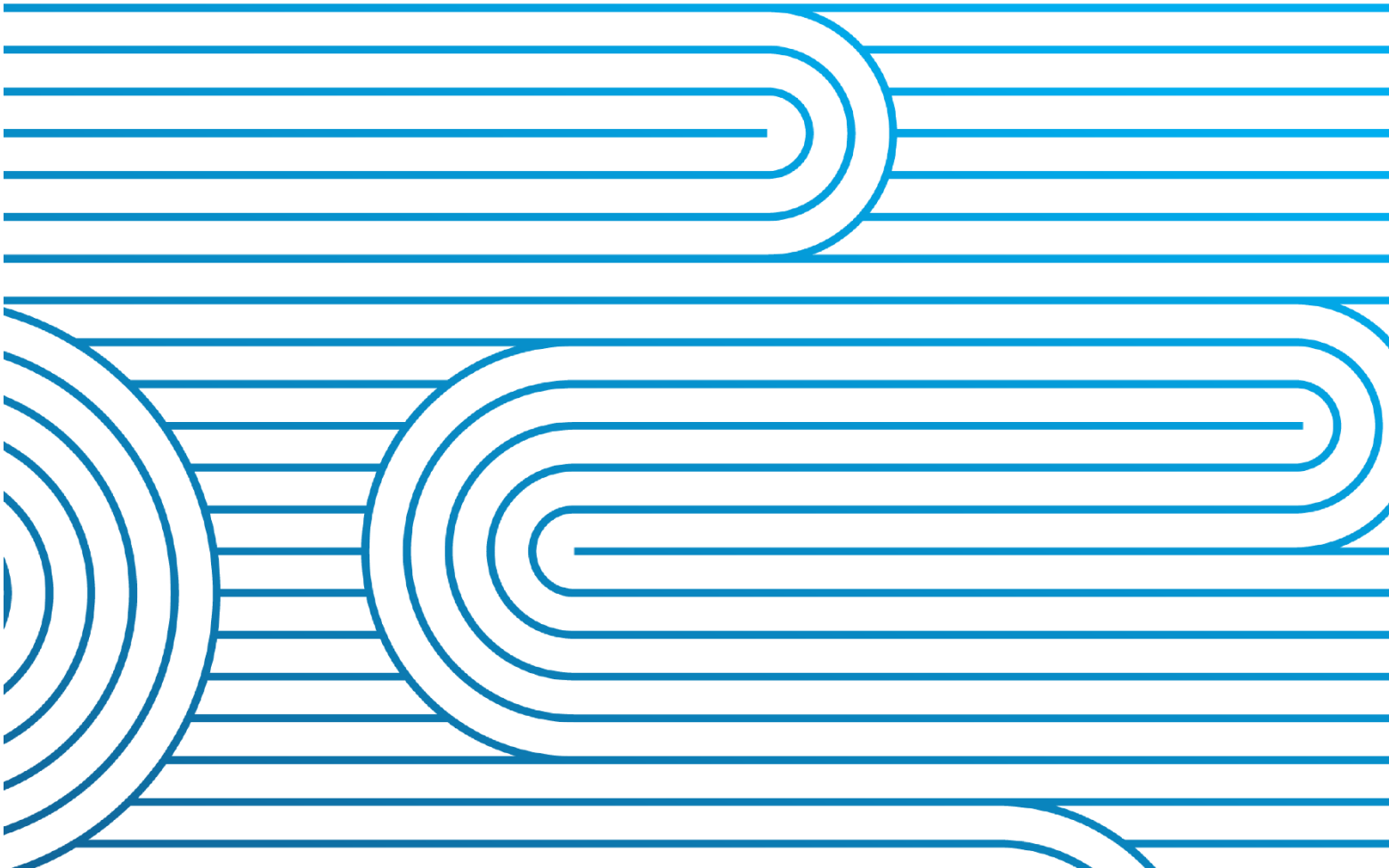
TRANSPOWER

Net Zero Grid Pathways 1

Major Capex Project (Staged) Investigation

Attachment E: Costing Report

Date: 02 December 2022



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Glossary

Capex IM	Transpower Capital Expenditure Input Methodology Determination, New Zealand Commerce Commission[1].
Code	Electricity Industry Participation Code 2010.
Connection Asset	A grid asset that connects a customer to the interconnected transmission network.
Connection Charge	The sum of the annual asset, maintenance, operating and (injection for generation customers) cost components for a connection asset over that pricing year. The charge recovers part of Transpower's AC revenue.
Exempt Major Capex	The amount of the major capex allowance (MCA) to which the major capex incentive rate does not apply.
EDGS	Electricity Demand and Generation Scenarios.
GEIP	Good electricity industry practice.
GIP	Grid injection point.
Grid Reliability Standards	The Grid Reliability Standards (GRS) are a set of standards against which the reliability performance of the existing grid (or future developments to it) can be assessed.
GXP	Grid exit point.
Interconnection Charge	Recovers the remainder of Transpower's AC revenue and is based on a customer's contribution to Regional Coincident Peak Demand (RCPD).
Investment Test	The Capex Input defines the 'Investment Test' (IT), being the detailed economic assessment required for Major Capex Projects.
Major Capex Incentive Rate	Major Capex Incentive Rate means 15% or an alternative rate specified by the Commission in respect of an approved major capex project.
MBIE	Ministry of Business, Innovation and Employment.
MCP	Major Capex Proposal, as defined by the Capex IM.
MW	Megawatt, one million watts, being the power conveyed by a current of one ampere through the difference of potential of one volt.
MWh	Megawatt hour of electrical energy.
N-1	A security standard that ensures with all facilities in service Transpower's transmission system remains in a satisfactory state following a single fault (e.g. a circuit outage).
P50	Expected peak demand forecast. P50 is the 50th percentile of the peak demand forecast probability distribution.

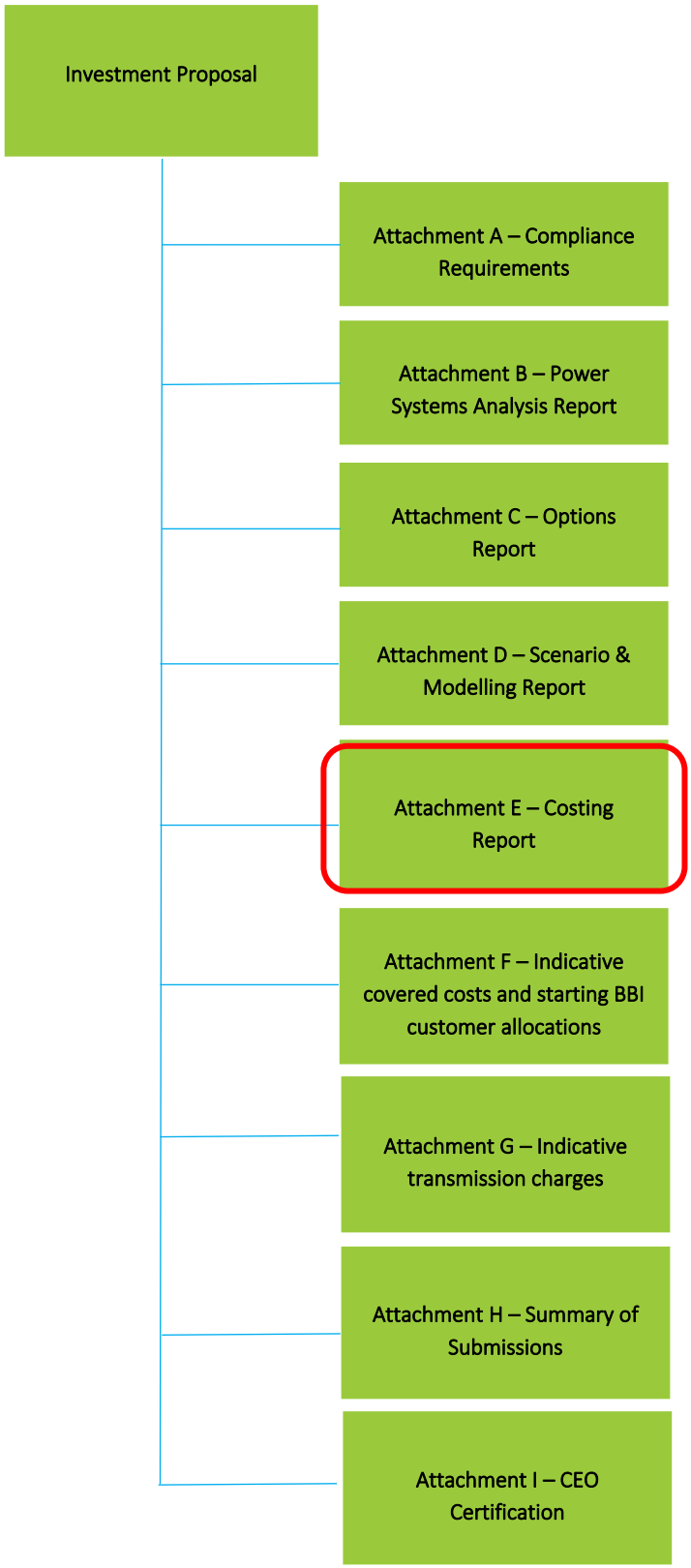
[1] See https://comcom.govt.nz/regulated-industries/input-methodologies/transpower-ims

	Also, P50 means the estimated aggregate project costs where the probability of the actual project cost being lower than that estimated is 50%
Present Value	Future costs discounted to a present value using a discount rate specified in the CapexIM.
Prudent forecast	Prudent peak demand forecast. P90 is the 90th percentile of our peak demand forecast for the first seven years, then grows at the same rate as the expected for all remaining years in the analysis period.
RFI	Request for information.
RFP	Request for proposal.
SDDP	Stochastic dual dynamic programming – a market dispatch model used to determine the optimal dispatch of hydro, thermal and other renewable generation.
SRMC	Short run marginal cost
TPM	Transmission Pricing Methodology, defined in Schedule 12.4 of the Code.
Transpower	Transpower New Zealand Limited, owner and operator of New Zealand's high-voltage electricity network (the national grid).

1.0 Introduction

This attachment provides an overview of our assessment of costs for the Net Zero Grid Pathways 1 Major Capex Proposal application.

This document explains how we have assessed the cost and revenue impact of the preferred option. It is one of the supporting attachments to our main report ('Net Zero Grid Pathways 1 Major Capex Proposal') and should be read in conjunction with our main Investment Proposal.


Investment Proposal
Attachment A – Compliance Requirements
Attachment B – Power Systems Analysis Report
Attachment C – Options Report
Attachment D – Scenario & Modelling Report
Attachment E – Costing Report
Attachment F – Indicative covered costs and starting BBI customer allocations
Attachment G – Indicative transmission charges
Attachment H – Summary of Submissions
Attachment I – CEO Certification

2.0 Proposal cost and major capex allowance

Transpower is seeking approval from the Commission to recover the full costs associated with the proposed investment (NZGP1.1).

In this section we outline our calculation of the major capex allowance and the cost for the proposed investment, covering our estimates of capital expenditure and our approach to estimating those costs.

2.1 Approach to estimating capex

We use TEES (Transpower's Enterprise Estimating System) to estimate the cost of all capex projects. TEES provides:

- instant access to the best available, up-to-date information for all users.
- the ability to apply cost escalation (commodity input prices and exchange rates).
- consistency of costing across many parts of the business.
- a costing system which is easily updated based on lessons learnt.
- high quality and detailed spend forecasting capability (spend curves which determine where spend will occur over the project duration); and
- links to and interfaces with key cost forecast information to Transpower's financial management system (FMIS).
- TEES produces cost estimates for a project based on the historical rates from past projects or known current rates.
- TEES also factors in changes in the cost of foreign exchange and key commodities such as external labour, copper, steel, and aluminium

For this project, we have used TEES to produce estimates for the volumetric and enabling works scope items (e.g. cables, foundations, excavation). TEES produces cost estimates for a project based on the historical rates from past projects or known current rates as well as information from consultants and/or potential vendors (e.g. RFPs, concept design and solution study exercises).

We have then added costs to this base estimate, including:

- Environmental, Legal, Property and Stakeholder costs
- a risk adjustment – to account for cost uncertainty not represented in our lower and upper bound estimates.

Our estimated capex and proposed major capex allowance represent P50 estimates – i.e. the probability of the actual cost being higher or lower than our estimate is the same (i.e. 50%).

To derive P50 estimates for all capex categories other than the risk adjustment, we have estimated for each cost category a lower bound, an upper bound and a most likely (or mode) outcome and assumed that all possible capex outcomes would follow a triangular distribution.

To derive a P50 estimate for the risk adjustment, we have assigned probabilities of occurrence to each identified risk item and then treat each item as having an independent binomial distribution. For each risk item the P50 estimate is determined as the product of the risk and the probability. The sum of all the risk item P50s is our P50 risk adjustment estimate.

We note that our estimated project cost is expressed in 2022 dollars (it is 'real 2022'). To derive a nominal major capex allowance, we have added to it inflation cost and interest during construction (IDC).

The MCA is higher than the costs in earlier sections because it includes interest during construction, investigation costs, and inflation.

2.2 Capex breakdown

In Table 1 we describe the high-level cost categories used in this NZGP1.1 application.

Table 1: Cost category descriptions

Investigation	Investigation costs are costs related to the identification of our preferred solution and the development of this MCP proposal. This also includes consenting and designation costs.
Transmission lines Construction works	This includes material costs such as conductors, earth wires, towers poles and foundations, insulators, and hardware. This cost category captures all other major construction costs such as stringing costs (the labour and associated tools and machinery hire)
Civil works	Civil works are the costs to build foundations and other associated costs required for the Primary Plant to be installed and commissioned. The costs also include associated civil costs for this project such as oil containment, security fencing, earthworks, underground services, and drainage.
Overheads Consultants and contractors	Overhead costs are the Transpower staff and contractor overhead related costs to deliver this project, and some contractor overheads such as insurance, project management, health and safety plans.
Design	Design costs are the costs for detailed design and the technical investigations and studies required to implement the preferred solution. This category includes consultant support (e.g. environmental, noise) and commissioning consultants.

Primary plant works	Primary plant works are the costs of transformer supply and installation as well as associated equipment such as circuit breakers and bus modifications.
Cable works	Cable works are the costs of supplying and installing underground cable including the required trenching of the cable.
Protection works	Protection works are the costs to supply and install protection schemes related to this project.
Secondary works	Secondary works include the design, install and commissioning of SCADA and communication devices.
Miscellaneous works	Miscellaneous works include associated project costs not covered elsewhere including environmental costs and stakeholder engagement.
Overheads **Consultants and contractors**	Overhead costs are the Transpower staff and contractor overhead related costs to deliver this project, and some contractor overheads such as insurance, project management, health and safety plans.
Freight	Freight costs to deliver physical assets to site.
Legal	Required legal costs
Property	Costs associated with land purchase and easements.
Environmental costs	Costs of meeting environmental obligations.
Community Care Fund	Transpower's CommunityCare Fund assists communities affected by Transpower's overhead lines and substations by investing in their local projects.
Stakeholder costs	Costs associated with meeting stakeholder expectations.
Additional risk adjustment	In addition to our lower and upper bound estimates, we have itemised all foreseeable risks that may affect the cost of the project.

2.3 NZGP1.1 Capex estimate

Our estimated capex for this (NZGP1.1) MCP is presented in Table 2.

Table 2: NZGP1.1 Major capex proposal capex estimate (P50 cost excl. IDC and inflation) ($000's)[2]

	Central North Island					Wairakei Ring				HVDC		NZGP1.1
	Lines - BPE-TKU-A&B TTU	Lines - TKU-WKM TTU	Lines - TKU-WKM-AB Duplexing NZ	Subs - BPE-TKU-WKM 1&2 Uprating	CNI Supporting Projects	Lines - WRK-WKM-C TTU	Lines - EDG-KAW-3 TTU	Subs - WRK-THI-WKM 1&1 Uprating	Subs - EDG-KAW Uprating	Subs - HVDC Capacity Stage 1	Prepared-ness Projects	
Investigation	-	-	-	-	-	70	-	-	-	-	-	**70**
Civil Works	-	-	-	-	-	-	-	-	-	10,019	-	**10,019**
Primary Plant 220 kV - Statcom	-	-	-	-	-	-	-	-	-	36,379	-	**36,379**
Primary Plant 220 kV - other	-	-	-	10,140	-	-	-	5,124	191	8,984	-	**24,440**
Cables	-	-	-	-	-	-	-	-	-	369	-	**369**
Protection	-	-	-	-	-	-	-	-	-	764	-	**764**
SCADA	-	-	-	63	-	-	-	58	-	317	-	**438**
Secondary Equipment	-	-	-	-	-	-	-	-	-	4,186	-	**4,186**
Communications	-	-	-	-	-	-	-	-	-	103	-	**103**

[2] Further detail including excel spreadsheets, TEES cost outputs and solution study reports behind the figures in this document will be provided to the Commerce Commission separately due to the commercially sensitive nature of some information.

Miscellaneous works	-	-	-	-	-	-	-	-	-	277	-	**277**
Switching	-	-	-	-	-	-	-	-	-	65	-	**65**
Construction Work	45,374	17,392	55,778	-	-	1,024	5,381	-	-	-	-	**124,949**
Transpower overheads	5,452	1,608	6,160	747	-	443	1,064	570	36	3,493	-	**19,574**
Consultant support	-	-	-	-	-	-	-	-	-	1,221	-	**1,221**
Contractor overheads	8,738	3,145	14,763	2,273	-	440	1,410	1,103	67	5,353	-	**37,292**
Freight	-	46	562	-	-	20	-	-	-	178	-	**805**
Design	-	1,006	3,000	-	-	132	-	570	60	3,534	-	**8,302**
Legal	155	-	300	-	-	-	-	-	-	26	-	**481**
Property	826	677	3,800	-	-	-	-	-	-	-	-	**5,303**
Environmental costs	507	697	500	80	-	343	200	-	-	147	-	**2,474**
Community Care Fund	295	70	379	67	-	10	131	-	-	213	-	**1,165**
Stakeholder costs	369	1,152	390	225	-	159	159	-	-	-	-	**2,455**
Uncategorised	-	-	-	-	3,500	-	-	-	-	-	10,200	**13,700**
Capex - sub-total (Stage I)	61,717	25,792	85,632	13,594	3,500	2,642	8,345	7,425	354	75,628	10,200	**294,829**
Additional Risk adjustment	6,430	2,179	8,751	3,913	-	235	1,320	294	96	8,735	-	**31,954**
Capex - total risk adjusted (Stage I)	68,147	27,971	94,383	17,507	3,500	2,878	9,665	7,719	450	84,363	10,200	**326,783**

2.4 Cost estimate of potential MCP Stage 2

Our estimated P50 costs for the anticipated projects for NZGP1.2 are presented in Table 3.

We are not seeking approval for NZGP1.2 in this proposal.

Table 3: Estimate of future NZGP1.2 MCP capex estimate (P50 cost excl. IDC and inflation)

	Likely Stage 2 MCP (NZGP1.2)	
	Project	**$m**
HVDC	New Cook Strait cable	120
CNI	Reconductor BRK-SFD A line	75
Wairakei Ring	New WRK-WKM line	100

2.5 Major capex allowance

A summary of our NZGP1.1 major capex allowance calculation, including financing costs, and inflation is shown in Table 4 with an annual break down.

We consider this amount to be our P50 estimate of the costs of the NZGP1.1 project – that there is equal chance that the project could be delivered for more or could be delivered for less. As with any project, and consistent with the incentive regime, we will attempt to deliver this project as efficiently as possible. We propose this major capex project will use the default major capex incentive rate of 15%.

This proposed NZGP1.1 investment does not include any non-transmission solutions.

Table 4 Derivation of NZGP1.1 Major Capex Allowance and annual allocation ($000's)[3]

Major Capex Allowance, $000, P50	2022	2023	2024	2025	2026	2027	2028	2029	Total
Capex - total risk adjusted (real 2022)	4,768	31,734	65,204	86,915	77,350	49,014	11,798	-	326,783
Inflation	71	1,466	5,877	10,387	11,831	8,533	2,297	-	40,463
Capex - total risk adjusted (nominal)	4,839	33,200	71,081	97,302	89,182	57,547	14,095	-	367,246
Interest during construction (IDC)	22	501	1,181	3,046	9,649	8,683	2,708	-	25,789
Major Capex Allowance	4,861	33,700	72,262	100,348	98,830	66,230	16,803	-	393,035

2.6 Our proposal and outputs

Table 5 NZGP1.1 at a glance

NZGP1.1 at a glance

What:

Enable efficient dispatch of new generation and a reliable supply for future demand growth over the interconnected grid through investing in:

HVDC investment

Purpose: To increase HVDC transfer capacity north from 1070 MW to 1200 MW

- Implement new +/-60 MVAr continuous/120 MVAr overload STATCOM, +49MVAr filter bank, bus extension and associated equipment.

Central North Island (CNI) investments

Purpose: To increase transfer capacity north from Bunnythorpe by between 60% and 90%[4]:

- Implement Variable Line Rating and tactical thermal upgrade (TTU) of both 220 kV circuits on the Tokaanu-Whakamaru A and B lines to 95°C
- Duplex the 220 kV Tokaanu-Whakamaru A&B circuits with Goat conductor to operate at a maximum temperature of 120°C
- Implement VLR and TTU of the 220 kV Bunnythorpe-Tokaanu A and B circuits to 95°C
- Split the 110 kV Bunnythorpe-Ongarue A circuit at Ongarue
- Upgrade protection on the 220 kV Huntly – Stratford 1 circuit on the Huntly-Taumaranui A line and Stratford-Taumaranui A line, between Huntly and Stratford

[3] Further detail including Excel spreadsheets, TEES cost outputs and solution study reports behind the figures in this document will be provided to the Commerce Commission separately due to the commercially sensitive nature of some information.

	• Replace the special protection scheme at Tokaanu *Purpose: Preparatory work for NZGP1.2 CNI investment:* • Investigate options for reconductoring either 220 kV Brunswick-Stratford line *Purpose: Preparatory work for possible later stage CNI investment:* • Prepare designs to duplex the 220kV Bunnythorpe-Tokaanu A and B circuits • Prepare designs to TTU the 220kV Bunnythorpe-Wairakei A circuits • Investigate options, routes and progress design for a new 220 kV line north of Bunnythorpe • Develop a methodology for quantifying resilience benefits ***HVDC/CNI investments*** *Purpose: Preparatory work for possible later stage CNI investment:* • Investigate lower North Island (**LNI**) voltage stability • Investigate LNI system stability • Investigate diversifying the Bunnythorpe substation ***Wairakei investments*** *Purpose: To increase Wairakei Ring transmission capacity by 25% (300 MW) under typical operating conditions:* • TTU the 220 kV Wairakei-Whakamaru C circuits to 100°C • TTU of the 220 kV Edgecumbe-Kawerau 3 circuit on the OHK-EDG A and KAW-DEV A lines between Edgecumbe and Kawerau to 90°C *Purpose: Preparatory work for NZGP1.2 Wairakei Ring investment:* • Investigate options, routes and progress designs for a new or enhanced Wairakei-Whakamaru line
When:	Commence work as soon as funding is approved. Commissioning date assumption: 30 June 2028.
How much:	Major capex allowance: $393.0 million.
Incentive elements	Major capex incentive rate: 15% Exempt major capex: none
Approval expiry date:	31 December 2030[5]

[5] For NZGP1.1, we propose the approval expiry date to be 31 December 2030 - being two years after the latest expected commissioning date of the NZGP1.1 components.

Table 6 Estimated P50 and MCA costs of NZGP ($m)

Staged project	Purpose	Abbreviated grid outputs	P50	MCA	Estimated commissioning
HVDC	Stage 1	Implement reactive plant, filter banks and associated equipment to uprate HVDC	84.4	103.1	2027
			84.4	103.1	
CNI	Stage 1	Implement VLR and TTU 220 kV Tokaanu-Whakamaru A&B circuits	45.5	50.8	2024
CNI	Stage 1	Implement duplex conductors on 220 kV Tokaanu-Whakamaru A&B circuits	94.4	119.4	2028
CNI	Stage 1	Implement VLR and TTU 220 kV Bunnythorpe-Tokaanu A&B circuits	68.1	83.2	2027
CNI	Supports Stage 1	Implement split on 110 kV Bunnythorpe-Ongarue A line at Ongarue	0.5	0.5	2026
CNI	Supports Stage 1	Implement upgraded on 220 kV Huntly-Stratford 1 circuit	2.0	2.0	2026
CNI	Supports Stage 1	Replace Special Protection Scheme at Tokaanu	1.0	1.0	2026
			211.5	256.9	
CNI	Prepare for Stage 2	Investigate options for reconductoring either 220kV Brunswick-Stratford line	2.0	2.0	2025
			2.0	2.0	
CNI	Possible Stage 3	Prepare detailed design to duplex 220kV Bunnythorpe-Tokaanu A&B circuits	1.5	1.5	2025
CNI	Possible Stage 3	Prepare detailed design to TTU 220kV Bunnythorpe-Wairakei A circuits	0.5	0.5	2025
CNI	Possible Stage 3	Investigate options, routes, progress design new 220 kV line north of Bunnythorpe	3.0	3.0	2026
CNI	Possible Stage 3	Develop a methodology for quantifying resilience benefits	0.3	0.3	2026
			5.3	5.3	
			218.8	264.2	
Wairakei	Stage 1	Implement TTU on 220 kV Wairakei-Whakamaru C circuits	10.6	11.8	2024
Wairakei	Supports Stage 1	Implement TTU on 220 kV Edgecumbe-Kawerau 3 circuit	10.1	11.0	2024
			20.7	22.8	
Wairakei	Prepare for Stage 2	Investigate options, routes, design new/replaced Wairakei- Whakamaru line	2.0	2.0	2026
			2.0	2.0	
			22.7	24.8	
HVDC/CNI	Possible Stage 3	Undertake investigation into lower North Island voltage stability	0.3	0.3	2026
HVDC/CNI	Possible Stage 3	Undertake investigation into lower North Island system stability	0.3	0.3	2026
HVDC/CNI	Possible Stage 3	Investigate potential benefits and cost of diversifying Bunnythorpe substation	0.3	0.3	2026
			0.9	0.9	
Total			326.8	393.0	

3.0 Project requirements and project management approach to achieve proposed major capex project outputs

The requirements to complete the installation of equipment for the HVDC works at Haywards substation and to connect it to the transmission system are outlined at a high level as follows. The site is owned by Transpower hence there is no property acquisition is required.

- Detailed design
- Regional Council resource consents (if required)
- Civil works for the platform construction
- Structural works including equipment support structures and foundations
- Electrical site works
- Supply and installation of the STATCOM unit, and associated equipment
- Supply and installation of protection relays, auxiliary relays, cabinets/panels and circuits as well as underground cables and transformers as required,
- Station services
- Communication and HMI works
- A realignment of the 220kV Otahuhu-Huntly A transmission line involving the installation of a new transmission tower and several poles to enable a bus connection.

The requirements to complete the installation of equipment for the Stage 1 substations work at Tokaanu, Whakamaru, Edgecumbe and Kawerau is as follows:

- Detailed design
- Regional council consents (if required)
- Civil site works for platform modification or construction
- Electrical site works
- Supply and installation of primary equipment including disconnectors, outdoor junction boxes, current transformers and circuit breakers

- Supply and installation of secondary equipment including protection relays, cabinets and associated communications equipment as required
- Modification of station buswork and gantries
- Equipment testing and commissioning

The requirements to complete the lines upgrades of the Bunnythorpe to Tokaanu, Tokaanu to Whakamaru, Wairakei to Whakamaru and Edgecumbe to Kawerau circuits are outlined as follows:

- Detailed design
- Regional council consents (as required)
- Environmental and sustainability impact assessments
- Landowner agreements
- Access track construction (as required)
- Tower foundation strengthening
- Tower raising and strengthening
- Installation of new conductor (for duplexing projects)
- Reconfiguration of conductor tensions
- Modification and replacement of supplementary tower hardware including insulators

The requirements to complete the preparatory works for the Stage 1.2 projects are outlined as follows:

- Scope the investigation works necessary
- Tender the works according to Transpower's procurement policies
- Award the works
- Receive and review the outcome, being in part SSR reports

The proposed major capex project components will be implemented and managed using Transpower's standard project delivery procedures including governance oversight, planning, scheduling, contract management, cost management, risk management, technical review and performance reporting. Transpower has appropriate processes in place and will deploy suitably experienced management and technical resources to monitor cost performance against budget, project milestones against required dates and scope and quality of deliverables with the objective of delivering the projects to budget, on time and to the required quality standards.

Factors that may affect Transpower's ability to achieve the major capex project outputs that are proposed include:

- *Failure to secure required consents for the project.* This is largely outside Transpower's control. Transpower has significant experience in council and RMA applications.

- *Unforeseen changes to electricity market operations limiting our ability to secure the required system outages.* This is largely outside Transpower's control, but we consider it highly unlikely to impact on this project as we plan and forecast outage requirements to the market in advance.
- *Major disruptions to global supply chains impacting our ability to secure internationally sourced materials.* This is largely outside of Transpower's control but can be partially mitigated by ensuring long lead-time items are ordered sufficiently far in advance to not impact delivery timelines.

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