasing the accuracy of the forecast for future years and to enable more granular reconductoring projects (e.g., potential reconductor part but not all a transmission line circuit). This will increase maintenance spend on: – Close Aerial Surveys – Conductor sampling and repair (defect management)	The increase in conductor sampling and close aerial surveys is approx. $5.0m	Transpower estimate a ~$45m capex deferral from RCP4 to RCP5. This is based on ~55 circuit kms of reconductoring deferred from RCP4 to RCP5 through targeted repairs and sampling. The average cost of reconductoring in Transpower's custom scoping exercise was used to estimate this. This RCP4 capex trade-off is a small sub-set of the wider intelligent conductor management benefits. This is in addition to the deferral already offered through the

[317] Transpower, ERR018 TS 55.01 SF6 Management Strategy.pdf

Portfolio	Description of trade off	$ impact on maintenance (RCP4 total)	Estimated capex reduction (RCP4)
			intelligent conductor management programme in RCP3, where wider reductions in volumes were due to other improvements such as modelling that are not included in the maintenance cost, and continued deferral through defect management for specific transmission lines into RCP5 and RCP6.

Source: Transpower, RFI019-A Transpower Response.pdf

14.6 Opex reduction maintenance initiatives

Transpower has implemented several initiatives since 2010 aimed at reducing (in real terms) elements of its grid maintenance opex and delivering asset lifecycle cost savings. These initiatives include:

- A shift from 6 month interval to annual transmission line patrols
- Adoption of less frequent substation maintenance. A review of AC substation maintenance frequency cycles was undertaken in 2019. The review concluded that a change from 4 to 5 years and 8 to 10 years for servicing most AC substation assets was feasible. Implementation of the service frequency changes occurred in 2021/22 in conjunction with the new service provider contracts. These savings in preventive maintenance started in FY 2021/22, however the maintenance reductions have been somewhat offset by increases in other areas such as bridges, culverts and building and grounds work.
- The shift in Transpower's maintenance approach from a time-based maintenance and replacement programme towards a risk-based approach has resulted in an overall reduction in both time-based preventive maintenance as well as unplanned corrective maintenance. Corresponding the predictive maintenance component has increased, however the net result is likely to be a more efficient approach to grid opex.
- Improvement in data accuracy and reduction in administration costs through the introduction of Maximo in 2013 and later Transpower's mobile app.
- Vegetation management – Transpower have identified tree felling options to reduce ongoing vegetation management.
- Reliability Informed Maintenance – Transpower have undertaken reviews of specific assets to identify common failure modes which has enabled Transpower to identify and update maintenance procedures to reduce unnecessary maintenance.

It is our opinion that Transpower has reasonably identified and realised opportunities to reduce or optimise maintenance costs as the above initiatives demonstrate. However, we have not been able to verify the extent of opex reductions that Transpower have achieved in terms of a percentage of maintenance or in dollar terms. Transpower have stated that it is difficult to quantify the financial impact of each individual initiative however collectively it has reduced RCP4 maintenance spend compared to what it would have been without these reduction initiatives. They have also stated that the benefits of these initiatives are included in the base year (FY22) for the RCP4 submission, again we are not able to verify this although it is reasonable to consider that it has been incorporated.

14.7 Efficiency improvements

Transpower has implemented a number of efficiency improvements in previous RCPs and proposes to implement further improvements in RCP4 as outlined below.

14.7.1 RCP3 and previous efficiency improvements

Transpower's maintenance approach has evolved since RCP1 where it predominantly employed a time-based maintenance regime. Most maintenance work was classed as preventive, with reactive management addressed asset failures. Transpower relied on the knowledge of Service Providers to direct maintenance work and the quality and availability of asset information did not support risk-based approaches to renewal or maintenance decision-making.

In RCP2, Transpower implemented a risk-based approach, based on failure modes for many asset types. This approach often allows for reduction in scope of frequency and results in efficiency gains. The first stage of this initiative involved reviewing the scope and frequency of preventive maintenance work, as many modern assets require less maintenance interventions than older assets installed on the network more than 30 years ago.

Transpower has an on-going programme of Reliability Informed Maintenance (RIM), which includes Reliability Centred Maintenance (RCM), to further optimise the work within maintenance programs and their frequencies. RIM is expected to increase condition-based predictive maintenance and reduce preventive maintenance. RIM can be used to ensure the least whole of life costs for the level of asset reliability required. RIM can provide opex savings by minimising the need for corrective maintenance expenditure and minimising asset downtime. Asset Planning use RIM to inform decisions on allocation of spend.

During RCP3 Transpower has been building on the work of started during RCP2 by continuing to roll out reliability informed maintenance, increasing the proportion of work carried out proactively, and increasing the use of condition-based predictive maintenance.

14.7.2 Proposed RCP4 efficiency improvements

In addition to the improvements made in previous RCPs, Transpower is implementing the following RCP4 efficiency improvements:

- Further preventive optimisation work for transmission lines – condition assessments are normally completed 6 yearly on poles and 8 yearly on towers. While some high corrosive and high wear (wind etc.) areas are inspected at half the normal frequency, there is no corresponding increase in frequency for assets in low corrosive or low wear areas. This optimisation work has reviewed those assets where Transpower is potentially over inspecting and has proposed new inspection frequencies. The reduced frequencies have been implemented in the preventive maintenance schedules and are embedded within the RCP4 forecast.
- On going RIM investigations to improve efficiencies, approximately one to two investigations per year.
- Improvement of Transpower's risk-based approach, using the Work Order Risk Prioritisation tool and other tools available.

Similar to opex reductions it is our opinion that Transpower has reasonably identified and realised opportunities to improve efficiencies however the benefits have not been quantified. However, we have not been able to verify the extent of efficiency improvement that Transpower have achieved in previous regulatory periods or how much they are likely to achieve in RCP4.

Again, Transpower have stated that it is difficult to quantify the financial impact of each individual initiative (although they have supplied some information on expected transmission line preventive maintenance cost savings). They have also stated that the benefits of these initiatives are included in the base year (FY22) for the RCP4 submission.

Transpower have stated that the opex efficiencies for RCP4 are captured within the efficiency target is 0.5% per annum for RCP4. If these were added these on top, it would result in a double count of efficiency gains.

14.8 Preventive maintenance

The following table summarises our verification of Transpower's proposed preventive maintenance opex for RCP4.

Table 14-4 Verification summary of Transpower's proposed preventive maintenance opex

Verification element	Verification finding
RCP4 proposed amount	$206.9m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $206.9m
Potential scope for improvement	Continued evolution of the ongoing Reliability Informed Maintenance (RIM), to further optimise the work within maintenance programs and their frequencies.
Key issues that Commission should focus on	None identified.

14.8.1 Overview of preventive maintenance

Preventive maintenance comprises inspections, condition assessments, condition monitoring, and servicing of Transpower's network plant and equipment. It is Transpower's most regular asset intervention and is a key source of effective feedback information for the asset management system. Preventive maintenance work is scheduled from the asset management information system (Maximo) at regular intervals as determined by the specified frequency, or operation count, in the specific asset's maintenance strategy.

The overall maintenance objectives and strategies are outlined in the Grid Asset Management System - Framework describes Transpower's overall asset management strategies. The Maintenance Portfolio Management Plan and Maintenance Planning Framework documents the planning of Transpower's overall grid maintenance expenditure, including preventive maintenance forecast expenditure. The individual preventive maintenance strategies are outlined in the individual asset class portfolio management plans which describe the operational requirements for each asset class including inspections and condition assessments. Further preventive maintenance details are provided in the asset class service specifications, which set out the maintenance to be delivered and the skills and resources required, and maintenance standards which describe at a task level the current appropriate practice for maintenance of assets.

The main components of preventive maintenance expenditure are:

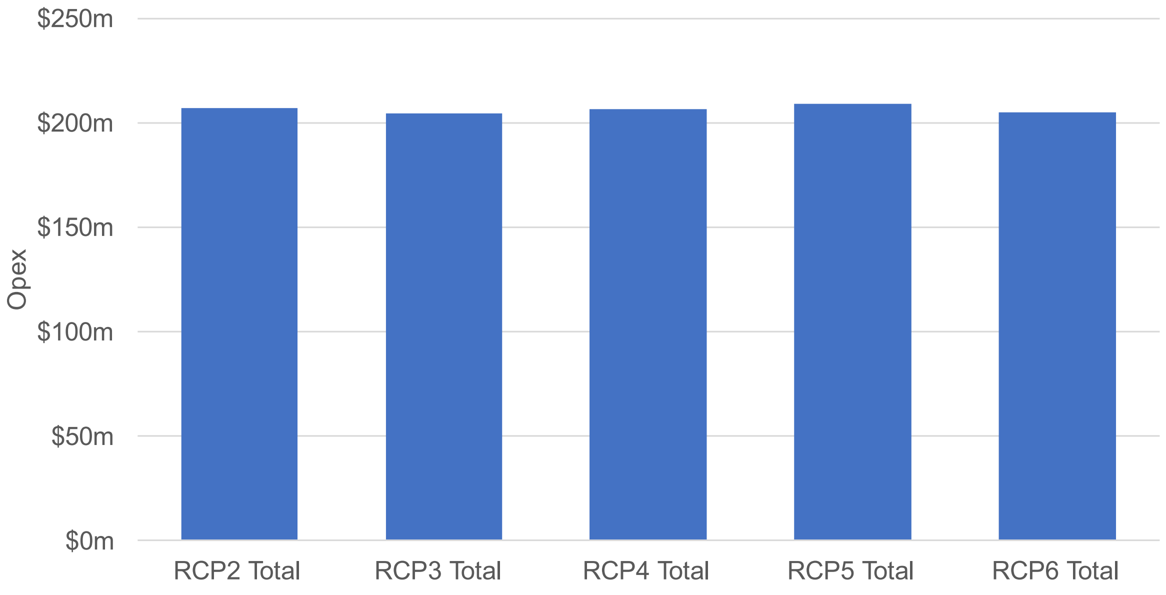
- Grid skills - technical training provided to service providers
- Preventive maintenance field work – consists predominantly of delivering time-based maintenance schedules mainly inspections, condition assessments and monitoring as well as servicing
- Other maintenance services and utility costs
- Service provider contract management service split between preventive and predictive maintenance.

The annual trend for this expenditure portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule. This opex portfolio has been nominated as an Identified Programme in the RCP4 revenue proposal and has been assessed against the relevant ToR evaluation criteria.

14.8.2 Expenditure profile

The figure below shows the longer term opex profile of preventive maintenance which indicates that from RCP2 to RCP6 expenditure is very stable across the five regulatory time periods.

Figure 14-3 Preventive maintenance opex long term profile



Source: Transpower, RT01 expenditure schedule

Transpower is proposing a very slight increase in expenditure in RCP4, compared to the present RCP3. The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3.

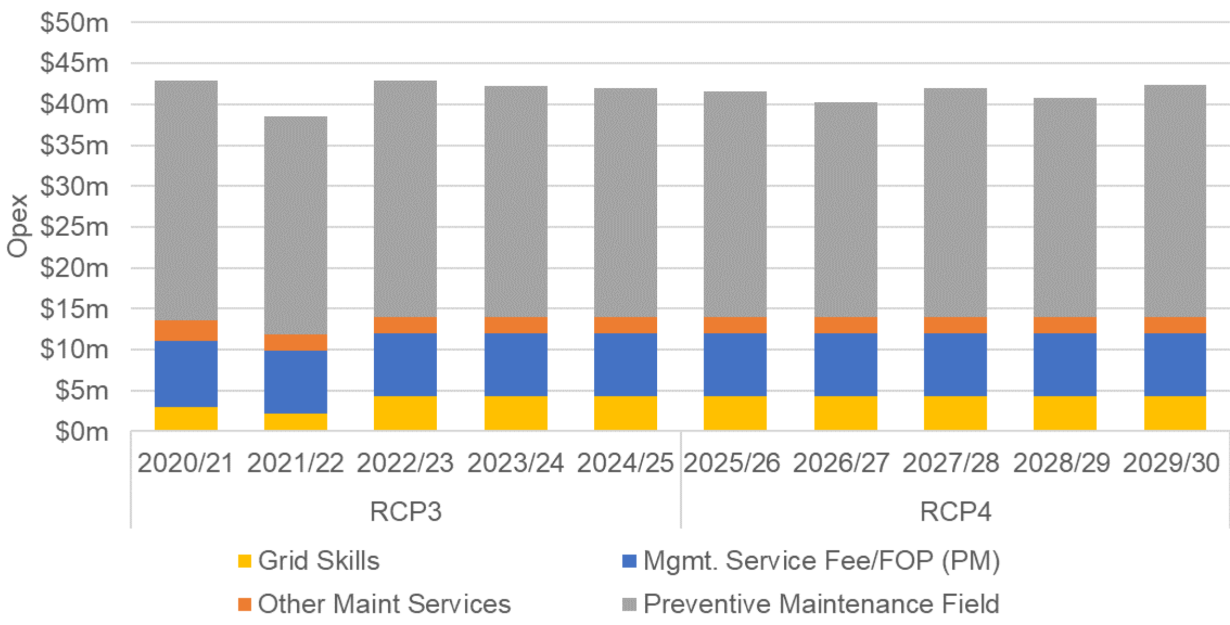
Table 14-5 Preventive maintenance opex for RCP3 and RCP4

Opex portfolio	RCP3 total	RCP4 total	Change
Preventive maintenance	$204.6m	$206.9m	1%

Source: Transpower, RT01 expenditure schedule

The annual RCP3 and proposed RCP4 opex profile for all the preventive maintenance broken down into both major maintenance subcategories is shown in the following figure.

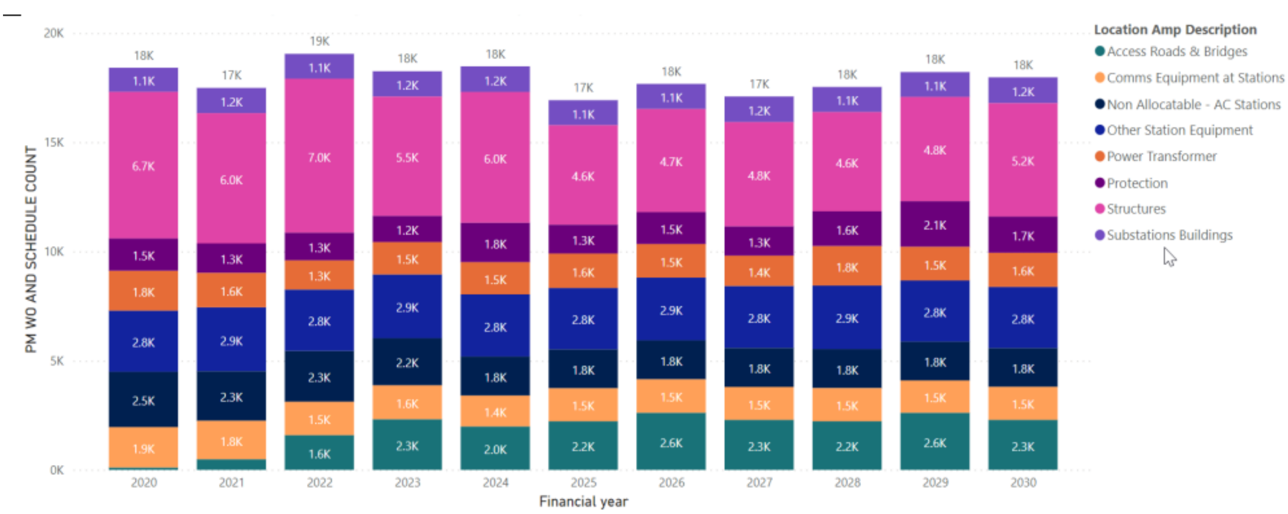
Figure 14-4 Preventive maintenance forecast expenditure subcategories



Source: Transpower, Maintenance Portfolio Management Plan

Transpower is presently planning to undertake approximately 18 thousand preventive maintenance activities (mainly inspections, condition assessments and monitoring as well as servicing) per annum for the largest eight asset maintenance classes which is consistent with RCP3 levels. The quantity profile for these asset classes is shown for the present RCP3 and proposed RCP4 in the following figure. The main change is the increase in access road and bridge maintenance from 2022 which has become a greater focus as the level of transmission line capex increases.

Figure 14-5 Preventive maintenance activity quantities for eight largest asset classes by volume



Source: Transpower, RFI019-A Transpower Response.pdf

14.8.3 Development of the expenditure forecast

Preventive maintenance expenditure forecast was developed using a combination of base-step-trend analysis and a bottom-up build as shown in the following table. Preventive maintenance field work, which is the largest component is forecast using a bottom-up estimate based on scheduled maintenance frequencies. The other components are estimated using base-step-trend.

Table 14-6 Budgetary components of preventive maintenance

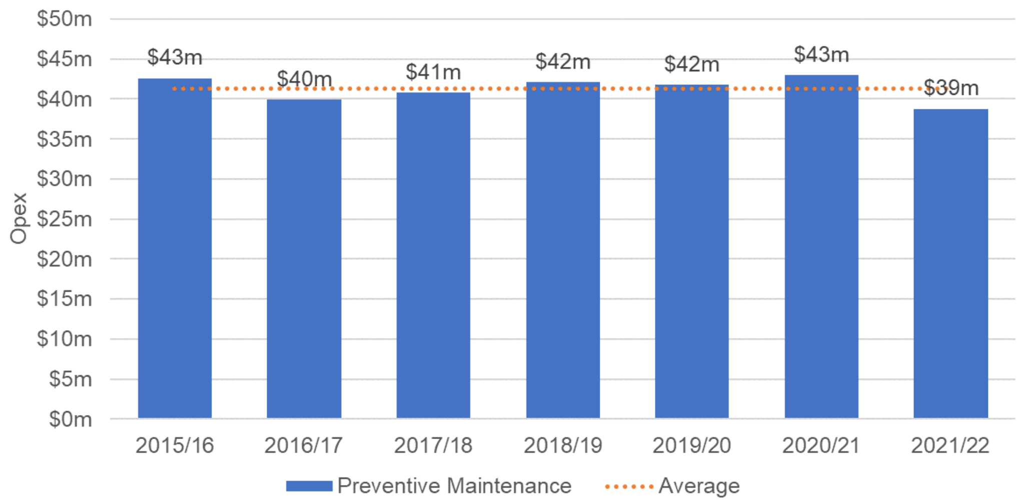
Component	Description	Forecast Method
Grid Skills	Technical training provided to service providers	Base-step-trend
Other Maintenance Services	Includes: Transpower share of Vector Tunnel Operating & Maintenance costs and non-pass-through Rates; Freight, Contract Settlement & Profit Share; Small Service Provider Engagement costs	Base-step-trend
Utility costs	Costs associated with the supply of electricity, water, telephone services.	Base-step-trend
Preventive Maintenance Field Work	Consists predominantly of delivering time-based maintenance schedules. Preventive maintenance activities are based on asset specific characteristics including age, asset type / model, manufacturer, network risk and criticality, and compliance with safety and other regulations. Primary activities are: – Inspections: Non-intrusive checks, patrols and functional testing to confirm safety and integrity of assets, check continued fitness for service, and identify follow-up work. – Condition assessments and monitoring: Periodic measurement activities performed to monitor asset condition and to provide systematic data for analysis. – Servicing: Routine tasks performed on the asset to ensure that its condition remains at an acceptable level. – Time-based schedules for maintenance activities are established within service specifications and asset class standards.	Bottom-up with specific step and trend adjustments
Management Service Fee / Fixed Overhead Payments	Covers the Service Provider contract management service fee and is split between Preventive and Predictive maintenance	Base step-trend

Measurement of the base year

As outlined in Section 13.3 of this report, FY2021/22 was selected by Transpower as the base year for any forecasts that utilise a base-step-trend method.

The following figure shows the base year for preventive maintenance which is below the average of RCP2 and the first two years of CP3 (show as the dotted line in the figure). This is primarily due to changes implemented by 2021/22, which included optimisation which reduce preventive maintenance field work costs and a deferment of work in Grid Skills training due to the establishment of the new Grid Services Contracts (GSCs) in that year.

Figure 14-6 Preventive maintenance base year



Source: Transpower, RT01 expenditure schedule

The following table shows the actual costs of the components of the unadjusted base year for preventive maintenance.

Table 14-7 Base year preventive maintenance

Base Year Component	Actual cost
Grid Skills	$2.13m
Other Maintenance Services	$1.68m
Utility costs	$0.3m
Preventive Maintenance Field Work	$26.69m
Management Service Fee / Fixed Overhead Payments	$7.75m
Total	**$38.56m**

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 18

Adjustments

To have a base that is representative of the preventive maintenance opex programme, adjustments for abnormal expenditure is required. An upwards adjustment of $1.1m was made because less service provider grid skills training was undertaken (compared to previous years) due to uncertainty surrounding the new GSCs.

Step changes

Several step changes to the base year were needed to account for expected changes in the scope of work delivered. These steps changes are summarised in the following table.

Table 14-8 Preventive maintenance step changes

Trends	Details	Total
Preventive Maintenance Field Work	Power cables PMs – Potential difference (PD) testing has been identified as required which requires a significant cost per test	$0.5m
	Leased buildings – New preventive maintenance required as part of the leased buildings policy (previously Transpower's opex was focused only Transpower owned buildings)	
	Asbestos – New inspections required as part of the asbestos management policy as outlined in the Buildings and Ground PMP	
	outdoor junction boxes- Five yearly inspections are required to align with Transpower's outdoor junction boxes strategy (this cost wasn't in the base year or the current preventive maintenance strategy).	

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 19

Trends

Two trend adjustments were made reflecting changes in the cost base for existing preventive maintenance activities as outlined in the following table.

Table 14-9 Preventive maintenance trends

Trends	Details	Total
Grid Skills	Higher volumes of grid skills training required to keep pace with the growth in service provider workforce necessary to deliver the forecast increase in capital work.	$1.2m
Preventive Maintenance Field Work	Grid growth via new substations because of anticipated customer connections. Transpower is expecting between 6 and 14 substations will be added by the end of RCP4 as a result of customer connections. Whilst the capital works may be funded by the customer Transpower undertakes the maintenance of substations that form part of the network.	

Source: Transpower, Transpower, Maintenance PMP 2022 Rev B.pdf, page 19

Bottom-up forecasting

Preventive maintenance schedules (tasks and frequencies) based on Transpower's substation management platforms are produced in Maximo. Transpower use these scheduled activities, together with established unit rates to forecast the expenditure. For new inspections, where the Maximo schedule has yet to be established, an estimated forecast is used.

The base Preventive Maintenance Field Work forecast was developed using the unit rates previously agreed with service providers. Now that the new GSC is in place the base forecast has been updated to reflect the new pricing.

Overall forecast

The following table summarises the yearly forecast for preventive maintenance, based on the above and total for RCP4.

Table 14-10 Total RCP4 forecast expenditure for preventive maintenance

	Base year	Adj to base	Step	Trend	Total (yearly)	Total RCP4
Preventive Maintenance	$38.6m	$1.1m	$0.5m	$1.2m	$41.4m	$206.9m

Source: Transpower, Transpower, Maintenance PMP 2022 Rev B.pdf, page 19.

14.8.4 Planning approach and RCP4 expenditure drivers

Transpower plans its preventive maintenance based on its Grid Asset Management Framework and the individual asset class strategies which set out the objectives and strategic approaches for each individual asset class throughout their lifecycle i.e. planning, delivery, operation, and maintenance. From the asset class life cycle plans maintenance service specifications are developed which includes all types of maintenance: preventive, predictive, proactive, and (schedulable) corrective. This involves determining and verifying all the jobs that need to be carried out, and what is involved in each, and assigning a priority to the work.

In addition to the maintenance service specifications around 60% of the maintenance of all maintenance field work requires network outages. Transpower's objective is to keep the number of planned outages to the minimum to enable appropriate maintenance work to be undertaken, and maximise the work done during each outage as much as possible. As a result, after revision by Transpower's outage planning and management teams as well as service providers the preventive maintenance plans are recast based on outage and resource constraints.

The preventive maintenance expenditure drivers are largely a result of the asset class strategies and maintenance specifications which list the frequency of inspections, routine servicing, and condition assessments. In terms of the elements of preventive maintenance the following drivers are present:

– **Grid training:** expenditure is largely driven by the size of the workforce (both Transpower and external service providers) which requires initial or refresher training.
– **Preventive maintenance field work:** expenditure is largely driven by the time-based schedules for inspections and routine maintenance. One of the recent changes to frequencies is the shift from 4 to 5 years and 8 to 10 years for substation primary equipment. Transpower have stated that the reductions in inspection costs will be offset by additional health and safety, environmental requirements and additional condition monitoring to be undertaken.
– **Management service fees:** expenditure is split between preventive and predictive maintenance. The size of the service fee is dependent on the volume of field work undertaken by service providers and rates charged for the works. The expected service fee has been updated to reflect the new GSC.
– **Other maintenance services and utilities:** the expenditure is relatively small and drivers are often different to other categories such as the individual cost of utility services or the extend of small service provider engagement required.

14.8.5 Evaluation

To assess whether Transpower's opex proposal for preventive maintenance was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 13.2 as applicable. This involved reviewing the provided asset management and strategy documentation, the maintenance portfolio management plan and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions used to develop the preventive maintenance opex proposal.

This opex programme is largely a volumetric programme. The RCP4 proposed budget as outlined above is developed using base-step-trend as well as a bottom-up build. The bottom-up build component (maintenance field services) is developed using scheduled work volumes in Maximo and applying the GSC rates for these maintenance activities. We examined the prudency and efficiency of both variables, i.e., unit rates and maintenance activity quantities as well as the assumptions in the base-step-trend approach.

Prudency

We analysed the different types of preventive maintenance and enquired about the reasons for any step changes in quantities or expenditure between RCP3 and RCP4. We reviewed the investment drivers as identified in the previous sub-section and considered them to be reasonable for informing the proposed opex for RCP4.

We reviewed the preventive maintenance requirements for several asset classes as well as the assumptions, the lifecycle plans and other inputs for creating the preventive maintenance requirements from which the inspections and routine servicing frequencies are determined. These frequencies determine the scheduled maintenance work orders in Maximo. We have not sighted individual work orders in Maximo. However, the documentation which we have reviewed as well as conversations with Transpower SMEs displays a consistency of approach from the asset class plans to the maintenance portfolio management plan to the schedule of preventive maintenance field work.

We also reviewed several asset classes with health models that require condition assessments to inform the asset health values. As with inspection and routine servicing frequencies we observed a consistent and reasonable approach to the development of the condition assessment requirements.

Transpower's overall approach to the development of its maintenance planning is to regard preventive maintenance as part of wider asset lifecycle of planning, delivery, operations, maintenance and disposal. The objective is around achieving an optimal level of expenditure for asset lifecycles while maintaining the current level of performance and risk. Evidence of this includes the consideration of capex-opex trade-offs outlined above which in some cases resulted in more preventive maintenance to optimise total lifecycle expenditure.

Transpower's preventive maintenance planning programme integrates a number of asset management information systems such as Maximo, Work Order Risk Prioritisation and CBRM. This integrated approach is similar to the approach we have observed from other TNSPs. The maintenance planning (including preventive maintenance) incorporates outage constraints and service provider resource constraints. As such the plan is seen as reasonable from a delivery perspective.

We did not find any instance of double counting between this portfolio and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures (including the requirements this place on condition assessments necessary for accurate asset health information) to determine the preventive maintenance field work needed for RCP4.

The relationship between preventive maintenance and other maintenance as well as capex portfolios and other cost categories, is appropriately aligned and well understood. An example of this is grid skills training which is related to the size of the workforce (both Transpower and service providers) undertaking future capex and opex work.

Efficiency

We reviewed the base-step-trend components of the forecast to determine whether the base year was representative as well as whether steps and trends are reasonable adjustments to be made. The selection of the base year as 2021/22 as an appropriate year was reviewed in section 8.3 where we determined that the selection of this year was reasonable. For Transpower to demonstrate that the base year was representative two adjustments were made. We reviewed the basis and assumptions for these adjustments which we consider reasonable. Transpower has also included several steps (representing a change in the scope of work delivered) and trends that reflect change in costs for existing expenditure items. We have reviewed the basis for these and how the quantum of the steps and trend were calculated. Both appear reasonable and are consistent with other Transpower documentation.

One way is which Transpower has been able demonstrate that preventive maintenance is efficient has been through lengthening the time-based inspection frequencies for a range of substation assets from 4 to 5 years and from 8 to 10 years.

For preventive maintenance field work we compared the quantities for a number of randomly selected inspection and routine service tasks for RCP3 and RCP4 included in asset class portfolio management plans. Generally, the quantities were similar reflecting the relatively stable total quantities and expenditure for RCP3 and RCP4.

We were not able to compare the TEES building block rates to Australian NEM unit cost information as we have done for some base capex areas. This was due to the lack of suitable comparable opex information. We were able to review Transpower's service provider price book which compares the unit costs of different service providers for standard maintenance activities. Review of randomly selected items demonstrates that unit cost rates are fairly consistent between service providers for maintenance activities.

The proposed preventive maintenance field work for RCP4 is generally aligned to the TEES building block unit rates × quantities cost building-up calculation. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.

14.8.6 Conclusion

We conclude that the proposed preventive maintenance opex totalling $206.9m satisfies the evaluation criteria in the ToR and our assessment is that the proposal is prudent and efficient and therefore reflects GEIP.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 14-11 Evaluation summary of proposed preventive maintenance opex

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
All opex categories			
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	Expenditure is consistent with drivers, such as inspections / condition assessment linked to capex investigations and maintaining asset condition levels
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Yes	Preventive maintenance built up based on agreed timeframes for maintenance activities. Proposed opex developed using combination of bottom up and base- step-trend with appropriate use of benchmarking of historical costs. Evidence of consideration of opex / capex trade-offs in the development of the preventive maintenance plan
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Evidence of RCP3 opex reduction initiatives & planned for RCP4. Refer to the opex efficiency improvement commentary in Section 14.7 of this report.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	Evidence of planned opex efficiencies in RCP4 link between planned opex efficiencies and previous investments. Refer to the opex efficiency improvement commentary in Section 14.7 of this report.
Identified programmes only			
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	Yes	The Maintenance PMP outlines the investment need and key drivers. The PMP is aligned with other supporting documentation. The preventive maintenance approach is in line with good asset management practice.

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
A3(b)	Policies and planning standards were applied appropriately	Yes	The Maintenance PMP is aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process for preventive maintenance. The maintenance activities, inspection frequencies are logical and consistent with approaches of Australian TNSPs. The process is cost effective through the use of GSC and price book contractor comparisons.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Investment need is challenged through the further development of Transpower's maintenance approaches which consider both whether time-based maintenance frequencies can be extended and whether preventive maintenance is able to be replaced with predictive maintenance based on condition and criticality.
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Yes	We did not find any instance of double counting between this proposed opex and other portfolio or expenditure categories.
A3(i)	Programme is appropriately linked with other projects or programmes	Yes	Preventive maintenance programme is closely linked with other maintenance programs as well as AM&O and base capex R&R programs.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The proposed procurement approach (primarily through the GSC) is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy.

Note: A3(e), A3(f) and A3(g) are not applicable to opex proposal categories.

14.9 Predictive maintenance

The following table summarises our verification of Transpower's proposed predictive maintenance opex for RCP4.

Table 14-12 Verification summary of Transpower's proposed predictive maintenance opex

Verification element	Verification finding
RCP4 proposed amount	$383.9m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $383.9m
Potential scope for improvement	Further implementation of Reliability Informed Maintenance (RIM), to further optimise the work within maintenance programs and their frequencies.
Key issues that Commission should focus on	None identified.

14.9.1 Overview of predictive maintenance

Predictive maintenance addresses defects identified through the preventive maintenance and asset information feedback processes. Transpower's objective for predictive maintenance work is to ensure that deferred maintenance is addressed, and asset health is managed in line with strategic objectives prior to asset failure. Predictive maintenance is scheduled in response to condition-based inspection and monitoring programmes.

The overall maintenance objectives and strategies are outlined in the Grid Asset Management System - Framework which describes Transpower's overall asset management strategies. The Maintenance Portfolio Management Plan and Maintenance Planning Framework documents the planning of Transpower's overall grid maintenance expenditure, including predictive maintenance and the RCP4 forecast for predictive maintenance opex. The individual predictive maintenance strategies are outlined as part of the individual asset class portfolio management plans which describe the operational requirements for each asset class. Further details are provided in the asset class service specifications, which set out the maintenance to be delivered and the skills and resources required, and maintenance standards which describe at a task level the current appropriate practice for maintenance of assets.

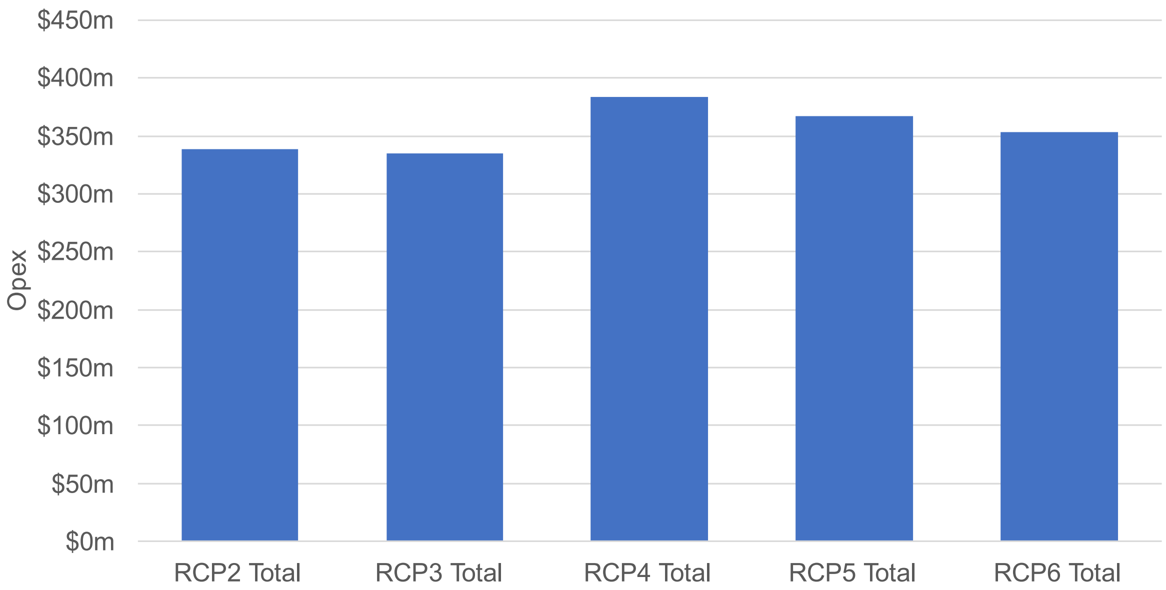
The main activities undertaken as part of predictive maintenance include:

- **Condition-based repairs:** activities to replace or repair assets to correct defects, wear and tear, damage, or poor condition; and to return the asset to a defined standard, keeping it operational.
- **Vegetation control:** follow-up vegetation control (such as tree trimming) to ensure adequate clearance between overhead lines and vegetation to mitigate unplanned faults.
- **Additional targeted condition monitoring:** follow-up objective measurement of condition using specialised test equipment to validate condition or predict failure likelihood (e.g. thermographic imaging, ad hoc remote operating vehicle (ROV) inspection).

14.9.2 Expenditure profile

The annual trend for this expenditure portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule. This opex portfolio has been nominated as an Identified Programme in the RCP4 revenue proposal and has been assessed against the relevant ToR evaluation criteria.

Figure 14-7 Predictive maintenance opex long term profile



Source: Transpower, RT01 expenditure schedule

The following table shows the change in proposed expenditure levels in RCP4 compared to the presently planned RCP3. The increase of 14% is largely due to an increase in predictive maintenance projects.

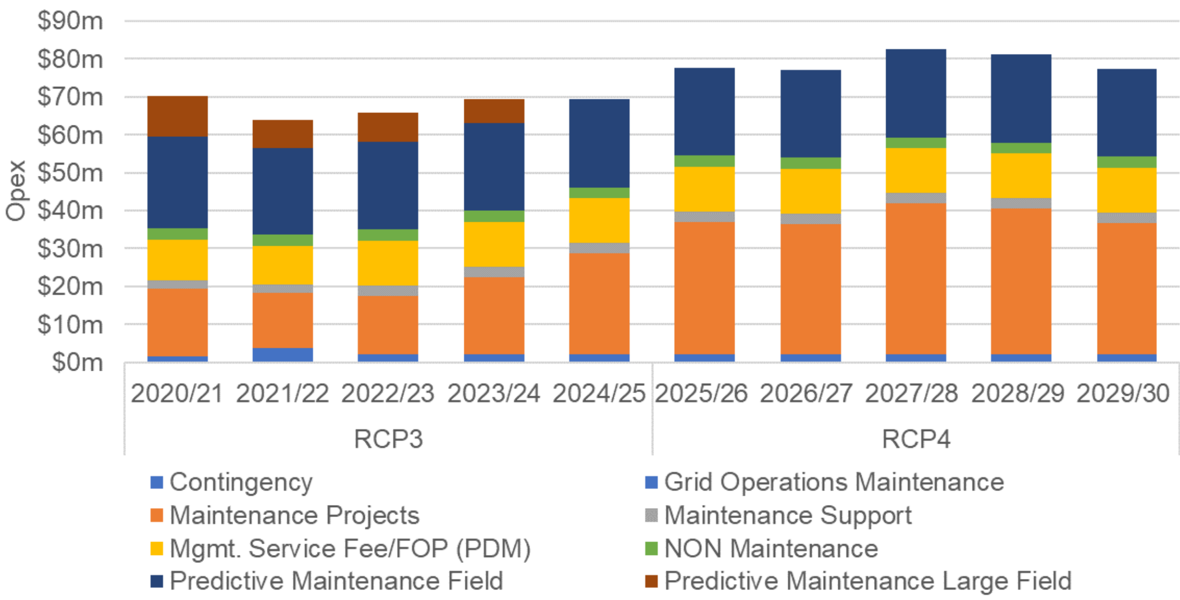
Table 14-13 Predictive maintenance opex for RCP3 and RCP4

	RCP3 total	RCP4 total	Change
Predicative maintenance	$335.3m	$383.9m	14%

Source: Transpower, RT01 expenditure schedule

The annual RCP3 and proposed RCP4 opex profile for all predictive maintenance broken down into both major maintenance subcategories is shown in the following figure. As the figure indicates the largest increase is for maintenance projects (in orange) whilst the large field projects in RCP3 are not present in RCP4. The changes in expenditure are discussed in the following section.

Figure 14-8 Total expenditure for components of predictive maintenance



Source: Transpower, Maintenance PMP 2022 Rev B.pdf

14.9.3 Development of the expenditure forecast

The predictive maintenance expenditure forecast was developed using a combination of base-step-trend analysis as bottom-up build as shown in the following table. Transpower provided a revised PMP in August 2023 and out analysis of the build-up of the predictive maintenance forecast relied on the information contained in that document.

Table 14-14 Budgetary components of predictive maintenance

Component	Description	Forecast Method
Operations	Based on typical spend for carrying out field switching for Connected Party isolations (feeders), power system re-configurations (non-maintenance related) and application of protection setting changes, temporary and permanent.	Base-step-trend
Non (Asset Specific) Maintenance	Seaworks MSF (approx. $1.4m); Skyworks Insulator washing ($0.1m); Siemens support service ($0.25m); Subcom HVDC cable emergency preparedness ($0.1m); T/Lines corridor management and warehouse spares testing. Also covers general expenses and business overheads i.e., non-asset related maintenance e.g., incident investigations, training, extraordinary meetings, legal support etc. based on historical spends.	Base-step-trend
Maintenance Support	Provides key maintenance framework supporting initiatives, including: Field audits; Contingency planning; substation management platform development; Event root cause analysis; Specialist engineering advice to support the Maintenance & Operations functions; SLD drawings; Buildings & Grounds facilities business case & design development; SP reset; Noise complaints; Environmental & archaeological reports; MetService Tools; RIM support.	Base-step-trend
Contingency	Used to ensure funding is readily available able for unforeseen events.	Base-step-trend
Predictive Maintenance Field Work	**Rectifying defects:** Repairing assets or replacing minor components to correct defects, address wear and tear or repair damage, or to return the asset to a condition that complies with a defined standard. **Targeted condition monitoring:** Using specialised test equipment to validate condition or predict the likelihood of failure.	Bottom-up with specific step and trend adjustments

Component	Description	Forecast Method
	Vegetation control: Cutting and/or trimming vegetation to maintain electrical clearance standards.	
Predictive Maintenance Field Large (PDM-L)	**Rectifying defects:** Repairing assets or replacing components (larger than standard PDM) to correct defects, address wear and tear or repair damage, or to return the asset to a condition that complies with a defined standard.	Bottom-up
Maintenance Projects (MPJ)	**Rectifying defects:** Repairing assets or replacing components to correct defects, address wear and tear or repair damage, or to return the asset to a condition that complies with a defined standard. This work is more complex and requires project management oversight.	Bottom-up
Management Service Fee / Fixed Overhead Payments	Covers the Service Provider contract management service fee and is split between Preventive and Predictive maintenance.	Base-step trend

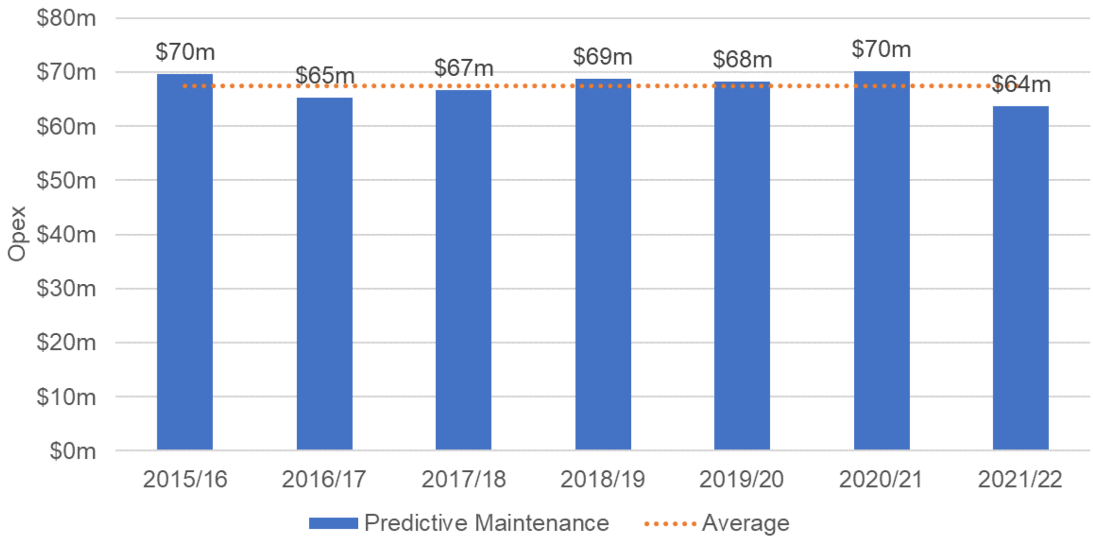
Source: Transpower, Maintenance PMP 2022 Rev B.pdf

Measurement of the base year

As outlined in Section 13.3 of this report, FY2021/22 was selected by Transpower as the base year for any forecasts that utilise a base-step-trend method.

The following figure shows the base year for predictive maintenance which is below the average of RCP2 and the first year of RCP3 (show as the dotted line in the figure).

Figure 14-9 Predictive maintenance base year



Source: Transpower, RT01 expenditure schedule

The following table shows the actual costs of the components of the unadjusted base year for predictive maintenance.

Table 14-15 Base year predictive maintenance

Base Year Component	Actual cost
Operations	$0.46m
Non (Asset Specific) Maintenance	$2.89m
Maintenance Support	$2.11m
Contingency	$3.28m
Management Service Fee / Fixed Overhead Payments	$10.28m
Predictive Maintenance Field Work	$22.97m
Predictive Maintenance Field Work Large	-
Maintenance Projects	$21.89m
Total	**$63.88m**

Source: Transpower, Maintenance PMP 2022 Rev B.pdf

Adjustments

To have a base that is representative adjustments for abnormal expenditure is required. There was a downward adjustment to the base year of $4.2M. This was due to several extreme weather events which meant there was a larger than average ($1.6M) amount for contingency expenditure. In addition, a downward $2.6m adjustment was made for non-recurring items which related to an increase in existing RCP3 provisions for transmission line under clearances and earth potential rise (EPR) safety related works.

Step changes

Transpower have identified a large number of step changes to the base year that were needed to account for expected changes in the scope of work delivered. These steps changes are summarised in the following table.

Table 14-16 Predictive maintenance step changes

	Details	Total
Maintenance Projects and Predictive Field Work	Secondary asset substation management systems - TUDS/Alarm Management - New maintenance projects for costs associated with deploying new substation management system/human machine interface configurations to site. These costs were previously treated as capex.	$1.5m
	ACS Power Cables – work identified to rectify issues due to an increase in outages. The previous work undertaken was corrective maintenance after cable failures.	$1.3m
	TL Conductor – The under-clearance programme, which is currently operating under a provision taken in RCP2, will complete all priority one violations during RCP4. It has been assumed that lower risk violations will still be required but do not come under the provision.	$1.7m
	TL Tower – The new tower to pole programme defers capex spend but will increase opex as towers are managed to the end of life prior to being replace by a pole. To help with this, and the increasing tower steel programme, required as assets age, Transpower have introduced a Tower Modelling programme. The step change is for significantly higher volumes of steel and bolt replacements.	$3.5m
	Transmission foundations – An increase in spend is required in non-grillage refurbishments and concrete over grillage interface refurbishments. Transpower are also monitoring several slope stability issues that will require some form of rectification work.	$2.7m
	ACS Buildings and Grounds – increase in both internal and external painting of buildings. An increase in requirements and obligations	$1.5m

	Details	Total
	resulting in an increase in costs relating to water infrastructure and as a result of a changed approach to safe roof access and leased buildings.	
	TL Access – increased information on the replacement needs of access tracks, bridges and culverts has led to an increase in forecast requirements in the transmission line access portfolio.	$1.1m
	SF6 management across indoor switchgear and outdoor circuit breakers.	$1.1m
	AC substation structures and busworks (28 sites over RCP4)	$1.7m
Miscellaneous	Range of small increases for resilience and HVDC opex work.	$1.1m
	Total	**$17.1m**

Source: Maintenance PMP 2022 Rev B.pdf

Trends

Transpower has identified that a material increase in grid works during RCP4 will require an increase in inspection work and in training. The following table shows the trend for predictive maintenance.

Table 14-17 Preventive maintenance step changes

Trends	Details	Total
Maintenance Support	The proposed increase in capital work requires an increase in support for audits and some drawings and grid information work.	$2.3m
Fixed overhead costs	Due to the increase in work expected, specifically for maintenance projects, it is expected that the fixed overhead payment to service providers will increase.	
Operations	Increase in the size of the grid via new substations and customer connections will increase the required support for event investigations.	
Predictive Maintenance Field Works	An increase in the size of the grid via new substations and customer connections will increase the need for more defect management.	

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 27

Bottom-up forecasting

Transpower have used a bottom-up approach to forecasting maintenance project and Predictive Maintenance Large (PDM-L) work. In some cases, this work has been indicated by asset health models and then reviewed by asset planning teams. Other work has been identified by operations and delivery teams. This work has been entered into Transpower's asset management planning system.

To develop a bottom up view of the RCP4 forecast for maintenance projects and large field work, Transpower cost the work using building blocks from Transpower's cost estimation system (TEES).

The majority of the growth in predictive maintenance is due to the increase in maintenance projects.

Two thirds of Transpower's predictive expenditure for RCP4 is determined via a base-step-trend approach with approximately a third via the bottom-up forecasting for maintenance project work and PDM-L.

Overall Forecast

The following table summarises the yearly forecast for predictive maintenance, based on the above and the total for RCP4. The total derived from the information in the PMP ($395.8m) differs from that shown in the RT01 expenditure schedule ($383.9m). The unexplained discrepancy is due to the opex productivity factor of 0.5% per annum being applied to the predictive maintenance expenditure (in the RT01 expenditure schedule spreadsheet) reducing the total amount by $11.9m. This productivity factor has not been included in the Maintenance PMP[318].

[318] Transpower, Maintenance PMP 2022 Rev B.pdf

Table 14-18 Total RCP4 forecast expenditure for predictive maintenance

	Base year	Adj to base	Step	Trend	Total (yearly)	Total RCP4
Predictive Maintenance	$63.8m	-$4.2m	$17.1m	$2.3m	$79.2m	$395.8m

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 30.
Note: The Maintenance PMP opex forecast amounts do not currently align with the RT01 expenditure spreadsheet opex amounts provided.

14.9.4 Planning approach and RCP4 expenditure drivers

Transpower plans its predictive maintenance based on its Grid Asset Management Framework and the individual asset class strategies which set out the objectives and strategic approaches for each individual asset class throughout their lifecycle i.e., planning, delivery, operation, and maintenance. From the asset class life cycle plans maintenance service specifications are developed which includes all types of maintenance: preventive, predictive, proactive, and (schedulable) corrective. This involves determining and verifying all the jobs that need to be carried out, and what is involved in each, and assigning a priority to the work.

Around 60% of the maintenance of all maintenance field work requires network outages. Transpower’s objective is to keep the number of planned outages to the minimum to enable appropriate maintenance work to be undertaken, and maximise the work done during each outage as much as possible. As a result, after revision by Transpower’s outage planning and management teams as well as service providers the predictive maintenance plans and projects are recast based on outage and resource constraints.

The purpose of predictive maintenance is to carry out maintenance to address known asset condition before its condition deteriorates into an unsatisfactory state (e.g. outside service specification) or asset failure. This is unlike corrective maintenance, where the work is after asset failure. As such the extent of asset condition and the quality and usability of asset health models is a driver for the level of predictive maintenance that Transpower is able to carry out. The asset condition information which enables Transpower to address defects prior to asset failure is primarily driven from its preventive maintenance inspections and condition assessments. In terms of key elements of predictive maintenance, the following drivers are present:

– **Operations:** This is primarily driven by the extent of field switching required as well as the level of network system re-configurations and protection setting changes that are needed.
– **Non (Asset Specific) Maintenance:** the drivers for this expenditure vary because this category covers both small individual maintenance contracts such as the HVDC cable emergency preparedness fee as well as non-asset costs such as warehouse spares testing and incident investigations.
– **Maintenance Support**: this expenditure category also have multiple drivers as it covers a wide range of elements such root-cause analysis, building and grounds business cases and noise complaints.
– **Contingency:** expenditure for this category will primarily depend on the extent of unforeseen events such as storms and other causes of unplanned outages.
– **Management service fees:** expenditure is split between preventive and predictive maintenance. The size of the service fee is dependent on the volume of field work undertaken by service providers and rates charged for the works.
– **Preventive maintenance field work (including large field work):** this will be driven largely by the extent of asset defects identified that require repair or component replacement to bring the asset up to a defined standard. In addition, expenditure will also be driven by the extent of equipment testing needed to validate asset condition or failure likelihood. Finally, the extent of vegetation encroaching transmission line clearance areas drives the amount of vegetation trimming or cutting required.
– **Maintenance projects:** the drivers are similar to maintenance field work except that the work is more complex a greater level of project management.

14.9.5 Evaluation

To assess whether Transpower’s opex proposal for predictive maintenance was prudent and efficient, we followed the evaluation criteria and employed the evaluation methods described in Section 13.2 as applicable. This involved reviewing the provided asset management and strategy documentation, the maintenance PMP and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions used to develop the predicative maintenance opex proposal.

This opex programme is a volumetric programme. The RCP4 proposed budget as outlined above is developed using base-step-trend as well as a bottom-up build. The bottom-up build component (maintenance field services) is developed using scheduled work volumes in Maximo and applying the GSC rates for these maintenance activities. We examined the prudency and efficiency of both variables, i.e., unit rates and maintenance activity quantities as well as the assumptions in the base-step-trend approach.

Prudency

We analysed the different types of predictive maintenance and enquired about the reasons for any step changes in quantities or expenditure between RCP3 and RCP4. We reviewed the investment drivers as identified in the previous sub-section and considered them to be reasonable for informing the proposed opex for RCP4.

We reviewed the predictive maintenance requirements for several asset classes as well as the assumptions, the lifecycle plans and other inputs for determining the requirements. We have not sighted individual defects and subsequent predictive maintenance work orders in Maximo. However, the documentation which we have reviewed, including an overview of the Work Order Risk Prioritisation system which prioritises defect work orders as well as conversations with Transpower SMEs displays a consistency of approach from the asset class plans to the maintenance portfolio management plan to defect management.

We reviewed the predictive maintenance project areas subject to step change and compared the description and justification in the portfolio management plan with the descriptions with individual asset classes plans. The documentation is consistent and Transpower have demonstrated a need for the additional step changes based on the description of the asset condition issues outlined in the relevant asset class portfolio management plans.

Transpower’s overall approach to the development of its maintenance planning is to regard predictive maintenance as part of wider lifecycle of planning, delivery, operations, maintenance and disposal. The objective is around achieving an optimal level of expenditure for asset lifecycles was maintaining the current level of performance and risk. Evidence of this includes the consideration of capex-opex trade-offs outlined above which in some cases resulted in more predictive maintenance to optimise lifecycle expenditure. An example of this is the increase in steel and bolt maintenance for transmission towers that are undergoing life extension until they are replaced with poles.

Transpower’s predictive maintenance planning programme integrates a number of asset management information systems such as Maximo, Work Order Risk Prioritisation and CBRM. This integrated approach is similar to the approach we have observed from other TNSPs. The maintenance planning (including predictive maintenance) incorporates outage constraints and service provider resource constraints. As such the plan is seen as reasonable from a delivery perspective.

We did not find any instance of double counting between this portfolio and other portfolio or expenditure categories.

Transpower has considered the linkages with the proposed service measures, especially the revenue-linked and asset health measures to determine the predictive maintenance field work needed for RCP4.

The relationship between predictive maintenance and other maintenance as well as capex portfolios and other cost categories, is appropriately aligned and well understood. An example of this is the projected growth in the grid as a result of additional customer connections which will lead to a greater level of defects to be rectified.

Efficiency

We reviewed the base-step-trend components of the forecast to determine whether the base year was representative as well as whether steps and trends are reasonable adjustments to be made. The selection of the base year as 2021/22 as an appropriate year was reviewed in section 8.3 where we determined that the selection of this year was reasonable. For Transpower to demonstrate that the base year was representative adjustments were made. We reviewed the basis and assumptions for these adjustments which we consider reasonable.

Transpower has also included a large several steps (representing a change in the scope of work delivered) and trends that reflect change in costs for existing expenditure items. We have reviewed the basis for these and how the steps and trend were calculated (including specific quantities for the volumetric components). The steps and trends appear reasonable and are consistent with other Transpower documentation, such as the asset class portfolio management plans they relate to.

For predictive maintenance field work we compared the quantities for a number of randomly selected opex components for RCP3 and RCP4 which were included in asset class portfolio management plans. Generally, the quantities were similar reflecting the relatively stable total quantities and expenditure for RCP3 and RCP4.

We were not able to compare the TEES building block rates to Australian NEM unit cost information as we have done for some base capex areas. This was due to the lack of suitable comparable opex information. We were able to review Transpower's service provider price book which compares the unit costs of different service providers for standard maintenance activities. Review of randomly selected items demonstrates that unit cost rates are fairly consistent across Transpower's network for maintenance activities.

The proposed predictive maintenance field work for RCP4 is generally aligned to the TEES building block unit rates × quantities cost building-up calculation. The increase in the building block unit costs between the RCP3 submission (in constant 2017/18 NZD) and RCP4 submission (in constant 2021/22 NZD) is generally modest when CPI is factored in.

14.9.6 Conclusion

We conclude that the proposed preventive maintenance opex totalling $383.9m satisfies the evaluation criteria in the ToR and our assessment is that the proposal is prudent and efficient and therefore reflects GEIP.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 14-19 Evaluation summary of proposed predictive maintenance opex

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
All opex categories			
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	Expenditure consistent with overall driver to replace / repair assets prior to failure.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Yes	Methodology is considered reasonable. Proposed opex developed using combination of bottom up and base- step-trend with appropriate justification given. Evidence of consideration of opex/capex trade-offs in the development of the preventive maintenance plan.
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Evidence of RCP3 opex reduction initiatives & planned for RCP4. Refer to the opex efficiency improvement commentary in Section 14.7 of this report.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	Evidence of planned opex efficiencies in RCP4 link between planned opex efficiencies and previous investments. Refer to the opex efficiency improvement commentary in Section 14.7 of this report.
Identified programmes only			
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	Yes	The Maintenance PMP outlines the investment need and key drivers. The PMP is aligned with other supporting documentation. The preventive maintenance approach is in line with good asset management practice.
A3(b)	Policies and planning standards were applied appropriately	Yes	The Maintenance PMP and Planning Framework and individual strategies are aligned with the Transpower's policies and planning standards with respect to the proposed expenditure.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The PMP sets out the planning process for preventive maintenance. The maintenance activities, inspection

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
			frequencies are logical and consistent with approaches of Australian TNSPs. The process is cost effective through the use of GSC and price book contractor comparisons.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Investment need challenged through the further development of Transpower's maintenance approaches which review the existing approaches and in particular whether time-based maintenance frequencies can be replaced with predictive maintenance based on condition and criticality to optimise the overall lifecycle cost for a given level of performance and risk.
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Yes	We did not find any instance of double counting between this proposed opex and other portfolio or expenditure categories.
A3(i)	Programme is appropriately linked with other projects or programmes	Yes	Preventive maintenance programme is closely linked with other maintenance programs as well as AM&O and base capex R&R programs.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The proposed procurement approach (primarily through the GSC) is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy.

Note: A3(e), A3(f) and A3(g) are not applicable to opex proposal categories.

14.10 Corrective and proactive maintenance

The following table summarises our verification of Transpower's proposed corrective and proactive maintenance opex for RCP4.

Table 14-20 Verification summary of Transpower's proposed corrective and proactive maintenance opex

Verification element	Verification finding
RCP4 proposed amount	$23.8m (corrective) and $4.6m (proactive)
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept: $23.8m (corrective) and $4.6m (proactive)
Potential scope for improvement	Further implementation of Reliability Informed Maintenance (RIM), to further optimise the work within maintenance programs and their frequencies.
Key issues that Commission should focus on	None identified.

14.10.1 Overview of corrective and proactive maintenance

Corrective and proactive maintenance is improvement work initiated from formal analysis and investigation by the engineering or reliability teams. This type of work is done to reduce risk or provide an efficiency gain through managing potential root causes of failure before a failure occurs. Proactive maintenance activities are driven by either tactical or strategic reliability analysis and approved by a reliability engineer. Current proactive maintenance work volumes are low. The process for categorising work as proactive maintenance is not yet well established, and this work has generally been categorised as predictive maintenance in the past (usually as maintenance projects).

The main components of proactive maintenance work activities are:

– Special inspections to determine fault causes or validate findings.
– Reliability driven corrective work.
– One off condition monitoring using specialist test equipment.

Corrective maintenance includes fault response activities or maintenance work undertaken to restore an asset to service following a fault and make it safe or secure or prevent an imminent event that will likely cause damage, degradation, or an operational failure. Such work is usually identified because of a fault or during inspections.

The main components of corrective maintenance work activities are:

– Fault restoration
– Repairs
– Inspections

The overall maintenance objectives and strategies are outlined in the Grid Asset Management System - Framework. The Maintenance Portfolio Management Plan and Maintenance Planning Framework documents the planning of Transpower's overall grid maintenance expenditure, including proactive and corrective maintenance and the forecast proposed opex. The individual maintenance strategies are outlined as part of the individual asset class portfolio management plans which describe the operational requirements for each asset class. Further maintenance details are provided in the asset class service specifications, which set out the maintenance to be delivered and the skills and resources required, and maintenance standards which describe at a task level the current appropriate practice for maintenance of assets.

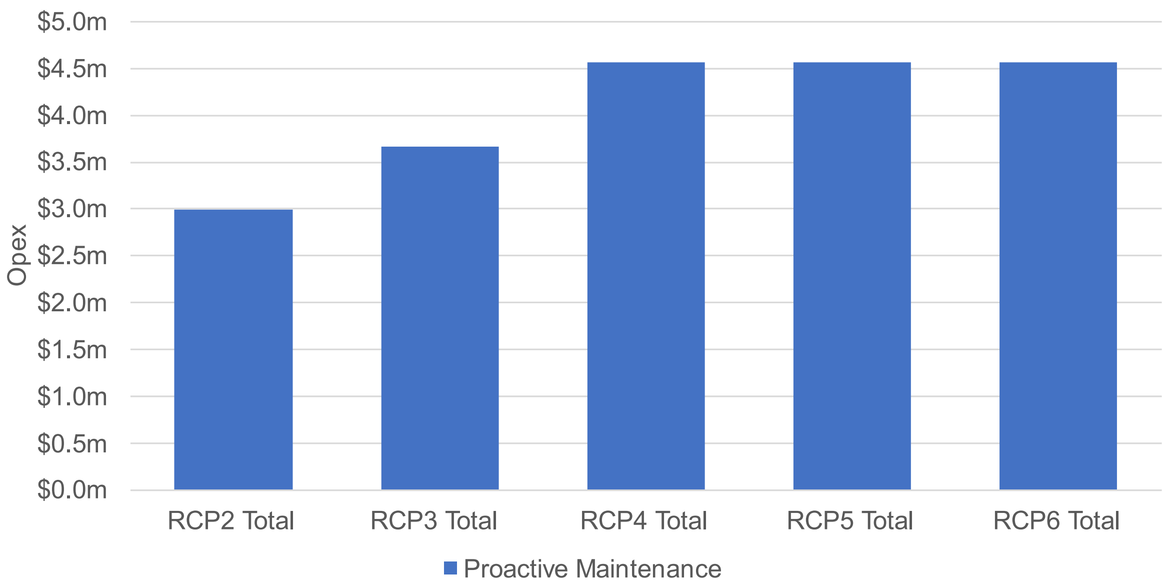
The annual opex trend for these expenditure portfolios including historical and future RCPs is presented in the RT01 Expenditure Schedule. These portfolios are not Identified Programmes in the RCP4 revenue proposal. It has been assessed against the relevant ToR evaluation criteria.

14.10.2 Expenditure profile

Proactive maintenance

The figure below shows the longer term opex profile of proactive maintenance which indicates that was an increase from RCP2 to RCP3 and further increase to RCP4 before remaining the same in RCP5 and RCP6.

Figure 14-10 Proactive maintenance expenditure by regulatory period



Source: Transpower, RT01 expenditure schedule

Transpower is proposing to an increase of 24% on very low expenditure levels from RCP3 to RCP4 as the following table shows.

Table 14-21 Proactive maintenance opex for RCP3 and RCP4

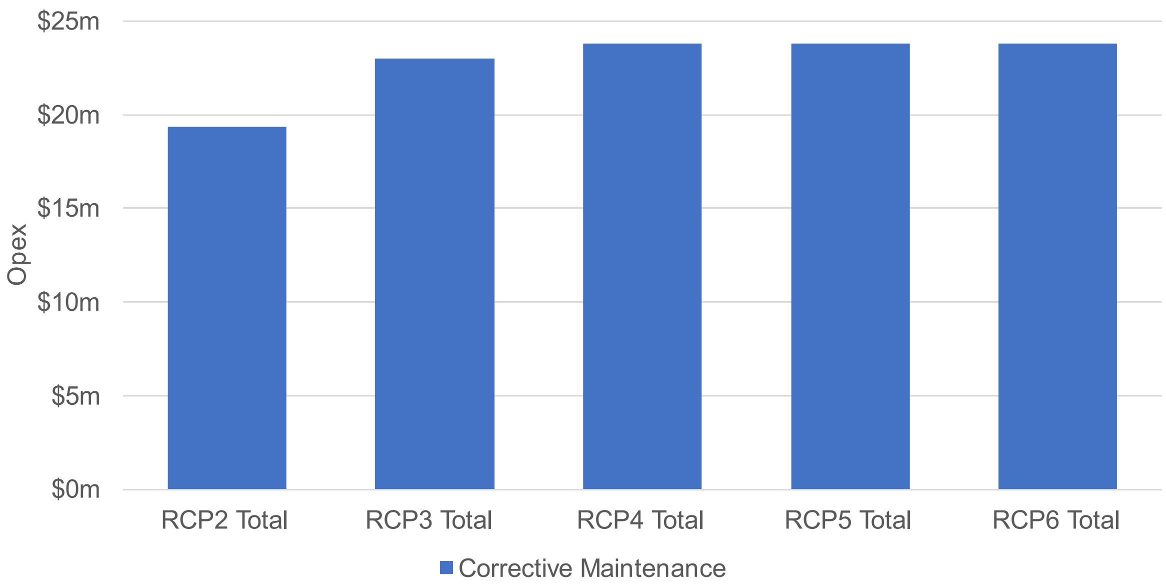
Opex portfolio	RCP3 total	RCP4 total	Change
Proactive maintenance	$3.7m	$4.6m	24%

Source: Transpower, RT01 expenditure schedule

Corrective maintenance

The figure below shows the longer term opex profile of corrective maintenance which indicates that was an increase from RCP2 to RCP3 and a very slight increase to RCP4 before remaining the same in RCP5 and RCP6.

Figure 14-11 Corrective maintenance expenditure by regulatory period



Source: Transpower, RT01 expenditure schedule

Transpower is proposing to an increase of 3%, on low expenditure levels from RCP3 to RCP4 as the following table shows.

Table 14-22 Corrective maintenance opex for RCP3 and RCP4

Opex portfolio	RCP3 total	RCP4 total	Change
Corrective maintenance	$23.0m	$23.8m	3%

Source: Transpower, RT01 expenditure schedule

14.10.3 Development of the expenditure forecast

Proactive maintenance

Proactive maintenance expenditure is forecast using a base-step-trend approach. Proactive maintenance consists of the following types of field work:

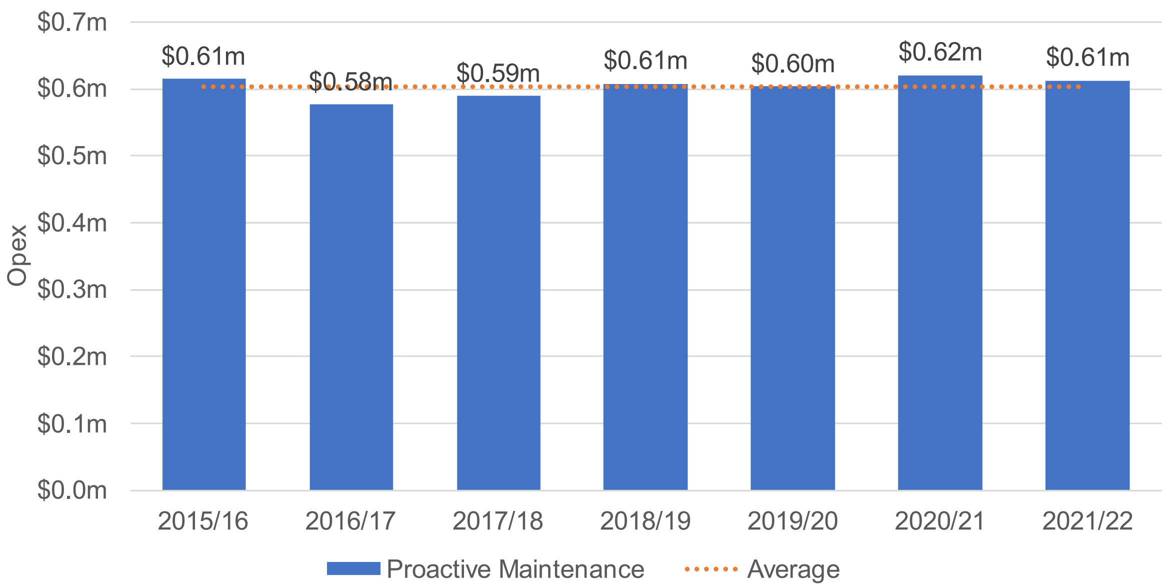
– Special inspection: Special reliability engineering inspections to further determine fault causes or validate findings.

– Reliability driven corrective work: Improvement modifications, design changes, or adjustments undertaken as scheduled activities that are planned and scheduled in advance to address reliability concerns.

– Condition monitoring: One-off condition monitoring using specialised test equipment to further determine fault causes or to validate findings for root causes analysis or reliability engineering purposes.

The following chart shows the how the base year expenditure compares to the expenditure since the beginning of RCP2.

Figure 14-12 Proactive maintenance base year



Source: Transpower, RT01 expenditure schedule

Transpower have a base year expenditure of $0.6m. There are no adjustments needed for absent or non-recurring costs. There is one step change for proactive maintenance: bird mitigation measures currently funded under predictive maintenance with a limited budget. This programme has been shifted to proactive maintenance with an increased annual budget of $0.3m to reduce bird streaming causing unplanned outages.

There are no forecast trend changes for proactive maintenance. The table below summarises the forecast total RCP4 spend.

Table 14-23 Total RCP4 forecast expenditure for proactive maintenance

Opex portfolio	Base year	Step	Total (yearly)	Total RCP4
Proactive Maintenance	$0.6m	$0.3m	$0.9m	$4.6m

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 32.

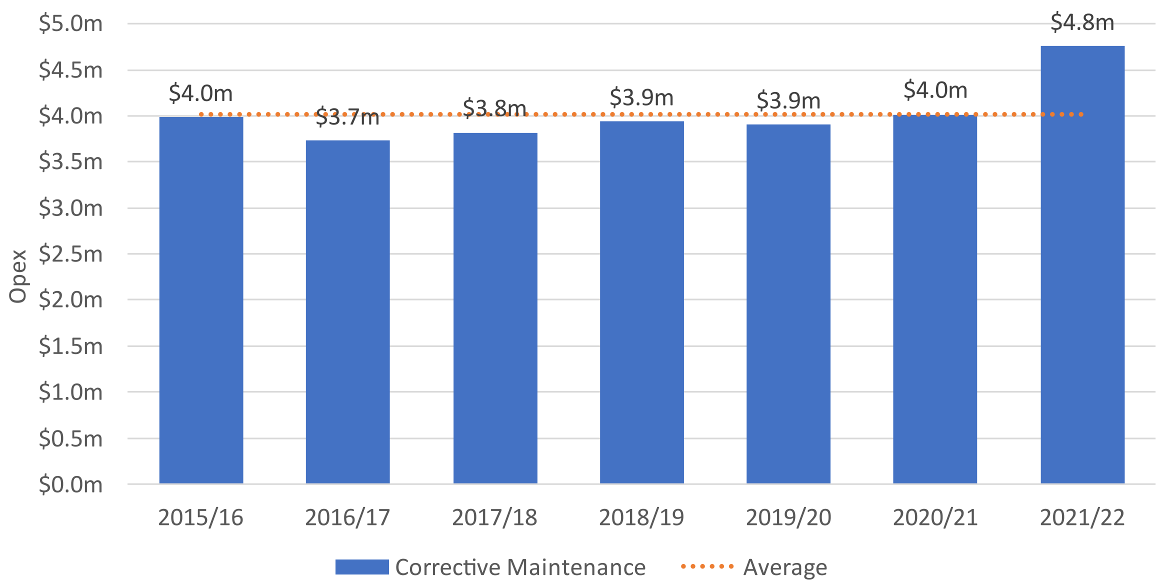
Corrective maintenance

Corrective maintenance expenditure is forecast using a base-step-trend approach. Proactive maintenance consists of the following types of field work:

– **Special inspection:** Special reliability engineering inspections to further determine fault causes or validate findings.
– **Reliability driven corrective work:** Improvement modifications, design changes, or adjustments undertaken as scheduled activities that are planned and scheduled in advance to address reliability concerns.
– **Condition monitoring:** One-off condition monitoring using specialised test equipment to further determine fault causes or to validate findings for root causes analysis or reliability engineering purposes.

The following chart shows the how the base year expenditure compares to the expenditure since the beginning of RCP2.

Figure 14-13 Corrective maintenance base year



Source: Transpower, RT01 expenditure schedule

Transpower have a base of $4.8m. There are no adjustments made from absent or non-recurring costs. There are no identified step changes or trends for corrective maintenance. The table below summarises the forecast total RCP4 spend.

There are no forecast trend changes for corrective maintenance. The table below summarises the forecast total RCP4 spend.

Table 14-24 Total RCP4 forecast expenditure for corrective maintenance

	Base year	Total (yearly)	Total RCP4
Corrective Maintenance	$4.8m	$4.8m	$23.8m

Source: Transpower, Maintenance PMP 2022 Rev B.pdf, page 37.

14.10.4 Planning approach and RCP4 expenditure drivers

Transpower plans its proactive and corrective maintenance based on its Grid Asset Management Framework and the individual asset class strategies which set out the objectives and strategic approaches specific to the management of individual asset classes throughout their lifecycle i.e. planning, delivery, operation, and maintenance. From the asset class life cycle plans maintenance service specification are developed which includes all types of maintenance: preventive, predictive, proactive, and (schedulable) corrective. It involves determining and verifying all the jobs that need to be carried out, and what is involved in each, and assigning a priority to the work.

The overall driver for growth in proactive maintenance will be a greater level of improvement work initiated from formal analysis and investigation by the engineering or reliability teams. This type of work is done to reduce risk or provide an efficiency gain through managing potential root causes of failure before a failure occurs.

The process for categorising work as proactive maintenance is not yet well established, and this work has generally been categorised as predictive maintenance in the past. If the categorisation process matures, then a greater percentage of spend could be classified as proactive, with predictive work reducing accordingly, overall, there would be no net reduction in expected spend because of reclassification.

The key drivers of corrective maintenance are safety and reliability which resulting in the following main corrective maintenance activities are:

– **Fault restoration:** Immediate response to repair a fault that has safety, environmental, or operational implications.

– **Repairs:** Work necessary to repair damage, or to prevent the failure or rapid degradation of equipment that is in an unsatisfactory condition.
– **Inspections:** Information gathering that is not directly related to the fault restoration activity itself.

Therefore, the level of corrective maintenance expenditure will be driven by the volume, condition and criticality of assets on the network which will determine the number and importance of asset failure defects to be addressed.

14.10.5 Evaluation

To assess whether Transpower's opex proposal for this asset portfolio was prudent and reasonable, we followed the evaluation criteria and employed the evaluation methods described in Section 13.2 as applicable.

This involved reviewing the provided asset management and strategy documentation, the maintenance portfolio management plan and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions used to develop the expenditure forecasts.

We reviewed the bases and steps applicable to consider their reasonableness. The level of review was less substantial than for preventive and predictive maintenance because the level of expenditure was significantly less, and they are not identified programmes.

Proactive maintenance expenditure is very limited to specific reliability initiatives and specialised condition monitoring or root cause analysis inspections. Individual asset classes, such the transmission line structure portfolio management plan with the bird mitigation measures, reference proactive maintenance. We did not find any examples of double counting between this portfolio and other portfolios. The proactive maintenance approach is considered reasonable for the level of expenditure.

The corrective maintenance expenditure is driven by the volume, condition and criticality of assets on the network. Transpower documentation indicates that the level of defects has remained relatively stable over the last few years and based on Transpower's asset health models and forecast totex is expected to remain stable in RCP4. Therefore, the corrective maintenance approach is considered reasonable.

The following table summarises our evaluation for this non-identified expenditure category.

14.10.6 Conclusion

We conclude that the proposed proactive and corrective maintenance opex totalling \$4.6m and \$23.8m satisfies the evaluation criteria in the ToR and our assessment is that the proposal is prudent and efficient and therefore reflects GEIP.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 14-25 Evaluation summary of proposed predictive maintenance opex

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
All opex categories			
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	Expenditure is consistent with drivers, such as repairs and fault restoration for corrective maintenance and reliability projects for proactive maintenance.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Yes	These cost estimate methods are considered reasonable for the level of expenditure. Individual proactive projects are costed and added to the base. The level of corrective maintenance is forecast to remain stable over RCP4 which is reasonable given the level of defects has been stable over the last few years.
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Evidence of RCP3 opex reduction initiatives & planned for RCP4. Refer to the opex efficiency improvement commentary in Section 14.7 of this report.

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	Evidence of planned opex efficiencies in RCP4 link between planned opex efficiencies and previous investments. Refer to the opex efficiency improvement commentary in Section 14.7 of this report. One measure to note for corrective maintenance is the implementation of the Matai App which allowed Transpower to revalidate existing defects during regular asset inspections and remove those already addressed during other works.

15. AM&O opex

The following table summarises our verification of Transpower's proposed AM&O opex requirement for RCP4.

Table 15-1 Verification summary of Transpower's AM&O opex

Verification element	Verification finding
RCP4 proposed amount	$408.9m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $408.9m
Potential scope for improvement	Transpower is currently developing a model for assisting service providers with sharing some of the costs associated with additional trainees to enable the delivery of a larger programme. This model should be finalised to ensure that the cost-sharing is limited to the intended purpose.
Key issues that Commission should focus on	None identified

15.1 Overview of AM&O opex

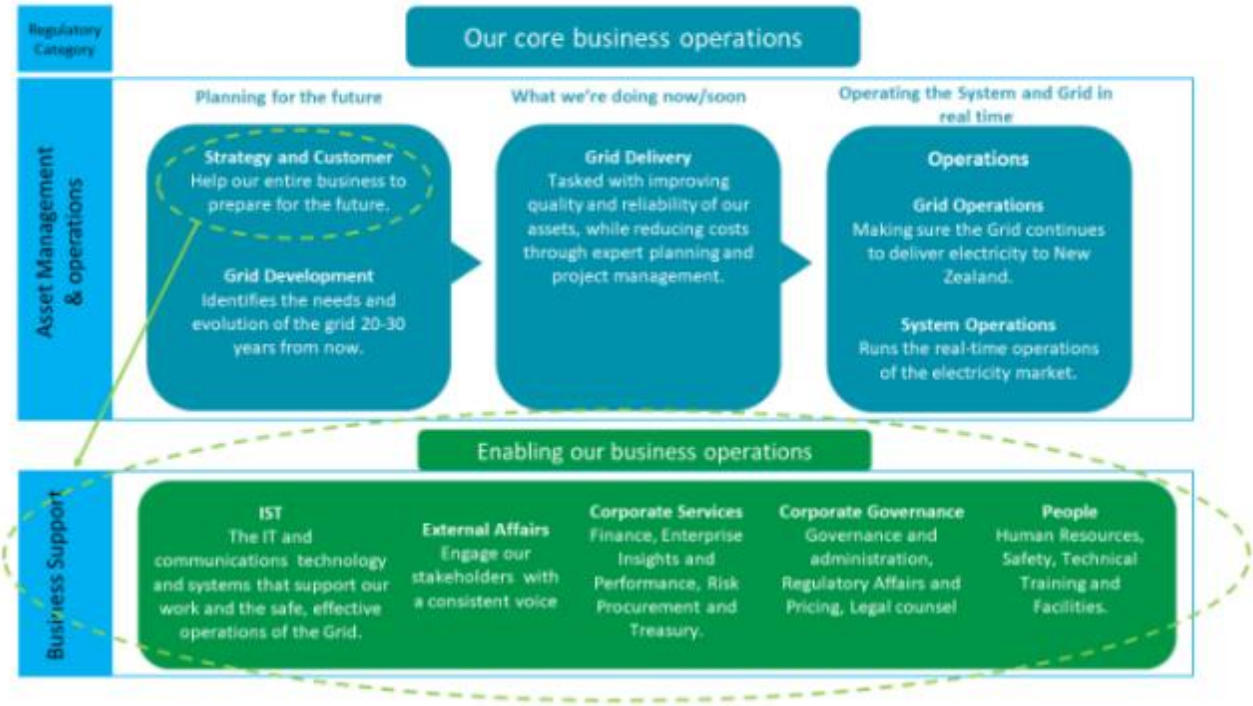
Asset Management and Operations (AM&O) opex includes the activities necessary to plan, build, operate the transmission network, and to plan and manage the maintenance of the network. The work to maintain the network is funded as grid maintenance opex which is considered in Section 14 of this report. AM&O covers the internal costs of permanent employees and contractors of the three divisions:

– Grid Development
– Grid Delivery
– Operations.

The functions of Procurement and Supply, Landowner Relations and Property, and Environmental Policy and Planning are also included in AM&O.

AM&O includes Transpower's investigations which are structured into asset investigations and innovation. There is a third class of investigations, referred to as business improvements that are related to Grid ICT investments, but these costs are included in the Business Support opex category. Investigation expenditure is any cost incurred in the investigation of potential improvements to the grid or business processes. The following figure outlines the AM&O divisions and a broad description of their role.

Figure 15-1 Mapping Transpower's AM&O divisions to Regulatory Categories



Source: Transpower, Asset Management & Operations Opex Overview RCP4, Version 0.5, March, page 2.

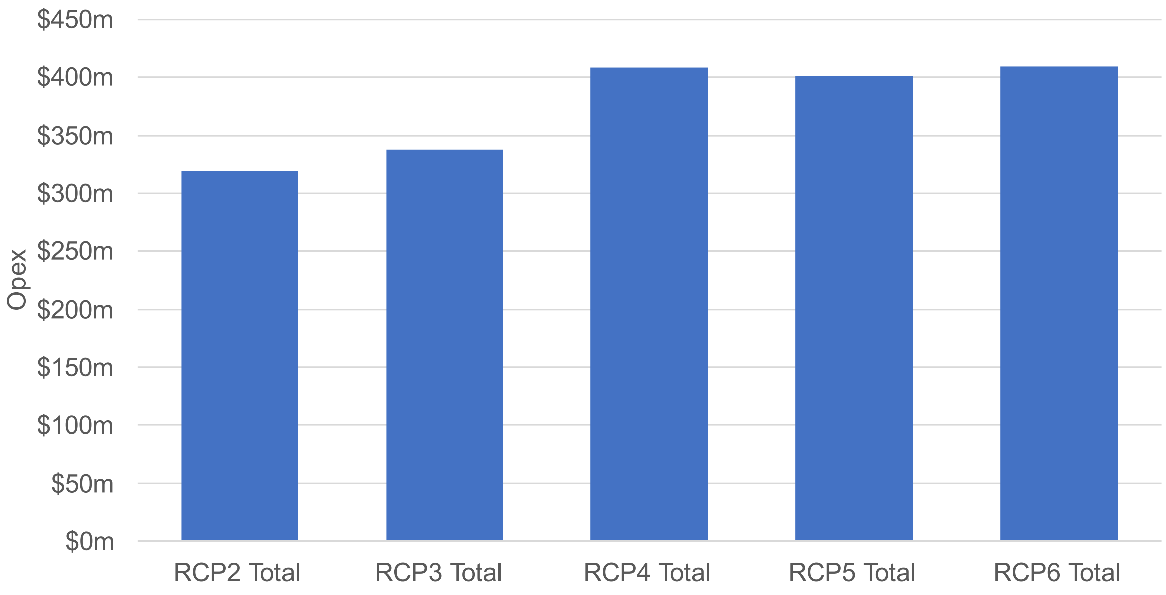
The overall asset management objectives and strategies are outlined in the Grid Asset Management System. The AM&O Management Plan documents the planning of Transpower's asset management and operations expenditure and the forecast of the RCP4 proposed opex.

The annual trend for this expenditure portfolio including historical and future RCPs is presented in the RT01 Expenditure Schedule. The opex proposal forecast for this portfolio has been nominated as an Identified Programme in the RCP4 revenue proposal and has been assessed against the relevant ToR evaluation criteria.

15.2 Expenditure profile

The figure below shows the longer term opex profile of AM&O which indicates a step up from RCP3 to RCP4 and then stable expenditure in RCP5 and RCP6.

Figure 15-2 AM&O opex long term profile



Source: Transpower, RT01 expenditure schedule

Transpower is proposing to a reasonably large increase in expenditure in RCP4, compared to the present RCP3. The following table shows a 21% change in proposed expenditure levels for RCP4 compared RCP3.

Table 15-2 AM&O opex for RCP3 and RCP4

	RCP3 total	RCP4 total	Change
AM&O	$338.0m	$408.9m	21%

Source: Transpower, RT01 expenditure schedule

As indicated above AM&O includes three divisions and several functions[319].

15.2.1 Grid Development

The Grid Development division identifies the future needs for the transmission grid for the next 20 to 30 years, develops transmission solutions that are economically efficient, and develops the business cases for those solutions. The key functional teams are:

- **System Planning and Grid Investment** is responsible for the development of grid capacity plans to meet customer needs, including new connections. They ensure the grid meets forecast reliability standards and enables electrification and develop investment proposals to secure funding for grid expansion to meet current and future needs.
- **Grid Strategy Risk and Performance** develop the grid strategies and long-term plans for the asset base required to provide required service level. They also develop asset health and criticality models to support expenditure and identify, manage, monitor, and ensure mitigations for key grid asset risks. They monitor performance of key grid assets.
- **Asset Planning** are responsible for applying the asset strategies and for developing solutions to maintain and enhance Transpower's asset base in accordance with long-term grid development strategies. Asset Planning's role is to optimise, maintain, replace, and enhance assets including identifying opportunities to

[319] Transpower, EOP008 Asset Management & Operations Opex Overview RCP4.pdf

integrate and align different projects to realise lower cost outcomes. Asset Planning produces Transpower's Asset Management Plan (AMP).

– **Tactical and Estimation** provide the engineering support for the development and delivery of projects and maintenance tasks. This includes the development of design and performance standards for assets. The engineering estimation team support the costing of projects and investigations.
– **Asset Information Management** manage and support the core asset database (Maximo), technical drawings, and geospatial capabilities.

15.2.2 Grid Delivery

The Grid Delivery division is responsible for the delivery of the grid works programme, including base and maintenance, major capital projects and customer funded work. Key functional teams include:

– **Planning, scheduling, and optimisation** are responsible for the development, coordination and execution of integrated works planning across all time horizons.
– **Grid Works Delivery** is responsible for the delivery of the works programme to agreed expectations and in a cost-effective manner. This requires close coordination with service providers, engineering consultants, landowners, customers as well as internal teams.
– **Service Delivery** is responsible for maintenance and fault response and liaison with service providers. This team is accountable for maintaining service levels to agreed customer expectations.
– **HVDC and Operational Engineering** provides specialist engineering for HVAC primary and secondary assets, protection & automation systems, and HVDC & power electronic assets. They ensure maintenance management, project management and scheduling works to ensure all apparatus and equipment and systems associated with the Transpower HVDC link, power electronics assets are monitored, maintained, serviced, repaired and operated to agreed standards.
– **Delivery Performance and Support** are accountable for supporting contract performance, instigating, and managing innovation initiatives, supporting project managers and driving best practice project performance (via the PMO office). They also support the delivery and visibility of overall grid performance.

15.2.3 Operations

The Grid Operations teams provide support for outage planning and real time operational functions. This includes continuous management and coordination of the transmission system via coordination centres in Auckland and Christchurch and operational availability of monitoring and control of the grid and the power system. The key functions are:

– **Outage Planning** develops and publishes the rolling outage plans including assessment of operational risk and impact on asset availability targets. They also lead and facilitate communication across industry participants so that maintenance and outages can be coordinated around planned grid outages.
– **Grid and System Operations (NGOC only)** are accountable for the day-to-day operational control of grid assets to enable equipment outages for maintenance or other works and ensure safe access for work crews during outages. They respond to unforeseen events and faults, including management of automatic systems which act rapidly to safeguard people and equipment when events occur. They also lead real time communications and coordination with customers, service providers, and the System Operator before, during and after planned and unplanned outages.
– **Real Time Systems (RTS)** maintain 24x7 operational availability of SCADA and associated systems used to monitor and control Transpower's assets and the power system. They deliver and maintain telemetry, data modelling, and standards for all new grid projects. They maintain the telemetry data into the wider Transpower business to drive asset investment and optimise asset capability/availability.

15.2.4 Procurement and Supply, Landowner Relations and Property, and Environment

Transpower have included the following functions as part of AM&O:

– **Procurement and Supply (part of Corporate Services)** accountable for Transpower's procurement strategy, operating model, and inventory management.
– **Environmental Policy and Planning (part of External Affairs)** accountable for enabling compliance with environmental laws and regulations.
– **Landowner Relations and Property (part of External Affairs)** accountable for managing the relationships with landowners where Transpower assets are located (or will be located) and acquiring the necessary property rights to support work on the grid.
– **Ancillary Services.** Transpower as the Grid Owner also bears the cost of 'black start; capability and over-frequency reserves. These costs are allocated to Transpower, as the Grid Owner, in accord with the Electricity Industry Participation Code (2010) (the Code). Within the construct of the procurement and cost allocations specified by the Code, no options to avoid or mitigate the availability or event charges for these ancillary services are available to Transpower.

15.3 Overall Expenditure drivers

The AM&O forecast expenditure is largely driven by staff and consultancy costs. The opex for these functions is directly correlated to the magnitude of investment required to deliver the future works programme (opex, base capex as well as listed projects, major capital projects and customer works). As the programme increases so does the need to increase the related planning, delivery and operations activities.

There is a 29% increase in the base capex work programme and an expected 200 plus percentage increase in the Major Capital Project capex work programme between RCP3 and RCP4. To deliver on this uplift in the work programme Transpower needs to scale its planning and delivery capacity. Transpower has commenced ramping up its capacity in 2022/23 and plan to continue to increase capacity for the remainder of RCP3 and into RCP4.

The increase in opex is based on analysis of the historic trends in opex required to support the capital program, including adjustment for economies of scale, productivity, and efficiencies. It includes a forecast 28 percent increase in FTEs from 2022/23 to 2029/30 (the end of RCP4) as referred to in the Transpower workforce plan – internal resource needs report[320].

The work programme has been based on the strategic context established in Whakamana i Te Mauri Hiko – Empowering our Energy Future and the five key strategic priorities outlined in the Transmission Tomorrow report[321]. The AM&O portfolio specifically supports the following five strategic priorities:

– Enhance Transpower's social licence to operate
– Deliver services that meet Transpower's customers' needs
– Facilitate delivery of an optimised transition path for New Zealand energy system
– Accelerate electrification through Transpower's asset investments
– Advance Transpower's organisational effectiveness.

The AM&O portfolio supports the delivery against these priorities by:

– Supporting the improvement in health and safety practices company wide.
– Delivering asset management improvement initiatives.
– Providing short- and long-term asset works plans, delivery of those plans, and procurement for delivery.
– Providing reporting, analysis, and asset management support to enable an efficient and effective transmission service.
– Developing and maintaining design standards, standard designs, and service specifications.

[320] Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf
[321] Transpower, COR002 Transmission Tomorrow 2023.pdf

– Supporting the effective management of environmental requirements.
– Supporting the effective management of stakeholder relationships.

15.3.1 Division level driver - Grid Development

The Grid Development team focuses two to three years ahead of the capex work programme to investigate solutions, plan grid expansions, consult with stakeholders and where required seek regulatory approvals for expenditure. A longer lead time is required for larger grid development projects such as Net Zero Grid Pathways 2 (NZGP2) which may take 10 years to deliver. The key drivers for Grid Development workforce growth are:

– Growth in base capex and associated system studies, project investigations and supporting asset modelling, and asset strategies;
– A forecast major capital project and listed project work programme of approximately $1 billion across RCP4. These projects have an impact on workload on the System Planning and Investment and Tactical groups.
– A forecast $500m in customer connections and regional development grid projects impacting system planning and investment and tactical noting that the capital cost of customer funded customer connections is separately funded.

The following table outlines the resource growth for the Grid Development team.

Table 15-3 Grid Development resource growth

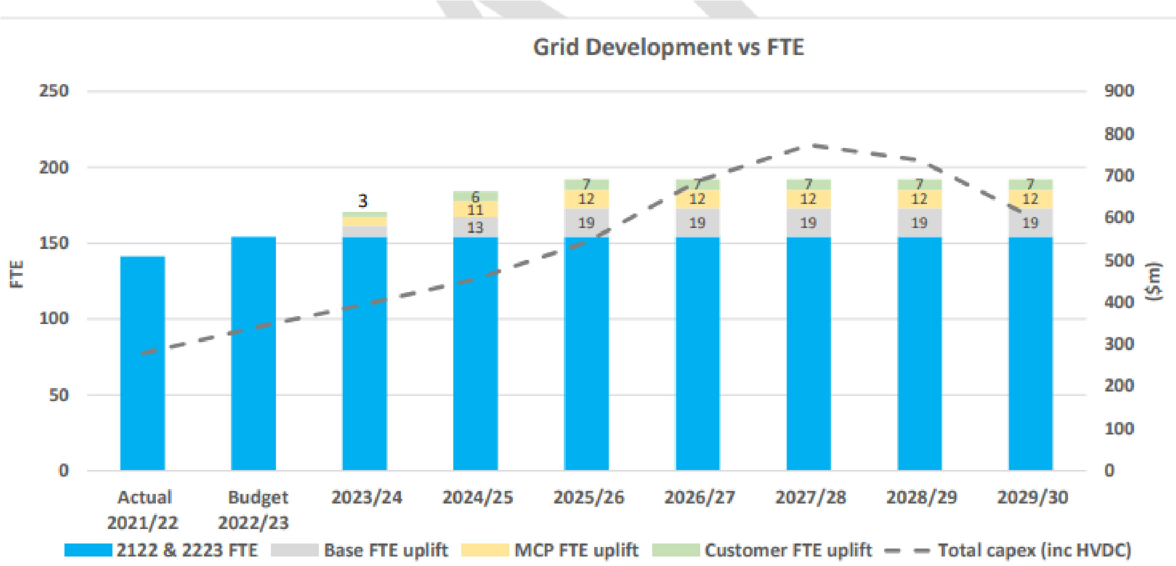
Area	Additional FTEs	Capability
System planning & grid investment	14	7 FTEs Grid Modelling and Investment 7 FTEs System Planning
Asset Planning	8	3 FTEs Lines Asset Planners 3 FTEs Substations Asset Planners 2 FTEs secondary Asset Planners
Tactical Engineering	12	6 FTEs Substation Engineering 2 FTEs Lines Engineering 2 FTEs Protection Engineering 2 FTEs Cost Engineering
Strategy performance and risk and asset information	4	4 FTEs Strategy performance and Risk and Asset information
Total	**38**	

Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The 38 additional FTEs are off a base of slightly less than 150 FTEs currently. The percentage of the cost of these FTEs that can be attributed to individual capex projects or customer projects is capitalized.

The following figure shows the phasing of the workforce capacity growth against the work programme. The figure also shows the approximate number of FTEs required by the growth in base capex, in major capital projects and in customer works. The nature of the work undertaken by the Grid Development division occurs before the capex associated with their work occurs. This requires Transpower to hire the additional FTE prior to the peak capex occurring in RCP4.

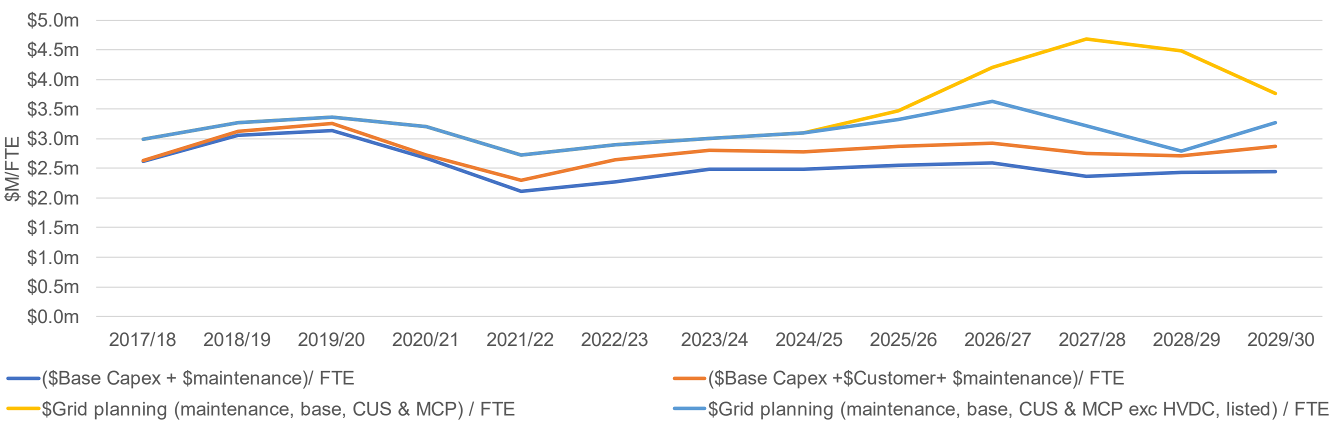
Figure 15-3 Grid Development work programme and workforce capacity



Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The following figure shows the level of programme outputs per FTE for Grid Development. This graph shows for all combinations of programme outputs whether base capex and maintenance or a wider programme that includes major capital projects and customer works the level of output measured in $m delivered / FTE improves across RCP4 compared to the 2021/22 base year. This indicates that the proposed increase in Grid Development FTEs is reasonable given the expected increase in the RCP4 programme.

Figure 15-4 Grid Development output ($m/FTE)



Source: Transpower, EOP009 FTE uplift summary Ratios

15.3.2 Division level driver - Grid Delivery

The Grid Delivery team is accountable for the delivery of the physical works associated with work programme. Therefore, there is a strong correlation between the workforce capacity and the total work programme expenditure. Grid Delivery has taken a flexible approach to resourcing; for example, scaling up to deliver the large lines project, Clutha Upper Waitaki Lines Project, and then scaling down at the end of the project.

The key drivers for growth are:

– The increase in base CAPEX and maintenance work;
– The increase in major capital project and customer work;
– Increasing focus on the centralisation of works planning and scheduling;
– Improved contract management to gain efficiencies and drive sustainability outcomes;
– increasing compliance expectations (including a 10-fold increase in Electricity code penalties).

The following table outlines the resource growth for the Grid Delivery team.

Table 15-4 Grid Delivery resource growth

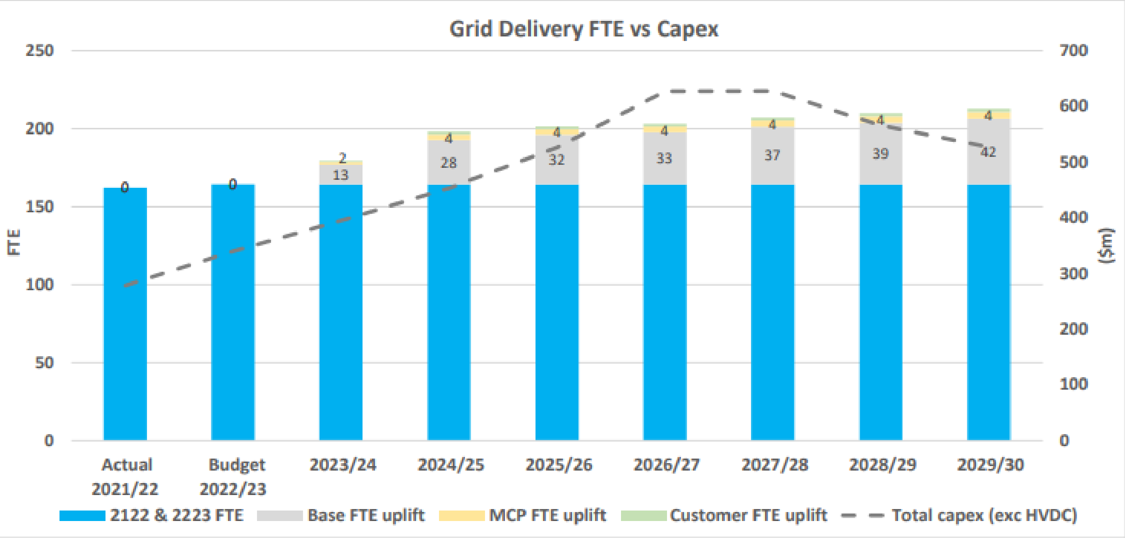
Area	Additional FTEs	Capability
Grid works planning	6	1 FTEs Planning and scheduling 2 FTEs Programme Managers 3 FTEs Schedulers
Regional Services Managers	6	3 FTEs Associate Service Delivery Managers 3 FTEs Office Coordinators
Grid Works Delivery	17	14 FTEs Grid work delivery 3 FTEs Grid works delivery – National Delivery Manager/ Investigations
Protection and Automation	6	6 FTEs Mix of HVDC & Protection Engineers
Project Management office	3	1 FTEs Resource/Scheduling lead 1 FTE Analyst 1 Grid skills application developer
Other	10	6 FTEs Project/Programme Coordinators 2 FTEs Business performance & planning 2 FTEs Service delivery quality assurance
Total	**48**	

Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The 48 additional FTEs are off a base of approximately 160 FTEs currently. The percentage of the cost of these FTEs that can be attributed to individual capex projects or customer projects is capitalized.

The following figure shows the phasing of the workforce capacity growth against the work programme. It also shows the approximate number of FTEs required by the growth in base capex, in major capital projects and in customer works. Grid Delivery recruitment is not required as early as Grid Development (hence the additional FTEs are added over a longer time period). However, there is still a lead time before the delivery of the capex to allow for upfront investigations and project management.

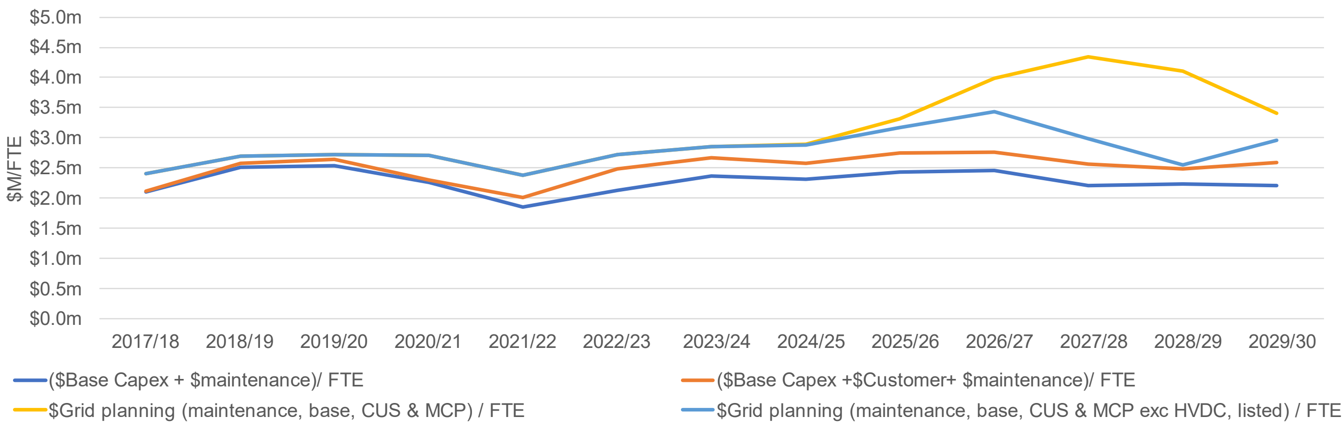
Figure 15-5 Grid delivery FTE and work programme



Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The following figure shows the level of programme outputs per FTE for Grid Delivery. This graph shows for all combinations of programme outputs whether base capex and maintenance or a wider programme that includes major capital projects and customer works the level of output measured in $m delivered / FTE improves across RCP4 compared to the 2021/22 base year. This indicates that the proposed increase in Grid Delivery FTEs is reasonable given the expected increase in the RCP4 programme.

Figure 15-6 Grid Delivery output ($m/FTE)



Source: Transpower, EOP009 FTE uplift summary Ratios

15.3.3 Division level driver - Operations

Operations are accountable for outage planning, asset availability, real time communication and coordination with customers and service providers and the System Operator before during and after planned and unplanned outages. The key drivers for growth are:

– The uplift in the work programme will require more planned outages.
– The increasing complexity of transmission technology. This requires an uplift in the capability of teams;
– Decreasing tolerance for service disruptions coupled with increasing tight supply have created increasing demands for the Operations division.

The following table outlines the resource growth for the Operations team.

Table 15-5 Operations resource growth

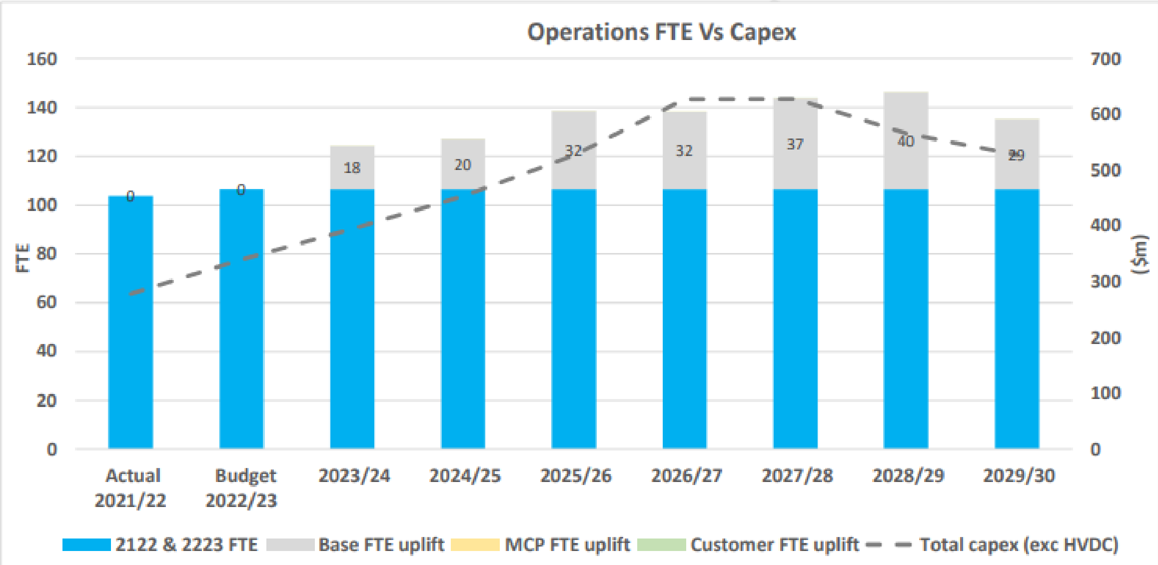
Area	Additional FTEs	Capability
Grid and System Operations	25	25 FTE Grid Asset Controller
Operations Process and Technical Improvement	3	2 FTE Operator tool specialists (1 TBC)
Operations Planning	6	3 FTE Operations Planning Engineer 3 FTE Outage Planners
Real time systems	6	6 FTEs Mix of HVDC & Protection Engineers
Total	**40**	

Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The 40 additional FTEs are off a base of approximately 100 FTEs currently. The percentage of the cost of these FTEs that can be attributed to individual capex projects or customer projects is capitalized.

The following figure shows the phasing of the workforce capacity growth against the work programme. It also shows the approximate number of FTEs required by the growth in base capex, in major capital projects and in customer works. Operations recruitment is not required as early as Grid Development or Delivery (hence the additional FTEs are added over a longer time period). In addition, the total number of additional Operations FTEs is forecast to drop by the end of RCP4 (from 40 to 29) reflecting expected efficiency improvements because of the Digital Switch Management initiative. This is one of the methods Transpower is intending to use to meet its 0.5% productivity improvement in opex.

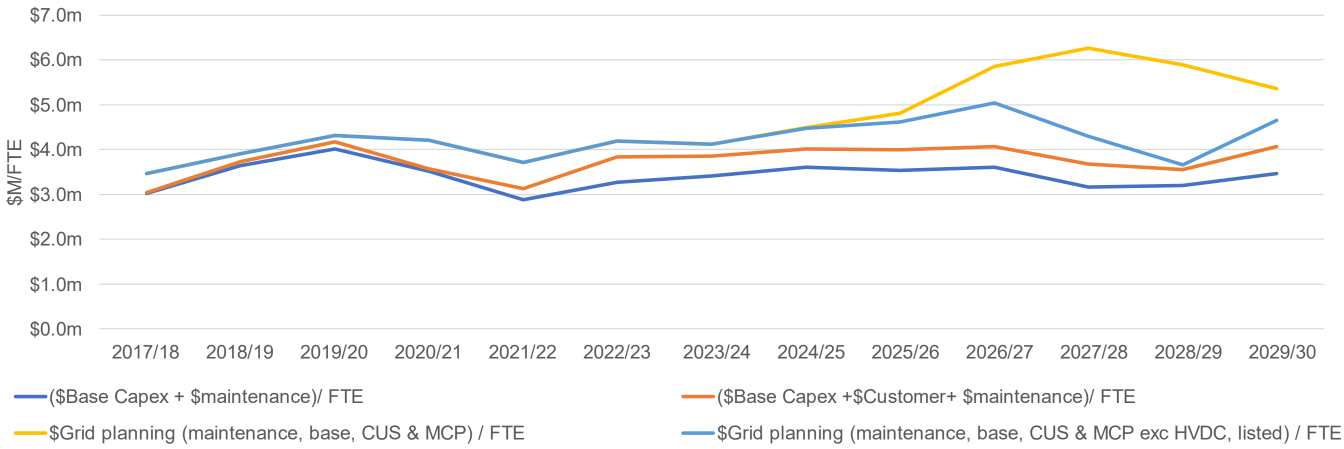
Figure 15-7 Grid operations workforce capacity profile



Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The following figure shows the level of programme outputs per FTE for Operations. This graph shows for all combinations of programme outputs whether base capex and maintenance or a wider programme that the level of output measured in $m / FTE improves across RCP4 compared to the 2021/22 base year. This indicates that the proposed increase in Operations FTEs is reasonable given the expected increase in the RCP4 programme.

Figure 15-8 Operations output ($m/FTE)



Source: Transpower, EOP009 FTE uplift summary Ratios

15.3.4 Division level driver - Environment, Landowner Relations and Property, and Procurement and Supply

Transpower has classified the Environment, Landowner Relations and Property, and Procurement and Supply functions as part of the AM&O category, as the drivers for growth of these functions are more aligned with the factors that drive grow in the other AM&O areas. The key drivers for growth for these functions are:

- The increase in the work programme resulting in the need for environmental approvals, landowner access and property rights negotiations. The increase in major capital projects and customer connections will also require more complicated property right negotiations and environmental approval requirements.
- The introduction of significant changes to current Resource Management laws in the form of the Natural and Built Environment and Spatial Planning Bills necessitating development of new approaches to the new legislative requirements. These new statutes place a significantly greater requirement on engagement requiring more resources. The transition phase is anticipated to be 7-10 years from late 2023.
- The increased work programme creates an increased workload for Procurement and Supply (P&S) team in terms of supply planning, procurement and contracting, commercial and category management, and warehouse movements.
- As the portfolio of projects become larger (and more complex) there will be increased complexity on the Transpower supply chain as well as need for improved resilience. To address this increased complexity Procurement and Supply requires additional resources and an improved technology platform.

The following table shows the breakdown of workforce capacity growth.

Table 15-6 Environment, landowner relations and procurement and supply resource growth

Area	Additional FTEs	Capability
Environmental and land access	5.5	2 FTE Landowner Relations Advisors 3 FTE Environmental Planners 0.5 FTE Property Services Advisor
Procurement and supply	15	3 FTE Inventory management 8 FTE Purchasing and Category management 4 FTE Warehousing 1 FTE Strategic Programmes Manager for a two-year fixed term (not included in Additional FTE total)
Total	**20.5**	

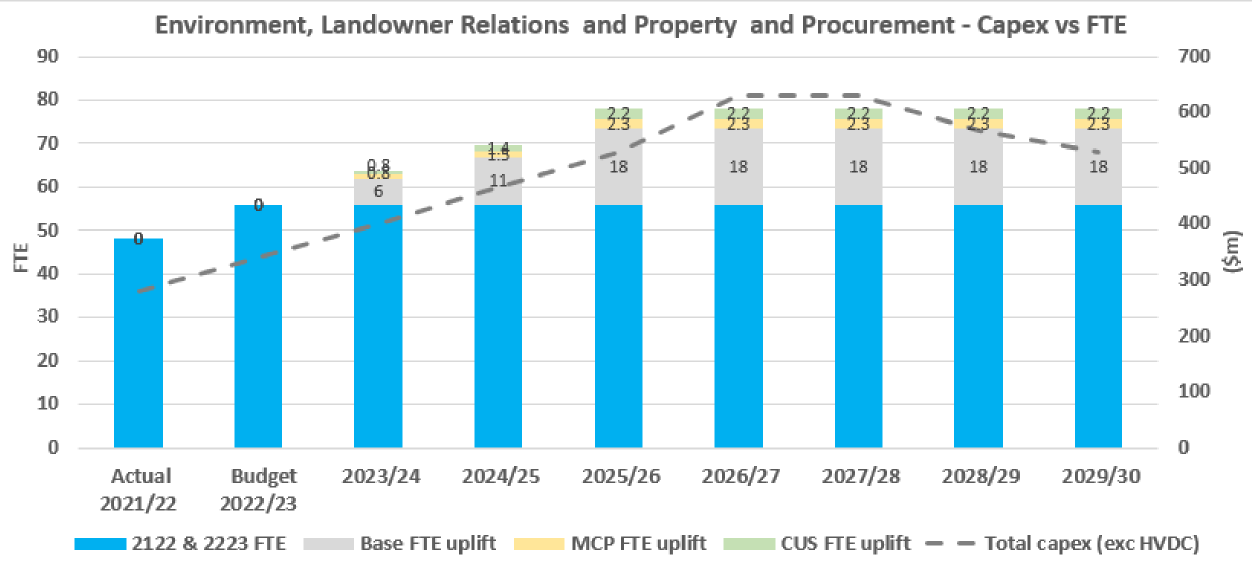
Source: Transpower, DEL005 Transpower Workforce Plan - internal resource needs V2.pdf

The 20 additional FTEs are off a base of approximately 60 FTEs currently. The percentage of the cost of these FTEs that can be attributed to individual capex projects or customer projects is capitalized.

The percentage increase in FTEs (approximately 33%) is larger than the 29% increase in base capex between RCP3 and RCP4 although it is significantly smaller when compared to a doubling of the overall forecast capex (base, major capital projects and customer works) reflecting the greater efficiency that occurs when those costs are spread over a larger programme. This indicates that the proposed increase in FTEs is reasonable given the expected increase in the RCP4 work programme.

The following figure shows the phasing of the workforce capacity growth against the work programme. It also shows the approximate number of FTEs required by the growth in base capex, in major capital projects and in customer works. Recruitment is not required before the capex associated with their work occurs. This requires Transpower to hire the additional FTE prior to the peak capex occurring in RCP4.

Figure 15-9 Environment, Landowner Relations, Property and Procurement workforce capacity profile



Source: Transpower, response to IV request to provide additional chart not present in the workforce plan

We note that the additional FTEs shown in the figure above exceed the additional FTEs proposed in the work force plan (22 vs 20.5). The 22 FTEs does however align with the information provided in the AM&O opex overview[322]. On the basis of proportionate scrutiny, we have not sought to reconcile this minor difference which accounts for less than 2% of the total increase in AM&O FTEs.

15.4 Development of the expenditure forecast

The AM&O opex forecast was developed using the base-step-trend approach which is the same approach used to develop the RCP3 forecast. The overall AM&O forecast of $409m is shown in the following table consisting of the base FY21/22 amount, a step change (mainly additional FTEs) and trend reduction due to productivity improvements.

Table 15-7 AM&O opex forecast by base, step and trend

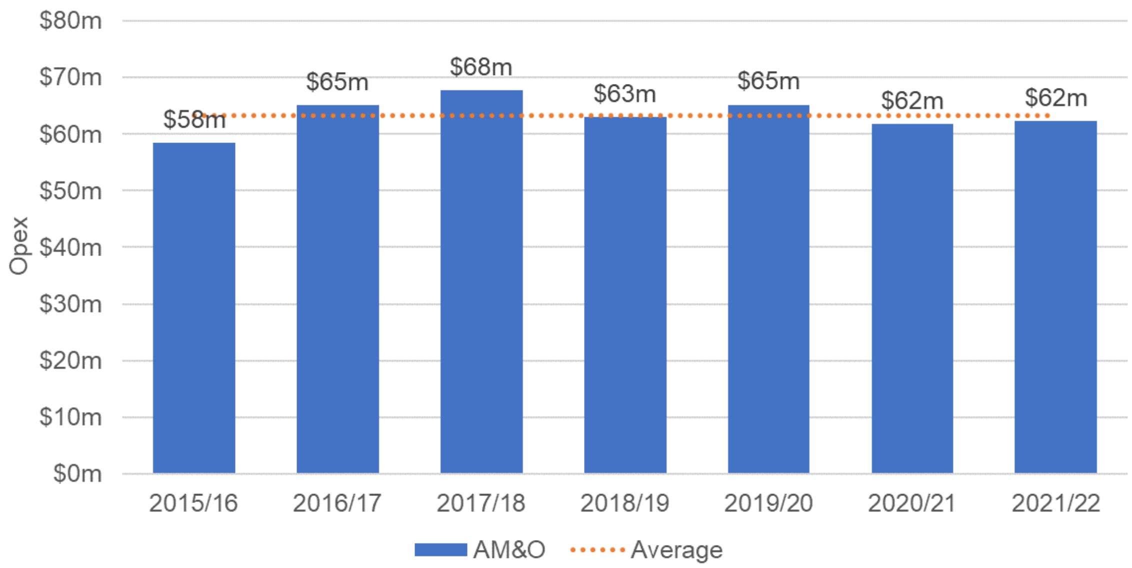
	Description	Expenditure
Base	FY21/22 is an appropriate base year after adjusting for atypical costs.	$311m
Steps	Increasing work plan and decarbonisation of the electricity sector requires additional FTE, supervision capacity and investigations.	$105m
Trend	Productivity improvement trend factor.	-$7m
	Total	**$409m**

[322] Transpower, EOP008 Asset Management & Operations Opex Overview RCP4.pdf

15.4.1 Base year

The starting point for the base-step-trend forecast is to identify an appropriate base year that broadly reflects the future network requirements (before any other steps), and then adjusting that amount for any atypical costs incurred or typical annual costs not incurred in that year. To assess the appropriateness of 2021/22 as a base year Transpower undertook a historical trend analysis and reviewed whether 2021/22 includes any atypical expenditure items. AM&O expenditure from 2017/18 to 2021/22 is shown in the following figure.

Figure 15-10 Historic and forecast AM&O opex by year



Source: Transpower, EOP008 Asset Management and Operations Opex

Based on the historical trend, the 2021/22 actual expenditure of $62.3m is materially consistent with the average of $64m (for the period between 2017/18 and 2021/22) and this was the basis for Transpower using it as their starting point. It was adjusted for any non-recurring AM&O opex items. The most obvious abnormal items were:

– Travel - COVID-19 significantly restricted travel.
– Leave – annual leave balances remained unusually high in 2021/22.

Transpower assessed that the 2021/22 opex of $62m is sufficiently representative of recent historical expenditure and is expected to be relatively typical of their requirements during RCP4. We agree with this assessment that the base year with the adjustments is considered representative.

15.4.2 Step changes

In addition to the recurring work reflected in the base amount, Transpower have identified three step changes necessary for RCP4 AM&O opex (although some of these costs began in RCP3). These step changes are set out in the following table.

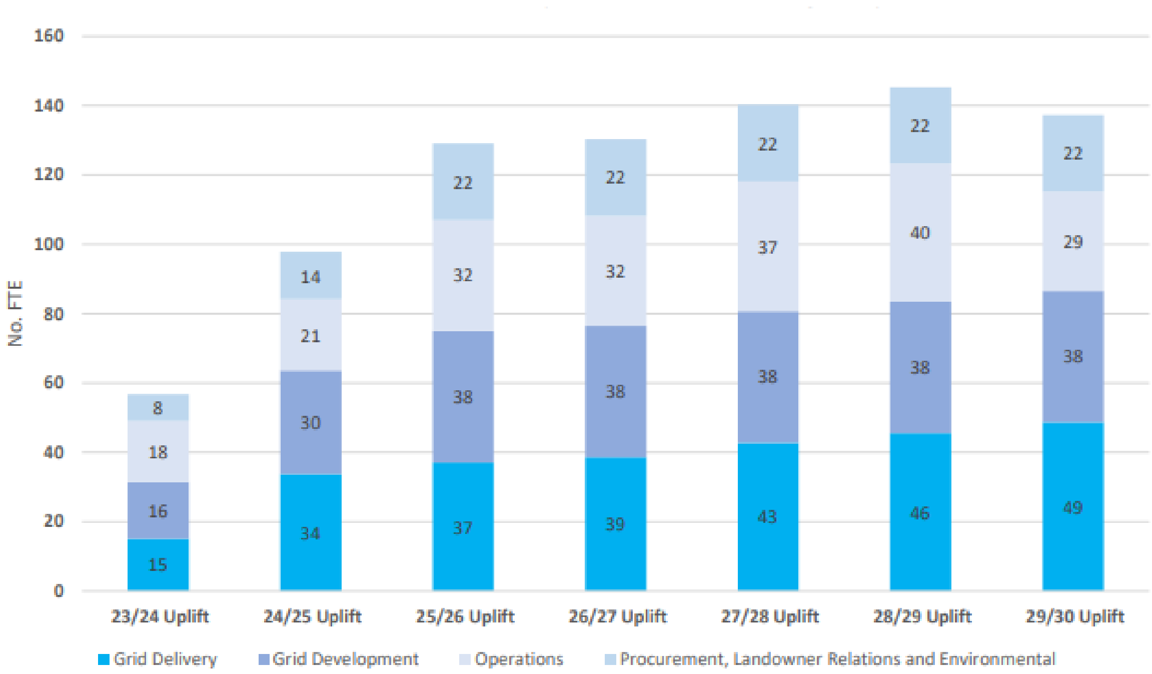
Table 15-8 AM&O step changes

Step changes	Description	Expenditure
Internal resources	Opex associated with the FTE increase required to deliver the increasing base capex and major capital project work programme over RCP4[323]. – FTE uplift 2022/23 $13.1 – FTE uplift 2023/24 onwards $66.8m	$80m
Resource Building (external)	Supporting Service Provider workforce growth	$18m
Investigations	capex investigations for major capital project, Base, resilience & sustainability	$7m
	Total	**$105m**

Source: Transpower, EOP008 Asset Management and Operations Opex Overview, page 9

The $80m step change in internal resources costs is driven by FTE growth (as outlined in the section above on drivers) which is illustrated in the figures below which shows the additional FTEs from 2023/24 to the end of RCP4 as well the longer trend in AM&O growth since the RCP3 submission.

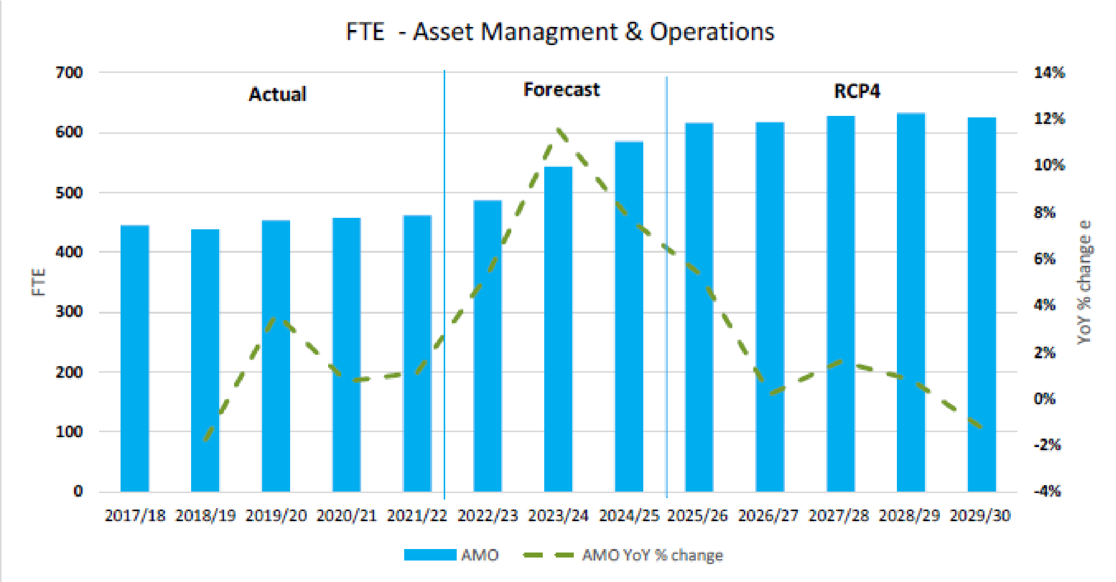
Figure 15-11 AM&O – FTE and Contractors (steps from 2022/23 budget by divisions)



Source: Transpower, EOP008 Asset Management and Operations Opex Overview, page 10.

[323] This includes the permanent step change in FTE resource included in the 22/23 budget

Figure 15-12 AM&O FTEs – historical and forecast profile



Source: Transpower, EOP008 Asset Management and Operations Opex Overview, page 11.

The growth in workforce capacity was relatively flat in the initial period of RCP3. However, in the 2022/23 budget Transpower added 25 FTEs to increase the capacity in project management, key engineering operations, and procurement and supply areas to enable delivery of the work programme. This increase adds $2.6m per annum to RCP3 and RCP4 costs.

The following table shows the workforce capacity growth, forecast resource capitalisation, and opex uplift from the budgeted 2022/23 through to the end of RCP4. Note, this is in addition to the $2.6m per annum included in the 2022/23 budget (a total of $13.1m over RCP4).

Table 15-9 AM&O workforce capacity

	23/24	24/25	25/26	26/27	27/28	28/29	29/30	Total RCP4	Aver. RCP4
Additional FTEs	55	98	130	131	141	146	138		138
Total additional cost	$4.3m	$11.2m	$15.8m	$17.4m	$18.7m	$19.3m	$18.2m	**$89.4m**	$17.9m
Capitalisation rate	32.%	37%	32%	32%	32%	32%	34%		32%
Additional opex	$2.7m	$7.1m	$10.4m	$11.8m	$12.7m	$13.2m	$12.2m	**$60.4m**	$12.1m
Additional other employee costs	$0.3m	$0.7m	$1.1m	$1.3m	$1.3m	$1.4m	$1.4m	**$6.4m**	$1.4m
Total additional AM&O opex	**$3.0m**	**$7.8m**	**$11.5m**	**$13.1m**	**$14m**	**$14.6m**	**$13.6m**	**$66.8m**	**$13.4m**

Source: Transpower, EOP008 Asset Management and Operations Opex Overview, page 11.

The growth in Transpower's RCP4 work programme significantly impacts their service providers. Transpower have modelled the increase in the capacity required to deliver the work programme. Transpower's opinion is that substantial (greater than 5 percent per annum) growth will be challenging without a step change in approach. This step change includes a greater focus on both offshore recruitment and increasing trainee numbers.

Transpower is currently working with their service providers to define a commercially robust model to support the uplift in the number of Service Provider trainees and the (consequential) growth in supervisors for trainees. These initiatives (trainees and trainee supervision) will commence in RCP3, and the costs have been included in Transpower's business planning and budgeting processes for 2023/24 and 2024/25. The following table outlines the two initiatives to support the growth in the number of trainees.

Table 15-10 Initiatives to enable service provider growth

Description	Purpose	RCP4 opex
Funding service provider uplift in capacity	The volume of work forecast in RCP4 drives an increase in Service Provider capacity. A significant proportion of the uplift will be provided through in an uplift in trainees. Transpower are working with the service providers to co-design a plan to enable this uplift. The forecast costs for this workstream are based on an estimate of the number of trainees by each type of trade. This initiative starts in RCP3 with $5.6 m budgeted. The cost covers the time that the additional trainees (above the current level) spend in training and developing their skills that is not chargeable on Transpower works until they finish their traineeship.	$15m
Supervision capacity and productivity	There will be an increased proportion of trainees in the workforce, which will put pressure on the current trainee supervision model. The purpose of this workstream is to co-design a workable model with Service Provider partners to account for the increased supervision requirement and enable retention of key staff. The costs in this workstream support an uplift in supervisor numbers and/or an uplift in the pay-scale for a supervisor. This uplift would work in a similar manner to the above step, covering the expected additional supervision cost of the additional trainees.	$3m

Source: Transpower, EOP008 Asset Management and Operations Opex Overview

The final proposed step change is the forecast growth in opex for investigations is forecast to increase by $7m over RCP4. This includes:

– Pre-major capital project investigations $0.5m per annum, due to the increasing number of investigations that are required to enable electrification and decarbonisation.

– Sustainability investigation uplift of $0.3m per annum for initiatives that are not funded under other cost categories.

– ICT investments related to transmission systems which are forecast to increase by $1m per annum.

The step changes are considered reasonable and prudent given the forecast growth in the RCP4 programmes. However, it should be noted that Transpower is currently still developing its trainee approach with its service providers. It would be beneficial for Transpower to provide an update on the model once if the costs or level of trainee uplift is expected to vary from Transpower’s current forecast.

15.4.3 Trend

Transpower have applied a productivity adjustment to reflect expected on going productivity improvements. The assumed rate is an annual improvement of 0.5 percent in productivity based on independent advice, from NZIER, using historical changes in New Zealand’s labour productivity in industries undertaking similar activities as Transpower. The adjustment for productivity improvements reduces Transpower’s RCP4 opex forecast by $7m.

The AM&O Opex Overview does not outline any specific initiatives to achieve the proposed productivity improvements. However, the Workforce Plan – Internal resource needs document does refer to the Digital Switch Management initiative which is forecast to reduce operation personnel in the final year of RCP4. In addition, in conversations with Transpower SMEs they have also made reference to streamlining the customer enquiry process to improve the efficiency of Transpower’s investigations before these projects reach the point at which they become customer funded.

It would be beneficial if Transpower provided greater detail around how they intend to achieve the productivity improvement apart from the Digital Switch Management initiative.

15.5 Evaluation

To assess whether Transpower's opex proposal for this asset portfolio was prudent and reasonable, we followed the evaluation criteria and employed the evaluation methods described in Section 13.2 as applicable. This involved reviewing the provided AM&O overview and strategy documentation, the workforce plan and deliverability plan and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and supporting model, framework and decisions that informed the AM&O opex proposal.

This opex programme is essentially an internal resource volumetric programme based on the number of FTEs needed to perform asset management and operations functions. The RCP4 proposed budget as outlined above was developed by determining the bottom-up number of FTEs needed in each division to resource the needs of that division. Transpower have taken the base FTE levels and used the bottom-up approach of additional FTEs to provide the steps and trends to arrive at the final forecast number of FTEs. We also examined the appropriateness of the service provider trainee and supervision uplift initiatives.

We examined the prudency of the approach and whether Transpower is able to demonstrate the extent of additional FTEs required.

15.5.1 Prudency

We commenced our analysis by considering whether the approach used by Transpower to determine the resource requirements for AM&O is prudent. Transpower developed a workforce planning model ("WFP Model") to forecast the organisational workforce needs into the future based on predicted volumes of network capex (including major capital projects and customer driven work), ICT work programmes and any other activities. A governance group reviewed the model and despite several iterations there were some areas where there was an over estimation of FTEs needed. As a result, Transpower undertook a bottom-up review of requirements which was used as the basis for most of the forecasts for AM&O areas. This revised forecast was tested by a general manager challenge and review process. This approach demonstrates a mature approach in terms of review and challenging forecasts and model outputs. In addition, the combination of a top-down approach compared to a bottom-up build by division managers increases the likelihood that Transpower forecast is reasonable and prudent.

We also reviewed the descriptions of additional FTEs that Transpower is proposing for each part of each division. The role descriptions such as grid modelling and investment and system planning for Grid Development, Planning and Scheduling and Delivery Managers for Grid Delivery and Grid Asset Controller and Real Time Systems Engineer for Operations are reasonable and consistent with the role descriptions of roles from other TNSPs. We also considered the timing of additional FTEs where Transpower has a logical approach of recruiting Grid Development and some Land and Environmental roles further ahead of the associated Grid Delivery and Operations roles because of the lead times needed. We consider this to be a prudent approach.

We compared the rationale for the additional FTEs and expenditure in the AM&O Opex Overview document with the Workforce Plan – internal resource needs and the Deliverability Overview report. The drivers, justification and additional FTE demand is consistent across these three documents. The key challenge with the additional FTEs required will be the ability of Transpower to recruit them within the required timeframe which is discussed in the Deliverability section of this report.

In addition to the forecast FTE growth to deliver the various programmes during RCP4 we also examined the step changes for resource building for eternal service providers. Transpower's service providers will be required to ramp their field-based capacity in several areas to deliver the expected programmes in RCP4. To address the increase needed in specialised field labour Transpower is assisting service providers with the funding of the non-chargeable time that trainees spend on training and development during their traineeship. This will cover the additional level of trainees needed above the current level. Transpower in conjunction with their service providers have determined the trade types, length of traineeship and the volumes of additional trainees needed. Due to the specialised nature of the work undertaken it is unlikely that the service providers will be able to recruit from other sectors without the need for retraining or developing trainees from school leavers. This is an additional cost that Transpower will bear, however given the challenge that TNSPs like Transpower are facing with retention and recruitment (given competition from renewables and the resources sectors in particular) we consider that on balance this is probably a necessary expenditure to reduce the risk that service providers will have sufficient resources to deliver the expected programmes of work in the required timeframe.

We did not find any instance of double counting of expenditure between this portfolio and Business Support expenditure. In addition, the component of the time that FTEs undertake on specific major capital projects, or customer funded works are capitalised, and the costs associated with their time is not included in the AM&O opex forecast.

Finally, the required increase in AM&O opex is driven by the growth in the capex programme. The prudency of that programme is assessed in the capex sections of this report.

15.5.2 Efficiency

The primary driver for AM&O is the ability to deliver the growth in the various RCP4 programmes rather than greater efficiency of AM&O resources. However, this is a prudent approach it is still necessary to review whether the AM&O expenditure is also efficient. We have reviewed this from three aspects:

– Trend analysis to determine if the FTE increase is appropriately proportional to the level of work required to deliver the expected programme
– Whether the base is representative and the step increases are reasonable
– Whether Transpower have considered efficiency improvements which have been applied to AM&O expenditure.

The trend analysis as outlined in the discussion on drivers above indicates that the programme output / FTE (measured as $m delivered / FTE) improves as the work programme grows across the remainder of RCP3 and across RCP4. This means that although Transpower is growing its FTEs in AM&O in RCP4 each FTE will contribute to a greater level of delivery thus improving the efficiency of the AM&O team when measured at a macro level. This is true both when considering the delivery of just the maintenance and base capex programme as well as the larger totex programme including major capital projects and customer works. The trend analysis also indicates that the output per FTE is approximately similar to the level at the time of their RCP3 submission.

We have analysed the components of the base, step and trend that Transpower used to develop its RCP4 forecast which is the same technique they utilised for their RCP3 submission. The base year expenditure when considering historic expenditure analysis of the previous five years and after making allowances for adjustments is considered reasonable. The step changes for FTE growth are considered efficient based on trend analysis outlined above. Transpower have developed a detailed cost breakdown of the trainee and supervision uplift costs based on the number of each type of trainee, the length of the traineeship, average trainee costs for each type and the percentage of each needed for training and development. The trainee step changes are considered reasonable given the growth in the RCP4 programme and range of initiatives Transpower is undertaking.

Transpower have applied a productivity factor of 0.5% across each year of the RCP4 programme. We have reviewed the appropriateness of this factor in the Productivity section of this report. The documentation sighted does not provide specific information on how this productivity improvement would be achieved. The only example provided is the forecast reduction in additional Operations FTEs in the final year of RCP4 because of the Digital Switch Management initiative. It would be beneficial if Transpower provided greater detail around how they intend to achieve the productivity improvement apart from this initiative.

15.6 Conclusion

We conclude that the proposed AM&O opex totalling $408.9m satisfies the evaluation criteria in the ToR and our assessment is that the proposal is prudent and efficient and therefore reflects GEIP.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 15-11 Evaluation summary of proposed predictive maintenance opex

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
All opex categories			
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	Expenditure is consistent with drivers to grow FTE capability in line with Transpower delivery requirements especially for the capex programme and investigations for major capital projects, customer connections and other expected expenditure.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Yes	Methods which utilised a combination of a top-down and a bottom-up approach based mainly on FTE growth requirements is considered reasonable. Very strong relationship between AM&O forecast opex and capital programmes is reasonable.
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	The only opex reduction referenced is the Digital Switch Management programme which is considered reasonable.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	There were no specific efficiency initiatives outlined in the AM&O Opex Overview document. However, the new grid service contracting arrangements that streamline service provider interfaces should improve AM&O efficiency.
Identified programmes only			
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	Yes	The AM&O Opex Overview document as well as the Workforce Planning documentation outlines the investment need and key drivers. The AM&O expenditure programme is derived from the forecast opex and capex programmes which are risk-based approaches. The main risk that the AM&O programme addresses is the deliverability of a larger programme in RCP4.
A3(b)	Policies and planning standards were applied appropriately	Yes	The AM&O Opex Overview is reasonably aligned with relevant Transpower documentation such as the Workforce Deliverability Planning, Transpower Workforce Plan – internal resource needs and People Strategy documentation.
A3(c)	Transpower's process is reasonable and cost effective	Yes	As outlined above Transpower's process for developing its RCP4 submission is considered prudent and efficient. The process is considered cost-effective by comparison to historical performance.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower have undertaken a formal challenge process as outline above. This is considered a prudent and reasonable approach.
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Yes	We did not find any instance of double counting between this proposed opex and other portfolios such as Business Support Opex. The AM&O expenditure is a derivative of the size of the capital programme.
A3(i)	Programme is appropriately linked with other projects or programmes	Yes	The very strong relationship between AM&O forecast opex and capital programmes is expected given the role of AM&O in enabling the delivery of the capex programme.
A3(j)	Proposed approach to procurement of associated goods and services	Yes	The proposed procurement approach where external resources are required is through the GSC or engineering

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
			consulting panels which is consistent with Transpower's procurement strategy, internal workforce strategy and contracted services strategy.

Note: A3(e), A3(f) and A3(g) are not applicable to opex proposal categories.

16. ICT opex

The following table summarises our verification of Transpower's proposed ICT opex requirement for RCP4. ICT opex is an identified expenditure programme.

Table 16-1 Verification summary of Transpower's ICT opex

Verification element	Verification finding
RCP4 proposed amount	$275.8m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $275.8m
Potential scope for improvement	None identified
Key issues that Commission should focus on	Outsourced Services and Licences trends are predominantly driven by an increasing number of FTEs and/or contractors. If the FTEs and Contractors are not realised, then the ICT opex needs to be scaled back proportionally for these opex categories.

16.1 Overview of ICT opex

ICT opex covers the operating expenditure related to all non-business support related costs required to run ICT functions. This typically includes:

- The cost of leases associated with ICT (for example rented fibre networks for telecommunications).
- The cost of specialist third party services (such as offsite backups or third-party infrastructure support services).
- The cost of outsourcing services to specialist providers.
- The cost of software and hardware licences.
- Third party costs associated with the TransGo network.
- The costs for investigations to explore possible solutions to deliver business outcomes.
- The costs associated with Software as a Service (SaaS).

The workforce cost (and associated overheads) associated with delivering ICT services is captured and reported as business support opex and is discussed in Section 12 of this report.

As noted in at the beginning of this section, SaaS is becoming a more common platform for the provision of software across many businesses and industries where users subscribe to the software instead of buying it. The Financial Reporting Standards (IFRS) Interpretations Committee (IFRIC) published a decision[324] in March 2021 on how entities are to account for the costs of configuring or customising a supplier's application in SaaS arrangements. The implication of this decision is that SaaS costs need to be expensed instead of capitalised. As of 2021/22, Transpower has re-categorised its reporting of SaaS expenditures. Prior to 2021/22 SaaS expenditures are reported as ICT capex. From 2021/22 onwards SaaS expenditures are reported as ICT opex.

For the purposes of this IV report and for the clarity of the reader:

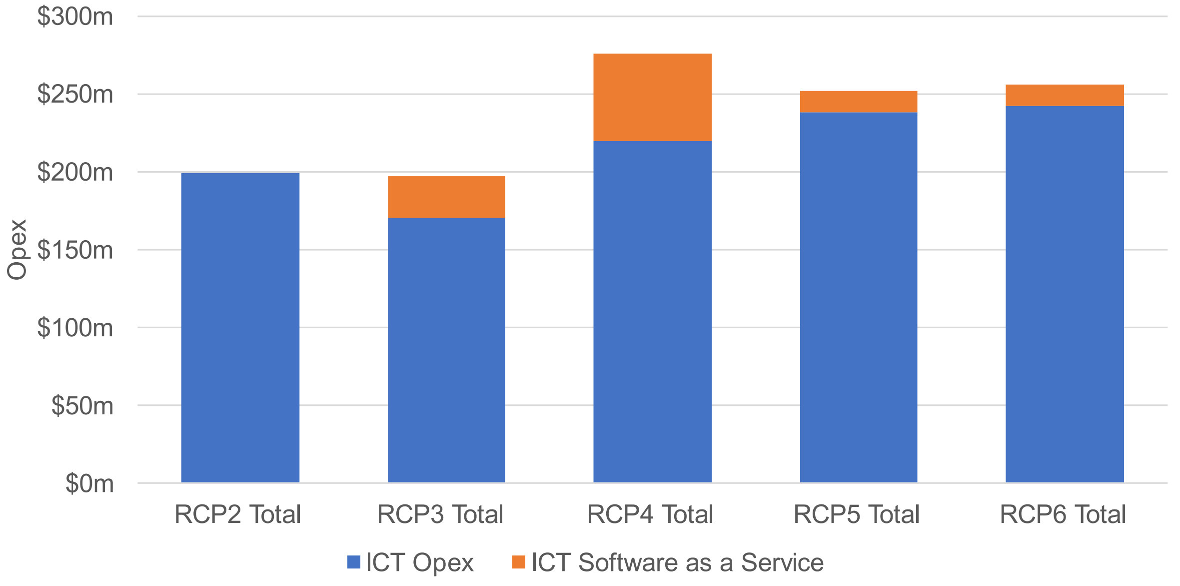
- when discussing ICT opex **including** SaaS expenditures, we refer to '**total ICT opex'**, and
- when discussing ICT opex **excluding** SaaS expenditures, we refer to '**underlying ICT opex'**.

[324] **https://www.ifrs.org/news-and-events/updates/ifric/2021/ifric-update-march-2021/**

16.2 Expenditure profile

The following figure presents the long-term cost profile of ICT opex from RCP2 to RCP6. The figure separately identifies underlying ICT opex and SaaS expenditures.

Figure 16-1 ICT opex long term expenditure profile



Source: Transpower, RT01 expenditure schedule.

Total ICT opex (i.e., costs including SaaS expenditures) is expected to increase significantly between RCP3 and RCP4. This is driven by significant increases in both underlying ICT opex and SaaS opex. Transpower is currently anticipating total ICT opex to reduce slightly in RCP5 in total, albeit remaining some 25% higher than RCP3 levels. The reduction is driven by an assumed reduction in SaaS costs from RCP5 onwards as underlying ICT costs are expected to continue to increase into RCP5, albeit at a slower rate than the increase from RCP3 to RCP4.

The following table presents the total expenditures in RCP3 and RCP4 broken down by underlying ICT opex and SaaS opex. Transpower is proposing an increase in total ICT opex of around 40%, although as RCP3 only includes four years of SaaS expenditure rather than five, the true overall increment is likely to be slightly lower.

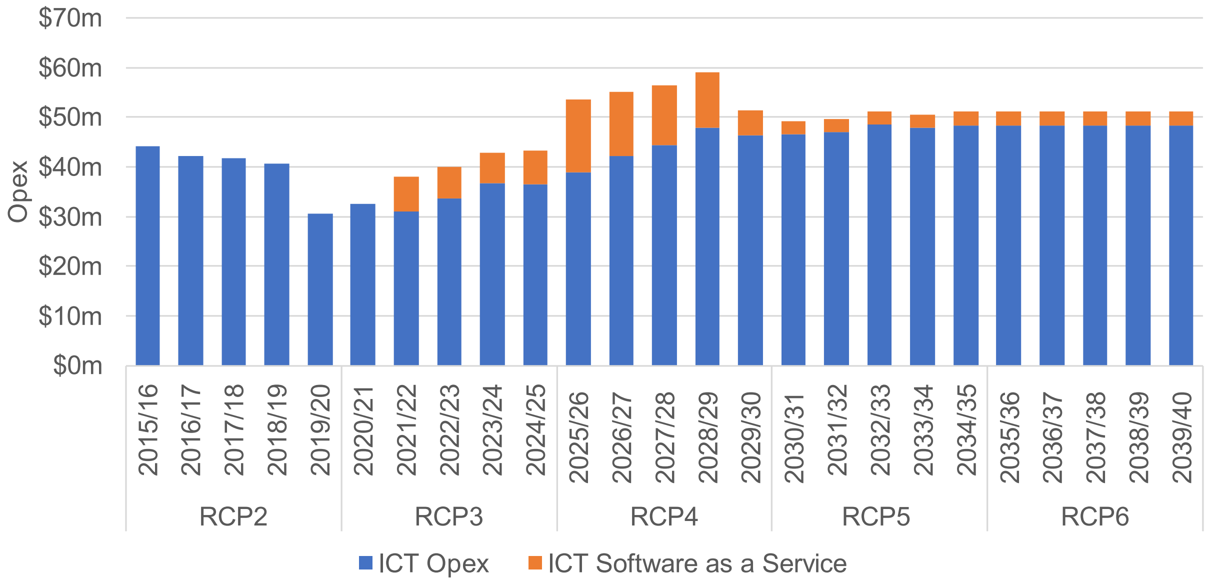
Table 16-2 Total ICT opex for RCP3 and RCP4

	RCP3	RCP4	Change (%)
(Underlying) ICT opex	$170.7m	$219.9m	28.9%
SaaS opex	$26.2m	$55.8m	112.9%
Total ICT opex	**$196.9m**	**$275.8m**	**40.1%**

Source: Transpower, RT01 expenditure schedule.

The annual ICT opex profile is shown in the following figure broken down by underlying ICT opex and SaaS.

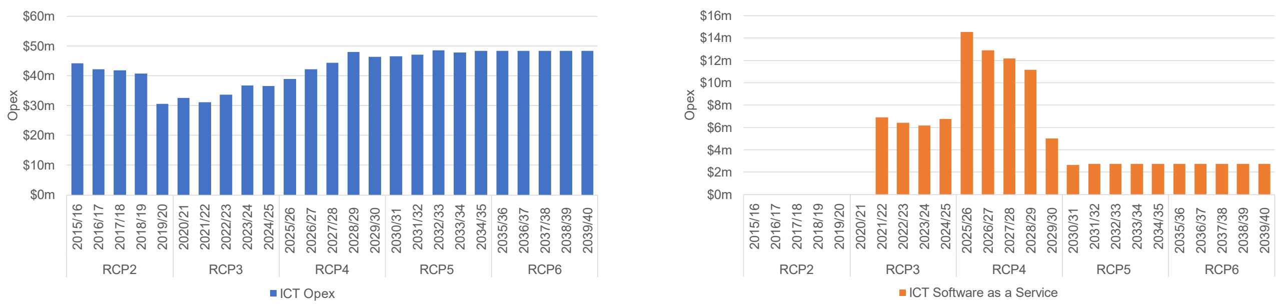
Figure 16-2 ICT opex long term annual expenditure profile ($m)



Source: RT01 expenditure schedule.

The following figure separates the two total ICT expenditure components onto separate charts where the expenditure profiles of each are more evident.

Figure 16-3 ICT opex and SaaS opex annual long term expenditure profile ($m)



Source: Transpower, RT01 expenditure schedule.

The figures highlight that underlying ICT opex dropped significantly in 2019/20. In 2019/20, leases that related to data centre racks and optic fibre connections were reclassified to be capitalised. This shifted the cost from opex to capex and the subsequent step reduction in opex visible in that year. Underlying ICT opex is forecast to gradually increase through the remainder of RCP3 and into RCP4, eventually levelling off in RCP5 at just under $50m per annum.

The introduction of SaaS as an opex element from 2021/22 is also evident in the figures, with annual costs in the region of $6-7m during the four years of RCP3 in which SaaS expenditures are identified as opex. Transpower is forecasting a large step increase in SaaS opex in the first year of RCP4, which slowly reduces over the following 3 years before stepping back down in the last year of RCP4. From RCP5 onwards, SaaS opex is expected to be between $2-3m per annum – significantly lower than early RCP4 period where per annum costs peaked at over $14m.

16.3 Expenditure drivers

As noted above, Transpower report ICT opex excluding all costs relating to people and their associated overheads. These costs are captured within business support opex.

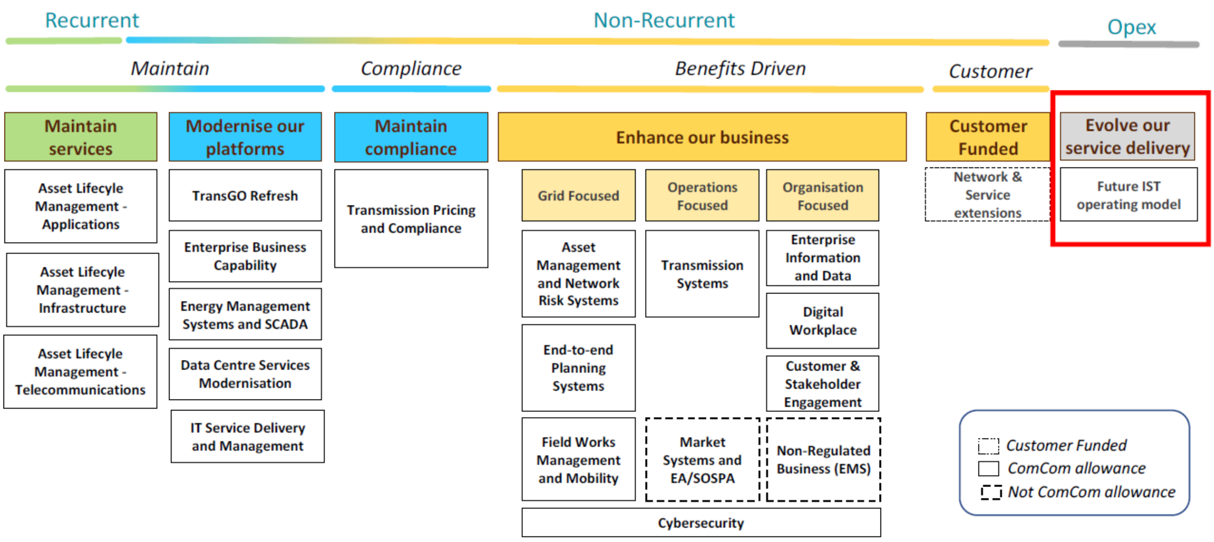
Transpower point to the following key drivers of ICT opex:

– An ongoing increase in the use of cloud services, as more applications are delivered via cloud-based SaaS (instead of on-premises).
– Additional license costs required for new capabilities and higher number of FTEs.
– An increased cost associated with the transition from the current "own and control" data centre approach towards adopting an "as a service" approach (driven by the Data Centre Services Modernisation (DCSM) sub-strategy).

The requirement for new ICT opex and new ICT capex is set in parallel through the ICT strategy and investment framework that is discussed in detail in Section 3 of this report.

The following figure shows all the ICT sub-strategies identified in the ICT strategy and asset lifecycle management strategies categorised by investment type. The proposed ICT opex requirement set out by Transpower is defined by the work programme set by the ICT sub-strategies and asset lifecycle management strategies. The area highlighted in red relates to ICT opex.

Figure 16-4 Strategy context for ICT opex



Source: EOP001 ICT opex Overview V0_3.pdf; Figure 1, page 5.

16.4 Development of the expenditure forecast

Transpower's ICT opex uses the base step trend approach. As with other opex categories where a base-step-trend approach is applied, Transpower has adopted 2021/22 as the base year. Transpower's choice of base year is discussed in more detail in Section 13.3 of this report.

Transpower has shared a detailed ICT opex overview document[325] which sets out the approach and assumptions applied by Transpower to determine the base year cost and all base year adjustments made, as well as the detailed steps and trends applied.

The base year expenditure and any adjustments, steps and trends applied to the base year expenditure are discussed below.

[325] Transpower, ICT PEX OVERVIEW.pdf, 24 February 2023, v0.3.

16.4.1 Base year expenditure and steps

Whilst the base year cost is considered on a total opex cost basis, the base year cost is identifiable by six categories within ICT opex, namely:

- Leases,
- Third party support and maintenance,
- ICT outsourced services,
- ICT licenses,
- Communications and control IST, and
- Invex

The steps and trends are specifically identified and applied to each of these categories individually.

It should be noted that a key component of the ICT strategy and investment framework and the subsequent identification of forward-looking ICT investment needs is the development of investment cases. Transpower has developed twelve ICT related investment cases covering the RCP3 and RCP4 period. Each investment case contains a forecast of future capex, opex, SaaS expenditure and invex requirements to deliver the recommended investments.

Whilst Section 11 of this report provides further discussion on the investment cases and their alignment to the RT01 expenditure schedule, the table below presents the identified ICT step opex, SaaS opex and total invex costs across the twelve investment cases. The total invex cost of $12.9m (and therefore the total opex of $112.2m) includes $7.0m of AM&O related invex and $5.9m of ICT invex.

Table 16-3 ICT opex, invex and SaaS identified from ICT investment cases for RCP4

	RCP4 Step ICT opex	RCP4 SaaS opex	RCP4 Invex1*	RCP4 Total opex[1]
IC01 – Maintain assets	$0.0m	$0.0m	$4.4m	$4.4m
IC02 – TransGo refresh	$3.0m	$0.0m	$0.2m	$3.2m
IC03 – BIM	$2.1m	$0.8m	$0.6m	$3.5m
IC04 – Transmission system	$1.5m	$0.0m	$0.9m	$2.4m
IC05 – DCSM	$20.0m	$1.4m	$2.2m	$23.6m
IC06 – Corporate IST	$2.2m	$32.1m	$1.5m	$35.8m
IC07 – Asset management	$0.5m	$7.5m	$1.6m	$9.6m
IC08 – Digital workplace	$2.9m	$0.6m	$0.1m	$3.6m
IC09 – Cyber security	$5.9m	$3.2m	$1.1m	$10.2m
IC10 – DA Analytics	$4.9m	$10.0m	$0.1m	$15m
IC11 – Digital switch management (DSM)	$0.0m	$0.0m	$0.3m	$0.3m
IC12 – IT Service, Delivery & Management (ITSM)	$0.4m	$0.3m	$0.1m	$0.8m
Total	**$43.5m**	**$55.8m**	**$12.9m**[1]	**$112.2m**[1]

Source: Transpower, IV recon RT01_IC.xlsx
Note: [1] value includes AM&O and ICT invex costs.

The step opex identified within the investment cases (as noted in the preceding table) are adopted within the step and trend changes applied within the base-step-trend approach. The (ICT related) invex projections identified within the investment cases are used to support the development of the investigations opex in a slightly different way (as we set out in Section 11 of this report).

The forecast of SaaS opex that is reported within Transpower's proposed total ICT opex, comes directly from the forecasts of SaaS expenditure set out in the investment cases.

In the following sections, we set out Transpower's proposed underlying ICT opex forecast for RCP4 using the base-step-trend approach in followed by the proposed RCP4 SaaS expenditure forecast.

16.5 'Underlying' ICT opex

The following table summarises Transpower's proposed underlying ICT opex requirement for RCP4.

Table 16-4 Transpower's RCP underlying ICT opex forecast by base step trend component

Component	Total
Base expenditure	$153.0m
RCP4 step changes	$61.9m
RCP4 trends	$10.1m
RCP4 productivity adjustments	-$4.0m
RCP4 opex	**$220.9m**

Source: EOP003ICT Opex Overview V0.3 Final.pdf, Table 2; page 7

The proposed underlying ICT opex for the RCP4 period in the ICT overview document is $220.9m. We note that this is $1.0m more than the amount proposed within the RT01 expenditure schedule (which was $219.9m was outlined at the start of this section of the report).

The assessment of Transpower's proposed RCP4 underlying ICT opex requirement in this report is based on the amount proposed in the RT01 expenditure schedule. Based on proportionate scrutiny, we have not sought to reconcile this minor difference which accounts for less than 0.5% of underlying ICT opex and less than 0.4% of Transpower's proposed total ICT opex requirement for RCP4. We understand that prior to its full submission, Transpower plans to update its base-step-trend calculations with the selection of a new base year following the availability of new full-year outturn cost data (2022/23). We suggest that Transpower ensure that all data presented in the final submission is clearly identifiably in all supporting documentation.

We understand that the difference of $1.0m arises in the estimation of the base year cost for 2021/22. The value of $219.9m is based on a base year cost of $30.4m whereas the base year cost that results in a proposed underlying ICT opex cost of $220.9m is based on a base year cost of $30.6m. Multiplying this difference over a period of five years (the duration of RCP4) results in a $1.0m difference. The step and trend elements set out in the overview document are not impacted.

Due to the detailed nature of the base-step-trend approach employed by Transpower (where the base year cost is established for each of the six opex categories and steps and trends applied separately to each category) we present Transpower's underlying ICT costs based on those set out in the ICT Overview document shared, noting the $1.0m discrepancy in the overall proposed RCP4 ICT opex forecast in our summary and verification.

In the following sections we set out the **base year cost** and steps and trends applied by each opex category, including:

– Leases,
– Third party support and maintenance,
– ICT outsourced services,
– ICT licenses,
– Communications and control IST, and
– Invex

Section 16.5.8 of this report summarises 'underlying' ICT opex amounts.

It should be noted where sub-totals and totals do not summate exactly, this is simply due to rounding as data is presented to one decimal place and in some cases is only provided by Transpower to one decimal place.

16.5.1 Base year cost

Transpower has adopted 2021/22 as the base year upon which the forecast of underlying ICT opex is developed. The choice of 2021/22 as the base year for ICT opex is consistent with other opex categories and its selection as an efficient and reasonable year is discussed in further detail in Section 13.3 of this report.

To summarise, the four main reasons why 2021/22 is chosen by Transpower as the base year are:

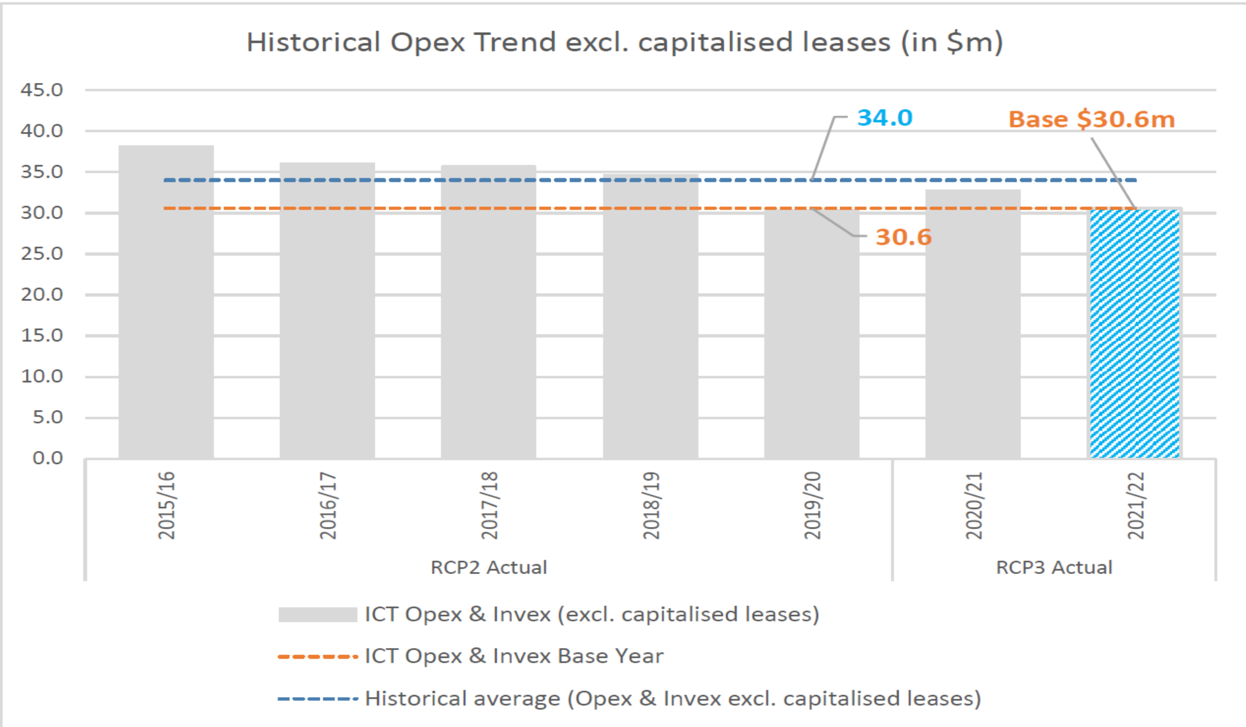
- **Use of actual costs and not estimated costs.** 2021/22 is currently the most up-to-date year with a complete set of actual data, which means that there are no cost estimates used.
- **The most up to date costs.** As the cost of goods and materials fluctuates over time, it is important that actual costs are the most up to date. Therefore, the selection of the most recent year of actual data is said to represent 'normal' costs.
- **Cost savings in RCP2.** By selecting the most recent year with a complete set of actual costs, the base year is said to incorporate any efficiencies realised by previous initiatives.
- **Historical trending.** To get an appreciation of the base year, the total opex in that year is compared to prior years (usually the previous five years) which provides a relative comparison of the base year and recent history.

Transpower has identified a base year underlying ICT opex value of $30.6m.

To assess the appropriateness of 2021/22 as a base year, Transpower undertook historical trend analysis and reviewed whether 2021/22 included any atypically high or low expenditure.

The trend analysis undertaken by Transpower is summarised in the figure below. As part of its historical trend analysis, $6.0m of capitalised leases that were transferred to capex in 2020/21 were excluded such that only remaining ICT opex and invex are included in the average (SaaS opex is also not included). The reduction in costs evident over the period is attributed to the 'Transformation 2 programme' that targeted cost reductions over the period. Over the period in question, the average expenditure per annum is $34.0m.

Figure 16-5 ICT opex historical trend across RCP2 and the first year of RCP3



Source: EOP001 ICT Opex Overview V0_3.pdf; Figure 3; page 8.

Transpower also reviewed the base year costs via an efficiency analysis whereby, the outturn cost in 2021/22 was reviewed in detail to identify any one-off expenditures or savings that should be removed (or added) to the outturn value. Opex in 2021/22 was $30.9m (again, excluding SaaS and capitalised leases but including ICT related invex). The efficiency assessment identified a net reduction of $0.3m to the base year outturn cost. The following table summarises the adjustment made to the base year cost to account for efficiencies gained in prior years.

Table 16-5 Adjustments made to the base year for efficiencies gained over RCP2.

Adjustment item	Opex Category	Adjustment
IT & T Ops Costs:		
Service Provider Reset - Fujitsu Transition Costs [3]	Third-Party Support and Maintenance (BP)	-$0.12m
Service Provider Reset - Datacom Milestone Payment	Outsourced Services (BP)	-$0.05m
Reversal of some minor one-off savings in Infrastructure Operations and Design	Outsourced Services (BP)	$0.01m
Reversal of minor one-off savings related to NTT Managed Services contract	Outsourced Services (BP)	$0.17m
Investigations		
Building Information Modelling	Invex	-$0.2m
Data & Analytics Modernisation	Invex	-$0.1m
Total		**-0.3**

Source: EOP001 ICT Opex Overview V0_3.pdf; Table 4; page 9.

Overall, we are of the view that the selection of 2021/22 as the base year is reasonable and that Transpower has adjusted the base year to account for efficiencies. The adopted base year opex value of $30.6m is considered reasonable.

16.5.2 Leases

Leases relates to the cost of leasing ICT components to support core business functions, including fibre circuits and telecommunications capacity.

The proposed RCP4 ICT leases opex is shown in the following table.

Table 16-6 Leases ICT opex in RCP3 and RCP4 ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base	1.8	1.8	1.8	1.8	7.2	1.8	1.8	1.8	1.8	1.8	9.0
Step	-	0.1	0.1	0.1	0.3	0.1	0.1	0.1	0.5	0.5	1.3
Trend	-	-	-	-	-	-	-	-	-	-	-
Total	**1.8**	**1.9**	**1.9**	**1.9**	**6.5**	**1.9**	**1.9**	**1.9**	**2.3**	**2.3**	**10.2**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 7

Base

The base cost for Leases in 2021/22 is $1.8m and covers the following main costs from RCP3:

– $1.4m for leases associated with telecommunications fibre network.
– $0.3m for phone rentals and usage.
– $0.1m for printer and copier leases.

From 2019 July, on term leases for fibre and data centres has been capitalised and therefore removed from the base year. For non-capitalised leases, the expectation is that the costs will remain contracted through RCP3 and RCP4.

Step

Transpower has identified two step changes for ICT leases, listed in the table below.

The TransGo Refresh investment case, reviewed in Section 11.5.3 of this report, sets out the need for an increase in radio licences. The step increase to fibre connections is an annual increase of $0.1m as the Christchurch to Dunedin fibre has been replaced.

Table 16-7 Leases ICT opex step changes in RCP3 and RCP4

Step Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
Increased radio leases (IC02 TransGo investment case)	TransGO Refresh programme will result in an increase in radio leases which are assumed to be non-capitalised leases.	2028/29	-	$0.9m
Fibre connection	A step change associated with a replacement of Christchurch to Dunedin fibre connection.	2022/23	$0.3m	$0.4m
Total			**$0.3m**	**$1.3m**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 6; page 13

Trend

No trends have been identified for leases.

16.5.3 Third-party support maintenance

Third-party support and maintenance describes the opex costs for third parties to deliver specialist outcomes such as off-site backup of media, infrastructure support, application support etc.

The proposed RCP4 ICT third party support and maintenance opex is shown in the following table.

Table 16-8 Third-party support & maintenance ICT opex across RCP3 and RCP4 ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base	6.2	6.2	6.2	6.2	24.8	6.2	6.2	6.2	6.2	6.2	31.0
Step	-	0.4	0.7	0.7	1.8	0.6	0.6	0.6	1.7	1.7	5.4
Trend	-	-	-	-	-	-	-	-	-	-	
Total	**6.2**	**6.8**	**6.8**	**6.8**	**26.6**	**6.8**	**6.8**	**6.9**	**8.0**	**8.0**	**36.4**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 7

Base

The base year expenditure is $6.2m and comprises of:

– $2.1m for enterprise application support by various service providers.
– $1.4m for managed services support around the security and firewall infrastructure.
– $1.3m for telecommunications support and maintenance.
– $0.5m for third party IT support for EMS regulated metering services.
– $0.4m for critical application support by various service providers.
– $0.4m for licensing, support and internet connectivity tools and services for the end user services network.
– $0.2m for bureau/data services for document offsite storage.

Transpower has reduced the third-party support and maintenance costs in RCP2 by insourcing the Critical Enterprise Service Bus (ESB) in 2016 (impact from 2017/18) and by virtualising and consolidating the firewall fleet, leading to a license and support cost reduction in 2018/19.

Step

Nine steps have been identified by Transpower and are listed in the following table.

Table 16-9 Third-party support and maintenance ICT opex step changes in RCP3 and RCP4 ($m)

Step Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
Outsourced Core Capacity (IC02 TransGO investment case	Outsourcing of core connectivity required because of the TransGO programme. It is assumed that this will be a non- capitalised lease following the completion of the build programme	2028/29	-	2.2
Canary Honeypot	Ongoing support of enhanced Insider Threat detection capabilities delivered in RCP3.	2022/23	0.6	1.0
Minor enhancements	Annual cost of $200,000 to cover the requirement to undertake minor enhancements on Transpower systems. This cost was previously accounted for as capex. This would include SCADA/EMS, Project Online etc.	2023/24	0.4	1.0
Maintenance Support & Technology	New pricing from supplier for third party support to EMS	2022/23	0.2	0.4
Telecommunications repairs and maintenance	Progressive increase in repairs and maintenance cost required across the telecommunications asset portfolio due to more extreme weather events. The estimate is based on the impact seen in early RCP3.	2023/24	0.1	0.5
New capability - one off cost increase	One-off cost increase to allow Telemetry Change Release Tool (TCRT) Phase 1 tool rollout to sites and Jira developments.	2022/23	0.3	-
New capability vendor support	Ongoing vendor support cost associated with the TCRT Phase 1 rollout.	2022/23	0.1	0.2
Expanded Penetration Test programme	Increased programme of penetration testing providing assurance for security controls, network configurations and cloud infrastructure and services.	2022/23	0.1	0.1
Telecomms service provider reset – Cable Locate Service	Increase in the cable locate service cost because of the service provider reset.	2022/23	0.02	0.04
Total			**1.8**	**5.4**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 15 and 16

Third-party support and maintenance costs have been gradually increasing since 2018/19 by an average of $0.1m per annum reflecting the increase in fibre optic cable maintenance expenditure caused by extreme weather events. It is anticipated that this trend to continue and is captured in the step change

Trend

There are no trends identified with third-party support and maintenance.

16.5.4 ICT outsourced services

This sub-strategy covers the costs for outsourcing of some services to specialist providers where practical and cost-effective.

The proposed RCP4 ICT outsourced services opex is summarised in the following table. The trend shown in this table assumes a constant annual contribution distributing evenly the total trend for each RCP specified by Transpower in the ICT opex overview. This approximation does not reflect the year-on-year variations in the step that are likely to arise given this component of cost is driven by FTEs as explained below. As a result, the annual opex amounts shown in the following table do not align with the sum of the base, step and trend contributions, however the totals for each RCP are aligned with the sum of base, step and trend contributions across those periods.

Table 16-10 Third-party support & maintenance ICT outsourced RCP3 and RCP4 ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base	11.7	11.7	11.7	11.7	46.8	11.7	11.7	11.7	11.7	11.7	58.4
Step	-	1.7	2.4	2.4	6.5	6.4	6.4	6.4	6.4	6.4	33.0
Trend	-	0.1	0.1	0.1	0.3	0.4	0.4	0.4	0.4	0.4	1.9
Total	**11.7**	**12.9**	**14.3**	**14.6**	**53.5**	**15.6**	**16.9**	**19.5**	**21.4**	**19.8**	**93.2**

Source: EOP001 ICT opex Overview V0_3..pdf

Base

The base year expenditure is $11.7 million, comprising:

- $3.9m for second and third level support for the TransGO network and providing specialist support, spares repair, equipment exchange and test laboratory support for the Transpower Network Operations Centre.
- $3.1m for infrastructure support (server management and desktops).
- $1.9m for cloud services (cost for AWS (production and test environments for Cloudera and Recollect) and Azure (other development and test environments).
- $1.0m for service desk costs.
- $0.5m for data centre facilities management.
- $0.4m for system modelling.
- $0.4m for system and internet operations support (relates to incident response and security compliance work, together with applications services core work).
- $0.3m for amortisations of telecommunications service fees (expensing of long-term operational fibre lease connections).

The outsourced services are reduced at the end of RCP2 by:

- Savings of $543,000 from 2017/18 as part of Transformation 2 programme.
- Reducing fibre optic connection fees and data centre rack expenditure in 2019/20.
- Reducing server management costs due to renegotiation the contracts.

The forecast incorporates a further $1.3m saving over a five-year period from 2022/23 because of the decision to replace the Check Point (non-substation) firewall fleet with Fortinet firewalls. The saving is incorporated into the opex forecast with the initial saving of $100,000 for 2022/23 and $300,000 for 2023/24. These are highlighted in the step change section below.

Step

Twelve steps have been identified and are listed in the following table.

Table 16-11 Outsourced services ICT opex step changes in RCP3 and RCP4 ($m)

Step Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
DCSM-related changes (*IC05 DCSM* investment case)	An increase in opex costs as a result of modernising Data Centre infrastructure by implementing the DCSM sub-strategy.	2023/24	0.3	20.9
Data and Analytics (D&A) (*IC10 Data Analytics* investment case)	An increase in opex costs driven by the D&A investment case (SaaS costs for Snowflake and Informatica and Data Based Tool (DBT)).	2022/23	2.4	4.9
IT Service Provider Reset - Server management fee	An increase in server management fee because of an increase in market service rates.	2022/23	1.9	3.1
Telecommunications service provider reset - Fixed Admin Payment	Increase in fixed admin payment as a result of the service provider reset and a reallocation of a portion of this fee from Grid maintenance to IST.	2023/24	0.8	2.9
Telecommunications service provider reset - TransGO break/fix	Reallocation of break/fix cost between Grid maintenance and IST following the telecommunications service provider reset.	2022/23	0.2	0.4
Increase in Cloud Services	Permanent new cost in AWS and Azure Cloud services. Note that any new usage costs from projects are covered by specific step changes detailed in investment cases.	2022/23	0.8	1.3
Network Managed Services Contract	An increase in Network Managed Services Contract costs based on estimated cost increase for licensing fees and Uptime support.	2023/24	0.3	0.8
IT Service Provider Reset – Transition	Transition milestone payment due to the new service provider. The payment is progressively amortised over the 5- year contract period until FY27/28.	2022/23	0.5	0.3
Reduction in server management (*IC05 DCSM* investment case)	This saving will be realised following the implementation of the DCSM sub- strategy and offsets the above mentioned opex increases.	2028/29		(0.7)
Consolidated Red Hat costs	Reduction in licenses following the renegotiation of a multiyear contract with Red Hat.	2022/23	(0.4)	(0.7)
Firewalls	Savings associated with the renegotiation of the contract for non- substation firewall fleet (from Check Point to Fortinet) applied to the subset of firewall assets transitioned during the year	2022/23	(0.4)	(0.9)
Web proxies	Transfer of costs to capex from opex for FY22/23 as existing solution (Bluecoat) is replaced by a different solution (ZScaler - capex project).	2022/23	-	(0.1)
Total			**6.5**	**33.0**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 7

Increases in outsourced services across RCP3 and RCP4 are due to the following:

– Increased cost associated with the transition from current “own and control” data centre approach towards adopting the “as a service” approach. The cost will be partially offset by vacating existing data centres and capital refresh costs included as savings in capex forecast.
– An ongoing increase in cloud services as more applications are delivered via cloud-based SaaS instead of on-premises. This will be partially offset by a reduction in on-premise hosting costs.

Trend

A variable component is the service desk cost is going to increase in line with the forecast FTE growth. This results in a step change of $0.3m in the remainder of RCP3 and $1.9m in RCP4. FTE growth is covered in business support opex in Section 12 of this report.

16.5.5 ICT Licences

This sub-strategy relates to the provision of licences across the business. The proposed RCP4 ICT licences opex is shown in the following table. The trend shown in this table assumes a constant annual contribution distributing evenly the total trend for each RCP specified by Transpower in the ICT opex overview. This approximation does not reflect the year-on-year variations in the step that are likely to arise given this component of cost is driven by a range of factors including FTEs as explained below. As a result, the annual opex amounts shown in the following table do not align with the sum of the base, step and trend contributions, however the totals for each RCP are aligned with the sum of base, step and trend contributions across those periods.

Table 16-12 Licences ICT opex across RCP3 and RCP4 ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base	8.9	8.9	8.9	8.9	**35.6**	8.9	8.9	8.9	8.9	8.9	**44.4**
Step	0.0	0.7	1.1	1.1	**2.9**	3.9	3.9	3.9	3.9	3.3	**18.6**
Trend	0.0	0.4	0.6	0.6	**1.5**	1.6	1.6	1.6	1.6	1.6	**8.2**
Total	**8.9**	**9.2**	**10.7**	**11.2**	**40.0**	**12.1**	**13.2**	**14.8**	**15.3**	**15.9**	**71.3**

Source: Transpower, EOP001 ICT opex Overview V0_3.pdf; Table 12; page 24 and table 13, page 24.

Base

The base year expenditure if $8.9m is for Microsoft, Oracle and other licenses. License costs have trended upwards by around $0.5m each year since FY16/17 due to a general increase in license costs across vendors and new capabilities being built and increasing adoption of tools.

Step

Nine steps have been identified and are listed in the following table.

Table 16-13 Licences ICT opex step changes in RCP3 and RCP4 ($m)

Step Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
Cybersecurity (*IC09 Cybersecurity* investment case)	Investment in cybersecurity and firewalls required for the TransGO upgrade will increase license costs by $3.1m in RCP4. Remainder of the forecast step change is driven by building new cybersecurity capabilities.	2022/23	0.4	5.9
Increase in license costs for new capabilities (*IC04 Transmission Systems*, *IC07 Assets Managements*, *IC08 Digital Workplace* and *IC06 Corporate* investment cases)	New license costs required for new capabilities built by the benefits- driven projects	2023/24	0.7	6.6
Applications moving to Software as a Service (SaaS) solutions	SaaS opex uplifts for applications planned to move from on premises to SaaS solutions	2022/23	0.5	2.9
BIM license costs (*IC03 BIM* investment case)	Forecast investment in Building Information Modelling capabilities is expected to drive an increase of $0.4m per year in licencing and SaaS subscriptions.	2022/23	0.7	2.1
Increase in hardware maintenance prior to the DCSM transition (*IC05 DCSM* investment case)	The step change will flatten out an increase in hardware maintenance cost as replacing equipment is deferred closely prior to the DCSM migration where risk profile allows.	2022/23	0.1	0.4
Vegetation management	License costs and data storage costs associated with building a new vegetation management capability	2022/23	0.3	0.8
ITSM licenses (*IC12 ITSM* Investment case)	Licenses for new capabilities required in the ITSM investment case.	2023/24	0.1	0.4
OT vulnerability system	Continued operations of the Operational Technology (OT) monitoring solution	2022/23	0.1	0.2
Reduction in hardware support costs following the DCSM transition (*IC05 DCSM* investment case)	Implementation of the DCSM sub- strategy will result in elimination of the current hardware support costs.	2029/30	-	(0.6)
Total			**2.9**	**18.6**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 12; page 24

The key driver for an increase in the license costs is aligned to the historical trends and new capabilities introduced, increased adoption and several systems being moved to SaaS solutions.

Trend

Four categories have been identified as trend increases and are listed in the table below. The main factor driving the trend classification is the increase in FTEs (and contractors). Therefore, if the recruitment of staff does not occur, a reduced number of licences will be needed.

Table 16-14 Licences ICT opex trend changes in RCP3 and RCP4 ($m)

Trend Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
FTE related increases	Increase in licenses driven by forecast FTE growth. FTE forecast as at December 2022 includes both permanent employees and contractors.	2022/23	0.8	4.5
Growth in usage	Growth in licenses across the enterprise (unrelated to FTE growth) driven by increasing digitalisation and increasing usage of tools. It is estimated to result in incremental annual increase of $100k p.a.	2023/24	0.3	2.5
Real time systems (RTS)	Increase from growing installations of human machine interface substation management systems	2022/23	0.3	1.0
Grid/EMS	Annual system updates and new licenses for Grid/EMS systems. These were previously capitalised.	2022/23	0.1	0.3
Total			**1.5**	**8.2**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 13; page 25

16.5.6 Communications and control IST

This describes the opex forecast for the communications and control category using the base–step–trend approach. This includes third party costs to maintain the TransGo Refresh national network.

The proposed RCP4 ICT communications and control is shown in the following table.

Table 16-15 Communications and control ICT opex across RCP3 and RCP4 ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base	1.0	1.0	1.0	1.0	**4.0**	1.0	1.0	1.0	1.0	1.0	**4.9**
Step	-	0.3	0.6	0.6	**1.4**	0.6	0.6	0.6	0.6	0.6	**3.0**
Trend	-	-	-	-	**-**	-	-	-	-	-	**-**
Total	**1.0**	**1.3**	**1.5**	**1.5**	**5.3**	**1.5**	**1.6**	**1.6**	**1.6**	**1.6**	**7.9**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 12; page 24

Base

The base year expenditure is $1.0m, for Maximo-related maintenance work on the substations. There has been the removal of obsolete legacy equipment at substations that resulted in a reduction of communications and control expenditure in early RCP3 and therefore a lower base year in comparison to RCP2 average expenditure.

Step

Two steps have been identified and are listed in the following table.

Table 16-16 Communications and control ICT opex step changes in RCP3 and RCP4

Step Change	Description	Change commences	RCP3 Total (22/23 - 24/25)	RCP4 Total
Telecommunications service provider reset - PM - Routine preventive maintenance work	Increase in routine preventive maintenance work cost because of the service provider reset. Additionally, an increase in the forecast cost is assumed reflecting the forecast increase in the number of substations.	2022/23	$0.9m	$1.8m
Telecommunications service provider reset - PDM – Predictive Maintenance	Reallocation of predictive maintenance cost between Grid maintenance and IST following the telecommunications service provider reset. There is a corresponding cost decrease is in the Grid maintenance opex forecast.	2023/24	$0.5m	$1.2m
Total			**$1.4m**	**$3.0m**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 15; page 26

The step changes relate to increase in routine maintenance and a relocation of funds, where the latter is cost neutral to Transpower as a whole.

Trend

There are no trends associated with communications and control.

16.5.7 Invex

Investigations expenditure (invex) describes the opex required for pre-capital project activities to explore possible solution options to deliver business outcomes. There is no step or trend applied to investigations opex.

The proposed RCP4 ICT investigations opex is shown in the following table.

Table 16-17 Invex opex across RCP3 and RCP4 ($m))

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Total	**1.1**	**1.7**	**1.9**	**0.9**	**5.6**	**1.6**	**2.6**	**0.7**	**0.7**	**0.4**	**5.9**

Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 7.

The base year expenditure is $1.1m. However, unlike other ICT opex categories, this base year value is not specifically used within the development of the investigations opex forecast.

The average investigations spend in RCP3 was $1.3m per year. An average base expenditure of $1.2m per year has been set by Transpower for the RCP4 forecast.

Following the establishment of the RCP4 total expenditure of $5.9m,[326] a series of assumptions have been applied to generate the investigations expenditure profile across RCP4. The allocation for investigations expenditure is dependent on the investment type, investment size and whether the investment is required to procure via a Request for Proposal in the market. This is then applied at an investment brief level and creates the variance in the year-on-year values. However, it is kept within the total RCP allocation.

[326] Amount is $5.9m as $1.2m is rounded to one decimal place.

16.5.8 Summary of 'underlying' ICT opex

Whilst establishing the underlying ICT opex forecast, Transpower were able to identify savings through procuring alternative technologies and reviewing the need to undertake investigations. These were classified as productivity adjustments. As the work is no longer needed, the cost does not need to be incurred, and can be netted off against the total opex requirement.

The productivity adjustment is shown in the following table.

Table 16-18 ICT opex reductions due to efficiencies (productivity adjustments)

ICT opex productivity adjustment	Total	
	RCP3 (base and 3 forecast years)	RCP4
ICT opex total	$137.1m	$225.0m
Productivity adjustment	-$0.2m	-$4.0m
Total	**$136.9m**	**$220.9m**

Source: EOP003 ICT Opex overview V0.3 Final.pdf; table 3; page 7

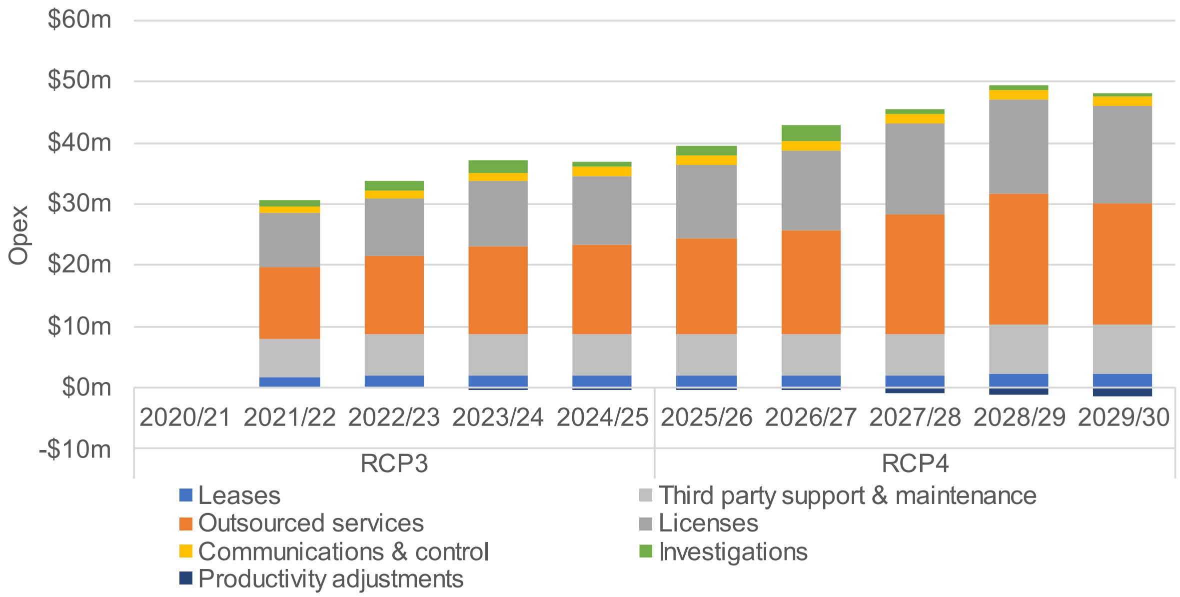
The following table and figure summarise the underlying ICT forecast on an annual basis.

Table 16-19 Underlying ICT opex total ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Leases	1.8	1.9	1.9	1.9	**7.5**	1.9	1.9	1.9	2.3	2.3	**10.2**
Third party support & maintenance	6.2	6.8	6.8	6.8	**26.6**	6.8	6.8	6.9	8.0	8.0	**36.4**
Outsourced services	11.7	12.9	14.3	14.6	**53.5**	15.6	16.9	19.5	21.4	19.8	**93.2**
Licenses	8.9	9.2	10.7	11.2	**40.0**	12.1	13.2	14.8	15.3	15.9	**71.3**
Communications & control	1.0	1.3	1.5	1.5	**5.3**	1.5	1.6	1.6	1.6	1.6	**7.9**
Investigations	1.1	1.7	1.9	0.9	**5.6**	1.6	2.6	0.7	0.7	0.4	**5.9**
Productivity adjustments	-	-	-0.1	-0.1	**-0.2**	-0.3	-0.5	-0.8	-1.1	-1.4	**-4.0**
Total	**30.6**	**33.4**	**36.5**	**36.4**	**136.9**	**38.8**	**42.1**	**44.2**	**47.8**	**46.2**	**220.9**

Source: EOP003 ICT Opex overview V0.3 Final.pdf; table 3; page 7

Figure 16-6 ICT opex by sub-category



Source: EOP001 ICT opex Overview V0_3.pdf; Table 3; page 7

16.6 SaaS opex

As noted above, the forecast of SaaS opex is developed within the ICT investment cases. Transpower examined the cost of continuing with the current services and looked at the options to move to the cloud-based services. The benefits have been defined in individual Investment Cases, which aligns with other strategies mentioned above. The business case highlights the capex / opex trade-offs in the case of reduction of on-site servers.

The following table shows the investment cases which have an element of SaaS expenditure.

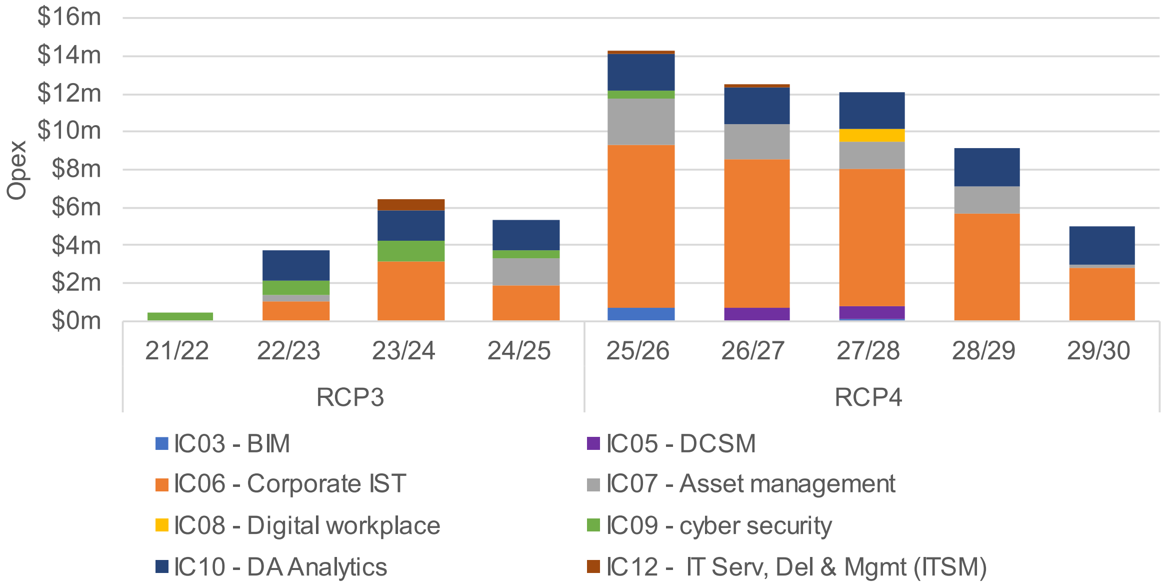
Table 16-20 ICT SaaS opex allocation against Investment case ($m)

Component	RCP3 (base and 3 forecast years)					RCP4					
	Base 21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
IC01 - Maintain assets	-	-	-	-	-	-	-	-	-	-	-
IC02 - TransGo refresh	-	-	-	-	-	-	-	-	-	-	-
IC03 - BIM	-	-	-	-	-	0.7	-	0.1	-	-	0.8
IC04 - Transmission system	-	-	-	-	-	-	-	-	-	-	-
IC05 – DCSM	-	-	-	-	-	-	0.7	0.7	-	-	1.4
IC06 - Corporate IST	-	1.0	3.2	1.9	6.0	8.6	7.8	7.2	5.7	2.8	32.1
IC07 - Asset management	-	0.4	-	1.5	1.8	2.5	1.8	1.5	1.5	0.2	7.4
IC08 - Digital workplace	-	-	-	-	-	-	-	0.6	-	-	0.6
IC09 - Cyber security	-	0.7	-	-	0.7	0.4	0.8	1.1	0.4	0.4	3.2
IC10 - DA Analytics	-	1.6	1.6	1.6	4.8	2.0	2.0	2.0	2.0	2.0	10.0
IC11- DSM	-	-	-	-	-	-	-	-	-	-	-
IC12 - ITSM	-	-	0.5	-	0.5	0.1	0.1	-	-	-	0.3
Total	**-**	**3.7**	**5.3**	**5.0**	**14.0**	**14.3**	**13.3**	**13.3**	**9.5**	**5.4**	**55.8**

Source: IV recon RT01_IC.xlsx

The SaaS expenditure profile is shown in the following figure by investment case.

Figure 16-7 ICT opex – Software as a Service (SaaS)



Source: RT01 expenditure schedules

projects ramp up - namely IC06 - Corporate IST (at $32m in RCP4) and IC10 - DA Analytics (at $10m in RCP4). The expenditure for these two investments accounts for 75% of the total SaaS opex expenditure in RCP4. This was also the case for RCP3 where these two projects accounted for 77% of the RCP3 SaaS opex expenditure.

16.6.1 Evaluation

ICT opex is an identified programme. To assess whether Transpower's ICT opex proposal for RCP4 is prudent and efficient, we have followed the evaluation criteria and employed the evaluation methods described for an identified programme in Section 13.2 of this report.

Our evaluation has involved reviewing the ICT strategy and policy documentation, exploration of the numerical data and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and decisions that have informed Transpower's ICT opex proposal.

ICT opex adopts the same approach to establishing the base, the step and the trend for every ICT opex category and, as such, we have evaluated the base, step and trend as a group, across all ICT opex categories rather than individually.

As the underlying ICT opex has been provided as a separate business case to the SaaS opex, along with the need for SaaS opex being different than underlying opex, these two are also reviewed separately.

16.6.2 'Underlying' ICT opex

Transpower has adopted a base-step-trend approach to establish the ICT opex forecast. Each element Is discussed in more detail below.

Assessment of the base year approach

The choice of base year as an appropriate year is discussed in detail in Section 13.3 of this report. This section analyses the data and the approach to define the cost in the proposed year with the correct inputs.

For each of the six categories, the same approach has been used to establish a base value. In all cases the starting point is the current RCP3 figures and the RCP2 actual values whereby an annual average is derived to provide insight into historical expenditures – with adjustments made to historical costs as appropriate. The annual average is used as a starting point for Transpower's analysis, but the adopted base cost is a bottom-up build of costs incurred in that category. The bottom-up build is clear on its source as the actual costs can be used, and this is enhanced by reviewing the RCP2 and RCP3 (to date) costs to confirm that the bottom-up build is reasonable.

For each category, the base is reviewed to ensure that any one-off costs are appropriately discounted. Examples include:

– Leases: Reduction in long-term leases which have been capitalised.
– Third-party support: Reduction by insourcing certain parts.
– Outsourced services: Reducing server costs by renegotiating the contract.

For each category, Transpower has identified several one-off cost corrections to establish the base cost.

Transpower has documented the bottom-up build and the correction within the overview document, and it is clear how the base cost has been created.

An exception can be found in 'Investigations' opex. The base year for investigations is based on the average annual expenditure in RCP2 and RCP3. This is used as the benchmark, and from here the required investigations are selected using an investment brief. In this scenario, the RCP4 budget is managed as a total rather than annually. To access the expenditure a business plan is developed, and the money is allocated.

We are of the opinion that the base expenditure approach and resulting ICT base opex values is reasonable.

Assessment of the step approach

For each category, any additional increases are identified along with the year that the increases will take effect. In most cases the increases are linked to the completion (partial or full) of investment cases, and as these investment cases are delivered, the ICT opex element will start.

There are also increases in maintenance and management fees, especially around outsourced services and Cloud based services as the business starts to rely more on these external services.

In ensuring that the included steps are efficient, each step is individually identified, explained, and planned across the RCP3 and RCP4 period. There are no step increases in Investigations opex.

We are of the opinion that the step expenditure approach and resulting step increments applied are reasonable.

Assessment of the trend approach

A trend increase is only applied to two of the six ICT opex categories, namely Outsourced Services and Licences. In both cases the trend is applied based on the increase in FTEs and Contractors employed by Transpower. This seems to be a logical approach as the number of licences is directly related to those who use it, and Transpower's case this can be FTEs or Contractors.

We are of the opinion that the trend expenditure approach and resulting trend-based increments are reasonable, although we do not the reliance of some trending assumptions based on achieving the proposed FTE forecasts.

16.6.3 SaaS opex

The move to SaaS is a strategic driver for the Data Centre, as a move away from server-based software to cloud means that the servers, and data centre are no longer needed. For clarity, it is envisaged that some software packages will not transition to a SaaS format and a data centre will still be needed, however this may be a scaled back version of the current infrastructure.

The justification for the move to SaaS is to meet the long-term strategic fit for Transpower, and the desire to reduce the need for Data Centres, but also a key enabler for Transpower infrastructure and that it increases reliability, productivity, and efficient use of software licences. Certain Critical Systems and Transpower applications will remain in the Data Centres in the near-term but must evolve to make them suitable for future migration to other "as-a-Service" offerings (Infrastructure as a Service / Platform as a Service). In the current market, no SaaS solutions are available for such systems and applications.

Licences associated with SaaS are set by the software company, and they are specific to a user, therefore the modernisation of the software will show an increase in SaaS opex through RCP4 as it is implemented.

In summary, SaaS cuts across several strategies and business cases, where a single reason does not drive the need, rather it is an artifact of modernisation of other functions, in the sense that the modernisation could not happen without SaaS, but by adopting SaaS more functions are released.

Overall, we are of the opinion that the development of the SaaS opex requirement and resulting proposed forecast is reasonable.

16.6.4 Summary

A summary of our evaluation is given in the following table.

Table 16-21 ICT opex summary

Opex Category	RCP4	Commentary
ICT Leases	$10.2m	Base year costs reflect on current lease costs in 2021/22, those leases continue to 2027/28. Base year costs have been determined following the standard process of excluding where appropriate one-off costs and savings. Steps are clearly set out and reasonable. No trend allocation for Leases. We are of the view that the RCP4 value is reasonable.
Third-Party Support and Maintenance	$36.4m	Third party support and maintenance relate to the cost of specialist contractors needed for specific maintenance works. Cost in the 2021/22 base year were $6.2 million, based on a five-year historical average. The steps are a mixture of workforce cost increases and specialist one-off activities provided by third parties. There are no trend increases. We are of the view that the RCP4 value is reasonable.
ICT Outsourced services	$93.2m	Transpower has broken down the base year (2021/22) cost into its constituent parts and detailed each cost element. In addition, Transpower reduced base year costs recognising savings achieved through procurement efficiencies, for example renegotiating contracts to provide server management. In total there are 12 steps which provide justification for the overall increase. Costs are based on recent similar procurements set out in the investment cases and coupled with the market rates. A trend change has been added for the forecast increases in FTEs. We are of the view that the RCP4 value is reasonable.
ICT Licences	$71.3m	Base year licence cost taken from average of the prior five-year period. This was stable at $8.9m p.a. for licences (Microsoft, Oracle etc). Transpower are proposing an annual increase of $0.5m from base year through RCP4 based on the historical trend since 2016/17 due to new capabilities within the licences and adoption of new vendor tools. Transpower has also added step change based on Investment Case analysis which identifies additional licence requirements as well as some licence savings, for example the delivery of the DCSM is expected to reduce the number of licences. A trends change has been added based on the forecast increases in FTEs. Our opinion is base year costs and forecast expenditure is reasonable.
Communications and control IST	$7.9m	Base year cost reflects current costs for Maximo-related maintenance work on substations. The cost is stable and not expected to increase in remaining RCP3 or RCP4 apart from cost increase associated with increasing the routine maintenance as the number of substations connected through Maximo increases. There is no trend increase. We are of the view that the RCP4 value is reasonable.
Investigations	$5.9m	Investigations expenditure in the base year (2021/22) was assessed as $1.1m and is reflective of the average expenditure across RCP2. Expenditure is expected to increase across RCP3 averaging $1.3m per year. Transpower are not forecasting a change in the cost of investigations across RCP4 and propose to use $1.2m per year as the average across RCP4.

		There is no step or trend increases with Investigations. We are of the view that the investigations RCP4 value is reasonable.
Productivity adjustments	-$4.0m	
Underlying ICT opex	$219.9m	Values as per the RT01 expenditure schedule. As noted previously, there is a slight difference in the base opex value used in the ICT overview document ($30.6m) compared to that used in the RT01 expenditure schedule ($30.4m). For RCP4 period, this variance is $1.0m.
SaaS	$55.8m*	
Total opex	**$275.8m***	

Source: EOP003 ICT Opex overview V0.3 Final.pdf; table 3; page 7 for category expenditure and RT01 expenditure schedule for RCP4 totals

16.6.5 Conclusion

Transpower's proposal is consistent with the efficient costs of a prudent electricity transmission services supplier. The proposed total ICT opex for RCP4 of $275.8m meets all the evaluation criteria, including GEIP.

The following table summarises our evaluation for this identified expenditure category.

Table 16-22 Evaluation summary of proposed ICT opex

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	Drivers have been clearly articulated and supported by the ICT investment cases and bottom-up cost analysis.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and proposed base capex	Yes	The opex changes are clearly linked through to the ICT investment cases which present the identification of preferred solutions which consider the appropriate mix of opex and capex. SaaS expenditure is classified as opex in line with financial reporting standards revised in March 2021, it was previously classified as capex. Transpower has applied a detailed bottom-up approach to establishing the SaaS opex requirement, reflecting the strategic driver to reduce the reliance on physical data centres. The Data Centre Service Modernisation (DCSM) investment case is one of the drivers for the SaaS implementation as an increase in '…. As a service' reduces the need for physical locations. That is the capital spend on data centres is reduced in both assets – servers etc and a corresponding reduction in physical space to house those assets.
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Multiple investments are being made which consider the option of reducing opex. This can be seen with the asset replacement options which use alternative suppliers who have a lower opex. Rather than an opex reduction, the initiatives are more reflective of opex efficiencies.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	No direct relation to previous efficiencies in prior investment programmes, rather the opportunity exists to evaluate the need of each software package as it moves across to SaaS
A3(a)	Identified need for programme is prioritised based on risk-based approach in line with good asset management and were applied appropriately	Yes	ICT opex overview documents the development of the ICT opex requirement for RCP4 which is consistent with the twelve ICT investment cases. Those investment cases consider risks when establishing the need for investment and selecting the preferred investment option. The ICT opex approach is in line with good asset management practice to the extent that traditional asset management practices are relevant to ICT systems.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A3(b)	Policies and planning standards were applied appropriately	Yes	ICT opex is appropriately based on meeting the ICT service performance standards, which are based on the business objectives.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The base year in this forecast has been developed using the business-as-usual budget processes. There are no material departures because Transpower's budgets are prepared in accordance with their internal policies and processes. These are considered reasonable. The process is considered cost-effective by comparison to historic expenditure. Transpower have efficiency gains to proposed ICT opex forecasts.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	Transpower evaluates alternative options as part of the investment case processes where possible.
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Yes	The ICT opex does not significantly impact the forecast capex but is a necessary support service. When capex projects are initially evaluated, the opex cost is considered as an input, and where possible Transpower use the actual costs of similar assets in the evaluation.
A3(i)	Programme is appropriately linked with other projects or programmes	Yes	ICT opex is a support service which is linked to various network and non-network functions and expenditure areas (such as for investigations and licences).
A3(j)	Proposed approach to procurement of associated goods and services	Yes	ICT procurement is based on standard software procurement processes. The most significant change has been the adoption of SaaS.

17. Business support opex

The following table summarises our verification of Transpower's proposed business support opex requirement for RCP4. Business support opex is an identified expenditure programme.

Table 17-1 Verification summary of business support expenditure

Verification element	Verification commentary
RCP4 proposed amount	$310.4m
Appropriate and sufficient information available for IV	Yes
Meets GEIP and ToR evaluation criteria	Yes
IV conclusion	Accept $310.4m
Potential scope for improvement	Transpower has provide limited information on the following three areas that collectively comprise approximately 3% of the total business support requirement: – Overhead at $2.8m in RCP4 – Resource initiative at $4.2m in RCP4 – TPM at $2.9m in RCP4 We have not pursued more detailed information consistent with the proportionate scrutiny principle.
Key issues and areas that the Commission should focus	Business support is heavily focussed on providing FTEs to support the workforce needed to deliver the network capex and opex projects. If those projects are delayed the need for business support may also be delayed. The converse may also be the case where the capex or opex project is delayed due to an inability to employ sufficient workforce with the correct skills in a suitable time. Hence a key issue will be the timely recruitment of FTEs to meet the prescribed project timelines. The Commission may wish to seek additional information from Transpower to confirm that there is no double counting of TPM related business support costs. TPM capability appears to be driving both the TPM component of the resource building initiatives and TPM step and additional corporate governance FTEs.

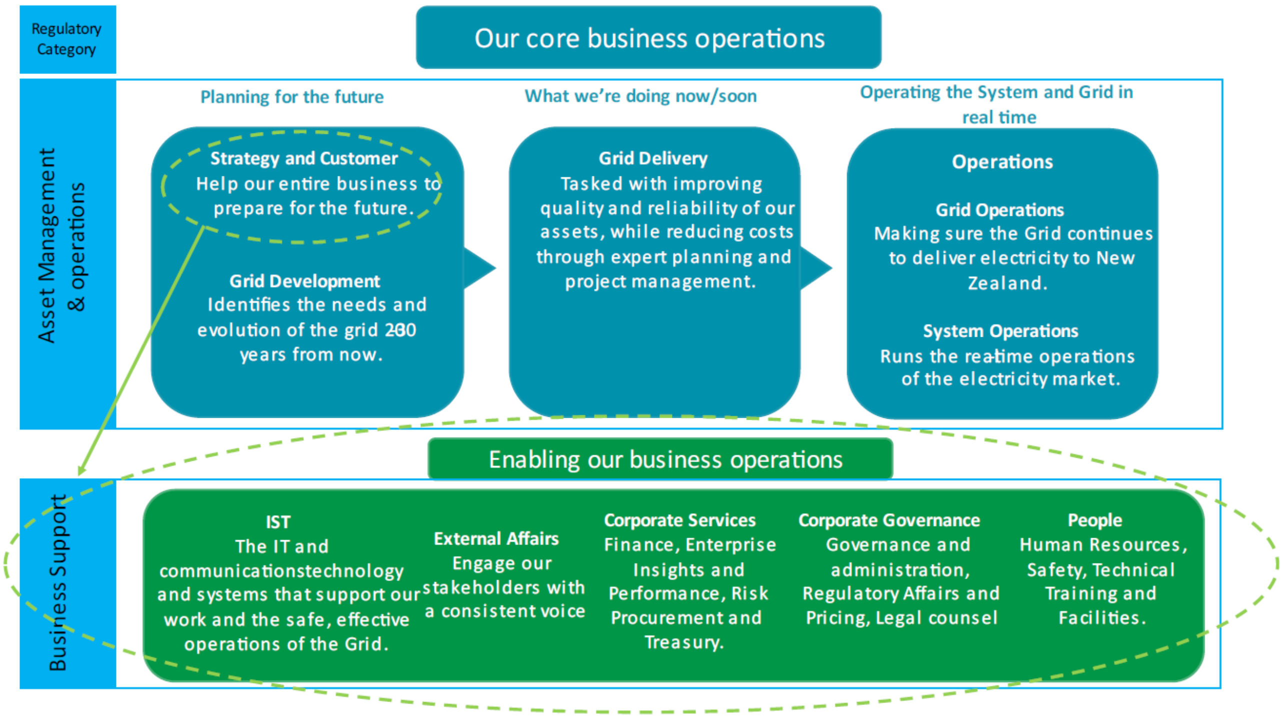
17.1 Overview of business support opex

The business support opex forecast primarily focusses on the funding for the business support functions that support the Asset Maintenance and Operations (AM&O) functions. It covers the internal costs of permanent employees and contractors of six ***divisions*** and excludes capex. The six divisions are:

– Information Services and Technology.
– External affairs.
– Corporate services.
– Corporate governance (Regulatory Affairs).
– People.
– Strategy and Customer.

The following figure shows the divisions that make up the business support regulatory category as well as the strategy and customer division which while sitting in 'asset management and operations' within the figure, is reported as business support for regulatory reporting and is included in this section of the report.

Figure 17-1 Transpower divisions and regulatory categories



Source: Transpower, EOP007 Business Support Opex Overview.pdf; figure 1; page 2

The functions of the six divisions are summarised below:

- **Information Services and Technology** is responsible providing real-time information about how the transmission network is performing and that the workforce has functioning and fit-for-purpose IT and systems platform to enable effectiveness and productivity.
- **External Affairs** are responsible for external relationships, including Corporate Communications, Landowner Relations and Property, Community and Iwi relations, Environmental Policy and Planning, and Sustainability.
- **Corporate Services** includes Finance, Procurement and Supply (including Warehousing), Risk and Assurance and Treasury teams.
- **Corporate Governance** is accountable for the provision of strategic legal advice to management and setting the internal governance policies, regulatory affairs and grid pricing.
- **People** comprises four functional groups – Health and Safety, Facilities Management, Human Resources, and Technical Training. The Technical Training function is responsible for development and delivery of trades and compliance training to Service Providers who work on the national grid, and training of staff in the Operations Division.
- **Strategy and customer** is responsible for the development and implementation of organisation strategy and innovation. The division incorporates strategy advisor roles, EMS Delivery, EMS Development, and Tradepoint teams, as well as the customer and commercial functions. Facing the opportunities and challenges of a changing electricity system, the Strategy function is focused on monitoring context, developing the strategy, and continuing to build our innovation methods and deliver innovation developments.

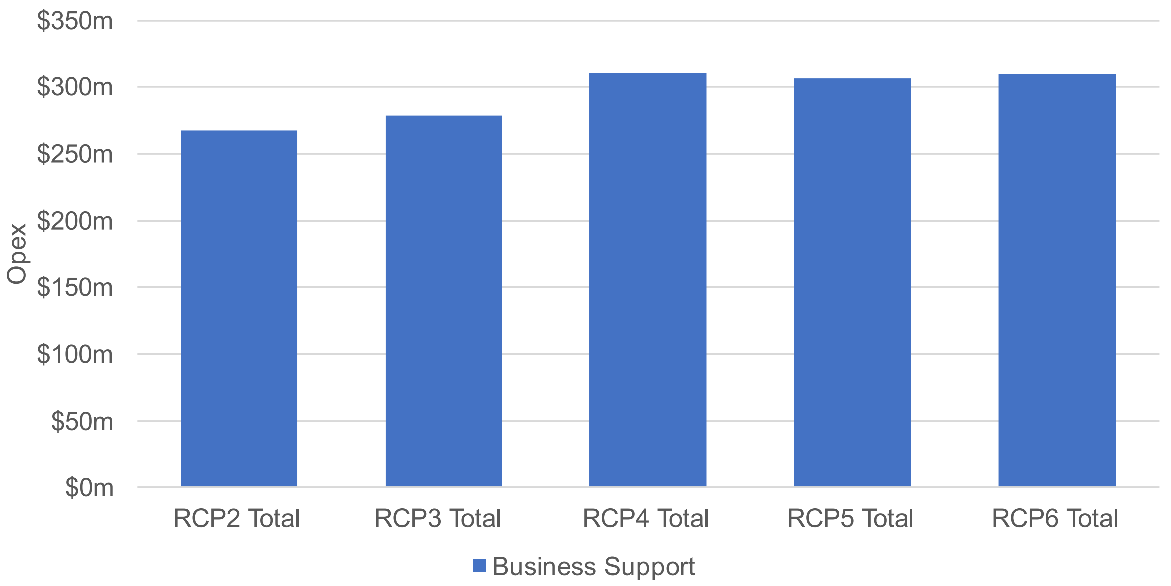
For clarity the following functions, that sit organisationally inside Business Support, have been included in the AM&O category:

- Procurement and Supply (part of Corporate Services)
- Environmental Policy and Planning (part of External Affairs)
- Landowner Relations and Property (part of External Affairs)

17.2 Expenditure profile

The following figure presents the long-term expenditure profile of business support opex from RCP2 to RCP6. The figure indicates that expenditure in business support is increasing between RCP2 and RCP4, before levelling off in RCP5 and beyond.

Figure 17-2 Business support opex long term expenditure profile



Source: Transpower, RT01 expenditure schedule

As shown in the following table, Transpower is proposing an increase in business support opex from $278.9m in RCP3 to $310.4m in RCP4, an increase of over 11%.

Table 17-2 Business support ***opex for RCP3 and RCP4***

Opex portfolio	RCP3 Total	RCP4 Total	Change
Business support	$278.9m	$310.4m	11.3%

Source: REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

Business support opex is predominantly the cost associated with FTEs and contractors (generally referred to as FTEs) – known by Transpower as 'internal resourcing'. However, there is also a small element of opex related to 'resource building initiatives' which includes promoting Transpower, recruiting internationally and attracting interns.

Business support opex also includes costs relating to establishing and maintaining the transmission pricing methodology (TPM). For simplicity of reporting, we have grouped resource building initiatives and TPM together in the following summary tables and figures.

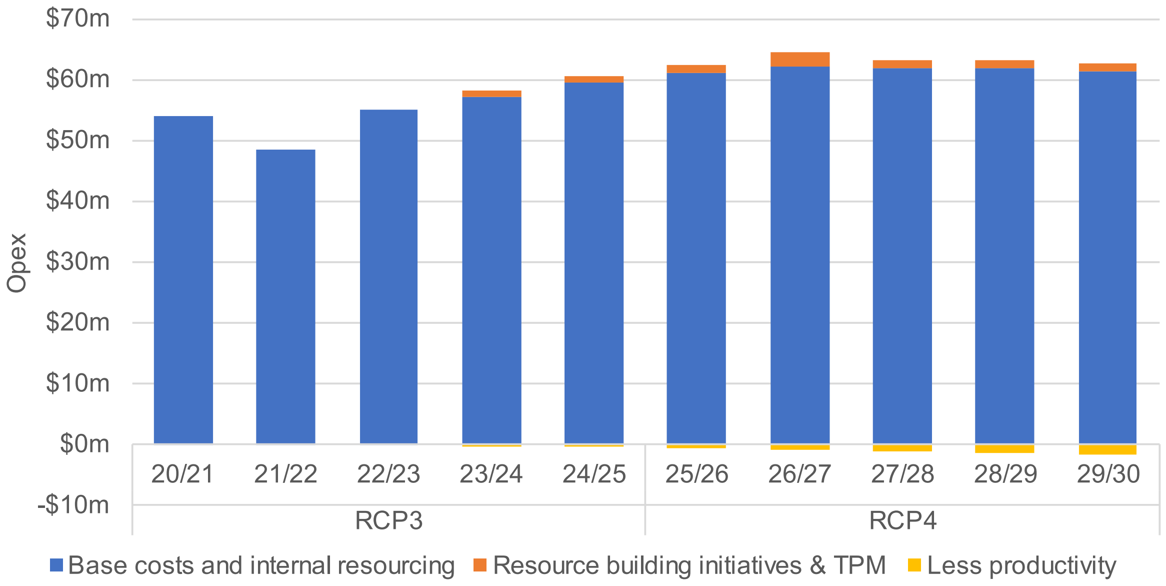
A breakdown of the proposed expenditure requirement for RCP3 and RCP4 is shown in the following table and figure. Resourcing initiatives, including TPM, account for $7.1m of RCP4 opex, which is around 2% of the total RCP4 submission prior to the application of productivity improvements ($7.1m of $316.2m).

Table 17-3 ***Business support opex broken into main categories for RCP3 and RCP4 ($m)***

Component	RCP3						RCP4					
	20/21	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Base costs and internal resourcing	54.0	48.5	55.2	57.2	59.7	274.7	61.2	62.2	62.1	62.0	61.6	309.1
Resource building initiatives & TPM	-	-	2.4	1.1	1.1	4.6	1.2	2.4	1.2	1.2	1.2	7.1
Less productivity	-	-	-	-0.1	-0.2	-0.3	-0.5	-0.9	-1.2	-1.5	-1.8	-5.7
Total	**54.0**	**48.5**	**57.6**	**58.2**	**60.6**	**278.9**	**61.8**	**63.7**	**62.1**	**61.7**	**61.0**	**310.4**

Source: Transpower, REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

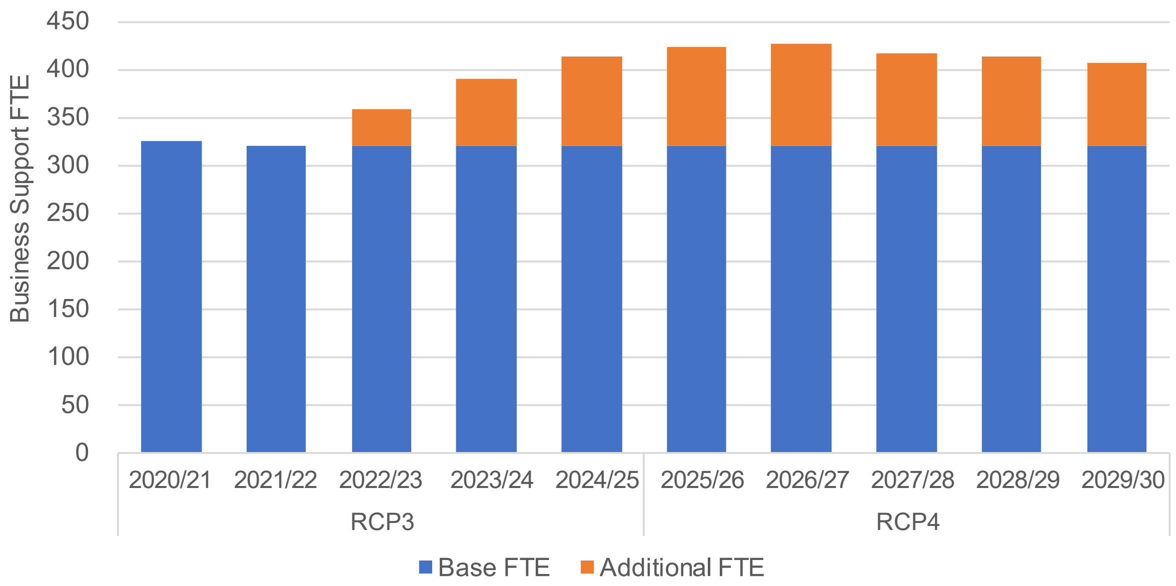
Figure 17-3 ***Business support opex by category***



Source: Transpower, REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

The actual (last year of outturn) and forecast number of FTEs employed within business support is shown in the following figure. At its peak, Transpower forecast a total of 427 FTE in business support by 2026/27 - an additional 106 FTE over and above the 321 FTE in 2021/22. By the end of RCP4, this forecast falls to 408 FTE in total.

Figure 17-4 Number of FTE's and contractors under business support



Source: Transpower, EOP009 FTE Uplift summary & Ratios.xlsx, worksheet 'Ratios'

17.3 Expenditure drivers

The business support opex category is largely driven by staff and contractor costs for the six aforementioned divisions. The need for staff is itself driven by the planned investments, including maintenance, in the grid.

The following table provides a more detailed summary of the growth drivers for each function.

Table 17-4 Business Support growth Drivers

Division	Growth driver
Information Services and Technology (IST)	The TransGO Refresh Programme. The modernisation of key applications and the introduction of Enterprise Business Capability. The increased investment in grid connections will result in an increased demand for telecommunications services. An increase in Transpower and Service Provider staff results in an increase in support services, specifically around cyber security incident response and end-user support.
External Affairs	The increasing sustainability and climate change obligations (e.g., the implementation of the Taskforce on Climate-related Financial Disclosures regime) and growing biodiversity requirements under international obligations and domestic law. Responding to changes to the current resource management legislation, with the Natural and Built Environment Bill and the Spatial Planning Bill requiring significantly different approaches to environmental planning and approvals. An increase in maintenance and enhancement work on the grid and an increase in major capital projects and customer connections.
Corporate Governance	An increased volume and complexity of key regulatory instruments such as the Input Methodologies, RCP and TPM regimes. The development and filing of a significantly increased volume of major capital projects for major capital investments with greater complexity and more complicated property rights and consenting requirements. The commencement (on 1 April 2023) of a fundamentally changed customer pricing regime in the TPM based on benefits-based charging requiring significantly more modelling and customer pricing interactions and anticipating litigation and pricing disputes that will flow from that. A significant increase in volume and complexity of customer connection contracts and negotiations required.

Division	Growth driver
	The introduction of significant changes to Resource Management laws in the form of the Natural and Built Environment Bill and the Spatial Planning Bill and the expectation of large volumes of litigation to bed in the reforms.
Corporate Services	Increasing regulatory requirements as a result of the management and reporting under the proposed Modern Slavery and Worker Exploitation legislation. The increase in the work programme will require additional business case support from finance. The increased number of projects and fixed assets resulting from those projects drives a need for additional resources in Projects and Fixed Assets Accounting team.
People	The forecast growth in the people is primarily related to the increasing recruitment activity and increased number of Transpower employees. An increase in the number of trainees requires additional trainers. Increases in health and safety and facilities management teams are required to create team resilience and enable improved policy compliance.
Strategy and customer	The forecast increase in connections for new customers (non-incumbents) and increased interaction with existing customers as part of the increased activity around decarbonisation will drive the need for a modest increase in the customer team.

Source: EOP010 Business Support Opex Overview.docx Version 0.5; July-2023; Table 1; page 4

17.4 Development of expenditure forecast

Transpower's business support opex uses the base step trend approach. As with other opex categories where a base-step-trend approach is applied, Transpower has adopted 2021/22 as the base year. Transpower's choice of base year is discussed in more detail in Section 13.3 of this report.

Transpower has provided a detailed business support opex overview[327] document and supporting spreadsheets which set out the approach and assumptions applied to determine the base year cost, adjustments made, as well as the detailed steps and trends applied.

The base year expenditure and any adjustments, steps and trends applied to the base year expenditure are discussed below.

17.4.1 Establishing the base year

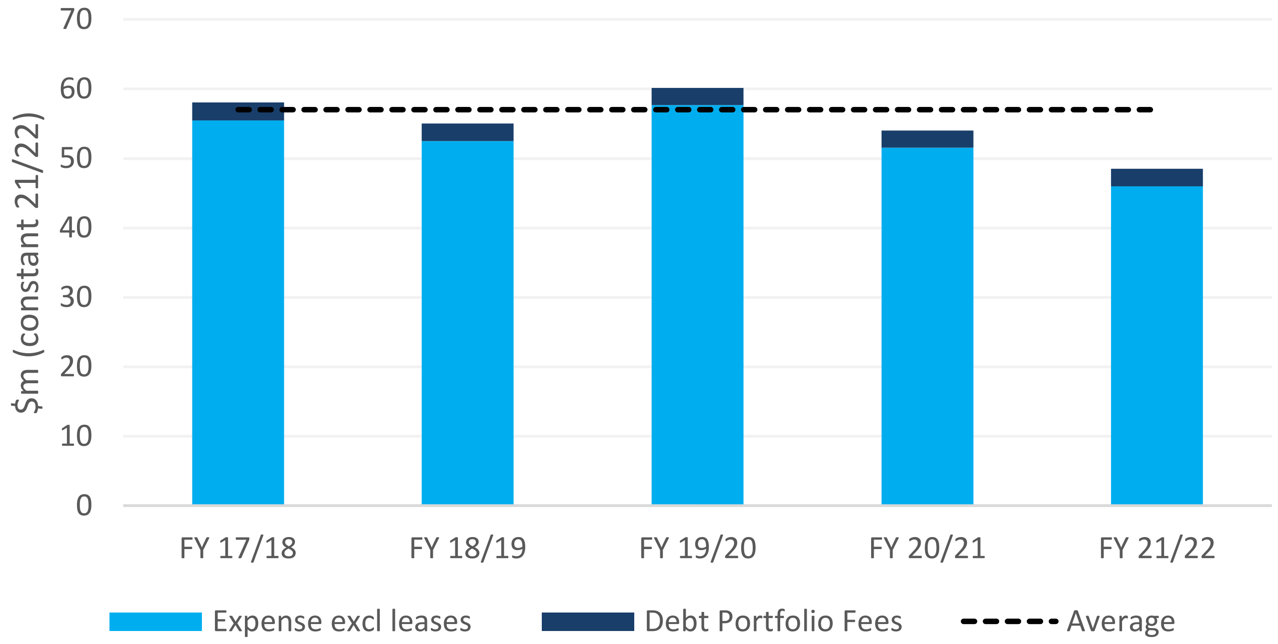
The choice of 2021/22 as the base year for business support opex is consistent with other opex categories and its selection as an efficient and reasonable year is discussed in further detail in Section 13.3 of this report.

In relation to business support opex specifically, Transpower assessed the appropriateness of 2021/22 as a base year by undertaking historical trend analysis and reviewing whether 2021/22 included any atypical expenditure items. Transpower has noted that from 2020/21 business support includes TPM costs and debt portfolio fees which includes costs for obtaining ratings, listings, trustee, and registry services but excludes debt raising costs. Prior to RCP3 the debt portfolio fees were categorised as Finance Costs whilst TPM implementation costs did not exist prior to 2020/21. Transpower deem the TPM costs a permanent upward adjustment to business support costs as more staff are needed to undertake the modelling and billing requirements of the new TPM.

The following figure shows the business support expenditure from 2017/18 to 2021/22 adjusted to include TPM from 2020/21 and debt portfolio fees from 2017/18. In 2021/22, the total business support opex is $48.5m, which includes an uplift of $4.5m for TPM.

[327] EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 1; page 4

Figure 17-5 Historical business support opex



Source: EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 1; page 4

Based on the above, Transpower has deemed 2021/22 as an appropriate choice as base year for the development of the business support opex. The base year cost of $48.5m (which includes $4.5m for TPM) has been further adjusted for a number of atypical, non-recurring costs. These include:

– 2021/22 costs included a one-off credit for the reversal of the Commerce Commission penalty provision of $3.0m. $3.0m has been added back to base year cost to account for this.
– Covid-19 restrictions in 2021/22 reduced travel. $0.3m has been added to the base year cost to account for normalised travel in the base year.
– 2021/22 costs included home equipment refunds. As this is expected to be a non-recurring expenditure, $0.3m was removed from the base year cost.
– Debt portfolio fees were reduced by $0.4m as the 2021/22 cost of $2.9m was deemed unusually high and costs are expected to be closer to $2.5m going forward.

The adjustments are summarised in the table below. Following these adjustments, a base year cost of $51.2m has been established and applied each year from 2022/23 onwards. Over the RCP4 period, this amounts to a total expenditure of $255.9m.

Table 17-5 Adjustments to the 2021/22 base year for non -recurring expenditure ($m)

Movements from the base	Adjustment to base year
2021/22 actual	44.0
Add 2021/22 Transmission Pricing Methodology	4.5
Base 2021/22	48.5
Adjustments:	
– Legal Fees credit in 2021/22 removed from base	3.0
– Increase travel as 2122 was low due to Covid	0.3
– Reduce work from home equipment refunds as 2021/22 was high due to Covid	(0.3)
– Remove higher than usual 2122 Debt Raising Costs	(0.4)
Total Adjustments	2.7
Proposed base year cost	**51.2**

Source: EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; section 1.6

17.4.2 Steps

The step increments applied by Transpower to the base year cost to derive the business support opex forecast can be defined into two key categories:

- Those relating to changes in the ***internal resourcing*** requirement (changes in FTE).
- Those relating to ***resource building initiatives*** and TPM.

Each step increment is discussed below.

17.4.3 Internal resourcing step increase (FTE)

As noted above, a key driver of business support expenditures are the workforce costs of permanent employees and contractors across six divisions - Information Services and Technology, External affairs, Corporate services, Corporate governance (Regulatory Affairs), People and Customer and Strategy. Therefore, a key driver of the change in future business support opex is Transpower's forecast resourcing plan, driven by its work programme.

Transpower has identified two separate 'steps' in its resourcing needs:

- A step in resourcing from 2021/22 to 2022/23, and
- The resourcing from 2023/24 onwards.

Transpower has split these two resource driven step changes into two because the step changes in FTE in 2022/23 have already been actioned through its budget process and the positions have been recruited. In effect, the step change in workforce (and associated cost as noted later) will ultimately be added to the base year when Transpower updates its opex projections to switch from a base year of 2021/22 to 2022/23 for its final submission to the Commerce Commission[328]. The step change in resourcing required from 2023/24 onwards remains a forecast and is set out as a separate step change by Transpower for transparency.

In the sub-sections below, we first set out Transpower's planned changes in workforce by division from the 2021/22 base year through to the end of RCP4. We then set out how those changes are captured as a step change in the business support opex forecast.

Information Services and Technology (IST)

Transpower's business support opex overview indicates that there are three key drivers behind changes in the IST workforce requirement from 2023/24 onwards:

- **TransGO refresh programme**: TransGo Refresh is a large investment project driven by a detailed investment case. There is a need to recruit resources to deliver the project.

  All project resources will be capitalised, therefore there is no financial impact on the business support opex forecast, although headcount is still reported within business support. Additionally, the FTEs associated with the TransGo Refresh programme are expected to reduce as the project moves to completion. The additional head count peaks at 7 FTE and will reduce towards the end RCP4 and into RCP5.
- **IST Project resource**: Additional resources are required to manage and deliver additional ICT projects. The Modernisation Plan and introduction of the Enterprise Business Capability programme requires updates to several key applications. Within business support opex, the allocation relates to both modernisation of the current key applications and the introduction of Enterprise Business Capability. This will be dominated by the large scale Enterprise Business Capability programme of works.

  Additional resources are also required to support the projected increase investment in grid connections. This is shown as additional resource due to the increasing capital plan. The business support overview document shows between 70% and 80% of the cost is capitalised with recruitment of up to 12 FTEs across RCP4. As with TransGo Refresh above, whilst some of the costs are capitalised and therefore only a proportion of the total costs impact business support opex, the full headcount is still reported within business support.
- **Resource and capability**: An increase in ICT resource to support the increase in Transpower workforce in areas of support services, specifically around cyber security incident response and end-user support. Transpower has identified an underlying increase in total employees and its Service Providers, and as such,

[328] Transpower, EOP010 Business Support Opex Overview.docx Version 0.5; July-2023

there is a need to increase the ICT related resources, by up to 8 new employees, to provide ICT end-user support services and cybersecurity responses. The cost will be 100% allocated as business support opex.

The following table presents the IST division headcount from 2021/22 (base year) through to the end of RCP4. The number of FTE has increased across 22/23 from 169 to 190. Further growth is expected with the number of FTEs increasing to 215 FTE at the start of RCP4, before reducing again to 193 FTE by the end of the RCP4 period. The increase beyond 2022/23 is profile is heavily driven by the ramp up and down associated with the TransGo project as noted above.

Table 17-6 IST change in FTEs and contractors across RCP3 and RCP4

IST	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	169	169	169	169	169	169	169	169	169
22/23 step	-	21	21	21	21	21	21	21	21
FTE step	-	-	8	20	25	25	9	7	3
Total	**169**	**190**	**198**	**210**	**215**	**215**	**199**	**197**	**193**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

External affairs

The external affairs division are responsible for external relationships with stakeholders, regulators, and communities. Originally corporate communications, landowner relations and property, community and Iwi relations, environmental policy, planning, and sustainability were part of external affairs, but are now reported as AM&O.

Transpower identify three drivers behind changes in the external affairs workforce across RCP3 and RCP4[329]:

– The increasing sustainability and climate change obligations and growing biodiversity requirements under international obligations and domestic law.
– Responding to changes to the current resource management legislation, with the Natural and Built Environment Bill and the Spatial Planning Bill requiring significantly different approaches to environmental planning and approvals.
– Increase in maintenance and grid enhancement work and an increase in major capital projects and customer connections.

Table The following table presents the proposed workforce in the External Affairs division from 2021/22 to the end of RCP4. There is no step increase in FTE in 2022/23 in this division. Three FTE are added in 2024/25 and a further employee added in 2026/27. Of the 4 FTE identified, 3 FTE relate to Iwi Relations, Regional Engagement and Sustainability whilst a further FTE relates to Corporate Communications.

Table 17-7 External Affairs change in FTEs and contractors across RCP3 and RCP4

External Affairs	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	13	13	13	13	13	13	13	13	13
22/23 step	-	-	-	-	-	-	-	-	-
FTE step	-	-	-	3	3	4	4	4	4
Total	**13**	**13**	**14**	**16**	**16**	**17**	**17**	**17**	**17**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

[329] Business support Response – External Affairs and Corporate Services FTE additional information.docx

Corporate services

Corporate Services includes finance, procurement, and supply (including warehousing), risk, assurance, and treasury teams. These are core business units within Transpower. In terms of drivers for the additional resourcing capability, Transpower has provided the following three reasons.

– Responding to the need to report on Business Payment Practices legislation once implemented and to coordinate the delivery of Climate reporting requirements.
– The increased number of projects and fixed assets resulting from those projects drives a need for additional resources in Projects and Fixed Assets Accounting team and TPM.
– Material uplift in customer connections drive a need for additional resources to assist with the administration and billing associated with Transpower works agreements.[330]

Transpower has stated a need to increase the Corporate Services FTEs by three in three areas, namely:

– 1 FTE in Climate Reporting and Business Payments Practices Regulations.
– 1 FTE in Projects and Asset Accounting.
– 1 FTE in Accounts receivable.

The following table presents the change in FTE’s in the division from 2021/22 to the end of RCP4. Transpower has recruited two additional FTE’s in this division in 2022/23, increasing the total number of FTEs from 41 to 43. However, Transpower forecast a reduction in FTE of a similar amount by the start of RCP4, with 41 FTE forecast throughout the RCP4 period.

Table 17-8 Corporate Services change in FTEs and contractors across RCP3 and RCP4

Corporate Services	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	41	41	41	41	41	41	41	41	41
22/23 step	-	2	2	2	2	2	2	2	2
FTE step	-	-	-3	-2	-2	-2	-2	-2	-2
Total	**41**	**43**	**40**	**41**	**41**	**41**	**41**	**41**	**41**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

Corporate governance (Regulatory Affairs)

Corporate governance is accountable for the provision of legal advice to Transpower management, setting internal governance policies, regulatory affairs, and grid pricing.

The following table shows the expected change in FTEs in the division from 2021/22 to the end of RCP4.

Table 17-9 Corporate Governance (Regulatory Affairs) change in FTEs and contractors across RCP3 and RCP4

Corporate Governance	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	26	26	26	26	26	26	26	26	26
22/23 step	-	4	4	4	4	4	4	4	4
FTE step	-	-	2	4	5	6	8	7	6
Total	**26**	**30**	**32**	**34**	**35**	**36**	**38**	**37**	**36**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

In 2022/23, Transpower has recruited a further 4 FTE, increasing the total number of FTE from 26 to 30. Transpower propose to engage an additional 8 FTEs from 2023/24 onwards, as set out below:

– 2 FTE relating to Regulatory Affairs.

[330] Business support Response – External Affairs and Corporate Services FTE additional information.docx

– 4 FTE relating to Grid Pricing with the total number of FTEs supporting grid pricing forecast to reduce by 3 towards the end of RCP4 as the TPM process matures.
– 2 FTE relating to Corporate Governance (legal).

The forecast number of FTEs is expected to peak at 38 in RCP4 from 34 at the end of RCP3. The driver for the additional FTEs is listed as[331]:

– Increased volume and complexity of key regulatory instruments such as Input Methodologies, RCP and TPM regimes.
– The development and filing of a significantly increased volume of major capital projects for major capital investments with greater complexity and more complicated property rights and consenting requirements.
– The commencement (on 1 April 2023) of a fundamentally changed customer pricing regime in the TPM based on benefits-based charging requiring significantly more modelling and customer pricing interactions and anticipating litigation and pricing disputes that will flow from that.
– A significant increase in volume and complexity of customer connection contracts and negotiations required.
– The introduction of significant changes to Resource Management laws in the form of the Natural and Built Environment Bill and the Spatial Planning Bill and the expectation of large volumes of litigation to bed in the reforms.

In terms of Regulatory Affairs and Legal FTEs, there are changes being introduced which may be more complex or introduce additional issues – litigation is stated as an expectation with new Bills.

People

The People function is a general grouping of four areas, namely:

– Health and safety,
– Facilities management,
– Human resources, and
– Technical training.

The following table shows the expected growth in FTEs in the division. There is significant growth expected in the people division headcount, primarily before the end of RCP3.

Table 17-10 People change in FTEs and contractors across RCP3 and RCP4

People	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	51	51	51	51	51	51	51	51	51
22/23 step	-	8	8	8	8	8	8	8	8
FTE step	-	-	26	31	33	34	37	37	37
Total	**51**	**59**	**85**	**90**	**92**	**93**	**96**	**96**	**96**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

The primary driver for these roles is set out below.

– The forecast growth in the people division is primarily related to increasing recruitment activity and an increased number of Transpower employees.
– The increase in the volume of trainees requires additional trainers.
– Increases in the Health and Safety and Facilities management teams are required to create team resilience and enable improved policy compliance.

There is a step up in FTE allocated to the People division in 2022/23 of 8 FTE, taking the total FTE in the People division to 59 FTE. This is followed by a further 26 FTE in 2023/24. By the end of RCP4, a total of 37 additional FTE is forecast (over and above 2022/23).

[331] EOP010 Business Support Opex Overview.docx

Of the 37 FTE, Transpower has identified the following roles:

– 16 FTE Graduates.
– 12 FTE Grid Skills (including transfers from Contractor to employee), including:
  - 2 X NGOC system trainers to complement the current capability to train the new starters.
  - 2 x Learning Design Specialist for redevelopment and update the existing maintenance activities to support the number of new OPTI/IST projects.
  - 1 x learning Resource Developer for building learning resources following design reviews. The current volume is exceeding the current team capacity.
  - 4 x Grid skill facilitators with the expected increase in course delivery and reducing reliance on outsourced training.
  - 1 x learner manager to coordinate and identify upskilling solutions.
  - 1 x administrator to support the increase in FTEs and the consequential increase in administrative tasks.
  - 1 x Sector Management Specialist to manage the interface between Transpower and school careers officers. Also raising awareness of Transpower as a vocation.
– 3 FTE Safety & facilities, including:
  - 2 x Health and Safety specialists driven by the increase in FTEs along with the need to enable improved policy compliance.
  - 1 x Facilities Management role to improve team resilience.
– 5 FTE People Services, including:
  - 1x Recruitment Co-Ordinator to deliver increase 24% increase in FTE count.
  - 1x Grad Co-Ordinator to deliver the increased number of graduates (100% increase in grad programme).
  - 1x Work Force Planning role which is a new capability.
  - 1x HRIS analyst to support the implementation and maintenance of a Human Resources Information System.
  - 1 x Business Partner driven by 24% increase in FTE from FY23.

A total of 16 graduates are planned to be recruited from 2023/24 onwards, however the graduate intake profile by year is not known. In practice, new graduate recruits are initially allocated to the People function during their training period and then subsequently transferred to their respective designated functions upon completion of their training. In most cases, these graduates would be re-assigned to operations, but not exclusively so.

The profile of FTE presented above suggests that the graduate intake of 16 FTEs are not re-allocated to their designated functions for the purposes of this regulatory reporting process. If they were re-allocated, we would expect a different FTE profile to be exhibited that would be lower in total terms and reflect the more cyclical nature of the process occurring in practice.

Transpower has confirmed via an RFI that the graduate FTE and the associated costs of these graduates are assumed to remain allocated to the People division once they join the business. This would appear a reasonable assumption on the basis that the final destination of the graduates may not yet be known.

Customer and strategy

The customer and strategy function is responsible for the development and implementation of Transpower's organisational strategy and innovation. This function includes strategy advisor roles, EMS Delivery, EMS Development, and Tradepoint teams, as well as the customer and commercial functions.

The driver for the additional FTEs in the customer team is related to the increase in the number of new customers (non-incumbents) and increased interaction with existing customers as part of the increased activity around decarbonisation[332].

[332] EOP010 Business Support Opex Overview.docx

The following table shows the expected growth in FTEs in the division. The increase is spread across the RCP4 period, and there is acknowledgement that the new connections work is increasing over the RCP4 period. The 3 FTE identified have been allocated to Customer Service roles.

Table 17-11 Customer and Strategy change in FTEs and contractors across RCP3 and RCP4

Customer & Strategy	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
Base	22	22	22	22	22	22	22	22	22
22/23 step	-	2	2	2	2	2	2	2	2
FTE step	-	-	-	-	1	2	3	3	3
Total	**22**	**24**	**24**	**24**	**25**	**26**	**27**	**27**	**27**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

Summary of internal resourcing step increase (FTE)

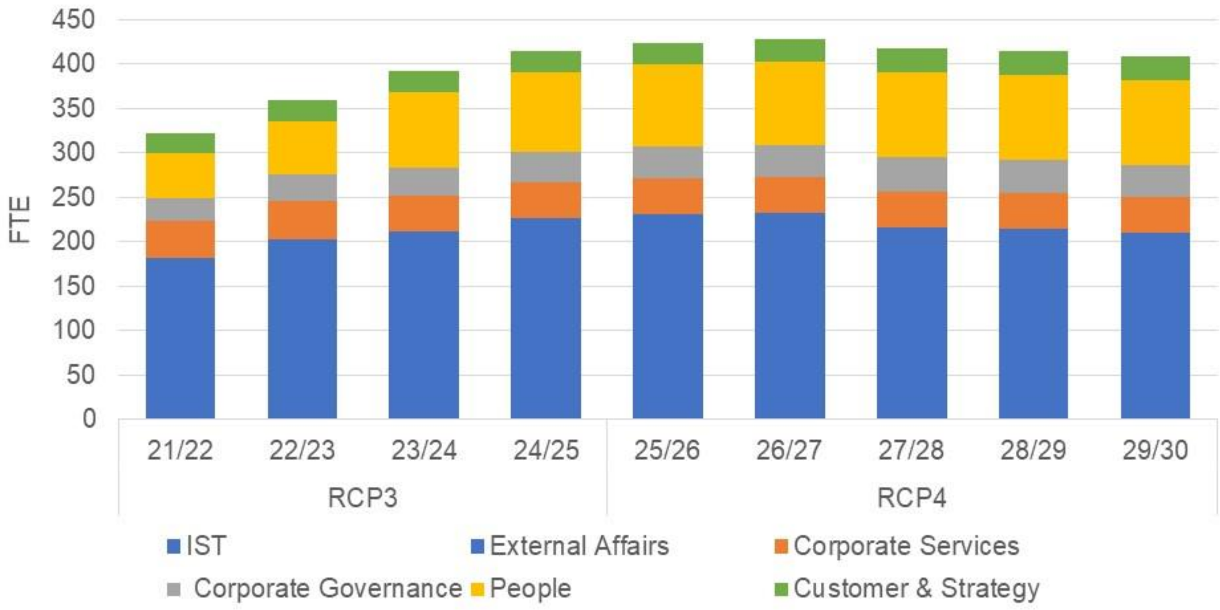
The following table and figure summarise the total number of FTEs allocated across each of the six divisions.

Table 17-12 Summary of FTEs total under Business Support

Total FTE	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
IST	169	190	198	210	215	215	199	197	193
External Affairs	13	13	13	16	16	17	17	17	17
Corporate Services	41	43	40	41	41	41	41	41	41
Corporate Governance	26	30	32	34	35	36	38	37	36
People	51	59	85	90	92	93	96	96	96
Customer & Strategy	22	24	24	24	25	26	27	27	27
Total	**321**	**359**	**392**	**415**	**424**	**428**	**418**	**414**	**409**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

Figure 17-6 Business support total FTEs (RCP3 and RCP4)



Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

Transpower has increased its budgeted workforce across the six business support divisions by 37 FTE in 2022/23, increasing the total FTE from 321 to 359. As noted above, this increase in FTE has already been actioned by Transpower and the positions have either been recruited or recruitment is underway. Of this 37 FTE, 21 FTE were added to the IST division, 8 to the people division, 4 to corporate governance and 2 each to corporate services and customer and strategy. External affairs did not receive any additional FTE.

The following table shows a summary of the step increases in FTEs across the six divisions from 2022/23 to 2023/24 and onwards. This remains a forecast. Transpower intends to grow the Business Support FTEs from 359 in 2022/23 to 428 in 2026/27, an increase of 27% over the four years. As a large proportion of the increase in this period relates to IST (and predominantly the TransGo Refresh project) and there will be a reduction as the project is delivered. By the end of RCP4, business support FTE's will have grown by only 14% from 2022/23. We note that the People division FTE includes graduates that, in practice, would move onto operations on completion of their training but do not move out of the People division in Transpower's regulatory reporting evaluated in this report.

Table 17-13 Summary of FTEs step increases under Business Support

FTE Step	RCP3				RCP4				
	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30
IST	-	-	8	20	25	25	9	7	3
External Affairs	-	-	-	3	3	4	4	4	4
Corporate Services	-	-	-3	-2	-2	-2	-2	-2	-2
Corporate Governance	-	-	2	4	5	6	8	7	6
People	-	-	26	31	33	34	37	37	37
Customer & Strategy	-	-	-	-	1	2	3	3	3
Total	**-**	**-**	**33**	**56**	**65**	**69**	**59**	**55**	**50**

Source: Transpower, IV AMO BS FTE Dollars V2.xlsx

17.4.4 Cost impact of step change in internal resourcing

Transpower has identified three step cost impacts relating to the changes in FTE. These are set out below:

2022/23 FTE uplift

Transpower has supplemented the Business Support opex forecast for 2022/23 with actual costs for 2022/23 based on actual recruitment. As noted above, 37 additional (net) FTEs have been added to the 2022/23 budget. Transpower has established that the opex cost increment associated with these additional employees in 2022/23 is $4.0m and has applied this opex cost as a step increment for the remainder of the forecast period.

For RCP4, this amounts to a step increment of $20.0m.

2023/24+FTE changes

Transpower has identified a separate business support opex step increment relating to the changes in FTE from 2023/24 onwards. A proportion of the total costs identified are capitalised. The following table summarises the total cost, the rate of capitalisation and subsequently the amount of expenditure that is reported as business support opex from those FTE allocated to the IST division.

Table 17-14 IST workforce cost allocation and capitalisation for RCP4

Growth from (22/23 $m)	RCP3		RCP4					Total RCP4 ($m)
	23/24	24/25	25/26	26/27	27/28	28/29	29/30	
FTE	8	20	25	25	9	7	3	-
Total cost ($m)	0.9	2.1	3.0	3.2	1.2	0.9	0.3	8.6
Capitalisation (%)	72	64	61	58	45	17	-	-
Business support opex ($m)	**0.3**	**0.7**	**1.1**	**1.3**	**0.6**	**0.7**	**0.6**	**4.4**

Source: Transpower, EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 6; page 11

The following table summarises the total cost, the rate of capitalisation and subsequently the amount of expenditure that is reported as business support opex from those FTE allocated to the other five divisions (i.e. the non-IST workforce). A capitalisation rate of 2% has been applied to these costs and this data aligns with the data presented in the RT01 expenditure schedule. However, it is noted that some of the data contained within the business support opex overview does not show a capitalisation of these costs.

Table 17-15 Non-IST workforce cost allocation and capitalisation for RCP4 ($m)

Growth from (22/23 $m)	RCP3		RCP4					Total RCP4
	23/24	24/25	25/26	26/27	27/28	28/29	29/30	
FTE	25	35	40	44	49	48	47	-
Total cost ($m)	1.6	3.5	4.3	5.1	5.8	5.6	5.4	26.2
Capitalisation (%)	2	2	2	2	2	2	2	-
Business opex ($m)	**1.5**	**3.4**	**4.2**	**5.0**	**5.7**	**5.5**	**5.3**	**25.8**

Source: Transpower, EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 9; page 13

A summary of the business opex step increment (post capitalisation) is shown in the following table.

Table 17-16 Business Support workforce capacity and allocation ($m)

Growth from (22/23 $m)	RCP3		RCP4					Total RCP4
	23/24	24/25	25/26	26/27	27/28	28/29	29/30	
FTE	33	56	65	69	59	55	50	-
Total cost ($m)	2.4	5.6	7.3	8.3	7.0	6.5	5.7	34.8
Capitalisation (%)	19	25	25	22	8	4	-	-
Business opex ($m)	**1.8**	**4.1**	**5.4**	**6.3**	**6.3**	**6.2**	**5.9**	**30.1**

Source: Transpower, EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 4; page 9

Overhead

Overhead is an allocation of *other* FTE related costs that were incurred by Transpower, such as the Kiwisaver scheme. It also includes other employee related costs. A total of $2.8m is forecast for the RCP4 period. The table below shows the forecast for other costs. Other costs are approximately less than 1% of the overall proposed RCP4 business support opex. Consistent with the principle of proportionate scrutiny[333], we have not sought detailed information on how these 'other costs' have been estimated.

Table 17-17 Business Support other costs ($m)

Growth from (22/23 $m)	RCP3		RCP4					Total RCP4
	23/24	24/25	25/26	26/27	27/28	28/29	29/30	
Other costs	0.2	0.4	0.6	0.6	0.6	0.5	0.5	2.8

Source: Transpower, EOP010 Business Support Opex Overview.docx Version 0.5; Dated July-2023; table 4; page 9

[333] ToR clause 20.6

Summary of internal resourcing step increment

The step additions set out above are summarised in the following table.

Table 17-18 Summary of internal resourcing step for RCP3 and RCP4 ($m)

Business Support FTEs	RCP3					RCP4					
	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
FTE uplift to 2022/23	-	4.0	4.0	4.0	12.0	4.0	4.0	4.0	4.0	4.0	20.0
Base FTE 2023/24 onwards	-	-	1.8	4.1	5.9	5.4	6.3	6.3	6.2	5.9	30.1
Overhead	-	-	0.2	0.4	0.6	0.6	0.6	0.6	0.5	0.5	2.8
Total	**-**	**4.0**	**6.0**	**8.6**	**18.5**	**10.0**	**11.0**	**11.0**	**10.8**	**10.4**	**53.2**

Source: Transpower, REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

17.4.5 Resource building initiatives step increase

As noted above, Transpower also proposes a step increment in business support opex relating to resource building initiatives and the TPM. The resourcing building initiatives step is summarised in the following table.

Table 17-19 Summary of Resource Initiatives and TPM total under Business Support for RCP3 and RCP4 ($m)

Business Support (Sm)	RCP3					RCP4					
	21/22	22/23	23/24	24/25	Total	25/26	26/27	27/28	28/29	29/30	Total
Promote Transpower	-	-	0.7	0.6	1.2	0.3	0.3	0.3	0.3	0.3	1.5
International recruitment	-	-	0.5	0.5	0.9	0.2	0.2	0.2	0.2	0.2	1.2
Attract interns	-	-	0.2	0.3	0.4	0.3	0.3	0.3	0.3	0.3	1.5
TPM Forecast	-	-	-0.2	-0.3	-0.5	0.3	1.6	0.3	0.3	0.3	2.9
Total	**-**	**-**	**1.1**	**1.1**	**2.2**	**1.2**	**2.4**	**1.2**	**1.2**	**1.2**	**7.1**

Source: Transpower, REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

The resource building initiatives to promote Transpower, international recruitment and attract interns is approximately $0.8 million per annum in RCP4, which is lower than assumed in RCP3. Although it is a relatively low amount. Consistent with the principle of proportionate scrutiny, we have not sought detailed information on how this step has been calculated. It would be reasonable to assume the higher costs in RCP3 relate to the required recruitment drive needed to step up the FTE headcount, but this is our interpretation only.

We note that the TPM expenditure profile includes a one-off expenditure of $1.6m in 2026/27. Consistent with the principle of proportionate scrutiny, we have not sought detailed information on how this step has been calculated. We note that step changes in FTEs in the corporate governance division include additional FTEs to address the need for increased TPM capability. Those FTEs are reflected in the business support opex requirement through the workforce allocation shown in Table . The Commerce Commission may wish to seek evidence from Transpower that the TPM costs have not been accounted for twice in the business support opex forecast.

17.4.6 Trend

Transpower do not use an output growth trend for Business Support, instead relying on the step changes linked to its resourcing plan and work programme growth. A productivity adjustment has been applied by Transpower as discussed in the next sub-section.

17.4.7 Proposed business support opex

The following table summarises the business support opex forecast for RCP3 and RCP4 as set out in the previous sub-sections.

Table 17-20 Summary of Business Support categories for RCP3 and RCP4 ($m)

	RCP3						RCP4					
Component	**20/21**	**21/22**	**22/23**	**23/24**	**24/25**	**Total**	**25/26**	**26/27**	**27/28**	**28/29**	**29/30**	**Total**
Base	54.0	48.5	51.2	51.2	51.2	256.1	51.2	51.2	51.2	51.2	51.2	255.9
Internal resourcing step			4.0	6.0	8.6	18.5	10.0	11.0	11.0	10.8	10.4	53.2
Resource building and TPM step	-	-	2.4 *	1.1	1.1	4.6	1.2	2.4	1.2	1.2	1.2	7.1
Productivity savings	-	-	-	-0.1	-0.2	-0.3	-0.5	-0.9	-1.2	-1.5	-1.8	-5.8
Total	**54.0**	**48.5**	**57.6**	**58.2**	**60.6**	**278.9**	**61.8**	**63.7**	**62.1**	**61.7**	**61.0**	**310.4**

Source: REG016 RCP4 RT01 20230807.xlsx, worksheet ‘BS’
* Budget reconciliation and movement of costs from another division rather than resource initiatives. Included for simplicity and transparency.

As noted above, Transpower has applied a Productivity Adjustment to reflect expected ongoing productivity improvements as a trend. An assumed an annual improvement of 0.5% has been applied. The adjustment for productivity improvements reduces the RCP4 opex forecast by $5.8m.

The total Business Support opex for RCP3 is reported as $278.9 million – noting that we have included the outturn cost of $54.0m in 2020/21 and $2.4m of budget reconciliation in 2022/23 within the resourcing building step for reporting simplicity. The proposed business support opex requirement increases to $310.4m in RCP4.

17.5 Evaluation

Business support opex is an identified programme. To assess whether Transpower’s business support opex proposal for RCP4 is prudent and efficient, we have followed the evaluation criteria and employed the evaluation methods described for an identified programme in Section 13.2 of this report.

Our evaluation has involved reviewing the business support strategy and workforce policy. We have also reviewed the numerical data and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and decisions that have informed Transpower’s business support opex proposal.

Transpower has adopted a base-step-trend approach to establish the business support opex forecast. Each element is discussed in more detail below. First, we provide an overview of the proposed opex requirement from the perspective of an annual cost per FTE.

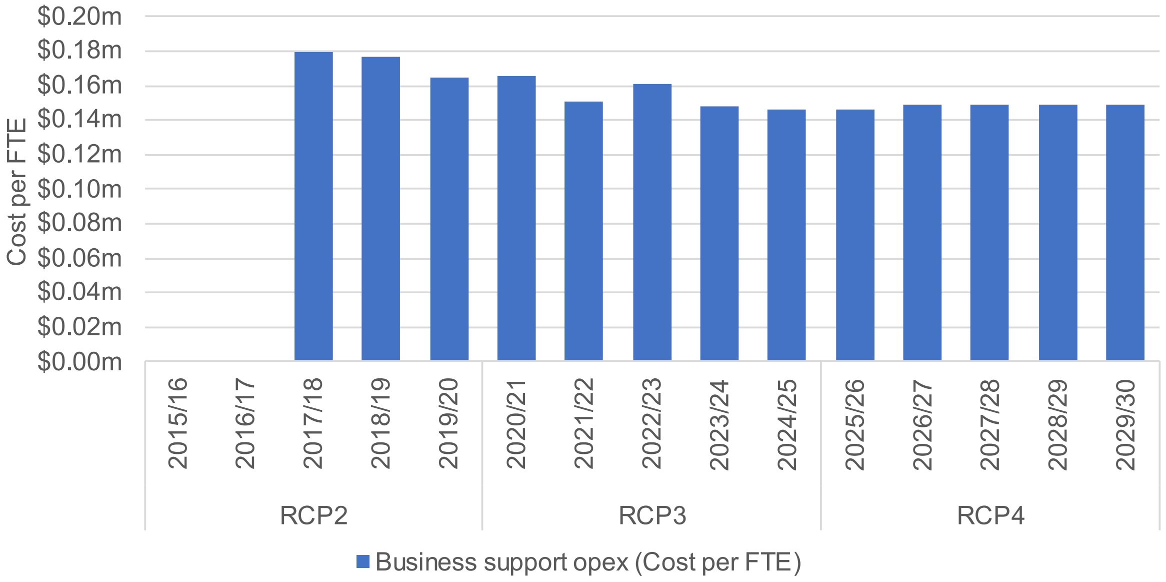
17.5.1 Cost per FTE

Whilst it is evident that Transpower is forecasting an increase in workforce and in turn an increase in business support opex, it is important to understand if the proposed costs are growing broadly in line with the FTE increases, at a faster pace or a slower pace. A simple but effective way to analyse this is through a simplistic calculation of the cost per FTE. Cost per FTE analysis can provide insight into the overall reasonableness of the opex forecast that looking at only headcount growth or cost growth in isolation cannot. It can provide an appreciation of the synchronisation of the two.

The following figure shows the average business support opex cost per FTE from 2017/18 through to the end of RCP4 (2029/30). In this analysis, we have adopted the whole business support opex costs as reported in the RT01 expenditure schedule and compare this to the known business support FTE headcount and forecast headcount set out in the preceding sections (Table).

We note that there is some cost recategorization occurring in the historic cost data prior to 2020/21 (as noted by Transpower and considered within their base year cost analysis discussed in Section 17.4 of this report). An adjustment has not been applied nor is it required for this high-level analysis. On a similar basis, as the cost data includes a wider range of cost components, we also note that the resulting cost per FTE is not intended to reflect an average salary for the identified business support FTE. Finally, we note that the headcount considered as 'business support' includes all FTE's previously discussed and analysed. However, a proportion of total costs relating to the changes in headcount are capitalised. Again, we do not believe that this is sufficient to detract from the general trending and finding of the below analysis.

Figure 17-7 Business Support cost per FTE for RCP3 and RCP4



Source: Transpower, REG016 RCP4 RT01 20230807.xlsx, worksheet 'BS'

The average cost per FTE ranges from nearly $180k per FTE in 2017/18 to around $145k per FTE at the end of RCP3/start of RCP4. By the end of RCP4, the cost per FTE has increased by around 2.5% to a little over $149k per FTE. Overall, from 2023/24 onwards, the business support opex cost per FTE is stable between $145k and $149k, although it does appear to be increasing slowly over time.

Noting that there are one-off costs and non-salary related costs included in the business support opex cost build used in the above, the high-level analysis suggests that the business support costs and headcount are moving in proportion to each other across the later part of RCP3 and throughout RCP4. It is difficult to infer too much from the costs presented in RCP2 and early RCP3 due to some cost reclassifications, although the general trend points to a reduction in the overall cost per FTE before the apparent stabilisation from 2023/24 onwards.

There is a one-off increase in the cost per FTE in 2022/23 that is immediately reversed in 2023/24. There are a number of things going on in 2022/23 that may cause this:

– This is the first year in which the base cost of $51.2m is adopted within the forecast – and thus includes some base year cost adjustments to the 2021/22 outturn cost.
– This is the year in which Transpower has applied a one-off step cost increment of $4.0m to account for the completed recruitment of 37 FTE in that year.
– There are some additional one-off budget re-allocations (net impact of +$2.4m) also occurring in this year[334].

Given the immediate reduction in cost per FTE in 2023/23 it is not likely that the base year cost valuation is driving the short-term jump in cost per FTE in 2022/23.

The other two factors both appear to relate to Transpower knowing the outturn costs for the year and that they are seeking to incorporate such knowledge into the 2022/23 'forecast' year - ahead of their expected recalculation of opex by moving to a 2022/23 base year ahead of final submission to the commission.

[334] This cost is identified against resource building initiatives step change in previous sections for simplicity.

Such practices need to be carefully considered by Transpower. For example, the $4.0m step increment applied in relation to the 37 FTE's employed in 2022/23 is applied equally in all future years. This implies that the $4.0m of opex covers the total expected opex cost to be incurred in 2022/23 as well as all future years for those 37 FTE. However, given it is unlikely that each of those FTE's started employment on the first day of the new financial year in 2022/23, there may be a slight disparity in the costs being appropriate for both 2022/23 and all future years.

For example, the costs could be marginally over-stated in 2022/23 (as they reflect a full year of costs associated with 37 FTE but each of the 37 FTE were not employed by Transpower in each day of 2022/23). Alternatively, the costs are understated from 2023/24 onwards (as they reflected a profiled recruitment of the 37 FTE in 2022/23 and these are being applied going forward).

That the cost per FTE reduces again in 2023/24, if this is a driver for the short term spike in cost per FTE, it is most likely that the 2022/23 cost is potentially slightly overstated rather than being understated in future years.

Likewise, the step change in cost per FTE could also be driven by the one-off budget reconciliation that has occurred in 2022/23. As this is applied as a one off however, it would have no impact the RCP4 forecast.

Overall, the cost per FTE profile suggests that business support opex costs are growing broadly in proportion to the change in FTE – as would be expected – and gives comfort that the link between proposed costs increases and proposed FTE changes are stable.

17.5.2 Assessment of the base approach

The choice of base year as an appropriate year is discussed in detail in Section 13.3 of this report. This section analyses the data and the approach to define that year with the correct inputs.

For business support opex a single base year cost has been used across all divisions - $51.2m per annum. The annual average and historic profile of costs are used as a starting point for Transpower's assessment, but ultimately the base year cost is derived from a bottom-up build of costs incurred across the whole of Business Support. The base year cost is reviewed to ensure that any one-off costs are appropriately discounted and any costs excluded by may be incurred going forward are added. Examples include:

– Reduction due to work from home equipment refunds
– Removal of higher than usual debt raising costs
– Inclusion of TPM costs.

Transpower has provided a detailed business support overview document that sets out the bottom-up base year cost build and the adjustments. We have been able to follow the adjustments applied by Transpower and reconcile those with the proposed business support opex forecast set out in the RT01 expenditure schedule.

We are of the opinion that the base expenditure approach and resulting base year cost value is reasonable. The base year cost for 2021/22 is below the historic average.

It should be noted that Transpower plans to re-state its base year to 2022/23.

17.5.3 Assessment of the step approach

The step increments applied by Transpower to the base year cost to derive the business support opex forecast can be defined into two key categories:

– Those relating to changes in internal resourcing requirement (changes in FTE).
– Those relating to resource building initiatives and TPM.

The internal resourcing requirement accounts for a $53.2m step change in RCP4 (prior to productivity adjustments), whereas the resource building initiatives account for $7.1m (also prior to productivity adjustments), of which $2.9m relates to ongoing increases in TPM related costs. As such, a key driver of the change in future business support expenditures is Transpower's forecast resourcing plan, driven by its work programme.

Internal resourcing

The number of FTEs forecast to be recruited each year is shown in the figure below.

Transpower's plan is heavily focussed on recruiting 93 FTEs (and contractors) by the end of RCP3 – 37 FTE in 2022/23, 33 FTE in 2023/24 and another 23 in 2024/25. The recruitment drive starts to tail off at the start of RCP4, with only 9 FTE required in 2025/26. From 2027/28, the overall recruitment turns negative (net reduction in FTE) as the TransGo Refresh requirements reduce.

This places a challenge on Transpower to ensure that they do recruit the necessary staff early so they are in place to deliver the projects. We discuss deliverability issues in more detail in Section 7 of this report.

Figure 17-8 Recruitment requirement per annum to meet the business support opex step

Source: IV AMO BS FTE Dollars V2.xlsx; GHD analysis

The annual FTE requirement is defined for each of the six divisions considered within the reporting of business support opex for RCP purposes. In IST business support in most cases the increases in FTE are linked to the implementation of investment cases, and as these investment cases are delivered, the business support opex element will start and adjust as the project requires. In non-IST business support there are also step increases in management and governance roles, especially around corporate governance where it is seen that the regulatory instrument and controls are becoming more onerous and complex.

The following table summarises our FTE evaluation.

Table 17-21 Summary of step change findings for Business Support categories for RCP4

Area	Max FTE#	Evaluation
TransGo Refresh	7	TransGo Refresh is supported with an Investment Case which is reviewed in Section 11.5.3 of this report. The Investment Case sets out the roadmap and the expected timeline to deliver the project. The Investment Case does identify the need for additional resources when TransGo Refresh is rolled into business as usual. We are of the opinion that the Investment Case is reasonable, as is the subsequent FTE requirement.
IST Project resource	12	Along with the large TransGo Refresh, there is a second initiative to modernise key applications and to deliver the capital plan. The capital plan includes eleven other Investment Cases which captures those resource needs. Most of this cost is capitalised against the Investment Case they are delivering against. We are of the opinion that the Investment Cases are reasonable, and therefore the stated FTE requirement is also reasonable.

Area	Max FTE#	Evaluation
Resource and capability	8	These additional staff provide underlying ICT resources to support existing and new FTEs. Overall, there is an expectation that the Transpower FTE base will grow by 22% over RCP4. The addition of up to eight new FTEs is equivalent to an increase of ICT resource of 20%. We are of the opinion that the additional increase in FTE is proportional to the underlying growth and is therefore reasonable.
External Affairs	4	External Affairs respond to international obligations, changes to domestic law and obligations placed on the business, such as climate change, sustainability, and biodiversity requirements. The 4 FTEs are for specified roles within External Affairs and is based on a gap assessment of the workplace structure/skills base relative to the changing or expected changes in the business' regulation activities and obligations. Transpower developed a workforce planning model ("WFP model") to forecast the organisational workforce needs into the future based on predicted volumes of network capex (including major capital projects and customer driven work), ICT work programmes and any other activities. A governance group reviewed the model and despite several iterations there were some areas where there was an over estimation of FTEs needed. As a result, Transpower undertook a bottom-up review of requirements which was used as the basis for most of the forecasts for AM&O and business support areas, including External Affairs. This revised forecast was tested by a General Manager challenge and review process. This approach demonstrates a mature approach in terms of review and challenging forecasts and model outputs. In addition, the combination of a top-down approach compared to a bottom-up build by division managers increases the likelihood that Transpower forecast is reasonable and prudent.
Corporate services	3	Corporate Services require 3 additional FTE's which have been identified, based on Transpower's gap assessment of their workplace structure and skills base. The assessment and recruitment follow the same approach as External Affairs and the authorisations are in place to ensure prudent recruitment. The new FTEs are offset by reductions projected across RCP4, resulting in no net increase of FTEs. Our opinion is that the increased number of FTEs appears reasonable.
People	37	Transpower are expecting a large increase in the number of connection requests. This is support by the observed growth in connection enquiries. The 2022 Transmission Planning Report reports that enquiries for new generator connections have increased from 5 in 2019 to 74 in 2022 and enquiries for load connections have increased from 0 to 25 across the same period[335]. The additional FTE requirement is confirmed by the workforce planning model to forecast Transpower's organisational workforce. The model goes through several iterations to refine the outputs. However the output goes through a review and challenge process with the Workforce Planning Group. The output is then adjusted prior to being submitted to the Senior Leadership team for review. When it comes to recruitment, a similar process is followed as described in External Affairs to ensure the need is justified. As set out in previous sections, the FTE roles are identified and include 12 x Grid Skills, 16 x Graduate, 5 x People services, 3 x safety and facilities. Transpower has identified the need to grow the graduate intake to supplement the overall FTEs, which feeds into the sustainability of the resources needed. We understand that Graduates are assigned to Business Support opex during their initial period, where they will then be reassigned to the appropriate business unit. In that time their cost is captured under the People section. As many of the Graduates would be transferred to AM&O once their graduate training has been completed. We would expect to see a consequential drop in the FTEs under People, however Transpower has confirmed that under

[335] **2022 Transmission Planning Report.pdf (amazonaws.com)** section 4.3

Area	Max FTE[#]	Evaluation
		this RCP submission, they have not been transferred to AM&O and their costs also remain in the business support category. We are of the opinion that the overall request for FTEs is well-defined and reasonable.
Corporate governance (Regulatory Affairs)	8	The increase in the corporate governance FTEs is required to meet demands for additional capacity spanning regulatory affairs, grid pricing and corporate governance. An additional 8 FTEs with specific roles have been identified, and as described in other divisions, this is driven by a gap assessment of their existing skills base and projected demand for services. A dominant driver for additional FTEs is the TPM which is a fundamental change in customer pricing and requires significantly more modelling, customer pricing interactions and anticipating litigation and pricing disputes that will flow from that. For this particular case, Transpower has provided a more detailed proposal for recruitment. Again, it covers the key elements described in other Divisions. Overall, we are of the opinion that the proposed FTE requirement is reasonable and ensures prudent recruitment.
Customer and strategy	3	Strategy and Customer follows the same approach to recruitment as External Affairs where a gap analysis is needed to assure that the additional staff is needed. In this case, the main driver is due to the expected increase in customer connection enquires where the Strategy and Customer business unit interact with existing customers. Transpower estimate a need to increase the FTEs by 10% to account for the additional workload. This accounts for two of the three FTEs. The proposed increase in FTE is moderate as part of the existing team. We are of the opinion that it is reasonable.

Excludes 2022/23 recruitment.

We do not propose any adjustment to Transpower’s proposed FTE requirement for the RCP4 period. Transpower has provided sufficient evidence to demonstrate the need for these FTEs. We are of the opinion that the underlying recruitment process should enable prudent recruitment forecasts to be established and the that the process is being followed.

In terms of the resulting step costs, Transpower has mapped out the proposed step changes transparently across both the RT01 expenditure schedule (and supporting worksheets) as well as in the business support opex overview documentation. We are able to reconcile the two.

Transpower has separately identified the step increment relating to the 2022/23 outturn recruitment and applied this across the remainder of the forecast. Whilst we note that there may be *minor* uncertainty regarding the value applied in 2022/23, an analysis of the cost per FTE suggests any potential issue is isolated to 2022/23 data only and the base year is to be re-stated ahead of the final submission. The proposed step uplift of $4.0m to the business support opex is assumed to relate to the non-capitalised element of the total costs incurred in 2022/23.

The changes in resourcing from 2023/24 onwards are also separately identified as a step change, although we are unclear why Transpower has capitalised 2% of the total cost relating to corporate functions. This only lowers the business support requirement by $0.4m in total across RCP4 and has not been considered further, consistent with the principle of proportionate scrutiny.

The overhead step change broadly moves in parallel with the costs of the recruitment plan from 2023/24 onwards – approximately 10% of the stated FTE costs in the year.

An additional amount of $2.8m is added to the business support opex as other FTE related costs, given the relatively small quantum of expenditure we have not interrogated the basis for this element of the proposed business support opex allowance. We believe this is consistent with the proportionate scrutiny principle in the ToR.

In ensuring that the included steps are efficient, each step is individually identified, explained, and forecast across the RCP3 and RCP4 periods.

Resource building and TPM

Transpower proposed a step increment in business support opex relating to resource building initiatives and the TPM. Whilst justification for these increments is relatively light, the step increments are relatively small and remain relatively flat across the RCP4 period.

We are of the opinion that the step approach and resulting step increments are reasonable.

17.5.4 Assessment of the productivity approach

Transpower has applied a productivity adjustment to the proposed step changes. The productivity adjustment reflects a targeted ongoing annual improvement of 0.5%. We note that the adjustment is based on independent advice and using historical changes in New Zealand's labour productivity in industries undertaking similar activities as Transpower.

We are of the opinion that the approach and stated reduction of $5.8m across RCP4 is reasonable and sets a good challenge to Transpower.

17.5.5 Conclusion

We have reviewed the business support opex in detail and we are comfortable that the approach taken to generate the forecast is reasonable. Transpower has set out how it has established the base year cost and how the steps are then added to that base.

Transpower's proposal is consistent with the efficient costs of a prudent electricity transmission services supplier. The proposed RCP4 business support opex of $310.4m meets all the evaluation criteria, including GEIP.

The following table summarises our evaluation for this expenditure category.

Table 17-22 Evaluation summary of business support opex maintenance

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	The opex drivers are consistent with the proposed expenditure. There is a clear link to the work needed and the additional business support opex.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and proposed base capex	Yes	Business support opex is a combination of investment cases requirement and support services drivers. For the proposed opex which is linked to capex projects and AM&O projects, the relationship between opex and base capex is reasonable.
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Transpower has applied a Productivity saving across the RCP3 and RCP4, where they expect to driver a 0.5% efficiency saving across Business Support opex. Where the opex is linked to capex, the investment cases demonstrate reduction initiatives across the project in RCP3 and RCP4.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	Where the opex is linked to capex, the investment case demonstrates reduction initiatives across the project in RCP3 and RCP4 and efficiencies have been shown to be considered.
A3(a)	Identified need for programme is prioritised based on risk-based	Yes	Investment Cases identify the capitalised investment need and drivers and include risk-based considerations of staffing levels. For

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
	approach in line with good asset management and were applied appropriately		services provision, the requirement is less so as the headcount is on an 'as needed' basis. The Business support approach is in line with good asset management practice to the extent that traditional asset management practices are relevant to business support systems (as opposed to traditional physical transmission assets).
A3(b)	Policies and planning standards were applied appropriately	Yes	Business support follows Transpower's relevant people and business systems policies rather than engineering standards.
A3(c)	Transpower's process is reasonable and cost effective	Yes	The forecast has been developed using base-step-trend. Whilst the base year 2021/22 is adopted, the 2022/23 costs have been updated to use 2022/23 outturn figures based on known recruitment. Overall, the process is considered reasonable but does present a potential requirement to revisit an updated forecast.
A3(d)	Investment need is challenged, and alternative solutions considered	Yes	The Business support opex area presents few alternative solutions once the investment need for additional FTEs is established beyond use of external resources.
A3(h)	Effect of forecast opex on other cost categories, including capex relationship	Yes	We did not find any instance of double counting between this proposed opex and other portfolios or expenditure categories. Business support opex does not significantly impact the forecast capex but is a necessary support service.
A3(i)	Programme is appropriately linked with other projects or programmes	Yes	Business support is a support service which is linked to various network and non-network functions and expenditure areas
A3(j)	Proposed approach to procurement of associated goods and services	Yes	There is limited procurement required within business support as most costs are direct employee costs. The only procurement required

18. Insurance opex

The following table summarises our verification of Transpower’s proposed AM&O opex requirement for RCP4.

Table 18-1 Verification summary of Transpower’s AM&O opex

Verification element	Verification finding
RCP4 proposed amount	$183.5m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $183.5m
Potential scope for improvement	The RT01 submission includes a $0.5m expenditure in 2022/23 year. There is no explanation for the $0.5m in 2022/23, but we believe that this may be a correction applied based on recent premium payments. By adding the $0.5m it aligns the RT01 forecast with the expert forecast. We would recommend that this may be an area that the Commission may want to focus on to confirm our assumption.
Key issues that Commission should focus on	None identified

18.1 Overview of insurance opex

Transpower procure insurance to mitigate the risks associated with damage to property and liability to others through the normal conduct of business. Transpower's insurance cover comprises of a number of policies to cover a portfolio of risks. The level and range of insurance cover Transpower should be cognisant of the size of the business and the type of risks encountered by the business.

Transpower classify their insurance coverage into three main areas:

– **External insurance:** Transpower maintain a limited number of insurance policies that cover larger risks such as high value catastrophic risks and business interruption, as well as readily available cover for vehicles, travel and material damage.

– **Captive insurance:** Captive insurance is used to manage the risks where external insurance may not be readily available or presents a high expenditure compared to the associated risk. These insurance policies are held with Risk Reinsurance Limited (RRL). Risk Reinsurance Limited is a wholly owned captive insurance subsidiary of Transpower New Zealand Limited and part of the Transpower group of companies. Captive insurance policies have an upper limit and a deductible fee and cover a number of risk areas.

– **Self-Insurance:** Self-insurance is equal to the deductible cover under its captive insurance policies. Self-insurance also covers where the business has assessed the risk where the insurance procured would not be fit for purpose. This may be to the value of the overall risk or relate to the number of claims that were submitted, meaning that they would be low value claims, but could be many and the cost of administration could be higher than the initial claim. In these cases, the costs are covered through capex or opex expenditure.

Further discussion regarding external insurance, captive insurance and self-insurance is set out below.

18.1.1 External insurance

Transpower procures insurance to cover the larger risks it encounters. This is guided by Transpower’s risk management framework, which is in line with local standards, namely the Australian and New Zealand Risk Management Standards.

The table below provides some further information regarding the key areas covered by external insurance policies held by Transpower.

Table 18-2 External insurance vectors

Area	Insured amount	Comment based on Transpower's most credible loss
Material damage and business interruption	$650.0m	Based on catastrophic earthquake.
Submarine cables (failure)	$45.0m	Based on loss of both cables between the two islands.
General third-party liability	$150.0m	Based on loss of cables across the Auckland Harbour Bridge & through Vector Tunnel.
Directors and Officers	$90.0m	Based on coverage held by similar entities.
Minor policies (vehicle / travel)	$0.1m	Based on coverage for minor policies such as vehicle, travel and transit insurance.

Source: Transpower, RCP4 insurance opex overview.pdf; Appendix 1; pages 23 – 24

18.1.2 Captive-insurance

Risk Reinsurance Limited are a captive insurance[336] company owned and used solely by Transpower to provide formalised policies and management agreements for insurance purposes. The Transpower Group retains some risk in Risk Reinsurance Limited and reinsures the majority of the catastrophe risks with external reinsurance markets as set out above.

Transpower has developed a portfolio of insurance policies which fall under 'self-insurance' risk but are managed through actuarial reviews to determine the claims and the appropriate premiums.

There are five areas with capped cover and deductibles, as set out in the table below.

Table 18-3 Risk Reinsurance Limited cover and deductibles ($m)

	Upper limit	Deductible
Material damage	10.0	1.0
Submarine cables (failure)	30.0	-
Transmission lines / underground cables	10.0	0.1
Consumer guarantees act	2.0	1.0
Cyber risk	3.0	0.1

Source: Transpower, RCP4 insurance opex overview.pdf; Appendix 1; page 23 – 24

Through the use of a captive reinsurer, Transpower is allowed to ring-fence most of its self-insured risks in identified formal policies. Quantification of risks, documentation, capital reserves and premiums are determined via formal processes with external (actuary and broker) determination.

Risk Reinsurance Limited is covered by regulatory oversight under the Insurance (Prudential Supervision) Act, 2010 of New Zealand by the Reserve Bank of New Zealand. Risk Reinsurance Limited is the sole vehicle for the use by Transpower to provide these services. It is stated that there are no employees and the Risk Reinsurance Limited Board meet quarterly. The cost associated with the cover are determined through third party, actuarial and broker (market observed) advice. To clarify, we note that Transpower state that Risk Reinsurance Limited is regulated.[337]

18.1.3 Self-insurance / deductible

As part of the captive insurance policies held under Risk Reinsurance Limited, Transpower will be required to pay any identified deductibles as set out in the table above. For example, material damage is covered up to $10m as

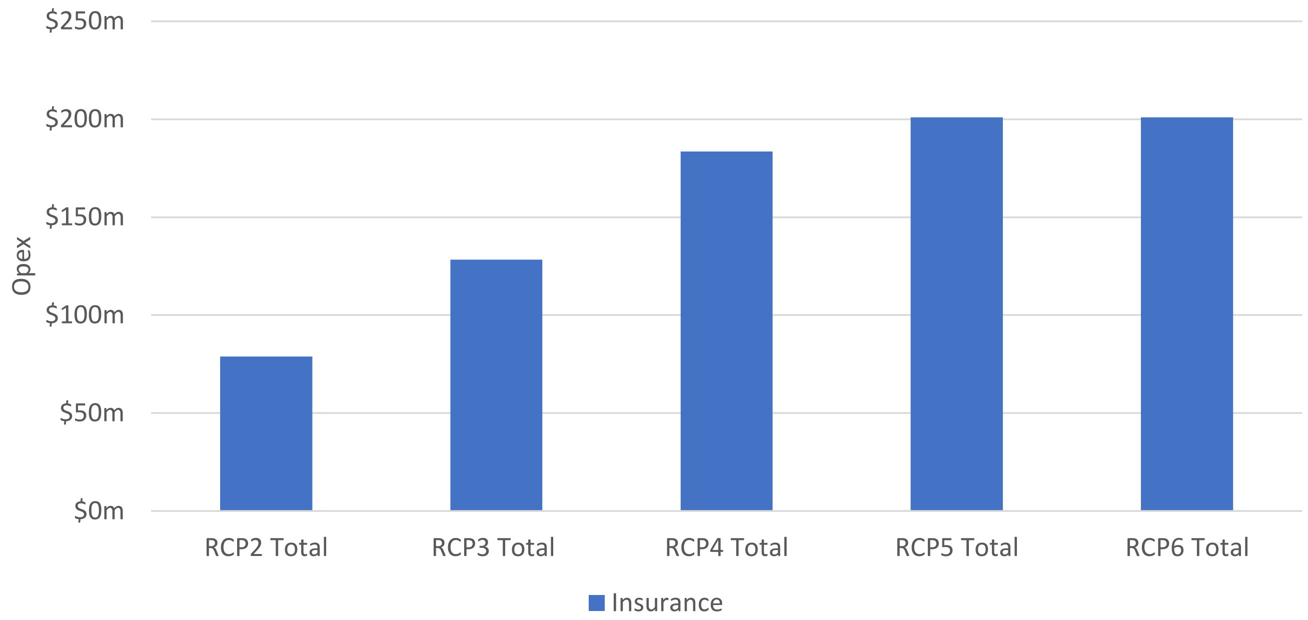
[336] Captive insurance is a form of self-insurance where a company (in this case Transpower Ltd) sets up its own in-house insurer or reinsurer (in this case Risk Reinsurance Limited) and Risk Reinsurance Limited manage a portion of the risk.
[337] RCP4 insurance opex overview.pdf; Section 4.2; page 20

‘captive-insured’, and up to $1m is a deductible. The $1m that is deductible within the captive insurance policy is ‘self-insured’ such that it is captured through capex or opex.

18.2 Expenditure profile

The figure below presents the long-term cost profile of insurance opex from RCP2 to RCP6. The figure indicates that expenditure in insurance has increased significantly during RCP3 and will increase further into RCP4.

Figure 18-1 Insurance opex long term expenditure profile



Source: Transpower, RT01 expenditure schedule

As shown in the table below, Transpower is proposing a substantial increase in insurance expenditure in RCP4 compared to the present RCP3 period. Expenditure on insurance is anticipated to increase from $128.3m in RCP3 to $183.5m in RCP4, an increase of over 43%.

Table 18-4 Insurance opex for RCP3 and RCP4

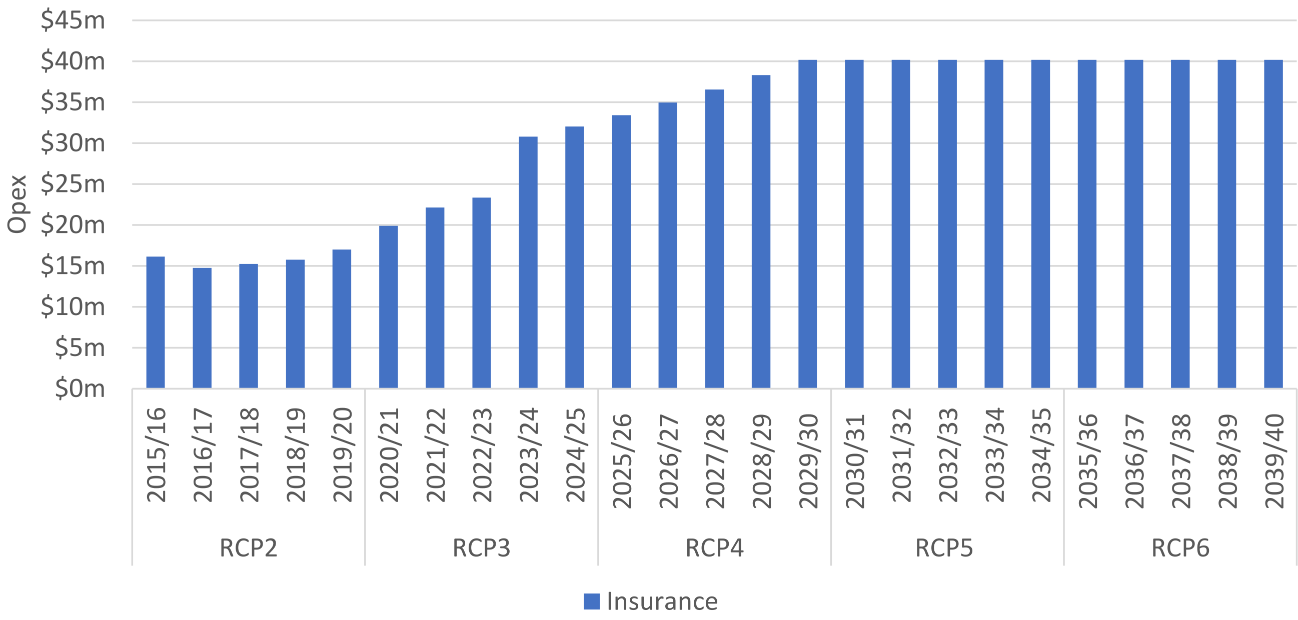
Opex portfolio	RCP3 Total	RCP4 Total	Change
Insurance opex	$128.3m	$183.5m	43.1%

Source: REG016 RCP4 RT01 20230807.xlsx, worksheet ‘Insurance’

An annual breakdown of the total cost of insurance is shown in the figure below, further highlighting the recent increases in insurance expenditure in the first half of RCP3 and progressing through to the end of RCP4.

In the first three years of RCP3, the average annual increase in insurance costs is expected to be around 11.2% per annum. Transpower is forecasting a step increase of nearly 32% in 2023/24 before costs continue to increase at an average annual rate of around 4.5% per annum through to the end of RCP4.

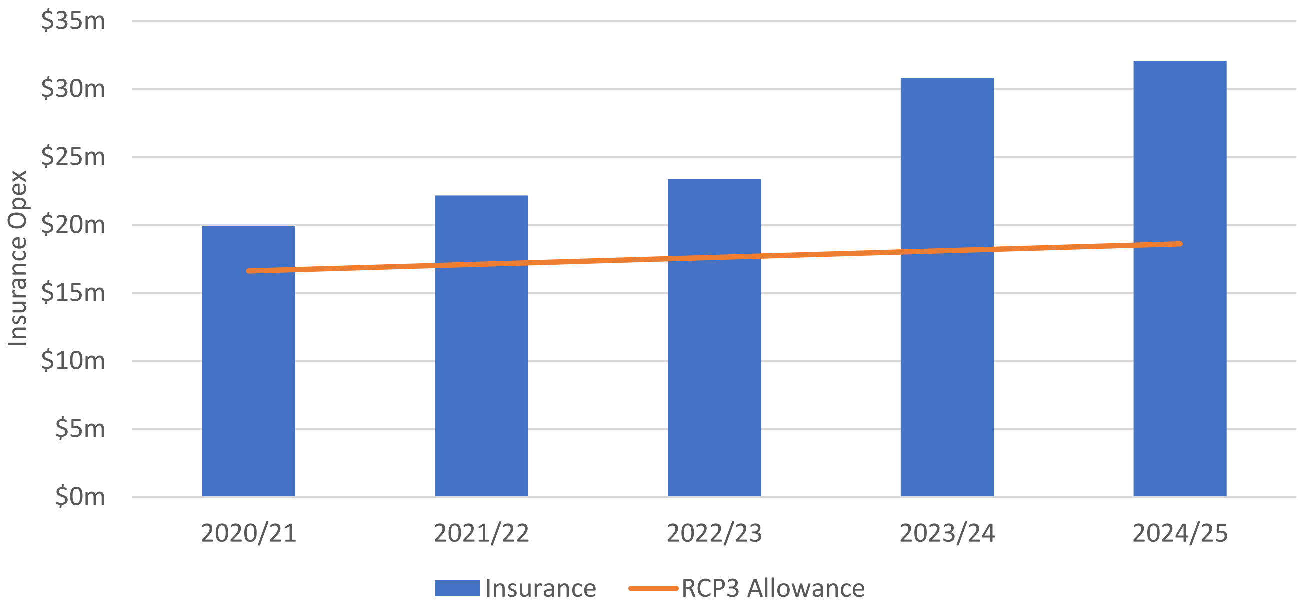
Figure 18-2 RCP2 to RCP6 annual insurance opex per annum



Source: Transpower, RT01 expenditure schedule

The figure below compares insurance opex (outturn and forecast) across RCP3 to the allowances set at the time of the RCP3 determination. The chart clearly shows that insurance costs have been substantially higher than allowances to date and that expenditure is expected to move further away from allowances as RCP3 progresses.

Figure 18-3 RCP3 forecast and actual premiums



Source: Transpower, RCP4 insurance opex overview.pdf; figure 2; page 8

The drivers for the witnessed expenditure increases in RCP3 and into RCP4 are described in more detail below.

18.3 Expenditure drivers

In 2022, Transpower commissioned two reports on the cost of insurance and the changing drivers that are impacting Transpower premiums. The two reports commissioned were:

– Melville Jessup Weaver: Regulatory control period 4 – estimated premiums (01 July 2022).

– Willis Towers Watson (WTW): RCP4 Premium Forecasts (December 2022)

As insurance is a specialist area, we have relied on these reports to provide a fair reflection of the insurance market in New Zealand. According to the reports, there are some key factors that are driving the increase in insurance premiums:

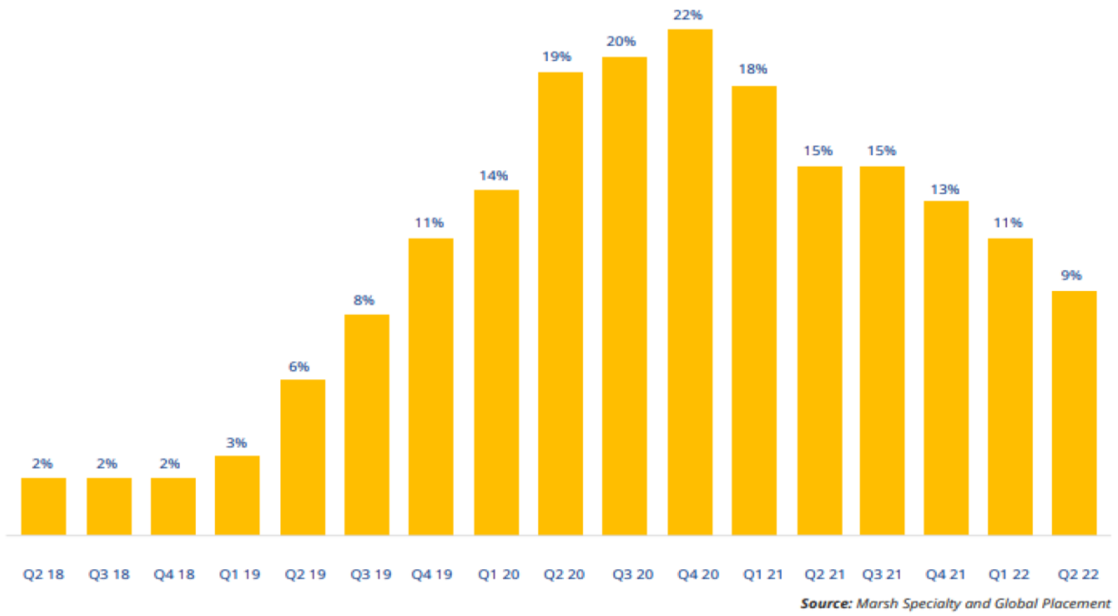
– Premiums have and are expected to continue rise across the market over the coming years - particularly for insurable risk within earthquake catastrophe zones.[338] Transpower own assets in these areas and can expect to see increases in their premiums.
– There is growth in capex and additions to Transpower's asset base that will increase the replacement values over time.[339] The asset base is expected to grow by around 3.3% per annum across the insured asset base through RCP3 and RCP4.

The expert reports suggests that while changes in premiums have been variable over the past six to seven years, it is anticipated that in future years, a less pronounced increase will be seen. The forecasts contained within the reports state that on average, insurance premiums of Transpower will increase between 4% to 5% per annum across the [remainder of the] RCP3 period[340], factoring in the trend in the insurance market to remediate underwriting portfolios to a more sustainable technical rating.

Further to this, the expert view is such that premium levels are clearly affected by a variety of factors, such as catastrophic events and market capacity shifts. As premium rates respond quickly to catastrophic events such as earthquakes and hurricanes, it is noted that capital has been limited in the insurance market as a result of underwriting constraints imposed by Lloyds of London - who have placed higher underwriting standards on member insurers, driving the limiting capacity.

Further to the above, Transpower has also provided supporting evidence that global insurance prices have moved significantly in recent years, as shown in the figure below.

Figure 18-4 Global insurance composite pricing change



Source: RCP4 insurance opex overview.pdf; December 2022; page 8

The following table below, extracted by GHD, shows the number of recent earthquakes in and around New Zealand since 2020. There have been a number of earthquakes during the 2021-22 period. The occurrences of earthquakes create uncertainty in the markets, which at the time of establishing the forecast have had an impact on the outcome.

[338] Willis Towers Watson (WTW); RCP4 Premium Forecasts; December 2022; page 7
[339] Willis Towers Watson (WTW); RCP4 Premium Forecasts; December 2022; page 7
[340] Willis Towers Watson (WTW); RCP4 Premium Forecasts; December 2022; page 7

Table 18-5 Earthquakes in and around New Zealand from 2020 to present

Date	Location	Region
19 June 2020	SE of L'Esperance Rock	Kermadec Islands
5 March 2021	East of East Cape	Gisborne
5 March 2021	S of Raoul Island	Kermadec Islands
5 March 2021	S of Raoul Island	Kermadec Islands
6 March 2021	NE of Gisborne	Gisborne
20 June 2021	S of Raoul Island	Kermadec Islands
2 March 2022	S of Raoul Island	Kermadec Islands
15 February 2023	NW of Paraparaumu	Kāpiti Coast
26 April 2023	5 km off Porangahau	South of Hawke's Bay
11 August 2023	5 km north off French Pass	Kāpiti Coast

Source: GeoNet, 'GeoNet Quake Search', accessed August 2023, refer to: **https://quakesearch.geonet.org.nz/**

In our opinion, it is apparent that, as evidenced by the expert reports, there are some key drivers of insurance premium in recent years – notably general market trends, natural events and a changing business - and those changes are evidence by the costs incurred by Transpower.

18.4 Development of expenditure forecast

Transpower's insurance opex forecast uses the base step trend approach. As with other opex categories where a base-step-trend approach is applied, Transpower has adopted 2021/22 as the base year. Transpower's choice of base year is discussed in more detail in Section 13.3 of this report.

The base year expenditure and any adjustments, steps and trends applied to the base year expenditure are discussed below.

18.4.1 Base year expenditure and adjustments

Given the changes in the insurance market and significant growth in insurance premiums in recent years, Transpower has adopted the 2021/22 outturn expenditure as its base year expenditure. Whilst some historical trend analysis has been conducted, there has been a significant escalation in premiums since 2018 and with recent weather events, estimates of premiums have increased over historical trends. It has subsequently been determined by Transpower that historical expenditure would not provide a good predictor of future costs.

Insurance costs in 2021/22 were $22.2m and this is used as the starting point for Transpower's proposed insurance opex forecast.

In the August-2023 update of the RT01 forecast, for the year 2022/23, the 2021/22 outturn has been uplifted by +$0.7m to account for the actual premiums to be paid in the year. This means that the 2021/22 is based on actual premiums paid for that year.

Overall, the choice of 2021/22 as the base year is reasonable. 2021/22 is the most up-to-date year of actual premiums paid. Premiums are increasing significantly, and the aim of the base year is to establish a representative year to forecast forward only. We also note that the expert reports also agree that the use of 2021/22 as a base year for RCP4 is not unreasonable.

18.4.2 Steps changes

A single step increment to insurance costs has been included from 2025/26 onwards, for an improved level of bush fire cover. Transpower identified a need for insurance cover over and above the base amount for third party bushfire risk. This additional risk arises out of the rising risk of bushfire and escalating costs of replacement and compensation associated with bushfires. The result is an increase in the level of bushfire sublimit insured from $10m to $30m with premiums increasing as shown in the table below.

There are no other step change increases to the base year for insurance.

Table 18-6 Insurance opex step changes

Step change	Description	Total
Bush fire	Increasing risk of bushfire and costs - insured sublimit raised from $10m to $30m with $0.260m p.a. premium increase.	$1.3m total RCP3 - $0.0m RCP4 - $0.26m per annum
Total		**$1.3m**

Source: Transpower, Source: RCP4 insurance opex overview.pdf, Table 2, page 14

18.4.3 Trend

Within the base-step-trend framework, the insurance expert modelled two key trends within its insurance opex forecast, namely:

– Long-term changes in output, to allow for expected changes in business size.

– Claims experience and actuarial estimated premium forecasts.

The long term changes in output is forecast to growth by 3.3% per annum, which is based on the growth due to new capex and additions to Transpower's asset values and increase in replacement values over time.

Claims and estimates for forecasts are broken down into the differing areas of insurance, namely:

– Inflation estimate of 3.3% per annum (over the long term change due to new capex and additions)

– Between 7.5% to 20% increase in premiums for submarine cables and material damage and business interruption.

The expert report has used these estimates for the forecasts. [341]

Table 18-7 Insurance opex trend changes

Step change	Description	Total
Increased in insured asset	Forecast to increase by 3.3% per annum in line with asset base growth	$85.5m RCP3 – $17.6m RCP4 - $67.9m
Changes in actuarial forecasts and claims experience	Further increases in premiums, with apparent significant step change in 2023/24.	
Total		**$85.5m**

Source: Transpower, Source: RCP4 insurance opex overview.pdf, Table 2, page 14

18.4.4 Summary

The table below summarises the base step trend approach applied by Transpower to arrive at the RCP4 forecast of insurance opex. We note:

– An adjusted base opex of $22.9m is assumed in each year of RCP4.

– The step change represents a busfire risk premium increase of $0.26m per annum.

– The adjustment for trend represents combined asset base growth and shorter-term premium forecasts based on expert reports.

Table 18-8 Total RCP4 forecast expenditure for insurance opex

Opex portfolio	Base	Step	Trend	Total RCP4
Insurance opex	$114.3m	$1.3m	$67.9m	$183.5m

Source: Transpower, RT01 Expenditure Schedule.

[341] Willis Towers Watson (WTW); RCP4 Premium Forecasts; December 2022, page 7.

18.5 Evaluation

Insurance opex is a not an identified programme. To assess whether Transpower's insurance opex proposal for RCP4 is prudent and efficient, we have followed the evaluation criteria and employed the evaluation methods described for non-identified programmes in Section 13.2 of this report.

Our evaluation has involved reviewing the insurance related strategy and policy documentation, expert reports, exploration of the numerical data and interviewing the relevant Transpower management team. We also requested and reviewed further information to test, corroborate and challenge the assumptions and decisions that have informed Transpower's insurance opex proposal.

The most difficult element of our evaluation is establishing if 2021/22 is a prudent year. This is due to the current flux around the New Zealand insurance market which has international impacts relating to capacity and local impact with catastrophise in recent years. We are of the opinion that the expert reports provide sufficient detail on the current state of the insurance market as well as estimates of increases in insurance premiums that are also consistent with the costs being seen by Transpower. As a result, we are comfortable that the selection of the 2021/22 outturn costs is reasonable, as are the proposed adjustments to the base year costs to account for actual costs in 2022/23 and in 2023/24 (noting insurance premiums are set ahead of time).

In terms of the step change in cover for bush fire insurance, in Transpower's opinion, the current level of cover is falling behind as the value of the assets is increasing but the cover has not changed. We are satisfied that this approach and the assumed uplift (which accounts for less than 1% of the overall insurance opex) is reasonable.

We understand that the trending applied by Transpower assumes that expenditure on insurance will increase at the same rate as the insurable asset base (at 3.3%). We are of the opinion that this assumption is also reasonable. However, we do note that total insurance opex increases at a rate of around 4.6% per annum in RCP4, which is higher than the 3.3% indicated as part of the asset base. This is in line with the expert reports forecast however of growth between 4% and 5%.

We see in the RT01 submission the trend analysis includes a $0.5m expenditure in 2022/23 year. By applying the $0.5m, along with the trend recommendation above, the RCP4 forecast matches the forecast provided by the expert. [342] However, there is no explanation for the $0.5m in 2022/23. We believe that this may be a correction applied based on recent premium payments.

As we mention, this aligns the RT01 with the expert forecast. We would recommend that this may be an area that the Commission may want to focus to confirm our assumption.

18.6 Conclusion

Based on our evaluation, we accept Transpower's proposed insurance opex for RCP4 of $183.5m.

The following table summarises our evaluation against the ToR evaluation criteria.

Table 18-9 Evaluation summary of proposed insurance opex

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
All opex categories			
A2(a)	Whether opex drivers are consistent with the proposed expenditure	Yes	The opex drivers are consistent with the proposed expenditure on insurance and provide the same level of cover with one increase for bush fire insurance.
A2(b)	Reasonableness of methods used in establishing the proposed opex including relationship between the proposed opex and the proposed base capex	Yes	Transpower has used its latest insurance premium data and expert reports to help confirm the base value upon which steps and trends can be applied. The steps and trends applied are reasonable and derived following a suitable method.

[342] Willis Towers Watson (WTW); RCP4 Premium Forecasts; December 2022; Appendix 3, page 26.

ToR Clause	Evaluation criteria	Met criteria	Evaluation commentary
A2(c)	Reasonableness of opex reduction initiatives undertaken in RCP3 or planned for RCP4	Yes	Insurance is reviewed on an annual basis with external advisors who monitor the insurance market. Reduction initiatives are very limited as this is an ongoing service.
A2(d)	Efficiencies in proposed opex because of investment programme carried out in RCP1, RCP2 and RCP3.	Yes	No investment programme for insurance. Insurance is reviewed regularly to ensure it is providing the necessary cover. It does not readily lead to efficiency improvements as is the case with other opex categories such as maintenance.

Part F

Uncertainty mechanism and service measures

19. Uncertainty mechanisms and expenditures

Our evaluation of the proposed new uncertainty mechanisms, proposed changes to the existing mechanisms and their application, the proposed capex using the new uncertainty mechanisms, and the proposed listed projects in RCP4 against the applicable ToR evaluation criteria is presented in this section.

This section contains the following sub-sections:

– Section 19.1 covers the proposed new uncertainty mechanisms, their design and usage against the applicable ToR evaluation criteria A11.
– Section 19.2 covers the proposed changes to existing uncertainty mechanism/thresholds and their application. We have considered the reasons provided by Transpower for the change and alignment with clause 18.8 in the ToR.
– Section 19.3 covers proposed expenditures using the new uncertainty mechanism. We have assessed such expenditures, in light of the evaluation of the usage of the proposed mechanism as above, in reference to the intent of ToR Clause 18.8, and against the applicable ToR evaluation criteria A11.
– Section 19.4 covers proposed listed projects. We provide our evaluation against the applicable ToR evaluation criteria A10.

Each of the sub-sections contain their respective ToR evaluation criteria and method (as applicable) followed by our analysis, evaluation and conclusion.

19.1 New uncertainty mechanisms

Our assessment of Transpower's proposed new uncertainty mechanisms is presented in this sub-section and is summarised in the following table.

Table 19-1 Verification summary of Transpower's new uncertainty mechanisms

Verification element	Verification finding
Appropriate and sufficient information available for IV	Yes
Reasonable assumptions made	Yes for Use-It-Or-Lose-It (UIOLI) mechanism No for insurance recoverable cost mechanism
Meets GEIP and ToR evaluation criteria	Yes for UIOLI mechanism No for insurance recoverable cost mechanism
IV conclusion	Accept: UIOLI Reject: Insurance recoverable cost mechanism
Potential scope for improvement	None identified
Key issues that Commission should focus on	None identified

19.1.1 Evaluation approach

The following table outlines the applicable ToR criteria and our approach to assessing the features of Transpower's proposed new uncertainty mechanisms.

In assessing the proposed new uncertainty mechanisms, we have evaluated a range of documents. The key document is the 'RCP4 Uncertainty Mechanisms Version 1'[343]. Supplementary documents also helped us understand specifics behind the changes, such as the 'Portfolio Management Plan: Resilience'[344] for the Resilience UIOLI mechanism. We further raised an RFI requesting further justification on how expenditure items are categorised across each uncertainty mechanisms.[345]

[343] Transpower, RCP4 Uncertainty Mechanisms Version 1, 28 February 2023.
[344] Transpower, Portfolio Management Plan: Resilience, December 2022.
[345] Transpower, RFI021 Transpower Response.pdf

In assessing the new uncertainty mechanisms, we also considered Transpower's presentation on the logic used in justifying the proposed changes (meeting held on 23 March 2023) and have held several follow up discussions to better understand that logic (over the week starting 1 May 2023).

Table 19-2 Proposed new uncertainty mechanism evaluation criteria and method

ToR Clause	Evaluation criteria	Evaluation method
A11(a)	Where Transpower proposes new uncertainty mechanisms that are not currently identified in the IMs, evaluate whether the expenditure is sufficiently uncertain that it requires a separate uncertainty mechanism.	– Considered whether the expenditure can be reasonably forecasted as part of Transpower's proposed capex or opex. – Considered whether the expenditure can be included as part of another existing uncertainty mechanism.
A11(b)	Where Transpower proposes new uncertainty mechanisms that are not currently identified in the IMs, evaluate whether the proposed allocation of risk between Transpower and its customers is appropriate.	– Reviewed the design set-up of the proposed UIOLI mechanism in terms of process, interaction with incentive scheme, monitoring, cost recovery, need, risk allocation, proportionate assessment and separability with other expenditures (high level governance and process review). – Did not evaluate the Insurance recoverable cost mechanism, as in our view the mechanism did not meet the requirements of criterion A11(a).
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	– Reviewed the design set-up of the proposed UIOLI mechanism in terms of process, interaction with incentive scheme, monitoring, cost recovery, need, risk allocation, proportionate assessment and separability with other expenditures (high level governance and process review). – Did not evaluate the Insurance recoverable cost mechanism, as in our view the mechanism did not meet the requirements of criterion A11(a).
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	– Reviewed the design set-up of the proposed UIOLI mechanism in terms of process, interaction with incentive scheme, monitoring, cost recovery, need, risk allocation, proportionate assessment and separability with other expenditures (high level governance and process review). – Did not evaluate the Insurance recoverable cost mechanism, as in our view the mechanism did not meet the requirements of criterion A11(a).
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is	– Reviewed the design set-up of the proposed UIOLI mechanism in terms of process, interaction with incentive scheme, monitoring, cost recovery, need, risk allocation, proportionate assessment and separability with other expenditures (high level governance and process review). – Did not evaluate the Insurance recoverable cost mechanism, as in our view the mechanism did not meet the requirements of criterion A11(a).

19.1.2 Overview of new uncertainty mechanisms

Transpower proposes to carry forward mechanisms from RCP3 (and proposes a change to one of them, which is discussed in Section 19.2 of this report below) and to introduce two new mechanisms in RCP4.

While we have not been asked to express an opinion on the suitability of **existing** uncertainty mechanisms[346], for reference, the existing mechanisms are:

- Listed projects
- Low incentive rate base capex projects
- Reopeners for a number of matters including a catastrophic event, a change in legislative or regulatory requirements, an error event, a large build up in the economic value account balance, and for both foreseeable and unforeseeable E&D projects.

[346] The Commission is reviewing these as part of the 2023 IM Review.

We have been asked to evaluate the new proposed mechanisms. These are:

- UIOLI mechanism with proposed expenditure allowances for 1) resilience, and 2) enabling customer electrification.
- New recoverable cost mechanism for insurance (cost pass through with 0.5% of maximum allowable revenue (MAR) cap and collar).

19.1.3 Evaluation

We have evaluated and support one of the proposed new uncertainty mechanisms—the UIOLI mechanism for resilience capex and enabling customer electrification capex, as in our view it meets the evaluation criteria under A11 of the ToR.

We have not at evaluated the other new mechanism, a recoverable cost mechanism for insurance, as we do not consider the mechanism meets the requirements of criterion A11(a) of the ToR.

Our evaluation of the UIOLU mechanism and our explanation for our finding on the recoverable cost mechanism for insurance is provided in the sections below.

UIOLI mechanism

The new UIOLI mechanism would operate with the Commission determining a maximum expenditure allowance for the UIOLI amounts. Transpower would be able to expend those amounts in the relevant expenditure category and receive an automatic (without additional Commission intervention) appropriate uplift to MAR on an ex post basis. The uplift would only happen if Transpower went ahead with the expenditure, and would only allow recovery of costs up to the approved cap.

Where the actual expenditure is more than the approved amount, Transpower would be penalised under the existing expenditure incentives mechanism.

Overall UIOLI mechanisms create relatively little risk for customers. The total amount of potential approved expenditure, and therefore the revenue recovery from customers, is capped at the start of the period. Provided that the cap is small relative to other major categories of expenditure (as has been proposed by Transpower), the impact on revenues and prices is minimal. Any overspend beyond the allowance is penalised in much the same way as any other capex overspend. Revenue is only recovered if, and only to the extent that, Transpower goes ahead with actual expenditure allowed for under this mechanism, and so any ‘underspend’ does not benefit Transpower. UIOLI mechanisms are also relatively low cost to administer once they’ve been set up.

By contrast, pass through or reopener mechanisms are much more powerful tools that can shift significant (often uncapped) risks back to consumers. Administering such mechanisms also requires significant cost and effort on behalf of both the regulator and the regulated entity. For example, one alternative to the proposed resilience UIOLI allowance, would be to treat such expenditure as a network enhancement and deal with any overspend issues via a new reopener trigger. The existing re-opener mechanism would need to be changed as it does not include resilience as a potential trigger. However, this would materially increase the administration effort required by all stakeholders involved.

The two proposed expenditure allowances for the UIOLI (resilience and enabling customer electrification) are discussed in turn.

UIOLI for resilience

The resilience expenditure aspect of the proposed UIOLI mechanisms seeks “access to funds for selected resilience projects which will deliver customer benefits via risk mitigation from resilience threats, but their scope/size are uncertain at the time of the base capex proposal submission.”[347]

The proposed resilience expenditure in base capex and opex, and the UIOLI uncertainty mechanism would fund a programme that “includes improving preparedness and risk reduction for seismic risks, building fire, volcanic ash

[347] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf, 28 February 2023.

impacts, land stability and common mode failures. It also includes wind and flood strengthening for towers and mitigation of solar storm impact to transformers and time synchronisation."[348]

Transpower's asset planning decision framework has identified resilience areas where investments deliver value to customers. Section 6 of Transpower's Resilience PMP[349] explains the planning and investment prioritisation approach. Transpower's current portfolio plan has identified projects that it argues have consumer value but high scope and cost uncertainty.

The UIOLI allowance for resilience would only cover the following workstreams identified in Transpower's resilience portfolio management plan (PMP):

– Space weather mitigations for transformers.
– Flood-resilience solutions at substations.
– Hardening HVDC towers against wind and flood damage.
– Flood- hardening critical and vulnerable HVAC towers in braided rivers.
– Mitigation for loss of time synchronisation within the network due to solar storms.

In the Resilience PMP, Transpower has estimated what it considers to be the minimum efficient scope and cost for these workstreams and identified these workstreams as being sufficiently uncertain to warrant inclusion in the UIOLI mechanism, rather than base capex and opex. Transpower has included other (more certain) resilience workstreams in its proposed base capex or opex. Transpower argues that, if these are not approved by the Commission in the base allowances due to uncertainty (as opposed to other more fundamental reasons), that these workstreams should then be included in the uncertainty mechanism.

Following our review of the Resilience PMP, we agree that the five potential projects (or capex workstreams) would indeed provide important benefits to consumers and note this has been reflected in feedback from customers and consumers.[350] It is also clear that the exact scope and cost of these projects are uncertain at the time Transpower submits its proposal. Infrastructure resilience is an increasingly important topic for both policy makers and consumers, especially given the recent extreme whether events in Zealand. It would be prudent in our view to set aside a reasonable UIOLI allowance to address this issue. We also consider that the proposed risk allocation between Transpower and its customers is appropriate because:

– Transpower proposes a relatively small expenditure amount for resilience under the UIOLI mechanism, though we note that Transpower is reviewing its resilience programme given recent events and government policy proposals.
– Any underspend is not charged to customers and do not accrue to Transpower (unlike base capex).
– Transpower is effectively penalised for any overspend through the expenditure incentives.

The proposed mechanism is also relatively simple and creates minimal administrative burden beyond the initial setup costs. We therefore consider it meets the suitability and proportionality criteria.

Lastly, resilience projects can indeed be easily separated from other Transpower expenditure.

Given the above, we consider the use of a UIOLI uncertainty mechanism for resilience expenditure is consistent with the ToR clause A11 evaluation criteria. However, implementation will be subject to an IM amendment to allow the UIOLI mechanism.

UIOLI for enabling customer electrification

The expenditure proposed under the enabling customer electrification allowance in the UIOLI mechanism is to undertake works on connection assets that would otherwise be unfunded during RCP4. Namely:

– Bringing forward connection asset replacement at customer's request, and
– Adding anticipatory connection capacity to new connections to deal with the First Mover Disadvantage

[348] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf, 28 February 2023.
[349] Transpower, ERR028 Resilience 2022 PMP.pdf, section 6.
[350] Four out of eight submitters (Electra, ERANZ, Fonterra, and Meridian) touched on resilience (question 12) in Transpower's RCP4 submissions. They all agreed that Transpower should quickly and proactively strengthen its resilience programme. Electra further highlighted that "Transpower's approach has set the benchmark for what good looks like in this space." The Consumer Advisory Panel also supported improved resilience in a June 2022 meeting, noting the importance of engagement to understand what resilience looks like for different communities.

Our assessment of a UIOLI allowance for enabling customer electrification followed a similar approach to the assessment of an allowance for resilience.

While electrification of processes will clearly be an important feature of New Zealand's emissions reduction strategies, the scope and pace of the electrification is indeed highly uncertain.

The allowance expenditure amount is capped, and revenue recovery only occurs if Transpower incurs the relevant expenditure—there is no upfront revenue increase. Transpower is penalised for overspends above the allowance in the same way as for any other overspend. This creates an appropriate allocation of risk between Transpower and its customers.

Risk allocation is appropriate, and customers have an additional ability to influence whether and how much expenditure is ultimately recovered through the mechanism because all expenditure must be triggered by and go through the New Investment Contract / Transmission Works Agreement process to which extensive customer scrutiny is applied. More importantly, given how the relevant revenues will be recovered, all the risk is to be shared by Transpower and the customers benefiting from the works. No risk is borne by the wider customer base.

On matters of suitability, proportionality and separability, the assessment is the same as for the resilience UIOLI uncertainty mechanism.

Given the above, we consider that including an allowance for enabling customer electrification in the UIOLI uncertainty mechanism is consistent with the ToR clause A11 evaluation criteria. However, implementation will be subject to an IM amendment to allow the UIOLI mechanism.

Conclusion on UIOLI mechanism

We conclude that the proposed new uncertainty mechanism (UIOLI) and its intended application during RCP4 satisfies all the relevant evaluation criteria in the ToR.

The following table describes our verification of Transpower's proposed new UIOLI uncertainty mechanism against the evaluation criteria.

Table 19-3 Proposed new uncertainty mechanism on UIOLI evaluation

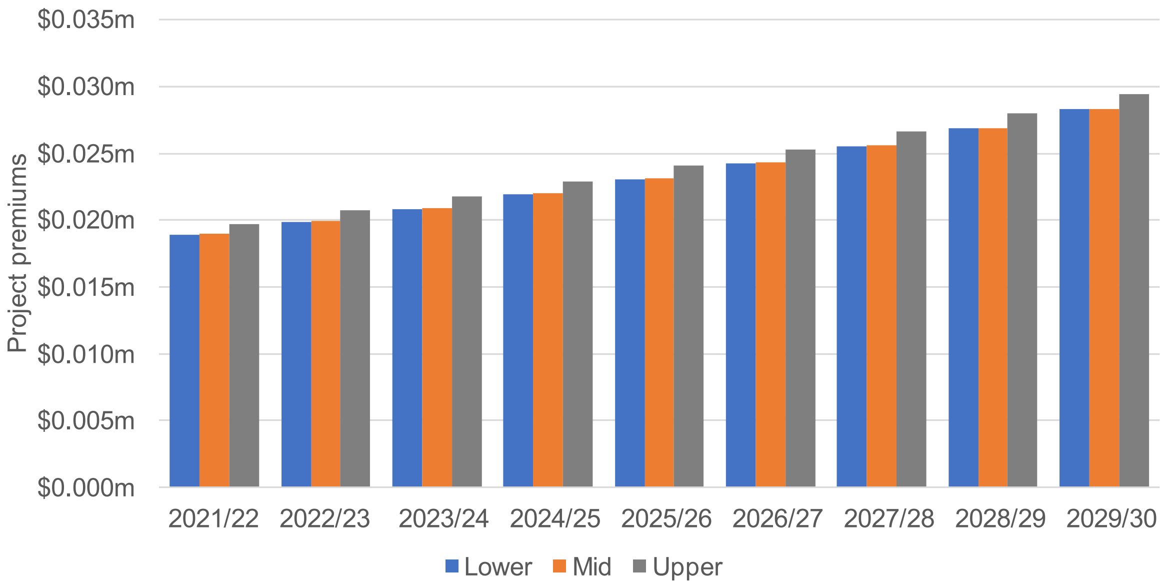
ToR Clause	Evaluation criteria	Met criteria	Comment
A11(a)	Where Transpower proposes new uncertainty mechanisms that are not currently identified in the IMs, evaluate whether the expenditure is sufficiently uncertain that it requires a separate uncertainty mechanism.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.
A11(b)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed allocation of risk between Transpower and its customers is appropriate.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.

Recoverable cost mechanism for insurance costs

Transpower is proposing to shift insurance costs to a recoverable cost arrangement with cap and floor uncertainty mechanism, where Transpower would be exposed to the incentive rate on overspends and underspends up to a value equivalent to 0.5% of MAR. Transpower argues that when comparing to the long-term trend, insurance premiums have been rising more quickly and more unpredictably in recent years.

If that argument were backed with sufficient evidence, we agree that it may be appropriate to introduce an uncertainty mechanism dealing with the issue. However, while the evidence presented to us does show that the insurance increases have in recent year become steeper, it does not demonstrate how those increases have become more volatile or less predictable. The figure below shows the premiums Willis Towers Watson forecasted for Transpower in December 2022. We do not see sufficient evidence for increased volatility.

Figure 19-1 Forecasted Transpower premiums over RCP4



Source: Willis Towers Watson, EOP005 Insurance Opex Overview - Appendix 4 - WTW RCP4 Report.pdf, December 2022.

We therefore consider that, while there may well be a strong argument to forecast large increases in the insurance expenditure allowance for RCP4, at this stage there is insufficient evidence to move away from the current method of cost recovery.

Conclusion on recoverable cost mechanism for insurance

We conclude that the proposed new uncertainty mechanism does not meet criterion in A11(a) of the ToR. As a result, we did not assess the uncertainty mechanism against the other criteria.

The following table describes our verification of Transpower's proposed new recoverable cost uncertainty mechanism for insurance costs against the evaluation criteria.

Table 19-4 Proposed new uncertainty mechanism for insurance evaluation

ToR Clause	Evaluation criteria	Meets criteria	Comment
A11(a)	Where Transpower proposes new uncertainty mechanisms that are not currently identified in the IMs, evaluate whether the expenditure is sufficiently uncertain that it requires a separate uncertainty mechanism.	No	This is evident and documented in the section above.
A11(b)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed allocation of risk	N/A	Not assessed, given proposed mechanism does not meet criterion A11(a).

ToR Clause	Evaluation criteria	Meets criteria	Comment
	between Transpower and its customers is appropriate.		
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	N/A	Not assessed, given proposed mechanism does not meet criterion A11(a).
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	N/A	Not assessed, given proposed mechanism does not meet criterion A11(a).

19.2 Changes to existing uncertainty mechanism

Our assessment of Transpower's proposed changes to existing uncertainty mechanism/threshold and their application is presented in this sub-section and is summarised in the following table.

Table 19-5 Verification summary of proposed changes to existing uncertainty mechanism/threshold and their application

Verification element	Verification commentary
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	No
IV conclusion	Reject
Potential scope for improvement	A cost-based re-opener threshold, based on the costs of undertaking a re-opener process.
Key issues that the Commission should focus on	The appropriate trade-off between the genuine likely need for re-opening the expenditure allowance due to a range of factors, and the cost and uncertainty of multiple reopeners. Also, the logic for establishing the materiality threshold for a re-opener.

19.2.1 Evaluation approach

We have assessed the proposed change to the existing uncertainty mechanism/threshold and their application based on Transpower's reasoning itself and in reference to the intent of clause 18.8 of the ToR. We note that there are no criteria specifically available in the ToR to evaluate this proposed change.

Similar to the approach used to assessing the new uncertainty mechanisms (discussed in Section 19.1 of this report), in assessing the proposed revisions to existing mechanisms, we have evaluated a range of documents. The key document is the 'RCP4 Uncertainty Mechanisms Version 1'.[351] Supplementary documents also helped us understand specifics behind the changes. We further raised an RFI requesting further justification on how expenditure items are categorized across each uncertainty mechanisms.[352]

We also considered Transpower's presentation on the logic used in justifying the proposed changes (meeting held on 23 March 2023) and have held several follow up discussions to better understand that logic (over the week starting 1 May 2023).

[351] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf, 28 February 2023.
[352] Transpower, RFI029 Transpower Response.pdf

19.2.2 Overview of changes to existing uncertainty mechanisms

Clause 3.7.3 of the Transpower IM, provides for the Commission to reconsider the Individual Price-Quality Path if a legislative or regulatory change, that was not already included for in the IPP, changes Transpower's costs by more than 1% of MAR.

The New Zealand government is reforming the Resource Management Act, and the impact on Transpower is likely to be both significant and uncertain. Transpower intends to use the legislative or regulatory change reopener to address this issue in future and is suggesting a change to set a lower materiality threshold of 0.5% specifically for triggering the reopener due to the upcoming Resource Management Act reforms.

19.2.3 Evaluation

In principle, we agree that the impact of upcoming Resource Management Act reforms on Transpower needs to be addressed through the re-opener mechanism. Transpower provided no logic or quantitative analysis to support the 0.5% figure. However, we also note that the Commission's 1% threshold for the existing re-opener mechanism is also arbitrary. While it is true that other regulators often adopt percentage-of-revenue materiality thresholds, to our best knowledge, the reasoning for such thresholds has never been grounded in microeconomic first principles.

We consider that changing the materiality threshold for one particular trigger in the legislative or regulatory change reopener is not a proportionate response to the issue being addressed because the change does not provide a robust solution to the underlying problem. A more robust and principle-based approach to setting the materiality threshold is needed.

Where the Commission has determined that a re-opener mechanism is appropriate in principle for some types of expenditure, the materiality threshold is currently set with reference to the revenue impact of the underlying issue. It is not clear to us how ignoring revenue impacts below a certain percentage or having the absolute value of the threshold fluctuate in line with changes in MAR, promotes the long-term interests of consumers. In our view a principle-based approach to determining a materiality threshold would be grounded in a net-benefit analysis.

Clearly, there is no net benefit to commencing a re-opener process where the cost of undertaking the process exceeds the value of the expected adjustment from the process. Therefore, the materiality threshold must be set at least as high as the estimated costs to the Commission, Transpower, and any other relevant stakeholders in running and participating in the re-opener process. Ultimately, one way or another, these costs are borne by consumers. However, these costs are likely to be significantly less than 1 percent of Transpower's revenue. We suggest that Transpower and the Commission work together to estimate the likely all-in costs of running a re-opener process and set a fixed dollar amount materiality threshold.

We note that the draft decision on the IMs proposes a range of new materiality thresholds expressed as fixed dollar amounts. This approach is consistent with our logic above.

19.2.4 Conclusion

We assessed the proposed change to the existing legislative or regulatory change reopener uncertainty mechanism/threshold and its application based on the current approach in the IMs, Transpower's reasoning itself and in reference to the intent of clause 18.8 of the ToR. We note that there are no criteria specifically available in the ToR to evaluate this proposed change. Given this context, we conclude that the proposed change does not solve the underlying issue and is not proportionate. A cost-based, fixed-dollar-amount threshold would be more appropriate. We note that the Commission has proposed such a threshold as part of its draft decision on the IMs.

19.3 Expenditures using new uncertainty mechanism (UIOLI)

Transpower is proposing the following two expenditure categories, both of which are subjected to uncertainty, using the newly proposed uncertainty mechanism (UIOLI) in RCP4:

– Resilience expenditure consisting of multiple workstreams, multiple cost categories (capex, opex, network, non-network) and multiple asset portfolios.

– Enabling customer electrification capex.

The subsequent sub-sections describe the evaluation criteria and assessment method, followed by descriptions of the proposed programme, their expenditure profiles, underlying strategy and planning approaches, drivers, solutions and our analysis in evaluating the reasonableness of the proposed programme using the UIOLI uncertainty mechanism.

19.3.1 Evaluation approach

The following table outlines the applicable ToR criteria and our approach to assessing the features of Transpower's proposed expenditures using the UIOLI uncertainty mechanism.

In conducting our evaluation, we also gave consideration to our evaluation of the design and usage of the proposed UIOLI uncertainty mechanism (outlined in Section 19.1 of this report) and the intent of clause 18.8 of the ToR.

Table 19-6 Proposed expenditures using new uncertainty mechanism evaluation criteria and method

ToR Clause	Evaluation criteria	Evaluation method
A11(a)	Whether having applied the general (A1) and specific (A2 and A3) evaluation criteria, the proposed expenditure is sufficiently uncertain at the time of RCP4 proposal and it requires a separate uncertainty mechanism.	– Benchmarked Transpower's asset management policy, investment decision framework, assessment models and tool to support those policy and framework, especially focusing on HILP event driven workstreams, against GEIP. In doing so, we considered ex-ante (proactive) funding vs ex-post (reactive) funding, the nature of HILP event, Transpower exposure to such event, consumer preferences, and recent arguments, practice and regulatory notes from overseas jurisdictions (AER[353] and Ofgem[354]) assessing resilience workstream expenditure (process benchmarking). – In reviewing these resilience workstreams, we appreciate the close relationship between resilience and reliability. We note that resilience is an input that can contribute to the achievement of reliability improvement. We examined impacts to service measure outcomes while also appreciating the normalisation of the service measure by excluding impacts due to major events (process or functional modelling). – Reviewed the design and use of the multi criteria analysis for establishing threat dimension, mitigation dimension and relative investment priority for these resilience workstream (high level governance and process review). The multi criteria analysis is contained in Transpower's Resilience 2022 PMP document. – Reviewed the provided high level description of driver, questioning the purpose of investment, exposure to Transpower assets and service performance and testing Transpower acceptance and ability to manage inherent risks. Space/solar storm driven resilience workstreams were further examined by seeking inputs from engineering SMEs and by referring to various technical and power system planning information published by A2 and C4 study committees of CIGRE and power system security guidelines published the AEMO (project and programme sampling). – Reviewed the deduced average unit cost estimate (for e.g., per tower, per transformer etc.) from the provided expenditure information proposed for RCP4. Where applicable we compared the unit rates and quantities allowed in this build-up with our industry knowledge (unit rate benchmarking), or appreciated the method adopted to generate the cost estimate (high level governance and process review). – Reviewed the implication of bringing forward asset replacement on the asset AHI and its influence on annual service measures performance (process or functional modelling). – Analysed the sensitivity of the chosen base case 'accelerated electrification' scenario in the Whakamana i Te Mauri Hiko report and how it influences and set organisation wide views on the future state by testing

[353] https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/aer-note-on-network-resilience
[354] https://www.ofgem.gov.uk/publications/consultation-extreme-weather-resilience-medium-sized-investment-project-national-grid-electricity-transmission

ToR Clause	Evaluation criteria	Evaluation method
		the validity of inputs and assumptions especially focusing on electrification of transport and heat processing industries (speed of adoption, enabling Government policies, availability of subsidies, enabling technologies, cost hurdles etc.). – Reviewed the new Transmission Pricing Methodology and the Electricity Industry Participation Code to verify Transpower's right to build incremental connection capacity to alleviate the first mover disadvantage situation and how it recovers the connection costs. – Reviewed the TWA example provided for Gore substation site triggered by Mataura Valley Milk Ltd. Request (project and programme sampling). – Reviewed the estimated cost allowed per site for bringing forward connection asset replacement while appreciating the usual nature of such capital works (critiques cost estimation).
A11(b)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed allocation of risk between Transpower and its customers is appropriate.	– Refer to the same evaluation criteria and method in Section 19.1 of this report.
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	– Refer to the same evaluation criteria and method in Section 19.1 of this report.
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	– Refer to the same evaluation criteria and method in Section 19.1 of this report.
A11(e)	Whether the proposed expenditure is sufficiently separable from other expenditure areas and/or uncertainty mechanisms.	– Examined the basis and scope of resilience workstreams and compared it against other proposed works (base opex, base R&R capex, base E&D capex, grid electrification using UIOLI uncertainty mechanism) for any duplication or overlap. This also involved examining for capacity expansion, non-like-for-like replacement to identify any capacity expansion element etc. (high level governance and process review). – Examined the basis and scope of customer electrification capex and compared it against other proposed works (base R&R capex, base E&D capex, re-opener) for any duplication or overlap (high level governance and process review).

19.3.2 Resilience expenditures

Transpower has proposed several resilience workstreams in RCP4 with each of them being either capex/opex, network/non-network and included within various asset portfolios. Only a subset of these resilience workstreams are being proposed using the UIOLI uncertainty mechanism. The remainder of resilience workstreams are proposed using the base expenditure submission. This is illustrated in the following table. The scope of evaluation in this sub-section pertain to only those that are being proposed using the UIOLI uncertainty mechanism.

Table 19-7 Scope of evaluation of resilience workstream being proposed using the UIOLI uncertainty mechanism

Expenditure type	Expenditure categories	Portfolios / Asset class	RCP4 proposed total amount (including ICD)	Proposal pathway	Comment
Opex	Non-network	ICT	$1.5m	Proposed using establish base expenditure submission.	Evaluated in the proposed ICT opex Section 16.
	Network	Grid opex	$4.2m	Proposed using establish base expenditure submission.	Evaluated in the proposed grid opex Section 14.
Capex	Non-network	ICT	$9.9m	Proposed using establish base expenditure submission.	Evaluated in the proposed ICT capex Section 11.
	Network	**Multiple asset classes**	$52.0m	Proposed using establish base expenditure submission.	Evaluated in the proposed base R&R capex Section 9.
			$53.2m	**Proposed using the UIOLI uncertainty mechanism.**	**Evaluated in this section.**
Total			**$120.8m**		

The following table summarises our verification for this expenditure category.

Table 19-8 Verification summary of proposed resilience expenditure under uncertainty mechanism

Verification element	Verification commentary
RCP4 proposed amount	$53.2m capex using UIOLI uncertainty mechanism consisting of multiple resilience workstreams and residing within multiple asset portfolios.
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $53.2m
Potential scope for improvement	Transpower should further analyse the investment case for geomagnetic induced current (GIC) mitigation workstream. It may also result in Transpower accepting the level of inherent risk and focusing on readiness, response and recovery, rather than risk reduction.
Key issues and areas that the Commission should focus on	Inputs to the threat and mitigation dimensions of the multi criteria analysis within the Resilience PMP that determines and prioritise the investment for GIC mitigation workstream. Also, the implementation of this mechanism pertaining to exclusive separation of expenditure, tracking and reporting of its delivery, its cost recovery pathway, impact to future asset refurbishment and replacement activities, current asset health scores and service performance, and timing of the MAR adjustments.

Overview

Historically, Transpower had a developed framework for investigating unexpected major hazard event impacting its substation sites. Transpower has used this old framework to justify for regulatory expenditure during its previous RCP submission for several High Impact Low Probability (HILP) mitigation measures.[355] This HILP framework was initially based on an insurance view of risk event and lacked holistic and continual strategy to identify and inform the breath of risk scenarios and mitigation measures.

Transpower's HILP risk reduction expenditures in past have not been specifically identified or tracked as resilience workstream or programme because this type of risk reduction typically occurred through grid upgrades and asset replacement (via building back better), rather than through targeted pro-active resilience programs.

Since then, Transpower's approach has matured to leverage its event planning capability using empirical industry data. [356] Transpower has improved its resilience framework, reviewed its threat exposures and major hazard risk scenarios, and documented how its risk exposure may change in the future. These are detailed in Transpower's inaugural Grid Resilience Strategy which was approved and issued in February 2023.[357]

The Grid Resilience Strategy 'talks' to various of Transpower's existing organisational strategies and frameworks. It states Transpower's obligation as a lifeline utility under the New Zealand Civil Defence Emergency Management Act 2002, which stipulates lifeline utility's ability to function during and after an emergency.

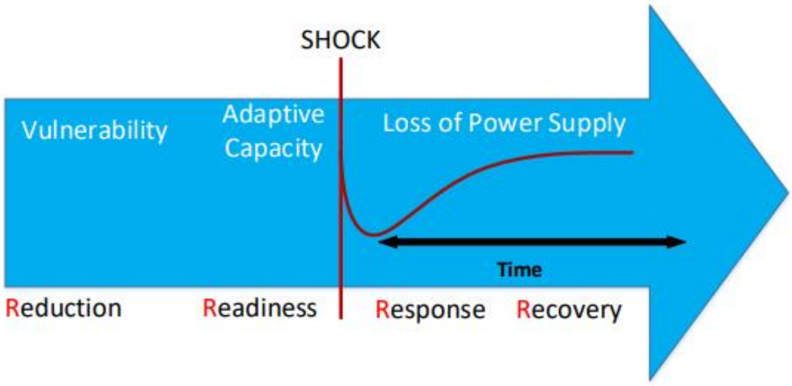
The strategy also identifies a number of threats (for e.g., seismic, volcanic, flooding, third party activities etc.) that can be grouped into two broader categories – natural threats including extreme weather events and asset/system threats. Each of these threats is mapped to a number of major hazard's impacts on the grid. This strategy describes these identified threats and major hazards, and Transpower's approaches to managing its transmission service. These approaches are implemented at varying levels of maturity dependant on the perceived risk or current understanding of the specific threat and major hazard.

Transpower's Grid Resilience Strategy clearly distinguished the definition of 'grid resilience' from 'grid reliability' by recognising that resilience is wider than reliability and includes the ability to withstand natural threats including extreme weather events and asset/system threats. The grid resilience definition is broadened in this strategy from the previous narrow definition of HILP events to one that investigates all known vulnerabilities and the mitigation of major hazard events.

The focus of Transpower's Grid Resilience Strategy is on asset related resilience, i.e., the ability of its physical assets and systems to either continue to function normally or to an acceptable level of performance when exposed to threats. It considers all aspects of disaster management cycle – reduction, readiness, response and recovery (the four 'R's). This is illustrated in the following figure.

[355] Refer to: **Commerce Commission - Otahuhu Substation diversity project (comcom.govt.nz)**, and **Commerce Commission - Upper South Island grid upgrade – stage 1 (comcom.govt.nz)**
[356] Transpower, IVP013 RCP4 IV Resilience - overview.pdf
[357] Transpower, ERR017 TG 10.03 Grid resilience strategy.pdf, February 2023.

Figure 19-2 Timeline of a major hazard's impact on the grid



Reduction:	Identification and mitigation of network vulnerabilities
Readiness:	Contingency planning and preparation for major hazards
Response:	Immediate actions before, during and after an event to make safe, and restore supply
Recovery:	Post event reinstatement of network to provide pre-event security or better of asset capability and supply.

Source: Transpower, ERR017 TG 10.03 Grid resilience strategy.pdf, February 2023.

The key objectives of the Grid Resilience Strategy anchors around the four 'R's.

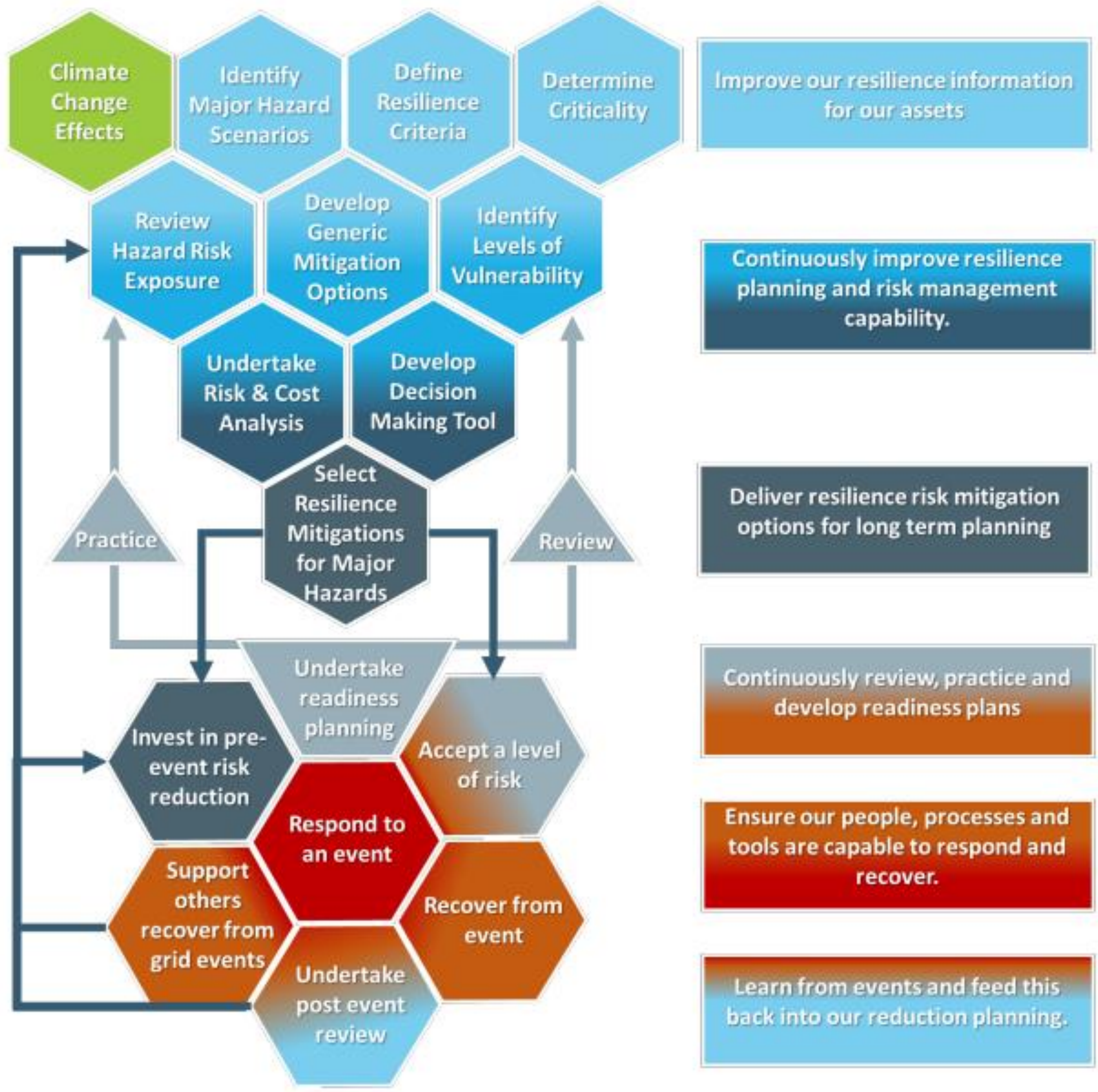
To support the key objectives, Transpower has setup the following eight strategic approaches or focus areas:

- Improve resilience information for its assets [reduction].
- Embedding resilience decision making into asset management planning [reduction].
- Develop risk mitigation options [reduction].
- Develop and manage emergency readiness plans and systems for each major hazard [readiness].
- Ensure co-ordination and communication response plans are effective [readiness].
- Ensure people have the capability to respond to major hazards [readiness].
- Leverage the emergency readiness plan and System Operation's management of credible events [response].
- Build back better [recovery].

The Grid Resilience Strategy then describes these eight strategic approaches or focus areas in detail to support the key objectives.

The Grid Resilience Strategy also describes the current version of Transpower's resilience framework which is illustrated in the following figure. Transpower's resilience framework defines and provide consistency in how it implements the four Rs aspects of disaster management cycle.

Figure 19-3 Transpower's detailed resilience framework



Source: Transpower, ERR017 TG 10.03 Grid resilience strategy.pdf, February 2023.

This resilience framework is continually maturing and presently focuses more on reduction aspect. Transpower's capability to plan for resilience has progressed in recent years and using this resilience framework it is now proposing dedicating expenditures in its upcoming and future RCP submission.

As part of this framework, Transpower has developed a resilience specific portfolio management plan (Resilience 2022 PMP) dated February 2023.[358] This PMP applies the Grid Resilience Strategy and outlines Transpower's planning and expenditure need in grid assets to address resilience concerns over RCP4 through to RCP6. This PMP focuses on developing a credible and defendable programme of workstreams to deliver a resilient transmission service.

The RCP4 programme of workstreams mostly include risk reduction and improving readiness aspects of resilience for seismic risks, building fire, volcanic ash impacts, land stability, common mode failures, wind and flood strengthening for towers, mitigation of solar storm impact to transformers and time synchronisation. These programme of resilience workstreams in RCP4 can be broadly grouped into the following three categories, based on cost categories and proposed cost recovery mechanisms:

– Four resilience workstreams in grid preventive maintenance opex (across multiple asset portfolios) and ICT opex totalling $5.7m. These resilience workstreams are being proposed using the base opex pathway for cost

[358] Transpower, ERR028 Resilience 2022 PMP.pdf, February 2023.

recovery because the drivers, proposed solutions, costs, scope and timing are relatively well defined and mature.

- Eleven resilience workstreams in base R&R capex (across multiple asset portfolios) and ICT capex (across multiple investment cases) totalling $61.9m (including IDC). These resilience workstreams are being proposed using the base capex pathway for cost recovery because the drivers, proposed solutions, costs, scope and timing are relatively well defined and mature.
- Five resilience workstreams being proposed in capex (across asset portfolios) totalling $53.2m (including IDC). These resilience workstreams are being proposed using the UIOLI uncertainty mechanism because of the nature of threats, the likelihood of major hazard, proposed solutions, costs, scope and timing are presently unknown or uncertain or ill-defined.

The following sub-sections outline the expenditure amounts for each of these three categories.

Resilience workstreams categorised as opex and included in the proposed opex

The proposed base opex of $5.7m consists of four resilience workstreams pertaining to readiness, response and recovery aspect of resilience, and included within the four asset portfolios as shown in the following table. The expenditure for these resilience workstreams expenditure is verified in Section 14.8 for preventive maintenance and in Section 16 of this report for ICT opex.

Table 19-9 Resilience workstreams categorised as opex and included in the proposed opex

Resilience workstreams	RCP4 proposed amount	Asset Portfolios	Expenditure categories
Land stability works on 14 towers and poles.	$2.5m	TL Foundation	Preventive maintenance
10 planned drill or emergency exercises for tower restoration.	$1.2m	TL Tower	Preventive maintenance
Run 1 emergency exercise after acquiring the mobile switch room for South Island.	$0.5m	ACS Indoor Switchgear	Preventive maintenance
Responding to changing cyber threats scenarios. Develop new capabilities.	$1.5m	IT telecoms, network and security services (IC09 investment case)	ICT opex
Total	**$5.7m**		

Source: GHD analysis of Transpower, ERR028 Resilience 2022 PMP.pdf

Resilience workstreams categorised as base R&R capex and included in the proposed base R&R and ICT capex

The proposed base capex of $61.9m consists of eleven resilience workstreams pertaining to risk reduction and readiness aspect of resilience and is included within the base R&R capex across seven asset portfolios and also within the ICT capex across two investment cases as shown in the following table. The expenditures for these resilience workstreams are verified in the respective base R&R capex asset portfolios in Section 9 and in the respective ICT capex investment cases in Section 11. This table is presented in this section for completeness purpose only.

Table 19-10 Resilience workstreams categorised as base R&R capex and included in the proposed base R&R and ICT capex

Resilience workstreams	RCP4 proposed amount	Asset Portfolios	Expenditure categories
Land stability works for towers and poles.	$5.1m	TL Foundation	Base R&R capex
Hardening bridges and access tracks against land instability and flooding.	$1.1m	TL Access	Base R&R capex
Hardening transmission lines for a volcanic ash event.	$1.6m	TL Insulators	Base R&R capex
Seismic strengthening of buildings.	$26.2m	ACS Buildings and Grounds	Base R&R capex
Fire – stopping and detection upgrades to substation buildings.	$6.7m	ACS Buildings and Grounds	Base R&R capex
Remove earth wire overhead stations – common mode failure risk mitigation	$3.2m	ACS Structures and Buswork	Base R&R capex
Pre-enabling works for major failures of non-air bushings/gas insulated switchgear (WIL).	$1.8m	ACS Indoor Switchgear	Base R&R capex
Acquire portable switchroom for South Island.	$3.1m	ACS Indoor Switchgear	Base R&R capex
Equipment spares for the new seismic hazards model risk (site exceeding IEEE693 'high').	$3.2m	ACS Instrument Transformers	Base R&R capex
Cybersecurity investment to replace existing regional base firewalls	$2.1m	IT telecoms, network and security services (IC09 investment case)	ICT capex
Improve information to enable decision making and improve visibility and awareness	$7.8m	Transmission system (IC04 investment case)	ICT capex
Total	**$61.9m**		

Source: GHD analysis of Transpower, ERR028 Resilience 2022 PMP.pdf

Resilience workstreams categorised as capex and proposed using the UIOLI uncertainty mechanism

The remaining proposed capex of $53.2m consists of five resilience workstreams pertaining to risk reduction aspect of resilience and has elements of uncertainty associated with their risk determination, costs and solutions. Hence, these workstreams are being proposed using the newly proposed UIOLI uncertainty mechanism in RCP4 and resides within five asset portfolios as shown in the following table. These resilience workstreams expenditure are verified in this section.

Table 19-11 Resilience workstreams categorised as capex and proposed using the UIOLI uncertainty mechanism

Resilience workstreams	RCP4 proposed amount	Asset Portfolios	Expenditure categories
Flood resilience solutions at substations To withstand 100 year return period flood scenario in two prioritised sites.	$6.9m	ASC General	UIOLI uncertainty mechanism
Space weather mitigations for transformers To protect nine prioritised transformers from geomagnetically induced current at neutral connections impacted by solar storms and changes to earth magnetic field.	$16.9m	ACS Power Transformers	UIOLI uncertainty mechanism
Flood hardening critical and vulnerable HVAC towers in braided rivers.	$12.3m	TL Foundation	UIOLI uncertainty mechanism

Resilience workstreams	RCP4 proposed amount	Asset Portfolios	Expenditure categories
To withstand braided river flooding scenario which have significant river widths, high flow, high velocity and unique morphological characteristics on thirty prioritised structures.			
Hardening HVDC towers against wind and flood damage. To withstand braided river flooding scenario as above on nine HVDC tower foundations and to strengthened approx. 174 HVDC towers. Also to meet 50 year return period wind scenario on these HVDC towers.	$12.7m	TL Tower	UIOLI uncertainty mechanism
Mitigation for loss of time synchronisation within the network due to solar storms. To avoid loss of GPS time synchronisation service with eight high precision terrestrial clocks and associated network infrastructure to prevent degraded (slower) and erroneous protection operation.	$4.4m	Secondary Asset Substation Management Systems	UIOLI uncertainty mechanism
Total	**$53.2m**		

Source: GHD analysis of Transpower, ERR028 Resilience 2022 PMP.pdf

For these resilience workstreams being proposed using the UIOLI uncertainty mechanism Transpower has undertaken preliminary analysis to identify potential sites/assets/locations based on risk exposure and existing vulnerabilities[359]. Transpower has also analysed criticality values of those identified sites/assets/locations to enable them to shortlist and prioritise the highest risk for mitigation measures. Transpower has explored mitigation options, potential solutions and have build-up preliminary cost estimates. However, there are elements of uncertainty in defining and quantifying some or all aspects of need, scope of potential solution and costs.

Transpower realises that further site/asset/location specific assessments are needed to refine these risk assessments and to develop definitive options and cost and benefit information. As each site/asset/location gets further investigated at business case phase, the options and cost estimates will have greater certainty. It is this context that has led Transpower to propose the resilience capex programme in RCP4 using the UIOLI uncertainty mechanism.

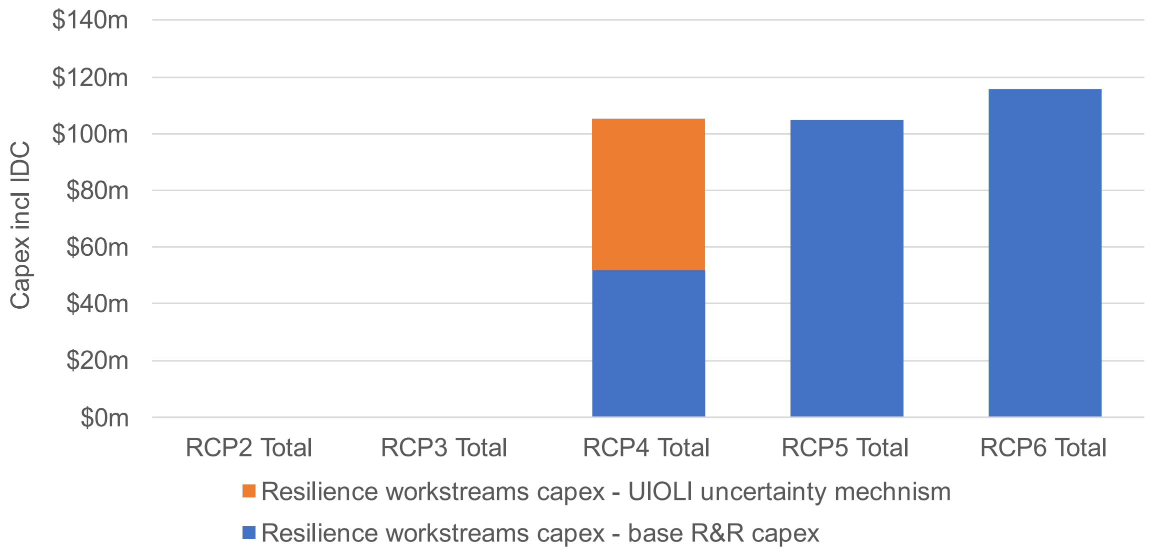
Expenditure profile

The following figure shows the longer term resilience capex forecast including both base capex and UIOLI capex profiles. We note that the two ICT capex resilience workstreams (totalling $9.9m) in RCP4 is not shown in this profile and that they are included within the ICT investment cases IC04 and IC09.

In previous RCPs, Transpower did not identify or itemise resilience workstreams within its proposed expenditure nor specifically tracked their deliveries against such workstreams. These types of work have typically occurred through grid upgrades and asset replacement (via building back better) when opportunities arises rather than through targeted pro-active investment programs categorised as resilience workstreams.

[359] Transpower, ERR028 Resilience 2022 PMP.pdf

Figure 19-4 Resilience capex (including base capex and UIOLI capex) long term profile

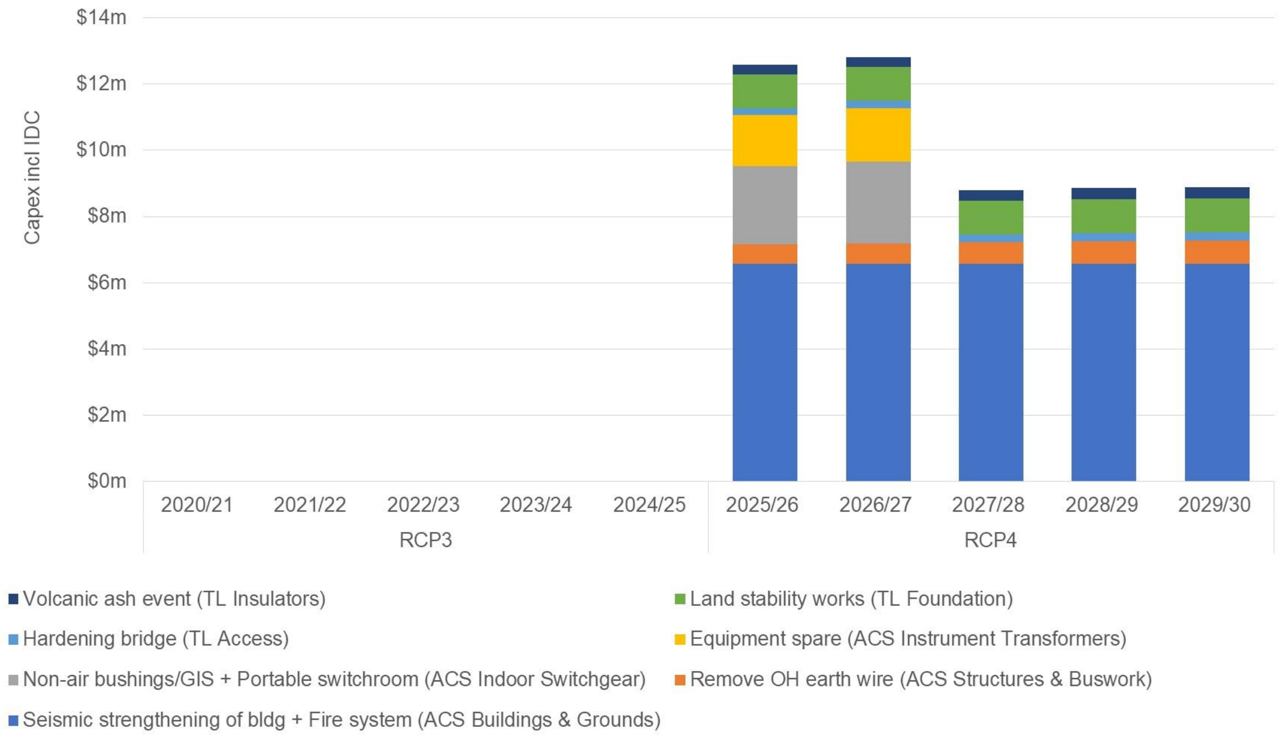


Source: Transpower. RT01 expenditure schedule and ERR028 Resilience 2022 PMP.pdf

Transpower is proposing some portion of its resilience programme of work using the UIOLI uncertainty mechanism in RCP4. The forecast for RCP5 onwards has not been categorised into base or the UIOLI uncertainty mechanism, and the full programme is forecast within base capex and opex for simplicity. We expect that the future iteration of the Transpower IMs and Capex IM will have provisions for such programme of work and defined cost recovery pathways.

The following figure is the annual capex profile of only those resilience workstreams being proposed within the base R&R capex in RCP4 (totalling $52.0m) showing nine workstreams are mapped to seven asset portfolios. The remaining two ICT capex workstreams (totalling $9.9m) is not shown in this profile and that they are included within the ICT investment cases IC04 and IC09.

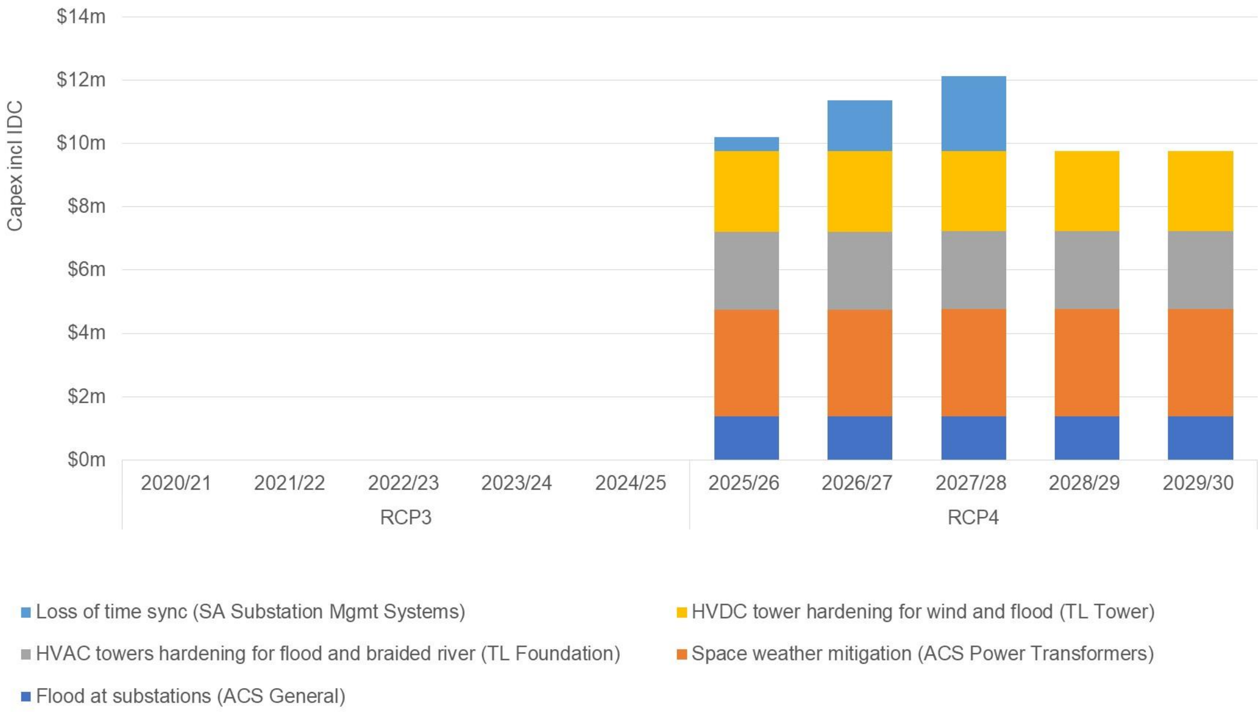
Figure 19-5 Proposed resilience workstream annual profile via base R&R capex



Source: Transpower, Resilience 2022 PMP, RT01 expenditure schedule, GHD analysis.

The following figure shows the annual capex profile of only those resilience workstreams being proposed using the UIOLI uncertainty mechanism in RCP4 (totalling $53.2m) showing five resilience workstreams are mapped to five asset portfolios.

Figure 19-6 Proposed resilience workstream annual profile via UIOLI uncertainty mechanism



Source: Resilience 2022 PMP, RT01 expenditure schedule, GHD analysis.

RCP4 expenditure drivers and solutions

The proposed resilience workstreams categorised and included within the opex (four workstreams), the base R&R capex (nine workstreams), and the ICT capex (two workstreams) are driven by high impact events with relatively known probability or/and has been experienced by Transpower in recent past or/and driven by climate change phenomenon.[360] While such high impact events, in the past, were considered as non-business-as-usual risk or 'force-majeure' scenarios, it is reasonable now to expect that the severity and frequency of such risk scenario for **some** events will increase in the future. [361] Hence the risks warrant pro-active consideration of solutions. For the remaining events, there may be no change in the likelihood. However, Transpower now have better information on the probability and/or impact of such events.

The proposed resilience workstreams are also based and prioritised on vulnerability or risk determination (asset location, condition, service performance requirement etc.). The solution provided by these proposed workstreams encompass risk reduction, readiness, response and recovery aspect of resilience objectives.

The capex resilience workstreams being proposed using the UIOLI uncertainty mechanism in RCP4 are driven by high impact events with either:

– relatively known probability or/and has been experienced in recent past or/and driven by climate change phenomenon (three workstreams); or
– relatively unknown probability, or/and no recent history or/and sensitive marginal cost benefit factor or/and driven by space/solar storms (two workstreams).

The first three capex resilience workstreams being proposed under the UIOLI uncertainty mechanism have greater uncertainty regarding the defined need, scope, solution and costs when compared with the nine resilience workstreams being proposed as base R&R capex. Hence, Transpower is proposing these three workstreams using the UIOLI uncertainty mechanism in RCP4 after analysing their risk exposure, need, scope, solution and costs, and testing them through their multi criteria analysis for prioritisation.[362] The multi criteria analysis is documented in Transpower's Resilience 2022 PMP.[363]

The remaining two capex resilience workstreams being proposed under the UIOLI uncertainty mechanism have even higher degree of uncertainty in defining the risk exposure to Transpower assets and therefore scoping the need. Transpower is proposing these two workstreams using the UIOLI uncertainty mechanism in RCP4 and have tested them through their multi criteria analysis for prioritisation.

Evaluation

We used the evaluation criteria and method as detailed in Section 19.3.1 of this report to assess the five resilience workstreams capex being proposed using the UIOLI uncertainty mechanism in RCP4. In doing so, we also appreciated our evaluation of the design and usage of the proposed UIOLI uncertainty mechanism (refer to Section 19.1 of this report) and the intent of clause 18.8 of the ToR.

For avoidance of doubt, only the five capex resilience workstreams being proposed using the UIOLI uncertainty mechanism are verified within this sub-section. We examined various elements of these five capex resilience workstreams and observed the following.

Transpower estimated the cost of these five workstreams differently according to the nature of proposed solution and scope. In general, Transpower workshopped with its SMEs and also liaised with a potential OEM supplier to estimate the costs to mitigate the risk. We note that these five workstreams presently have low definition of solution and scope and very wide cost estimation accuracy.[364]

The investment planning approach to develop and propose solution to address the following three workstreams broadly reflects the steps included in Transpower business-as-usual asset planning decision framework. These workstreams and solutions represents a relatively mature set of assumptions, input information such as scope and

[360] Transpower, ERR028 Resilience 2022 PMP.pdf
[361] **https://environment.govt.nz/news/the-science-linking-extreme-weather-and-climate-change/**
[362] Transpower, ERR028 Resilience 2022 PMP.pdf
[363] Transpower, ERR028 Resilience 2022 PMP.pdf
[364] Transpower, ERR028 Resilience 2022 PMP.pdf, 20230503 Resilience - additional information.pdf, RFI021-01 Example volumetric forecast calculations for resilience workstreams.pdf, 20230501 Uncertainty mechanisms - additional information.pdf

cost estimate build-up and conclusions drawn from the investment planning process including the use of multi criteria analysis to determine relative priority of each workstream over the other.

– Flood resilience solutions at substation (ASC General), $6.9m including IDC.
– Flood hardening critical and vulnerable HVAC towers in braided rivers (TL Foundation), $12.3m including IDC.
– Hardening HVDC towers against wind and flood damage (TL Tower), $12.7m including IDC.

These three capex resilience workstreams are driven by high impact events with relatively known probability or/and has been experienced in recent past or/and driven by climate change phenomenon. We accept these three proposed workstreams on the basis that Transpower will continue to gather evidence and undertake engineering assessments to further define the solution and scope in the future and use the proposed UIOLI uncertainty mechanism to separately track, deliver and report these works.

Loss of time synchronisation

The workstream to mitigate the loss of time synchronisation within the network due to solar storms (Secondary Asset Substation Management Systems) estimated at $4.4m. This workstream is driven by cybersecurity concerns and the loss of phasor measurement unit and merging unit functionality concern - functionalities that are increasingly used to manage wide area auto-reclose and special protection schemes to preserve stability in an ever-increasing inverter-based power system.

The loss of time synchronisation workstream leverages the TransGo refresh programme in increasing the timing accuracy of substation clocks up to 1µs and in having GPS clocks at strategic locations throughout the Transpower network. We accept this proposed workstream on the basis that Transpower will continue to define its TransGo refresh programme and must progress its engineering assessment to further define the scope and uses this proposed UIOLI uncertainty mechanism to separately track, deliver and report this capex work.

Space weather mitigations

The investment case for the space weather mitigations for transformers (ASC Power Transformers) estimated at $16.9m was examined to greater detail because of the relative magnitude of the cost estimate and the nature of the risk this investment proposes to mitigate. This capex resilience workstream is driven by high impact events, with relatively unknown exposure profile, sensitive marginal cost benefit factor, and supported by academic research and scientific information.

Transpower has depended on University of Otago research on geomagnetic induced current (GIC), supported by Transpower, to support the case for this capex workstream. We note the research isolated the GIC phenomenon solely due to the solar storm (from HVDC stray ground currents) and have identified the need for further modelling to predict and understand the detailed impact of GIC in New Zealand during solar storms. The research found the magnitude of GIC and its impact is dependent on combination of multiple factors such as network configuration, transformer design, existence of NER, varying ground structure and soil resistivity.

The peak GIC magnitudes observed by Transpower in recent years are ~30A (6 November 2001 when HWB T4 failed) and ~50A (2 October 2013). Nine simulations were performed in this research using three storm event scenarios and three latitude variations to identify certain set of transformers/sites that maybe vulnerable to solar storm phenomenon. However, the three storm event scenarios used in this simulation have been massively scaled up to represent extreme/worst case scenario which is expected to occur every 150 years on average (where magnetic field rate of change = 4000 nT/min at Eyrewal).

Our examination aimed to verify whether or not the proposed investment is needed and if the proposed solution reflects a 'no or least regret' solution. We accept this proposed workstream on the basis that Transpower will:

– continue to gather evidence,
– undertake engineering assessments,
– further analyse the risk and investment prioritisation,
– perform optioning that analyses system operation mitigation measures,
– further define the solution and scope, and
– use the proposed UIOLI uncertainty mechanism to separately track, deliver and report these works.

Our opinion is supported by our independent analysis which is described in the following paragraphs.

We referred to multiple technical and power system planning information[365] published by the A2 and C4 study committees of CIGRE that independently corroborated Transpower's position. In summary, CIGRE found:

– Intense solar storms are cyclic in nature and are usually experienced every 11-15 years apart. The last two periods of high intensity were observed around 2002 and 2015 suggesting that the next cycle is likely to occur during RCP4.
– Monitoring and modelling across the Australian NEM indicated during the mid-2010s indicated the following:
– Geomagnetically induced currents (GIC) as a result of such intense solar storm have greater impact in higher voltage transmission lines and transformers.
– Geomagnetic field variations are generally larger in the geomagnetic north-south direction, resulting in geoelectric fields that drive GICs being larger in the geomagnetic east-west direction.
– GICs are expected to be larger in further latitudes in southern hemisphere.

We also referred to the power system security guidelines published the AEMO[366] that recognises the potential of GIC impacts and describes the operational measures and market notification procedures taken upon the receipt of space weather forecast from the Australian Bureau of Meteorology's Space Weather Branch.

Based on the above, we deem this resilience capex workstream to be acceptable considering that it is being proposed using the UIOLI uncertainty mechanism to address the uncertainty regarding the optimal expenditure. In determining the optimal expenditure, we expect Transpower to undertake further work to:

– Confirm that they have proposed an optimal mix of operational measures and capital investments to prudently mitigate risk.
– Has selected the optimal volume of capital investment.
– Have selected the most appropriate form of capital investment.

The 'societal expectation' variable and 'currency' variable used in determining the threat dimensions in the multi criteria analysis documented in the Resilience 2022 PMP are not the same or proxy for each other. Also, the use of 'societal expectation' variable and the weighting/descriptor assigned to each workstreams should be explicitly supported by Transpower customer engagement process outcome at individual workstream level (to supplement or corroborate the risk analysis and their use of assumptions and inputs into the investment case).

'All or nothing' weighing/descriptor for the marginal cost benefit factor within the mitigation dimension in the multi criteria analysis is a sensitive input and behaves like a binary qualification. We believe the selection of this descriptor incentivise the investment case to continue to spend more and hence distorts the risk vs cost vs benefit argument of the investment case.

Transpower should use empirical asset failure experience (HWB T4 in 2001) to inform likelihood/currency variable in the threat dimension determination along with the solar flare cycle/prediction. The resulting threat dimension should be moderated using such variables. This will in turn reduce the inherent risk level, which should be high enough to warrant proactive investments.

If the inherent risk level is low or tolerable, Transpower should accept its existence and mitigate it by focusing on readiness, response and recovery aspects of the resilience objectives. For example, focusing on:

– Spare policy (readiness).
– Disconnecting the identified lines and removing the HVR_GOR_T11 transformer as identified by the research while keeping the network operational by System Operation role based on solar flare prediction and exposure to Transpower network (readiness and response elements of the resilience objectives).

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[365] Effects of geomagnetically induced currents on power transformers and power systems by R Girgis, K Vedante and K Gramm, A2-304, CIGRE 2012.
Technical Brochure 780 Presentation and Paper: Understanding of the geomagnetic storm environment for HV power grids by Dr Willian A Radasky, WG C4.32, CIGRE 2020.
Monitoring and modelling of geomagnetically induced currents across the Australian NEM, multiple authors from Powerlink, BOM, AEMO, Transgrid, Geoscience Australia, TasNetworks and ElectraNet, C4-114, CIGRE 2020.
Observations of geomagnetically induced currents in the Australian power networks, multiple authors, American Geophysical Union 2012.
Modelling geomagnetically induced currents in Australian power networks, multiple authors, American Geophysical Union 2017
[366] AEMO Operational Support, SO_OP_3715, Version 102, dated March 2023, Appendix E.

- Asset condition assessment and AHNR modelling to identify assets degrading at faster rate due to saturation/overheating caused by GIC and to prioritise its solution via the next base R&R capex proposal (recovery). Transpower can use GIC measurements from its network (after isolating HVDC stray ground currents and other harmonic distortion caused by industrial load, i.e., variable speed drives), establish the causal relationship and then inform the AHNR model to lower the asset remaining/effective age.
- Re-prioritising asset repair/replacement from its fungible base R&R capex allowance or apply for cost pass through if the damage is substantial (recovery).

Conclusion

We conclude that the proposed five resilience workstreams totalling $53.2m (including IDC) in capex being proposed using the UIOLI uncertainty mechanism in RCP4 satisfies all the relevant evaluation criteria in the ToR.

The following table describes our verification of Transpower's proposed resilience expenditures being proposed using the UIOLI uncertainty mechanism against the evaluation criteria.

Table 19-12 Proposed resilience workstream expenditures using new uncertainty mechanism evaluation

ToR Clause	Evaluation criteria	Meets criteria	Comment
A11(a)	Whether having applied the general (A1) and specific (A2 and A3) evaluation criteria, the proposed expenditure is sufficiently uncertain at the time of RCP4 proposal and it requires a separate uncertainty mechanism.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.
A11(b)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed allocation of risk between Transpower and its customers is appropriate.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(e)	Whether the proposed expenditure is sufficiently separable from other expenditure areas and/or uncertainty mechanisms.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.

19.3.3 Enabling customer electrification

Our assessment of Transpower's proposed capex programme to enable customer electrification being proposed using the UIOLI uncertainty mechanism in RCP4 is presented in this sub-section and is summarised in the following table.

Table 19-13 Verification summary of proposed enabling customer electrification capex

Verification element	Verification commentary
RCP4 proposed amount	$100.0m capex using UIOLI uncertainty mechanism.
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $100.0m
Potential scope for improvement	Not identified
Key issues and areas that the Commission should focus on	Implementation and the actual practice of using this mechanism. Especially the functioning, regulation and reporting of exclusive separation of expenditure, project triggers, tracking, cost recovery, impact to future R&R activities, current AHI score, service performance, and timing of MAR adjustments.

Overview

Transpower is proposing $100.0m capex under the UIOLI uncertainty mechanism to meet customer connection need during RCP4. This amount is an upper bound estimate given the uncertainty around the volume of work associated with customer electrification[367]. This amount consists of the following two components and are triggered by successful negotiation with customer and contract execution called Transpower Works Agreement (TWA):

– $75.0m is being proposed to bring forward connection asset replacement at customer's request and is based on estimated 5 sites/transformers (along with its associated infrastructure) at an estimated $15m per site/transformer.[368] This involves customer contributing towards the cost difference between the requested and the existing asset rating/size specification and also reimbursing for the residual value of the existing asset to be retired.
– $25.0m is being proposed for anticipatory connection capacity which Transpower can build under the new Transmission Pricing Methodology. This capex coupled with the cost allocation proposed in the Transmission Pricing Methodology aims to address the first mover disadvantage of the connecting customer. Transpower has no experience in building anticipatory connection capacity (Anticipatory Connection Asset) but wants to be agile and responsive to the customer need where it can successfully demonstrate long term benefits of its customer.[369]

Expenditure profile

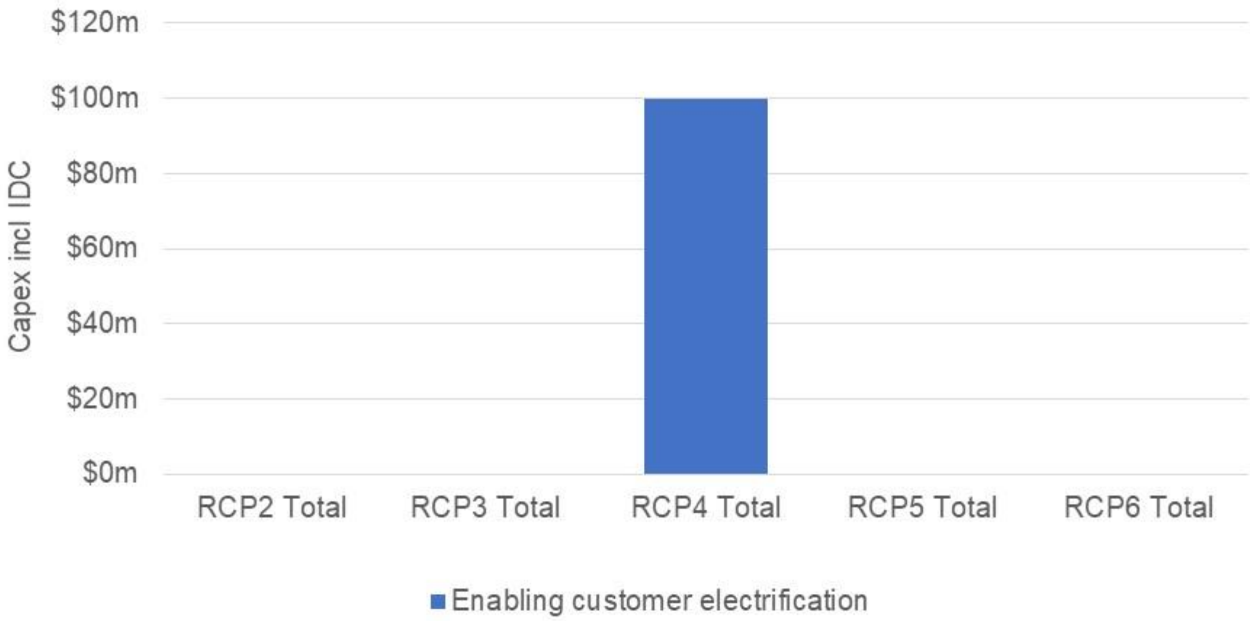
In previous RCPs Transpower did not identify or itemise capital works to bring forward connection asset replacement at customer request and/or to build Anticipatory Connection Asset within its proposed expenditure.

In RCP3, Transpower has so far delivered one TWA triggered project costing ~$10m that was not foreseen during the RCP3 IPP submission. Transpower expects to see much more of similar types of work in RCP4 at customer request but does not have a strong and certain basis to establish a confident forward looking expenditure profile.

This is the first time that Transpower is specifically identifying the need for such capital work and categorising as enabling customer electrification capex programme and proposing using the UIOLI uncertainty mechanism in RCP4. The following figure shows the longer-term enabling customer electrification capex profile including historical and forecast expenditures.

[367] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf
[368] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf
[369] Transpower, REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf

Figure 19-7 Enabling customer electrification capex long term profile

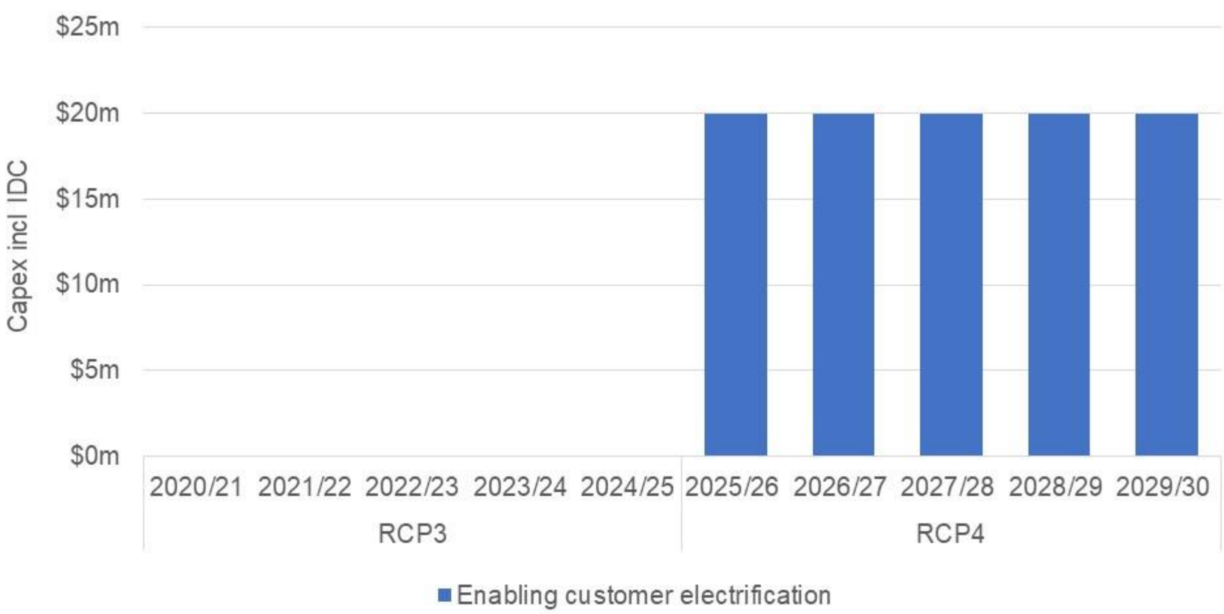


Source: Transpower, RT01 expenditure schedule

Going forward from RCP5 onwards Transpower is envisaging that such capital works will be proposed using the base capex. We expect that the future iteration of the Transpower IMs and Capex IM will have provisions for such programme of work and defined cost recovery pathways.

Transpower is estimating $100.0m as high upper bound to cope with uncertainty around the volume of work associated with customer electrification during RCP4. The following figure is the annual capex profile for enabling customer electrification programme being proposed using the UIOLI uncertainty mechanism.

Figure 19-8 Proposed enabling customer electrification annual profile via UIOLI uncertainty mechanism



Source: Transpower, RT01 expenditure schedule

RCP4 expenditure drivers and solutions

Transpower's customer are generators, local electricity distribution businesses and some large directly connected consumers. Request from these customers to either bring forward Transpower's connection asset replacement (R&R activities) or to install a bigger capacity connection asset to provide anticipatory capacity, would give rise to capex allocated to the UIOLI uncertainty mechanism.

The process for recovering the cost for this additional investment is defined in the Transmission Pricing Methodology[370] which specifies that costs associated with accelerated replacement are recovered from the customer that utilises the connection asset, while the cost for anticipatory capacity is recovered across all customers. The driver for this capex is to facilitate the electrification of process industry in New Zealand which is taking advantage of the availability of Government Investment in Decarbonising Industry (GIDI) funding[371] that incentivise heat intensive processes to move from fossil fuel usage to electricity usage.

The latest iteration of Transpower's Whakamana i Te Mauri Hiko report which reviews and models multiple scenarios of New Zealand's decarbonisation journey and charts various rate of electrification also informs the magnitude and speed of this electrification activities going forward.

Responding to such customer requests while also addressing the first mover disadvantages requires Transpower to be agile and being able to undertake capital work where it can demonstrate long term customer benefits. It requires holistic planning and asset management of the network and finding synergies in bundling R&R work and requested E&D work.

Evaluation

We used the evaluation criteria and method as detailed in Section 19.3.1 of this report to assess the capex for enabling customer electrification programme being proposed using the UIOLI uncertainty mechanism. In doing so, we also appreciated the evaluation of the design and usage of the proposed UIOLI uncertainty mechanism in Section 19.1 of this report and the intent of clause 18.8 of the ToR.

We understand that this funding will be only used for the stated purpose (no fungibility) and the MAR will be updated annually, up to the allowed funding level, on actual spend basis. Also, this fund can only be accessed upon the connecting customer request and the execution of TWA with them. The proposed investment is initiated by customer request with customers scrutiny of the investment occurring through the negotiation of the TWA. This process should ensure that the prudency of any capex is demonstrated by Transpower.

The cost incurred by Transpower to bring forward the R&R activities will be recovered from all customers using the transmission pricing pool method per the TPM. 50% of the cost of the incremental connection capacity will be recovered from all customers using the transmission pricing pool and the remaining 50% will be recovered using the benefit based investments method per the TPM.

We believe that having this allowance available to Transpower under this mechanism will enable it to be more responsive and agile to connecting customers' requests.

We understand that the bringing forward of the R&R activity is limited to the next future RCP time horizon, i.e., in RCP4 Transpower can only bring forward those R&R activities identified for the RCP5 and not beyond.

We tested the inputs and assumptions supporting the base case 'accelerated electrification' scenario in Transpower's Whakamana i Te Mauri Hiko report, especially pertaining to electrification of transport and heat processing industries. For example, we reviewed Government policies on exemption on road user charges for electric vehicle and potential future rule changes and funding available through the Government Investment in Decarbonising Industry (GIDI) fund. We tested these inputs and challenged Transpower's adopted base case scenario in the Whakamana i Te Mauri Hiko report with an alternate 'measured action' scenario to model and understand the impact on customer connection requests for TWA. The proposed capex of $100.0m was immune to such change in scenarios in Whakamana i Te Mauri Hiko report. This demonstrated that the expectation of the

[370] Transpower, Guide to the new TPM, Refer to: **Guide to the new TPM.pdf (amazonaws.com)**
[371] Energy Efficiency & Conservation Authority, 'About the Government Investment in Decarbonising Industry Fund', accessed 28 August 2023. Refer to: **https://www.eeca.govt.nz/co-funding/industry-decarbonisation/about-the-government-investment-in-decarbonising-industry-fund/**

customer connection request for TWA in RCP4 is at similar level under a less aggressive electrification scenario also.

We also reviewed the three six monthly monitoring reports[372] for Whakamana i Te Mauri Hiko (March 2022, September 2022 and March 2023) which measure the pulse of various industry indicators, identifies any changes within the key drivers, inputs and assumptions underpinning the Whakamana i Te Mauri Hiko scenarios. The monitoring report periodically test the validity of the chosen base case ‘accelerated electrification’ scenario. All these three most recent monitoring reports consistently confirmed that the chosen base case ‘accelerated electrification’ scenario is aligned with the observed industry indicators.

Review of the provided TWA connection project example (Mataura Valley Milk Ltd) which is being undertaken presently in RCP3 involves the following scope:[373]

– Supply and install two additional feeders.
– Bringing forward the asset replacement of existing 2×30MVA transformers at Gore substation (i.e., premature asset replacement) and installing new 2×80MVA transformers with PowerNet paying for the incremental cost (i.e., difference between the new transformers and the modern equivalent of the existing transformers), plus reimbursing the residual value of the existing transformers.

This transformer replacement project is consistent with Grid Reliability Standards and the proposed process will include updating and tracking the AHI score for these two transformers and analysing its impact to the service measure performance. Transpower is presently using its fungible base R&R capex to fund this activity. We however note that it is bringing forward this R&R activity by 10 years, i.e., from 2033 (i.e., RCP5) to present (i.e., RCP3).

Considering the generic scope of connection works in similar situation, such as busbar extension, constructing new foundation, firewall, bunding as applicable to accommodate new/bigger transformer, and protection as needed and feeder upgrades, we consider an average estimate of $15.0m per site/project is reasonable. We appreciate every project will be different, the commercial negotiation with the customers will be different and the asset composition and sizing will be different.

We also consider the estimate of 5 sites in RCP4, i.e., an average of 1 each year, is reasonable considering the growing volume of customer enquiries and appreciating not all of them will progress ahead and convert to projects.

We reviewed processes in place to avoid duplication of capex with base R&R capex and base E&D capex and are satisfied that there is no overlap because of the completely independent drivers which for this capex include:

– GIDI funding is driving this capex only.
– The connection enquiries is driving this capex to build anticipatory connection capacity at GXP or in its immediate proximity exclusively triggered by customer TWA. It also drives the base E&D capex/ re-opener/ major capital project (as the case maybe) to augment the upstream interconnected grid and won’t be triggered by any customer TWA.
– The peak demand forecast is driving this capex to build incremental connection capacity at GXP or in its immediate proximity exclusively triggered by customer TWA. It also drives the base E&D capex/ re-opener/ major capital project (as the case maybe) to augment the upstream interconnected grid and won’t be triggered by any customer TWA.

Conclusion

We conclude that the proposed capex for enabling customer electrification programme totalling $100.0m using the UIOLI uncertainty mechanism in RCP4 satisfies all the relevant evaluation criteria in the ToR.

The following table describes our verification of Transpower’s proposed capex for enabling customer electrification programme being proposed using the UIOLI uncertainty mechanism against the evaluation criteria.

[372] Transpower, RFI014-12 WiTMH Monitoring Report - Mar 22 - FINAL.pdf, RFI014-11 WiTMH Monitoring Report - Sept 22.pdf, 20230503 WiTMH Monitoring Report - March 23.pdf
[373] Transpower, RFI014 Transpower response.pdf

Table 19-14 Proposed enabling customer electrification capex using new uncertainty mechanism evaluation

ToR Clause	Evaluation criteria	Meets criteria	Comment
A11(a)	Whether having applied the general (A1) and specific (A2 and A3) evaluation criteria, the proposed expenditure is sufficiently uncertain at the time of RCP4 proposal and it requires a separate uncertainty mechanism.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.
A11(b)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed allocation of risk between Transpower and its customers is appropriate.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(c)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is suitable.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(d)	Where Transpower proposed new uncertainty mechanism that are not currently identified in the IMs, evaluate whether the proposed mechanism is proportionate in regard to the materiality, administrative burden, and ease of implementation.	Yes	This is evaluated and concluded to accept the proposed new UIOLI uncertainty mechanism for RCP4 in Section 19.1 of this report.
A11(e)	Whether the proposed expenditure is sufficiently separable from other expenditure areas and/or uncertainty mechanisms.	Yes	This is evident and documented in the earlier overview and evaluation sub-sections.

19.4 Listed projects

Transpower is proposing four large R&R projects whose capex are estimated to be above the threshold value of $20.0m and hence are being proposed as listed projects. These are:

- HLY-OTA-A (OTA-DRY section) reconductoring
- Rangipo gas insulated switchgear replacement
- Haywards bus rationalisation
- HVDC cables replacement

The subsequent sub-sections describe the evaluation criteria and method, then followed by the verification summary, brief overview of project, its evaluation and conclusion for each proposed listed project.

We note that Transpower has undertaken preliminary investigations and analysis for the four proposed listed projects. However, they have not completed detailed business cases for these projects. We understand these will be completed once Transpower resolve uncertainties associated with these projects and determines that a listed project submission is required during RCP4. As such our review of these listed project is limited to whether the proposed projects meet the specific criteria for a listed project. It is not to be considered as an evaluation of completed business cases with full application of Transpower’s asset planning decision framework steps for these projects.

We note that listed project must be included within the RCP IPP submission to enable Transpower to formally apply for funding request to the Commission during the RCP4 once the inputs to the investment case matures and gains certainty. This enables the Commission to gain an advance visibility of the potential pipeline of large R&R projects in the future. It also allows Transpower to submit a formal application for listed project during the RCP4.

19.4.1 Evaluation approach

The following table outlines the applicable ToR criteria and our approach to assessing the features of Transpower's proposed listed projects.

We note that unlike base capex projects, listed projects have elements of some uncertainty in its cost, timing and/or scope, and hence they are evaluated using separate and specific set of criteria.

Table 19-15 Listed Projects evaluation approach

ToR Clause	Evaluation criteria	Evaluation methodology
A10(a)	Will require capex greater than $20m.	– Reviewed the project capex estimate to assess whether the threshold is met.
A10(b)	Is reasonably required by Transpower.	– Reviewed the investment need to determine the validity of the justification provided. – Reviewed the scope of the proposed solution to determine if it addressed the defined investment need.
A10(c)	At least one asset likely to be commissioned in RCP4.	– Reviewed the project brief and proposed timelines and milestones, especially front-end project development activities to determine the commissioning timeframe of a part of or complete proposed solution during RCP4.
A10(d)	Is in relation to either asset replacement, asset refurbishment or both.	– Reviewed the investment need, assets involved and scope of the solution to confirm R&R activity.
A10(e)	Has an anticipated commencement date in RCP4 but that cannot be forecast with specificity	– Evidence and justification for uncertainty with respect to project timing. – Reviewed proposed project timeline to assess whether commencement is likely to occur in RCP4, considering factors contributing to potential uncertainty.
A10(f)	Not included in the proposed RCP4 base capex.	– Reviewed against the proposed base capex, especially same or associated asset portfolios and same project location to rule out potential for double counting of proposed capex.

19.4.2 HLY-OTA-A (OTA-DRY section) reconductoring

Our assessment of Transpower's proposed HLY-OTA-A (OTA-DRY section) reconductoring project which is being proposed as a listed project in RCP4 is presented in this sub-section and is summarised in the following table.

Table 19-16 Verification summary of proposed HLY-OTA-A (OTA-DRY section) reconductoring project capex

Verification element	Verification commentary
RCP4 proposed amount	$31.2m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $31.2m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus on	Consistent application of Transpower's asset planning decision framework process when the business case is eventually developed and submitted for funding request in the future.

Project overview

The HTY-OTA-A is a double circuit 220kV transmission line commissioned in 1983 in the vicinity of Auckland. It has a total of 69 structures and the majority of the line is located in urban areas without significant easements resulting housing, a highway, motorway and main roads being within very close proximity to the line. As such the line has a very high public safety criticality. Visual inspection in 2011/12 flagged the earthwire as “approaching mid-life condition”, with almost 90% of the spans coded 60 or below. At the time, bulging had already been identified in some spans. On the conductors inspected, several instances of white powder were found where old dog bone spacers had been removed, including one span where loss of section was visible (13 strands affected by corrosion).

Two sections of the transmission line conductor have been inspected by a drone close aerial survey: T125-DRY in 2020/21 and DRY-OTA in 2021/22. For both sections, the results show multiple white powder instances, particularly for T125-DRY which had white powder spread on all spans inspected. Onset of bulging was detected for both sections, along with multiple instances of dog bone spacer damage. There has not been any earthwire close aerial survey by drone on this line done to date.

Transpower assessed the overall risk of failure as low, but the combination of corrosion caused by spacer damage (which affects the conductor from the outside in) and galvanic corrosion (affects the conductor from the inside out) increases the likelihood that actual loads may exceed the residual capacity of the conductors in the medium term.

The DRY-OTA section was found in better condition than the asset health model suggested, however, given the peak of work expected for RCP5-6 and the high public safety criticality of these assets, Transpower have recommended that this replacement is brought forward to RCP4 to manage longer term deliverability and resource utilisation. Repeat drone inspections and sample testing will be required to finalise the scope and timing of this intervention work. Transpower have proposed that the DRY-OTA section be included as a Listed Project for RCP4 to cater for this uncertainty.

Evaluation & conclusion

The HLY-OTA-A (OTA-DRY Section) reconductoring project for $31.2m meets all the evaluation criteria as a listed project for RCP4 IPP submission.

The following table summarises the evaluation of HLY-OTA-A (OTA-DRY Section) Reconductoring project:

Table 19-17 HLY-OTA-A (OTA-DRY Section) listed project evaluation

ToR Clause	Listed Project Criteria	Evaluation
A10(a)	Capital Expenditure greater than $20m	The proposed expenditure of $31.2m based on the TEES cost estimate detailed breakdown. Therefore, this **meets criteria**.
A10(b)	Reasonably required by Transpower	Visual inspections and aerial surveys have identified the need for reconductoring to address corrosion caused by spacer damage and galvanic corrosion to prevent conductor failure. The information was supplied in the HLY-OTA-A Conductor Condition Report (16/2/23). **Meets criteria.**
A10(c)	At least one asset likely to be commissioned in RCP4	Investigation phase to be completed by June 2026, approved as a listed project by Feb 2028 it would be completed by May 2030. Given absence of long lead time material the timeline is considered reasonable. The information was supplied by Transpower after the second-round interviews in the form of indicative milestone dates. The dates appear reasonable for a reconductoring project. **Meets criteria.**
A10(d)	Asset replacement, refurbishment or both	Involves asset replacement of existing conductor which is a R&R activity. **Meets criteria.**
A10(e)	anticipated commencement date in RCP4 but that cannot be forecast with specificity	Indicative timeline is for project to be undertaken between 2028 and 2030. However additional surveys are required to be undertaken which may change the scope and timing of the project. The information was supplied by Transpower after the second-round interviews in the form of indicative milestone dates. The dates appear reasonable for a reconductoring project. **Meets criteria.**
A10(f)	Not included in the base capex forecast	The project capex is not included in the conductors and hardware base capex forecast. **Meets criteria.**

19.4.3 Rangipo gas insulated switchgear replacement

Our assessment of Transpower's proposed Rangipo gas insulated switchgear replacement project which is being proposed as a listed project in RCP4 is presented in this sub-section and is summarised in the following table.

Table 19-18 Verification summary of proposed Rangipo gas insulated switchgear replacement project capex

Verification element	Verification commentary
RCP4 proposed amount	$58.4m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $58.4m
Potential scope for improvement	None identified
Key issues and areas that the Commission should focus on	Consistent application of Transpower's asset planning decision framework process when the business case is eventually developed and submitted for funding request in the future.

Project overview

The Rangipo indoor and underground gas insulated switchgear site consisting of four circuit breakers and indoor associated switchgear (instrument transformers, disconnector and earth switch) was installed in 1979. It is under joint ownership between Genesis Energy and Transpower.

Two circuit breaker switchbays belong to Genesis Energy and two circuit breaker switchbays belong to Transpower. Due to the deteriorating asset condition and poor SF6 leak performance Genesis Energy recently decided to retrofit new circuit breakers in their gas insulated switchgear switchbays. Similar asset condition and performance issues exist with the Transpower gas insulated switchgear switchbays. These are the oldest gas insulated switchgear assets that Transpower owns and they have the highest SF6 emission out of all the other gas insulated switchgear models/sites. They have been leaking since the 1990s and the leaks have grown significantly worse over the recent years even after few reactive attempts to address leaks.

In 2020, Transpower undertook an analysis to investigate various options to this problem and recommended a preferred solution (to undertake repair in the interim and life extension activities in longer term). This preferred solution has not been effective in arresting the SF6 leakage and as such Transpower have commenced the investigation to decommission their portion of the existing gas insulated switchgear arrangement at Rangipo and to install a non-SF6 modern equivalent alternative asset.

The proposed listed project will also assist Transpower in meeting its SF6 Management Strategy's key objective of net zero emissions by 2050. We note that this proposed listed project will be the first gas insulated switchgear replacement project for Transpower and presently non-SF6 solutions are not widely available. Transpower proposed solution and its cost estimate allows for the trialling of some technology before a final solution is delivered. Additionally, we note that the Rangipo site is challenging as it is 60m underground.

The replacement of this gas insulated switchgear asset will be undertaken with wider site renewal works, such as the cable replacement and protection upgrade works, as soon as non SF6 solutions are available at 220kV.

Evaluation & conclusion

The Rangipo gas insulated switchgear replacement for $58.4m meets all the evaluation criteria as a listed project for RCP4 IPP submission.

The following table summarises our evaluation of Rangipo gas insulated switchgear as a listed project for RCP4 IPP submission.

Table 19-19 Rangipo gas insulated switchgear Listed Project Evaluation

ToR Clause	Listed Project Criteria	Evaluation
A10(a)	Capital Expenditure greater than $20m	Transpower has proposed $58.4m. This cost estimate relates to the trialling of commercially available technologies before a final non-SF6 solution with low leak rate design is adopted and allows for challenging construction site environment. [374] The cost estimate also includes 220kV oil filled cable replacement and protection upgrade works. The cost estimate does not provide much a detailed cost breakdown details as it entirely consists of a single vargen value and associated inflation and IDC allowances.[375] Therefore, we also reviewed the Rangipo site single line diagram (SLD)[376] to appreciate the scale and scope of the Transpower's portion of the 220kV bus structure and the connected gas insulated switchgear for the proposed R&R work. Considering the amount of gas insulated switchgear equipment and their unit rates (of SF6 asset) from the TEES building block and the unit rate for 220kV underground cables, and the brownfield underground construction work needed for such proposed solution, we are satisfied that the estimated cost for the project will to be greater than the $20.0m threshold. We believe the cost estimate for non-SF6 modern equivalent asset will also be greater than $20.0m threshold. The final costs will not be confirmed until the investigation and detailed design are sufficiently progressed with a preferred solution. We also understand that several lower cost alternatives will be considered as part of the investigation to determine the preferred option which we believe may cost more than the $20.0m threshold value to address the same need. **Meets criteria**
A10(b)	Reasonably required by Transpower	SF6 leaks from Rangipo gas insulated switchgear have increased significantly in recent years and both 220kV gas insulated switchgear assets and oil filled underground cable are approaching end of life.[377] Neither are supported by their original equipment manufacturers. Given this, and the fact that Genesis Energy undertook similar investment recently, we agree that Transpower has a need to renew its gas insulated switchgear assets and the associated oil filled cables and secondary systems at Rangipo. **Meets criteria**
A10(c)	At least one asset likely to be commissioned in RCP4	Given the asset age and its deteriorating performance (increasing leaking rate even after performing several reactive interventions) [378], there is a need to undertake a R&R intervention at Rangipo substation. We understand Transpower plans to proactively replace the seals in shorter term to arrest the SF6 leaking rate and then replace the old gas insulated switchgear assets in RCP4. We verified this asset condition in recent reports that shows the SF6 emission, gas pressure measurements, repair works performed and timeline for low SF6 alarms. [379] We agree that at least one asset is likely to be commissioned in RCP4 irrespective of the preferred solution adopted to address the same need. **Meets criteria**
A10(d)	Project is either asset replacement, refurbishment or both	The solution or viable alternate options relates to R&R activities. **Meets criteria**
A10(e)	Commencement date in RCP4 but that cannot be forecast with specificity	We understand that the investigation for investment case for this proposed listed project is not complete. This means the exact solution, its costs and the timing is presently unknown. With the available information that has been provided we are reasonably satisfied that this listed project needs to commence in RCP4, but given the uncertainty around the non-SF6 solution the timing cannot be forecast with specificity. **Meets criteria**

[374] Transpower, RFI034-16 Rangipo GIS - GMT Paper.pdf
[375] Transpower, RFI012-25 CP_RPO_007_0_00 - RPO 220kV GIS Replacement - RC A7 TEES report.pdf
[376] Transpower, RFI034-18 Rangipo GIS Options Analysis - Draft V3.pdf
[377] Transpower, RFI034-17 GM Paper - October 2022 - Rangipo GIS SF6 leaks.pdf, RFI034-19 RPO Criticality.xlsx
[378] Transpower, RFI034-17 GM Paper - October 2022 - Rangipo GIS SF6 leaks.pdf
[379] Transpower, RFI034-16 Rangipo GIS - GMT Paper.pdf

ToR Clause	Listed Project Criteria	Evaluation
A10(f)	Not included in the base capex forecast	Review of other proposed expenditure programmes (especially the indoor switchgear, power cables and secondary systems asset portfolios) indicates that this expenditure is not included in other base capex for RCP4. **Meets criteria**

19.4.4 Haywards bus rationalisation

Our assessment of Transpower's proposed Hayward bus rationalisation project which is being proposed as a listed project in RCP4 is presented in this sub-section and is summarised in the following table.

Table 19-20 Verification summary of proposed Hayward bus rationalisation project capex

Verification element	Verification commentary
RCP4 proposed amount	$43.8m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $43.8m
Potential scope for improvement	Explore alternate options to address all or some of the need and estimate their costs. Assess these costs against the benefits and residual risks.
Key issues and areas that the Commission should focus on	Consistent application of Transpower's asset planning decision framework process when the business case is eventually developed and submitted for funding request in the future.

Project overview

The Haywards substation is the largest and most complex substation in Transpower network. It hosts both HVDC and HVAC assets and comprises of four switchyards. Switchyard A is the main HVAC switchyard and contains both 110kV and 220kV assets. The 110kV double bus structures in Switchyard A is arranged in a vertical fashion with Bus A on top of Bus B.

This arrangement attracts smaller site footprint area and provides greater flexibility to switch circuits between the two buses but introduces worker safety risk (the need to manually performed switching steps in a restricted access environment), operational constraints (the need to de-energise both Bus A and Bus B for maintenance of any assets in either bus) and costly switching activities (lengthy and complex switching sequence which is mostly paper based).

Presently this is the only site in Transpower network with such bus arrangement. Transpower is currently investigating its options to address this situation and to determine the optimal solution. The investigation is in the early stage and presently only high-level information is available.

Transpower has in recent past experienced near misses and unplanned supply outage at Hayward Switchyard A due to this bus arrangement and attributed to human error during switching procedure. The proposed listed project seeks to engineer a solution that eliminates this risk and constraint.

Evaluation & conclusion

The Hayward bus rationalisation project for $43.8m meets all the evaluation criteria as a listed project for RCP4 IPP submission.

The following table summarises our evaluation of Hayward bus rationalisation as a listed project for RCP4 IPP submission.

Table 19-21 Haywards Bus Rationalisation Listed Project Evaluation

ToR Clause	Listed Project Criteria	Evaluation
A10(a)	Capital Expenditure greater than $20m	Transpower has proposed $43.8m. This cost estimate relates to reconfiguring the 110kV bus structures at Switchyard A to a single bus including replacing the connected outdoor switchgear. The cost estimate sighted does not provide a detailed cost breakdown.[380] It consists of a single vargen value and associated inflation and IDC allowances. Therefore, we also reviewed the Switchyard A SLD to appreciate the scale of the 110kV bus structure and the amount of the connected outdoor switchgear for the proposed R&R work.[381] Transpower also provided us with a list of impacted assets.[382] This indicated a large bus structure with lots of connected 110kV equipment such as instrument transformers, disconnectors and earth switches and circuit breakers. Considering the amount of such equipment and the bespoke scope of buswork and structure, and the staging of brownfield construction work needed for the proposed solution, we are satisfied that the estimated cost will be greater than the $20.0m threshold. The cost estimate for any alternate and cheaper options is not fully developed. Transpower is considering various alternative options such as remote/motorized switching, physical constraints around the site, and partial bus reconfiguration. It is possible that the cost estimate of an alternative option may be less that the $20.0m threshold. **Meets criteria**
A10(b)	Reasonably required by Transpower	Given the arrangement of the double bus in Switchyard A and its operational procedures, we agree that safety incidents and unplanned outages have a greater likelihood of occurring due to the complexity of the double bus vertical configuration.[383] In principle we agree that Transpower need to address this situation. While we accept the need to address the existing worker safety risk, operational constraints and costly switching activities, Transpower needs to further explore the following options and assess the cost vs. benefit vs. risk of: – Operating the Hayward substation until the majority of its HVAC Switchyard A outdoor switchgear and/or buswork and structures are ready for R&R work in similar fashion to Wilton substation bus rebuild in 2017. – Addressing some safety risks, operational constraints and costly switching sequences with other cheaper alternatives (for e.g., motorised disconnector and remote switching). – Testing the proposed investment against the SFAIRP/ALARP position. This situation is similar to Wilton substation where the double bus structure substation was reconfigured in 2017 to address the same issue. **Meets criteria**
A10(c)	At least one asset likely to be commissioned in RCP4	Presently there are 8 current transformers connected to this double bus structures manufactured by Nissin and pre-2000 non-galvanised bodied models that are showing signs of corrosion and oil leaking from its stainless-steel bellow tanks. These 8 current transformers have been identified for replacement in Transpower base R&R programme within their outdoor switchgear portfolio. As such it provides Transpower an opportunity to undertake the wider bus rationalisation work alongside the proposed R&R current transformer replacement work. In order to exploit the synergies, the bus rationalisation work can be planned alongside the proposed R&R work. If so, there will be at least one bus structure asset that is likely to be commissioned in RCP4. **Meets criteria**
A10(d)	Project is either asset replacement, refurbishment or both	The proposed elimination solution or any other viable alternate options relates to R&R activities.

[380] Transpower, RFI012-24 CP_HAY_00W_0_00 - HAY 110kV Rebuild Placeholder A7.pdf
[381] Transpower, RFI034-14 Haywards 110 kV Bus Investigation Need Statement.pdf
[382] Transpower, RFI034 Transpower Response.pdf
[383] Transpower, RFI034-15 Haywards interruption report.pdf

ToR Clause	Listed Project Criteria	Evaluation
		Meets criteria
A10(e)	Commencement date in RCP4 but that cannot be forecast with specificity	We understand that the investigation for investment case for this proposed listed project is not complete yet. This means that the exact solution, its costs and the timing is presently unknown. However, please also note our assessment against the above criteria on at least one asset that is likely to be commissioned in RCP4. **Meets criteria**
A10(f)	Not included in the base capex forecast	Review of other proposed expenditures (especially the outdoor switchgear and buswork and structures asset portfolios) indicates that this expenditure is not included in other base capex for RCP4. **Meets criteria**

19.4.5 HVDC cables replacement

Our assessment of Transpower's proposed HVDC cable replacement project which is being proposed as a listed project in RCP4 is presented in this sub-section and is summarised in the following table.

Table 19-22 Verification summary of proposed HVDC cable replacement project capex

Verification element	Verification commentary
RCP4 proposed amount	$239.6m
Appropriate and sufficient information available for IV	Yes
Meets ToR evaluation criteria	Yes
IV conclusion	Accept: $239.6m
Potential scope for improvement	
Key issues and areas that the Commission should focus on	

Project overview

Transpower has proposed to list a HVDC project that aims to potentially replace one or more existing HVDC subsea cables. While acknowledging the uncertainties surrounding the scope, timing, and necessity of this project, Transpower qualifies it as a listed project, with a total projected funding of $239.6m. Transpower indicates, based on quotations received, $70m of the total cost will need to be spent during RCP4. This will cover key early activities such as; development of business case, rebuilding and moving of spare cable store, cable design, securing of cable manufacture slot and securing of required marine vessel and crew.

Transpower's indicate their project plan[384] expects the spares cable store to be moved and rebuilt during RCP4. Delivery of this in RCP4 is needed to meet the ToR clause A10(c).

Two drivers were initially indicated for this project:

1. Forecast deterioration of the existing cables, and
2. Need to have a cable replacement solution compatible with the 1400MW upgrade solution (cable size and total number of cables).

Information provided on the 15 June 2023[385], indicate the sole diver for the project is the forecast deterioration of the existing cables.

Evaluation & conclusion

The updated asset condition assessment information, forecast asset condition information, and indicative project timeline suggest the likely need to intervene to remediate the cable is within RCP5. However, the long lead time

[384] 20230615 – HVDC and reactive – additional information first and second session.pdf
[385] 20230615 – HVDC and reactive – additional information first and second session.pdf

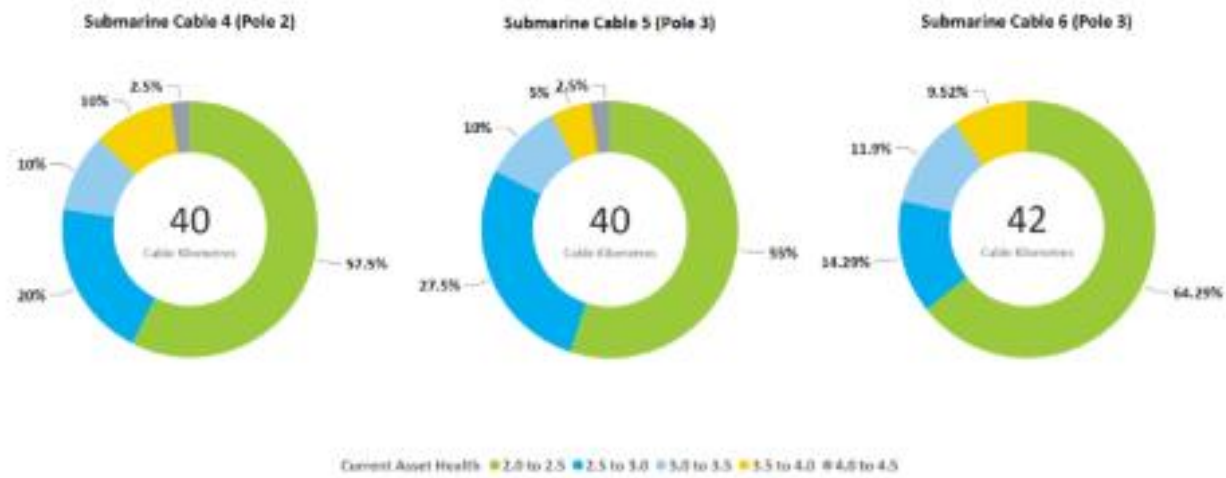
required to, develop the justification to start planning, design, procure and potentially manufacture the subsea cables, justifies the project to be initiated during RCP4.

Regarding the timing of the proposed listed HVDC project, there was ambiguity due to the information provided during the review. Table 3 in the document "ERR027 HVDC Assets 2022 PMP.pdf" indicates the expected end of asset life for all three cables to be 2032. However, in a subsequent response to RFI041, an extract from Transpower's health model was provided, which indicated the modelled end of asset life for, various sub-sections of the cables, to fall between 2034 and 2038, with the majority falling in 2038.

Further updated asset condition information provided on 15 June 2023,[386] provided updated asset health score information including for the HVDC cable. It indicated asset health scores to be worse than previously provided. With the predicted year a specific cable section will reach an asset health score of 8, now at 2032 for cable 4 and cable 5, and 2035 for cable 6 (which is earlier than the ERR027 HVDC Assets 2022 PMP0 indicates). This latest information was used to gauge the current asset health that then was used to determine Transpower's forecast replacement date. Transpower asset strategies use an asset health value of 8 to decide the timing for intervention.

Transpower has a comprehensive assessment programme for subsea cables, which classifies the health of each kilometre of the assets. The graph below indicates the current health models for the subsea cables. While the cables are in relatively good overall asset health, the section in the worst condition will determine the likely intervention date. Intervention will either involve, replacing damaged sections of cable or replacing the entire cable. The business case will determine the optimal solution.

Figure 19-9 Subsea cable health



Source: Transpower, ERR027 HVDC Assets 2022 PMP.pdf

Noting the qualification above on asset health and considering the long lead time, we consider the HVDC cable replacement for $239.6m meets all the evaluation criteria as a listed project for RCP4 IPP submission.

The following table summarises our evaluation of HVDC cable replacement as a listed project for RCP4 IPP submission.

Table 19-23 HVDC Cables Replacement Listed Project Evaluation

ToR Clause	Listed Project Criteria	Evaluation
A10(a)	Capital Expenditure greater than $20m	Forecast total cost of proposed listed project is $239.6m. $70m is forecast to be spent in RCP4 Costing provided in PMP and responses to various RFIs. **Meets criteria**
A10(b)	Reasonably required by Transpower	Based on the last set of cable condition information provided. It is reasonable that some form of remediation on the subsea cable will be required in RCP5. Scope of work is described in PMP and responses to various RFIs. **Meets criteria**

[386] Source: HVDC subsea cable Asset Health 2023.pdf

ToR Clause	Listed Project Criteria	Evaluation
		See note 1 below for details.
A10(c)	At least one asset likely to be commissioned in RCP4	Indicative project plan indicates the new spare cable store will be commissioned in RCP4. Scope of work is described in PMP and responses to various RFIs. **Meets criteria**
A10(d)	Asset replacement, refurbishment, or both	The scope of the proposed listed project is indicatively to be asset replacement. Scope of work is described in PMP and responses to various RFIs. **Meets criteria**
A10(e)	Anticipated commencement date in RCP4 but that cannot be forecast with specificity	Though project delivery is expected to be in RCP5. Due to the long lead time to precure subsea cable and the need to reserve specialised marine fleet. It is reasonable that project planning and ordering of long lead items to commence in RCP4. Scope of work is described in PMP and responses to various RFIs. See note 1 below for details. **Meets criteria.**
A10(f)	Not included in the base capex forecast	Potential scope overlap to be aware of. The rebuilding of the spare cable store is not in the proposed base capex. However, the RCP4 base capex requests funding to remediate parts of the spare cable store that is in poor condition. As a new spare cable store is likely to be rebuild and moved in ~10 years' time. Consideration needs to be given on criticality and urgency of these repairs. Limiting repairs to sections that present safety or functional risks. **Meets criteria.**

20. Service measures

Our verifications of grid output (service) measures considered four revenue linked measures (GP1, GP2, AP1, and AP2), six measures that are not revenue linked (GP-M, AP3, AP4, AP5, AH, and NR) and two new pilot measures (CS1 and CS2). The measures cover grid performance, asset performance, network risk, asset health and customer outcomes. Service measures are reported on in disclosure years, which run from 1 July to 30 June, unless otherwise specified.

For the RCP4 proposal, Transpower proposes to discontinue two of the existing measures and proposes to introduce three new measures. Modifications or updates are also proposed to five of the remaining seven measures. The following table summarises the proposed grid service measures, changes from RPC3 and our verification for Transpower's proposed service measures.

Table 20-1 Summary of grid output (service) measures and verification outcomes

Code	Grid service measure	Summary of changes from RCP3 to RCP4	Verification finding
GP1	Number of unplanned interruptions	Retain measure, and update POS categorisation.	Support as proposed. However, consider GHD's recommendation in setting targets.
GP2	Average duration of unplanned interruptions	Retain measure, and update POS categorisation.	Support as proposed. However, consider GHD's recommendation in setting targets.
GP-M	Number of momentary unplanned interruptions, <1min	Discontinue measure.	We support discontinuing this measure.
AP1	HVDC capacity availability (%) of the HVDC inter-island bipole link	Modify measure. Exclude major capital projects, listed projects and HVDC resilience workstreams. Cap the impact of a single unplanned outages events and introduce pooling across disclosure years for the Quality Standard.	Support all proposed changes to this measure, including allowance for resilience work, except: – Limiting impact on penalties from individual major events.
AP2	Average percentage of time selected HVAC assets are available	Modify measure. Exclude major capital projects, listed projects, base capex E&D and customer-funded work. Update the list of assets that can cause market constraints. Remove the quality standard for AP2 or introduce pooling across disclosure years for the quality standard. Cap impact of a single unplanned events.	Support proposed changes to the measure except: – Removing the Quality Standard.
AP3	Return to service	Retain measure and align with updated AP2 selected assets.	We support retention of measure and updated assets list.
AP4	Return to service communications	Retain measure and align with updated AP2 selected assets.	We support retention of measure and updated assets list.
AP5	N-Security reporting	Discontinue measure.	We support discontinuing this measure.
AH	Proportion of assets in poor health for selected asset classes	Modify measure. Expand to seven asset classes. Introduce weighting by criticality for some asset classes. Remove the quality standard for AH or introduce annual quality limits with pooling across asset classes and disclosure years	Support proposed changes to the measure except removing the Quality Standard.
NR	Energy not served	Trial new pilot measure (reporting-only) for network risk, reporting energy not served against the same four supply points of service sub-categories as GP1 and GP2	Support as proposed. However, recommend that the title be changed to correctly reflect this measure.

Code	Grid service measure	Summary of changes from RCP3 to RCP4	Verification finding
CS1	Overall customer satisfaction	Trial new pilot measure (reporting-only) for overall customer satisfaction	Support as proposed.
CS2	New and enhanced grid connections	Trial a new pilot measure (reporting-only) for new and enhanced grid connections	Support as proposed.

20.1 Overview of existing RCP3 and proposed RCP4 service measures

Transpower have a range of service measures in place to ensure Transpower's delivery services its customers value, efficiently and in line with its regulatory and safety requirements. This section summarises the existing RCP3 service measures and the proposed changes, including new service measures for RCP4.

20.1.1 RCP3 service measures

Currently, in RCP3, Transpower has ten service measures summarised in the figure below:

- Three measures of grid performance (GP)
- Five measures of asset performance (AP)
- Two measures of asset health (AH)

The services measures are divided into:

- measures that have revenue incentives and quality standards (GP1, GP2, AP1, AP2), where the revenue incentive has implications for Transpower's revenue if the performance exceeds or fails to meet specified caps and collars set for the service measure,
- non-incentive measures with quality standards (AH), and
- non-incentive measures with no quality standards (AP3, AP4, GP-M, AP5).

If the Commission sets a quality standard for a service measure, Transpower must meet it otherwise it will be non-compliant with its IPP. Breaching a quality standard will likely trigger an investigation by the Commission. The Commission may also investigate other performance trends revealed in yearly reports.

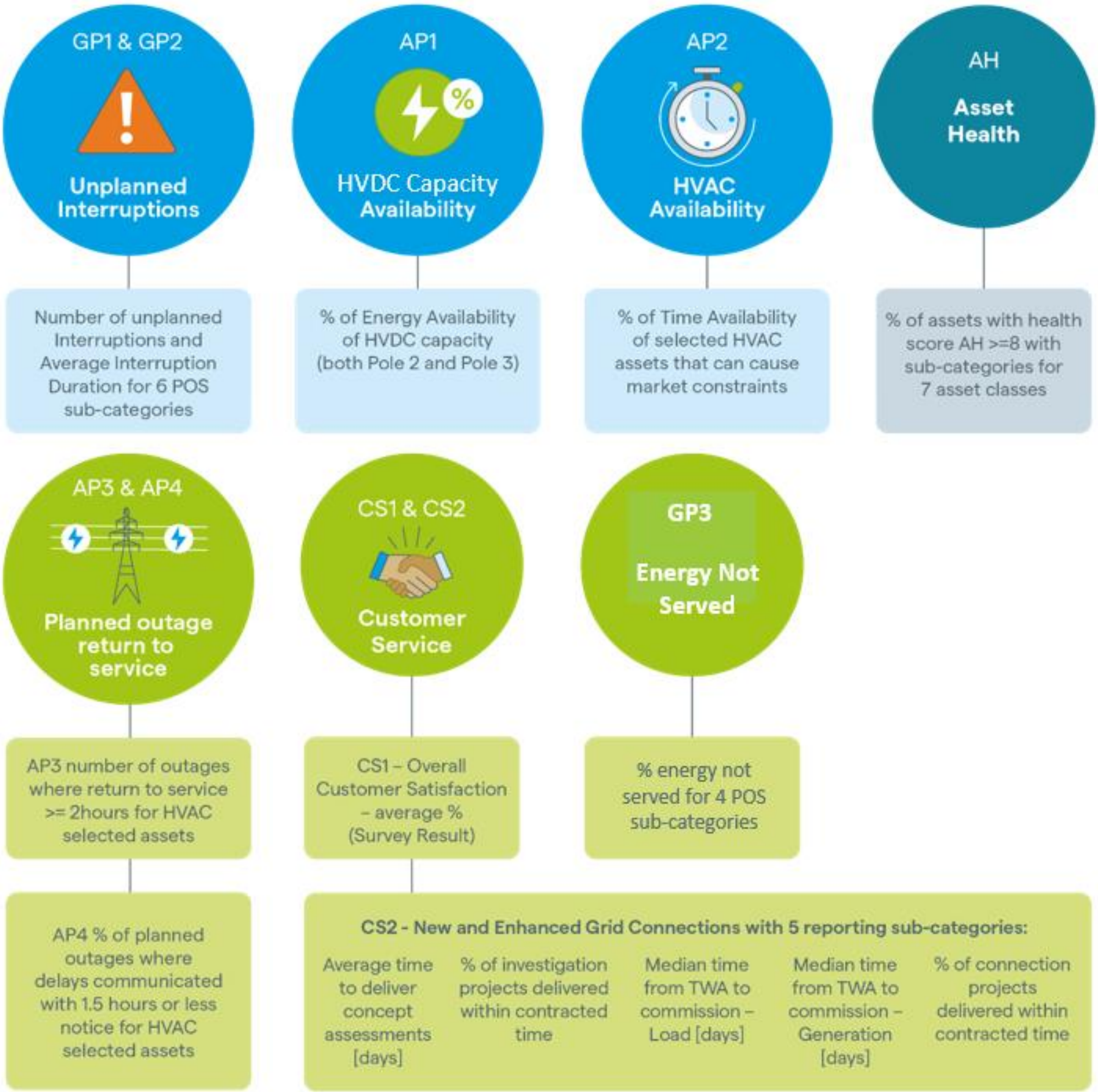
Figure 20-1 RCP3 service measures

Source: Transpower, RCP4 Grid Service Measure Refresh – Working Summary, Version 1, March 2023, page 5. [GSM004]

20.1.2 Proposed RCP4 service measures

For RCP4 Transpower is proposing ten service measures. Four are revenue linked and six are not revenue linked. Two measures are for grid performance, four for asset performance, one for network risk, one for asset health and two customer measures. The figure below summarises the proposed RCP4 service measures.

Figure 20-2 Proposed RCP4 service measures



Source: Transpower, RCP4 Grid Service Measure Refresh – Working Summary, Version 1, March 2023, page 6. [GSM004]

The proposed service measures build on the current RCP3 measures with some changes. Transpower propose to:

– Continue revenue-linking four of the measures – GP1, GP2, AP1, and AP2.
– Retain quality standards for GP1, GP2, and AP1, with the quality standard for AP1 being adjusted to include pooling across disclosure years and thereby align with the approach applicable for GP1 and GP2.
– Continue reporting-only measures of AP3 and AP4, and make AH a reporting only measure.
– Introduce new reporting only measures. NR, CS1 and CS2 are new measures proposed for RCP4.
– Remove the RCP3 quality standards for AP2 and AH or if they are retained, modify how they are applied.

The following table outlines the proposed changes to services measures for RCP4.

Table 20-2 Proposed RCP4 service measures

Code	Grid service measure	Summary of proposed changes from RCP3 to RCP4
GP1	Number of unplanned interruptions	Retain measure, and update POS categorisation based on forecast load, rather than historic load.

Code	Grid service measure	Summary of proposed changes from RCP3 to RCP4
GP2	Average duration of unplanned interruptions	Retain measure, and update POS categorisation based on forecast load, rather than historic load.
GP-M	Number of momentary unplanned interruptions, with a duration <1 min	Discontinue measure and include customer-specific information about momentary interruptions in Customer Individual Engagement Plans.
AP1	HVDC capacity availability (%) of the HVDC inter-island bipole link	Modify measure. Exclude major capex projects and listed projects and HVDC resilience workstreams proposed under a new uncertainty mechanism. Cap the impact of single unplanned event to 0.125% and introduce pooling across disclosure years for the quality standard, similar to settings for GP1 and GP2.
AP2	Average percentage of time selected HVAC assets are available	Modify measure. Exclude major capex projects, listed projects, base capex E&D work and customer-funded work. Update the list of selected assets to 62 assets that can cause market constraints. Remove the quality standard for AP2 for RCP4. Cap the impact of a single unplanned event to 150 hours and introduce pooling across disclosure years for the quality standard (if retained), similar to settings for GP1 and GP2.
AP3	Return to service	Retain measure and align with updated AP2 selected assets.
AP4	Return to service communications	Retain measure and align with updated AP2 selected assets.
AP5	N-Security reporting	Discontinue measure and continue with existing business processes related to N-security and outage planning.
AH	Proportion of assets in poor health for selected asset classes	Modify measure. Expand to seven asset classes. Introduce weighting by criticality for some asset classes. Remove the quality standard for AH for RCP4. If quality standard retained, introduce annual quality limits with pooling across asset classes and disclosure years, similar to settings for GP1 and GP2.
NR	Energy not served	Trial new pilot measure (reporting-only) for network risk, reporting energy not served against same four supply points of service sub-categories as GP1 & GP2.
CS1	Overall customer satisfaction	Trial new pilot measure (reporting-only) for overall customer satisfaction, based on our customer survey.
CS2	New and enhanced grid connections	Trial a new pilot measure (reporting-only) for new and enhanced grid connections, with five reporting sub-categories – Average time to deliver concept assessments (days) – % of investigation projects delivered within contracted time – Median time from TWA4 to commission – Load (days) – Median time from TWA to commission – Generation (days) – % of connection projects delivered within contracted time

Source: Transpower, RCP4 Grid Service Measure Refresh – Working Summary, Version 1, March 2023, page 9. [GSM004]

20.1.3 Changes to proposed revenue at risk (RCP3 to RCP4)

The current RCP3 revenue at risk of approximately $54m represents 1.4% of expected revenue for the period. For RCP4, Transpower propose to retain a 1.4% revenue at risk incentive level, which, given the higher proposed expenditure level for RCP4 compared to RCP3, represents $65m (based on proposed RCP4 expenditure).

Transpower also propose that revenue at risk remain for the same four services measures in RCP4: GP1, GP2, AP1, and AP2. Significantly more of this revenue is proposed for GP1 and GP2 than AP1 and AP2 reflecting the higher economic impact of interruptions and grid reliability for customers and end-consumers. This emphasis on unplanned interruptions over availability is considered reasonable and supported by the stakeholder engagement (refer to next sub-section) that Transpower undertook. The following table shows the allocation of at-risk revenue between service measures.

Table 20-3 Allocation of total revenue at risk for incentive measures RCP3 and RCP4

Code	Service measure	Approximate percentage of revenue at risk	
		RCP3	RCP4
GP1	Number of unplanned interruptions	43%	~45%
GP2	Average duration of unplanned interruptions	43%	~45%
AP1	HVDC capacity availability (%) of the HVDC inter-island bipole link	5%	~3%
AP2	Average percentage of time selected HVAC assets are available	9%	~6%

Source: Transpower, Grid Service Measures Refresh Summary, March 2023. [GSM004].

20.1.4 Stakeholder engagement on service measures

Transpower undertook an engagement process to ensure that the proposed service measures reflect customer and stakeholder expectations with respect to levels of service. The engagement process consisted of

– Publishing an engagement paper outlining proposed measures to retain, modify, discontinue, or introduce along with providing supporting material.
– Holding a stakeholder webinar to discuss and provide feedback on RCP3 service measures and proposed RCP4 measures.
– Publishing a summary of feedback received on the proposed RCP4 measures.
– Publishing a second engagement paper in September 2022 providing more detail on the proposed RCP4 service measures, and the proposed methods by which the measures will be calculated. It also formed part of Transpower's wider RCP4 consultation.
– Publishing a second summary of feedback received.
– Meeting with interested stakeholders between March and November 2022 including the customer representative panel, the Major Electricity Users' Group (MUEG), Electricity Networks Association (ENA), Electricity Retailers' Association of New Zealand (ERANZ), along with the Consumer Advisory Panel.

Transpower have stated that submissions received indicated there was general satisfaction with the current level of performance Transpower provides. Stakeholders have also indicated they are satisfied with the consultation on service measures to date, and that they do not want Transpower to consult again on specific targets before Transpower submit their RCP4 proposal.

GHD has not independently interviewed Transpower's key customer or stakeholders. However, we have sighted Transpower's engagement papers and feedback summaries. The summaries in general indicate that customers and stakeholders are satisfied with Transpower's current level of service and the proposed changes to service measures for RCP4.[387] The stakeholder engagement process is also consistent with engagement processes undertaken by Australian TNSP's for regulatory resets. Where customers or stakeholders have raised concerns with a service measure, that concern and Transpower's response is discussed in the context of the relevant service measure.

20.1.5 Benchmarking of service measures

As part of Transpower's preparation for the RCP4 submission, a benchmarking exercise was carried out to gauge the suitability of their existing service measures. Two international regulatory bodies were used in this benchmarking:

– Ofgem - regulates electricity transmission and distribution owners in Great Britain
– AER - regulates electricity transmission and distribution systems in all Australian states and territories, except for Western Australia.

Ofgem have six (6) areas they measure:

[387] Transpower, Grid Service Measures Engagement Paper 2 (Annex).pdf. [GSM003]; Transpower, Submission Summary - Grid Service Engagement Paper 1.pdf. [GSM005]

- Energy not served - improve network reliability.
- Timely connections - encourage the efficient timely delivery of connection offers.
- Insulation and interruptions leakage - incentivise a reduction in leakage of SF6 and other IIGs.
- Quality of connections - incentivises companies to improve the quality of service for connections customers.
- Network optimisation - two-year trial to reduce constraint costs.
- Environmental score card - targets in their Environmental Action Plan.

AER categories service measures into three broad areas: Service Component, Market Impact Component and Network Capability Components). The specific items within these areas were provided in the benchmarking:

- Service Component:
  - Unplanned circuit outage event rate
  - Loss of supply event frequency
  - Average outage duration
  - Proper operation of equipment
- Market Impact Component:
  - Performance Target
  - Unplanned outage event limit
  - Dollar per dispatch interval ($/DI)
- Network Capability Component:
  - Improve the capability of the transmission network at times when it is most needed.

The benchmarking analysis found that Transpower's existing service measures generally align with the areas Ofgem and AER consider.

For RCP4, Transpower are proposing to include two new measures for customer service covering customer satisfaction and the grid connection process. This change compares favourably with areas measured by Ofgem that does not currently consider equivalent measures. The approach aligns with global observations where lengthy grid connection timeframes are often a concern for customers.

One area of measures that both Ofgem and AER use is aimed at incentivising actions that improve network capability and reduce constraints. We note AP1 and AP2 measures proposed by Transpower for RCP4 also consider availability and hence the impact of network constraints.

For clarity, it is noted the methods used to calculate the various measures were not benchmarked. However, it would be difficult to compare these usefully. Unique customer, geographic or regulatory drivers create the need for specific measures relevant to that jurisdiction (for example using averages vs. medians or using 5-year averages vs. 10-years averages).

20.2 Historical performance against service measures

In this section, we consider Transpower's performance against service measures for RCP2 and the first few years of RCP3.

20.2.1 RCP2 performance

For RCP2, Transpower was subject to 20 separate annual quality standards, and an additional three quality standards that were assessed over the full five years of RCP2. Transpower's performance against grid performance and availability and asset health measures for RCP2 is shown in the following tables.[388]

In the tables, cells that are shaded red indicate a quality standard that was not achieved, leading to a breach and cells shaded in green indicate a quality standard was achieved.

As the tables indicate, Transpower had a range of breaches across the RCP2 service measures, including:

– 19 breaches related to grid performance[389].
– 6 breaches related to asset performance[390], and
– 15 breaches related to asset health[391].

These breaches prompted the Commission to engage an independent consultant to review the breaches with two separate engagements:

– Investigation into the RY2016 and RY2017 breaches, and
– Investigation into the RY2018, RY2019 and RY2020 breaches.

Findings from these investigations are summarised below.

Table 20-4 RCP2 performance against grid performance and availability measures

Quality Measures		RY2016	RY2017	RY2018	RY2019	RY2020	Collar
Number of unplanned interruptions (GP1)	High Priority (A)	0	3	1	2	2	4
	Important (B)	2	6	10	3	6	14
	Standard (C)	14	23	48	16	16	31
	Generator (D)	4	20	7	13	2	16
	N-Security (E)	22	26	51	30	19	74
Average Duration (GP2)	High Priority (A)	0	47	141	9	113	110
	Important (B)	14	200.8	40	55	81	170
	Standard (C)	42.2	75.3	164	96	78	130
	Generator (D)	161.5	105.4	229	183	134	210
	N-Security (E)	166.7	615.7	188	415	81	115
P90 (GP3)	High Priority (A)	0	72	141	10	146	160
	Important (B)	17.0	482	65	118	98	310
	Standard (C)	116.0	131	202	225	145	200
	Generator (D)	234.0	173	588	342	178	440
	N-Security (E)	341.0	1056	381	473	182	260
Availability	HVDC (AP1)	98.9	98.6	98.8	99.1	88.26	97.5
	HVAC (AP2)	99.0	99.0	99.0	98.7	97.38	99.2

Source: Transpower, 20230509 Service Measures Refresh – Second interview IV slides.]

[388] RFI response - 20230509 Service Measures Refresh - Second interview IV slides.pdf
[389] GPI (2 breaches), GP2 (9 breaches), GP3 (8 breaches)
[390] AP1 (1 breach), AP2 (5 breaches)
[391] AH1 (2 breaches), AH2 (5 breaches), AH3 (5 breaches), AH4 (1 breach), AH5 (1 breach), AH6 (1 breach).

Table 20-5 RCP2 performance against asset health performance measures

Volume Measures	RY2016		RY2017		RY2018		RY2019		RY2020	
	Actual	Collar	Actual	Collar	Actual	Collar	Actual	Collar	Actual	Collar
No. of transmission towers refurb (AH1)	461	387	542	483	532	477	508	518	474	515
No. of grillage foundations refurb (AH2)	276	308	320	365	323	377	226	359	174	346
No. of insulator sets replaced (AH3)	755	1417	887	1351	844	1287	644	1200	874	1260
	All of RCP2								**Actual**	**Collar**
Outdoor circuit breakers (AH4)									11	14
Power transformer (AH5)									113	129
Outdoor to indoor conversions									19	24

Source: Transpower, 20230509 Service Measures Refresh – Second interview IV slides.

Investigation into 2016 and 2017 breaches

The Commission issued a notice to Transpower for 2016 and 2017 breaches of the quality standards and engaged Strata Energy Consulting Limited (Strata) to undertake an independent review[392]. Review findings are summarised as follows:

- **GP1/GP2/GP3**: Strata concluded that these breaches were principally caused by a small number of major events that are high-impact-low-probability events. Strata accepted Transpower's explanations for the events and the way they managed outage duration. Strata did not raise any concerns or identify areas where Transpower acted inconsistently with GEIP. Strata did, however, state that Transpower did not provide sufficient historical performance context when explaining performance outside the collar level and should have continuous monitoring and analysis to determine if performance was changing. Strata noted in its report that a combined Synergies and GHD review of these incidents did not agree that the evidence supported these Strata criticisms. (Note: Transpower have stated that monthly reporting takes place).
- **AP2:** Strata concluded that the AP2 target was overly optimistic. However, given the quality measures for RCP2 were classed as 'prototypes' it would be unreasonable to consider that Transpower acted inconsistently with GEIP. Strata also concluded for unplanned outages Transpower undertook detailed post event reviews and have implemented improvement initiatives whilst for planned outages Transpower undertakes detailed planning including risk-based prioritisation of works. The approaches for both unplanned and planned outages are considered aligned with GEIP. Strata did however recommend that the availability target and collar for RCP3 could be improved.
- **AH:** Strata was satisfied with the revised grillage approach which was in line with GEIP. However, they stated Transpower had not met GEIP in the following areas:
  - by not advising the Commission of over estimation of insulator replacements. (Note: Transpower now indicate they advise the Commission though yearly public disclosures with numbers and explanation as to why there were lower interventions).
  - RCP2 calculations did not take into account complex grillage repairs. (Note: Transpower have since matured its cost estimation).
  - risk assessment should have been clearly documented, reported to the CGT, and approved by the CGT at the time grillage volumes were initially reduced (Note: Transpower indicated that they disagreed with

[392] Strata Energy Consulting, Quality measures non-compliance report: Transpower New Zealand's performance for the 2016 and 2017 disclosure years (Stage 1 Report), 12 August 2019. Available at: **https://comcom.govt.nz/__data/assets/pdf_file/0030/175782/Strata-Energy-Consulting-Limited-Report-on-Transpower-New-Zealand-Limiteds-performance-for-the-2016-and-2017-disclosure-years-12-August-2019.pdf**

this finding. The finding was based on the BECA report referenced in Strata's report,[393] which determined the intervention points to be economic, so strategy changes do not impact the risk profile).

Overall Strata concluded Transpower acted largely in accordance with good electricity industry practice and found that Transpower's asset management practices were sound. The Commission also noted that, given the large number of quality standards, some breaches were inevitable and there was no evidence that Transpower put the interests of its shareholder above the needs of its capital programmes[394].

GHD is satisfied that the Strata review was conducted independently and did not identify systemic issues with Transpower's asset management practices or approach to managing the network.

Investigation into 2018, 2019 and 2020 breaches

The Commission issued a notice to Transpower for breaches of the 2018, 2019 and 2020 quality standards and engaged Strata[395] to undertake an independent review of the contraventions. Review findings are summarised as follows:

- **GP1/GP2/GP3:** Strata found no evidence of underlying asset deterioration regarding Grid Performance breaches.
- **AP1:** Strata found Transpower acted consistently with good electricity industry practice when managing and mitigating its HVDC asset availability (AP1) during disclosure year 2020. This breach was due to a planned outage to undertake reconductoring work.
- **AP2:** Strata found that the AP2 HVAC availability collar levels were set at an unachievable standard. Strata indicated that Transpower stated there was an error made when proposing AP2 for RCP2 and that there was also an error by the Commission in their final decision. Strata's review did not raise any departures from GEIP relating to the method Transpower uses to plan and manages outage duration.

Strata's review looked at each of the six (6) asset health quality standards and found the following:

- **AH1:** The reduced number of transmission towers refurbished reflected external impacts and the effects of an improvement initiative.
- **AH2:** The reduced grillage refurbishments reflect improved asset management.
- **AH3:** The reduced insulator replacements reflect improved condition information.
- **AH4:** The reduced outdoor circuit breaker replacements are attributable to CBRM introduction and that the Commission should acknowledge the benefits that Transpower is realising.
- **AH5:** The reduced power transformer replacements are attributable to improved and more cost-efficient strategy.
- **AH6:** The new strategy for ODID conversions resulted in reduced cost and risk management benefits, and that Transpower demonstrated that it had included its customers in the decisions that affected their service.

The asset health quality standards set in for RCP2 do not reflect Transpower's ability to maintain particular asset health levels for asset classes. Rather they reflect the ability of Transpower to deliver a certain volume of R&R work for the six asset classes covered by AH1 to AH6. This measure encourages Transpower to replace assets regardless of age or condition. A more effective measure that aligns with prudent expenditure would require assets in a class of a certain criticality to be maintained to a certain asset health level.

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[393] Strata Energy Consulting, Quality measures non-compliance report: Transpower New Zealand's performance for the 2016 and 2017 disclosure years (Stage 1 Report), 12 August 2019. Available at: **https://comcom.govt.nz/__data/assets/pdf_file/0030/175782/Strata-Energy-Consulting-Limited-Report-on-Transpower-New-Zealand-Limiteds-performance-for-the-2016-and-2017-disclosure-years-12-August-2019.pdf**

[394] Commerce Commission, Warning letter to Transpower New Zealand Limited, 12 September 2019, paragraphs 20 and 22. Available at: **https://comcom.govt.nz/__data/assets/pdf_file/0017/174104/Warning-letter-to-Transpower-New-Zealand-Limited-12-September-2019.pdf**

[395] Strata Energy Consulting, Quality Performance Report: An assessment of Transpower New Zealand Limited's performance for the 2018, 2019 and 2020 disclosure years, October 2021, Available at: **https://comcom.govt.nz/__data/assets/pdf_file/0031/278536/Strata-Energy-Consulting-Report-on-Transpower-New-Zealand-LimitedE28099s-performance-for-the-20182C-2019-and-2020-disclosure-years-October-2021.pdf**

20.2.2 RCP3 performance

While Transpower is mid-way through RCP3, it provided its annual report outlining its performance against RCP3 service measures based on data available to end of June 2022.[396] This report states that the rate of unplanned interruptions to transmission service is trending down over the long term. Based on the data available at the time, the RCP3 service measures are seen to be performing well with respect to the number (GP1) and average duration (GP2) of unplanned interruptions across all points of service sub-categories.

Disclosure year 2022 saw the fourth best performance in 24 years with 52 unplanned interruptions for the RCP3 points of service, excluding automatic under frequency load shedding, customer caused and momentary interruptions. In 2022, Transpower reported one normalisation event. This event relates to the repairs of damaged transmission assets caused by a malicious act. Transpower also noted one outlier event associated with the outages for the Clutha Upper Waitaki Lines Project, which was not included in Transpower's RCP3 plan. The Clutha Upper Waitaki Lines Project outlier event was indicated to continue into disclosure year 2023.

Following the discovery of the root causes of certain events, Transpower have identified additional unplanned interruptions arising on the Kinleith feeder that should have been included in their GP1 (number of unplanned interruptions) and GP2 (duration of unplanned interruptions) service measures for disclosure year 2020 (the last year of RCP2) and disclosure year 2021 (the first year of RCP3). Transpower has updated these disclosures and re-published on their website.[397]

For disclosure year 2022, the following performance was reported for service measures with revenue incentives:[398]

– **GP1:** Transpower met 5 of the 6 subcategories of performance measures linked to revenue, failing to meet the GP1F: N generator subcategory. Transpower met the quality standard.
– **GP2:** Transpower met 4 of the 6 subcategories of performance measures linked to revenue, failing to meet the GP2B: N-1 material EC and GP2E: N-1 generator subcategories. Transpower met the quality standard.
– **AP1:** Transpower did not meet its defined target but met the quality standard.
– **AP2**: Transpower did not meet its defined target or quality standard, and this has resulted in an investigation by the Commission (discussed below).
– **AH:** Transpower met the quality standard for circuit breakers and power transformers.

Quality standards for disclosure years 2021 and 2022, were met for five of the six measures. The quality service measures AP2 (HVAC availability %) was not met in disclosure years 2021 or 2022.

For service measures without quality standards, the table below displays performance for 2021 and 2022. These service measure have no specified performance targets.

Table 20-6 Service measure performance for disclosure years 2021 and 2022 (actual)

Measure	Units	2021	2022
GP-M – Momentary unplanned interruptions	Count of interruptions with duration < 1 min	22	29
AP3 - Return to service time	% >2 hrs of planned return to service	3.66	3.29
AP4 - Return to service time – communications	% < 1.5 hours' notice of delay	7.0	8.55
AP5 – N security reporting	Count of points of service on N-security >20% of time	8	4

Source: Transpower, 2022 Service Measures Report, September 2022. [CSM001]
Note: These results are preliminary and may change because of the final audit process.

Investigation into 2021 and 2022 breaches

The Commission has commenced an investigation into both 2021 and 2022 disclosure years for AP2 only. Transpower received a notice commencing the investigation and requesting information. Transpower have responded to this notice and request.

[396] Transpower, 2022 Service Measures Report, September 2022. [CSM001]
[397] Transpower, 'RCP3 updates and disclosures' webpage, accessed 20 August 2023, refer to: **https://www.transpower.co.nz/our-work/industry/regulation/rcp3/rcp3-updates-and-disclosures**
[398] Transpower, 2022 Service Measures Report, September 2022. [CSM001]

For disclosure years 2021 and 2022, there were two events that contributed to breaches of AP2's quality standard:

– The Clutha Upper Waitaki Lines Project, and
– Remediation of cable joint failures on the BHL-PAK transmission cable.

When Transpower became aware of these breaches they advised the Commission and the industry of the likely impacts.[399] Transpower managed AP2 exceedance through a formal AP2 governance group who met monthly. Their stated view is that their response and management of these two events are at GEIP.

An independent investigation is ongoing and GHD has not sighted any findings from the investigation. As such we have not formed an opinion on Transpower's management, responsiveness, or the performance of the transmission system in relation to these service measure breaches.

20.3 Evaluation approach

The following table summarises how we assessed proposed services measures against the criteria specified in the ToR. The following sections consider each service measure and present the outcome of our evaluation.

Table 20-7 Evaluation criteria and approach: Service measures

ToR Clause	Evaluation criteria	Application	Evaluation commentary
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	All service measures	Reviewed RCP4 service measures to assess whether they are similar to measures adopted by other jurisdictions or TNSPs as a method of monitoring network risk or transmission performance.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified;		We reviewed whether proposed RCP4 expenditure is aligned with achieving service measures.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.		We sought evidence to confirm that Transpower's processes are aligned and support meeting the service measures.
A6(a)	Measure is a recognised measure of grid outputs valued by consumers	Revenue-linked service measures	We sought evidence of value demonstrated through either customer feedback or industry recognised measures such as VOLL.
A6(b)	Strength of relationship with base capex		We sought evidence demonstrating a strong link between RCP4 base capex and maintaining service measure performance.
A6(c)	Measure is quantifiable, controllable by Transpower, auditable and replicable over time		We sought evidence demonstrating that the measure is quantifiable, controllable by Transpower, auditable and replicable over time.
A7(a)	Value consumers place on measure and relationship between this value and the proposed incentive rate	Assessment of **caps, collars, incentive rate targets** for **revenue-linked grid output measure**	Sought to confirm that incentive rates applied are derived from the remainder of value-at-risk and the value is considered reasonable with justification provided.
A7(b)	Quantification of relationship between base capex and the grid output for both RCP4 and longer term		Sought evidence to confirm that the base capex is designed to neither improve performance against the target, nor allow it to deteriorate. The target normalises the impact of base capex on performance.
A7(c)	Factors unrelated to investment that impact measure: (i) natural degradation in asset condition (ii) impact of grid loading changes		Assessed whether in designing the performance measure relevant factors have been considered and any exclusions are appropriate.

[399] 230331 Confidential Transpower Letter to Commerce Commission (Redacted version)' see paragraphs 98-99 regarding industry notification of the outages and impact of these outages.

	(iii) extreme weather events		
A7(d)	Plausible range of grid outputs based on factors in A7 (b) and A7 (c)		Sought evidence that demonstrates that the proposed measures would likely lead to reasonable outputs. Transpower should not systematically over- or under-perform.
A7(e)	Relationship between range and proposed caps and collars		See response to row above.
A7(f)	Impact on return on capital implied by both the range and the application of the proposed cap, collars and grid output incentive rate		Assess whether the revenue incentive is appropriate considering the implied return on equity.

20.4 GP1 and GP2: Unplanned interruptions

20.4.1 Overview of service measure

The grid performance measures, GP1 and GP2, assess grid reliability and relate to Transpower's ability to provide a reliable uninterrupted transmission service. GP1 and GP2 measure and report the yearly number of unplanned interruptions (GP1), and the yearly average duration of unplanned interruptions greater than one minute (GP2), across all points of service divided into separate sub-categories (where each of the six sub-categories has a separate measure of grid performance).

Points of service

Transpower is proposing to update the points of service categorisation to be based on forecast load, rather than historic load. The GP1 and GP2 measures are reported across six points of service sub-categories for RCP3. The points of service categorisations are based on the level of security, whether it is a generation or supply point of service, and if the supply connection is of material or high economic consequence. Transpower proposes to retain the same points of service sub-categories for RCP4.

Transpower is proposing to use a similar approach to RCP3 to update the categorisation of points of service into sub-categories for RCP4, modified to use forecast load rather than historical load data. Transpower have reviewed the level of security assigned to each point of service and calculated economic consequence using value of lost load and forecast load based on their 2022 Transmission Planning Report.

Transpower's justification for proposing to use forecast load is based on the rapid pace of change within the electricity industry. It is necessary to tailor the grid performance measures to the future period they will apply to, rather than basing them on historical conditions. Stakeholder submissions supported this approach.

Proposed targets

Transpower propose a similar approach to RCP3, with targets based on historical data:

– GP1 to use the five-year average for equipment-related unplanned interruptions as equipment failures have reduced in recent years, and to use the 24-year average for non-equipment related causes,
– GP2 to use the 24-year average for all causes of unplanned interruptions,
– For new points of service, without historical data, use average of the other points of service in the sub-category for determining GP1 and GP2 targets,
– For GP1 and GP2, the historical data excluded events due to automatic underfrequency load shedding, as well as events that did not originate in Transpower's system. This includes a seven-day cap on the duration of the interruption (to reduce the effect of extreme events), similar to RCP3.

Proposed caps, collars and incentives

The caps and collars for each GP1 and GP2 sub-category are based on historical interruption data. Caps and collars for each sub-category are set at +/- one standard deviation from the target based on the data for the relevant points of service, except for the 'Material Economic Consequences' sub-categories where a 1.5 standard deviation was applied as greater variation was observed in the data.

Transpower has proposed 1.4% of revenue at risk for performance against all service measures for RCP4. The proposed incentive rates for GP1 and GP2 allocate approximately 45% of the revenue at risk to each service measure. This allocates the residual of the 1.4% of revenue at risk after making explicit allocations for AP1 and AP2. Transpower also cross-checked the incentive rates to ensure they are not in excess of the value of lost load. For RCP4, the incentive rate is equivalent to 40 percent of lost load (compared to 50 percent in RCP3).

Proposed quality standards

Transpower propose to retain the current approach for setting the quality standards for GP1 and GP2. This includes pooling across disclosure years and sub-categories, which are assessed against annual quality limits. Annual quality limits proposed for GP1 and GP2 for RCP4 align with the collar values.

20.4.2 Evaluation of proposed changes

The measure of unplanned interruptions (GP1), and yearly average duration of unplanned interruptions (GP2) is widely used by other transmission service providers and seen to be GEIP. Reliable supply with minimal interruptions and quick restoration of supply when an interruption occurs are universally accepted key outputs valued by customers.

Transpower proposes to maintain a revenue linked quality standard, that is similar to the standard applicable for RCP3. Due to the value customers place on reliability, GHD supports maintaining the quality standard for these service measures. We also consider that it is appropriate to maintain the existing arrangements that incorporate pooling across disclosure years and sub-categories to assess the annual performance against the quality standard.

Transpower propose updating the points of service categorisation for RCP4. The intent is to reflect network changes that occurred after the points of service were defined for RCP3 and that are expected to occur in RCP4 (noting that changes proposed for RCP4 have not been committed and are subject to change). The total number of points of service increase from 229 in RCP3 to 231 in RCP4. GHD supports the active review and update to the points of service list and the proposed approach of using historical performance to set the quality standard for RCP4. Where there are new points of service, without historical data, GHD support the use of averages from other relevant points of service in the same sub-category. This is reasonable approach until historical data is available.

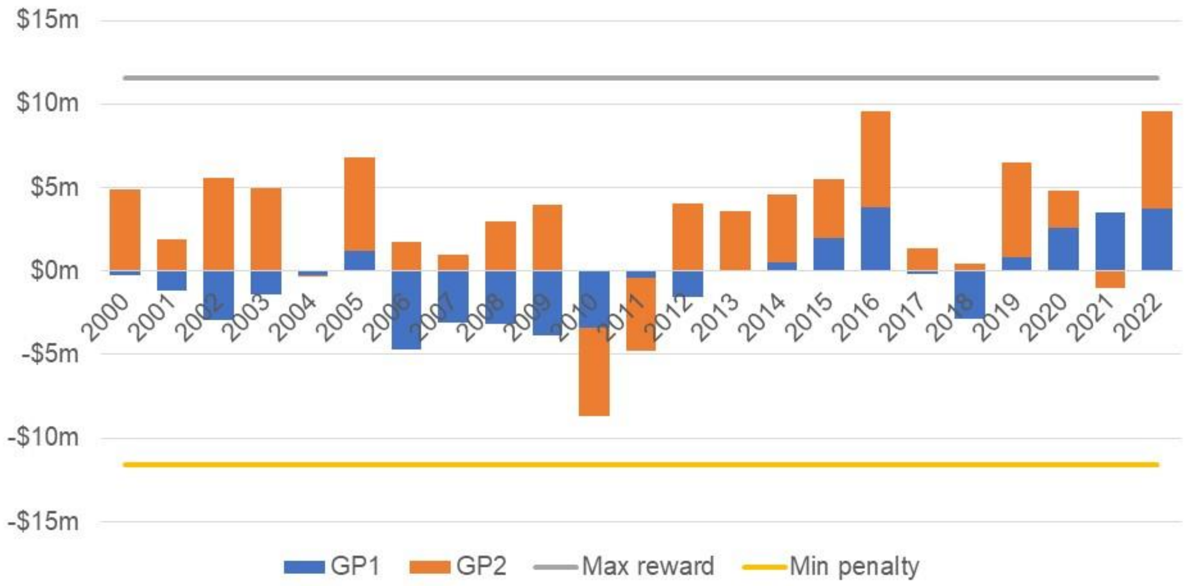
GHD supports the exclusion of automatic underfrequency load shedding, as well as events that did not originate in Transpower's system from historical data events. As these events do not reflect poor network management by Transpower.

Transpower propose to use forecast load in RCP4 rather than historical load. The intent is based on the expectation that there will be rapid pace of change within the electricity industry. GHD supports this change, whether rapid change occurs or not, as it will align grid performance service measures with the network as it is expected to look in the future.

Regarding the use of historical averages of network performance to set targets. There is a risk, if network performance deteriorates over time, that this performance will be 'baked in' when averaging historical performance to set targets. We suggest that when exploring quality standards for future RCPs Transpower explore the merit in setting defined minimum performance levels acceptable to stakeholders. As an alternative to averaging of historical performance, particularly if the historical average shows declining performance.

The following figure shows how Transpower would have financial performed against the proposed GP1 (in blue) and GP2 (in orange) measures had these been applied in previous years. The figure does not demonstrate any systemic over or under performance from a financial perspective and as such appears to be a balanced approach to incentivising outcomes.

Figure 20-3 Hypothetical historical performance against proposed GP1 and GP2



Source: Transpower, 20230509 Service Measures Refresh – Second interview IV slides.

The following table summarises our evaluation of the proposed changes to the GP1 and GP2 measures.

Table 20-8 Evaluation summary of proposed GP1 and GP2 measures

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	Unplanned interruptions and duration of unplanned interruptions are recognised measures of transmission service performance as demonstrated in Section 20.1.5 of this report.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	One of the main drivers of base capex, major capex and opex is to provide reliable uninterrupted transmission service. This is demonstrated by evidence provided in support of the base capex and opex for RCP4.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	Transpower quantifies the annual risk of asset failure in its PMPs if it does not undertake the RCP4 investments.
A6(a)	Measure is a recognised measure of grid outputs valued by consumers.	Yes	The measures are an evolution of the approach used historically, with the suggested changes being supported by customers through the stakeholder engagement process.
A6(b)	Strength of relationship with base capex.	Yes	Risk models and asset health models identify assets with the highest need of remediation. In the medium to long term, that risk will directly impact these service measures.
A6(c)	Measure is quantifiable, controllable by Transpower, auditable and replicable over time.	Yes	Service measures are quantifiable, and controllable by Transpower (e.g., unplanned outages caused by third parties are excluded), are auditable and can be repeated over time as demonstrated by reporting of performance against those measures across RCP3.
IV Conclusion (on service measure)		On the basis that GP1 and GP2 does meet all these criteria it is considered reasonable to retain these service measures	

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Caps, collars, the grid output incentive rate, grid output targets and quality standard			
A7(a)	Value consumers place on measure and relationship between this value and the proposed incentive rate	Yes	Incentive rates applied are derived from the remainder of value-at-risk once AP1 and AP2 have been deducted ($5.3m each for GP1 and GP2). The rates align with Transpower's VOLL estimates. The rates are generally high (e.g., up to $409k per event for GP1 breaches), reflecting the high value consumers place on avoiding outages. Transpower proposed multiple rates depending on the nature of the interruption.
A7(b)	Quantification of relationship between base capex and the grid output for both RCP4 and longer term	Yes	Base capex is designed to neither improve performance against the target, nor allow it to deteriorate. The target normalises the impact of base capex on performance.
A7(c)	Factors unrelated to investment that impact measure: (i) natural degradation in asset condition (ii) impact of grid loading changes (iii) extreme weather events;	Partially	Items i and ii - Transpower's asset inspection and continued network load monitoring are in place to identify and forecast changes to performance values. Item iii – is considered as extreme weather events can be excluded from determining performance. The process to determine performance targets for RCP4 period from historical information also allows for identification and exclusion of anomalies from the historical data set.
A7(d)	Plausible range of grid outputs based on factors in A7 (b) and A7 (c)	Yes	Based on ex-post analysis, the proposed measures would likely lead to reasonable financial outputs. Had the proposed GP1 and GP2 quality standard been in place, Transpower would not have systematically over- or under-performed. Refer to the figure above.
A7(e)	Relationship between range and proposed caps and collars	Yes	See response to row above
A7(f)	Impact on return on capital implied by both the range and the application of the proposed cap, collars and grid output incentive rate	Yes	These measures are each allocated approximately 45% of the revenue at risk. That is 90% of the total 1.4% of revenue at risk across all service measured is allocated to GP1 and GP2. 1.4% of revenue, has an implied impact of approximately 50 basis points on return on equity. We therefore consider the impact on capital is appropriate as a component of the overall revenue at risk.
IV Conclusion (incentive rate, caps, collars, target and quality standard)		We consider that the following are appropriate and satisfy the evaluation criteria specified in the ToR: – the proposed incentive rate, caps and collars. – retaining current approach for setting quality standards for GP1 and GP2. Including pooling across disclosure years and sub-categories, assessed against annual quality and the use of forecast load growth. – the new points of service and using historical info for new points of service. – excluding AUFLS and non-Transpower originating system events from historical data when setting performance targets. – using forecast load in RCP4 rather than historical load for the points of service categorisation. We suggest that when exploring quality standards for future RCPs Transpower consider whether there is merit in setting defined minimum performance levels acceptable to stakeholders as an alternative to averaging of historical performance, particularly if the historical average shows declining performance.	

20.5 GP-M: Momentary interruptions reporting

20.5.1 Overview of service measure

The GP-M service measure provides a view of momentary interruptions over time. Momentary interruptions are brief service disruptions due to temporary faults in the system, such as those caused by lightning strikes. They are not included in GP1 and GP2, and for most customers and end consumers have a much lower impact. GP-M measures the number of momentary unplanned interruptions across a year. This measure only includes interruptions with a duration of less than one minute.

Transpower propose to discontinue GP-M for RCP4 as they do not consider that this measure provides a useful indication of service performance at an aggregate level. Submissions received to the consultation on RCP4 service measures indicate that customers do not use the GP-M performance reports. Customers indicated that they could see the benefit of specific data being available via their annual individual engagement plan. In RCP4 Transpower intend to provide information relating to momentary interruptions in those plans.[400]

20.5.2 Evaluation of proposed changes

Information about momentary interruptions in some situations may be a useful measure about the performance of the grid. However, GP1 and GP2 are more significant measures in terms of customer impacts.

The feedback that customers are not utilising GP-M supports Transpower's proposal to remove this measure provided the momentary interruption data is included in customers' annual engagement plans. We understand customers can also raise any concerns or issues they may have regarding interruptions as part of their regular engagement processes with Transpower.

The following table summarises our evaluation for this non-incentive grid output measure against the criteria in the ToR.

Table 20-9 Evaluation summary of proposal to discontinue GP-M measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	While not recognised as a measure of the risk to supply of electricity transmission services, momentary interruption statistics may provide useful insight into the performance of the supply of transmission services for some customers.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	No	Base capex, major capex and opex is invested to improve or maintain assets and system performance in a cost efficient method to the level of service expected by consumers. Momentary interruptions do not necessarily indicate poor performance or a required need for investment. They may indicate the network correctly responding to an external disturbance.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Partial	Transpower systems are both designed to avoid interruptions of supply and, in some situations, to interrupt supply through the design of its protection systems in order to avoid damage to equipment, protect the safety of people and avoid wider network interruptions.

[400] Transpower, Submission Summary - Grid Service Engagement Paper 1, page 12-13. [GSM005]

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
IV Conclusion (on service measure)		On the basis that GP-M does not meet all these criteria and considering customer feedback indicated they did not generally use this information, but information could be supplied via customer engagement plans.[401] It is considered reasonable to **discontinue** this as a measure. Provided this information is included in customers' annual engagement plans.	

20.6 AP1: HVDC capacity availability

20.6.1 Overview of service measure

The AP1 service measure incentivises Transpower to minimise the impact on the electricity market from capacity reduction of the HVDC Pole 2 and Pole 3 due to outages on the HVDC itself. AP1 measures the HVDC capacity availability (%) of the inter-island HVDC system. The capacity availability measure is impacted by the availability of the bipoles within the HVDC link. It does not consider any HVAC assets or reactive support assets impacting HVDC transfer capacity.

Transpower are proposing the following changes to the measure:

- Exclude the impact of outages from major capex projects and listed projects (which are subject to separate approval and engagement processes) involving the HVDC Pole 2 and Pole 3. There are several major interventions planned on the HVDC Pole 2 and Pole 3 in RCP4 and RCP5, including replacement or upgrade of the HVDC Cook Strait cables.
- Exclude the impact of new resilience workstreams proposed to harden HVDC towers against wind and flood damage. These workstreams are proposed for RCP4 under a new 'uncertainty mechanism' and have significant outage requirements and uncertainty (similar to major capex projects and listed projects). The level of work may increase before and after the RCP4 proposal.
- To develop the AP1 target for the measure based on Transpower's proposed workplan.
- Mitigates the impact of major unplanned outages by including a threshold limit for major unplanned outage hours to ensure that no single unplanned event can have a disproportionate impact on the overall performance against the measure in a year. This concept has been introduced in other jurisdictions and a similar threshold exists for duration in GP2. The threshold limit would be set at a relatively large value, e.g. 0.125 per cent of the total annual capacity availability. If a single event caused an outage(s) that exceeded this threshold, its impact on AP1 would be capped at 0.125 per cent. Transpower would continue to have a significant incentive to avoid unplanned outages, and the revenue incentive to meet the measure would not be extinguished by a single event.
- Introduces annual quality limits that are pooled across several disclosure years for the quality standard.

There was mixed customer support from submitters for Transpower's proposal:

- There was support for excluding major capex projects and listed projects provided the specific consultation on these projects and Transpower's annual outage plan process continues to include engagement from industry stakeholders.
- Submitters did not support the modification to mitigate the impact of major unplanned outages.

The proposal was amended based on feedback so that the measure includes all unplanned outages, however Transpower consider there are merits to a threshold limit for outages relating to a single event and disagree this would negate the incentive to uphold the availability of the HVDC.

Proposed targets

For setting the targets for RCP4, Transpower propose a similar method to RCP3, as follows:

- Deduct estimated planned outages to maintain HVDC assets,

[401] Transpower, Grid Service Measures Engagement Paper 2, Version 1, September 2022.

– Deduct reasonably expected unplanned outages based on historic performance and percentage approved in RCP3, and
– Apply project-specific allowances to recognise work that will require much longer outage times than what would normally be required for routine maintenance.

Proposed deductions and allowances are set out in the table below. By comparison the overall availability target in RCP3 is 98.75%. Assessment of appropriateness in the difference between RCP3 and RCP4 is discussed in our evaluation of this service measure below (refer to Section 20.6.2 of this report).

Table 20-10 Summary of proposed HVDC capacity availability target

AP1 Target Summary	RCP4 %	Notes
Annual target		
Planned outages	1.75%	Includes 1.25% for yearly maintenance typically undertaken on the HVDC stations and cables; and 0.5% for tower painting and attachment point replacements.
Unplanned outages	0.25%	Based on historical performance and the percentage approved in RCP3.
Overall availability target	98.0%	
Project-specific allowances to be excluded from the above proposed target		
Project K - Pole 2 refurbishment project	1.26%	Allows for 11-day Pole 2 outage (in addition to yearly shut down) across one or two disclosure years (in total).
Combined TCU (Thyristor control unit) and human machine interface software upgrade	3.84%	Allows for 2-week bipole outage (in addition to yearly shut down) during one disclosure year.

Source: Transpower, RCP4 Grid Service Measure Refresh – Working Summary, page 22.

Proposed cap, collar and incentives

Transpower propose to retain the same one per cent availability offset from the target for caps and collars, and the same annual revenue at risk for RCP4 as they had in place for RCP3.

Proposed quality Standard

Transpower propose that the AP1 quality standard is modified to introduce pooling across disclosure years, assessed against annual quality limits. This approach would align with GP1 and GP2 which already use a pooling mechanism in RCP3. Pooling would reduce unnecessary investigations due to intrinsic variability or variance to delivery plan due to unforeseen changes.

The proposed method for pooling is to comply with the AP1 quality limit in the current disclosure year or, if not, then to have complied in the previous two disclosure years. The pooling therefore applies the following method:

– For disclosure year 2026, calculate values, no compliance assessment
– For disclosure year 2027, comply with the quality limit in the disclosure year or, if not, then must have complied in disclosure year 2026
– For disclosure years 2028 to 2030, comply with the quality limit in the disclosure year or, if not, then must have complied in the previous two disclosure years.

In a submission to Transpower, Meridian[402] considered that the combination of an allowance for unplanned outages, the threshold limit for major unplanned outages related to a single event, and the ability to pool across disclosure years do not provide a meaningful indication of performance for HVDC capacity availability. Meridian stated that:

– Setting the unplanned outage allowance based on past performance risks reinforcing poor performance. The method for determining this allowance is also unclear. Meridian suggests a fixed deduction applied consistently across RCP4 that is not sensitive to performance within the RCP.

[402] Meridian, Submission to RCP4 and Grid Service Measures consultations, 2022, Appendix B

- The unplanned outage threshold limit would hide the market impact of unplanned outages. Meridian expressed concern that decoupling HVDC capacity availability from unplanned outages reduces Transpower's incentive to minimize unplanned outages
- Pooling would, combined with other proposed changes to AP1, hide poor performance in any given year.

Transpower has stated that the design of GP2 for RCP3 included these three features and continues to be an effective measure. Furthermore, that pooling applied to the quality standard focuses any investigations on a trend of poor performance, rather than poor performance in a single year.

20.6.2 Evaluation of proposed changes

Transpower proposes to deduct project-specific and resilience workstream allowances that recognise work requiring much longer outage times than what would normally be required for routine maintenance. GHD supports this proposal. Most, if not all, HVDC interconnectors are given this allowance in determine their availability performance.

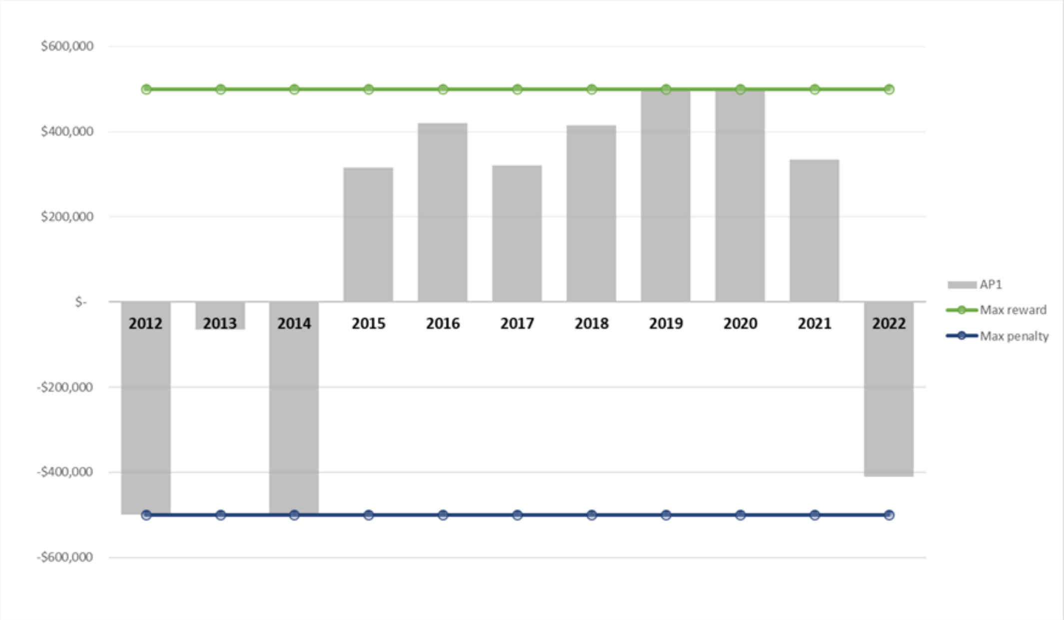
We recommend supporting the requested RCP4 allowance of 98.0% for unplanned and planned outages in setting the availability target. The reduced target supports the additional 0.5% needed for tower painting and attachment points and 0.25% for additional planned maintenance. Sufficient information was provided regarding the condition of the affected overhead HVDC line and the early planning considerations, to verify that the addition allowance for planned maintenance is reasonable. As in RCP3, we support project-specific allowances to recognise work that requires much longer outage times. Therefore, we support the proposed allowances of 1.26% for Project K, 3.84% upgrade of TCU and human machine interface.

GHD regards this performance measure to be as beneficial as the other revenue linked measures. We support introducing pooling across disclosure years, assessed against annual quality limits. As this would reduce unnecessary investigations due to intrinsic variability or variance to delivery plan due to unforeseen changes.

We do not support limiting the impact of a single event, instead recommend maintaining the full incentive for a single event. This is because major long duration HVDC events that have historically not been frequent but when they occur have a significant impact on the network. The HVDC network is also made up of a far smaller population of assets compared to the HVAC network, which in our view differentiates the need to maintain an incentive after a single major event.

As part of its submission, Transpower considered the performance against the proposed AP1 measure had it applied historically. The following figure shows how Transpower would have performed financially. Had the proposed AP1 standard been in place, Transpower would not have systematically over- or under-performed.

Figure 20-4 Hypothetical historical performance against proposed AP1



Source: Transpower, REG008 RCP4 RT02 Output Incentives Model v2.xlsx.
Note: The drop in performance in 2022 was due to an extended outage to replace multiple insulators after one insulator failed.

The following table summarises our evaluation for Transpower's proposed changes to the AP1 measure.

Table 20-11 Evaluation summary of proposed AP1 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	Availability of HVDC systems are recognised transmission service performance measures.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	One of the main drivers of base capex, major capex and opex is to provide a reliable transmission service. Transpower quantifies the annual risk of asset failure in its PMPs if it does not undertake the RCP4 investments.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	Transpower systems are both designed to avoid interruptions of supply and in some situations to interrupt supply through the design of its protection systems to avoid damage to equipment, safety of people and wider network interruptions
A6(a)	Measure is a recognised measure of grid outputs valued by consumers.	Yes	Customer feedback confirms that AP1 is a valuable and relevant measure carried forward from RCP3.
A6(b)	Strength of relationship with base capex.	Yes	Risk models and asset health models identify assets with the highest need of remediation. In the medium to long term that risk will directly impact this service measures. Also the impact of additional planned capex work that require outages, has been assessed for this measure.
A6(c)	Measure is quantifiable, controllable by Transpower, auditable and replicable over time.	Yes	The measure is quantifiable, controllable by Transpower is auditable and can be repeated over time. This is demonstrated by the successful reporting of performance for AP1 across RCP3.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
IV Conclusion (on service measure)		On the basis that AP1 meets all these criteria it is considered reasonable to retain this service measure.	
Caps, collars, the grid output incentive rate, grid output targets and quality standard			
A7(a)	Value consumers place on measure and relationship between this value and the proposed incentive rate	Yes	The incentive proposed is \$0.5m per year across RCP4, or \$500,000 per one percent change in the measure. The \$0.5m figure comes from multiplying outage costs, from Stochastic Dual Dynamic Programming (SDDP) modelling with HVDC availability.
A7(b)	Quantification of relationship between base capex and the grid output for both RCP4 and longer term	Yes	Base capex is designed to neither improve performance against the target, nor allow it to deteriorate. The target normalises the impact of base capex on performance.
A7(c)	Factors unrelated to investment that impact measure: (i) natural degradation in asset condition (ii) impact of grid loading changes (iii) extreme weather events;	Yes	Transpower's asset inspection and network load monitoring is in place to identify and forecast changes to performance values due to all three factors.
A7(d)	Plausible range of grid outputs based on factors in A7 (b) and A7 (c)	Yes	Based on ex-post analysis, the proposed measures would likely lead to reasonable outputs. Had the proposed AP1 target, cap and collar been in place, Transpower would not have systematically over- or under-performed. Refer to the figure above.
A7(e)	Relationship between range and proposed caps and collars	Yes	See the response in the row above.
A7(f)	Impact on return on capital implied by both the range and the application of the proposed cap, collars and grid output incentive rate	Yes	This service measure is allocated approximately 3% of the revenue at risk. That is 3% of the total 1.4% of revenue at risk across all service measured is allocated to AP1. 1.4% of revenue, has and implied impact of approximately 50 basis points on return on equity. We therefore consider the impact on capital is appropriate as a component of the overall revenue at risk.
IV Conclusion (incentive rate, caps, collars, target and quality standard)		It is our opinion that the incentive rate, targets, caps and collars are appropriate. We support the reduction in availability target due to tower painting, Project K and upgrade of TCU & human machine interface projects. We support the quality standard being modified to introduce pooling across disclosure years, assessed against annual quality limits. We do not support limiting the impact of a single event, but to maintain the full incentive per event.	

20.7 AP2: HVAC selected asset availability

20.7.1 Overview of service measure

The AP2 service measure is aimed at minimising the impact of the Electricity Market on consumers due to system constraints in the transmission system from HVAC assets being unavailable. AP2 measures the average percentage of time selected HVAC assets are available.

Transpower propose that AP2 is modified for RCP4 (from the RCP3 approach) in the following ways:

- Limit the scope of planned outages included to unavailability caused by Transpower's maintenance and base replacement and refurbishment works.
- Exclude availability interruptions caused by the following work types (described in Transpower's Capex IM): customer-funded work; listed projects; enhancement and development projects and major capital projects.
- Mitigate the impact of major unplanned outages by including a threshold limit for major unplanned outages so no single unplanned event can have a disproportionate impact on the overall performance in a year. This concept has been introduced in other jurisdictions and a similar threshold exists for duration in GP2. While each major unplanned outage would count towards AP2, up to the defined limit (150 hours), any outage hours beyond the limit would not. This would help to ensure the revenue incentive remains throughout the year to efficiently manage other planned works and avoid the situation where the target for AP2 is continually beyond reach.
- Update the list of selected HVAC assets based on Transpower's latest System Security Forecast and upcoming enhancement and development work to ensure that the list appropriately reflects anticipated constraints on the Electricity Market during RCP4
- Remove the quality standard (preferred option) or introduce annual quality limits that are pooled across several disclosure years. The service measure remains revenue linked.

Transpower propose updating the asset list to 62 assets from the 71 assets in RCP3 based on the assets that would have the most market impact when out of service in RCP4.

There was mixed support from customers who made a submission:

- There was support for excluding major capex projects and listed projects provided the specific consultation on these projects and Transpower's annual outage plan process continues to seek engagement from industry stakeholders; there were no objections to excluding enhancement and development projects and customer-funded work.
- Submitters disagreed with use of the System Security Forecast. Transpower considered this feedback and noted that System Security Forecast continues to provide strong relevance to updating the list of selected HVAC assets.
- Submitters did not support the modification to mitigate the impact of major unplanned outages.

Transpower listened to this feedback and have amended the proposed measure, so it includes all unplanned outages, however Transpower still consider there are merits to a threshold limit for outages relating to a single event. The threshold limit will provide incentives to manage availability through the year rather than performance being dominated by a single major unplanned outage event.

Proposed targets

Transpower have proposed a new method for setting the target for AP2 for RCP4. Transpower propose to use a linear regression model to forecast unavailability due to planned outages consistent with forecast expenditure for RCP4. This model would be fitted based on historic expenditure (in 2021/22 dollars) and historic planned unavailability data (2009-2022 data). The proposed asset list has 62 assets, which represents a small reduction from 71 assets in RCP3. The selected asset list is subject to review/refinement prior to the RCP4 submission, and targets, caps, collars, and quality limits will be updated accordingly.

Proposed cap, collar and incentives

In setting caps and collars for AP2, Transpower propose the 67 per cent prediction interval associated with the linear regression model (discussed above) for planned unavailability (equivalent to a confidence interval band of one standard deviation), and 300-hour deduction for unplanned unavailability. Transpower propose to have flat caps and collars based on the annual averages.

The difference between Options 1 and 2 in the table are the inclusion or exclusion of quality standard, which is discussed below.

Table 20-12 Summary of proposed cap, collar and targets for the AP2 measure

AP2 availability for RCP4	Number of assets	Cap	Target	Collar	Incentive rate (per annum)
Option 1 (preferred): AP2: HVAC availability (%) – no quality standard	62	98.63%	98.35%	98.07%	$3.57m
Option 2: AP2: HVAC availability (%) – with pooled quality standard	62	98.63%	98.35%	98.07%	$3.57m

Source: GHD analysis of Transpower data in RCP2 RT02 Output Incentives Model. [REG002]

Proposed quality standards

Transpower propose removing the quality standard for AP2 and retaining it as a revenue incentive measure only for RCP4. This approach was not consulted with customers and wider stakeholders on during 2022. However, Transpower indicated customers will have an opportunity to share their views on this approach during the Commission's consultation.

Alternatively, if the quality standard is retained for AP2, Transpower propose to introduce pooling across disclosure years, assessed against annual quality limits. And to set quality limits based on the 95 per cent prediction interval associated with the linear regression model for planned unavailability (equivalent to approximately two standard deviations), plus the 300-hour deduction for unplanned unavailability.

The proposed method for pooling is to comply with the AP2 quality limit in the current disclosure year or, if not, then to have complied in the previous two disclosure years. The pooling therefore applies the following method:

– For disclosure year 2026, calculate values, no compliance assessment.
– For disclosure year 2027, comply with the quality limit in the disclosure year (i.e. disclosure year 2027) or, if not, then must have complied in disclosure year 2026.
– For disclosure years 2028 to 2030, comply with the quality limit in the disclosure year or, if not, then must have complied in the previous two disclosure years.

20.7.2 Evaluation of proposed changes

There are several changes being proposed for RCP4. In considering the proposed changes, a balance is needed to ensure the intent of each measure is maintained, while adopting changes that better reflect asset performance monitoring. Therefore, five of the six proposed changes are supported by GHD.

GHD sees the AP2 service measure to be as beneficial as the other revenue linked service measures. Therefore, we recommend retaining the quality standard to maintain the existing regulatory gravity. We have not identified sufficient reason for eliminating a quality standard. We do support introducing pooling across disclosure years, assessed against annual quality limits based on 95% prediction interval of the regression model. As this would reduce unnecessary investigations due to intrinsic variability or variance to delivery plan due to unforeseen changes.

Transpower raised the concern that breaches in not meeting quality standard took significant time and effort to investigate and resolve. Data was not provided for GHD to quantify the extent of time and effort taken. We recommend the Commission and Transpower discuss the investigation process outside of the IV review process to explore opportunities for improvement.

We believe it is reasonable to exclude availability interruptions caused by customer-funded work, listed projects, E&D projects and major capital projects. These events do not measure or indicate deterioration in network performance caused by Transpower.

We support introducing a 150-hr threshold limit for major individual unplanned outages because this covers a larger population of assets compared to HVDC. There is also not the same impact of one major asset failure as for unavailability of the inter-island HVDC link.

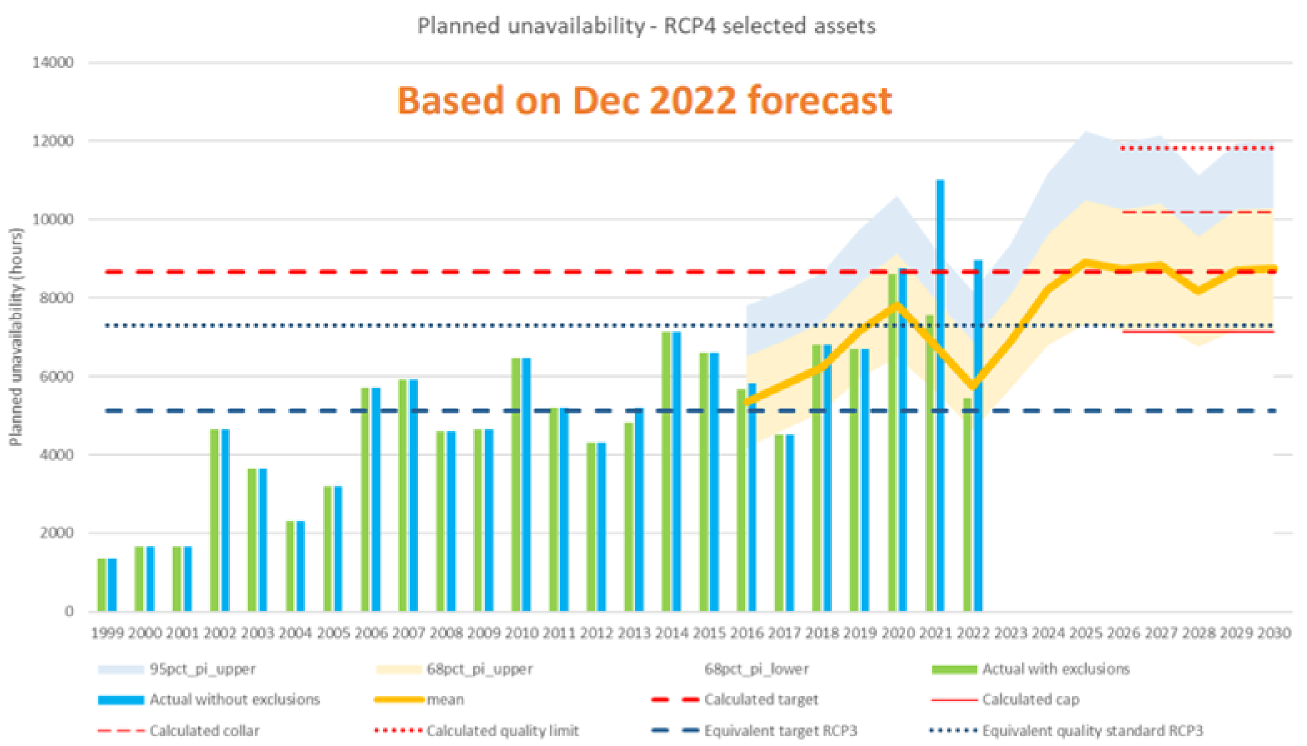
Transpower propose updating the list of 62 selected HVAC assets (from 71) based on Transpower's latest System Security Forecast. Actively reviewing changes affecting the market is consistent with GEIP and GHD support the change. Considering the factors Transpower listed in updating the HVAC assets list. We agree these are suitable in considering network changes that will more accurately represent the network in RCP4.

We support the proposed methodology for setting the target using a linear regression model to forecast unavailability due to planned outages and forecast expenditure for RCP4. GHD agrees this is an improved approach to setting the target for RCP4. It is our opinion that the incentive rate, targets, caps and collars are appropriate.

We support maintaining the same annual allowance deduction of 300 hours for unplanned unavailability as in RCP3. GHD believe the existing target sufficiently caters for reasonable unplanned outages and there is no reason to reduce this target.

The figure shows how Transpower derived the new target (including cap and collar) for AP2. There has been a clear increase in planned unavailability, which Transpower has modelled to continue increasing into RCP4 (mean expectation is orange line, excluding major, listed, customer projects, and circuit sections). The area shaded in yellow represents the upper and lower 68th percentile prediction interval, while the area shaded in blue represents the upper 95th percentile prediction interval. The proposed target is directly based on these (target at mean, cap at lower 68th, and collar at upper 68th). The calculated quality limit shows what Transpower would propose if it must retain a quality limit (upper 95th).

Figure 20-5 Forecasted planned unavailability for selected RCP4 assets



Source: Transpower, 20230509 Service Measures – additional information.pdf
Note: Based on December 2022 forecast.

The following table summarises our evaluation of Transpower's proposed changes to the AP2 measure.

Table 20-13 Evaluation summary of proposed AP2 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	Planned and unplanned interruptions have the potential to impact customers by creating the potential for electricity market constraints. Monitoring availability provides an indication of those risks.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	One of the main long term outcomes of base capex, major capex and opex is to provide reliable uninterrupted transmission service. Transpower PMP's quantifies the annual risk of asset failure if proposed RCP4 investments does not occur.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	Transpower systems are designed to avoid interruptions of supply and to efficiently manage planned outages. While in some situations to interrupt supply through the design of its protection systems to avoid damage to equipment, wider network interruptions and maintain the safety of people.
A6(a)	Measure is a recognised measure of grid outputs valued by consumers.	Yes	AP2 is a valuable and relevant measure carried forward from RCP3. Though customers who submitted on AP2 had concerns with some of the changes proposed, we find Transpower's proposed changes reasonable and unlikely to undermine the value of AP2.
A6(b)	Strength of relationship with base capex.	Yes	Transpower's approach to asset risk and asset health models identify assets with the highest need of remediation (capex or opex). In the medium and long term this expenditure will impact these performance measures. The impact of additional planned capex work that require outages, has been assessed for this measure.
A6(c)	Measure is quantifiable, controllable by Transpower, auditable and replicable over time.	Yes	The measure is quantifiable, by Transpower. The long-term management of the network by Transpower, makes the network performance controllable by Transpower. (Excluding significant environmental events).
IV Conclusion (on service measure)		On the basis that AP2 meets all these criteria it is considered reasonable to **retain** this measure.	
Caps, collars, the grid output incentive rate, grid output targets and quality standard			
A7(a)	Value consumers place on measure and relationship between this value and the proposed incentive rate	Yes	The incentive rate stems from the value at risk, which is derived from Concept Consulting modelling of the market impact of HVAC asset availability ($1m over RCP4). This is the same approach as RCP3.
A7(b)	Quantification of relationship between base capex and the grid output for both RCP4 and longer term	Yes	Base capex is designed to neither improve performance against the target, nor allow it to deteriorate. The target normalises the impact of base capex on performance.
A7(c)	Factors unrelated to investment that impact measure: (i) natural degradation in asset condition (ii) impact of grid loading changes (iii) extreme weather events;	Yes	Transpower's asset inspection and network load monitoring are in place to identify and forecast changes to performance values due to all three factors.
A7(d)	Plausible range of grid outputs based on factors in A7 (b) and A7 (c)	Yes	Transpower forecasts outages using a linear regression model on past data. The increase in unavailability is driven largely by planned work needed to deliver RCP4. The model and its outputs are reasonable, aligning with trends and planned RCP4 activities.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
			Had the proposed AP2 targets applied in the past, Transpower would have systematically overperformed as previously there was less planned work than proposed in RCP4. This is expected given the proposed changes. Further explanation was provided above and in Figure .
A7(e)	Relationship between range and proposed caps and collars	Yes	Refer to response in row above.
A7(f)	Impact on return on capital implied by both the range and the application of the proposed cap, collars and grid output incentive rate	Yes	This service measure is allocated approximately 6% of the revenue at risk. That is 6% of the total 1.4% of revenue at risk across all service measured is allocated to AP2. 1.4% of revenue, has and implied impact of approximately 50 basis points on return on equity. We therefore consider the impact on capital is appropriate as a component of the overall revenue at risk.
IV Conclusion (incentive rate, caps, collars, target and quality standard)		We consider that the following are appropriate and satisfy the evaluation criteria specified in the ToR: – the incentive rates, caps, targets and collars. – excluding availability interruptions caused by customer-funded work; listed projects; E&D projects and major capital projects. – introducing a 150-hr threshold limit for major individual unplanned outages. – maintaining the quality standard with the introduction of pooling across disclosure years, assessed against annual quality limits. – updating the list of 62 selected HVAC assets based on Transpower's latest System Security Forecast. – the proposed methodology for setting the target using a linear regression model to forecast unavailability due to planned outages and forecast expenditure for RCP4. – maintaining the current RCP3 allowance for unplanned outages in setting availability target.	

20.8 AP3: Return to service

20.8.1 Overview of service measure

The AP3 measure aims to reduce the impact of the Electricity Market on consumers by improving certainty around the return to service of certain transmission assets. Delays on returning these assets to service can cause increases in spot prices. AP3 measures the number of planned outages of selected HVAC assets that are returned to service two or more hours after the original planned return to service time.

Transpower is proposing that the AP3 measure is retained in its current form. Customers supported the retention of this measure. Transpower are not proposing to introduce a target, incentive or quality standard to AP3.

20.8.2 Evaluation of proposed changes

There is no change proposed for this measure. In our opinion it is beneficial that this measure be retained as it provides an incentive for Transpower to exercise GEIP by appropriately planning and managing outages to ensure that planned work on the HVAC does not result in greater unavailability than forecast.

The following table summarises our evaluation for this service measure.

Table 20-14 Evaluation summary of proposed AP3 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(i) Not a recognised electricity supply risk (ii) Return to service performance is a recognised measure
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	Planned outages that enable the completion of base capex, major capex and opex within the scheduled allowed outage timeframes are critical to Transpower's ability to deliver its RCP4 programme.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment this measure and Transpower's business processes with respect to planning, output management and service provider management.
IV Conclusion (on service measure)		On the basis that AP3 meets all these criteria, it is considered reasonable to **retain** this measure in its current form.	

20.9 AP4: Return to services communications

20.9.1 Overview of service measure

The AP4 measure aims to reduce the impact of the Electricity Market on consumers through timely communication to industry participants about delays to certain transmission assets being returned to service. AP4 measures the number of outages where a delay to the planned, or extended, return to service time was communicated with 90 minutes or less notice, against the total number of planned outages. The measure counts an outage once, even if there are multiple communications of 90 minutes or less related to that outage. This measure applies to the same HVAC assets selected for the AP2 measure.

Transpower propose the AP4 measure is retained in its current form. Stakeholders responding in submissions supported the retention of this measure. Transpower are not proposing to introduce a target, incentive, or quality standard to AP4.

20.9.2 Evaluation of proposed changes

There is no change proposed for to the AP4 measure for RCP4. In our opinion it is beneficial that the AP4 measure is retained as in provides an incentive for Transpower to exercise GEIP by timely communication of changes to planned outages on the HVAC network.

The following table summarises our evaluation for this service measure.

Table 20-15 Evaluation summary of proposed AP4 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(i) Not a recognised electricity supply risk (ii) Return to service performance is a recognised measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	Timely communication of extended or delayed panned outputs that enable the completion of base capex, major capex and opex within the scheduled allowed outage timeframes are critical to Transpower's ability to deliver its RCP4 programme.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment this measure and Transpower's business processes with respect to planning, output management, customer communication and service provider management.
IV Conclusion (on service measure)		On the basis that AP4 meets all these criteria, it is considered reasonable to **retain** this measure in its current form.	

20.10 AP5: N-security reporting

20.10.1 Overview of service measure

AP5 was introduced in RCP2 as Transpower and the Commission considered at that time that reporting on grid exit points subject to N-security could provide a leading indicator of grid deterioration. The Commission also noted there is the potential for significant impact on customers if they are placed on N-security without adequate warning to prepare. AP5 measures the extent to which Transpower has placed customers on a reduced level of supply security due to an outage; referred to as N-security.

Transpower propose that the AP5 measure is discontinued for RCP4 as they do not consider that this measure provides a leading indicator of grid deterioration or assists in mitigating outage risks. AP5 records historic information which is not valuable for our customers in mitigating risks. Transpower consider that outage notification protocols ensure customers receive sufficient warning when their security is reduced to N-security, allowing them to assess and understand the level of risk.

An annual outage plan, a planned loss of supply and N-security outage report, up-to-date outage information are also available to customers. Transpower states that AP5 reporting is time-consuming to compile yet is not valuable to its customers. All submitters involved in the engagement process now support AP5 discontinuation.

20.10.2 Evaluation of proposed changes

Timely and accurate information about the level of supply security to customers during outages is essential to enable customers to make effective decisions about how they manage the risk of loss of supply. However, historic information about N-security may not necessarily assist customers with risk management of current or future outages. This measure does have the potential to be a leading indicator of grid deterioration when monitoring unplanned outages leading to N-security, as opposed to planned outages for capex and opex works that lead to N-security.

Transpower do have an outage notification protocol to ensure customers receive sufficient warning when their security is reduced to N-security. Transpower also provide an annual outage plan to customers. These outage protocols and outage planning information as well as a planned loss of supply and N-security outage report may be more effective in providing risk management information to customers.

In addition, customers engaged as part of the RCP4 service measure development process did not indicate a requirement for Transpower to continue to provide the AP5 information.

On balance of the above factors, GHD support the discontinuation of this measure.

The following table summarises our evaluation for this service measure.

Table 20-16 Evaluation summary of proposal to discontinue AP5 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(i) Level of network security is a measure of the risk of electricity supply (ii) Not a recognised measure of transmission service performance
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	One of the overall drivers of Transpower's of base capex, major capex and opex is to ensure the security of supply by ensuring that the network is robust enough to handle a range of outages.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	Transpower's business processes are more aligned to the overall risk management of loss of supply (which incorporates criticality) rather than a more deterministic approach of strict security of supply levels (independent of criticality).
IV Conclusion (on service measure)		The N-security reporting measure generally meets the terms of reference evaluation criteria for grid outputs. However, customers have provided feedback that the AP5 measure is not used to manage their risk of loss of supply and support its removal, and other relevant customer reporting exists. On this basis, we support **discontinuing** the AP5 service measure.	

20.11 AH: Asset health

20.11.1 Overview of service measure

Asset health (AH) measures the health of selected assets throughout a regulatory control period. Asset health modelling is used to understand and manage the current and future grid risk profile, and asset health is a key input for decision-making processes. Asset health forecasts include consideration of degradation processes and the investments needed for replacement, refurbishment and maintenance of the assets.

The AH measure proposed reports on the proportion of assets in poor health, i.e. those which have an asset health index score of eight or above. This measure provides a leading indicator to show how Transpower see the state of their transmission assets and to foresee and communicate any asset health issues. In RCP3, there were two AH measures: power transformers and outdoor circuit breakers.

Transpower has proposed the following changes to this service measure:

- Expand the asset classes from two to seven, including tower protective coatings, tower grillage foundations, insulators, conductors and protection relays, and retain power transformers and outdoor circuit breakers. All these asset classes have a material impact on the reliability of the grid and/or a material impact on future investment. Transpower have improved the capability of these asset health models.
- Combine the asset classes into one overall AH measure with sub-categories
- Based on stakeholder feedback, weight the measure by criticality where suitable for the asset class (see table below). Criticality weighting can reflect risk-based strategies.
- Remove the quality standards (preferred option) or introduce annual quality limits that are pooled across asset classes and across a number of years to create a single quality standard for AH.

Transpower propose that the measure remains non-incentivised and that a target is not introduced.

Table 20-17 Proposed asset classes with criticality weighting for AH measure

Asset class	Weighted by criticality?	Explanation
Conductors	Yes	
Insulators	Yes	
Outdoor Circuit Breakers	Yes	
Power Transformers	Yes	
Protection Relays	No	Limited criticality of this asset class
Tower Grillage Foundations	No	Transpower plan for economic intervention in asset class so criticality has minimal relevance
Tower Protection Coatings	No	Transpower plan for economic intervention in asset class so criticality has minimal relevance

Source: Transpower, RCP4 Grid Service Measures Refresh – Working Summary.

Proposed quality standards

Transpower are proposing two options with respect to quality standards for this service measure:

1. **Removal of the Quality Standard**

   The first option is to remove quality standards for AH for RCP4, retaining this as a single reporting-only measure covering the seven asset classes. With the expectation that the RCP5 proposal, occurring mid-period RCP4, will provide an opportunity for the Commission to interrogate the AH performance and reflect any findings in the RCP5. Noting that the Commission has the ability to investigate concerns without defined quality standard triggers. With a further factor that the AH measure may also be impacted by prioritisation or phasing of replacement and refurbishment work, customer-funded work, and enhancement and development work during RCP4. Transpower have also stated that AH is a leading indicator of reliability which is already captured by GP1 and GP2. Therefore, there should not both leading and lagging quality standards for the same measure of reliability. This option is Transpower’s preferred option.

2. **Apply Pooling to Quality Standards for Asset Health**

   If a quality standard for AH is required, Transpower propose introducing a pooling method for the quality standard that factors in the number of AH quality limits that were exceeded in a year, this result would then be pooled across disclosure years. This would allow for some variance to their delivery plan due to unforeseen changes, reprioritisation, or optimisation of the workplan for delivery within RCP4.

   Transpower consider that pooling is necessary given the uncertainty of supply chain issues, that asset health models are not perfect prediction tools, that new customer and connection works may need to be prioritised, and that optimising the workplan for delivery may be required due to changing requirements.

   The proposed method for pooling is for four out of the seven asset classes to meet their respective quality limits in the current disclosure year, or if not, then to have met those quality limits in the previous two disclosure years. This pooling method is consistent with the method used for the grid performance measures and applies the following method:

   – For disclosure year 2026, calculate quality limits, no compliance assessment.

   – For disclosure year 2027, at least four of the seven (4/7) asset classes met their respective quality limits the current disclosure year (i.e., 2027) or, if not, at least for of the seven (4/7) have been met in 2026.

   – For disclosure years 2028 to 2030, at least four of the seven (4/7) asset classes met their respective quality limits in the disclosure year or, if not, at least for of the seven (4/7) have been met in each of the previous two disclosure years.

   To develop the annual quality limits for each asset class Transpower use the forecasted asset health index score for each asset, in all seven asset classes, with and without intervention based on the proposed investment plan for RCP4. Quality limits relating to the proportion of assets in poor health (i.e., those which have an asset health index score of eight or above) are calculated assuming a 25 per cent benefit from the ‘with intervention’ improvement, as is the approach in the RCP3 limits. For criticality weighted asset classes, the assets will be grouped into criticality quartiles. The AH will be weighted using the median value for the quartile and the sum of quartile medians.

20.11.2 Evaluation of proposed changes

Expanding the use of asset health as a tool for monitoring and selecting assets is supported, as the development and use of AH models in decision making is consistent with GEIP. Therefore, expanding the number of assets for which AH is used as a performance measure is a positive approach by Transpower. It is recommended that the relevant asset health models continue to be matured and validated.

Critical consideration should also be given to this measure becoming an incentivised measure in the future. Incentivising this measure would not ‘double count’ the current incentivisation of GP1 or GP2. The measurement of AH convers a broad spectrum of business tool and systems not concurrent to GP1 or GP2. Such as the efficacy of asset risk assessments by correctly developing and maturing the consequence and probability models. The accuracy of data feeding into these models and potentially the effort taken to gather accurate and appropriate data. Also, whether asset strategies are effective, potentially years before GP1 and GP2 start indicating problems.

We do **not** support removing the quality standard for this measure as AH can be an effective leading indicator of the future performance of the network.

We support the following:

– Pooling across disclosure years. This would allow for some variance to the delivery plan due to unforeseen changes, reprioritisation or optimisation.
– Quality limits relating to the proportion of assets in poor health calculated assuming at 25 per cent benefit from the ‘with intervention’ improvement, as is the approach in the RCP3 limits.

The following table summarises our evaluation for this service measure.

Table 20-18 Evaluation summary of proposed AH measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(i) Asset Health Index is a recognised tool for informing risk to transmission supply. (ii) Asset Health Index is a recognised tool for determining long term performance of transmission services.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	Asset Health Index are appropriate tool for determining appropriate use of base capex, major capex and opex and critical to Transpower’s ability to deliver its RCP4 programme.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment this measure and Transpower’s business processes with respect to planning, output management, customer communication and service provider management.

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
IV Conclusion (on service measure)		We consider that the following are appropriate and satisfy the evaluation criteria specified in the ToR: – Retaining this service measure. – Expanding the service measure to include 7 asset class health indicators. – Combining the 7 asset classes into one overall AH measure with sub-categories. – Using criticality weighting to reflect risk-based strategies. – Retaining the quality standard for this measure and introducing pooling across subcategories and disclosure years. – Setting quality limits relating to the proportion of assets in poor health calculated assuming at 25 per cent benefit from the ‘with intervention’ improvement, as is the approach used to set the RCP3 limits.	

20.12 NR: Energy not served (new)

20.12.1 Overview of service measure

The proposed network risk (NR) service measure is intended to indicate the impact to supply customers of events on the grid that Transpower can influence. NR will measure energy not served, which is the amount of energy demand that is not supplied due to a transmission interruption to supply. Transpower will report against the same four supply points of service sub-categories applied to GP1 and GP2, i.e., N-1 high economic consequence; N-1 material economic consequence; N high economic consequence and N material economic consequence.

Transpower are proposing NR as a pilot reporting-only measure (with no targets, incentives or quality standards) as their capability to forecast energy not served is still maturing. The service measure would:

– Be the percentage of energy not served (MWh), i.e. the yearly percentage of MWh not served due to interruption divided by total energy demand MWh for that disclosure year. For the purpose of this measure, energy demand equals energy not served, plus energy served
– Be reported on within the same four supply points of service sub-categories as applied to GP1 and GP2
– Include all interruptions, except those caused by customers as they are outside Transpower’s control.

Customers who participated in the engagement process were supportive of the NR measure proposed and offered suggestions. Transpower considered these suggestions but did not incorporate them into the measure.

20.12.2 Evaluation of proposed changes

In our opinion the inclusion of the NR as a service measure would be beneficial as it provides a quantifiable measure of the level of energy Transpower is not able to serve due to interruptions within its control. This measure does not quantify the impact of interruptions on generation customers. However, it should be noted that this is still a reasonable measure, and that service performance to generation customers is supported through other measures such as GP1, GP2, AP1 and AP2.

Reporting against the same four supply points of service sub-categories as applied to GP1 and GP2 is logical and standardises the reporting approach across different measures. The absence of targets, incentives or quality standards are considered reasonable for a new service measure. GHD recommend the title of this measure be changed to accurately reflect the intent of this measure. As it does not practically measure risk.

The following table summarises our evaluation for this service measure.

Table 20-19 Evaluation summary of proposal to introduce the NR measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(i) This is not a measure of risk (ii) The measure of energy not served to customers is seen as measure of electricity services performance.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	Investment in base capex, major capex and opex improves reliability, security of supply and network performance. These would be correlated to customer satisfaction. Given this is a proposed new measure the relationship is not able to be quantified
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment between this measure and Transpower's ability to accurately manage assets impacting Transpower's inability to supply customers.
IV Conclusion (on service measure)		The proposed NR measure meets all these criteria. We consider it beneficial and reasonable that NR be introduced. We recommend the title be changed to correctly reflect this measure as the measure does not assess risk but rather assesses the network impact after incidents occur.	

20.13 CS1: Overall customer satisfaction (new)

20.13.1 Overview of service measure

The proposed pilot customer service measure (CS1) aims to continually improve the experience of Transpower customers. CS1 will measure the average level of overall customer satisfaction (%) based on responses to a direct question in their annual customer engagement survey.

While there was support from stakeholders in submissions for measures relating to customer service, they expressed a desire for more information which Transpower felt was beyond this service measure. Transpower stated that in addition to the annual survey they also engage with customers throughout the year, as appropriate, and as set out in annual individual customer engagement plans. They also conduct post-interruption surveys with customers after significant unplanned interruptions. From 2022 onwards, Transpower propose including a more granular breakdown of summary results from the annual customer engagement survey in these engagement plans.

20.13.2 Evaluation of proposed changes

In our opinion the inclusion of the CS1 would be beneficial as it provides a measure of customer satisfaction that can be benchmarked by year and across different customers to determine trends in customer satisfaction. Further, it provides an additional opportunity for Transpower to engage with customers and address issues that may impact on customer satisfaction.

The absence of targets, financial incentives or quality standards are considered reasonable for a new service measure. The annual survey should be conducted by an independent survey organisation which we understand is how Transpower currently undertakes this survey.

The following table summarises our evaluation of this measure.

Table 20-20 Evaluation summary of proposal to introduce the CS1 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Yes	(ii) Customer satisfaction is a recognised measure of an organisations service performance. However, it has not traditionally been seen as measure of electricity services performance.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	Yes	Investment in base capex, major capex and opex improves reliability, security of supply and network performance is likely to be correlated to customer satisfaction. Given this is a proposed new measure the relationship is not able to be quantified.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment between this measure and Transpower's business processes with respect to project planning, client engagement and communication.
IV Conclusion (on service measure)		The proposed CS1 measure meets all these criteria. Whilst customer satisfaction is not a traditional measure of network performance it is our opinion that it is an important indicator on whether Transpower are well performing as an organisation. We consider it beneficial and reasonable that CS1 be introduced as a new measure.	

20.14 CS2: New and enhanced grid connections (new)

20.14.1 Overview of service measure

The proposed pilot measure for new and enhanced grid connections (CS2) aims to incentivise fair allocation of resource to customer-driven projects which add energy demand and energy supply capacity and to incentivise continual improvement of the connection process. Transpower consider that reporting these measures is more relevant now with the formal queueing processes for new generator connections.

Transpower are proposing a measure would include annual reporting in five sub-categories:

– Average time to deliver concept assessments [days], which measures the average turnaround time for the initial feasibility assessment of new connection concepts in calendar days.
– Percentage of investigation projects delivered within contracted time, which measures and reports annually the percentage of connection investigations completed within the timeframe agreed in the associated Transpower Services Agreement
– Median time from TWA to commission – Load [days], which measures and reports annually on the median time from the start day of the associated Transpower Works Agreement to commissioning for all load connection projects commissioned within the reporting period
– Median time from TWA to commission – Generation [days], which measures and reports annually on the median time from the start date of the associated Transpower Works Agreement to commissioning for all generation connection projects commissioned within the reporting period
– Percentage of connection projects delivered within contracted time, which measures and annually the percentage of connection projects commissioned within timeframe agreed in the associated Transpower Works Agreement.

Transpower have proposed this measure based on submissions from their May 2022 engagement paper. Stakeholders indicated in submissions that they support Transpower's CS2 proposal as outlined in Transpower's September 2022 engagement paper.

20.14.2 Evaluation of proposed changes

In our opinion the inclusion of the CS2 would be beneficial as it provides a measure of the effectiveness of Transpower's customer connection process in terms of responsiveness, time to deliver connections and whether customer expectations have been met). From our experience, engaging with Australian TNSPs and their connection customers, the connection process is often seen as opaque, expensive, overly lengthy, and subject to project delays. Measures to streamline the process, such as formal queueing processes as well as the proposed CS2 measure have the potential to simplify the connection process and provide greater connection certainty.

We agree with Transpower's perspective outlined in the RCP4 Grid Services Measures Refresh document[403] that simple measures of progress against connection delivery stages are more effective than measures of end-to-end connection time due to the bespoke nature of connection projects and significant external influences.

We expect that these categories may change over time to greater reflect customer connection expectations. In addition to undertaking these reporting measures Transpower should regularly review its connection processes and performance and should set internal benchmarks for these measures.

It is our opinion from overseas experience that transmission connection processes are an area that connection customers expect higher levels of performance than they often receive. In addition, Transpower anticipate that they will receive greater volumes of customer connections which will require more opex investment in TFEs to respond to these enquires.

Therefore, whilst CS2 may not meet all the evaluation criteria it is our opinion that there would be benefit in including this measure.

The following table summarises our evaluation for this grid output measure.

Table 20-21 Evaluation summary of proposal to introduce the CS2 measure

ToR Clause	Evaluation criteria	Meets criteria	Evaluation commentary
Service measure			
A5(a)	Is the service measure a recognised measure of: (i) risk in the supply of electricity transmission services; or (ii) performance of the supply of electricity transmission services.	Partial	(ii) Measuring service related to delivery of new and enhanced connections satisfaction is a recognised measure of an organisations service performance. However, it has not traditionally been seen as measure of electricity services performance.
A5(b)	Relationship between measure, base capex, major capex and opex and whether it can be quantified.	No	Investment in base capex, major capex and opex are not related to connection customer satisfaction levels as connection projects are separate from these expenditure levels.
A5(c)	Alignment with Transpower business processes for electricity supply transmission services.	Yes	There is a high degree of alignment between this measure and Transpower's business processes with respect to communication, investigations, project planning, project delivery and commissioning.
IV Conclusion (on service measure)		Whilst measuring service related to delivery of new and enhanced connections is not a traditional measure of network performance it is our opinion that it is an important indicator on whether Transpower are performing well as an organisation. Assessment against the evaluation criteria in the ToR indicates that this measure does not meet all of the evaluation criteria. However, it is our opinion that there would be benefit in including this service measure.	

[403] Transpower, Grid Service Measures Refresh Summary, March 2023. [GSM004]

Appendix A

Acronyms

A-1 Abbreviations

Appendix Table 1 Abbreviations used in this report

Term	Definition
ACS	Asset class strategy
AH	Asset health
AHI	Asset health index
AHNR	Asset health and network risk
AM&O	Asset management and operations
AP	Asset performance
AR/VR	Augmented reality/virtual reality
AUFLS	Automatic under frequency load shedding
BIM	Building information modelling
BYOT	Bring your own technology
Capex	Capital expenditure
Capex IM	Capital expenditure input methodology
cct	Circuit
CPI	Consumer price index
CUWLP	Clutha upper waitaki lines project
DC	Direct current
DCSM	Data centre services modernisation
DER	Distributed energy resource
DNSPs	Distributed network service providers
E&D	Enhancement and Development
EDGS	Electricity demand and generation scenarios
EMS	Energy market services
ENA	Electricity Networks Association
ERANZ	Electricity Retailers' Association of New Zealand
FMIS	Financial management information system
FTE	Full time equivalent
FY	Financial year
GEIP	Good electricity industry practice
GIDI	Government investment in decarbonising industry
GP	Grid performance
GSCs	Grid services contracts
GWh	Giga watt hour
GXP	Grid exit point
HV	High voltage
HVAC	High voltage alternating current
HVDC	High voltage direct current
I/O	Input/output
IaaS/PaaS	Infrastructure as a service / platform as a service

Term	Definition
IBC	Investigation business case
ICT	Information & communications technology
IDC	Interest during construction
IEP	Individual engagement plan
IFRIC	Interpretations committee
IFRS	Financial reporting standards
IIMM	International infrastructure management manual
IP	Internet protocol
ISO27001:2012	Information security management standard
IST	Information services and technology
IT	Information technology
ITT	Invitation to tender
Invex	Investigations expenditure
k	Thousand
kms	Kilometres
KPI	Key performance indicator
kV	Kilovolt
LV	Low voltage
LVAC	Low voltage alternating current
m	Million
MAD	Maximum approach distance
MAR	Maximum allowable revenue
MEUG	Major electricity users group
MTBF	Mean time between failures
MTFP	Multilateral total factor productivity
MV	Medium voltage
MVA	Mega volt ampere
NCC	National construction code
NCT	Neutral current transformer
NGOCs	National grid operating centres
NZD	New Zealand dollar
NZIER	New Zealand Institute of Economic Research Inc
NZTA	New Zealand Transport Agency
ODID	Outdoor-indoor conversion
OEM	Original equipment manufacturer
Ofgem	Office of gas and electricity markets
Opex	Operational expenditure
PMP	Portfolio management plan
PoF	Probability of failure
PPF	Partial productivity factor
PPI	Partial performance indicators

Term	Definition
PSE	Protection signalling equipment
Qty	Quantity
R&R	Replacement and refurbishment
RCM	Reliability centred maintenance
RCP	Regulatory control period
RCP3	Third regulatory control period
RCP4	Fourth regulatory control period
RFIs	Request for information
RIM	Reliability informed maintenance
RTUs	Remote terminal units
RY	Regulatory year (1 March to 30 April)
SaaS	Software as a service
SAP	Systems applications and products (widely used enterprise resource planning software)
SCADA	Supervisory control and data acquisition
SCORED	Risk register used during risk and cost estimation workshop
SDDP	Stochastic dual dynamic programming
STATCOMs	Static synchronous compensators
Strata	Strata energy consulting limited
SVCs	Static var compensators
TEES	Transpower enterprise estimating system
TL	Transmission line
TNSPs	Transmission network services providers
ToR	Terms of reference
Totex	Total expenditure = opex + capex
TPM	Transmission pricing methodology
TPR	Transmission Planning Report
TransGo	Transpower network to support grid operations
TWA	Transpower works agreement
UIOLI	Use it or lose it (new uncertainty mechanism being proposed)
UK	United Kingdom
Vargen	Variable generic allowance
VCSS-CSO	Voluntary Security Standards for Control System Operators
VoLL	Value of Lost Load

Appendix B

Terms of reference (ToR)

Appendix C

Mapping of IV report content to ToR requirements

C-1 Mapping of IV report content to clause 4 of the ToR

The following table outlines the section of this IV report that addressed each of the report content requirements from the clause 4 of the ToR.

Appendix Table 2 Mapping of IV report sections to clause 4 ToR requirements

Clause	ToR clause 4 requirement	IV report section
4.1	Provide an opinion on whether Transpower's proposed opex, proposed base capex, proposed grid output measures, and key assumptions are consistent with the expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.	Sections 8 to 12 Base capex Sections 13 to 18 Opex Section 20 Service measures
4.2	Provide an opinion on the extent to which Transpower's relevant policies and governance processes (including Transpower's approach to, and use of, asset health modelling) are consistent with good asset management practice and are directed towards the expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP and the evaluation criteria.	Section 3 Strategy development and implementation
4.3	Provide an opinion on the extent to which Transpower's relevant policies and governance processes (including those described at paragraph 4.2), on which the proposal or its implementation depend, have been effectively implemented in Transpower's development of its RCP4 proposal.	Section 3 Strategy development and implementation
4.4	Provide an opinion on the extent to which Transpower's AHNR modelling informs the expenditure and grid output measures forecasts, consistent with the expenditure outcome which represents the efficient costs of a prudent electricity transmission services supplier having regard to GEIP, the evaluation criteria, and the GHD Advisory Expert Opinion Progress Review – Report on asset health and risk modelling, dated 21 October 2022[404] (required by the section 53ZD notice dated 11 December 2019).	Section 3 Strategy development and implementation Section 9 Base R&R capex Section 14 Grid maintenance opex
4.5	Provide an opinion on the extent to which Transpower has adequately addressed in its proposal its ability to deliver against its proposed base capex and proposed opex during RCP4, taking into account the expected availability of Transpower and external resources required to deliver the proposed work.	Section 7 Deliverability
4.6	Provide an opinion on the extent and effectiveness of Transpower's consultation with its stakeholders.	Section 6 Stakeholder consultation
4.7	Provide an opinion on the extent to which Transpower has considered stakeholder feedback in developing its proposal.	Section 6 Stakeholder consultation
4.8	Provide a list of the key issues and areas that it considers the Commission should focus on when the Commission evaluates Transpower's RCP4 proposal.	Addressed at the beginning of each section and outlined in the Executive Summary.
4.9	Provide an opinion on whether Transpower provided the Verifier with the type and depth of information it needed to provide its verification report.	Addressed at the beginning of each section.
4.10.1	Identify any other information not included in the RCP4 proposal that the Verifier reasonably believes would be available to Transpower.	Addressed at the beginning of each section.
4.10.2	Identify any other information not included in the RCP4 proposal that the Verifier reasonably believes would assist the Commission's evaluation of Transpower's RCP4 proposal.	Addressed at the beginning of each section.

[404] GHD, AM013 AHNR Expert Opinion Progress Review Report.pdf, October 2022.

C-2 Mapping of IV report content to clause 18 of the ToR

The following table outlines the section of this IV report that addressed each of the report content requirements from the clause 18 of the ToR.

Appendix Table 3 ***Mapping of IV report content to Clause 18 in ToR***

Clause	ToR clause 18 requirement	IV report section
18.1.1	IV to review Transpower's proposed opex, with emphasis on identified programmes, broken down into the further agreed types.	Sections 13 to 18 Opex
18.1.2	IV to review Transpower's proposed base R&R capex, with emphasis on identified programmes, broken down into the further agreed types.	Section 9 Base R&R capex
18.1.3	IV to review Transpower's proposed base E&D capex, with emphasis on identified programmes, broken down into the further agreed types.	Section 10 Base E&D capex
18.1.4	IV to review Transpower's proposed ICT opex, with emphasis on identified programme, broken down into the further agreed types.	Section 16 ICT opex
18.1.4	IV to review Transpower's proposed ICT capex, with emphasis on identified programmes, broken down into the further agreed types.	Section 11 ICT capex
18.1.5	IV to review Transpower's proposed business support capex with emphasis on identified programmes, broken down into the further agreed types.	Section 12 Business support capex
18.2	IV to review Transpower's proposed grid output measures.	Section 20 Service measures
18.3	IV to review the extent that Transpower proposes the inclusion of listed projects, whether its proposed listed projects meet the criteria specified in clause 2.2.2(7) of the Capex IM.	Section 19.4 Listed projects
18.4	IV to review the extent that Transpower includes low incentive rate base capex projects (as defined in the Capex IM) in its RCP4 proposal, whether those projects should be specified by the Commission as low incentive rate base capex projects.	Section 11.5.3 IC02 – TransGo Refresh
18.5	IV to review the extent to which Transpower adequately demonstrates that its RCP4 proposal is consistent with the relevant Input Methodologies.	Throughout the IV report
18.6	IV to review the extent of Transpower's stakeholder engagement (including on grid output measures) and how Transpower has incorporated stakeholder feedback.	Section 6 Stakeholder consultation
18.7	IV to review whether any base E&D capex projects or programmes included in Transpower's RCP4 proposal are subject to such uncertainty of timing or amount that the Verifier recommends to the Commission that it should not include them in the base capex allowance, with the view that Transpower would apply for reconsideration of the IPP for eligible E&D projects during RCP4 in accordance with the Transpower IM determination. For any such projects or programmes, the Verifier should also provide its view on Transpower's proposed arrangements for the E&D base capex projects or programmes.	Section 9 Base R&R capex Section 19 Uncertainty mechanisms and expenditures
18.8	IV to review whether any base capex projects or base capex programmes included in Transpower's RCP4 proposal are subject to uncertainty such that the Commission should consider making those projects or programmes subject to an uncertainty mechanism.	Section 9 Base R&R capex Section 19 Uncertainty mechanisms and expenditures

C-3 Mapping of IV report to Attachment A of the ToR

The following table outlines the sections of this IV have applied the evaluation criteria outlined in Attachment A of the ToR.

Appendix Table 4 ***Uses of evaluation criteria in Attachment A of the ToRfi***

Clause	ToR Attachment A clause	IV report section
A1	General evaluation of base capex proposal and opex proposal	
A1(a)	the reasonableness of key assumptions relied upon, including- (i) the method and information used to develop them; (ii) how they were applied; (iii) their effect on the proposed base capex and opex.	This criterion is assessed in Section 4 Cost estimation, Section 5 Section Electricity demand forecast and applied to any non-identified programmes in: – Sections 8 to 12 Base capex – Sections 13 to 18 Opex
A1(b)	whether policies regarding the need for, and prioritisation of, projects and programmes demonstrate a risk-based approach consistent with good asset management practice and are directed towards cost-effective and efficient solutions;	This criterion was applied in Section 3 Strategy development and implementation
A1(c)	the dependencies between the proposed grid output measures and the proposed base capex and proposed opex at the level of the grid and for each base capex category and opex category;	This criterion is applied to relevant opex and base capex programmes in: – Sections 8 to 12 Base capex – Sections 13 to 18 Opex – Section 20 Service measures
A1(d)	the dependencies between the proposed grid output measures and the proposed base capex and proposed opex at the level of the grid and for each base capex category and opex category;	This criterion is applied to relevant opex and base capex programmes in: – Sections 8 to 12 Base capex – Sections 13 to 18 Opex – Section 20 Service measures
A1(e)	the extent to which the grid output targets were met in the previous regulatory period	This criterion is assessed in Section 20 Service measures.
A1(f)	the overall deliverability of the proposed base capex and opex during the current regulatory period	This criterion is assessed in Section 7 Deliverability.
A1(g)	the reasonableness and adequacy of any models used, including but not limited to asset replacement models, to prepare the proposed base capex and proposed opex including- (i) inputs to the model; and (ii) the methods used to check the reasonableness of the forecasts and related expenditure	This criterion is assessed in Section 4 Cost estimation and applied as required in: – Sections 8 to 12 Base capex – Sections 13 to 18 Opex
A1(h)	the reasonableness of the key assumptions, key input data and forecasting methods used in determining demand forecasts;	This criterion is assessed in Section 5 Electricity demand forecast.
A1(i)	appropriateness of demand forecasts and other key assumptions in determining proposed base capex and opex;	This criterion is assessed in Section 5 Electricity demand forecast and projects in Section 10 Base E&D capex as appropriate.
A1(j)	the extent to which Transpower has demonstrated the type of efficiency improvements obtained in the current and previous regulatory periods; and	This criterion is assessed in Sections 13 to 18 Opex.
A1(k)	the extent that Transpower has demonstrated scope for efficiency improvements during the regulatory period in question.	This criterion is assessed in Sections 13 to 18 Opex.
A2	Specific evaluation of the opex proposal (clauses (a) to (d))	This criterion is applied to relevant programmes in Sections 13 to 18 Opex.
A3	Evaluation of identified programmes (clauses (a) to (j))	This criterion was applied to identified programmes in: – Sections 8 to 12 Base capex

Clause	ToR Attachment A clause	IV report section
		– Sections 13 to 18 Opex
A4	Evaluation techniques (a) to (h)	We have employed a number of these techniques. Appendix E Verification techniques outlines the techniques employed for capex, opex and service measures.
A5	Criteria for considering proposed grid output measures (Clauses (a) to (c))	This criterion was applied to all grid services measures in Section 20 Service measures.
A6	Criteria for considering proposed revenue-linked grid output measures (Clauses (a) to (c))	This criterion is applied to GP1, GP2, AP1 and AP2 in Section 20 Service measures.
A7	Criteria for considering matters relating to revenue-linked grid output measures (Clauses (a) to (f))	This criterion is applied to GP1, GP2, AP1 and AP2 in Section 20 Service measures.
A8	Criteria for considering low incentive rate base capex (Clauses (a) and (b))	This criterion is applied to the low incentive rate base capex project in Section 11.5.3 IC02 – TransGo Refresh
A9	Criteria for considering base capex allowance adjustment mechanism (Clauses (a) to (c))	This criterion is applied to relevant base E&D capex projects in Section 10 Base E&D capex
A10	Criteria for listed projects (clauses (a) to (f))	This criterion is applied to the Listed Projects in Section 19.4 Listed projects
A11	Evaluation of other uncertainty mechanisms (clause (a) to (e))	This criterion is applied in Section 19 Uncertainty mechanisms and expenditures

Appendix D

Documents sighted

D-1 Documents sighted in IV review

The following table list the documents that have been sighted as part of our review of the Transpower RCP4 proposal.

In total there were 1128 documents. We received and reviewed five confidential documents that we have not listed in the below tables due to their sensitive nature. The remainder of the documents are split into two tables. The first table contains the IV Review documents. The second table contains the RFI documents.

Appendix Table 5 IV Review Documents ECHO library

Name	Created (uploaded to data room)
AM001 TG 01.02 Grid Business Strategic Asset Management Plan.pdf	9/03/2023
AM002 AM-G 01 Grid Business Asset Management System Framework.pdf	9/03/2023
AM003 2022 Asset Management Plan.pdf	9/03/2023
AM004 TG 10.02 Network Strategy.pdf	9/03/2023
AM005 TG 10.05 Grid delivery strategy.pdf	9/03/2023
AM006 TG 10.04 Grid operations strategy.pdf	9/03/2023
AM007 Asset Health Framework February 2023 - FINAL.pdf	10/03/2023
AM008 Asset Criticality Framework February 2023 - FINAL.pdf	10/03/2023
AM009 Cost Estimation Framework.pdf	9/03/2023
AM010 Maintenance Planning Framework.pdf	9/03/2023
AM012 AHNR Progress Update.pdf	9/03/2023
AM013 AHNR Expert Opinion Progress Review Report.pdf	9/03/2023
AM014 DG 25.04 Key principles of the asset planning decision framework.pdf	9/03/2023
COR001 Transpower Statement of Corporate Intent 2022-23.pdf	10/03/2023
COR002 Transmission Tomorrow 2023.pdf	10/03/2023
COR003 Transpower Whakamana i Te Mauri Hiko.pdf	10/03/2023
COR004 Transpower FS 21-22.pdf	10/03/2023
COR005 Transpower Integrated Report FY22.pdf	10/03/2023
DEL001 Grid Services Contract journey.pdf	22/03/2023
DEL002 RCP4 Deliverability Review.pdf	22/03/2023
DEL003 Procurement Methodologies for Identified Programmes .pdf	24/03/2023
DEL004 Programme Delivery Framework .pdf	24/03/2023
DEL005 Transpower Workforce Plan - internal resource needs V2.pdf	2/04/2023
EED001 Transmission Planning Report 2022.pdf	10/03/2023
EED002 Transpower-Application-to-reconsider-IPP-for-revenue-control-period-3-25-May-2022.pdf	27/03/2023
EED003 Transpower-IPP-reconsideration-to-allow-for-recovery-of-TPM-development-costs-Reasons-paper-22-No.pdf	27/03/2023
EOP001 Maintenance Opex Overview 2022.pdf	10/03/2023
EOP002 Maintenance 2022 PMP.pdf	10/03/2023
EOP003 ICT Opex Overview V0.3 Final.pdf	10/03/2023
EOP004 Insurance Opex Overview.pdf	21/03/2023
EOP005 Insurance Opex Overview - Appendix 4 - WTW RCP4 Report.pdf	28/03/2023

Name	Created (uploaded to data room)
EOP006 Insurance Opex Overview - Appendix 5 RCP4_Estimated_Premiums_Actuarial_Estimates.pdf	28/03/2023
EOP007 Business Support Opex Overview .pdf	31/03/2023
EOP008 Asset Management & Operations Opex Overview RCP4.pdf	31/03/2023
EOP009 FTE uplift summary & Ratios.xlsx	28/04/2023
EOP010 Business Support Opex Overview.docx	7/08/2023
EOP011 Asset Management & Operations Opex Overview RCP4.docx	7/08/2023
ERR001 FL 01.01 Towers and poles asset class strategy.pdf	10/03/2023
ERR002 FL 02.01 Insulators and fittings asset class strategy.pdf	10/03/2023
ERR003 FL 03.01 Conductors and hardware asset class strategy.pdf	10/03/2023
ERR004 FP 01.02 Protection asset class strategy.pdf	10/03/2023
ERR005 FP 10.01 Protection DC supplies asset class strategy.pdf	10/03/2023
ERR006 FP 12.01 Substation management systems asset class strategy.pdf	10/03/2023
ERR007 FP 13.01 Metering asset class strategy.pdf	10/03/2023
ERR008 FS 03.01 Outdoor disconnectors and earth switches asset class strategy.pdf	10/03/2023
ERR009 FS 20.01 Power transformers asset class strategy.pdf	10/03/2023
ERR010 FS 22.01 Outdoor instrument transformers asset class strategy.pdf	10/03/2023
ERR011 FS 31.01 Capacitors and reactors asset class strategy.pdf	10/03/2023
ERR012 FS 32.02 Synchronous condensers asset class strategy.pdf	10/03/2023
ERR013 FS 45.01 Static var compensators asset class strategy.pdf	10/03/2023
ERR014 FS 46.01 HVDC assets asset class strategy.pdf	10/03/2023
ERR015 FS 51.01 Outdoor circuit breakers asset class strategy.pdf	10/03/2023
ERR016 FS 53.01 Buildings and grounds asset class strategy.pdf	10/03/2023
ERR017 TG 10.03 Grid resilience strategy.pdf	10/03/2023
ERR018 TS 55.01 SF6 Management Strategy.pdf	10/03/2023
ERR019 Transmission Lines Portfolio Overview.pdf	13/03/2023
ERR020 Substations Portfolio Overview.pdf	10/03/2023
ERR021 Secondary Assets Portfolio Overview.pdf	10/03/2023
ERR022 ACS Buildings and Grounds 2022 PMP.pdf	10/03/2023
ERR023 ACS Disconnectors and Earth Switches 2022 PMP.pdf	10/03/2023
ERR024 ACS Outdoor Instrument Transformers 2022 PMP.pdf	10/03/2023
ERR025 ACS Outdoor Circuit Breakers 2022 PMP.pdf	16/03/2023
ERR026 ACS Power Transformer 2022 PMP.pdf	10/03/2023
ERR027 HVDC Assets 2022 PMP.pdf	10/03/2023
ERR028 Resilience 2022 PMP.pdf	10/03/2023
ERR029 SA Protection and Revenue Metering 2022 PMP.pdf	10/03/2023
ERR030 SA Reactive Power Assets 2022 PMP.pdf	10/03/2023
ERR031 SA Station DC Systems 2022 PMP.pdf	10/03/2023
ERR032 SA Substation Management Systems 2022 PMP.pdf	10/03/2023
ERR033 TL Conductors 2022 PMP.pdf	10/03/2023

Name	Created (uploaded to data room)
ERR034 TL Insulator 2022 PMP.pdf	10/03/2023
ERR035 TL Paint 2022 PMP.pdf	10/03/2023
ERR036 TL Structures 2022 PMP.pdf	10/03/2023
GSM001 2022 Service Measures Report.pdf	10/03/2023
GSM002 Grid Service Engagement Paper May 2022.pdf	10/03/2023
GSM003 Grid Service Measures Engagement Paper 2 (Annex).pdf	10/03/2023
GSM004 RCP4 Grid Service Measures Refresh Summary - March 2023.pdf	10/03/2023
GSM005 Submission Summary - Grid Service Engagement Paper 1.pdf	10/03/2023
ICT001 ICT Investment Framework V0.3_Final_endorsed.pdf	10/03/2023
ICT002 ICT_Delivery Approach_RCP3_RCP4_Final.pdf	10/03/2023
ICT003 S01 Asset Management and Network Risk Systems APPROVED V1.0.pdf	10/03/2023
ICT004 S02 End-to-End Planning Systems APPROVED V1.0.pdf	10/03/2023
ICT005 S04 Transmission Systems APPROVED V1.0.pdf	10/03/2023
ICT006 S06 Enterprise Information & Data APPROVED V1.0.pdf	10/03/2023
ICT007 S07 Digital Workplace APPROVED v1.0.pdf	10/03/2023
ICT008 S08 Customer Engagement Systems APPROVED V1.0.pdf	10/03/2023
ICT009 S10 Transmission Pricing & Compliance APPROVED V1.0.pdf	10/03/2023
ICT010 S11 Asset Lifecycle Management - Telecommunication Sub-Strategy.pdf	10/03/2023
ICT011 S12 TransGO Refresh APPROVED V1.0.pdf	10/03/2023
ICT012 S13 Enterprise Business Capability APPROVED V1.0.pdf	10/03/2023
ICT013 S14 Energy Management Systems and SCADA APPROVED V1.0.pdf	10/03/2023
ICT014 S15 Asset Lifecycle Management - Applications Sub-Strategy APPROVED V1.0.pdf	10/03/2023
ICT015 S16 Asset Lifecycle Management – Infrastructure Sub-Strategy APPROVED V1.pdf	10/03/2023
ICT016 S17 IT Service Delivery & Management APPROVED V1.0.pdf	10/03/2023
ICT017 S18 Cybersecurity APPROVED V1.0.pdf	10/03/2023
ICT018 S20 Data Centre Services Modernisation APPROVED V1.0.pdf	10/03/2023
ICT019 IC03 BIM Final Investment Case v1.2 Final - signed off.pdf	10/03/2023
ICT020 IC10 DA Programme Final Investment Case - signed off.pdf	10/03/2023
ICT021 IC12 ITSM Investment Case.pdf	10/03/2023
ICT022 IC01 Maintain Assets ICT Investment Case.pdf	10/03/2023
ICT023 IC02 TransGO ICT Investment Case.pdf	10/03/2023
ICT024 IC05 DCSM ICT Investment Case.pdf	10/03/2023
ICT025 IC06 Corporate ICT Investment Case.pdf	10/03/2023
ICT026 IC07 Assets Management ICT Investment Case.pdf	10/03/2023
ICT027 IC08 Digital Workplace ICT Investment Case.pdf	10/03/2023
ICT028 IC09 Cybersecurity ICT Investment Case.pdf	10/03/2023
ICT029 ICT Strategy.pdf	10/03/2023
ICT030 IC11 Digital Switch Management Investment Case V1.4 - Final signed off.pdf	10/03/2023
ICT031 IC04 Transmission Systems.pdf	3/04/2023
ICT032 ICT Long term planning - Cost estimation approach - Final v.04 - endorsed.pdf	10/03/2023

Name	Created (uploaded to data room)
IV Document Register.xlsx	13/06/2023
IVP001 RCP4 IV kick-off session.pdf	10/03/2023
IVP002 RCP4 IV Presentation - Asset Management System and Decision Framework.pdf	10/03/2023
IVP003 RCP4 IV E&D presentation.pdf	10/03/2023
IVP004 RCP4 IV Opex Slides.pdf	10/03/2023
IVP005 RCP4 IV HVDC and Reactive - overview.pdf	10/03/2023
IVP006 RCP4 IV ICT - Overview.pdf	10/03/2023
IVP007 RCP4 IV Secondary Assets - overview.pdf	10/03/2023
IVP008 RCP4 IV AC Substations - Overview.pdf	10/03/2023
IVP009 RCP4 IV Deliverability – overview.pdf	10/03/2023
IVP010 RCP4 IV Transmission Lines - Overview.pdf	10/03/2023
IVP011 RCP4 IV Grid Service Measures - Overview.pdf	10/03/2023
IVP012 RCP4 IV Buildings & Grounds - Overview.pdf	10/03/2023
IVP013 RCP4 IV Resilience - overview.pdf	10/03/2023
IVP014 RCP4 IV Regulatory - Overview.pdf	10/03/2023
REG001 RCP4 RT01 Expenditure schedules IV version midFeb 23.xlsx	10/03/2023
REG002 RCP4 RT02 Output Incentives Model.xlsx	10/03/2023
REG003 RCP4 RT03 Cost escalators.xlsx	10/03/2023
REG004 NZIER Cost escalation forecasts and methodology - draft 221031.pdf	10/03/2023
REG005 NZIER report to Transpower OPEX productivity.pdf	10/03/2023
REG006 Transpower - RCP4 - Uncertainty mechanisms.pdf	10/03/2023
REG007 Transpower MTFP benchmarking (for IV).xlsx	10/03/2023
REG008 RCP4 RT02 Output Incentives Model v2.xlsx	22/03/2023
REG009 RCP4 Incentives for revenue-linked services summary.xlsx	22/03/2023
REG010 RCP4 RT01 Expenditure schedules IV version with links 20230324.xlsx	24/03/2023
REG011 RCP4 RT01 Expenditure schedules IV version midFeb 23_w RCP1.xlsx	8/06/2023
REG012 NZIER report to Transpower OPEX productivity 090623.pdf	15/06/2023
REG013 RCP4 RT01 Expenditure schedules IV version with links 20230711.xlsx	20/07/2023
REG014 NZIER Cost escalation forecasts and methodology July 2023_FINAL.pdf	20/07/2023
REG015 NZIER report to Transpower OPEX productivity_July2023_FINAL.pdf	20/07/2023
REG016 RCP4 RT01 Expenditure schedules IV version with links 20230807.xlsx	7/08/2023
SHE001 Transpower RCP4 Consultation.pdf	10/03/2023
SHE002 Transpower Grid Service Measures Engagement Paper 1.pdf	10/03/2023
SHE003 Transpower Grid Service Measures Engagement Paper 2 (for RCP4).pdf	10/03/2023
SHE004 Transpower RCP4 Consultation webinar slide deck.pdf	10/03/2023
SHE005 Transpower RCP4 Consultation webinar video link.pdf	10/03/2023
SHE006 Transpower RCP4 Consultation Summary.pdf	10/03/2023
SHE007 Mercury submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE008 Transpower RCP4 Consultation Summary of submission feedback.pdf	10/03/2023
SHE009 Vector submission on Transpower RCP4 consultation.pdf	10/03/2023

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SHE010 MEUG submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE011 Euroclass submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE012 ERANZ submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE013 Fonterra submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE014 Meridian submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE015 Electra submission on Transpower RCP4 consultation.pdf	10/03/2023
SHE016 Electra submission on Transpower Grid SM Paper 2.pdf	10/03/2023
SHE017 Grid Service Engagement Webinar May 2022.pdf	10/03/2023
SHE018 RCP4 webinar June 2022 - Planning for RCP4.pdf	10/03/2023
SHE019 RCP4 webinar August - Material Portfolios.pdf	10/03/2023
SHE020 SSHJ RCP4 final expert opinion 1122.pdf	10/03/2023
SHE021 CAP Mar 2022 Item 8 - RCP4 engagement (Stacey Newlands).pdf	10/03/2023
SHE022 CAP Meeting 14 - Minutes and Actions.pdf	10/03/2023
SHE023 CAP Meeting 15 - Minutes and Actions final 002.pdf	10/03/2023
SHE024 Customer Engagement Plan - High Level Scope (May 2020).pdf	10/03/2023
SHE025 IEP Kiwirail DRAFT.pdf	10/03/2023
SHE026 IEP Meridian Energy DRAFT.pdf	10/03/2023
SHE027 IEP OMV NZ Production Ltd DRAFT.pdf	10/03/2023
SHE028 IEP Orion Signed.pdf	10/03/2023
SHE029 IEP Powerco DRAFT.pdf	10/03/2023
SHE030 IEP PowerNet Signed.pdf	10/03/2023
SHE031 Efficiencies from engagement (non-revenue benefits)_CONFIDENTIAL.pdf	10/03/2023
SHE032 2022 ITP Schedules.pdf	10/03/2023
SHE033 2022 ITP Glossary.pdf	10/03/2023
SHE034 2022 ITP Compliance Report.pdf	10/03/2023

Appendix Table 6 RFIs ECHO library

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20230501 Uncertainty mechanisms - additional information.pdf	8/05/2023
20230502 Power Transformers – additional data.xlsx	10/05/2023
20230502 Power Transformers - additional information.pdf	10/05/2023
20230503 Base E&D and demand forecasting - additional information.pdf	5/05/2023
20230503 Resilience - additional information.pdf	12/05/2023
20230503 Transpower_space_weather_extreme_storm_ - Updated Aug 2022.pdf	12/05/2023
20230503 TranspowerResilienceStrategyReview_220912.pdf	12/05/2023
20230503 WiTMH Monitoring Report - March 23.pdf	5/05/2023
20230504 DBC TL-Grillage 2023-25.pdf	11/05/2023
20230504 DBC TL-Insulator 2023-25.pdf	11/05/2023
20230504 Deliverable quantities for transmission lines volumetric work - updated.xlsx	11/05/2023
20230504 HLY-OTA-A (OTA-DRY) B10 (Tees Estimate) CP_637_006_0_00.pdf	11/05/2023

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20230504 Outdoor switchgear - additional information.pdf	15/05/2023
20230504 Outdoor switchgear - AH, CA, and criticality examples.xlsx	15/05/2023
20230504 Outdoor switchgear - RCP4 assets.xlsx	15/05/2023
20230504 Transmission Lines - additional information.pdf	11/05/2023
20230508 Cost estimation - additional information - part 1.pdf	17/05/2023
20230508 Cost estimation - additional information - part 2.pdf	19/05/2023
20230508 Cost estimation - additional information - part 3.pdf	23/05/2023
20230508 Cost estimation - IV slides second round interviews.pdf	17/05/2023
20230508 Penrose control room building project_Replacement and demolition.xlsx	17/05/2023
20230508 Project Registers for Risk and Issues etc - How to use.pdf	19/05/2023
20230508 Risk Allowance Process v1.6.pdf	19/05/2023
20230509 - 09092021 RCP4 output measures refresh - memo - Appendix 2 - Overseas experience.pdf	12/05/2023
20230509 13-01-2023_RSC1_2 Year Work Schedule.xlsx	15/05/2023
20230509 2014.04.11 Partna-Consulting-Group-Review-of-Transpowers-proposed-quality-measures-11-April-2014.PDF	12/05/2023
20230509 AER Service Target Performance Incentive Scheme (STPIS).pdf	12/05/2023
20230509 AP2 governance info pack - 20230210.pdf	12/05/2023
20230509 AP2 governance meeting minutes - 20230210.pdf	12/05/2023
20230509 Grid Services Contract - additional information.pdf	15/05/2023
20230509 KPI Presentation 27-06-2022.pdf	15/05/2023
20230509 Service Measures - additional information.pdf	12/05/2023
20230509 Service Measures Refresh - Second interview IV slides.pdf	12/05/2023
20230509 WP 1 - Service Attributes Final.pdf	12/05/2023
20230510 - HVDC and reactive - additional information v1.pdf	17/05/2023
20230510 - HVDC and reactive - additional information v2.pdf	22/05/2023
20230510 - HVDC and reactive - additional information v3.pdf	31/05/2023
20230510 - HVDC and reactive - additional information.pdf	12/05/2023
20230511 Transpower_RCP4 EDB workshops_Lower South Island.pdf	19/05/2023
20230515 RCP4 EDB workshop - Questions for consideration and feedback.pdf	19/05/2023
20230519 RCP4 stakeholder engagement summary.xlsx	19/05/2023
20230531 Resilience - additional information - part 2.pdf	1/06/2023
20230607 GL-OP-1024 Outage Planning Process.pdf	7/06/2023
20230612 ACS Other Substation Equipment 2022 PMP.pdf	12/06/2023
20230615 - HVDC and reactive - additional information first and second session .pdf	15/06/2023
20230615 - HVDC and reactive - additional information first and second session .pdf	15/06/2023
20230615 - Service Measures - Asset Health scenario.pdf	15/06/2023
20230615 HVDC subsea cable Asset Health 2023.pdf	15/06/2023
20230615 ICT investment case versus RCP4 submission V2 Transpower reworked 15 June.xlsx	15/06/2023
20230619 IV question - Opex reduction and efficiencies.docx	19/06/2023
20230620 ICT investment case versus RCP4 submission V2 Transpower reworked.xlsx	20/06/2023

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20230623 ICT investment case versus RCP4 submission V3 Transpower reworked.xlsx	23/06/2023
20230815 Workforce initatives.xlsx	18/08/2023
Additional information - AP5.pdf	3/08/2023
Business Service categories.xlsx	19/06/2023
Business support Response - External Affairs and Corporate Services FTE additional information.docx	18/08/2023
Concept Consulting White Paper 4 - Service incentives Final.docx	31/07/2023
Deliverability response - Table 138 Capex and Opex.xlsx	16/06/2023
Filter Bank Refurbs - Cigre WG B4.90 - Operation and maintenence of HVDC and FACTS Facilities (Draft on Filter Equipment).pdf	9/05/2023
Filter Bank Refurbs - HAY DC Structure-Gantry CA Report Final Rev01.pdf	9/05/2023
Filter Bank Refurbs - HVDC filter condition evidence.pdf	9/05/2023
General reference - Life Extension of HVDC Systems 649.pdf	9/05/2023
HVDC Camera Systems Replacement.pdf	9/05/2023
HVDC cooler groups replacements costing.pdf	9/05/2023
HVDC HMI Upgrade OEM offer.pdf	9/05/2023
HVDC Roof Bushings Life Expectancy.pdf	9/05/2023
HVDC Second Fire Water Supply.pdf	9/05/2023
HVDC subsea cable Asset Health 2023.pdf	15/06/2023
HVDC Transient Fault Recorder Upgrade quote.pdf	9/05/2023
HVDC Vacuum Diverters - Oil diverter brochure from Hitachi.pdf	9/05/2023
HVDC Vacuum Diverters - quote for Pole 2 - Confidential.pdf	9/05/2023
HVDC Vacuum Diverters - Vacuum diverter brochure from Hitachi.pdf	9/05/2023
Images.docx	21/08/2023
IV recon RT01_IC.xlsx	18/08/2023
MCS building condition.pdf	9/05/2023
Other AC Substation Equipment RCP4 breakdown.pdf	3/08/2023
Outdoor switchgear.docx	18/08/2023
Pole 2 converter transformer refurbishment programme - DBC extract.pdf	9/05/2023
Pole 2 converter transformer refurbishment programme - DBC options analysis extract.pdf	9/05/2023
Pole 2 TCUs replacement discussions with the OEM.pdf	9/05/2023
RE_ Follow up questions.msg	15/06/2023
RE_ RFI010 - Formulas in spreadsheets.msg	27/03/2023
RE_ RPC4 - HVDC cables.msg	15/06/2023
RFI 001 HVDC & Reactive.docx	17/03/2023
RFI 002 HVDC & Reactive.docx	17/03/2023
RFI 003 HVDC & Reactive.docx	17/03/2023
RFI 004 HVDC & Reactive.docx	17/03/2023
RFI 005 HVDC & Reactive.docx	17/03/2023
RFI 006 HVDC & Reactive.docx	17/03/2023
RFI 007 HVDC & Reactive.docx	17/03/2023

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RFI 008 HVDC & Reactive.docx	17/03/2023
RFI 009 HVDC & Reactive.docx	17/03/2023
RFI 011 HVDC & Reactive.docx	27/03/2023
RFI 012 Cost Estimation Framework.docx	27/03/2023
RFI 038-00 Transpower Response.pdf	20/04/2023
RFI 038-01 Deloitte TransGo Review v2.05.pdf	20/04/2023
RFI 038-02 TransGo Categorisation v3.0 (003) MASTER _for IV.xlsx	20/04/2023
RFI 038-03 ICT011 S12 TransGO Refresh APPROVED V1.0.pdf	20/04/2023
RFI 038-04 Network A1 Can Transpower leverage market servicesV1.2.pdf	20/04/2023
RFI 038-05 Question 2A Principles.pdf	20/04/2023
RFI 038-06 Question 3A Network Strategy Scope.pdf	20/04/2023
RFI 038-07 Question 3B Network Capabilities.pdf	20/04/2023
RFI 038-08 Question 4 - What network services does the network need to support.pdf	20/04/2023
RFI 038-09 Question 5A - The approach for capturing network service characteristics1.pdf	20/04/2023
RFI 038-10 Question 5B and 6 - Service Characteristics and Migration Constraints.pdf	20/04/2023
RFI 038-11 Question 9 - What are the strategic options for supporting protection signalling.pdf	20/04/2023
RFI 038-12 Question 12 - What are the strategic options for supporting substation Critical IP Services.pdf	20/04/2023
RFI 038-13 Question 13a - What are the strategic options for supporting substation Non-Critical IP Services.pdf	20/04/2023
RFI 038-14 Question 14 - What are the strategic options for supporting Core Services (Office Cloud NOC).pdf	20/04/2023
RFI 039 Transpower Response.pdf	21/04/2023
RFI Template - RFIXXX_Subject Name.docx	15/03/2023
RFI Tracking Register - RCP4.xlsx	10/03/2023
RFI010 Transpower response.pdf	24/03/2023
RFI010-01 Formulas in spreadsheets.docx	24/03/2023
RFI012 TP Response.pdf	3/04/2023
RFI012-01 WIR TEES Report A27 4Feb2019.pdf	3/04/2023
RFI012-02 WIR TEES Report A42 1Oct2019.pdf	3/04/2023
RFI012-03 CP_WKM_00L_0_00 CNI NZGP Substations - Build - Investigation Business Case (IBC) estimate.pdf	3/04/2023
RFI012-04 CP_WKM_00L_0_00 CNI NZGP Substations - Build - Delivery Business Case (DBC) estimate.pdf	3/04/2023
RFI012-05 CP_WKM_00L_0_00 CNI NZGP Substations-Build (Basis of Estimate).xlsx	3/04/2023
RFI012-06 NZGP1 MCP ATTACHMENT E - COSTING REPORT.pdf	3/04/2023
RFI012-07 NZ1-12887087-Penrose Control Building Replacement Concept Design Report (CDR) rev 2 - combined (1).pdf	3/04/2023
RFI012-08 #2 SCORED workshop agenda - PEN.pdf	3/04/2023
RFI012-09 Appendix I - SCORED Register - Penrose Control Building Replacement.pdf	3/04/2023
RFI012-10 Penrose Control Room Risk Allowance Schedule Rev1.xlsx	3/04/2023
RFI012-11 Penrose Control Room DBC Final Approved Sign.pdf	3/04/2023

Name	Created (uploaded to data room)
RFI012-12 Penrose Control Building Replacement - Installation Specification - without Appendices.pdf	3/04/2023
RFI012-13 BPR Pack Oct 2022.pdf	3/04/2023
RFI012-14 Fcst vs RCP3 Allowance cost qty analysis May21 fcst (publ Aug21).pdf	3/04/2023
RFI012-15 Delegated Authority Policy.pdf	3/04/2023
RFI012-16 BCA Policy.pdf	3/04/2023
RFI012-17 TL-Grillage 2021-22 - DBC.pdf	3/04/2023
RFI012-18 BCA Memo CP_PEN_PL_00_00 - PEN Asbestos Works (002).pdf	3/04/2023
RFI012-19 CP_WIR_76_00_00 BCA Memo - WIR ODID.pdf	3/04/2023
RFI012-20 Proportion of vargens in RCP3 and RCP4.xlsx	3/04/2023
RFI012-21 Process to add a project to the plan AMPS.pdf	3/04/2023
RFI012-22 Published Building Block Rates for RCP3 and RCP4.xlsx	3/04/2023
RFI012-23 Huntly-Otahuhu A (OTA-DRY) CP_637_006_0_00 Report Short.pdf	3/04/2023
RFI012-24 CP_HAY_00W_0_00 - HAY 110kV Rebuild Placeholder A7.pdf	3/04/2023
RFI012-25 CP_RPO_007_0_00 - RPO 220kV GIS Replacement - RC A7 TEES report.pdf	3/04/2023
RFI012-26 CP_HAY_SK_00_00 A17 - HVDC cables - Capex Build A17 TEES report .pdf	3/04/2023
RFI012-27 TEES master cost library and screenshots.pdf	3/04/2023
RFI012-28 198 - Battery Bank (Station Battery, Fuse Box, Spreader Frames, Scoping Study) - BBB17-mBAT Resource Extract.xlsm	3/04/2023
RFI012-29 246 - Tower Painted Vinyl less than 230m2 avg - LBB-TP1 Resource Extract.xlsm	3/04/2023
RFI012-30 101 - 66 50kV ES - Earth Switch - BBA4-dES Resource Extract.xlsm	3/04/2023
RFI013 Transpower Response.pdf	3/04/2023
RFI013-01 HVDC CS Cables Replacement - RFI Summary.pdf	4/04/2023
RFI013-02 General requirements for working on TP assets update 2021.pdf	3/04/2023
RFI013-03 General conditions on the contracts.pdf	3/04/2023
RFI013-04 Extract clause 19 MSGC.pdf	3/04/2023
RFI013-05 Tender response form.pdf	3/04/2023
RFI013-06 Tender evaluation areas.xlsx	3/04/2023
RFI013-07 GSCP-SUP-14883 Final Probity Audit Report - 20220510.pdf	3/04/2023
RFI013-08 Grid Delivery Project Manager Competency Supplementary Material.pdf	3/04/2023
RFI013-09 Grid Engineering Progression Pathway.pdf	3/04/2023
RFI013-10 IST Project Management Competency Framework.pdf	3/04/2023
RFI013-11 Risk Management Dashboard 20221207 IV.pdf	3/04/2023
RFI013-12 Risk Management Dashboard 20230315 IV.pdf	3/04/2023
RFI013-13 iwp-works-plan 20230222.pdf	3/04/2023
RFI014 Transpower response.pdf	3/04/2023
RFI014-01 CP_ISL_002_0_00 USI Voltage Management Prepurchase Delivery Business Case.pdf	3/04/2023
RFI014-02 CP_ISL_01K_0_00 Delivery Business Case - USI Voltage Norwood ISL Reactor.pdf	3/04/2023
RFI014-03 CP_VNN_27_00_00 220406 Delivery Business Case - UNI Reactor CAPEX.pdf	3/04/2023
RFI014-04 CP_KAW_006_0_00 Initial business case KAW Interconnector.pdf	3/04/2023
RFI014-05 CP_VTL_85_00_00 - Delivery Business Case - WRK Ring Reactor.pdf	3/04/2023

Name	Created (uploaded to data room)
RFI014-06 ATI Reactor SFE decrease memo 090323.pdf	3/04/2023
RFI014-07 OTA-WKM C Installation of VLR Investigation - IBC.pdf	3/04/2023
RFI014-08 Transpower-IPP-reconsideration-Final-decision-on-enhancement-and-development-projects-16-December-2022.pdf	3/04/2023
RFI014-09 Proposal to update MAR and SMAR for approved E&D projects.msg	3/04/2023
RFI014-10 Net Zero Grid Pathways 1 major capex proposal.pdf	3/04/2023
RFI014-11 WiTMH Monitoring Report - Sept 22.pdf	3/04/2023
RFI014-12 WiTMH Monitoring Report - Mar 22 - FINAL.pdf	3/04/2023
RFI014-13 DG 25.02 Grid Planning Technical Guidelines.pdf	3/04/2023
RFI015 Transpower response.pdf	3/04/2023
RFI015-01 Deliverable quantities for substation volumetric work.xlsx	3/04/2023
RFI015-02 AHI and Annualised Risk.pdf	3/04/2023
RFI015-03 Asset Management Plan 2018.pdf	3/04/2023
RFI015-04 RCP3 Circuit Breaker Clearance Investigation - IBC.pdf	3/04/2023
RFI015-05 RCP3 Circuit breakers Business Case - Approved.pdf	3/04/2023
RFI015-06 Outdoor Instrument Transformers RCP3 DBC.pdf	3/04/2023
RFI015-07 CP_VAR_1EA_0_00 - DS headgear refurbishment 23-24 DBC.pdf	3/04/2023
RFI015-08 CP_MDN_BW_00_00_DBC_230328_SIGNED.pdf	3/04/2023
RFI015-09 20230327 Prep - Substations - outdoor switchgear and other portfolios.pdf	3/04/2023
RFI015-10 FS 17.01 Indoor switchgear asset class strategy.pdf	3/04/2023
RFI015-11 ACS Indoor Switchgear 2022 PMP.pdf	3/04/2023
RFI015-12 FS 04.01 Power cables asset class strategy.pdf	3/04/2023
RFI015-13 ACS Power Cables 2022 PMP.pdf	3/04/2023
RFI015-14 FS 40.01 Low voltage AC systems asset class strategy.pdf	3/04/2023
RFI015-15 ACS LVAC 2022 PMP.pdf	3/04/2023
RFI015-16 FS 01.02 Structures and buswork asset class strategy.pdf	3/04/2023
RFI015-17 ACS Structures and Buswork 2022 PMP.pdf	3/04/2023
RFI015-18 FS 01.01 Outdoor 33kV Switchyards asset class strategy.pdf	3/04/2023
RFI016 Transpower Response.pdf	4/04/2023
RFI016-01 AMOG_Cook Strait Power Cable Risk Assessment_r2010.j074.001.0.pdf	4/04/2023
RFI016-02 Transpower New Zealand risk review report July 2020.pdf	4/04/2023
RFI016-03 AIR Transpower MDBI Loss Report - May 2021.pdf	4/04/2023
RFI016-04 REP - Haywards underwriting report 2021.pdf	4/04/2023
RFI017 Transpower Response.pdf	4/04/2023
RFI017-01 Cybersecurity cost build up and historical trends.xlsx	4/04/2023
RFI017-02 Software Security Enhancement- lifecycle refresh - Maintain.pdf	4/04/2023
RFI017-03 Sustain Security Control Effectiveness_SaaS Opex from FY25-26.pdf	4/04/2023
RFI017-04 Honeynet Lifecycle Refresh - Maintain.pdf	4/04/2023
RFI017-05 Identity and access management (IDAM) – Lifecycle Refresh - Maintain.pdf	4/04/2023
RFI017-06 SEP Lifecycle - Maintain.pdf	4/04/2023

Name	Created (uploaded to data room)
RFI017-07 SEP Lifecycle - Modernise.pdf	4/04/2023
RFI018 Transpower Response.pdf	4/04/2023
RFI018-01 ICT031 IC04 Transmission Systems.pdf	4/04/2023
RFI019 Transpower Response.pdf	5/04/2023
RFI019-01 PM Major Asset Table and Major Equipment.xlsx	5/04/2023
RFI019-02 Projects Major Asset Table and Major Equipment.xlsx	5/04/2023
RFI019-03 Preventive Maintenance cost and quantities.xlsx	11/05/2023
RFI019-A Transpower Response.pdf	11/05/2023
RFI020 Transpower Response.pdf	6/04/2023
RFI020-01 TL Foundations 2022 PMP.pdf	6/04/2023
RFI020-02 TL Access 2022 PMP.pdf	6/04/2023
RFI020-03 FL 01.02 Foundations asset class strategy.pdf	6/04/2023
RFI020-04 FL 04.01 Accessways and corridors asset class strategy.pdf	6/04/2023
RFI020-05 GOR-INV-A T321-T326A Conductor Condition Summary.pdf	6/04/2023
RFI020-06 GOR-INV-A (T321-T326A) ReCond & Uprate B4 TEES Estimate.pdf	6/04/2023
RFI020-07 GOR-INV A(T321-T326A) and INV-ROX-A (INV-T22) Reconductoring Capex investigation BC.pdf	6/04/2023
RFI020-08 HLY-OTA DRY-OTA and T125-DRY Conductor Condition Summary.pdf	6/04/2023
RFI020-09 HLY-OTA-A (OTA-DRY) ReCond & Uprate B4 TEES Estimate.pdf	6/04/2023
RFI020-10 Deliverable quantities for transmission lines volumetric work.xlsx	6/04/2023
RFI020-11 Asset Health and Annualised Risk.pdf	6/04/2023
RFI020-12 BPE-WGN towers to pole Delivery Business Case.pdf	6/04/2023
RFI020-13 Strategic notes for T2P deployment.pdf	6/04/2023
RFI021 Transpower Response.pdf	6/04/2023
RFI021-01 Example volumetric forecast calculations for resilience workstreams.pdf	6/04/2023
RFI021-02 5-TPSMC.00 Invercargill 33kv ISA Final 30062020.pdf	6/04/2023
RFI021-03 5-TPSMC.00 Naseby Control DSA Final 15062021.pdf	6/04/2023
RFI021-04 SolidGround brochure SG_2GNM110098_Feb 2015.pdf	6/04/2023
RFI021-05 Expenditure quantities and vulnerable and critical assets.pdf	6/04/2023
RFI021-06 Design standards and link to resilience criteria.pdf	6/04/2023
RFI022 Transpower Response.pdf	6/04/2023
RFI022-01 CP_ADD_BR_00_00-ADD Warehouse New Storage Building-DBC.pdf	6/04/2023
RFI022-02 WHI - Control Building Roof Maintenance - DBC.pdf	6/04/2023
RFI022-03 DS 53.02.pdf	6/04/2023
RFI022-04 Updated definitions for fencing standard.pdf	6/04/2023
RFI023 Transpower Response.pdf	6/04/2023
RFI023-01 ~$Northpower Ltd_v1.xlsx	6/04/2023
RFI023-02 EmailtoNorthPowerNov2021.msg	6/04/2023
RFI023-03 Northpower Ltd_v1.xlsx	6/04/2023
RFI023-04 NorthpowerResponseJan2022.msg	6/04/2023

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RFI023-05 EmailtoVectorNov2021.msg	6/04/2023
RFI023-06 Vector Ltd (North Isthmus GXPs)_v1.xlsx	6/04/2023
RFI023-07 Vector ResponseDec2022.msg	6/04/2023
RFI023-08 EmailtoPowerNetNov2021.msg	6/04/2023
RFI023-09 PowerNet_v1.xlsx	6/04/2023
RFI023-10 PowerNetresponseJan2022.msg	6/04/2023
RFI023-11 StepIncreases2017-2022Analysis.xlsx	6/04/2023
RFI023-12 230322 Demand forecasting overview.pdf	6/04/2023
RFI024 Transpower Response.pdf	11/04/2023
RFI024-01 RCP4 Consultation - Feedback Register - November 2022.xlsx	11/04/2023
RFI024-02 RCP4 Consultation Feedback Register 06_2022.xlsx	11/04/2023
RFI024-03 20221121 ERM meeting slides - Update on RCP4 consultation responses.pdf	11/04/2023
RFI024-04 Service Measures Refresh - September Update.pdf	11/04/2023
RFI024-05 Transpower_Response to ERANZ RCP4 submission_20230315.pdf	11/04/2023
RFI024-06 CAP Meeting 15 Slides (9 June 2022).pdf	11/04/2023
RFI024-07 CAP Meeting 17 - Slides - An update on RCP4.pdf	11/04/2023
RFI024-08 CAP Meeting 17 (24 November 2022) Minutes and Actions.pdf	11/04/2023
RFI025 Transpower Response.pdf	18/04/2023
RFI025-01 Escalation Support.xlsx	18/04/2023
RFI026 Transpower Response.pdf	13/04/2023
RFI027 Transpower Response.pdf	11/04/2023
RFI027-01 SP-OC-759 Outage planning policy.pdf	11/04/2023
RFI027-02 PR-OP-1020 Short Time Planning Process Procedure.pdf	11/04/2023
RFI028 Transpower Response.pdf	12/04/2023
RFI028-01 GSCP_Benefits IV-Mtnce.pdf	12/04/2023
RFI028-02 E2E Benefit tracking_IV.xlsx	12/04/2023
RFI029 Transpower Response.pdf	12/04/2023
RFI029-01 20230222 ERM meeting slides - Uncertainty Mechanisms extract.pdf	12/04/2023
RFI029-02 Warning-letter-to-Transpower-New-Zealand-Limited-12-September-2019.pdf	12/04/2023
RFI029-03 Strata-Energy-Consulting-Limited-Report-on-Transpower-New-Zealand-Limiteds-performance-for-the-2016-and-2017-disclos.pdf	12/04/2023
RFI029-04 Compliance-advice-letter-to-Transpower-New-Zealand-Limited-10-March-2022.pdf	12/04/2023
RFI029-05 Strata-Energy-Consulting-Report-on-Transpower-New-Zealand-LimitedE28099s-performance-for-the-20182C-2019-and-2020-di.pdf	12/04/2023
RFI029-06 Transpower-New-Zealand-Limited-Response-to-final-report-from-Strata-Energy-Consulting-15-December-2021.pdf	12/04/2023
RFI029-07 230331 Confidential Transpower letter to Commerce Commission (Redacted version)_Redacted.pdf	12/04/2023
RFI030 Transpower Response.pdf	14/04/2023
RFI031 Transpower Response.pdf	14/04/2023
RFI031-01 Procurement Plan - HAY SC8 Excitation 20211008 (002)-signed off.pdf	14/04/2023

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RFI032 Transpower Response.pdf	14/04/2023
RFI033 Transpower Response.pdf	14/04/2023
RFI034 Transpower Response.pdf	13/04/2023
RFI034-01 CP_WAI_62_00_00 230322 waiotahe dbc signed.pdf	13/04/2023
RFI034-02 CP_WRK_AK_00_00 220308 Wairakei T29 T30 Replacement DBC Mar2021.pdf	13/04/2023
RFI034-03 Power Tx Planning IV April 2023.pdf	13/04/2023
RFI034-04 AHI data for replacement works.xlsx	13/04/2023
RFI034-05 RCP4 Asset health with and without investment.xlsx	13/04/2023
RFI034-06 TMI Economic Assessment EDGS Scenarios.pdf	13/04/2023
RFI034-07 MLG T3 Replacement 110-33kV 100 MVA Transformer Cost Estimate.pdf	13/04/2023
RFI034-08 220 kV and 33 kV Bushings Replacement (3 Phase Bank) Cost Estimation.pdf	13/04/2023
RFI034-09 RCP3 Asset Health Incentive Sensitivity Power Transformer June 2018.xlsx	13/04/2023
RFI034-10 20230216 iwp-works-plan extract.xlsx	13/04/2023
RFI034-11 ACS Power Transformer 2018 PMP.pdf	13/04/2023
RFI034-12 AMP 2020.pdf	13/04/2023
RFI034-13 2021 Asset Management Plan.pdf	13/04/2023
RFI034-14 Haywards 110 kV Bus Investigation Need Statement.pdf	13/04/2023
RFI034-15 Haywards interruption report.pdf	13/04/2023
RFI034-16 Rangipo GIS - GMT Paper.pdf	13/04/2023
RFI034-17 GM Paper - October 2022 - Rangipo GIS SF6 leaks.pdf	13/04/2023
RFI034-18 Rangipo GIS Options Analysis - Draft V3.pdf	13/04/2023
RFI034-19 RPO Criticality.xlsx	13/04/2023
RFI035 Transpower Response.pdf	14/04/2023
RFI035-01 SS 03.72.pdf	14/04/2023
RFI036 Transpower Response.pdf	20/04/2023
RFI036-01 RCP3 FTE Actual vs. Budget.xlsm	20/04/2023
RFI037 Transpower Response.pdf	21/04/2023
RFI037-01 DCSM IaaS Opex Cloud_Cost_Scenario_Planning_Tool (version 20220506).xlsm	21/04/2023
RFI037-02 Pricing Calculator DCSM v20221125 MASTER - with 60-40 acam splits.xlsx	21/04/2023
RFI037-03 ICT Investment Classification Framework_September 2022_1.2 Final.pdf	21/04/2023
RFI039-01 Transmission System Initiative Cost Summary.xlsx	21/04/2023
RFI039-02 IC05 Energy Management Systems, SCADA and Transmission Costs Master .xlsx	21/04/2023
RFI040 Transpower Response.pdf	21/04/2023
RFI040-01 Digital Workplace Cost Breakdown.xlsm	21/04/2023
RFI040-02 EBC cost breakdowns.xlsx	21/04/2023
RFI040-03 Digital Workplace Benefits Breakdown.xlsx	21/04/2023
RFI040-04 DPSC Benefits.xlsx	21/04/2023
RFI040-05 Common Digital Workplace Portal enabling Knowledge sharing and learning.pdf	21/04/2023
RFI040-06 Innovation Sandpit fostering digital innovation and collaboration.pdf	21/04/2023
RFI040-07 Blended Workplaces enabling seamless physical and virtual collaboration.pdf	21/04/2023

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RFI040-08 Digital Workplace Governance enabling delivery of digital platform that meets business outcomes.pdf	21/04/2023
RFI040-09 Digital Workplace Resiliency providing confidence and flexibility to handle disruptions.pdf	21/04/2023
RFI040-10 Workplace Analytics to provide insights into adoption of digital ways of working.pdf	21/04/2023
RFI040-11 AR-VR training environment.pdf	21/04/2023
RFI040-12 Implement holistic customer centric views.pdf	21/04/2023
RFI040-13 Advanced digital workflows and mobility.pdf	21/04/2023
RFI040-14 Education of stakeholders through media rich digital content.pdf	21/04/2023
RFI040-15 Advanced landowner engagement capability.pdf	21/04/2023
RFI040-16 Enhance customer Operations Portal.pdf	21/04/2023
RFI040-17 Advanced environment guidance and compliance tracking.pdf	21/04/2023
RFI041 Transpower Response.pdf	9/05/2023
RFI041-01 Evidence for work plan.xlsx	9/05/2023
RFI041-02 RCP4 HVDC cost estimates.xlsx	9/05/2023
RFI041-03 HVDC Subsea Cable Asset Health Design Document 2020.pdf	9/05/2023
RFI041-04 SC Refurbishment cost per machine for IV.pdf	9/05/2023
RFI041-05 Review of Effective Short Circuit Ratio at Haywards rev01.pdf	9/05/2023
RFI042 Business support capex - Additional information.docx	28/07/2023
RFI042 Business support capex - Additional information.docx	18/08/2023
RFI042 Business support capex and IST capex.docx	19/06/2023
RFI042-01 Motor Vehicle Policy.pdf	19/06/2023
RFI042-02 Master vehicle list.xlsx	19/06/2023
RFI043 ICT reconcilation and ICT opex question.docx	18/08/2023
Total expenditure for components of predictive maintenance data.csv	22/08/2023
Preventive maintenance forecast expenditure components data.csv	22/08/2023
FW Decision Request Grid Delivery Change Proposal CONFIDENTIAL.msg	25/08/2023
Grid Development Decision Pack.pdf	25/08/2023
Increase Delivery Process FTE 12042022 (002).docx	25/08/2023
IV AMO BS FTE Dollars v2.xlsx	25/08/2023
TPM Establishment Pricing Team - FTE Request Sept 21.docx	25/08/2023

Appendix Table 7 Documents provided by yet to be loaded to ECHO library

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Maintenance PMP 2022 Rev B.pdf.pdf	27/8/2023

Appendix E

Verification techniques

E-1 Verification techniques

The following table lists the verification techniques adopted for the IV review.

Appendix Table 8 Verification areas and techniques

Verification area	Tool or technique
Base capex,[1] identified programmes and listed projects	
– Review expenditure drivers (risk mitigation, asset conditions, regulatory obligations, strategic decisions, GEIP, supplier pressure, market movement, demand growth. – Review optioning evaluation, investment deferral analysis, non-network solution exploration. – Review volumetric work/programme forecast vs. project forecast. – Review asset management system (detailed in Grid Business Strategic Asset Management Plan and Grid Business Asset Management System Framework) and supporting asset class strategies, models, processes, and investment decisions. – Review application of asset management enablers – data, technology, process, and engagement. – Review sample of projects/programs to test their prudency and efficiency, from R&R, E&D, information system and technology assets, business support. – Where appropriate, examine past capex and forecasting techniques, assumptions and inputs, and models used. Identify any changes to the approach. – Review asset renewals (R&R) forecasting techniques including models; test for sensitivity. – Review asset augmentation (E&D) forecast techniques including models; test for sensitivity. – Review actual capex delivery outcomes and its interaction/influence on grid output measures. – Review inputs and assumptions, including labour unit rate, materials, plant and equipment unit rate forecasts, their basis, their sources etc. – Review inputs and assumption like demand forecast, macro-economic and demographic forecasts, comparing with actual demand. – Review cost allocations. – Review trade-off with opex. – Review resourcing and deliverability. – Review changes or new business models, technology for information system and technology assets. – Review effectiveness of Transpower's stakeholder engagement process: what information was made available and how feedback was considered. – Use proportionate scrutiny principle as per clause 18 of the ToR.	High level governance and process reviews Desktop and model review Interviews/evidence validation Trending or time-series analysis Project and programme sampling Critiques of: – demand forecasts – labour unit cost forecasts – materials forecasts – plant forecasts – equipment unit cost forecasts GEIP benchmarking Internal benchmarking against RCP3 costs and delivery performance Project and programme sampling
Opex	
– Review expenditure drivers and any proposed step change (risk mitigation, regulatory obligations, GEIP). – Review asset management system and supporting asset class strategies, models, processes, and investment decisions. – Review application of asset management enablers – data, technology, process and engagement. – Review sample of opex programs proposed for the forecast period to test their prudency and efficiency. – Where appropriate, examine past opex and forecasting techniques, assumptions and inputs, and models used. Identify any changes to the approach. – Review actual opex delivery outcomes and its interaction/influence on grid output measures. – Review opex forecasting techniques including models; test for sensitivity.	Process or functional modelling Trending or time-series analysis Process benchmarking Project and programme sampling High level governance and process reviews Desktop and model review Interviews/evidence validation Critiques of: – demand forecasts – labour unit cost forecasts – materials forecasts

Verification area	Tool or technique
– Review routine tasks, preventive maintenance, condition assessment, corrective work etc. by asset categories. Review annual expenditure items, i.e., recurring maintenance activities (volumetric work) including both planned and unplanned works. Review unplanned work arising from equipment failures through normal operations vs non-normal operating condition events. – Use the base-step-trend method, review the basis for Rate of change (t) = Output growth (t) + Real price growth (t) - Productivity growth (t) – Review inputs and assumptions, including labour unit rate, materials, plant and equipment unit rate forecasts, their basis, their sources etc. – Review cost allocations. – Reviewing trade-off with capex. – Review resourcing and deliverability. – Use proportionate scrutiny principle as per clause 18 of the ToR.	– plant forecasts – equipment unit cost forecasts GEIP benchmarking Internal benchmarking against RCP3 costs and delivery performance
Service measures	
– Review previous/present RCP periods performance. – Review the latest annual Grid Output Report. – Understand revenue linked grid and asset performance measures, quality standards, points of service categories and sub-categories, target values, cap values, collar values, incentive rates and annual $ at risk value. – Understand changes proposed RCP4 points of service categories. – Assess method used for setting targets, caps and collars for each performance measure, and the nominated incentive rates for each measure. Assess reasonableness of proposed targets, caps and collars and propose alternative values where appropriate. – Understand and link the above to network planning and asset management practices. – Review AMP and supporting documents for how investment decision impacts grid output measures. – Understand any quality standard forecast modelling to assess the validity of the forecasts and examine how these have been incorporated into the forecast expenditure plans and proposed quality standards. – Review effectiveness of Transpower's stakeholder engagement process, exploring what information was made available and how feedback was considered and adopted. – Use proportionate scrutiny principle as per clause 18 of the ToR.	Process or functional modelling Trending or time-series analysis Process benchmarking High level governance and process reviews Desktop and model review Interviews/evidence validation Internal benchmarking against RCP3 costs and delivery performance

[1] Base capex includes R&R, E&D, information system and technology assets, business support.

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