Quality Measures
Non-compliance Report

Transpower New Zealand Limited's performance for the 2016 and 2017 disclosure years

Stage 1 Report
for
The Commerce Commission

FINAL STAGE 1 REPORT
12th August 2019

Preface

Strata Energy Consulting Limited specialises in providing services relating to the energy industry and energy utilisation. The Company, which was established in 2003, provides advice to clients through its own resources and through a network of associate organisations. Strata Energy Consulting has completed work on a wide range of topics for clients in the energy sector in both New Zealand and overseas.
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Executive Summary

The Commerce Commission asked Strata Energy Consulting (Strata) to provide its expert opinion and advice in relation to Transpower's quality measure performance below collar for the 2016 and 2017 disclosure years in the form of a Quality Performance Report.

The Commission required Strata to focus its review on those measures where Transpower's performance was outside the cap and collar boundaries.

Transpower indicated that in its Compliance Statements for the assessment periods 2017 and 2018, its performance had fallen below the collars in:

(a) grid performance measures;
(b) asset performance measures; and
(c) asset health grid output measures.

Establishing the validity of Transpower's reasons for the below collar performance in the two assessment periods is the primary focus of Strata's investigation.

Strata submitted to the Commission its initial findings in a Draft Stage 1 Report on the 8th November 2018. An objective of the Stage 1 Report was to inform the Commission on potential areas of interest for additional investigation to be completed in Stage 2. Following the provision of our Draft Stage 1 report in November 2019, the Commission did not advise Strata of any further detailed review of the issues identified in the report.

In February 2020, Transpower supplied the Commission with a report that it had commissioned from GHD/Synergies to provide a peer review of Strata Energy Consulting's (Strata's) Draft Stage 1 Report. Whilst the Commission had decided that it did not require further detailed review of the issues identified by Strata, in its review, GHD/Synergies considered additional information to that provided to Strata by Transpower. Also, GHD/Synergies, to some extent, undertook components of the Stage 2 scope through its further examination of issues identified by Strata in its Draft Stage 1 Report.

The Commission asked Strata to provide comments on the GHD/Synergies Report and review the initial findings in its Draft Stage 1 Report.

This report sets out Strata's initial findings
:

- contained in its Draft Stage 1 Report);
- views, issues and additional information provided by GHD/Synergies in its report to Transpower, and
- Strata's revised and final findings and opinions.

This report is Strata's Final Stage 1 Report to the Commission.

Strata's final findings from its Stage 1 investigation are:

On above collar performance against Grid Performance Measures, Strata's opinion is that:

1. Transpower's explanation for the events and the manner in which it managed outage duration has not raised any concerns nor identified areas where Transpower acted inconsistently with GIP.
2. Transpower's explanations for the outside collar performance were not given within the context of historical performance, and it did not identify and explain adverse effect of significant one-off periodic events in 2015/16 and 2016/17.
3. Transpower should have undertaken continuous monitoring and analysis to determine if its level of performance was changing; failing to do so was a departure from GIP for an electricity Transmission operator.

Strata's opinion is that, in not undertaking such analysis prior to this review, Transpower did not act consistently with GIP.

We understand that Transpower has yet to present its analysis and findings on the significant events identified by GHD/Synergies. Nor has it provided an explanation as to why Transpower did not undertake this analysis prior to the Commission's non-compliance review. We consider that Transpower should provide this information immediately to the Commission for its review.

On below collar performance against Asset Performance Measures we found that:

1. Given that the quality measures for RCP2 were classed as 'prototype', in our view, it would be unreasonable to conclude that Transpower acted inconsistently with GIP when proposing them.
2. For the unplanned outages, we found that Transpower undertook detailed post event reviews that included identification of opportunities to reduce future impacts from similar factors and causes. We also identified that Transpower has implemented the improvement initiatives that it identified. In our opinion, this is consistent with GIP.
3. For planned outages, our review has found that Transpower undertakes detailed planning that includes risk based prioritisation of work on the 27 selected circuits. We have not identified concerns that Transpower's work planning and prioritisation is not aligned with GIP.
4. Transpower could have improved the process though which it developed its proposed availability target and collar. We note that Transpower is proposing changes in this process for RCP3 but evaluation of this is outside the scope of this review.

On above collar performance against Asset Health Measures, Strata's opinions are:

1. The long term strategic actions that Transpower took in response to its identification of increasing costs and the resulting budget blow-out included:
   a) monitoring of regulatory compliance performance through the CGT structure. This provided an early escalation pathway for the issues to be resolved and the governance framework through which actions taken could be monitored;
   b) the CGT's initiation of the Portfolio Savings Initiative that implemented 6 actions resulting in a revised foundations strategy and grillage replacement forecast;
   c) engagement of an independent expert (BECA) to study the options Transpower had developed internally and assess the ongoing risks of the revised strategic approach; and
   d) continuing focus on further options to improve its approach to grillage management through the use of a cathodic protection solution.

We consider that, in taking these actions, Transpower responded appropriately to the increasing costs of its grillage replacements an refurbishments and acted consistently with GIP.

2. In our opinion, applying RCP2 grillage R&R expenditure forecasts based on the unit cost of easy access, less complex grillage works, is not good forecasting practice as it was bound to be exceeded and does not meet a GIP benchmark.
3. A risk assessment should have been clearly documented, reported to the CGT, and approved by the CGT at the time grillage volumes were initially reduced below the collar to ensure that safety and reliability risks were not outside its tolerance level; because of this, our opinion is that Transpower did not meet the GIP criteria when making its deferral decision.
4. Transpower's omission to advise the Commission of the potential overestimation of insulator replacement requirements prior to the final establishment of the targets, caps and collars indicates that it did not follow GIP in regard to disclosure of information to a regulator.
5. Whilst we do not consider that Transpower's insulator replacement strategy is inappropriate and not at GIP, the lack of analysis and supporting documentation concerning reduced insulator replacements indicate that Transpower has not met GIP when it made significant changes to its operational practices.

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This Stage 1 Report presents our findings

1. The Commerce Commission asked Strata Energy Consulting (Strata) to provide its expert opinion and advice in relation to Transpower's quality measure performance below collar for the 2016 and 2017 disclosure years in the form of a Quality Performance Report.
2. Strata must ensure that it obtains the necessary information to prepare the Quality Performance Report, including:
    (a) holding discussions with relevant Transpower staff; and
    (b) reviewing relevant information and documentation held by Transpower.
3. The Quality Performance Report must be prepared in a way that provides credible and reliable evidence of the matters it is required to consider.

What Strata has been asked to do

4. Strata must provide its opinions on:
    1. whether or not, having regard to the relevant failure events and triggers, Transpower acted consistently with Good Industry Practice in relation to each of the measures;
    2. whether Transpower's actions were inconsistent with Good Industry Practice and the identification of instances where, by not taking an action, Transpower was inconsistent with Good Industry Practice;
    3. the appropriateness of the actions Transpower has undertaken to prevent or mitigate similar events in the future, and an assessment of the likely efficacy of those actions;
    4. whether any of Strata's findings indicate there is any cause for concern about:
        (a) Transpower's asset management practices;
        (b) Transpower's knowledge of the conditions of its assets; and
        (c) Transpower's practices on prioritising works;
    5. the validity of impact reviews undertaken by Transpower (if any) of each instance of the quality measure performance outside the collar on persons directly or indirectly acquiring or consuming electricity lines services and on the broader electricity market; and
    6. any recommendations on further action that Transpower could and should undertake to prevent or mitigate similar events in the future.
5. Strata was also asked to consider (together with any other factors it considers relevant):
    (a) Transpower's understanding of its asset condition and the quality of its asset condition data;
    (b) trends in factors that have contributed to the interruption of supply (like human error, equipment failure, etc.);
    (c) changes in Transpower's operational strategy since it proposed the quality standards and grid output measures in December 2013;

(d) the impact of Transpower's operational strategy and approach to managing its performance against the quality standards (the target and the collar) on its performance outside the collar;

(e) the likely impact of Transpower's performance outside the collar on persons directly or indirectly acquiring or consuming electricity lines services and on the broader electricity market;

(f) whether Transpower's performance outside the collar was inadvertent or intentional.

Strata's Initial Stage 1 report was submitted to the Commission to the Commission on the 8th November 2018

6. The Commission asked Strata to produce a Stage 1 Report based on the initial analysis and findings drawing from information provided by Transpower. An objective of the Stage 1 Report was to inform the Commission on potential areas of interest for additional investigation. Strata's finding from its initial investigation together, with any additional investigations required by the Commission, was to be provided in a Stage 2 report.

7. Following the provision of our Draft Stage 1 report in November 2019, the Commission did not advise Strata any further detailed review of the issues identified in the report.

Transpower engaged GHD/Synergies to respond to Strata's stage 1 report

8. In February 2020 Transpower supplied the Commission with a report[1] that it had commissioned from GHD/Synergies to provide a peer review of Strata Energy Consulting's (Strata's) Stage 1 Draft Report on the circumstances of Transpower's failure to comply with several of its quality standards in 2015/16 and 2016/17.

9. Whilst the Commission had decided that it did not require further detailed review of the issues identified by Strata, in providing a rebuttal of Strata's negative comments, GHD/Synergies has to some extent undertaken components of the Stage 2 scope through its further examination of these issues. Because GHD/Synergies has reviewed the issues identified by Strata for Stage 2, Transpower has essentially reopened the components of Stage 2 to more detailed scrutiny than the Commission had originally considered to be necessary.

10. Whilst GHD/Synergies undertook the assignment as an advisor to Transpower, and the potential for bias towards its client must be kept in mind, the additional review work could provide further insights and additional information. GHD/Synergies may have had greater access to Transpower's resources and information and this could provide additional context and explanation for the Commission regarding Transpower's non-compliance.

The Commission asked Strata to consider GHD/Synergies report

11. The Commission asked Strata to consider the GHD/Synergies views as this may provide additional insights into Transpower's performance relevant to its non-compliance.

12. Strata's Initial Stage 1 findings together with its consideration of the additional information contained in the GHD/Synergies report, are provided in this Final Stage 1 report.

[1] Response to Strata Report on Transpower's Service Quality Performance_Revised Final_050219

Strata's consideration of GHD/Synergies views

13. In this section of our Stage 1 report we provide a summary of GHD/Synergies views on Strata's Draft Stage 1 report, and our consideration of those views.

14. In later sections of this report covering areas covered in Strata's investigation, we record our consideration of GHD/Synergies views relevant to the specific subject matter.

GHD/Synergies provided a summary of its findings

15. In its executive summary GHD/Synergies concluded that its views align with those of Strata in its Stage 1 Draft Report in many areas, particularly in Transpower's responses to failure events. GHD/Synergies did not provide discussion on the areas of agreement.

16. GHD/Synergies highlighted the following themes where it considered it held divergent views to those presented by Strata in its Stage 1 Draft Report:

Availability and use of evidence

> *We also have concerns that Strata's initial findings do not always have regard to available evidence. This includes regarding Transpower's historical outage performance, information which we understand was available but not requested by Strata, and which led Strata to find that Transpower's actions were not consistent with GEIP regarding its grid performance.*

Interpretation and application of the Commission's Good Industry Practice criteria

> *several areas where our findings diverge with Strata and which appear to reflect different interpretations of what actions are required to satisfy the GEIP concept, including the extent to which wholesale electricity market prices are relevant to post-event outage reviews.*

Effects of the efficiency incentive framework to Transpower's non-compliance

> *a common underlying theme arising through Strata's initial findings is the operation of the Commission's RCP2 service and expenditure efficiency incentive framework and the strong effect this has had on the reported instances of non-compliance in 2015/16 and 2016/17 across the grid and asset performance and asset heath measures. We consider the relative newness and evolving nature of this incentive framework has contributed materially to Transpower's reported service quality non-compliance.*

17. Strata has considered these points and provides its response to GHD/Synergies' divergent general theme below.

Availability and use of evidence

18. GHD/Synergies has not taken into account the 'initial views' status of Strata's report and because of this, its criticisms are inappropriate

19. In its report, GHD/Synergies confirmed that it had been provided with the scope set by the Commission for Strata's review. Part of the scope has been reproduced by GHD/Synergies in its report. The Commission's scope for Strata's review clearly stated that Strata's final report would be in the form of a *Quality Performance Report*.

GHD/Synergies appears not to have understood that the report which it reviewed is a draft initial finding report and not the Quality Performance Report. Strata's report title clearly states that it is a 'Draft Stage 1 Report and the heading of the first section states: *this Stage 1 Report presents our initial findings*.

20. As set out in the Description of Services the Commission required Strata to undertake, the review had to be completed in two stages.

The Services will be supplied over two stages to include a review point.

a) Stage 1 will include initial review and identification of key issues. The Supplier will present its initial findings to the Commission at the end of Stage 1 of the review.

b) The detailed scope of Stage 2 of the review will be discussed and agreed upon following the interim report presentation by the Supplier.

21. The purpose of the Stage 1 initial views report was to identify key issues for the Commission's consideration prior to it asking Strata to embark on a detailed review of these issues. The largest component of the budgeted resource for the review was allocated to Stage 2.

22. The Commission set out the scope for Strata's review including the proposed structure and timeframes at the commencement (review kick-off) meeting[2] with Transpower in April 2018.

23. In several places in its report GHD/Synergies correctly refer to Strata's report as the Stage 1 Draft Report, and yet it appears that it did not question the relevance of the 'Stage 1' title or why the report title was not Quality Performance Report. There is no acknowledgement of the Stage 1 status of Strata's report in GHD/Synergies' report. It is possible that Transpower did not highlight the Stage 1 status of the Strata report to GHD/Synergies before it embarked on its peer review.

24. Strata agreed with the Commission that its views for Stage 1 would be formed on the basis of information provided in response to an initial set of information requests. Transpower provided this information through a series of papers, meetings and background documents. Importantly, Strata relied on Transpower's explanation of the reasons for non-compliance. Where Transpower's explanation and information was insufficient to satisfy the GIP and other criteria set by the Commission, Strata identified this as a potential issue for further consideration in Stage 2.

25. Because GHD/Synergies has not taken the status of Strata's report into consideration, the basis of its review and criticisms of Strata's approach, analysis and findings are inappropriate.

26. In several places, GHD/Synergies comments negatively on its perception that Strata has failed to source information or undertaken sufficient analysis; for example:

> *Strata's criticism of Transpower's conduct relates primarily to the latter's lack of analysis of the outage events in an historical performance context. It is not clear to us that this criticism is causally related to Transpower's non-compliance with its quality standards.*[3]

27. As discussed earlier, the purpose of the Stage 1 was not to undertake detailed analysis but rather to identify potential areas for detailed analysis. At the commencement of the review, the Commission agreed that Strata would form its initial views on the basis of information provided by Transpower.

[2] Review Initiation Meeting, 5 April 2018, item 3 on the agenda was; *the scope of Strata Energy Consulting's (Strata) review, approach and structure of its report*
[3] GHD/Synergies, page 5

28. In April 2018, Strata produced an information request that was given to Transpower. This request included 32 items. Transpower provided information to the Commission via its web portal. It is this information that Strata relied on to form its initial views. Over six months, Transpower provided its response to Strata's information request. Several meetings were held where Transpower discussed progress on sourcing information and on the development of its explanations for the non-compliance.

29. In taking this approach, Transpower was given an opportunity to present its analysis of the reasons for non-compliance and how it had managed these events. The Commission did not require Strata to further its research and source data and information beyond that provided in Transpower's request; this was the basis for forming Strata's opinions at a Stage 1 Review level.

30. Taking the above GHD/Synergies' comment as an example, Strata's information request included an outage/interruptions data set and asset failure data. Transpower provided this data from 2015 to 2017 only. Strata also requested reports and papers on any analysis Transpower had undertaken on triggers and causes of interruptions. In response, Transpower provided a 114 page paper on N-site interruptions. This paper was comprehensive and Strata considered that post event reviews Transpower had undertaken were at GIP. However, Transpower did not provide any data, papers and analysis on pre-event interruptions and outages.

31. The absence of this information caused Strata to highlight a possible issue for the Commission to consider in Stage 2 of the review. As noted earlier in this paper, GHD/Synergies undertook the analysis of historical data and found:

> *potential worsening of grid performance in these two years warrants examination, which we understand Transpower has undertaken and will present to the Commission.*[4]

32. We do not consider that Strata undertook insufficient analysis or examination of evidence to meet the Stage 1 requirements. In addition, we think that GHD/Synergies' analysis and findings confirm that Strata's initial view that there may be an issue for Transpower to explain, was valid.

33. Strata understands that Transpower has yet to present to the Commission the results of the examination indicated by GHD Synergies.

Interpretation and application of the Commission's Good Industry Practice criteria

34. The first topic GHD/Synergies discusses in its ES and in the second section of its peer review report is the criteria it used when considering Good Electricity Industry Practice (GEIP).

> *In undertaking our peer review, we have had regard to the concept of good electricity industry practice (GEIP) as specified in the Electricity Industry Participation Code (the Code) and by the Commerce Commission (the Commission), as well as under Australia's national electricity regulatory framework, which we consider are all consistent.*[5]

35. In the scope for Strata's review, the Commission provided the following Good Industry Practice criteria against which Transpower actions were to be assessed:

> *In considering whether Transpower acted in accordance with Good Industry Practice, the opinion should consider whether in relation to any undertaking*

[4] GHD/Synergies, page 5 of 109
[5] GHD/Synergies, page 3 of 109

and any circumstances, Transpower exercised that degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected from a skilled and experienced operator engaged in the same type of undertaking under the same or similar circumstances.

36. In making this statement, GHD/Synergies appears to have relied on GEIP criteria other than that set by the Commission for Strata's review. Whilst discussion on differences in good practice definitions both in New Zealand and internationally has some merit, the task set by Transpower for GHD/Synergies was to review Strata's work in meeting its scope which was to consider Transpower's actions against GIP criteria set by the Commission.

37. Whilst most GEIP definitions are similar to those in Strata's scope, in its report[6] GHD/Synergies goes further and introduces, for example, comments made by the Commission in previous discussion papers as its basis for assessing GEIP.

38. In our opinion, a peer review of Strata's reports should be undertaken against the set scope including the very specific direction given by the Commission for the consideration of GIP. GHD/Synergies has effectively defined its own view of what the scope criteria should have been; in our view, this is an inappropriate approach to take in a peer review.

How GHD/Synergies assessed GEIP

39. In Section 2 (Good Electricity Industry Practice), GHD/Synergies explains that it has established a baseline for GEIP and how this applies to outage and asset management on the basis of:

    e) the Commission's comments made in previous discussion papers;

    f) the GEIP definition in the Electricity Industry Participation Code (the Code);

    g) Australia's national electricity regulatory framework definition of GEIP;

    h) Australian Energy Regulator (AER) identified the key components of GEIP; and

    i) legal obligations in relation to outage management under the Code and its associated Outage Protocol.

40. In addition to the above, GHD/Synergies states that it considers that best practice in outage management requires a full integration of systems (five examples are provided). GHD/Synergies does not provide details of any standards or guidelines used to consider and assess whether integration has been achieved at GEIP.

How Strata assessed Transpower's performance against the Commission's GIP criteria

41. Consistent with previous reviews undertaken for the Commission, when considering GIP, Strata has referred primarily to the GIP criteria set out in the Commission's scope for the review. In this application, Strata referred to a range of guiding documents including:

    - the utilities own GIP criteria (i.e. what the utility under review considers to be GIP);
    - the GIP criteria applied to and used by operators engaged in the same types of undertaking;
    - standards generally applied to and used by utilities (e.g. ISO 31000 Risk Management; ISO 55000 Asset Management, ISO 21500 Project Management);

[6] GHD/Synergies, section 2.1, page 19

- guidelines and manuals (e.g. EEA papers, International Infrastructure Management Manual (IIMM);
- standard utility policies and procedures; and
- experience of other utility practices.

42. Our understanding of the baseline described by GHD/Synergies is that it draws from a range of GEIP definitions and comments, and from Transpower's own procedures (e.g. set out in its Outage Protocol and in its application of systems integration).

43. GHD/Synergies did not question nor assess if there was any relevance in the Commission's use of GIP vs GEIP. Strata's understanding is that the Commission's use of GIP allows consideration of practices across other similar businesses to Transpower, for example, in other critical infrastructure businesses. In Strata's opinion, for non-compliance reviews that consider asset management practices and network performance management, the broader GIP criteria is appropriate.

44. In contrast to GHD/Synergies' interpretation and application of GEIP, Strata applied the Commission's GIP criteria as its baseline and in doing this, considered international and New Zealand industry standards and practices to determine what would reasonably and ordinarily be expected from a skilled and experienced operator engaged in the same type of undertaking under the same or similar circumstances to Transpower.

The differences in interpretations of GIP could be relevant

45. GHD/Synergies state its view that:

> *Based on our peer review, we have not identified any of Transpower's actions regarding the occurrence of outage events and/or triggers in 2015/16 and 2016/17 that, in our view, are inconsistent with GEIP. Nor do we have any related material concerns about Transpower's associated outage management, asset management practices, or works planning and prioritisation.*

46. GHD/Synergies goes on to say that:

> *In reaching this view, we are not suggesting that Transpower's failure to comply with several of its grid and asset performance quality standards was totally beyond its control, or that lessons have not been learned regarding these outage events. This includes taking steps to prevent or mitigate the impact of similar outage events in future. Rather, we consider Transpower acted in accordance with GEIP, while recognising the need for improvements in the future if certain outage circumstances are repeated.*

47. In the above paragraph, GHD/Synergies appears to be saying that whilst the breach events were to some extent within Transpower's control, and actions could have been taken to mitigate the impact of the events, because Transpower has recognised this post-event, it has acted consistently with GIEP. Whist this may be the case it certainly cannot be taken that it implies that failure to take the actions previously was GIEP/GIP.

48. Strata's Stage 1 report identified seven areas where it considered Transpower's performance may have fallen short of GIP. GHD/Synergies' views on each of these areas are addressed in the relevant sections of the report where we reconsider our initial conclusions. We have taken these views plus any additional information into consideration in developing our revised conclusions and advice for the Commission.

Effects of the efficiency incentive framework on Transpower's non-compliance

49. GHD/Synergies describes one of its *key findings* as:

> *a common underlying theme arising through Strata's initial findings is the operation of the Commission's RCP2 service and expenditure efficiency incentive framework and the strong effect this has had on the reported instances of non-compliance in 2015/16 and 2016/17 across the grid and asset performance and asset heath measures.*[7]

50. Whilst it identifies the above in its discussion on 'key findings', GHD/Synergies does not include the issue in the summary table of its key findings.

51. As Strata did not mention or discuss any issues relating to the efficiency incentive framework in its Stage 1 Draft Report, we have reviewed each section of the GHD/Synergies report where the efficiency incentive scheme is mentioned in an attempt to identify and understand the point that GHD/Synergies is making.

52. The first discussion on the efficiency incentive framework concerns the scheme itself rather than any issues that Strata raised in its report:

> *Further, we consider the use of works delivery targets as service performance measures creates tension with the expenditure efficiency incentives also applying under the Commission's RCP2 regulatory framework, which are designed to encourage efficient investment and operational actions by Transpower, which may include reducing asset replacement/refurbishment work volumes to reduce costs, subject to appropriate risk management. That is, such targets should not drive dysfunctional behaviour.*[8]

53. The above comment relates to GHD/Synergies' view that there is an inherent problem in using works delivery quality measures in a service performance incentive mechanism. Strata did not make comment of this issue in its report as it wasn't relevant to the scope of its review (i.e. the Commission did not ask Strata to consider and provide an opinion on the operation of the incentive scheme).

54. GHD/Synergies' second discussion point is:

> *Given Transpower's appraisal of the overall risk for the grillage fleet was Low and their understanding of grillage degradation meant that a deferral of work would represent no material increase in the risk (refer clause 258), we consider the CGT decision to constrain expenditure whilst a solution was found to be in line with GEIP. This is because of no prospect of material risk to the network and Transpower's actions were consistent with optimising expenditure without compromising service levels, as opposed to re-allocating refurbishment capital from other programmes to sponsor a likely over-run in costs for this programme of work. These actions were also consistent with the expenditure efficiency incentives applying in RCP2.*[9]

55. We discuss the specific grillage risk and substitution issues later in this report. Our understanding is that the point GHD/Synergies' makes is that Transpower's actions

[7] GHD/Synergies, Key Findings, page 3
[8] GHD/Synergies, page 64
[9] GHD/Synergies, page 69

were consistent with the expenditure efficiency incentives. However, Strata did not make any comment on this issue in its Stage 1 Draft Report.

56. GHD/Synergies' third and final discussion on the expenditure incentive scheme relates to its view that Transpower's revised asset strategy for CoG works is *in line with GEIP in asset management and the expenditure efficiency incentives applying to Transpower in RCP2*[10]. Strata did not comment on this issue in its Stage 1 Report; the issue we identified related to reduced grillage expenditure occurring before the revised asset strategy was introduced.

57. GHD/Synergies does not identify any comments by Strata that could be considered to be a *common underlying theme.* GHD/Synergies' actual issue appears to be its views on the expenditure efficiency scheme and its opinion that Transpower acted consistently with the incentives provided to it.

58. Interestingly, GHD/Synergies has formed the following conclusion:

> *We consider the relative newness and evolving nature of this incentive framework has contributed materially to Transpower's reported service quality non-compliance.*[11]

59. GHD/Synergies is clearly laying the blame for Transpower's non-compliance on the immaturity of the efficiency incentive framework. This is a bold conclusion and very much at odds with Strata's findings on the reasons for non-compliance.

60. Unfortunately, the peer review report contains no further discussion on how GHD/Synergies reached this conclusion and the evidence it used to form this view. Strata's position is that Transpower's non-compliance in both Grid Performance Measures and Asset Availability Measures was due to planned and unplanned outages.

61. If GHD/Synergies considers that the efficiency incentive scheme has contributed materially to Transpower's failure to comply in the above areas, it is important for the Commission to understand the basis on which this view has been formed (i.e. how did the efficiency incentive scheme framework impact affect the major outages such as the transformer trip at Ohakune or the planned outages for the Twizel bus zone project?).

62. If GHD/Synergies meant its comment to apply only to Asset Health Grid Output Measures, then again, how the immaturity of the efficiency incentive scheme made a material contribution to the grillage and insulator deferment should be clearly set out.

63. We consider that GHD/Synergies' conclusion on the materiality of the immaturity of the efficiency incentive scheme to Transpower's service quality non-compliance is a potential issue. GHD/Synergies' comment implies that Transpower is balancing quality measure compliance with its efficiency incentives, and that this is a material contribution towards its non-compliance. Understanding how Transpower is responding to the incentives could provide valuable input into the Commission's revenue determinations.

[10] GHD/Synergies, page 69
[11] GHD/Synergies, Key Findings, page 3

Transpower's performance against the Quality Standards

64. The Commission required us to focus our review on those measures where Transpower's performance was worse than the collar (i.e. outside the cap and collar boundaries). The Commission provided the following table to indicate the focus areas for the review.

Table 1: Transpower's performance against quality standards for 2016 and 2017

Category	Quality Measure		2016	2017
Grid performance measures	Number of unplanned interruptions for generator sites	GP1		✓
	Average duration of interruptions for Important sites	GP2		✓
	Average duration of interruptions for N-security sites	GP2	✓	✓
	Long term (P90) duration of interruptions for Important sites	GP3		✓
	Long term (P90) duration of interruptions for N-security sites	GP3	✓	✓
Asset performance measures	HVAC availability – Selected circuits	AP2	✓	✓
Asset health grid output measures	Number of grillage foundations refurbished	AH2	✓	✓
	Number of insulators replaced	AH3	✓	✓

Sources: Commerce Commission

65. Accordingly, the focus areas for the review are:

(a) grid performance measures;

(b) asset performance measures; and

(c) asset health grid output measures.

66. Strata's initial findings for each of the above areas are provided in the following sections. The findings include those set out in our Stage 1 Draft Report, together with our review of those findings taking into consideration GHD/Synergies Peer Review.

Assessment of above collar performance against Grid Performance Measures

67. Three measures for grid performance were applied:
    1. number of unplanned interruptions each year;
    2. average duration of unplanned interruptions each year; and
    3. 90th percentile duration of unplanned interruptions in minutes each year.

68. To reflect the variability in customer expectations on supply reliability performance. For setting targets, caps and collars, and for reporting, Transpower categorised customer sites as high-priority important, standard, generator or 'N-security.

69. Grid performance measure targets were set on a forward-looking basis reflecting the expected performance capability of the relevant assets.

Table 2: Categories where Transpower exceeded its grid performance collars

Number of unplanned interruptions for generator sites				
	Target	Cap	Collar	Actual
2016 - 17	11	6	16	20

Average duration (minutes) of unplanned interruptions for important sites				
	Target	Cap	Collar	Actual
2016 - 17	100	30	170	210

Average duration (minutes) of unplanned interruptions for N-security sites				
	Target	Cap	Collar	Actual
2015 - 16	80	45	115	167
2016 - 17	80	45	115	616

Duration (minutes) of P90 unplanned interruptions for important sites				
	Target	Cap	Collar	Actual
2016 - 17	240	170	310	482

Duration (minutes) of P90 unplanned interruptions for N-security sites				
	Target	Cap	Collar	Actual
2015 - 16	215	170	260	341
2016 - 17	215	170	260	1056

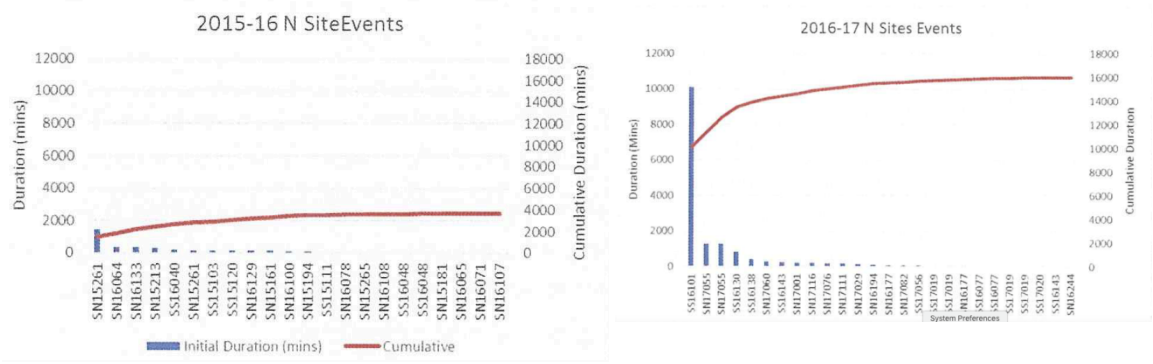
Sources: Transpower Compliance Reports 2015-16 and 2016-17

70. Transpower's performance, including our assessment of the relevant failure events and triggers, is assessed in the following subsections. Because the explanation assessment of average duration of planned interruptions for N-security sites and the duration of P90 unplanned interruptions for N-security sites covers most of the interruptions in the other three measures, we discuss these measures first.

Average duration of unplanned interruptions for N-security sites and duration of P90 unplanned interruptions

71. In both 2015-16 and 2016-17 unplanned interruptions for N-security sites was dominated by single events; however the scale of the significant event in 2016-17 is a major factor in the performance for that year. Figures 1 and 2 show the differences in the interruption event profiles between the two years.

Figure 1: N-security interruption events contributing to the overall performance

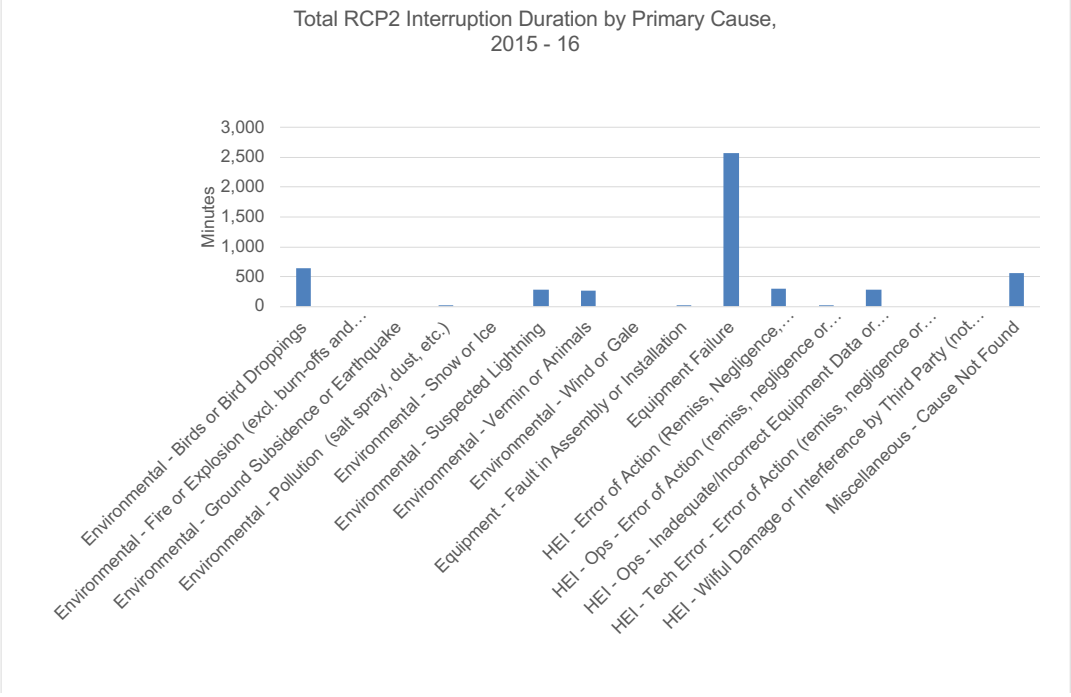


Source: Transpower N-Security_Interruptions_15-16.xlsx.

72. The 2015-16 year had one significant event, that if it had not occurred would have resulted in the average duration being below the cap.

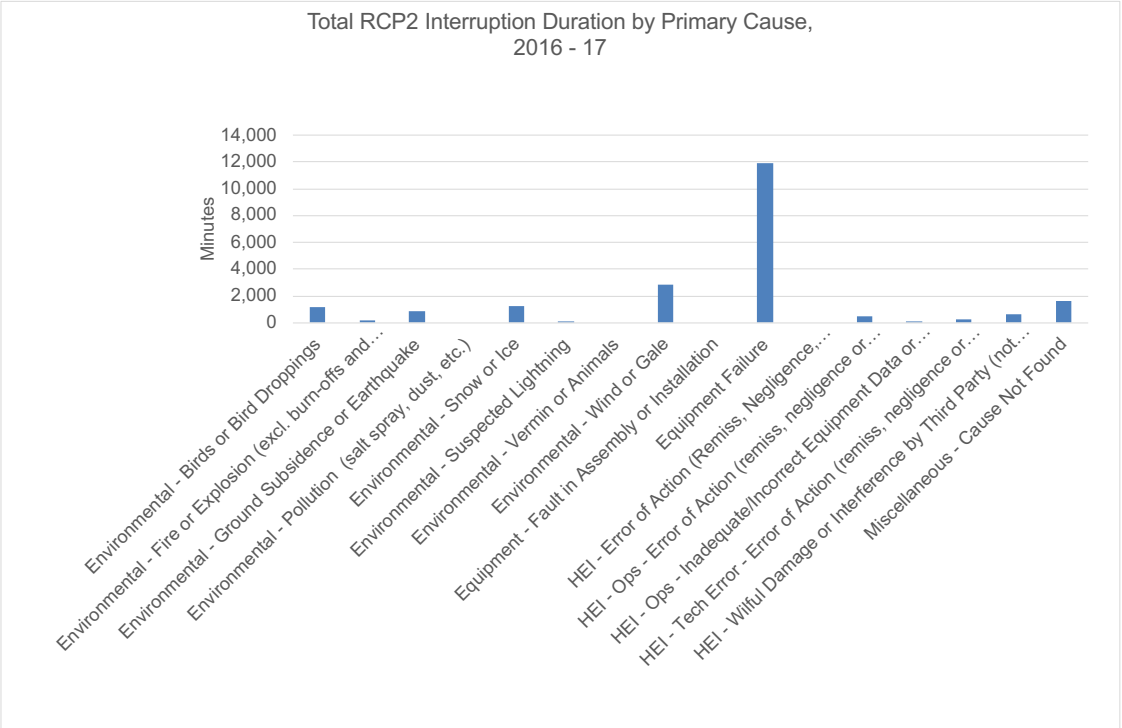
73. The 2016-17 year has 5 significant events, that if they had not occurred would have resulted in the average duration under the cap.

Figure 2: Primary causes of interruptions in 2015-16



Source: Transpower N-Security_Interruptions_15-16.xlsx.

Figure 3: Primary causes of interruptions in 2016-17



Source: Transpower N-Security_Interruptions_15-16.xlsx.

74. The cause of interruptions in both years is primarily due to equipment failure with other consistent contributors being environmental causes.

2015-16 N Site Average Duration (minutes) of unplanned interruption & Duration (minutes) of P90 unplanned interruptions

75. In 2015-16 a single event due to a transformer trip at Ohakune recorded an outage duration of 1456 mins for the Powerco connection plus 141 mins for The Lines Company connection.

76. The transformer was new and had been commissioned in May 2015; approximately six months later the trip occurred on the 11 December 2015. Transpower's post incident response identified that butterfly valves at either side of the Bucholz had been left closed after commissioning. The consequence of this error was that the transformer was tripped on main tank over pressure.

77. Transpower undertook a formal post event review which had oversight from its National Event Review Group (NERG)[12]. The post event review resulted in changes being made to transformer post commissioning procedures.

> *The Operational Engineering report recommended that 1) checking and documenting the in service status of all valves must be made a priority following commissioning and during the maintenance of transformers, 2) Thermovision should be carried out on new transformers after livening to ensure the transformer valves are in the correct service position and 3) the*

[12] The NERG serves as a centralized Problem Management function ensuring visibility of significant incidents (including near misses) and underlying root cause, driving identification and application of corrective, preventive & continual improvement actions at a national and company-wide level.

LV cable connector plugs should be considered for testing following installation / re-installation.[13]

78. Transpower provided information setting out actions that had been taken to reduce the duration and impact of the incident.

- *The Lines company were able to back feed via Tangiwai, which reduced their Loss of Supply. They managed load initially by controlling water heating. If the event had been in peak of the ski season, they would not have been able to back feed all load.*
- *Transpower advised Powerco to source generators, and these were installed on TP site inside the security fence and were in service on the Saturday morning. Constraints within the Powerco network meant it was late Saturday before all Customers had power returned.*
- *Plans were developed to move the Mobile substation from Bunnythorpe to Ohakune in case the transformer failed its tests. Service Provider staff were put on standby on Friday night to move the mobile substation. The mobile sub needs transport permits, and the substation was expected to be on the road by midday Monday 14th May if needed.*
- *Planning commenced to move the system spare to Ohakune from Bunnythorpe, in case the transformer was extensively damaged.*[14]

79. Each action list point has been addressed and completed.

80. Two recommendations from the post event review led to significant further workstreams.

1. *The NERG noted in the actions the need for some form of coordinated incident management to address issues raised in the post event review with Powerco. This need was also identified as part of the final report of the Transpower & Vector Penrose cable fire investigation that had just been released prior to the Ohakune incident in September 2015. This recommended that Transpower review incident response capability for suitability to embed within a multi-agency emergency management response structure.*

   Transpower determined that the Coordinated Incident Management System (CIMS) approach was best fit for Transpower and this was implemented as a direct outcome of issues observed at both events. A summary of CIMS and its use in Transpower is provided in Section 5.3.

2. *The potential lack of clarity, that was identified post incident with Customers, on the level of service at the site, the extent of possible outages under a variety of failures, and the contingency plans for the site led to a full review for Ohakune, but also the commencement of a review of all N sites.*

The second largest incident was also an unplanned interruption of a generation site

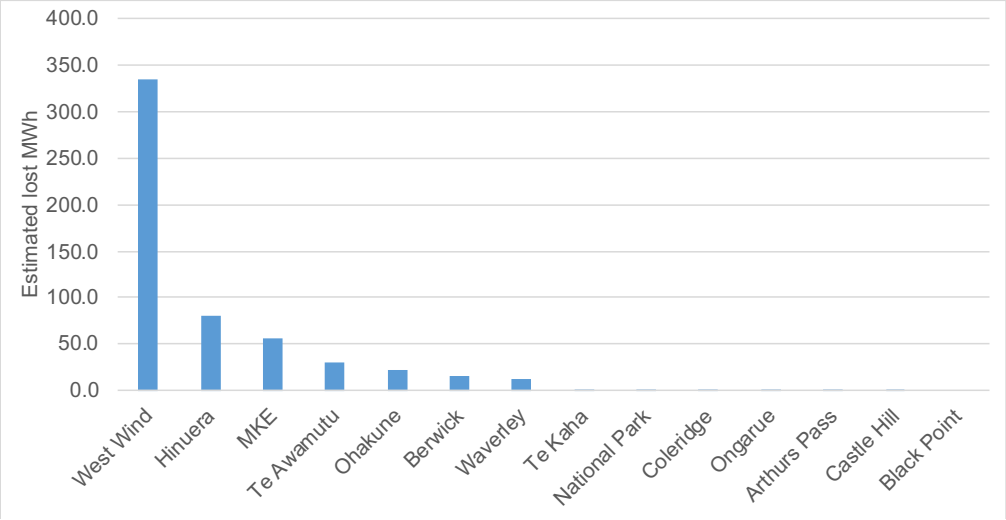
81. The next largest event in 2015-16 was due to a failing gearbox on an overload tap changer (OLTC) on Transpower's Central Park T3 transformer. This event recorded an

[13] Transpower System Fault and Interruption Report SFIR Ref: SN15261 Event No 88361
[14] Transpower, InterruptionsDraftV1, section 5

outage duration of 357 minutes. This event caused a partial interruption of Meridian Energy's West Wind generation facility for 357 minutes[15].

82. Whilst the T3 interruption was much smaller in duration than the Ohakune transformer failure its impact on lost energy (MWh) was strikingly more significant (see Figure 4).

Figure 4: Energy lost due to N-security site interruptions in 2015-16



Source: Transpower N-Security_Interruptions_15-16.xlsx.

83. Whilst the incident was recorded as an unplanned, it was a planned response to a potentially failing component. A large current imbalance on T3 and a high circulating current through the transformer neutral were identified by Transpower's service provider during a substation monthly inspection of relays. Transpower's Regional Control Centre was notified and, in co-ordination with Meridian Energy, it took action to rectify the faulty OLTC gearbox. This action included the need for the interruption of West Wind's connection at T3.

Our assessment of the relevant failure events and triggers in 2015-16

84. The two major events described above were outstanding factors in Transpower's failure to keep within its Grid Performance Measures in 2015-16. In the absence of these events, Transpower would have performed within its cap and collar.

85. Both incidents were the result of equipment failure; the first being due to a commissioning error and the second due to Transpower addressing an identified transformer fault.

86. We found that Transpower's post event reviews had been at an appropriate level and were consistent with GIP. The management of the events had led to the duration of interruptions being minimised. Whilst the reviews identified areas where improvements could be made to avoid similar events in the future, there is scope for improvement by adding a review of past inspection and maintenance to identify if the faults could have been avoided or identified earlier.

87. We consider that Transpower's explanations for the below cap performance in 2015-16 has been appropriately explained and we do not have concerns regarding Transpower's management of the relevant assets or the events.

[15] Meridian's West Wind T1 supply transformer, also connected to Central Park and West Wind - Wilton circuit 2, remained in service during the Central Park T3 incident.

88. We do consider that the potential cost of interruptions is important to highlight. Figure 4 presents the estimated energy lost due to N-security interruptions by cause. It is possible, using wholesale market price differences for forgone generation and Value of Lost Load (VoLL) for supply lost to consumers, to establish a cost of interruptions. In our view, this would be valuable information to present alongside the current measures.

2016-17 N Site Average Duration (minutes) of unplanned interruption & Duration (minutes) of P90 unplanned interruptions

89. During the 2016-17 year, 3 events contributed 12,617 minutes

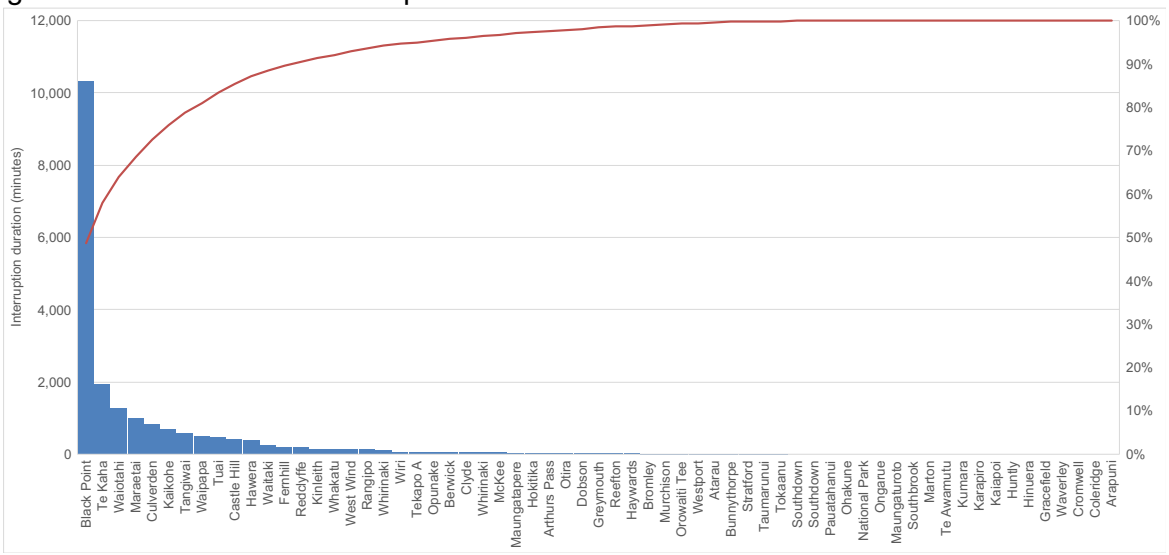
(a) Waitaki T24 Bushing - Black Point Interruption (SFIR SS 16101) — 10,080 minutes

(b) Edgecumbe - Waiotahi cross arm (SFIR SN17055) — 1269 + 1268 minutes

(c) Culverden Ti Trip — Kaikoura Earthquake (SFIR 16130) —843 minutes

90. Figure 5 shows the contribution curve for the connection points that experienced interruptions during 2016-17. The impact of the Black Point event and others can clearly be seen.

Figure 5: Contributions to interruptions in 2016-17



Source: Strata analysis of Transpower RCP2_Interruptions_Period 15-17 wo AUFLS and Capping.xlsx

Note One of the large Edgecumbe - Waiotahi interruptions is identified at the Te Kaha connection point in the interruptions data.

91. The significant 7 day interruption event on the Waitaki T24 transformer on 25 August 2016. Given the significance of this event, a summary of the information provided by Transpower is given below.

92. A maintenance contractor advised Transpower that Waitaki T24 should be removed from service immediately due to a noise, "like an arc welder", being heard coming from the main tank. The transformer was immediately removed from service and on-site tests were undertaken to determine the cause of the noise. The tests were inconclusive, and due to the perceived risk of catastrophic failure, a decision was made to replace the transformer with the spare unit.

93. Transpower identified options to provide capacity to return elements of supply to N-1 during the transformer replacement and a number of switching operations were undertaken to minimise risk and provide security in the event of subsequent failures.

94. Due to difficulties experienced in switching the transformers, the interruption duration extended to nine days.

95. At the time of this event, Transpower was in the process of reviewing options for improving contingency plans for N-security sites through use of bowtie risk methods to identify and review existing controls to identified event causes. Options developed for Waitaki through the post event evaluation were presented to Network Waitaki. The options assessment identified that closing the bus split at Oamaru was a practical solution to improve service during maintenance. However, the customer decided that further capital investment to manage the consequences of this rare event was not warranted.

96. The Edgecumbe - Waiotahi cross arm failure incident caused two interruptions that were triggered by the same cause. The total duration due to both interruptions was 2,537 minutes. The fault was attributed by Transpower to a plantation tree falling onto overhead lines during Cyclone Cook. This caused the cross arm to bend. Due to the weather conditions it took Transpower eleven hours to mobilise a line crew and locate the fault and a further ten hours to source, transport and install a cross arm and new insulators before the fault could be repaired and the line returned to service.[16]

97. The third largest event occurred as a result of the Culverden earthquake when shaking caused an aseismic Bucholz relay to trip. Transpower had knowledge that the aseismic relays may still trip in such conditions and had evaluated that the risk of a rare trip event during an earthquake was sufficiently low compared with the operational benefits of an in service Bucholz.

98. We reviewed information that Transpower provided on two additional contributing interruption events at Castle Hill (disconnector failure duration 435 minutes and Te Kaha - Waiotahi (trip duration 276 minutes). In both cases, the information (SFIR SS16138 and SFIR SN17060) described the types of failure incidents that would normally be expected to occur on transmission networks. In other words, what would be expected to be manageable within the collar.

Our initial assessment of whether Transpower acted consistently with GIP

99. Our initial review of Transpower's explanation for the events and the manner in which it managed outage duration has not raised any concerns nor identified areas where Transpower acted inconsistently with GIP.

100. Our primary concern is that explanations for the outside collar performance are not given within the context of historical performance. As a result, we have no means of establishing if performance is deteriorating over time and what the reasons for this might be.

101. Based on discussions with Transpower, it seems that the average duration of interruptions rather than number of interruptions has been increasing. If this is the case, analysis of the underlying causes will be valuable in understanding how the situation can be managed.

102. Our initial view is that in not undertaking such analysis prior to this review, Transpower did not act consistently with GIP.

[16] Transpower InterruptionsDraftV1, section 6.2

103. The unavailability of historical data has impeded our understanding of historical trends and if exceedance of collars was due to unusual years.

Our views of the validity of Transpower's impact reviews

104. Transpower has not provided information on any specific impact reviews that it has undertaken. It has provided information on the post event technical/engineering reviews that it undertook and, whilst these are good engineering reports, they contain only basic information and analysis on the impact of the interruptions on consumers.

105. For example, it is possible to estimate the cost of interruptions on consumers using Transpower's estimated lost MWh for each interruption and multiplying this to obtain the VoLL. For its generator customers, Transpower could estimate the cost of an interruption as the lost revenue at the wholesale price. In addition, Transpower could estimate the impact of the interruption on the wholesale electricity market by calculating the differences in wholesale market prices due to the loss of the lower priced energy.

106. The exposure of the cost of interruptions would provide valuable information to Transpower's customers on options for improving security and reliability.

Strata's initial views on above collar performance against Grid Performance Measures were summarised in two points

107. Strata's initial views were that:

(a) explanations for the outside collar performance are not given within the context of historical performance - as a result, we had no means of establishing if performance is deteriorating over time and what the reasons for this might be; and

(b) in not undertaking such analysis prior to this review, Transpower did not act consistently with GIP.

Consideration of relevant GHD/Synergies' points on above collar performance against Grid Performance Measures

Our understanding of GHD/Synergies' point is that Strata's initial view is incorrect because Strata could have researched and found historical performance data:

> *appears to be a "strawman" argument as both historical performance data and post-event review information is available, if requested, to allow a full analysis of the reasons for the outage events to be made.*[17]

108. In our opinion, GHD/Synergies has misinterpreted Strata's point which was, to meet GIP, Transpower should have undertaken analysis of its historical performance to determine if trends or other issues were highlighted. Undertaking such analysis for our initial views report was outside our scope for stage 1.

109. GHD/Synergies' report confirms our concern that Transpower had not previously undertaken sufficient performance analysis (i.e. because GHD/Synergies had to do the analysis as part of its peer review of Strata's report). In doing so, GHD/Synergies found the adverse effect of significant one-off periodic events in 2015/16 and 2016/17[18]. It concluded that the potential worsening of grid performance in these two years warranted examination.

110. In our opinion, not only has GHD/Synergies confirmed Strata's concern that Transpower had not undertaken the analysis of historical data but also that a

[17] GHD/Synergies, page 5
[18] ibid

significant issue warranting further examination has been uncovered by GHD/Synergies' analysis.

111. We had expected that Transpower would have undertaken continuous monitoring and analysis to determine if its level of performance was changing; failing to do so would be a departure from GIP for an electricity Transmission operator.

Strata's revised views on above collar performance against Grid Performance Measures were summarised in two points

112. Based on the information provided by GHD/Synergies, we have revised our initial views.

113. Strata's opinion is that:

(a) Transpower's explanations for the outside collar performance were not given within the context of historical performance, and it did not identify and explain adverse effect of significant one-off periodic events in 2015/16 and 2016/17.

(b) Transpower should have undertaken continuous monitoring and analysis to determine if its level of performance was changing; failing to do so was a departure from GIP for an electricity Transmission operator.

(c) our opinion is that in not undertaking such analysis prior to this review, Transpower did not act consistently with GIP.

114. We understand that Transpower has yet to present its analysis and findings on the significant events identified by GHD/Synergies. Nor has it provided an explanation why Transpower did not undertake this analysis prior to the Commission's non-compliance review. We consider that Transpower should provide this information immediately to the Commission for its review.

Assessment of below collar performance against Asset Performance Measures

115. Two asset performance measures were set for RCP2. These measures relate to the impact that asset availability can have on access to the lowest-cost mix of generation.

116. For RCP2, two asset performance measures were set for Transpower:

(a) availability of our inter-island high-voltage direct current (HVDC) system and;

(b) the availability of selected high-voltage alternating circuits (HVAC).

117. A cap and collar was established around a target value for each of the performance measures. To remain compliant, Transpower had to remain within the cap and collar boundaries.

118. For HVAC availability, Transpower's performance was below the collar in 2015-16 and in 2016-17.

HVAC circuit availability

119. The HVAC availability is measured as the percentage of time that a selected set of 27 220 kV circuits was available during a year. The selection of the circuits was based on the potential impact that outages on these circuits could have on wholesale prices in the electricity market.

120. Table 2 shows that in both 2015-16 and 2016-17 the HVAC availability on selected circuits was below the collar by 0.2%.

Table 3: Where Transpower was below its HVAC availability collars

	HVAC selected circuits			
	Target	Cap	Collar	Actual
2015 - 16	99.6	100	99.2	99.0
2016 - 17	99.6	100	99.2	99.0

Sources: Transpower Compliance Reports 2015-16 and 2016-17

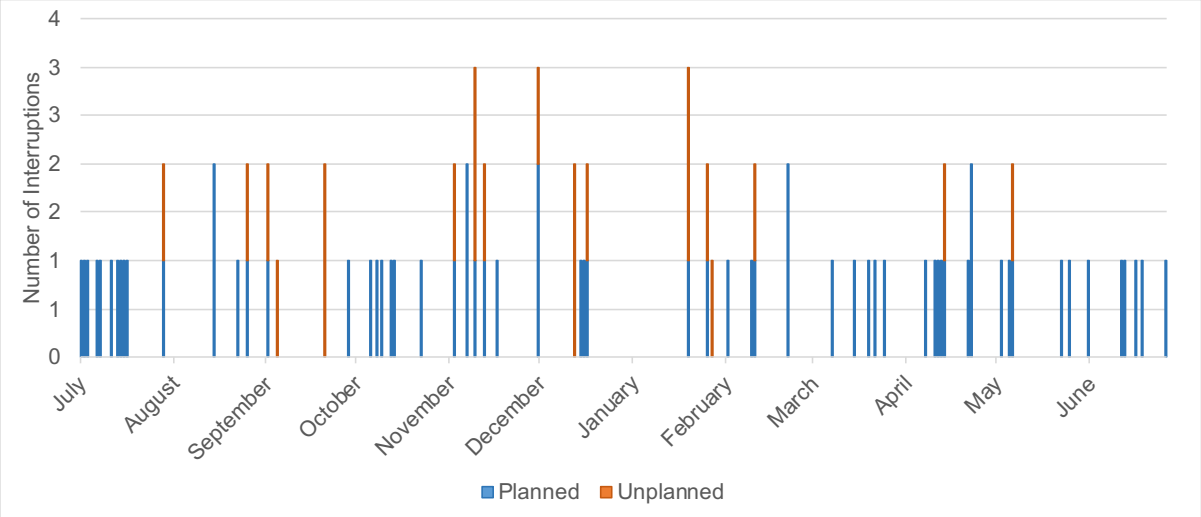
121. The following assessment of the factors leading to Transpower's circuit availability falling below the collar focuses on the relevant years and on the contribution made for planned and unplanned circuit outages.

Assessment of the factors relevant to circuit availability during 2015-16

Unplanned outages were not a material contributing factor in 2015-16

122. Transpower's data for 2015-16 shows that unplanned outages contributed a material proportion of the number of outages on the RCP2 selected HVAC circuits (Figure 6).

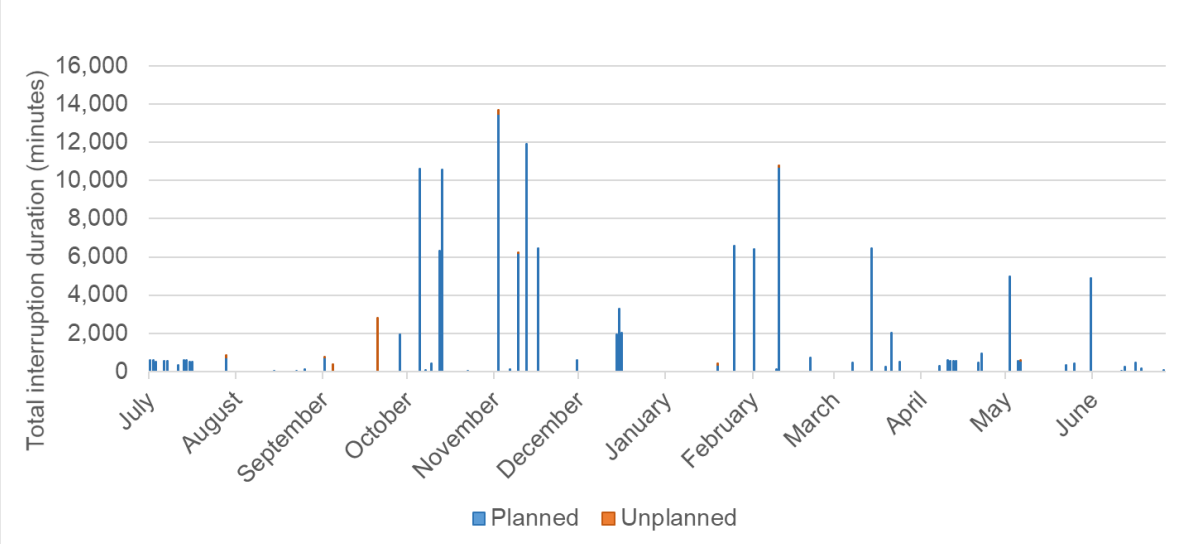
Figure 6: Number of RCP2 HVAC Circuit Outages in 2015-16 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_15-16-2.xlsx.

123. However the contribution of unplanned circuit outages (Figure 7) to total duration of circuit outages was not a significant factor in circuit availability.

Figure 7: Duration of RCP2 HVAC circuit Outage Durations in 2015-16 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_15-16-2.xlsx.

124. The single unplanned tripping on 27/9/2015 accounted for 73% of the total unplanned and 2% of all selected circuit outages for 2015-16. Transpower records the following description of the event.

> *BPE-TKU-2 trip and A/R for a Yph - Bph fault after a delay another trip and A/R for a Yph - Bph fault then a trip and lockout for a Bph-E fault caused by smoke from a pine forest fire started by a Genesis 33kV pole crossarm failure. No damage to circuit. Outage to fell burnt fall distance trees.*[19]

[19] Transpower RCP2_CCT_availability_15-16-2 our interpretation is that the outage was needed to cut down burnt trees that were within the falling distance to the line.

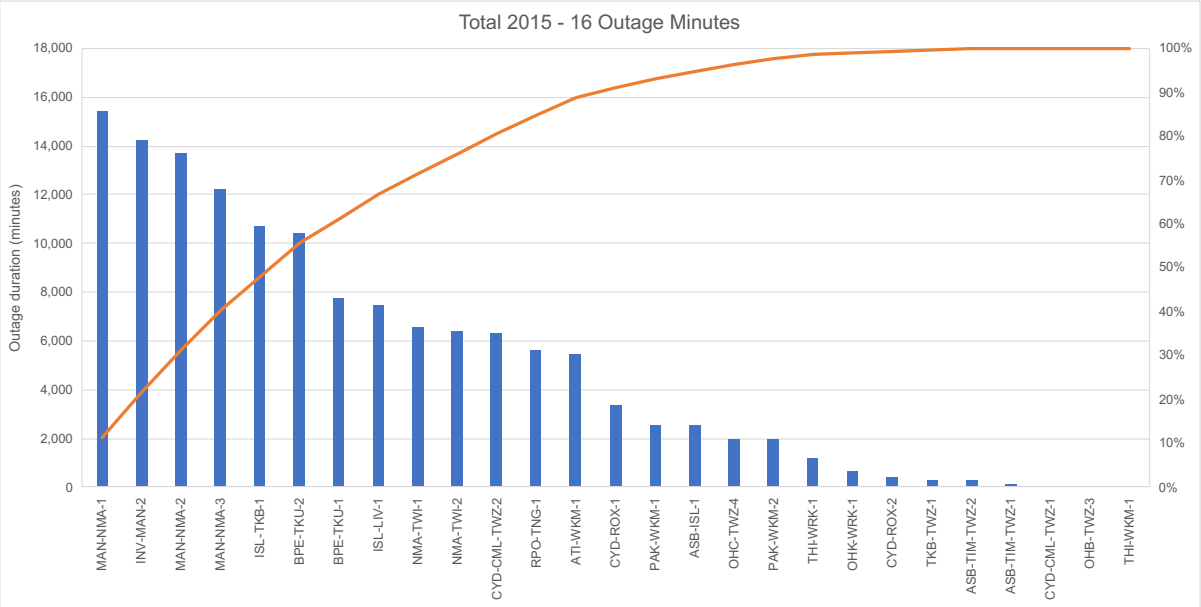
125. The underlying cause of this unplanned event was found to be due to a fire on a 3rd Parties asset and therefore beyond Transpower's reasonable control.

126. Accordingly, we have found that unplanned outages were not a factor in Transpower's availability performance falling below the collar in 2015-16.

Planned circuit outages were the main contributing factor in 2015-16

127. Planned outages on circuits in the lower South Island made the most significant contribution to outages and Transpower's failure to perform within its cap for the 2015-16 availability measure (Figure 8).

Figure 8: Duration of RCP2 HVAC Circuit Outages in 2015-16 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_15-16-2.xlsx.

128. The lower South Island outages predominantly occurred in October and November 2015. Transpower attributed the outages to the completion of non-discretionary maintenance and replacement work on these circuits.

> *There were a series of outages, each lasting between 10,000 and 13,000 minutes, typically around a week in duration. Care was taken to bundle work into these outages. This includes tower painting, protection work, reinsulating, line trap removal, and Meridian Energy took simultaneous outages on their side of the disconnector. The outages must be continuous for all that work to be completed simultaneously.*

129. The work undertaken on the four highest contributing circuits accounted for 35% of the total circuit outage duration which occurred between 5th October and 20 November 2015. Had these planned outages not occurred, circuit availability for the 2015-16 year would have been 99.42 which is within the cap and collar boundaries.

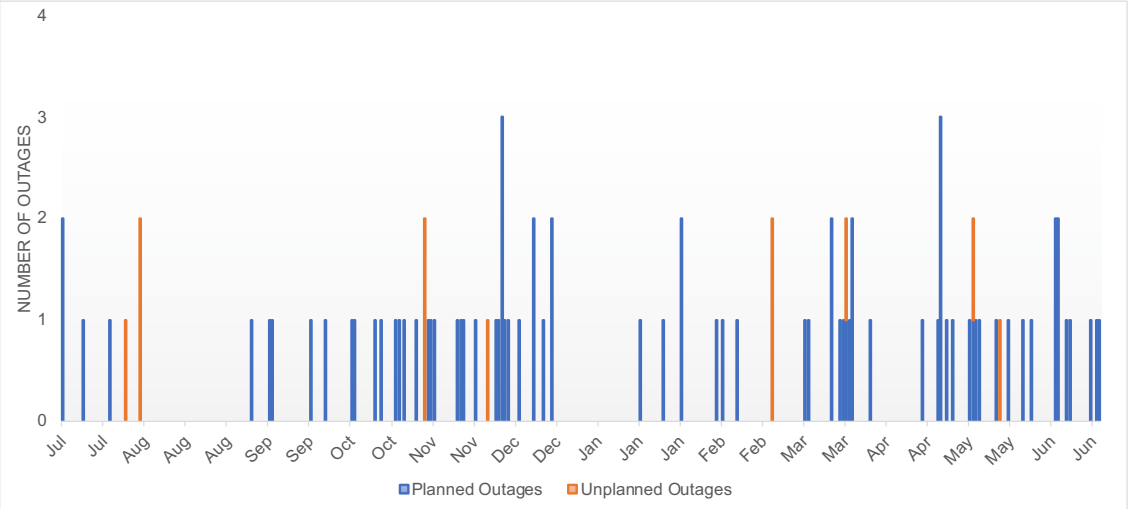
Assessment of the factors relevant to circuit availability during 2016-17

Unplanned outages were not a material contributing factor in 2016-17

130. As in 2015-16, Transpower's data for 2016 -17 shows that unplanned outages contributed a material proportion of the number of outages on the RCP2 selected HVAC circuits (Figure 9). However, Figure 10 indicates that there were only two

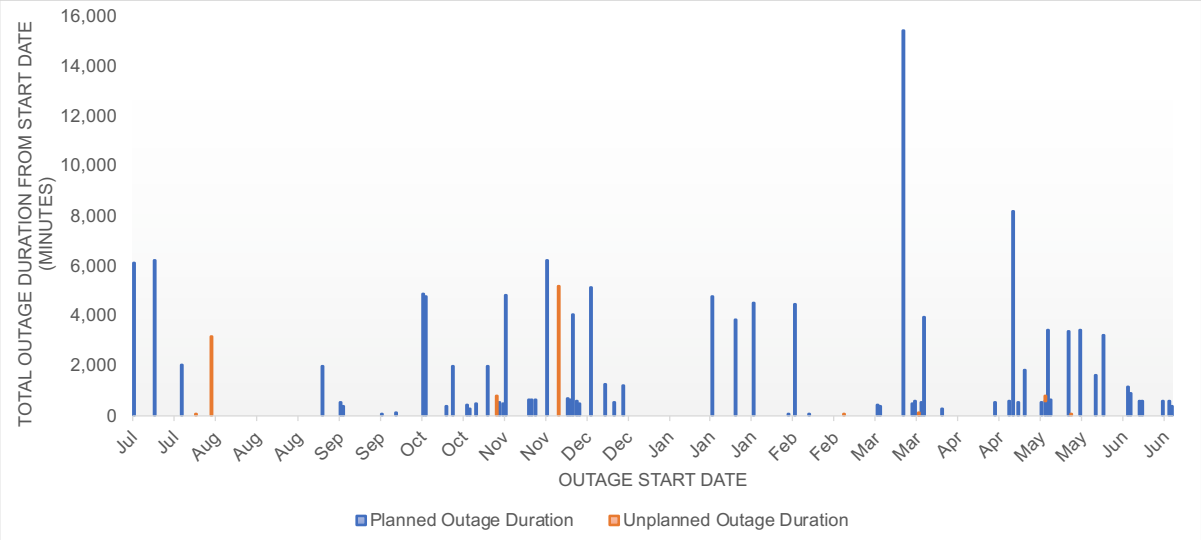
unplanned outages that materially contributed to the total duration of circuit outages and therefore availability performance.

Figure 9: Number of RCP2 HVAC Circuit Outages in 2016-17 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_15-16-2.xlsx.

Figure 10: Duration of RCP2 HVAC circuit Outage Durations in 2016-17 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_15-16-2.xlsx.

131. Transpower considers that the two large unplanned events were primarily related to a heavy snowfall on 30 July 2016.

> *On 30 July 2016, the INV_MAN cct 2 tripped during a heavy snowfall. Until the weather cleared a line patrol was delayed. In accordance with our policies, the line could not be returned to service until the cause was known and/or the line patrolled. When the weather cleared a patrol was completed with no evident cause found, and the line was re patrolled during which an inverted duplex conductor was identified. This did not explain the cause of the event but was a consequence of the heavy snow and coincident wind. The duplex conductor inversion was corrected, and the line returned to*

service after 2296 minutes. It is Transpower's belief that the cause of the tripping was heavy snow loading on the earthwire combined with wind causing the earthwire to contact the phase conductor.

On 25 November 2016, the INV_MAN cct 2 again tripped, and after line patrol it was found to be a broken jumper on strain tower number 22. Due to the difficulty in getting to the site, and mobilising equipment, it took 3 days to repair and return to service (5186 minutes). We believe that the incident of 30 July 2016 and this incident are related. It was postulated that the fault current through the bolted joint contributed to the weakening of the bolts and subsequent failure. At the time, thermo vision was undertaken on all other bolted joints. An investigation has been undertaken by Operational Engineering of the failed deadend.

132. In addition to the snow related issues, Transpower identified that there are other contributing factors including the lack of grease in the joint and the metallurgy of the bolt. Transpower has initiated a joint refurbishment programme to address issues in similar joints.

133. The combined outage duration due to these events was 7482 minutes which is 5.2% of total circuit outage duration. We consider that this is not a sufficiently material contribution to warrant detailed review.

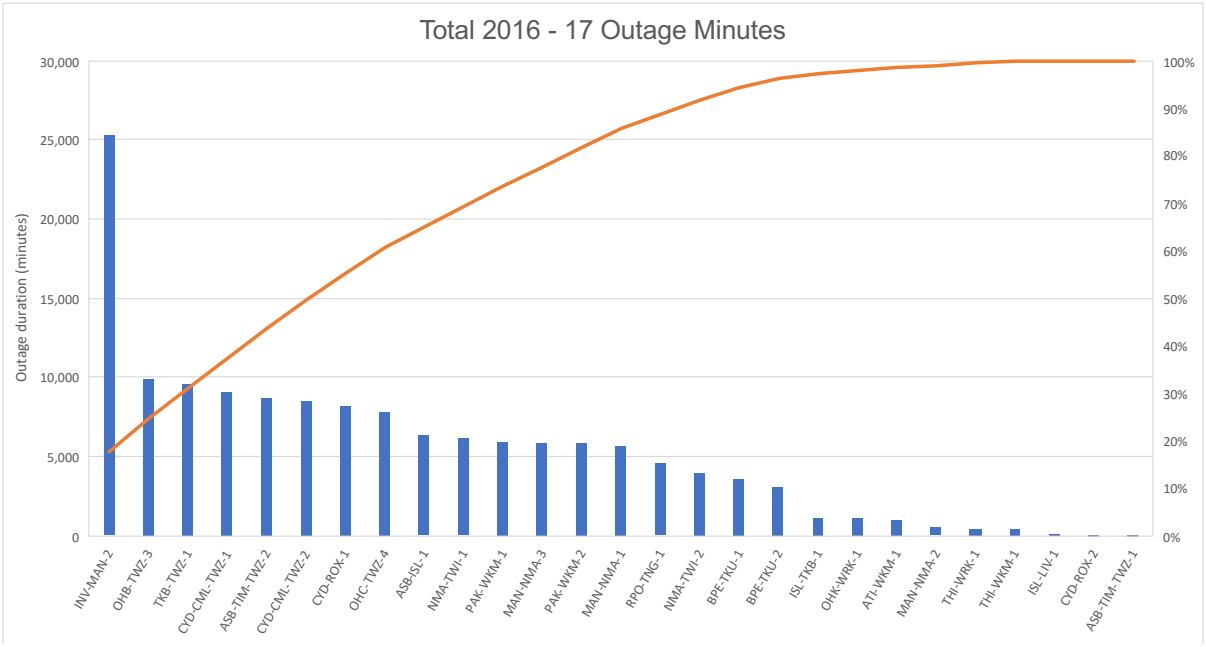
Planned circuit outages were the main contributing factor in 2016-17

134. For 2016-17 planned projects contributed 93.4% of the circuit outage minutes. Transpower provided evidence that planned project related work had contributed 44% (64,270 minutes out of 144,388 minutes). Two projects contributed approximately half of the minutes attributed to planned projects, these projects were the:

1. Ashburton - Timaru - Twizel protection replacement (8,786 minutes); and
2. Twizel bus zone project (21,842 minutes).

135. On a circuit specific basis, Figure 11 shows the circuits that contributed to circuit outages.

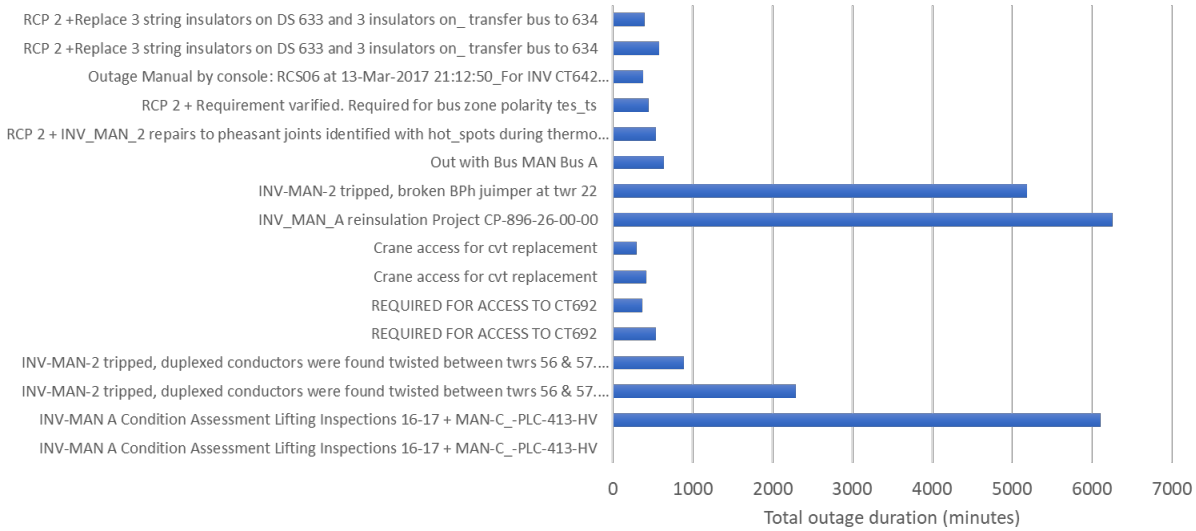
Figure 11: Duration of RCP2 HVAC Circuit Outages in 2016-17 by start date



Source: Strata analysis of Transpower data RCP2_CCT_availability_16-17-2.xlsx.

136. The planned work on the Invercargill-Manapouri Circuit 2 totalled 16,986 minutes. Figure 12 shows that this was dominated by two projects for condition assessment lifting inspections and reinsulation.

Figure 12: Work on the Invercargill-Manapouri Circuit 2 requiring circuit outages in 2016-17



Source: Strata analysis of Transpower data RCP2_CCT_availability_16-17-2.xlsx.

137. Other planned work that contributed significantly to planned circuit outages were:

1. An outage on NMA_TWZ cct 1 of 6241 minutes to undertake CA lifting inspections, but also to complete routine maintenance on disconnectors, earth switches and circuit breakers at Tiwai.

2. An outage of 9098 minutes on Ohau B to Twizel circuit 3 as part of commissioning a new bus zone scheme at Twizel[20].
3. An outage of 6347 minutes on Ashburton to Islington 1 for maintenance on CVTs, CTs, circuit breakers and earth switches.

138. The data supports Transpower's explanation that planned work, and in particular planned condition assessment lifting inspections, was the main contributing factor in the availability of the selected circuits falling below collar in 2016-17.

Our initial assessment of actions and omission that contributed to reduced HVAC circuit availability

139. Transpower claims that its availability performance was better than had been achieved previously and when setting its RCP2 target it:

(a) applied logic that was too optimistic;

(b) applied only high-level analysis using a fundamentally top down approach; and

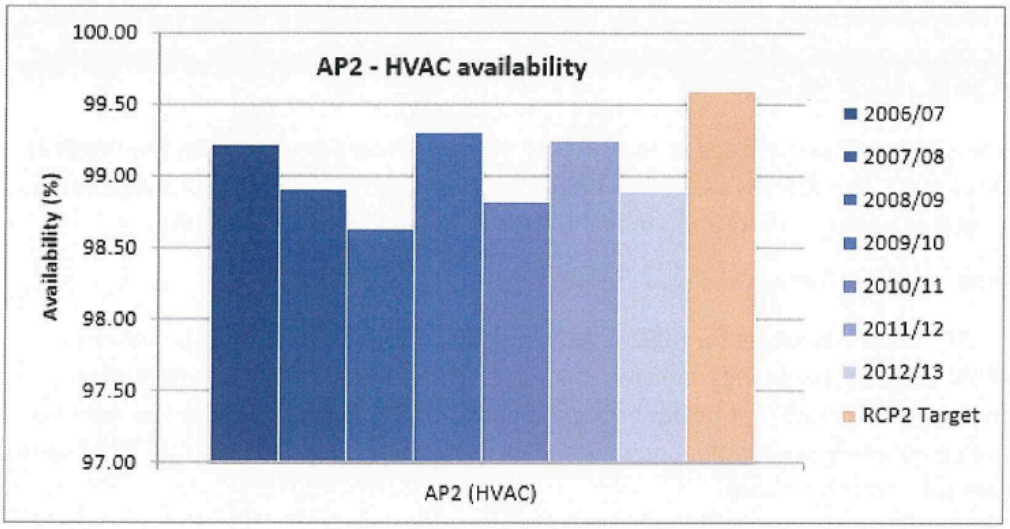
(c) set the target at an aspirational level relative to historical availability performance.

140. We have assessed the information provided by Transpower and formed initial views on the factors identified for the below collar performance together with Transpower's claim that the collar had been set inappropriately low.

The target for availability in each year set a high bar

141. The average availability for the two years 2015-17 was higher than the average for the previous 7 years that preceded RCP2 (Figure 13). Transpower claims that this supports its view that the target and collar was set at an aspirational level.

Figure 13: Comparison between the RCP2 target and total HVAC network historical availability performance



Source: Transpower Availability Draft V2

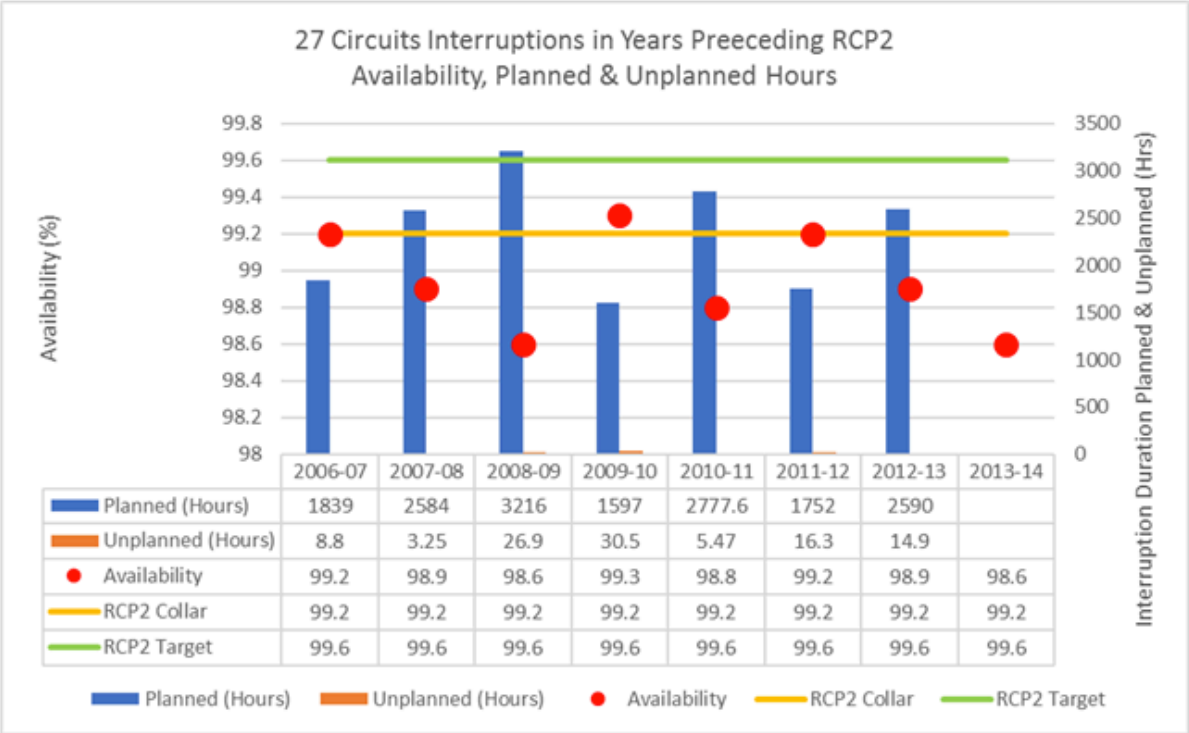
142. The data shows that three out of the seven historical years had availability at or above 99.2%. 2008-09 was a low performing year with performance around 98.6%. This year will have reduced the seven year average.

[20] The Ashburton – Timaru -Twizel protection replacement and the Twizel bus zone project were major projects that combined contributed 30,628 minutes.

143. At the time of making our initial findings, we were awaiting Transpower's provision of the historical data with a planned and unplanned breakdown and confirmation that the data is for the whole HVAC network.

144. Transpower's analysis of the historical data for the selected 27 circuits suggests that, in the absence of other reasons, 99.2% would have been more appropriate as the target than the collar for RCP2.

Figure 14: Comparison between the RCP2 target and the 27 selected circuit historical availability performance



	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Planned (Hours)	1839	2584	3216	1597	2777.6	1752	2590	
Unplanned (Hours)	8.8	3.25	26.9	30.5	5.47	16.3	14.9	
Availability	99.2	98.9	98.6	99.3	98.8	99.2	98.9	98.6
RCP2 Collar	99.2	99.2	99.2	99.2	99.2	99.2	99.2	99.2
RCP2 Target	99.6	99.6	99.6	99.6	99.6	99.6	99.6	99.6

Source: Transpower Availability Draft V2

145. Transpower has not provided any analysis on the underlying factors relating to the historical years and explanation on why these factors were not taken into account when it proposed the RCP2 target, cap and collar.

146. The data supports the view that Transpower proposed a target and collar on the expectation that its RCP2 availability performance would be higher than it had historically achieved. The data does not explain why Transpower proposed a target and collar at these levels.

Why did Transpower propose overly optimistic targets?

147. Transpower considers that the volatility of work programmes was insufficiently considered when establishing its proposed target and collar.

> *There is a high degree of year to year work volatility, which supports our belief that the availability targets need to be built bottom up, rather than top down as completed or RCP2.*
>
> *• for projects there was a doubling of outage duration between 2015-16 and 2016-17, and*
>
> *• in the 2016-17 year there was no tower painting required on the 27 circuits.*

148. Transpower provided data showing the year to year volatility caused by a range of work activities (Figure 15) indicating *swings of up to 90%, but significantly on work types that contributed significantly to durations*.

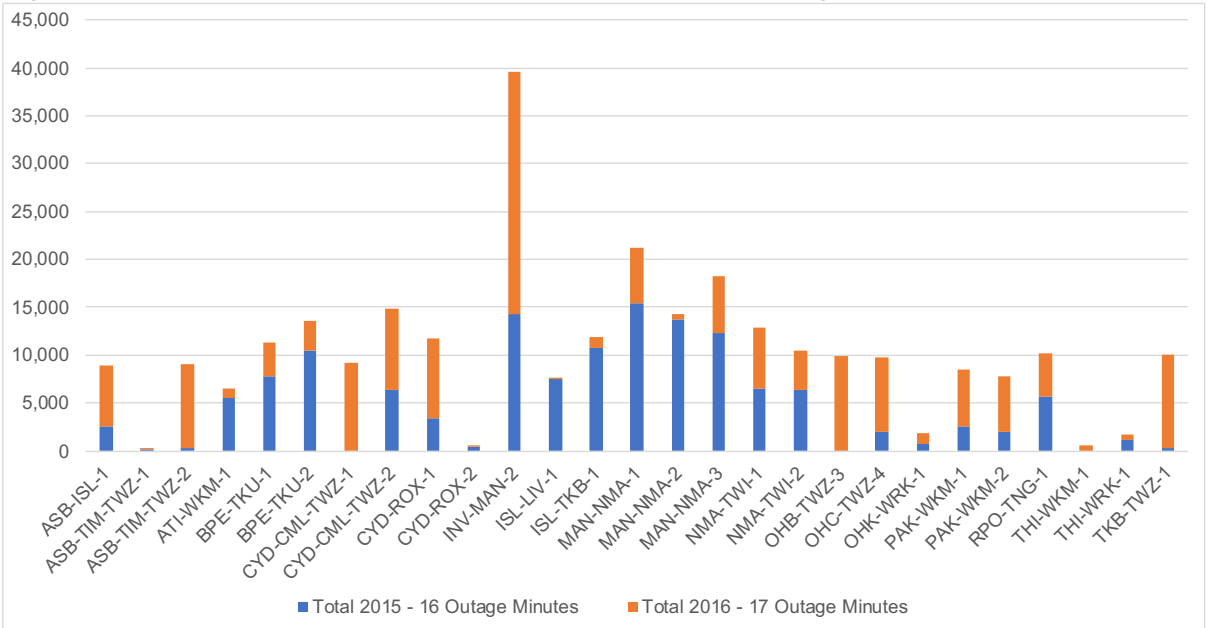
Figure 15: Transpower's analysis of work type outage volatility

Comparison of Work Types causing Outage (minutes)			
	2015-16	2016-17	Difference
Condition Assessment	17,737	17,248	- 489
Line Maintenance	15,603	8,674	- 6,929
Project works	24,632	48,530	23,898
Reinsulating	5,995	11,440	5,445
SMS	717	7,278	6,561
Subs Maintenance	21,976	38,603	16,627
Blackstart	740	-	- 740
Tower Painting	46,557	-	- 46,557
Unplanned	3,849	9,566	5,717

Source: Transpower Availability Draft V2

149. Using outage data provided by Transpower, we looked for the potential impact of year to year volatility on the duration of outages for each of the 27 selected circuits. Figure 16 shows that, whilst there is some consistency, the application of a top-down target would need to assume some swings and roundabouts.

Figure 16: Variation between 2015-16 and 2016-17 circuit outages



Source: Strata analysis of Transpower data RCP2_CCT_availability_16-17-2.xlsx.

150. The 2015-6 and 2016-18 planned work included some significant groups of projects that required significant planning and preparation. The need for the work would have been identified as part of Transpower's forecasting for RCP2 works and the planning would have commenced at least 12 months prior to the required work being undertaken.

151. Given the significance of the planned works in the lower South Island, we would expect that any top-down target setting process would have taken this future work into account. A top down target setting process should have been more than a wet finger in the air; in our view, the process should have considered the underlying historical performance (planned and unplanned), and the variability and scale of the larger projects scheduled for RCP2. The process should have also set out its key assumptions such as continuing live line working practice (if this was an assumption).

152. In its preparation for its RCP3 submission, Transpower is using a bottom-up target setting process and applying a revised internal target and collar for the remainder of RCP2. Our initial assessment of Transpower's bottom up target and collar is provided below.

What would be an appropriate target, cap and collar?

153. Transpower says in its 2017 Services Report[21] that a target of 98.7% is more appropriate and has been adopted internally for RCP2. However, this is below the 2015-6 and 2016-17 actual performance of 99.0%, and 0.5% below the RCP2 collar.

> *The HVAC availability target for RCP2 has proven difficult to meet and may be further impacted by our decision regarding live line work. In response, we have worked to an internal target of 98.7% that better balances need for HVAC availability with the need for lines to be de-energised for planned maintenance. We will refine this target for RCP3 so that it better reflects this balance.*[22]

154. Transpower did not clearly set out the assumptions used when revising its target, nor did it provide a suggested revised collar. We identified the following assumptions that were discussed in the information Transpower did provide:

(a) that its workload is changing, with increasing outages due to tower painting and projects which take many days; - Transpower noted that in the 2016-17 year there was no tower painting required on the 27 circuits;

(b) investigating means of reducing the impacts of tower painting on outage durations;

(c) continuing to minimise outages where possible;

(d) trading off effects against the need to undertake the work;

(e) consolidating work;

(f) looking for ways to make the process efficient;

(g) returning to live line work if justified by our current review to assist in reducing durations;

(h) preplanning outages as soon as live work is restarted; and

(i) as a consequence of lessons learnt, changing the method for building up the availability targets for RCP3, and what assets are included in the target.

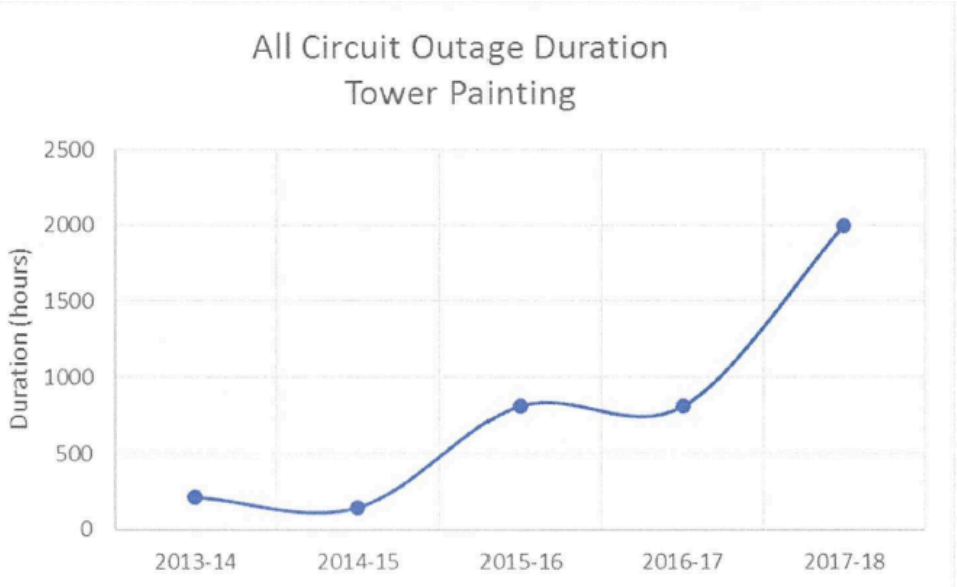
155. Transpower's proposed target for RCP3 is 98.9% which it says is reasonable because:

> *the proposed baseline target of 98.9% follows a detailed review of historical data, consideration of planned maintenance and currently known project work for RCP3, and an allowance for the future trends…*[23]

[21] Transpower Availability Draft V2, section 3
[22] ibid
[23] Ibid, section 3

156. We understand that this target was formed on a largely bottom up basis that, without a rigorous top down review, may swing the target, cap and collar from being optimistic to pessimistic. For example, Transpower shows the impact of tower painting as an increasing trendline (Figure 17). Transpower attributes the trend to its suspension of live line work.

Figure 17: Duration trend for tower painting refurbishment



Source: Transpower Availability Draft V2

157. Transpower provided information that it is investigating alternative methods for tower painting that will allow live line painting. Key top down challenge questions are:

(a) how probable is it that alternative methods will be realised?;

(b) what impact would they make?; and

(c) what is the likely timing?

158. In our view, it is reasonably likely that Transpower will adopt alternative methods that will bring down the impact of tower painting on circuit outages. If this is the case, the proposed 98.9% target would be pessimistic.

159. Clearly these are issues for the Commission to consider as it reviews Transpower's RCP3 proposal. For this review, the issue we have considered is whether or not an overly optimistic target and collar was a factor in Transpower's under collar performance on circuit availability measures.

160. Our initial finding is that the target, cap and collar for circuit availability was optimistic in that it did not fully reflect the extent of planned outages that would be needed; nor did it account for the impact of Transpower's suspension of live line working.

161. We consider that, on the basis of the information provided by Transpower, the revised target that Transpower is working to internally is likely to be pessimistic and, by applying it, Transpower may be setting a lower performance than it could achieve.

No assessment on the impact on market price

162. We understand that the 27 circuits were selected as outages and were likely to have the greatest impact on changes in wholesale market prices. In other words, outages of these circuits are more likely to increase the cost of electricity to consumers as opposed to outages on other circuits.

163. The information provided by Transpower indicates that the market price effect is not a primary focus when considering the impact of the planned work.

> *The outages were coordinated with Meridian, and Transpower maintained an N-1 security connection to their bus while the outages took place. Therefore, the minimum possible impact on network security and capacity resulted. Given the high importance of these circuits, they require a considerable volume of work to ensure they continue to perform with the highest reliability.*[24]

164. The impact of the circuits connecting a major hydro generating station would be expected to have potential impacts on market prices. Transpower explains that it undertook a trade off when prioritising work on the basis of network security and reliability risk. However, there is no information explaining if the potential impact on market prices was considered. If the outages were managed without any potential impact on market prices, Transpower's under collar performance could be seen as being an acceptable trade off to gain improved security and reliability.

165. Our initial view is that Transpower should have, but did not, assess the impact of its below collar availability performance on wholesale market prices. If this analysis is resource hungry, this exercise should at least have been done for the circuits contributing most significantly to outage duration.

Our initial assessment of whether Transpower acted consistently with GIP

The circuit outage profiles should not have been unexpected

166. The profiles the outage numbers, duration and circuits affected over the two years should have been predictable. The predominance of planned outage duration supports this view. Our initial view is that Transpower's target setting process for RCP2 either did not consider these factors or did consider and accept them.

167. In the absence of clearly identified initiatives to lift availability performance, Transpower set its RCP2 target at an optimistic level. It is not good industry practice to set even top-down targets without identifying key input assumptions. However, the targets and collars were subjected to the Commission's review and consultation with stakeholders without adjustment. We have not found any information indicating that the Commission and stakeholders accepted that the target and collar were aspirational.

168. Given that the quality measures for RCP2 were classed as 'prototype', in our view, it would be unreasonable to conclude that Transpower acted inconsistently with GIP when proposing them.

The relevant asset management practices, work planning strategies and prioritisation appear to be aligned with GIP

169. The information that we have considered has been focused on the management of the outages relating to the 27 selected circuits. This initial review has not included a detailed investigation of Transpower's asset management practices.

170. For the unplanned outages, we found that Transpower undertook detailed post event reviews that included identification of opportunities to reduce future impacts from similar factors and causes. We also identified that Transpower has implemented the improvement initiatives that it identified. In our opinion, this is consistent with GIP.

171. For planned outages, our initial review has found that Transpower undertakes detailed planning that includes risk based prioritisation of work on the 27 selected circuits. We

[24] Ibid, section 1

have not identified concerns that Transpower's work planning and prioritisation is not aligned with GIP.

172. We did identify a potential issue regarding the quantification of the impact on market prices from outages. Our initial finding that Transpower does apply GIP in works planning and prioritisation is based on our, as yet unqualified, assumption that impact on market prices is considered.

Our views on other actions that Transpower could have taken

173. Our findings indicate that Transpower could have improved the process though which it developed its proposed availability target and collar. We note that Transpower is proposing changes in this process for RCP3 but evaluation of this is outside the scope of this review.

174. Transpower has implemented a revised availability target that it is applying internally. The implication of adopting this target does not appear to have been fully considered by Transpower. A top-down challenge of the revised target is not visible. Our initial view is that the resulting target is likely to be overly pessimistic.

175. We have found that Transpower has not sufficiently explained how it included consideration of impact on market prices when planning and prioritising its work. The quantification of price impacts of planned and unplanned outages would be a useful submission alongside availability performance assessments.

Strata's initial views on below collar performance against Asset Performance Measures

176. Strata's initial views on below collar performance against Asset Performance Measures can be summarised in two points:

(a) there was a potential issue regarding the quantification of the impact on market prices from outages. Our initial finding that Transpower does apply GIP in works planning and prioritisation is based on our, as yet unqualified, assumption that impact on market prices is considered; and

(b) we found that Transpower has not sufficiently explained how it included consideration of impact on market prices when planning and prioritising its work. The quantification of price impacts of planned and unplanned outages would be a useful submission alongside availability performance assessments.

Consideration of relevant GHD/Synergies' points on below collar performance against Asset Performance Measures

177. GHD's views are provided in its Table 1: Summary of key findings regarding Transpower's non-compliant performance measures. This includes the following statements:

> *For planned outages, Strata found that Transpower undertakes detailed planning that includes risk-based prioritisation of work on the 27 selected HVAC circuits, such that this is consistent with GEIP. However, in so doing, Strata states its position is based on an unqualified assumption that the impact on market prices is considered by Transpower in its outage management, which we do not consider to be reasonable or relevant to GEIP given the responsibilities of grid owners.*

and

> *we consider that Strata's criticism that Transpower has not sufficiently explained how it included consideration of the impact of electricity market*

> *prices when planning and prioritising work is not supported by evidence. We consider that the Outage Protocol is the key document that guides how Transpower manages its planned and unplanned outages and that Strata has made no mention of this document in its analysis.*

and

> *Strata's criticism that Transpower has not sufficiently explained how it included consideration of the impact of market prices when planning and prioritising its work programme does not appear to be causally linked to Transpower's non-compliance with its AP2 quality standard.* [25]

178. Transpower's RCP3 documentation contains the following explanation of its grid availability measures:

> *Our asset performance measures assess grid availability and are intended to be a proxy for market availability of the grid:*
>
> *AP1 and AP2: revenue-linked measures, aimed at minimising planned or unplanned availability of our HVDC and selected HVAC assets that impact on least-cost generation dispatch*
>
> *AP3 and AP4: new, trial, non-revenue linked measures on timely return to service after a planned outage and how effectively we communicate any delays to our customers in relation to selected HVAC assets that impact on least-cost generation dispatch.*[26]

179. In Section 2 of its report, GHD/Synergies sets out the requirements of Transpower's outage protocol; the requirements of this protocol will be well known to the Commission. The primary purpose of the Outage Protocol is to make Transpower's planned outages visible to other participants in the wholesale electricity market, and through this, enable participants (including the System Operator) to manage risks associated with coincident outages of generation plant.

180. We agree with GHD/Synergies that the Outage Protocol is important when considering Transpower's performance in managing both planned and unplanned outages. For the latter, Transpower's actions, taken to ensure assets are returned to service as swiftly as possible, are relevant to meeting the Commission's GIP criteria. We also agree with GHD/Synergies that Transpower's Outage Policy and Outage Protocol provide an appropriate framework for Transpower's management of planned and unplanned outages.

181. Strata's identification of a potential issue of concern related to how Transpower considered the grid availability measures when establishing is outage plans. For example, did the fact that outages planned for selected circuits might impact on least cost generation dispatch (and through this, wholesale market prices), have any influence on Transpower's prioritisation and plans? This question is valid because, if there is no consideration of the impact of outages on the selected circuits, what is the point of availability measures solely for these circuits? (i.e. because they are included as selected circuits on the basis of their potential impact).

182. Breaching availability targets on the selected circuits, by definition, will have had an impact on the least cost dispatch outcomes; and through this, on market prices. Further understanding of how Transpower manages compliance with the availability measures may throw some light on the appropriateness of these measures.

[25] GHD/Synergies, page 6 of 109
[26] Transpower Grid Outputs Report 2018 – FINAL, page 13

183. However, we agree with GHD/Synergies that the absence of this is not a contributor to non-compliance and was therefore not directly relevant to the non-compliance investigation.

Strata's revised views on below collar performance against Asset Performance Measures

184. Strata's opinion is that Transpower:

a) could have improved the process though which it developed its proposed availability target and collar. We note that Transpower is proposing changes in this process for RCP3 but evaluation of this is outside the scope of this review; and

b) has implemented a revised availability target that it is applying internally. The implication of adopting this target does not appear to have been fully considered by Transpower. A top-down challenge of the revised target is not visible. Our view is that the resulting target is likely to be overly pessimistic.

Assessment of above collar performance against Asset Health Measures

185. Three annual asset health measures were set for RCP2. The measures related to the following asset classes:

(a) total number of transmission towers refurbished or replaced within Transpower's asset replacement and asset refurbishment programme during a disclosure year);

(b) total number of grillages commissioned within Transpower's asset replacement and asset refurbishment programme during a disclosure year; and

(c) total number of insulators commissioned within Transpower's asset replacement and asset refurbishment programme during a disclosure year.

186. In addition, three five year asset health measures were set for total number of outdoor circuit breakers, power transformers and outdoor to indoor substation conversions commissioned within Transpower's asset replacement and asset refurbishment programme during the regulatory period.

187. A cap and collar was established around a target value for each of the performance measures. To remain compliant, Transpower had to remain within the cap and collar boundaries.

188. For the transmission tower refurbish or replace (R&R) asset health measure Transpower's performance was within the cap and collar boundaries in both 2015-16 and in 2016-17 (Table 2).

Table 4: Transpower's performance against quality standards for 2016 and 2017

	Transmission Tower Refurbished Volume Measure			
	Target	Cap	Collar	Actual
2015 - 16	427	467	387	461
2016 - 17	523	563	443	542

Sources: Transpower Grillage Volume Breach

189. For the grillage and insulator R&R asset health measures, Transpower's performance was below the collar in both 2015-16 and in 2016-17. Our assessment of the reasons for the below collar performance is provided in the following subsections.

Number of grillage foundations refurbished

190. The condition of transmission tower foundations is critical to the integrity of a tower and failure can result in safety hazards and potential interruption of electricity supply to consumers.

191. Steel grillage and concrete plug (also known as concrete pile) are the main types of foundation used by Transpower to support its steel lattice towers. In 2016, there were 10,698 steel grillage foundations representing 44% of the tower foundation population. Because they are steel structures buried in the ground, grillages are susceptible to corrosion. The primary strategy to address grillage corrosion is to encase the steel structure in concrete, this is known as concrete over grillage (CoG).

192. Given the potential consequences of grillage failure, the RCP2 targeted R&R programme and the associated asset health measure was established to manage the risk at a level acceptable to Transpower.

193. In 2015-16 and 2016-17 Transpower delivered a significantly lower number of grillages than the collar for both years.

Table 5: Transpower's performance against quality standards for 2016 and 2017

	Grillages Refurbishment Volume Measure			
	Target	Cap	Collar	Actual
2015 - 16	339	370	308	276
2016 - 17	396	427	365	320

Sources: Transpower Grillage Volume Breach

Our identification of the relevant factors

194. In the relevant annual Compliance Statements, Transpower attributed the reduced volumes of grillage replacements to:

(a) a deliberate slow-down of replacements to allow time to investigate and implement a number of efficiency measures aimed at reducing the cost of grillage installations; and

(b) a review of the grillage encasement strategy which has further been amended to incorporate Transpower's criticality framework.

195. Information provided by Transpower[27] during this review identified that, from October 2015, it had experienced increased unit costs relating to grillage R&R expenditure.

196. In a BECA report on the use of cathodic protection for grillage foundations, it identified that Transpower's intention at that time was to refurbish foundations at approximately 250 towers each year commencing in 2018/19.[28] Compared to the average asset health measure target for RCP2 of 382 commissioned grillages, this is a 35% reduction in targeted volumes.

The increasing unit costs were a factor in the deliberate slowdown of grillage R&R volumes.

197. Transpower identified that service provider costs were the major component of the net unit cost increases. The increases in service provider costs were attributed by Transpower to the initial targeting of smaller and easier access (e.g. lower cost) sites with a transition to more difficult (e.g. more costly) sites following completion of the initial replacements. A relatively small unit cost reduction had been gained on the initial sites but the more significant increase was seen in the forecast for more difficult to complete sites.

198. In 2015, Transpower forecast the net increase in the cost of grillage R&R for the remainder of its RCP2 programme to be $9.92 million which is 23% of its total RCP2 forecast for grillage R&R. At this point, Transpower's Capital Governance Team requested that a plan be developed for grillages that would identify options for managing the cost and risks appropriately.[29]

199. The reduced number of grillages being replaced or refurbished is coincident with the CGT direction.

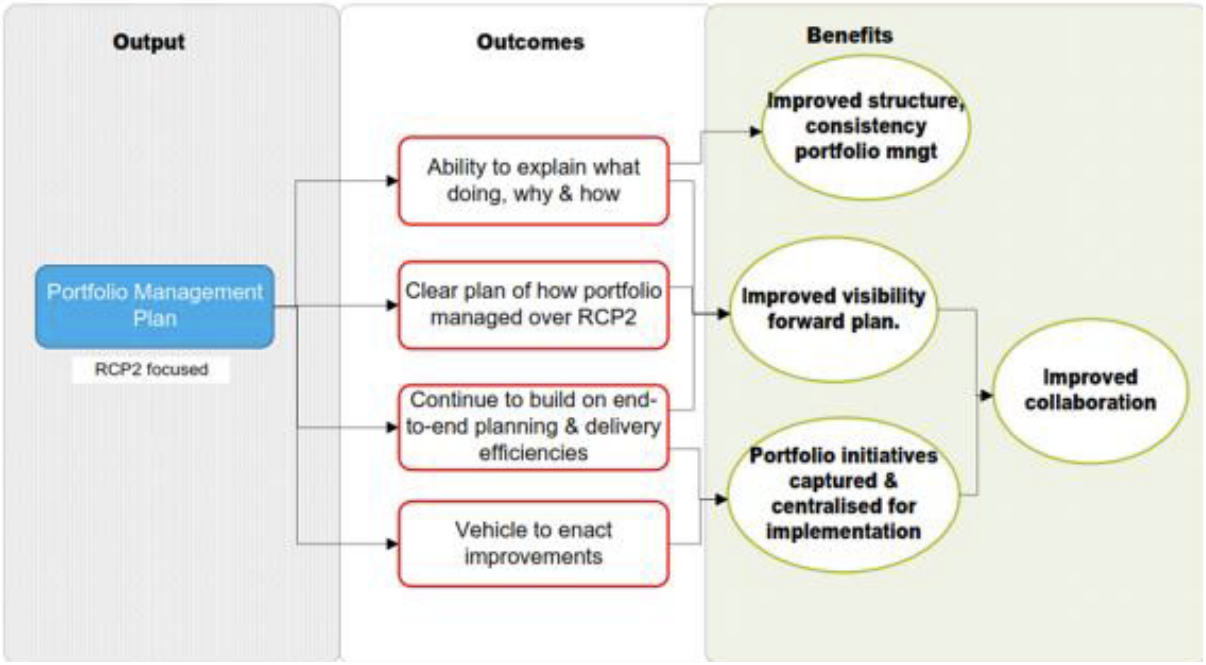
200. Transpower advised us that when the completion cost of the CoG refurbishment was forecast to exceed the *regulatory building block* a strategy was implemented to *reduce volumes to remain within the portfolio budget until improvement initiatives provided some solutions.* For high cost grillage situations Transpower advised that these

[27] Grillages (Draft for Strata Review_pre formal release)
[28] BECA Grillage Foundation Cathodic Protection Study, 26 June 2017, Executive Summary
[29] Grillages (Draft for Strata Review_pre formal release), Page 2

refurbishments were deferred in anticipation that *improvement initiatives might provide savings in the future*.

201. The increasing unit costs were a factor in the deliberate slowdown of grillage R&R volumes. In April 2016, a grillage improvement plan was presented to the CGT. A Portfolio Savings Initiative was proposed which provided for a dedicated project manager tasked with ensuring lifecycle reviews were undertaken across all areas of improvement and that progress was managed and reported.[30] The purpose for and structure of the Portfolio Savings Initiative is reproduced in Figure 1.

Figure 18: Transpower's Portfolio Savings Initiative framework



Source: Transpower CGT meeting April 2016 – Improvement Project Setup.

202. At the April 2016 CGT meeting, a grillage working group listed 6 key strands to the improvement plan; this was a consolidation from 14 ideas identified to update grillage. The 6 key strands were:

(a) review of strategy;

(b) internal review of existing initiatives;

(c) review of the Asset Health and condition assessment;

(d) review of the loadings code;

(e) review of the procurement approach for grillages; and

(f) external discussion with service providers to access any of their improvement ideas.

203. The first initiative, review of strategy, was critical to the forecast of ongoing R&R requirements and the management of risks associated with reduced R&R volumes. Transpower engaged BECA to study and provide advice on the practicality and risk of adopting three hypothetical approaches to grillage replacements. BECA's report was received by Transpower in August 2016 and its findings included in the revised Asset

[30] Ibid, Page 2

Class Strategy – Transmission Lines Foundations (foundations strategy) that was approved on 30 January 2017.

204. Following approval of the revised strategy, Transpower developed a plan to manage the implications of the planned reduction in grillage R&R volumes. As the change in strategy occurred during the 2016-17 year, work commitments with contractors continued as planned for that year. BECA had also identified deferred grillage R&R work requiring completion to meet the revised strategy. Where considered appropriate, Transpower re-planned the deferred work into the 2018-19 year and tapered the remaining work to match a projected long run volume of 250 for the remaining 2 years of RCP2.

205. Transpower's intention in taking this approach was to ensure that work deferred in the first 2 years would be reassessed against the revised foundations strategy and rescheduled. The expectation was that the position would be reached where grillage R&R volumes would align with the revised strategy as if it had been applied at the start of the RCP2 period.

206. Transpower's information provides evidence that grillage R&R volumes had been reduced in anticipation of the grillage improvement plan, and subsequent revision to the foundations strategy, delivering a new lower volume and cost approach.

Risk due to short term deferral was not a factor in reducing the number of grillage refurbishments

207. Documents provided by Transpower indicate that it was evaluating risks associated with the revisions it was contemplating for its foundations strategy. The BECA study included consideration of the practicality and risks of the proposed changes to the strategic approach. The raised foundations strategy provides the following assessment of risks due to buried steel grillages:

> *Buried steel grillage foundations are subject to below-ground corrosion, leading to the risk of foundation failure and subsequent tower failure. Failures have consequent repair costs, as well as safety, property and network performance impacts. Foundations buried at depth cannot be readily condition assessed, and we have only excavated a relatively small proportion of the total number of grillages. This means that the condition of a significant number of grillages is therefore unknown.*
>
> *Our below-ground sampling has informed our asset management approach, but there is a risk that the condition of any buried grillage is worse than predicted. Looking ahead, we will develop a probability-of-failure approach that considers the structural loading on each site, to identify those most at risk should the condition be worse than expected. TP.FL01.0(P9) (P11)*
>
> *Recent studies, including full-scale foundation testing, suggest that under-strength foundations still exist. These structures continue to be investigated, with priority given to sites whose failure would pose significant risk to people, property or the Grid. TP.FL01.0(P12)*

208. All of the risk assessments discussed in the documents were forward looking. In other words, the documents do not identify that Transpower considered the change in risk that occurred when it responded to the cost increases by reducing its grillage R&R volumes below the collar.

209. The risk of grillage failure would have increased by deferral of the replacements unless a factor in assessing the risk had changed. Transpower had considered if the increased level of risk was acceptable. In the absence of evidence that risks resulting

from the immediate deferred grillage R&R volumes were assessed, our conclusion is that risk was not a factor, but it should have been.

Our initial assessment of the appropriateness of the performance and if it reflected GIP

210. There are three issues to cover:

a) were the initial volume targets and related R&R expenditure set appropriately?

b) was Transpower's initial response to the increasing costs consistent with GIP? and

c) is Transpower's long term strategic response to grillage management aligned with GIP?

Were the initial volume targets and related R&R expenditure set appropriately?

211. We considered the possibility that the grillage replacement volumes in Transpower's RCP2 proposal could have been forecasted at a higher level than necessary. This would have occurred if Transpower had prior knowledge that it could achieve reduced volumes through an alternative strategy. The relatively early deferment of grillage R&R in 2015-16 indicates that the opportunities for deferral may have been evident when the RCP2 forecasts were made.

212. Transpower's response to the increase in unit costs by implementing a Portfolio Savings Initiative suggests that it had not previously considered the potential for cost reductions. The development and approval of the savings initiative and the revised foundations strategy took approximately eighteen months from the first CGT report indicating the unit cost increase issue. This timeframe supports the proposition that the RCP2 forecast volumes were credible given the information Transpower held at that time.

213. When forecasting the RCP2 grillage R&R expenditure, we would have expected that Transpower would have either used profiled unit costs (i.e. a range of costs based on access and works complexity), or a blended unit cost (e.g. based on expected ease and difficulty of the total programme). Transpower's explanation suggests that the forecasts were based on the unit cost of easy access, less complex grillage works. Using such a rate for the entire portfolio R&R forecast is not good forecasting practice; it was bound to be exceeded and does not meet a GIP benchmark.

214. If Transpower did not apply the lower unit rate across the portfolio when setting the forecast, the reasons for the increase in the service provider costs must have been different from those provided by Transpower in its foundations strategy.[31] If this is the case, these reasons should have been exposed and managed.

Was Transpower's initial response to the increasing costs consistent with GIP?

215. Given that the quality measures for RCP2 were classed as 'prototype', in our view, it would be unreasonable to conclude that Transpower acted inconsistently with GIP when proposing them.

The relevant asset management practices, work planning strategies and prioritisation appear to be aligned with GIP

216. The information that we have considered has been focused on the management of the outages relating to the 27 selected circuits. This initial review has not included a detailed investigation of Transpower's asset management practices.

217. For the unplanned outages, we found that Transpower undertook detailed post event reviews that included identification of opportunities to reduce future impacts from

[31] Asset Class Strategy Transmission Line Foundations TP.FI 01.02, page 23

similar factors and causes. We also identified that Transpower has implemented the improvement initiatives that it identified. In our opinion, this is consistent with GIP.

218. For planned outages, our initial review has found that Transpower undertakes detailed planning that includes risk based prioritisation of work on the 27 selected circuits. We have not identified concerns that Transpower's work planning and prioritisation is not aligned with GIP.

219. We did identify a potential issue regarding the quantification of the impact on market prices from outages. Our initial finding that Transpower does apply GIP in works planning and prioritisation is based on our, as yet unqualified, assumption that impact on market prices is considered.

220. This lack of evidence indicates that Transpower did not undertake a risk assessment when the initial volume reduction was made and that this was inconsistent with GIP.

Is Transpower's long term strategic response to grillage management aligned with GIP?

221. The long term strategic actions that Transpower took in response to its identification of increasing costs and the resulting budget blow-out included:

a) monitoring of regulatory compliance performance through the CGT structure. This provided an early escalation pathway for the issues to be resolved and the governance framework through which actions taken could be monitored;

b) the CGT's initiation of the Portfolio Savings Initiative that implemented 6 actions resulting in a revised foundations strategy and grillage replacement forecast;

c) engagement of an independent expert (BECA) to study the options Transpower had developed internally and assess the ongoing risks of the revised strategic approach; and

d) continuing focus on further options to improve its approach to grillage management through the use of a cathodic protection solution.

222. We consider that, in taking these actions, Transpower responded appropriately to the increasing costs of its grillage replacements an refurbishments and acted consistently with GIP.

Causes of potential concern that we identified

223. In addition to the issues identified above, we noted that the documents provided by Transpower contained references to the concept of an RCP2 'allowance' for Grillage R&R quantities and expenditure.[32] Our understanding is that the price/quality regulation does not impose allowances or limits by asset class; instead, it provides an overall revenue envelope within which Transpower must work. This framework allows Transpower to apply substitution of expenditure between asset classes as it responds to changes in requirements and revisions to original forecasting.

224. We found that whilst the concept of individual asset class allowances is used to establish and monitor expenditure, Transpower has established a substitution approval process that should allow it to take advantage of its ability to substitute expenditure between asset classes. It is not clear why the initial response to the increasing cost of grillage R&R did not include consideration of a substitution option.

225. We also noted that, in addition to the Commission's RCP2 determination, Transpower applied a self-imposed 7.5% efficiency reduction. For grillage R&R, this has not been achievable, however efficiency gains in other asset classes could have been used to continue the higher cost grillage programme until the revised strategy was finalised.

[32] Grillages (Draft for Strata Review pre formal release), Page 7, Attachment 1.0

Doing this could have addressed any concerns regarding the risk implications from an immediate reduction in grillage volumes.

Number of insulators replaced

226. Table 3 shows that in 2015-16 and 2016-17 Transpower replaced a significantly lower number of insulators than the collar for both years.

Table 6: Transpower's performance against quality standards for 2016 and 2017

	Insulators Replacement Volume Measure			
	Target	Cap	Collar	Actual
2015 - 16	1352	1647	1417	755
2016 - 17	1466	1581	1351	887

Sources: Transpower Annual Compliance Reports

227. In 2015-16 56% fewer than expected insulators were replaced. In 2016-17 60% fewer than targeted replacements were completed. Documentation provided by Transpower indicates that the reduction in R&R expenditure against the RCP2 forecast was estimated to be $7 million which is 11% of the RCP2 forecast. The documents are not clear if an efficiency reduction had been placed on the insulator R&R and how this would relate to the projected savings.

228. At May 2017 Transpower's forecasts for insulator replacements during RCP2 was 4,555 which is a reduction of 56% of the original RCP2 target.

Our identification of the relevant factors

229. Transpower's explanation for the lower replacement numbers provided in its Compliance Statement was:

> *more recent condition assessment information was utilised in an improved asset health model to identify a lower volume that could be delivered without increasing the asset risk.*

230. The above statement is consistent with that provided in the Substitution Request made to the CGT in May 2017.

> *More rigorous analysis and review of CA data plus better asset health modelling has shown that some of the original RCP2 estimates were slightly conservative In the volume of Insulator replacement required. The modelling now Indicates this level of work is more likely to occur in RCP3/4.*

231. Transpower's view[33] is that there are two contributing factors to the volume reduction:

1. isolated low-quality condition assessment results affected its view on RCP2 volumes; and
2. changes it made to calibrate the asset health model with actual insulator replacement practice.

232. In our assessment of the relevant factors we have focused on:

1. claimed errors in condition assessment data and why these were not addressed earlier; and

[33] CC_investigation_Quality_breach_Insulators_29June2018, page 2

2. if it is reasonable that the recalibrated asset model led to a significant reduction in insulator replacement volumes.

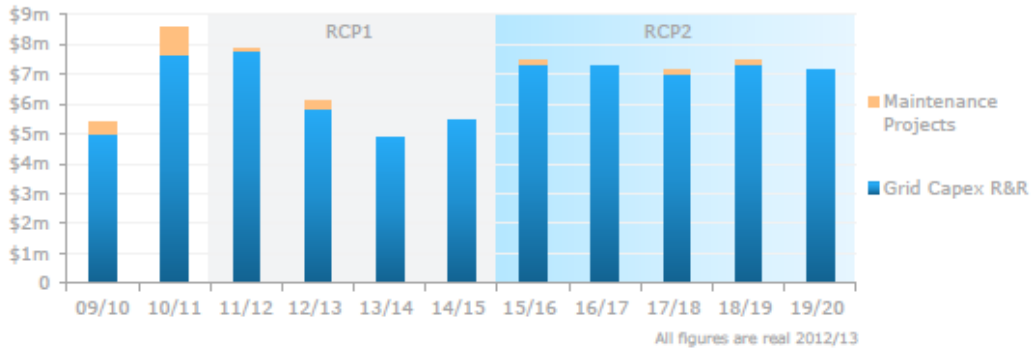
233. Each of these topics are discussed below.

Claimed errors in condition assessment data and why these were not addressed earlier

234. As noted in paragraph 113, Transpower's view is that its original RCP2 estimates were *slightly conservative in the volume of Insulator replacement required*. In our view, if the current volume reduction of 56% against original forecast is appropriate, the original forecast was significantly, not slightly, conservative.

235. Figure 19 shows that the original RCP2 forecast insulator R&R capex was higher than actual costs in RCP1.

Figure 19: Insulator actual and forecast R&R capex for RCP1 and RCP2



Source: Transpower PD07 Portfolio Overview Document TL Insulators, page 4

Note: The Maintenance Project component (orange) was for the replacement of insulator hot-end hardware (alone) on 120 circuit spans.

The higher expenditure during 2010-2012 is attributed by Transpower to the accelerated replacements made prior to the Rugby World Cup.

236. Transpower's RCP2 Proposal identified that the forecast volumes for insulator projects had been based on location specific environment and insulator age.

> *Our approach to risk management for the insulator fleet is to manage asset condition (the main cause of failure). An insulator replacement model based on asset health has been developed to predict future insulator condition, taking into consideration the type of the insulator, age, and site environment (level of corrosivity)..*
>
> *Deterioration is largely driven by the environment within which the insulator operates (for example, saline coastal environment) and age of the asset. Failure of insulators has significant implications for both safety and reliability.*[34]

237. The insulator replacement model used for the original RCP2 forecast produced an asset health indication using a 0 to 100 scale (100 being the best condition possible). Insulators reaching a score of 20[35] or less were scheduled for replacement (see

[34] Transpower PD07 RCP2 Portfolio Overview Document TL Insulators, page 2

[35] A condition rating of 20 represented the point below which an insulator could no longer carry its design load or its electrical performance had become unreliable

Appendix B for further detail). The condition forecasting was used for glass and porcelain insulators only; however, these made up 80% of the insulator fleet. At the time, Transpower said that it needed to gain further experience with condition assessment and lifetime forecasting for its composite insulators.

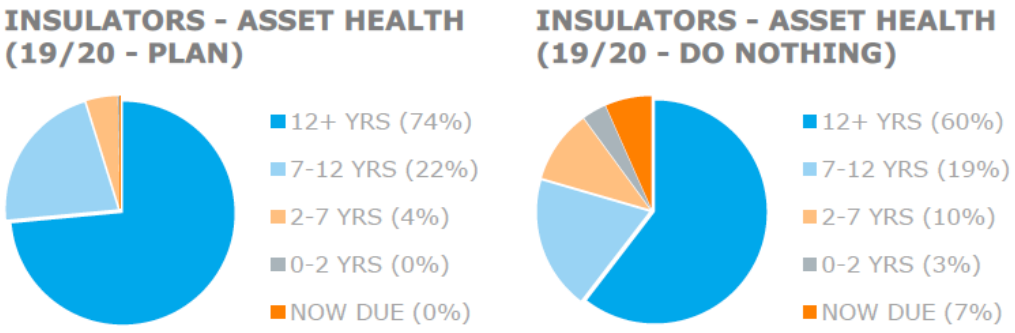
238. Using the insulator replacement model, Transpower forecast that 3,900 insulator circuit sets at or below 110 kV and 3,200 insulator circuit sets at 220 kV would reach CA scores of 20 during RCP2 and be replaced. The proposed replacement schedule used for the forecast was:

> *more than 1,000 insulator circuit sets per annum, being the minimum level of replacements required to replace only those sets reaching a CA score of 20;*
>
> *approximately 150 insulator circuit sets per annum to be replaced up to five years early (relative to predicted time of reaching a condition score of 20) by following the approach of reinsulating in consecutive blocks and structures; and*
>
> *approximately 300 insulator circuit sets per annum to be replaced as part of pole and replacements if they have a condition score between CA 20 and CA 60.*[36]

239. The above forecast is consistent with the targeted insulator replacement volumes in the 2015-16 and 2016-17 asset health measures.

240. The expected result of the insulator replacements was delivery of an insulator fleet in an improved health level at the end of RCP2 (Figure 20).

Figure 20: RCP2 proposal forecast Insulator asset health (remaining life)



Source: Transpower FS06 - Fleet Strategy - ACS Indoor Switchgear (table 10)

241. In 2013 Transpower became aware of a potential issue with the accuracy of its condition data following an insulator failure and conductor drop on the ATI-TRK- no 1 circuit. Further investigations identified more issues.

> *At the time the RCP2 submission was completed, Transpower did not have information to prove whether this was an isolated or systemic issue. We believed our CA processes were robust, but the volume of insulators predicted for RCP2 replacement was prudently increased in the submission assuming we might have a wider problem.*

[36] Transpower PD07 RCP2 Portfolio Overview Document TL Insulators, page 3

242. This occurred after Transpower had submitted its RCP2 submission to the Commission. Subsequently, Transpower found that the condition assessment data issue was isolated to a single service provider in one service area. Transpower states that *by this time the RCP2 submission was lodged with the allowance included*.

243. Transpower's RCP2 Portfolio Overview Document for TL insulators dated 15 November 2013 and its TL Conductors and Insulators Fleet Strategy did not identify or provide any information on adjustments for the potential condition data issue. Neither did Transpower identify the allowance nor the related data issue in its 27 June 2014 submission on the Commission's Draft Decision for RCP2[37]. In this document, Transpower proposes volume of insulator targets, caps and collars (Figure 21) for its asset health incentives.

Figure 21: Transpower's June 2014 proposed insulator asset health targets

Year	Revenue at risk	Target (no.)	Collar (no.)	Cap (no.)	Spread (no.)
2015/16	$216k	1,526	1,422	1,630	208
2016/17	$216k	1,466	1,362	1,570	208
2017/18	$216k	1,402	1,298	1,506	208
2018/19	$216k	1,315	1,211	1,419	208
2019/20	$216k	1,380	1,276	1,484	208
Total over RCP2[95]	**$1,080k**	**7,089**	**6,569**	**7,609**	**1,040**

Source: Transpower Response to IPP Draft Decision - 27 June 2014, table 18

244. In its 26 September 2014 submission[38] on the Commission's final decision on RCP2, Transpower identified errors in some of the volume targets, including insulators, that it provided for the asset health grid output measures and that these should be corrected to restore consistency between the targets and the asset volumes used to set the base capex allowance. Correcting the targets required consequential adjustments to the cap, collar and incentive rate settings.

245. For insulator replacements, Transpower identified that the error had a negligible impact adding a single insulator replacement to the total.

246. Transpower did not identify the potential condition assessment issues in any of the submissions it made to the Commission between the lodging of its RCP2 proposal and its September 2014 submission on the Commission's final decision.

247. Since the identification of the condition assessment data issue in early 2013 Transpower had several opportunities to disclose the issue to the Commission, but did not. Transpower has not provided us with any information on the size of the claimed adjustment made to its RCP2 forecast nor the net impact of its resolution of the issue on forecast volumes and expenditure.

248. Given the above, we consider that Transpower's claim that it had inflated its original volumes sufficient to create a material error in its forecast lacks credibility.

[37] Transpower Response to IPP Draft Decision - 27 June 2014
[38] TP_Sub_IPP_RCP2_FinalDrafting_26Sept2014

Is it reasonable that the recalibrated asset model led to a significant reduction in insulator replacement volumes?

249. We have also considered Transpower's second explanation point that its asset health model used for the RCP2 proposal has been subsequently improved through calibration. We found that the issue appears to concern both volumetric and unit cost assumptions.

250. In 2013 Transpower provided the following explanation on how it had applied unit costs to volumetric replacement estimates to form its forecast for insulator R&R capex.

> *A volumetric approach was used to estimate the expected cost of the insulator replacement programmes. This approach is appropriate because the programme of work is made up of a large number of relatively low-value, repetitive projects, with a well-defined scope. Volumetric estimates are less project specific than individual estimates and are based on the average cost to deliver similar projects historically…*
>
> *Historically cost estimates were developed using proprietary systems but we have transitioned to using the TEES (US Cost) system. Tailored 'building blocks' were developed for assets based on actual cost out turns from completed, equivalent works. This feedback-based process is used to derive average unit costs for future works.*
>
> *Assumptions made in the volumetric costs methodology for insulator and hardware replacements include:*
>
> - *average insulator costs are $4 k and $6.5 k per strain/suspension for voltages ≤110 kV, and 220 kV, respectively*
> - *unit cost for replacing insulator hot-end hardware alone is $3.3k per span (220 kV only)*
> - *the sample size of historic works is sufficiently large to provide a symmetric distribution for the cost*
> - *a large number of equivalent projects will be undertaken in future*
> - *cost 'building blocks' based on historic out turn costs capture the impact of past risks (updated building blocks were developed for RCP2); and*
> - *scope is reasonably well defined and reflects predetermined list of standard 'building blocks' applied to all estimates.*

251. The average insulator costs in the first bullet include the cost of replacing ancillary hardware at the same time as the insulator is replaced.

252. Transpower now considers that:

> *A significant contributor to the reduction in insulator volume was due to how the model scheduled replacement. In gathering CA data metrics are collected for hot and cold end hardware, and the insulator string itself. The asset health model forecast replacement based on the lowest component score and scheduled the replacement of the insulator set (Hardware and insulator) based on this score.*
>
> *Normal replacement practise is to replace both insulators and associated hardware, however when the hardware is at replacement criteria and the*

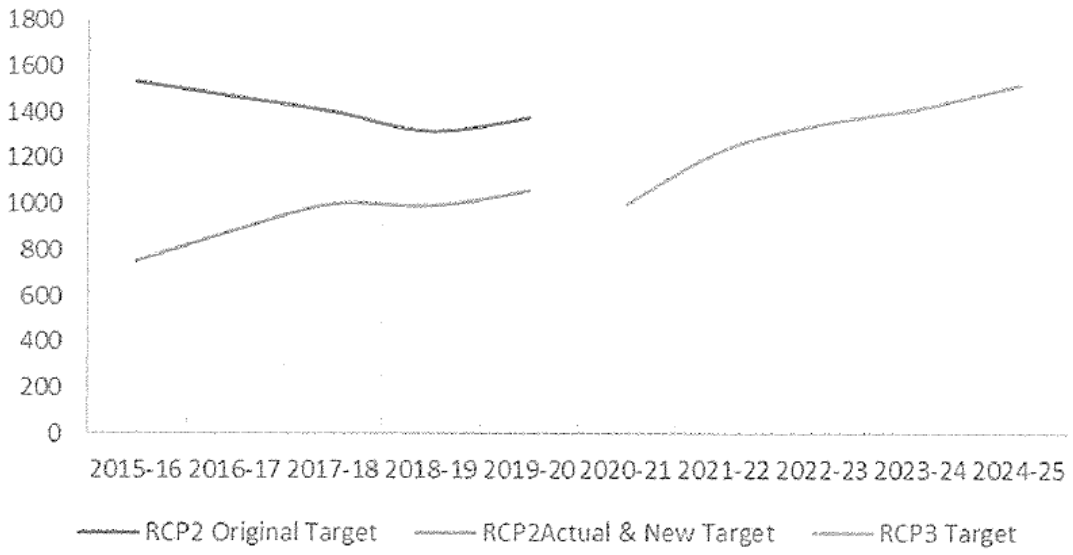
insulator is found to be at a very good condition, only the hardware was replaced. This has contributed to lower volumes of insulator replacements. The New Asset Health model has improved the scheduling, with the individual scores of each component used and an economic assessment undertaken to determine whether it is justified to replace the whole insulator set, or just the lowest rated hardware. The model now better forecasts insulator volumes against what we are seeing in the field.

253. Transpower's 2013 RCP2 Portfolio Overview Document indicates that the practice of replacing both insulators and insulator hardware was considered to be significantly more cost effective than Transpower's current practice.

Associated insulator hardware is replaced at the same time as the insulators under most current work programmes, as it is significantly more cost-effective to do in this way, even if the ancillary hardware has a higher condition score

254. Transpower appears to be applying a different cost/risk trade off than it did when forming its RCP2 forecasts. It is now deferring replacement of insulators when replacing hardware if the condition of the insulator allows this. The result will be an increase in future costs to replace the deferred insulator replacements. This effect can be seen in the revised insulator replacement trends provided by Transpower (Figure 3).

Figure 22: Insulator replacement volume trendlines (actual and forecast)



Source: Transpower Graph 1.0— Insulator Volume Trends across RCP2 and RCP3.

255. The change in practice to replacing insulators and insulator hardware separately on condition assessment will also have an impact on the unit costs; this should be applied to the forecast expenditure. Applying the unit costs from Transpower's 2013 TL Insulators Portfolio Overview Document (paragraph 173), we estimate that costs will be reduced possibly up to 50% ($6.5k - $3.3k) for 220kV circuits when only one component is replaced.

256. As Transpower has stated that the replacement rescheduling has made a significant contribution to forecast insulator volume reductions, we would also expect to see a

significant reduction in unit cost assumptions. Yet we are only seeing an 11%[39] reduction in R&R capex attributable to the reduced insulator volumes in RCP2.

257. Based on the information we have reviewed, Transpower's explanation for the significant reduction in volumes, but not in capex, is difficult to accept.

Our initial assessment of the appropriateness of the performance and if it reflected GIP

258. Whilst Transpower's initial failure to manage the quality of the condition assessment provided by its service provider could be considered to be not consistent with good practice, similar issues are not uncommon in electricity network businesses. This is especially the case for condition assessments as the practices are relatively new and the methodologies are developing and evolving with experience and now technologies.

259. Actions taken by Transpower to address the issues through broader investigation and removal of the errant contractor from its service provider list are consistent with GIP.

260. We have no information to assist in concluding why Transpower did not address the issues relating to its claimed inclusion of an adjustment to insulator replacement volumes much earlier. We consider that Transpower's failure to identify the adjustment in its RCP2 TL Insulators Portfolio Overview Document was a significant omission. This failure, combined with Transpower's omission to advise the Commission of the potential overestimation prior to the final establishment of the targets, caps and collars indicates that it did not follow GIP in regards to disclosure of information to a regulator.

261. To meet GIP changes in operational practices, such as those Transpower claims have driven a significant proportion of the reduced insulator volumes, would require a comprehensive business case and revisions to the relevant asset fleet strategy. We have not seen such analysis or documents. The presentations and minutes of the CGT give no indication that the required depth of analysis and justification has been reached. We consider that the lack of analysis and supporting documentation indicates that Transpower has not met GIP when it made significant changes to its operational practices.

Strata's initial views on above collar performance against Asset Health Measures

262. Strata's initial views on above collar performance against Asset Health Measures can be summarised as:

a) RCP2 grillage R&R expenditure forecasts based on the unit cost of easy access, less complex grillage works, is not good forecasting practice as it was bound to be exceeded and does not meet a GIP benchmark (if this is what Transpower did);

b) to meet GIP, a risk assessment should have been clearly documented, reported to the CGT, and approved by the CGT at the time grillage volumes were initially reduced below the collar to ensure that safety and reliability risks were not outside its tolerance level – Transpower did not provide evidence that this had occurred;

c) Transpower's omission to advise the Commission of the potential overestimation of insulator replacement requirements prior to the final establishment of the targets, caps and collars indicates that it did not follow GIP in regard to disclosure of information to a regulator; and

d) the lack of analysis and supporting documentation concerning reduced insulator replacements indicate that Transpower has not met GIP when it made significant changes to its operational practices.

[39] CGT Susbtuitution Request for Insulators — Extract May 2017.

Consideration of relevant GHD/Synergies' points on above collar performance against Asset Health Measures

Deferral of grillage replacements

263. Our understanding of GHD/Synergies' view is that, in its consideration of grillage replacement forecasts for RCP2:

> *Strata has unreasonably interpreted the available evidence regarding the basis of Transpower's RCP2 forecasts suggesting bias in the forecasts inconsistent with GEIP.*
>
> *Strata unreasonably characterises Transpower's actions to slow the replacement programme as a significant change in its operational practices that lacks analysis and supporting documentation, such that the change is inconsistent with GEIP. We consider that updated condition assessment data and improvements in the asset health model were the primary drivers of Transpower's decision to reduce insulator replacement volumes, which represents a prudent response to changing circumstances, including new asset condition information.*

264. GHD/Synergies confirms that the unit cost issue was:

> *based on Transpower's original building block rate being based on historic actual costs that later project work showed were more appropriate for smaller and easier access sites. Transpower identified that site-specific regional factors for larger and more difficult access sites had driven the updated unit rate higher*[40]

265. Strata's initial view was that when forecasting the RCP2 grillage R&R expenditure, its expectation was that Transpower would have used either profiled unit costs (i.e. a range of costs based on access and works complexity), or a blended unit cost (e.g. based on expected ease and difficulty of the total programme).

266. Strata relied on Transpower's explanation provided in its information[41] and discussion which suggested that the forecasts were based on the unit cost of easy access, less complex grillage works. Our view was that using such a rate for the entire portfolio R&R forecast is not good forecasting practice; it was bound to be exceeded and does not meet a GIP benchmark.

267. GHD/Synergies has formed a belief that *building block costs available would have been considered sufficiently representative*[42]. Based on its belief, GHD/Synergies disagreed with Strata that *Transpower knowingly relied solely on project costs based on easy access and lower complexity works.* Strata's Stage 1 comment on this issue did not state a view that Transpower 'knowingly' relied on inappropriate unit costs; our comment was:

> *When forecasting the RCP2 grillage R&R expenditure, we would have expected that Transpower would have either used profiled unit costs (i.e. a range of costs based on access and works complexity), or a blended unit cost (e.g. based on expected ease and difficulty of the total programme). Transpower's explanation suggests that the forecasts were based on the unit cost of easy access, less complex grillage works. Using such a rate for*

[40] GHD/Synergies, page 65
[41] Grillages (Draft for Strata Review_pre formal release), page 2
[42] GHD/Synergies, page 72

the entire portfolio R&R forecast is not good forecasting practice; it was bound to be exceeded and does not meet a GIP benchmark.

268. GHD/Synergies notes[43] that Transpower's current approach is to update its building block unit rates on a quarterly basis and that it considers this to be an important improvement to the cost estimation approach that Transpower applied in developing its RCP2 forecasts.

269. The above statement supports Strata's Stage 1 view that Transpower's unit cost approach, when forming its RCP2 forecast, could have been better.

270. GHD/Synergies agrees with Strata's initial finding that the reduction in grillage replacement volumes were initially made to remain within budget rather than on the basis of asset condition.

In response to this situation, Transpower chose to reduce work volumes to remain within budget until improvement initiatives could provide appropriate solutions. Transpower established a workgroup to investigate 13 initiatives to review the asset strategy and examine options to reduce costs.[44]

271. GHD/Synergies states that it disagrees with Strata that substitution of expenditure would have been appropriate in addressing the increase in unit rates for grillage replacement. However, Strata did not say that it would have been appropriate but rather than it should have been considered.

Transpower has established a substitution approval process that should allow it to take advantage of its ability to substitute expenditure between asset classes. It is not clear why the initial response to the increasing cost of grillage R&R did not include consideration of a substitution option.

272. GHD/Synergies appears to believe that there are rules that limit the use of substitution.

We understand that within the regulatory framework, Transpower is allowed to substitute expenditure between different asset classes to address any unforeseen changes in requirements from the original forecast. However, we are of the opinion that this fungibility in expenditure is intended to allow Transpower to reallocate funds to address events such as emergencies, extreme events or unforeseen changes that may affect network integrity or security of supply, rather than cost issues associated with lower risk assets.[45]

273. We have searched the *Commission's Transpower Capital Expenditure Input Methodology Determination 2015, Transpower Individual Price-Quality Path Determination 2015 and Companion paper to final determination of Transpower's individual price-quality path for 2015-2020* but found no mention of the phrases GHD/Synergies believes limit Transpower's ability to substitute.

274. The Commission has confirmed to Strata that it does not set such rules limiting the use of substitution.

275. It would be concerning if GHD/Synergies has identified a Transpower self-imposed limitation on substitution. However, we wonder why Transpower would do this.

[43] GHD/Synergies, page 72
[44] GHD/Synergies, page 65
[45] GHD/Synergies, page 73

276. Accordingly, we reject GHD/Synergies' criticism of Strata's point on the substitution option for grillage replacement costs, because GHD/Synergies has made an incorrect assumption/interpretation of the Commission's Inputs Methodologies.

277. GHD/Synergies' views on the absence of clear documentation and CGT approval when grillage volumes were reduced is summarised in the following paragraphs:

> *we disagree with Stata's initial finding that there was an increase in risk that was not appropriately considered by Transpower prior to the grillage refurbishment programme changes, because it ignores available evidence to the contrary – the overall risk profile for this asset class was assessed by Transpower to be low and was unaffected by the reduction in planned grillage refurbishments.*
>
> *the original intervention point for grillages was economic rather than based on asset criticality and so there was no prospect of a material increase in risk due to the deferred work (given Transpower had previously assessed the overall risk level as Low for these assets).*
>
> *with a nominal life expectancy of 70 years for grillages and a typical linear degradation rate over the life of the asset, grillages degrade slowly making a 10-month deferral not significant*[46]

278. In its discussion on this issue, GHD/Synergies does not identify any additional documents to those that Strata reviewed. The main difference in our views appears to be the extent to which Transpower considered the changed level of risk when it made the decision to reduce grillage replacement volumes to address its budget shortfall.

279. Both Strata and GHD/Synergies reference the BECA report which was received by Transpower in August 2016 and which led to a revised Asset Class Strategy – Transmission Lines Foundations (foundations strategy) approved on 30 January 2017. The extracts relied on by GHD/Synergies, together with its own experience, lead it to conclude that there was a low level of risk due to deferral of the grillage replacement programme. This is consistent with Transpower's view.

280. In its Stage 1 Draft Report, Strata also relied on Transpower's risk assessment contained in its April 2017 Transmission Lines – Foundations Asset Class Strategy (TP.FL01.0).

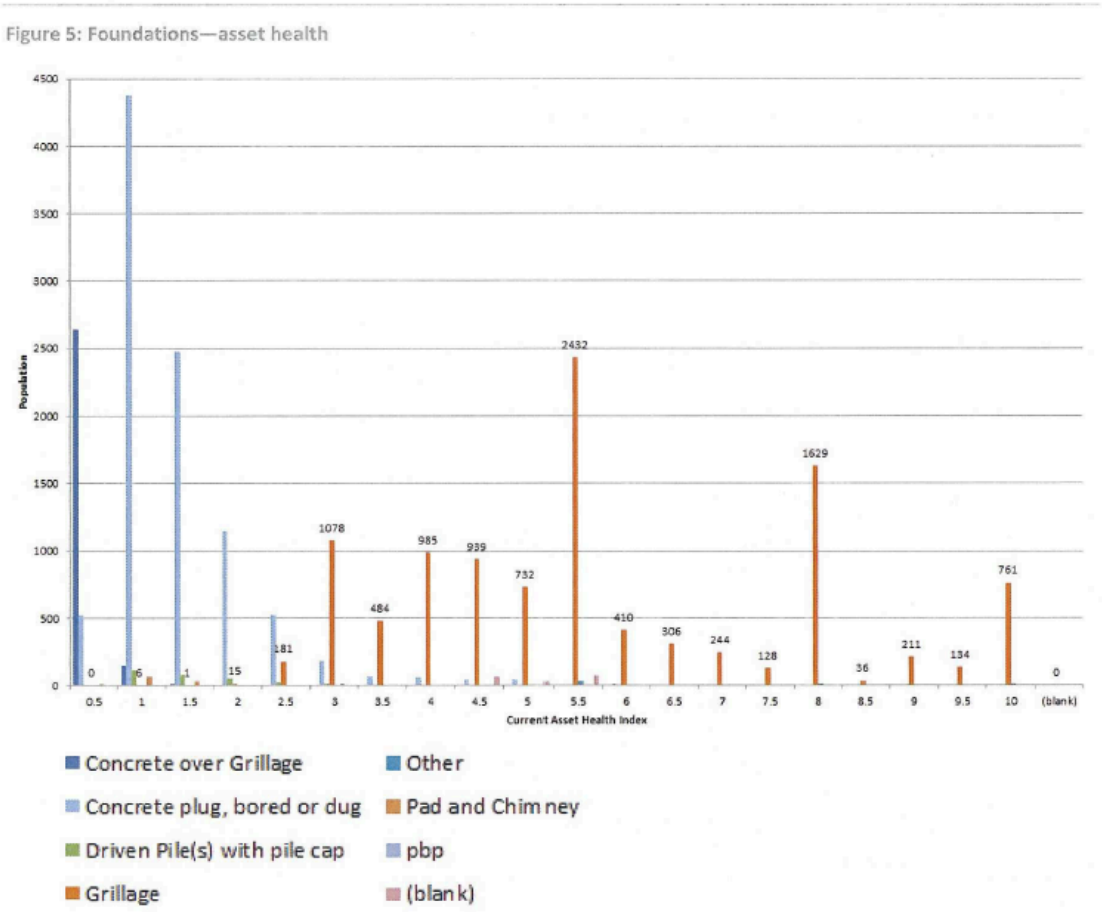
> *Buried steel grillage foundations are subject to below-ground corrosion, leading to the risk of foundation failure and subsequent tower failure. Failures have consequent repair costs, as well as safety, property and network performance impacts. Foundations buried at depth cannot be readily condition assessed, and we have only excavated a relatively small proportion of the total number of grillages. This means that the condition of a significant number of grillages is therefore unknown.*
>
> *Our below-ground sampling has informed our asset management approach, but there is a risk that the condition of any buried grillage is worse than predicted. Looking ahead, we will develop a probability-of-failure approach that considers the structural loading on each site, to identify those most at risk should the condition be worse than expected. TP.FL01.0 (P9) (P11)*
>
> *Recent studies, including full-scale foundation testing, suggest that under-strength foundations still exist. These structures continue to be investigated,*

[46] GHD/Synergies, page 66

with priority given to sites whose failure would pose significant risk to people, property or the Grid. TP.FL01.0 (P12)

281. The Foundations Class Asset Strategy also contains the following information on the Asset Health Indicator for foundations.

Figure 23: Foundations Asset Health



Source: Transpower Foundations Class Asset Strategy

282. The chart above indicates that in 2017 there were 2,770 grillages that had been assessed at condition grade 8 and above - an AHI score of 8 indicates that the planned intervention point has been reached. Addressing the 8 and above grillages over 10 years would require 277 interventions per year.

283. Given the assessment provided in Transpower's Foundations Asset Class Strategy, it is simply not possible to reach the conclusion that GHD/Synergies had done that, at that time, Transpower believed that it could defer grillage replacements without serious consideration of the risk. Transpower has not provided and GHD/Synergies has not identified evidence that the potential increase considered at an appropriate level, prior to the grillage refurbishment programme changes.

284. In our opinion, GHD/Synergies has provided insufficient information to support a conclusion that Transpower's understanding of grillage degradation, at the time it made the decision to reduce replacement numbers and defer work, would represent no change in risk.

285. In addition, the issue Strata raised was much more targeted than GHD/Synergies has presented. Our concern was that Transpower reduced grillage replacement volumes prior to commissioning the BECA report and prior to the development of its 2017 Foundations Class Asset Strategy. At this point, Transpower did not know what its new grillage replacement strategy would be and what number of grillage interventions it would need to take. In the documents Transpower provided for that period, we found insufficient evidence of risk assessments that would have supported a reduction in replacement volumes.

286. We did find evidence that, at the time of submitting its RCP2 proposal, Transpower's view was that risks would increase due to replacement deferral.

287. In its RCP2 proposal information, Transpower stated that grillage failure risk is managed most cost effectively by maintaining asset health so that the entire grillage fleet has an assessed condition score of CA 30 to 35 (lower CA score = worsening condition). Transpower stated that an average of 350 annual replacements would ensure that all grillages with a CA score less than 30 would be refurbished by 2020. Transpower considered and dismissed other options including deferring the grillage replacement by replacing at a lower CA:

> *Option 1 – refurbish grillages at a CA score of 20 by encasement in concrete, this being the level at which grillages have historically been refurbished. We are no longer taking this approach as the risks associated with foundation corrosion include rapidly increasing costs to maintain if left too late and reduced structural strength that could lead to foundation and tower failure.*
>
> *The key driver underlying the programme of refurbishment works is failure risk. Grillages with a CA score of 20 have lost 10% of the cross section of the steel that forms a grillage and cannot be relied upon to carry their design loads.*
>
> *Condition assessments have found that approximately 10% of grillages currently have CA 30 or less.* [47]

288. Transpower also noted in its POD that it had adopted a *conservative approach* involving targeting all grillages with a CA score of 40 or less for refurbishment. This means that the deferral decision would have been less conservative.

289. GHD/Synergies has not provided evidence that a risk assessment was undertaken by the Capital Governance Team at the time grillage replacements were initially reduced. GHD/Synergies formed its view of the level of risk on later evidence provided by the BECA review and more detailed condition assessment. At the time of the deferral decision, Transpower did not have this information and, based on its POD for grillages, should have considered that deferral of replacements would increase risk. Using the documentation provided by Transpower for our Stage 1 review, we could not conclude that an appropriate level of risk assessment had been undertaken at the time of deferral.

290. Accordingly, we raised this as an issue for the Commission to consider in Stage 2.

Insulator replacements

291. GHD/Synergies' view of Transpower's omission to advise the Commission of the potential overestimation of insulator replacement requirements are:

[47] Transpower RCP2 Portfolio Overview Document for Grillages PD05 - POD - TL Grillage

> *Transpower erred in not clearly identifying to the Commission the original adjustment in insulator volumes for RCP2 due to the condition assessment issue in its communication with the Commission.*[48]
>
> *We do not consider that Strata's linking of Transpower's failure to advise the Commission of a contingency factor built into its RCP2 insulator replacement volume forecasts is of sufficient magnitude to represent inconsistency with GEIP as suggested by Strata.*[49]

292. Strata's view is that accurate information disclosure is an important component of the Commission's regulatory regime. The reliance placed by the Commission and its advisors on the information provided by Transpower when assessing reasonable expenditure levels is critical to the 5 year regulatory revenue setting process. For RCP2, the implication of the over forecast in insulator replacements was not limited to the Quality Standard targets, caps and collars, but was relevant to the Commission's consideration of the reasonableness of Transpower's repex forecast.

293. We disagree with GHD/Synergies and consider that Transpower's omission to provide accurate information disclosure to the Commission was an appropriate issue for Strata to raise in its Stage 1 Draft Report.

294. In addition, GHD/Synergies states its belief that Strata *has insufficient evidence to imply Transpower may have misled the Commission regarding its forecast RCP2 replacement volumes*[50]*.* GHD/Synergies claims that Strata's implied view that Transpower 'misled' the Commission is set out in pages 37 to 39 of its Draft Stage 1 Report.

295. We have reviewed the relevant pages in the Stage 1 Draft Report and consider that, rather than making an unsupported, implied statement, the report lays out the facts Transpower provided in the information that it gave to the Commission and Strata. Specifically that *since the identification of the condition assessment data issue in early 2013 Transpower had several opportunities to disclose the issue to the Commission, but did not.*

296. It is likely that the factual information presented in Strata's report, regarding when Transpower was aware of the data discrepancy, has given GHD/Synergies the impression that Transpower may have misled the Commission. The Draft Stage 1 Report makes no comment on whether Transpower deliberately withheld the information.

297. GHD Synergies' views on the lack of analysis and supporting documentation concerning reduced insulator replacements are that:

> *Transpower has not changed the intervention point for asset replacement and rather has enhanced the insulator replacement decision making process. This is not an operational issue, and therefore we believe Strata is incorrect in suggesting a business case was required to address a change in operational practice.*
>
> *We disagree with Strata's contention that the change in asset replacement strategy is an operational change that should have been supported by a "comprehensive business case".*

298. As we noted in our Stage 1 Draft Report in May 2017, Transpower's forecast for insulator replacements during RCP2 was 4,555 which is a reduction of 56% of the

[48] GHD/Synergies, page 79
[49] GHD/Synergies, page 8
[50] GHD/Synergies, page 78

original RCP2 target. The result of this reduction was a $7 million saving against Transpower's RCP2 forecast. We consider that such reductions in replacement volumes are significant.

299. GHD/Synergies recognises that the reductions in insulator volumes reflect a change in Transpower's asset strategy[51]. Strata agrees with this. GHD/Synergies considers that the Insulator Portfolio Management Plan and Asset Class strategy that it has viewed provide sufficient documentation to support the change. Unfortunately, GHD/Synergies does not provide a reference for these documents.

300. In response to the Commission's information requests, Transpower provided its April 2018 Insulators and Fittings Asset Management Strategy[52] and Transmission Line Asset Attributes and Condition Assessment Part C: Insulators and Conductors[53]. We found that these documents did not contain sufficient discussion on the significant reductions in insulator replacement. In particular, we found that this documentation gave no indication of depth of analysis and justification that had been provided to the CGT. Accordingly, we raised this as an issue for potential further consideration.

301. GHD/Synergies considers that Strata's view on the need for a comprehensive business case is incorrect and that the revised asset strategy is sufficient.

302. On reflection, our use of the term 'comprehensive business case' can be read to imply a separate formal document and process. Given the information Transpower provided to the Commission for our Stage 1 review, we found insufficient consideration of the potential implications of the change in insulator asset strategy.

303. Our particular focus in making these comments was Transpower's comment that a significant contributor to the reduction in insulator volume was due to how the model scheduled replacement. In 2013, insulator hardware was replaced at the same time as the insulators, under most current work programmes; in RCP2, when the hardware met replacement criteria and the insulator was found to be at a very good condition, only the hardware was replaced.

304. Based on our initial review, we considered that the model scheduling of replacement was due to a change in practice and that this included a change in cost/risk trade off (i.e. deferring insulator replacement on condition vs at the time of replacing hardware). We would have expected some analysis, including economic analysis, to have been undertaken when making this change. We did not see this in the documents provided by Transpower.

305. For completeness, we do not consider that Transpower's insulator replacement strategy is inappropriate and not at GIP; our initial Stage 1 view was that the documentation that Transpower had provided did not give sufficient explanation on how it had considered the changes in practice that led to the significant reduction in insulator replacement. We consider that this was an appropriate point to identify to the Commission in our Stage 1 Draft Report.

[51] GHD/Synergies, Page 82
[52] TP.FL 02.01: Issue 1 APRIL 2018
[53] TP.SS 0217c TM Lines

Strata's revised views on above collar performance against Asset Health Measures

306. Strata's revised views on above collar performance against Asset Health Measures are:

a) RCP2 grillage R&R expenditure forecasts based on the unit cost of easy access, less complex grillage works, is not good forecasting practice as it was bound to be exceeded and does not meet a GIP benchmark;

b) whilst we do not consider that Transpower's grillage replacement strategy is inappropriate and not at GIP, a risk assessment should have been clearly documented, reported to the CGT, and approved by the CGT at the time grillage volumes were initially reduced below the collar to ensure that safety and reliability risks were not outside its tolerance level –Transpower has not provided evidence that it did undertake sufficient risk analysis and, in the absence of such evidence, our opinion is that Transpower did not meet the GIP criteria when making its deferral decision;

c) Transpower's omission to advise the Commission of the potential overestimation of insulator replacement requirements prior to the final establishment of the targets, caps and collars indicates that it did not follow GIP in regard to disclosure of information to a regulator; and

d) whilst we do not consider that Transpower's insulator replacement strategy is inappropriate and not at GIP, the lack of analysis and supporting documentation concerning reduced insulator replacements indicate that Transpower has not met GIP when it made significant changes to its operational practices.

Appendix A Glossary

Act	Part 4A of the Commerce Act 1986
AHI	Asset health index
AMP	Asset Management Plan
AP	Assessment Period
Capex	Capital Expenditure
CIMS	Coordinated Incident Management System
CoG	Concrete over Grillage
Commission	The Commerce Commission
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IPP	Individual Price Path
EDB	Electricity Distribution Business
GIP	Good Industry Practice
MWh	Megawatt-hour, a unit of electrical energy
NERG	National Event Review Group
HSWA	The Health and Safety at Work Act 2015
ICP	Installation Connection Point
ID	Information disclosure
kV	Kilovolts (= 1000 volts), a unit of electrical voltage
MVA	Megavolt-ampere, a unit of electrical power
MW	Megawatt, a unit of electrical power
OLTC	On Line Tap Changer
OOU	Onset of unreliability
Opex	Operational expenditure
SFIR	System Fault and Interruption Report

Strata	Strata Energy Consulting Limited
Transpower	Transpower New Zealand Limited
VoLL	Value of Lost Load

Appendix B RCP2 Circuit availability data

B.1 The charts below gives a summary of the data provided by Transpower for outages in 2015-16 on the selected circuits for the RCP2 availability measure. The areas highlighted in yellow indicate zero values in the data.

	Planned		Unplanned		Total	
	Number of Interruptions	*Minutes*	*Number of Interruptions*	*Minutes*	*Number of Interruptions*	*Minutes*
Outage Start Date	RCP2 Outages	RCP2 Total Duration	RCP2 Outages	RCP2 Total Duration	RCP2 Outages	RCP2 Total Duration
Wednesday, 1 July 2015	1	597	0	0	1	597
Thursday, 2 July 2015	1	606	0	0	1	606
Friday, 3 July 2015	1	509	0	0	1	509
Monday, 6 July 2015	1	571	0	0	1	571
Tuesday, 7 July 2015	1	573	0	0	1	573
Saturday, 11 July 2015	1	355	0	0	1	355
Monday, 13 July 2015	1	594	0	0	1	594
Tuesday, 14 July 2015	1	597	0	0	1	597
Wednesday, 15 July 2015	1	515	0	0	1	515
Thursday, 16 July 2015	1	522	0	0	1	522
Tuesday, 28 July 2015	1	732	0	0	1	732
Tuesday, 11 August 2015	0	0	1	141	1	141
Friday, 14 August 2015	2	5	0	0	2	5
Saturday, 22 August 2015	1	9	0	0	1	9
Tuesday, 25 August 2015	1	120	0	0	1	120
Thursday, 27 August 2015	0	0	1	0	1	0
Tuesday, 1 September 2015	1	710	0	0	1	710
Friday, 4 September 2015	0	0	1	9	1	9
Sunday, 20 September 2015	0	0	1	384	1	384
Sunday, 27 September 2015	0	0	2	2,825	2	2,825
Monday, 28 September 2015	1	1,958	0	0	1	1,958
Monday, 5 October 2015	1	10,603	0	0	1	10,603
Wednesday, 7 October 2015	1	66	0	0	1	66
Friday, 9 October 2015	1	414	0	0	1	414
Monday, 12 October 2015	1	6,342	0	0	1	6,342
Tuesday, 13 October 2015	1	10,557	0	0	1	10,557
Thursday, 22 October 2015	1	42	0	0	1	42
Monday, 2 November 2015	1	13,482	0	0	1	13,482
Friday, 6 November 2015	2	143	1	227	3	370
Monday, 9 November 2015	1	6,184	0	0	1	6,184
Thursday, 12 November 2015	1	11,915	2	59	3	11,974
Friday, 13 November 2015	0	0	1	0	1	0
Monday, 16 November 2015	1	6,469	0	0	1	6,469
Monday, 30 November 2015	2	606	0	0	2	606
Saturday, 12 December 2015	0	0	1	0	1	0
Sunday, 13 December 2015	0	0	2	0	2	0
Monday, 14 December 2015	1	1,958	0	0	1	1,958
Tuesday, 15 December 2015	1	3,270	0	0	1	3,270
Wednesday, 16 December 2015	1	2,013	0	0	1	2,013
Monday, 28 December 2015	0	0	1	0	1	0
Tuesday, 19 January 2016	1	330	0	0	1	330
Saturday, 23 January 2016	0	0	2	92	2	92
Monday, 25 January 2016	1	6,580	0	0	1	6,580
Wednesday, 27 January 2016	0	0	1	0	1	0
Friday, 29 January 2016	0	0	1	0	1	0
Monday, 1 February 2016	1	6,394	0	0	1	6,394
Tuesday, 9 February 2016	1	126	0	0	1	126
Wednesday, 10 February 2016	1	10,699	0	0	1	10,699
Wednesday, 17 February 2016	0	0	1	77	1	77
Sunday, 21 February 2016	2	740	0	0	2	740
Monday, 7 March 2016	1	458	0	0	1	458
Monday, 14 March 2016	1	6,436	0	0	1	6,436
Saturday, 19 March 2016	1	254	0	0	1	254
Monday, 21 March 2016	1	2,045	0	0	1	2,045
Thursday, 24 March 2016	1	492	0	0	1	492
Thursday, 7 April 2016	1	276	0	0	1	276
Sunday, 10 April 2016	1	614	0	0	1	614
Monday, 11 April 2016	1	539	0	0	1	539
Tuesday, 12 April 2016	1	537	0	0	1	537
Wednesday, 13 April 2016	1	541	0	0	1	541
Thursday, 14 April 2016	0	0	1	0	1	0
Thursday, 21 April 2016	1	486	0	0	1	486
Friday, 22 April 2016	2	961	0	0	2	961
Monday, 2 May 2016	1	4,966	0	0	1	4,966
Thursday, 5 May 2016	1	535	0	0	1	535
Friday, 6 May 2016	1	548	0	0	1	548
Thursday, 12 May 2016	0	0	1	35	1	35
Sunday, 22 May 2016	1	329	0	0	1	329
Wednesday, 25 May 2016	1	437	0	0	1	437
Tuesday, 31 May 2016	1	4,912	0	0	1	4,912
Saturday, 11 June 2016	1	47	0	0	1	47
Sunday, 12 June 2016	1	243	0	0	1	243
Thursday, 16 June 2016	1	450	0	0	1	450
Saturday, 18 June 2016	1	167	0	0	1	167
Sunday, 26 June 2016	1	63	0	0	1	63

Appendix C Insulator condition assessment grates

C.1 Transpower's RCP2 condition assessment guidelines for insulators (strings, glass/porcelain) are provided in the table below

CA score	Guidelines
100	New insulators.
90	Dulling of galvanised metal components.
80	Roughening of galvanised surfaces.
70	Roughening of galvanised metal parts.
60	Specks of rust appearing on pin beneath insulator skirt, more so on prevailing wind side. Possible wear to ball and socket on lightly loaded strings (jumper string), especially in windy locations.
50	Pin rust progressing to slight pitting.
40	Specks of rust appearing on cap. Increased corrosion to skirt end of ball pin, flaking rust, some loss of metal.
30	Ball and socket joint may be frozen by corrosion.
20 (R/C)	Metal loss from corrosion to ball pin cross section resulting in a 16% reduction of effective pin diameter (0.84 of original). "Complete freezing up" of units, due to corrosion of ball/socket joints. Alternatively the string may be badly damaged by flashover, but still functioning.
10	Significant metal loss on pins. Glass units may begin to shatter, and porcelain units fail electrical tests due to internal or external cracking.
0	Pin corrosion or extreme flashover damage. Excessive loss of ball pin diameter. Ball pin fatigued/cracked. Electrical test failure.

Table 19: Insulator (strings, glass/porcelain) Condition Assessment Guidelines

Source: Transpower RCP2 documents FS03 - Fleet Strategy - TL Conductors and Insulators

Appendix D Grid performance measures for RCP2

D.1 Reproduced from Part 4 of the Commerce Commission's Transpower Individual Price-Quality Path Determination 2015.[54]

Description: grid output measure	Category / Circuits / Disclosure year	Measure reference	Grid output target	Cap	Collar	Grid output incentive rate ($000)
[Column 1]	[Column 2]	[Column 3]	[Column 4]	[Column 5]	[Column 6]	[Column 7]
Measures of grid performance						
Number of unplanned interruptions	High Priority	GP1A	2	0	4	606
	Important	GP1B	9	4	14	242
	Standard	GP1C	26	21	31	133
	Generator	GP1D	11	6	16	133
	N-security	GP1E	56	38	74	10
Average duration (minutes) of unplanned interruptions	High Priority	GP2A	70	30	110	15
	Important	GP2B	100	30	170	9
	Standard	GP2C	65	0	130	5
	Generator	GP2D	130	50	210	4
	N-security	GP2E	80	45	115	3
Duration (minutes) of P90 unplanned interruption	High Priority	GP3A	120	80	160	15
	Important	GP3B	240	170	310	9
	Standard	GP3C	130	60	200	5
	Generator	GP3D	350	260	440	4
	N-security	GP3E	215	170	260	3
Asset performance measures						
HVDC availability (%)		AP1	98.5	99.5	97.5	1000
HVAC availability (%)	Selected circuits	AP2	99.6	100	99.2	2500
Asset health grid output measures						
Number of transmission towers refurbished or replaced	2015/16	AH1 (15/16)	427	467	387	28.2
	2016/17	AH1 (16/17)	523	563	483	28.2

[54] https://comcom.govt.nz/__data/assets/pdf_file/0029/78554/2014-NZCC-35-Final-Transpower-Individual-Price-Quality-Path-Determination-28-November-2014.pdf

Description: grid output measure	Category / Circuits / Disclosure year	Measure reference	Grid output target	Cap	Collar	Grid output incentive rate ($000)
[Column 1]	[Column 2]	[Column 3]	[Column 4]	[Column 5]	[Column 6]	[Column 7]
	2017/18	AH1 (17/18)	517	557	477	28.2
	2018/19	AH1 (18/19)	558	598	518	28.2
	2019/20	AH1 (19/20)	555	595	515	28.2
Number of grillages commissioned	2015/16	AH2 (15/16)	339	370	308	9.9
	2016/17	AH2 (16/17)	396	427	365	9.9
	2017/18	AH2 (17/18)	408	439	377	9.9
	2018/19	AH2 (18/19)	390	421	359	9.9
	2019/20	AH2 (19/20)	377	408	346	9.9
Number of insulators commissioned	2015/16	AH3 (15/16)	1532	1647	1417	1.9
	2016/17	AH3 (16/17)	1466	1581	1351	1.9
	2017/18	AH3 (17/18)	1402	1517	1287	1.9
	2018/19	AH3 (18/19)	1315	1430	1200	1.9
	2019/20	AH3 (19/20)	1375	1490	1260	1.9
Number of outdoor circuit breakers commissioned	2019/20	AH4	141	153	129	47.5
Number of power transformers commissioned	2019/20	AH5	26	28	24	1,370

Description: grid output measure	Category / Circuits / Disclosure year	Measure reference	Grid output target	Cap	Collar	Grid output incentive rate ($000)
[Column 1]	[Column 2]	[Column 3]	[Column 4]	[Column 5]	[Column 6]	[Column 7]
Number of outdoor to indoor conversions commissioned	2019/20	AH6	15	16	14	2,710

Appendix E

E.1 The following is reproduced from Transpower's System Fault Interruption Report (SFIR ref SN16064) for the interruption on 4th April 2016 for supply from the Central Park T3 transformer to Meridian Energy's West Wind facility.

DESCRIPTION OF FAULT

E.2 At 1220 RCC was advised by the service provider at Central Park that 13's Neutral Earthing Resistor was overheating. Relays in the Central Park control room indicated a large cun-ent imbalance on T3 and high circulating current through the transformer neutral. At 1223 RCC tapped the Central Park T3 supply transformer to tap 5 but the fault remained. RCC advised West Wind Meridian of a possible outage to Central Park - West Wind circuit 3 at 1231. RCC advised the GAO Duty Manager and NCC of Central Park 13 fault and Central Park -West Wind circuit 3 outage at 1231. The Service Delivery Manager approved the outage to Central Park 13. At 1301 NCC was advised of a short notice outage request (SNOR) for Central Park T3 due the high temperature of its NER.

E.3 At 1305 RCC manually opened West Wind CB262 as its one terminal end of Central Park - West Wind - Wilton circuit 3.

E.4 At 1307 there was a forced outage to Central Park 13 supply transformer to investigate a fault which resulted in its NER to overheat.

E.5 At 1308 there was a forced outage to Central Park - West Wind - Wilton circuit 3 for work on Central Park T3.

E.6 An inspection found 13's yellow phase right hand OLTC gearbox had failed so its tap changer was on tap 1 but its mechanism box indicated tap 7. Red and blue phase OLTC's were also on tap 7. 13's yellow phase right hand gear box was dismantled to find a worn bevel gear that had failed due to failed bearings and misalignment. Spare parts were unable to be sourced from Transpower due to the tight deadline so the gearbox was sent to Bettany gears for new bevel gears to be made with a complete overhaul of the gearbox. 13's red phase and blue phase OLTC gearboxes were inspected and found in good working condition. These gearboxes were re-greased and sealed. Severe motor bearing noise was found in red and yellow phase on load tap changers. These motors were refurbished with new bearings and cooling fans. Motors were tested and reinstated. A bearing noise was identified in the transfer case of the yellow phase mechanism

E.7 box and a specialist may be needed to examine this at the next outage. NER3 was dismantled, inspected and tested. This neutral earthing resistor had signs of heat discoloration on the stainless-steel fittings as expected however it tested to 5 ohms as per its nameplate and was good for service. A full suite of tests were =Tied out on all 3 units (see Maximo work order 1403574).

E.8 On 9 April 2016 at 1203 RCC removed partial NIS on Central Park T3 and tested its OLTC via SCADA control successfully under service providers instruction.

E.9 Central Park — West Wind— Wilton circuit 3 was returned to service on 4 April 2016 at 1902. Central Park T3 supply transformer was returned to service on 9 April 2016 at 1337.

E.10 There was a partial interruption of connection to Meridian Energy Ltd at West Wind for 357 minutes. Note Meridian Energy Ltd's West Wind T1 supply transformer, connected to Central Park - West Wind - Wilton circuit 2, remained in service during this incident.