Quality non-compliance Report

Horizon Networks Limited's non-compliance with the DPP quality standards for the 2018 Assessment Period

A report for

The Commerce Commission

9 March 2020

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.

More information about Strata Energy Consulting can be found on www.strataenergy.co.nz

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Executive summary

1) The Commerce Commission (Commission) engaged Strata Energy Consulting Limited (Strata) to undertake an investigation into the causes of Horizon Energy Limited (Horizon) contraventions for the 2017 and 2018 Assessment Periods of the Quality Standards in the Electricity Distribution Services Default Price-Quality Determination 2015 (DPP Determination 2015) made by the Commission under section 52P of the Act, and potential enforcement action in respect of those contraventions under sections 87(1)(a) and 87(2)(b)(ii) of the Act.
2) Strata's investigation included a desktop based study of the relevant documentation provided by Horizon in its regulatory disclosures and through its responses to the Commission's requests for additional information. On-site discussions were held with Horizon in January 2019.
3) Strata submitted to the Commission a Draft Quality Non-compliance Report (draft report) on the 17th June 2019. The Commission provided Horizon with a copy of Strata's draft report and Horizon responded by providing its views on:
    1. factual errors that, in its view, exist in the draft report;
    2. conclusions reached in the draft report that, in its view, are not correct; and
    3. matters in the draft report that, in its view are confidential and should be redacted from a publicly released version of the report.
4) In August 2019, Horizon supplied the Commission with its response[1] to Strata's draft report and the Commission asked Strata to consider Horizon's views and review the opinions set out in the draft report.
5) This report is the Final Quality Non-compliance Report in which Strata sets out its:
    1. initial findings and opinions contained in its draft report;
    2. consideration of additional information provided by Horizon in its response document;
    3. revised and final findings and opinions; and
    4. advice on additional concerns arising from Horizon's response document.
6) This report also describes the approach we took to complete the investigation and provides our responses to specific questions asked by the Commission including information and evidence to support our opinions.

Strata's revised and final findings and opinions from its investigation are:

7) By exceeding its reliability assessment limits in both 2017 and 2018, Horizon was in breach of the Quality Standard under Clause 9.1 of the DPP. We identified that the factors contributing to Horizon's contravention of the Quality Standard were:
    1. the impact on SAIDI attributable to unplanned outages on two major event days in the 2017 Assessment Period (AP 2017);
    2. the impact on SAIDI attributable to unplanned outages at times other than major event days in AP 2017;

[1] Horizon Response to Strata Draft Report 13 August 2019

3. the impact on SAIDI attributable to unplanned outages on eleven major event days in the 2018 Assessment Period (AP 2018);
4. the impact on SAIFI attributable to unplanned outages on eleven major event days in AP 2018; and
5. the impact on SAIDI attributable to unplanned outages at times other than major event days in AP 2018.

8) We researched Horizon's explanations for its non-compliance in annual reliability assessments and sought further explanation during an on-site visit to Horizon's office in Whakatāne. Our on-site visit included a field inspection component to gain an understanding of the network environment and to see examples of Horizon's asset management in practice.

Horizon's explanation was that adverse weather was the primary factor in its non-compliance

9) The understanding that we formed from Horizon's explanations for its non-compliance is summarised as:

1. Horizon considers that the exceedance of its annual reliability assessment SAIDI limit in AP 2017 was due to two MED attributed to weather and defective equipment - both beyond the reasonable control of Horizon;
2. Horizon considers that its exceedance of the annual reliability assessment SAIDI and SAIFI limits in AP 2018 was due to seven adverse weather related MED events beyond the reasonable control of Horizon, and the subsequent spill-over of unplanned SAIDI, and the need for planned outages to undertake repair work; and
3. Horizon considers that exceedance of annual reliability assessment limits in AP 2017 and AP 2018 was not due to deterioration of its network assets.

10) Horizon has presented its concerns to the Commission regarding the current normalisation process which it believes does not adequately normalise for weather related events. As this was outside the scope of this review, we have not addressed the normalisation adequacy issue.

We found that there were other factors that contributed to non-compliance

11) In this report, we take into account the circumstances of the adverse weather events and the impact on Horizon's network, and give consideration to the health of, and performance of, the network assets. We also examine the asset and operational management practices that Horizon applied prior to and during the events. We reach the following views on Horizon's explanations for its non-compliance.

12) We agree with Horizon that:

1. the ex-tropical cyclone events in AP 2018 made material contributions to its exceedance of the annual reliability assessment SAIDI limit in AP 2018;
2. the storms in AP 2018 were significant events and defective equipment related SAIDI will have been impacted by spill-over[2] related to these events;
3. spill-over effects from the AP 2018 storms, including increased need for planned repair work, had a material impact on Horizon's exceedance of the AP 2018 SAIDI limit in its annual reliability assessment; and
4. underlying deterioration of the overhead network assets was not a factor in Horizon's non-compliance.

[2] Faults and supply interruptions occurring within ten days following the event that are directly related to the event.

13) We disagree with Horizon that the lightning strike which damaged a surge arrestor on 10 April 2016 was the primary cause of this MED. Our opinion is that the primary cause was the ongoing reliance on the single, vulnerable Snake Hill feeder for supplies to the Galatea region. In our opinion, this situation should have been remedied in the seven years since it first arose.

14) Nothing that Horizon provided in its response document packages has changed our opinion that, from a technical perspective, the resolution of the Aniwhenua generation issue should not have taken seven years. In our opinion, the lack of swift progress during the 2009 to 2014 period was the primary cause of the 10 April 2016 MED. In forming this opinion, we acknowledge that Horizon identified, implemented and completed projects that have now improved reliability in the Galatea region.

15) In addition, we consider that:

1. in not undertaking a timely and robust post transformer failure event investigation in 2009, Horizon did not meet good industry practice;
2. Horizon could have, but did not identify, install and commission the required solution at the earliest date and because of this, missed an opportunity to mitigate the effects of the 2014 and 2016 MED in the Galatea region; and
3. if reinstatement of the Aniwhenua connection had been undertaken earlier, the MED in 2016 would not have occurred.

16) The documents that Horizon has provided clearly identify that the technical solution to the Aniwhenua reinstatement was completed in July 2014, well before the 2016 MED. Yet the Aniwhenua connection was only reinstated in November 2016. The reason for this delay clearly contributed to the impact of the 2016 MED in the Galatea area but Horizon has failed to provide a reasonable explanation or any evidence to support its view that the delay was outside its control.

17) In the absence of clear evidence to the contrary, Strata's opinion remains that resolution of the Aniwhenua generation connection issue should not have taken seven years and that Horizon failed to act consistently with good industry practice in its management of the Aniwhenua connection restoration.

18) The Commission also asked that we identify any particular instance where any failure to act in accordance with good industry practice was substantial.

19) Through our review of documentation, data and on-site discussions and inspections we have found:

1. the characteristics of the network, such as its design and construction, mitigated the impact of adverse weather conditions;
2. indications that Horizon’s expenditure on maintaining its network was potentially below optimum levels prior to 2013, but saw no evidence that this had made a material contribution to its non-compliance; and
3. that whilst there was an increase in defective equipment interruptions from 2009, the evidence indicated that this was not due to underlying deterioration of network assets.

20) We found that Horizon’s asset management practices were generally at good industry practice and were in several aspects above the level we have seen in our reviews of other New Zealand electricity distribution businesses (EDB).

21) We acknowledge Horizon’s commitment to continuing improvement in its asset management practices exemplified by its commitment to achieve ISO:55000 asset management standard accreditation by 2022. We consider that this provides independent assurance of the developing quality of Horizon’s asset management systems and documentation.

22) In addition, we consider that there is an important action that Horizon needs to reassess and strengthen. We found that, consistent with findings in recent reviews of other EDBs, whilst Horizon undertakes post event reviews, these fall short of good industry practice.

We consider that the additional actions that Horizon is taking will improve reliability performance

23) We consider that Horizon has taken a well-structured approach when setting policies, strategies and plans for improvement. In doing this, Horizon uses the development of in-house solutions and leverages off external experience and systems. Horizon provided clear descriptions of its development plans for asset management practices and network operations. The explanations indicated that Horizon has set long term strategies and implementation plans for key functions that impact on the reliability of electricity distribution services.

24) In addition, Horizon demonstrated that it has established an innovative culture and provided evidence that this is delivering real and quantifiable improvements. Many of these activities are targeted at the improvement of network reliability.

25) We reviewed several important initiatives that Horizon has implemented and/or plans to implement in the future. In particular, we found that Horizon's approach to fully informed asset lifecycle management including asset health, performance and risk based methodologies will deliver beyond good industry practice asset management.

26) We agree with Horizon's evaluations that the expected benefits of the improvements in asset management will be improved reliability at a lower cost.

Horizon should focus on the successful implementation of its improvement plans

27) We believe that the delivery of the intended improvements will be challenging but achievable. However, Horizon will need to take care that it secures the reliability improvements before it considers cutting investment in asset maintenance and replacements.

28) Horizon should continue its commitment to fully implement the asset management and operational improvements that it described in the documents and presentations. We have also provided our advice on improvements we consider Horizon should make in undertaking formal post event reviews that capture lessons from major interruption events.

29) Other than the above, we have identified no additional actions that we consider Horizon should be taking.

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1. Introduction, scope and approach

1. The Commerce Commission (the Commission) has engaged Strata Energy Consulting (Strata) to provide its expert opinion and advice in relation to Horizon Networks Limited's (Horizon) non-compliance with annual reliability assessments for the 2017 Assessment Period (AP2017) and the 2018 Assessment Period (AP2018).
2. Quality performance is measured by System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI). SAIDI measures interruption duration and is calculated as the average outage duration for each consumer connection in units of time. SAIFI measures interruption frequency and is calculated as the average number of interruptions that a consumer connection would experience over a year.
3. The Commission measures Horizon's performance against the Quality Standards each Assessment Period which are 12 month periods commencing on 1 April.
4. Horizon does not contravene the Quality Standard in respect of an Assessment Period if it either:
    a. complied with both of the annual reliability assessment (SAIDI & SAIFI) for the Assessment Period; or
    b. complied with both of the annual reliability assessment in the immediately preceding two Assessment Periods.
5. In AP2018, Horizon reported[3] its contravention of the Quality Standard due to failing to comply with the annual reliability assessments for AP2017 and AP2018.

1.1. Qualifications and experience of the reviewers

6. The people who undertook this review (the Reviewers) are:
    - William Alan Heaps – Managing Director of Strata Energy Consulting Ltd.; and
    - Alastair Glyn Jones – Managing Director of Induna Consulting Ltd.
7. The review panel was assisted by Richard Heaps, Associate Consulting Analyst with Strata Energy Consulting.

William Alan Heaps

8. William Alan Heaps is Managing Director of Strata Energy Consulting Limited which is an independent consultancy business specialising in energy supply and energy management. He is a qualified electrical engineer and member of the Institution of Engineering and Technology (MIET) and a member of the New Zealand Institute of Directors (MoID).
9. Mr Heaps has experience in many aspects of the electricity supply chain and has held several senior executive and governance positions in the energy sector. He was Commercial Manager for CentralPower, an electricity distributor, and General Manager of Energy Brokers, an electricity retail company. He managed the Wairakei and Ohaaki geothermal power stations for Electricity Corporation New Zealand and Contact Energy Limited and was General Manager, Commercial Services, with Transpower New Zealand Limited.
10. He was a Director of Christchurch's electricity distributor, Orion Networks Limited and Chairman of the Retail, Wholesale Market, Transmission and Investment Advisory Groups for

[3] Horizon Energy 2018 Default Price-Quality Path Compliance Statement

the Electricity Commission and Electricity Authority. He has also chaired several technical advisory groups for the electricity industry.

11. As Managing Director of Strata Energy Consulting Limited, Mr Heaps provides advice and consultancy services on energy issues to a range of clients in New Zealand, Australia, Singapore and Malaysia. Strata's clients include the major electricity users, electricity generators, retailers, distributors, governments and energy regulators. Mr Heaps currently advises the Security and Reliability Council (SRC), an industry committee required under section 20 of the Electricity Act 2010 to advise the Electricity Authority on electricity supply security and reliability issues. He has advised the SRC on issues relating to the management of risk and on the development of a risk management framework.

12. Mr Heaps has undertaken lead technical consultant roles on several major regulatory reviews of SP Power Assets (Singapore distribution and transmission), Powerlink (Queensland transmission), ElectraNet (South Australia transmission), SPAusNet (Victoria transmission), and Transpower New Zealand Limited (New Zealand Transmission). For the Public Utilities Office in Western Australia, he reviewed the legislative and regulatory framework for energy safety. He has provided expert evidence relating to resource consent applications for New Zealand electricity generation plant and, for the Australian Government Solicitor, relating to solar power generation. Mr Heaps has advised the Electricity Authority on its investigation of a major substation fire and associated power outage that occurred on a Transpower substation in Auckland. He has also been technical advisor to the Authority on reviews of major incidents on the power system.

13. Mr Heaps has undertaken several reviews of electricity distribution businesses for the Commission. He has advised the Commission on developing its Input Methodologies relevant to electricity distribution price/quality regulation. He is familiar with the legislation and regulations that govern electricity supply arrangements in New Zealand, including those that apply to electricity distribution network businesses such as Horizon.

Alastair Glyn Jones

14. Alastair Glyn Jones is Managing Director of Induna Consulting Ltd which he established in 2018 to provide professional management and advisory services in both the electrical power industry, and the wider utilities area.

15. Previously, Alastair was a maintenance manager with Transpower New Zealand (Transpower). In this role, he was responsible for the maintenance work undertaken by contract service providers on Transpower station and cable assets in a region of the North Island. These assets included switchgear, transformers, cables and buildings operating from 33kV to 220kV. Prior to his work at Transpower, Alastair was employed by Vector as the Performance Manager in the Planning Group with responsibility for maintenance policy and management of all network asset maintenance work. He was also responsible for monitoring and controlling the asset performance.

16. Alastair was previously a senior consultant with LineTech undertaking many assignments involving distribution network assets and reviews.

17. Alastair applies his broad experience in utility asset management by focusing the services he provides through Induna Consulting on improving the performance of electrical networks. He specialises in assisting clients to reduce and avoid adverse impacts to service and service delivery, as well as to system outages and safety incidents. These are primarily in the areas of electrical power system operation and maintenance, and reporting on asset condition.

18. Alastair has a Bachelor of Science in Electrical Engineering awarded by Cape Town University.

1.2. Evidenced based opinions

19. The members of Strata's review team have read the High Court's Code of Conduct for Expert Witnesses and have agreed to comply with it when undertaking this review and forming opinions. The review team members have confirmed that unless stated otherwise in the body of this report, the areas reviewed are within the reviewer's expertise and experience.

20. In forming the opinions in this report, the review team has not omitted consideration of any material facts known to them that might alter or detract from the views expressed. The review team has specified in this report where the opinions expressed are based on limited or partial information and identified any assumptions made in forming opinions.

1.3. Information we have relied on

21. The information provided to Strata by the Commission and Horizon has been relied upon for this review and when forming findings, opinions and recommendations. Where Strata has concerns regarding the reliability or quality of the information, this is stated with an assessment of the implications that this may have on the assessments and opinions contained in this report.

22. The information provided by the Commission includes all information forwarded by Horizon to the Commission in response to the Commission's requests to Horizon for further information.[4]

23. Where other information and data has been considered to be relevant or used to form findings, opinions and recommendations, a footnote reference identifying the source used has been provided.

1.4. The Commission's requirements describe the scope of this review

24. The Commission asked Strata to provide its expert opinion in relation to Horizon's failure to comply with the annual reliability assessments for the 2017 and 2018 Assessment Periods. The investigation scope included the following more specific requirement for us to provide opinions on three areas:

The validity of Horizon's reasons for non-compliance

25. An opinion on the reasons given by Horizon for its failure to comply with the annual reliability assessments for the 2017 and 2018 Assessment Periods, including:

    a. whether those reasons were valid;

    b. how much of an impact those reasons had on SAIDI and SAIFI for the 2017 and 2018 Assessment Periods; and

    c. having regard to a weather report provided by the Commission, an opinion on the extent to which weather contributed to Horizon's failure to comply with the annual reliability assessments for the 2017 and 2018 Assessment Periods relative to the reference period.

Horizon's adherence to Good Industry Practice (GIP)

26. An opinion on whether Horizon acted in accordance with good industry practice in areas of its network that relate to reliability performance for the 2017 and 2018 Assessment Periods.

[4] Draft Notice to supply information to the Commerce Commission Section 53zd of the Commerce Act 1986

27. If not, whether Horizon's failure to act in accordance with good industry practice contributed to its failure to comply with the annual reliability assessments for the 2017 and 2018 Assessment Periods and also, in particular:
    a. any evidence of whether Horizon's network is deteriorating or deteriorated; and
    b. any comments on the increase in Horizon's defective equipment interruptions; and
    c. whether the reasons for non-compliance arose as a result of a failure to act in accordance with good industry practice.
28. To the extent that Horizon has failed to act in accordance with good industry practice, identify any particular instance where the failure to act in accordance with good industry practice was substantial.

Actions Horizon has undertaken to prevent future non-compliance

29. Any comments on the extent to which Horizon has undertaken actions to prevent or mitigate further failures to comply with the annual reliability assessments in the future, including a description of those actions, and an assessment of the likely efficacy of those actions.

The Commission's additional requirements

30. The Commission advised Strata that if it was unable to form an opinion on any of the matters listed, the Quality Non-compliance Report must include:
    a. Strata's preliminary findings in respect of that matter; and
    b. Strata's opinion on what further investigation or analysis would be required to conclude on that matter.
31. In considering whether Horizon acted in accordance with good industry practice, the opinion should consider whether, in relation to any undertaking and any circumstances, Horizon 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.
32. The Commission requested that Strata's opinions and recommendations be set out in a Quality Non-compliance Report (this report).

1.5. Structure of this report is aligned with the scope

33. In forming our views and opinions, we have relied on Horizon's information and data as primary sources.
34. In the Executive Summary of this report, we provide an overview of our findings and our opinions on specific requirements from the scope for this investigation.
35. This report has three parts:
    A. Findings and opinions on the reasons for non-compliance

       Horizon's non-compliance in the 2017 and 2018 Assessment periods including an assessment of why Horizon exceeded its annual reliability assessment limits in the 2017 and 2018 assessments and our opinion on the reasons given by Horizon for its failure to comply;

    B. Assessment and opinions on whether Good Industry Practice was applied

       Our assessment and opinion on whether the steps taken by Horizon prior to its non-compliance met good industry practice including if we found evidence that it had not appropriately addressed network deterioration and/or increasing interruptions due to defective equipment; and

a description of, and commentary on, the actions that Horizon has undertaken to prevent or mitigate further non-compliance.

1.6. Specific terms and values used in this report

36. A glossary of the terms and acronyms used in this report is provided in Appendix J.

37. Horizon is responsible for the delivery of regulated services including meeting the Quality Standard. Accordingly, this investigation focused on Horizon's responsibilities for ensuring it did not contravene the Quality Standard.

38. When we refer to year, unless stated otherwise, we mean regulatory compliance Assessment Period. In the figures and charts provided in this report, unless stated otherwise, year is regulatory compliance Assessment Period.

Part A: Findings and opinions on reasons why Horizon was non-compliant

39. Part A primarily addresses the Commission's requirement that we provide our opinion and advice regarding Horizon's contravention of the Quality Standard due to non-compliance identified in its annual reliability assessments for AP2017 and AP2018. Horizon's breach of the Quality Standard limits in these Assessment Periods contributed to its contravention of clause 9.1 of the Commission's Electricity Distribution Services Default Price-Quality Path Determination 2015 (DPP).

40. In Part A we:

    1. set out that Horizon was non-compliant in its annual reliability assessments;
    2. assess why Horizon exceeded its reliability assessment limits in AP 2017 and AP 2018;
    3. provide the explanations given by Horizon for its failure to comply, and
    4. provide our assessment of the validity of Horizon's explanations.

2. Why Horizon breached the Quality Standard

41. The DPP Clause 9.1 'Compliance with the Quality Standards' requires that:

    A non-exempt EDB must, in respect of each Assessment Period, either:

    1. comply with the annual reliability assessment specified in clause 9.2 for that Assessment Period; or
    2. have complied with those annual reliability assessments for the two immediately preceding extant Assessment Periods.

42. Horizon is a non-exempt EDB and must therefore comply with one of the above conditions.

43. Horizon's compliance performance record for the 2013 to 2017 Assessment Periods (see Table 1) shows that it exceeded its limit for SAIDI in AP2017 and for SAIDI and SAIFI in 2018.

Table 1: Horizon's quality performance record 2012 to 2018

Assessment Period	SAIDI Limit	Assessed SAIDI	SAIFI Limit	Assessed SAIFI	Outcome
2012	220	175	2.4	2.24	Limits not exceeded
2013	220	192	2.4	2.3	Limits not exceeded
2014	220	186	2.4	1.77	Limits not exceeded
2015	220	173	2.4	1.98	Limits not exceeded
2016	176	128	2.21	1.58	Limits not exceeded
2017	176	219	2.21	2.17	Exceeded SAIDI limit
2018	176	287	2.21	2.99	Exceeded SAIDI and SAIFI limits

Source: Horizon Annual Compliance Statements 2013 to 2017

44. By exceeding reliability assessment limits in both 2017 and 2018, Horizon breached Clause 9.1 of the DPP Quality Standard.

3. Why Horizon breached its Quality Standards

3.1. Why Horizon exceeded its SAIDI limit in the 2017 Assessment Period

45. In its Annual Compliance Statement for AP 2017, Horizon provided information on two MED. The first occurring in April 2016 and the second in February 2017; the impact and normalisation of these events for Horizon's AP 2017 SAIDI are shown in Table 2.

Table 2 Normalisation of AP 2017 SAIDI due to the two major event days

	Raw SAIDI	Boundary Value	Adjustment in SAIDI due to normalisation
10/04/16	20.13	10.77	-9.36
17/02/17	12.08	10.77	-1.31
Total	32.21		-10.67

Source: Horizon Annual Compliance Statement 2017, Appendix E

Notes:
1. SAIDI includes both planned and unplanned interruptions.
2. Adjustments are made to the raw data to reduce the impact of major event days.

46. Table 2 shows that for AP 2017 normalisation reduced the impact on SAIDI attributed to the MED by 33%. The SAIDI resulting from the two MED was responsible for 9.8% of the total assessed SAIDI and was 12% of the SAIDI limit.

47. The SAIFI data for the two MED shows that the frequency of incidents occurring on the MEDs was not a material issue and normalisation did not occur (see Table 3). SAIFI overall was not a contributor to Horizon's exceedance of its SAIFI limit in AP2017.

Table 3 Normalisation of AP 2017 SAIFI due to the two major event days

	Raw SAIFI	Boundary Value	Adjustment in SAIFI due to normalisation
10/04/16	0.0691	0.1	0
17/02/17	0.0230	0.1	0
Total	0.0921		0

Source: Horizon Annual Compliance Statement 2017, Appendix E

Underlying network performance in AP 2017 contributed to non-compliance

48. When all SAIDI occurring on MEDs is removed from Horizon's total AP 2017 raw SAIDI, the result is 197.22 SAIDI which is 21.46 SAIDI (12.2%) above the SAIDI limit of 176 minutes. This means that the SAIDI occurring on the specific MEDs is not the sole contributor to the exceedance of the SAIDI limit for 2017.

3.2. Why Horizon exceeded its Quality Standard limits in the 2018 Assessment Period

49. In its Annual Compliance Statement for AP 2018, Horizon provided information on eleven MED. The normalisation attributable to the MED is provided in Table 4.

Table 4 Normalisation of 2017/18 SAIDI due to the eleven major event days

	Raw SAIDI	Boundary Value	Adjustment in SAIDI due to normalisation
06/04/17	18.43	10.77	7.66
13/04/17	718.71	10.77	707.94
14/04/17	34.65	10.77	23.88
12/05/17	11.72	10.77	0.95
20/07/17	27.97	10.77	17.2
21/07/17	4.89	10.77	0
29/08/17	16.74	10.77	5.97
18/09/17	3.56	10.77	0
21/09/17	6.01	10.77	0
24/10/17	8.94	10.77	0
05/01/18	34.83	10.77	24.06
Total	886.45		787.66

Source: Horizon Annual Compliance Statement 2018, Appendix E

50. Table 4 shows that for AP 2018 normalisation reduced the SAIDI attributable to the MED by 88.8%% and for total 2018 SAIDI by 73.3%.

51. Table 4 shows that for AP 2018 normalisation reduced the SAIDI attributable to the MED by 88.8%% and for total 2018 SAIDI by 73.3%.

52. The SAIFI data for the eleven MED shows the normalisation that Horizon applied to the SAIFI attributable to the MED.

Table 5 Normalisation of 2017/18 SAIFI due to the eleven major event days

	Raw SAIFI	Boundary Value	Adjustment in SAIFI due to normalisation
06/04/17	0.09	0.1	0
13/04/17	0.66	0.1	0.56
14/04/17	0.04	0.1	0
12/05/17	0.03	0.1	0
20/07/17	0.12	0.1	0.02
21/07/17	0.12	0.1	0.02
29/08/17	0.19	0.1	0.09
18/09/17	0.14	0.1	0.04
21/09/17	0.17	0.1	0.07
24/10/17	0.14	0.1	0.04
05/01/18	0.13	0.1	0.03
Total	1.83		0.87

Source: Horizon Annual Compliance Statement 2018, Appendix E

53. Table 5 shows that for AP 2018, normalisation of the MED SAIFI reduced the SAIFI attributable to the MED by 47.5% and for total 2018 SAIFI by 22.54%.

54. When all SAIFI occurring on MEDs is removed from Horizon's total AP2018 SAIFI the result is 2.12 SAIFI which is below the SAIFI limit of 2.21.

In AP 2018 the underlying network performance contributed 188.2 SAIDI

55. When all SAIDI occurring on MEDs is removed from Horizon's total AP 2018 SAIDI the result is 188.2 SAIDI which is 12.2 SAIDI above the SAIDI limit. This means that non-MED network performance contributed to Horizon's non-compliance in its annual reliability assessment for AP 2018.

3.3. Our summary of why Horizon was non-compliant

56. We have found that the factors contributing to Horizon's breach of the Quality Standard were:

1. the impact on SAIDI attributable to unplanned outages on two major event days in AP 2017;
2. the impact on SAIDI attributable to unplanned outages at times other than major event days in AP 2017;
3. the impact on SAIDI attributable to unplanned outages on eleven major event days in AP 2018;
4. the impact on SAIFI attributable to unplanned outages on eleven major event days in AP 2018;
5. the impact on SAIDI attributable to unplanned outages at times other than major event days in AP 2018.

4. Horizon's explanations for its non-compliance

57. In its annual Compliance Statements, Horizon provided explanations and supporting information for its non-compliance identified in its annual reliability assessments. Horizon also provided information submitted in response to the 53zd letter and during our on-site visit. We consider that the information provided by Horizon was comprehensive and enabled us to develop a sound understanding of Horizon's position and the analysis it had undertaken to support its views.

58. Much of the following discussion in this section has been reproduced from the information provided by Horizon.

4.1. Causes of MED in APs 2017 and 2018

59. Horizon provided the following explanation for the MED that occurred in AP 2017:

> *On 10 April 2016 suspected lightning damaged to a surge arrestor on the 33kV Snakehill feeder from Edgecumbe supplying the Galatea area. This outage affected 1713 customers. The project for the Galatea 33kV outdoor bus upgrade was completed during 2016 which enables us to run two 33kV lines in parallel and Galatea area is now supplied from Aniwhenua generator with Edgecumbe as a backup (switched n-1);*
>
> *On 17 February 2017 a failed insulator on the 11kV Factory feeder caused an extended outage. Faults on this section of the 11kV Factory (now Coast) feeder was on the coast between Opotiki and Hawai affected 571 customers. The line route being away from the main road, with no back-feed capability and the terrain contributed to delays in restoration. Horizon has previously identified a project to provide an alternative supply to the part of the Factory (now Coast) feeder however this is dependent on supplying Te Kaha at 33kV.* [5]

60. Horizon provided the following explanation for the MED that occurred in AP 2018:

> *On 6 April 2017 Whakatane District experienced major flooding from both the Whakatane and Rangitaiki rivers due to ex- cyclone Debbie;*
>
> *On 13 April 2017 more than 75% of the customer on Horizon's network lost supply due to severe wind gusts of ex-tropical cyclone Cook;*
>
> *Major event days recorded during May and July 2017 was caused by high winds resulting in widespread outages across the network;*
>
> *An 11kV cable on the Waiotahi substation's 11kV bus faulted and resulted in loss of supply to the entire Opotiki District. Although these faults are rare the bus arrangement will be assessed as part of the Opotiki sub-transmission development plan;*
>
> *The MED's during September were due to a faulty insulator on one of the three parallel 11kV feeders supplying the new Opotiki switchboard. The magnitude of the fault current was not enough to trigger the protection on any one of our feeder breakers however, the combined contribution from the*

[5] 3.38 Post fault investigations & major event days

three feeders resulted in a trigger on the Transpower protection at the GXP. Results of the investigation identified a required change in protection settings which was implemented as part of the corrective actions;

On 24 October 2017 an 11kV circuit breaker at Station Rd substation failed to operate due to a faulty auxiliary switch and the backup protection on the next upstream circuit breaker. Unfortunately, the substation was on N security at this time due to routine maintenance occurring on one of the power transformers which resulted in a loss of supply to the entire 11kV bus; The investigation was completed and identified there are to replacements available for these switches. Specific maintenance was put in place to exercise these switches annually until such time that an alternative replacement is available, or the switchboard is replaced.

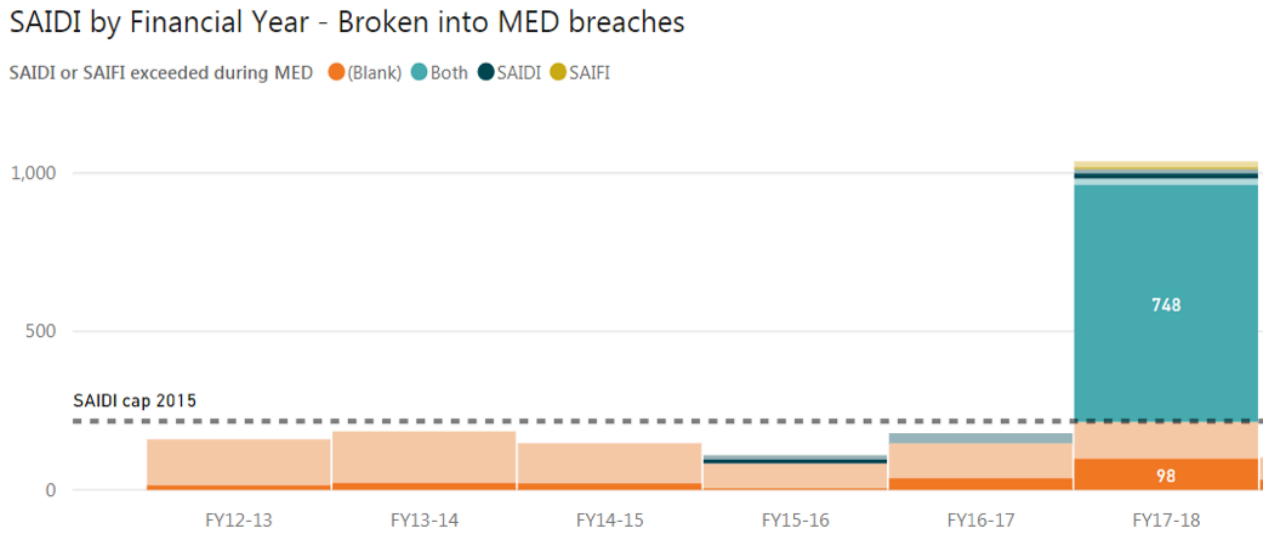
MED recorded on 5 January due to multiple high voltage feeder outages over the entire network due to high winds. [6]

4.2. Horizon's assessment of the impact of the MED

61. Horizon provided detailed analysis and breakdown of the impact of the MEDs on Horizon's network reliability measures.

62. Figures 1 and 2 provide a view of the SAIDI and SAIFI occurring on MED in each Assessment Period since 2013. The charts demonstrate that MED occur in each year; however AP 2018 was exceptional having a significant impact on SAIDI & SAIFI. The values shown in Figures 1 and 2 are raw SAIDI and SAIFI (i.e. pre-normalisation).

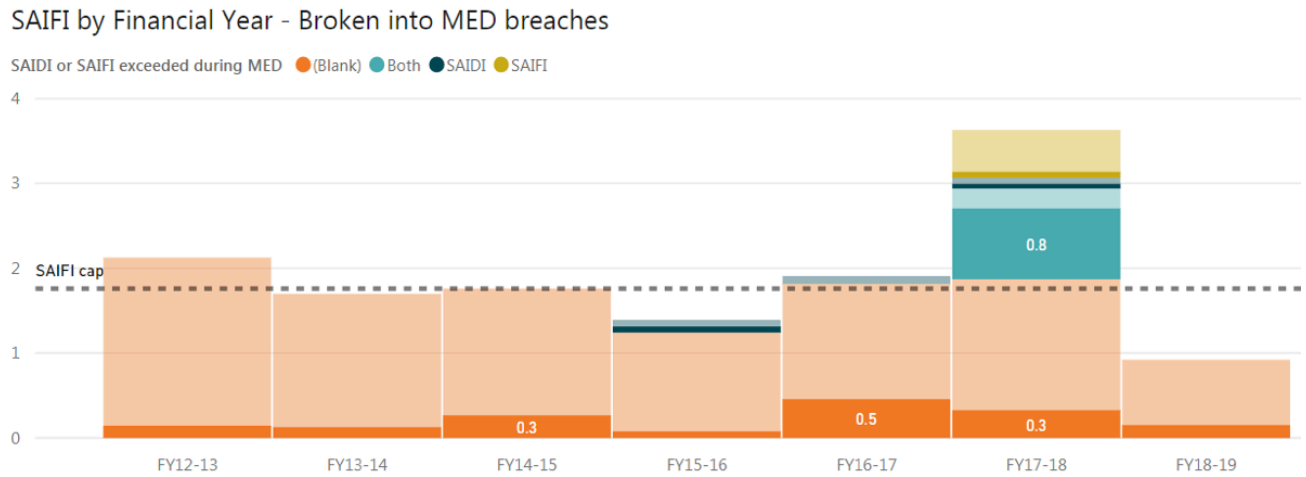
Figure 1: Extract 1 from Horizon Breach Report



Source: Horizon 2.1.6 2.17 Breach Report

[6] ibid

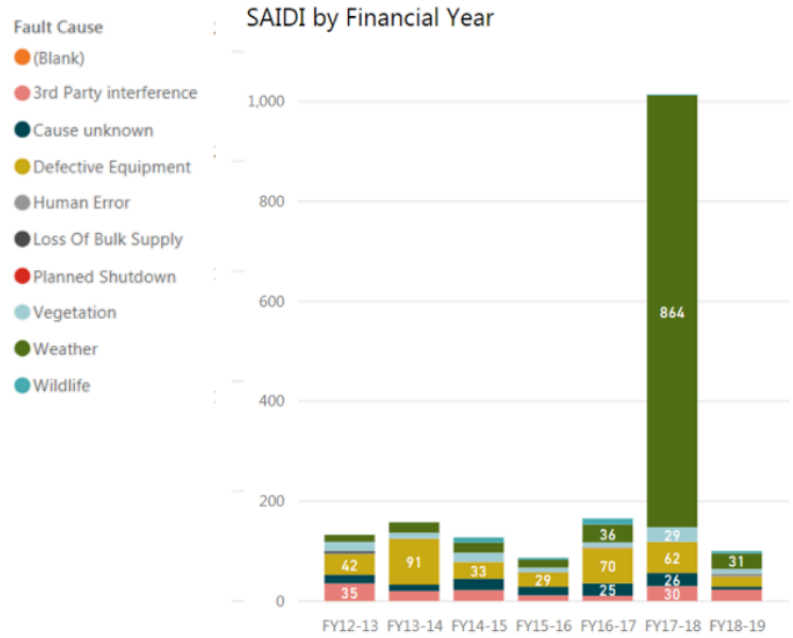
Figure 2: Extract 2 from Horizon Breach Report



Source: Horizon 2.1.6 2.17 Breach Report

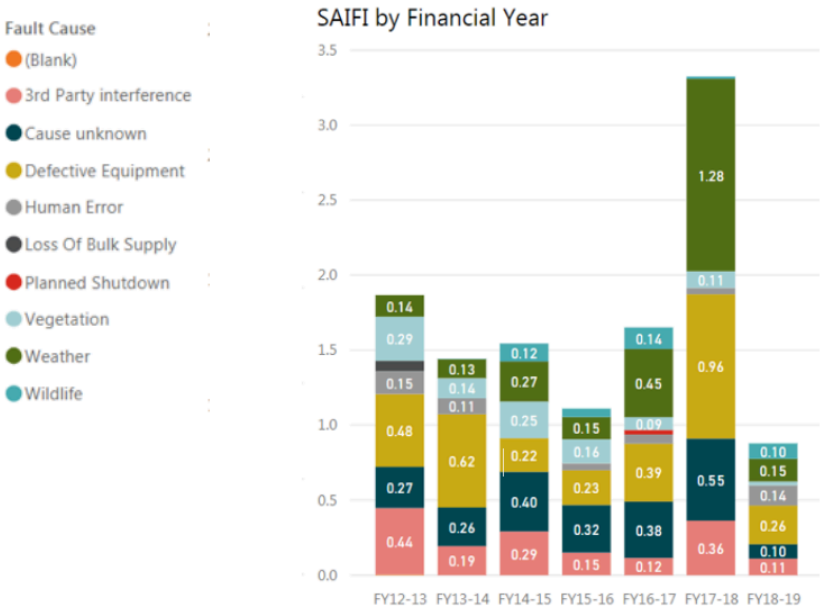
63. Figure 3 shows Horizon's analysis of the causes of network faults for each Assessment Period between AP 2013 to AP 2019 (AP 2019 being part of an Assessment Period). Horizon's conclusion from the analysis is that, because almost all SAIDI minutes that occurred on MEDs in AP 2018 were weather related, MEDs were largely the result of adverse weather.
64. Horizon also found that 25% of SAIDI in AP 2017 and 45% of SAIDI in AP 2018 were due to adverse weather, and that 16% of SAIFI in AP 2017 and 18% of SAIFI in AP 2018 were attributable to adverse weather.
65. Horizon found that an average of 20 faults were attributable to adverse weather in years where it had not exceeded the annual reliability assessment limits and that, whilst the increase in weather related faults had a significantly greater impact in AP 2018 SAIDI minutes, SAIDI in AP 2017 attributable to adverse weather was still above that seen in Assessment Periods where it had not exceeded the limits.

Figure 3: Extract 3 from Horizon Breach Report



Source: Horizon 2.1.6 2.17 Breach Report

Figure 4: Extract 4 from Horizon Breach Report

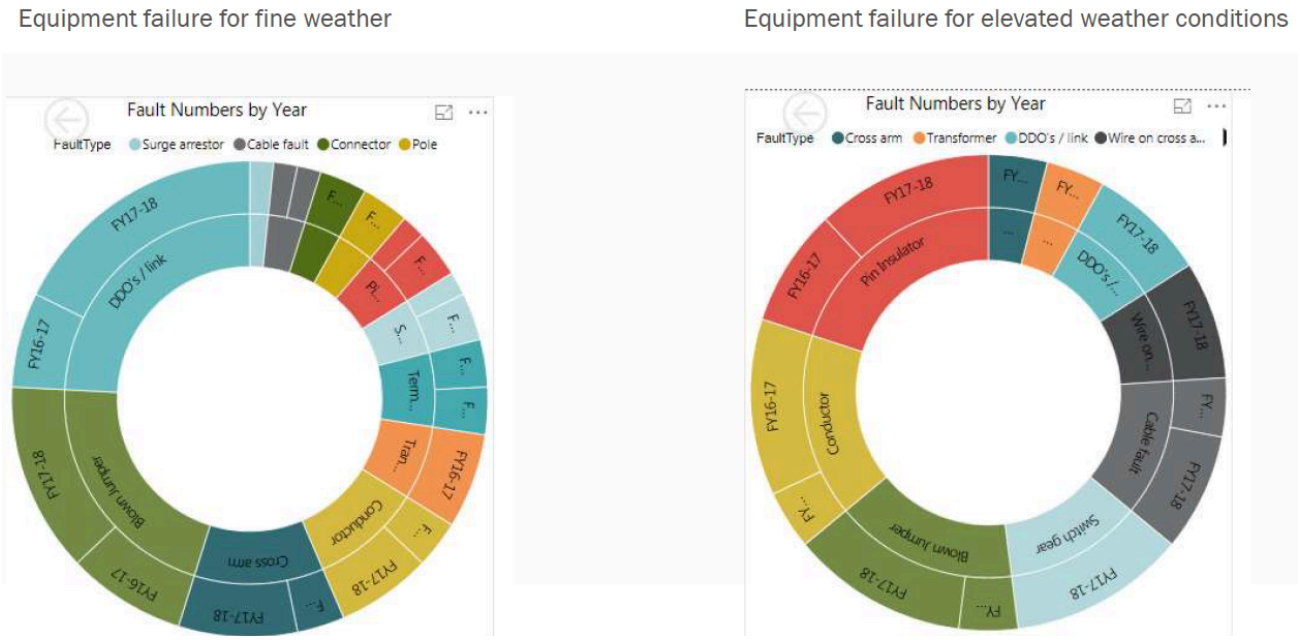


Source: Horizon 2.1.6 2.17 Breach Report

4.3. Impact of major adverse weather events the primary factor

66. Horizon provided the results of its analysis on the differences between fault types occurring on fine days, and days with elevated weather conditions. Figure 5 provides the results of this analysis which indicate that, other than for blown jumpers, the types of failures seen in elevated weather are predominantly conductor and pin insulators, which is quite different to faults experienced in fine weather conditions.

Figure 5: Extract 4 from Horizon Health and Performance of the Network presentation



Source: Horizon Tranche 2 The Health and Performance of the Network

67. Horizon found[7] that the total number of outages attributed to adverse weather, adverse environment and lightning increased from 10 in AP 2016 to 48 during AP 2017, and to 85 during AP 2018:

> *As a result of the adverse weather, Horizon exceeded the annual limit during the month of August 2017 with two ex-cyclones during April 2017 resulting in three MED's. Four additional MED's were recorded during the rest of the 2018 Assessment Period as a result of adverse weather.*[8]

68. Horizon has provided much information and evidence of the high number and ferocity of weather events that occurred in AP 2018 and especially the impact of ex-tropical cyclones Debbie and Cook:

[7] 3.38 Horizon Networks Quality Standards Explanatory Report, page 12

[8] Ibid

The devastating damage caused by ex-tropical cyclone Cook resulted in 19,405 customers without power at the end of day one. By the end of the second day power to 18,060 customers were restored, an additional 1,013 customers were restored by the end of the third day and by the end of the fourth day less than a 100 ICP's were still without power.[9]

Cyclone Cook made landfall in the Bay of Plenty, causing more damage to the already sodden area which was hit hard last week by ex-Cyclone Debbie.

Gusts of 209kmh were recorded at White Island and 154kmh at Cape Kidnappers in Hawke's Bay. Waves six metres high pounded coastlines around the Bay of Plenty. More than 200mm of rain fell overnight in the region.

There were slips, floods, and downed trees and power lines. Flights were disrupted, residents evacuated, and states of emergency declared.

Stuff: Katie Kenny 10:55, Apr 14 2017[10]

69. In June 2017 Horizon's CEO provided the following summary on the impact of cyclones Debbie and Cook:

Cyclone Debbie

- *Outages due to floods on 6 April 2017 contributed 18.5 SAIDI minutes; and*
- *A further contribution of 2.7 SAIDI minutes prior to Cyclone Cook were due to repairs and isolations requested by Civil Defence.*

Cyclone Cook

- *All outages for Whakatane and Kawerau District (excluding Waimana) that eventuated on 13 April 2017 contributed 691 SAIDI minutes;*
- *The Transpower outage for Waiotahi and Te Kaha was 276 SAIDI minutes;*
- *The Horizon SAIDI contribution for the Opotiki District including Waimana, from 14 April 2017 was 73 minutes; and*
- *SAIDI contribution for repairs done during April was 36 minutes.*[11]

70. Horizon also provided its analysis of the correlation between weather and defective equipment related faults between July 2016 and October 2017. Horizon considered that its analysis suggested there was not only a correlation between periods of high fault activity and periods of high wind speed but also that not all periods of high wind speed resulted in high fault activity. Horizon considered that this was probably due to factors such as wind direction and location having different effects on specific areas of the network.

71. The wind speed data provided by Horizon indicated that wind speeds in excess of 140km/h had occurred on six occasions during the 15 month period, and in excess of 180 km/h on two of those occasions.

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[9] 3.38 Horizon Networks Quality Standards Explanatory Report, page 14

[10] https://www.stuff.co.nz/national/91577795/big-cities-dodged-a-bullet-with-cyclone-cook

[11] Horizon s53ZD response Tranche 1, 3.7 23 June 2017 - CEO Board Report pg 2 3

4.4. Spill-over effects were material in AP 2018

72. An example of spill-over effect can be seen in the final bullet point of Horizon CEO's summary of the impacts of cyclone Cook (paragraph 70) where 39 SAIDI minutes were incurred on subsequent repairs.

73. In its explanatory paper, Horizon sets out information and analysis to support its view that the current normalisation process (although this may be intentional) does not adequately normalise for weather related events. In forming this view, Horizon noted that weather events are often a "trigger" event leading to further failures post the 24 hour normalisation period.

74. Horizon considered that its analysis showed that 50 - 75% of network outages were preceded by >90km/h wind in the 72 hours prior to the outages occurring.

75. Horizon's analysis of interruption data[12] identified that 79% of SAIDI in AP 2018 occurred on a day in which either the SAIDI or SAIFI limit was exceeded. For SAIFI in AP 2018, 49% occurred on a day in which either the SAIDI or SAIFI limit was exceeded. Horizon concluded that, excluding the contribution of SAIDI & SAIFI from MED, its SAIDI and SAIFI performance in AP 2017 and AP 2018 were comparable to previous years.

4.5. Interruptions attributable to vegetation are related to high wind events

76. Horizon explained its approach to vegetation management and the impact it considered this had on the performance of its network. An extract from the analysis provided by Horizon is given in Figures 6 and 7. The data in Figure 6 shows that SAIDI related to vegetation induced faults had fallen substantially in AP 2016 and AP 2017 but had risen sharply due to the adverse weather impacts in AP 2018. Horizon considered that:

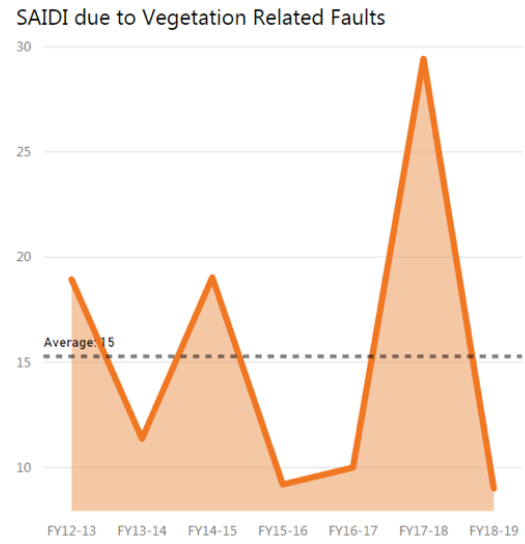
> *anomalous increase in SAIDI minutes due to vegetation faults in FY17-18 is due to a small number of faults with large impact. This is verified by the decrease in the FY17-18 count of vegetation faults relative to other years.*[13]

77. Horizon believes that its data indicates that the number of faults due to vegetation by financial year shows a strong downward trend in counts of vegetation related faults and SAIFI. Horizon considered that this was reflective of the overall trend due to Horizon's improved vegetation management programme.

[12] Horizon 2.1.6 2.17 Breach Report – Impact of MEDs Tab

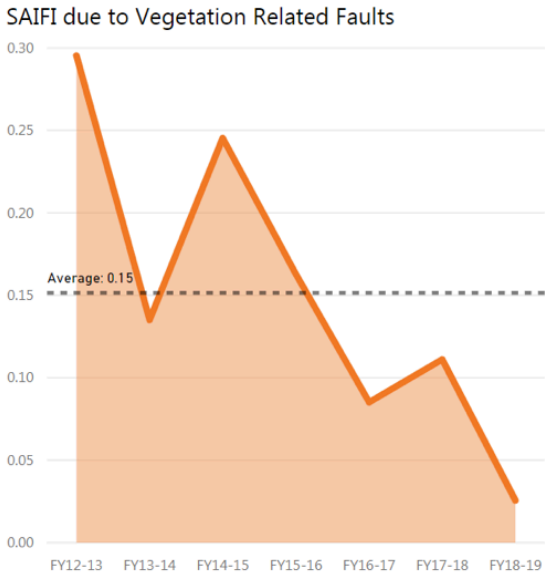
[13] Horizon 2.1.6 2.17 Breach Report (vegetation trend tab)

Figure 6: Extract 5 from Horizon Breach Report – SAIDI due to vegetation faults



Source: Horizon Tranche 1 2.1.6 2.17 Breach Report

Figure 7: Extract 5 from Horizon Breach Report SAIFI due to vegetation faults



Source: Horizon Tranche 1 2.1.6 2.17 Breach Report

78. Horizon also pointed to its analysis on the correlation between adverse high wind speed events and vegetation related faults.

79. Horizon gave the following summary of its vegetation management approach:

> *Vegetation management has been and remains a concern for Horizon Networks due to the number of interruptions and SAIDI minutes attributable to debris blown into our lines or trees outside the vegetation management zone falling onto lines during adverse weather events. Horizon Networks is*

in the process of implementing a risk-based vegetation management system and process to manage trees both in and out of zone that could negatively impact the performance of the network. ….

Horizon has included vegetation as part of our public awareness and safety campaign by running regular advertisements over local radio stations.[14]

80. Our understanding of Horizon's position is that:

    a. its improved vegetation management, including increased vegetation management related expenditure, had made a positive impact on vegetation related interruptions;

    b. the increased contribution of vegetation interruptions seen in AP 2018 were the result of the high wind events in that period; and therefore

    c. underlying issues with vegetation was not a cause of non-compliance.

Horizon identified that planned interruptions were high in AP 2017 and AP 2018

81. Horizon noted that planned interruptions had increased in AP 2017 due to the need to install 11kV surge arrestors:

    The Te Ahi O Maui (TAOM) project,….. also required the replacement of the Transpower 11kV switchboard and the installation of a neutral earth compensator (NER) to limit the earth fault current during faults at the GXP. The NER installation required replacement of all our 11kV surge arrestors on the Kawerau network which with the suspension of live line work also contributed in an increase in planned outages.[15]

82. For AP 2018, Horizon identified post storm related MED planned repairs added to SAIDI:

    Horizon Networks had breached the annual SAIDI limit by mid-August 2017 mainly due to the impact of the two ex-cyclones and the less severe storms in May and July 2017. Although most of the required repairs were done under fault conditions, there was also an increased number of subsequent defects raised on the network that were repaired during planned outages.

    Our planned annual target for the 2018 Assessment Period was 25 SAIDI minutes. We exceeded this annual target by 13.67 SAIDI minutes mainly as a result of additional planned work to rectify defects following the storm events and third party connection/upgrades.[16]

83. We have reproduced five years of Horizon's planned and unplanned SAIDI and SAIFI charts in Appendix D. The chart for AP 2017 (Figure 8) indicates that two months (May and March) during AP 2017 had unusually high planned outages compared to all other years (see Appendix D) and that these months immediately followed the months containing MED in AP 2017.

84. Whilst Horizon did not specifically discuss July 2016 in its AP 2017 Compliance Statement or in its Explanatory Report, our analysis of the fault data provided by Horizon shows that in July 2016 Horizon incurred 28.7 unplanned SAIDI and 0.3 unplanned SAIFI. The primary causes

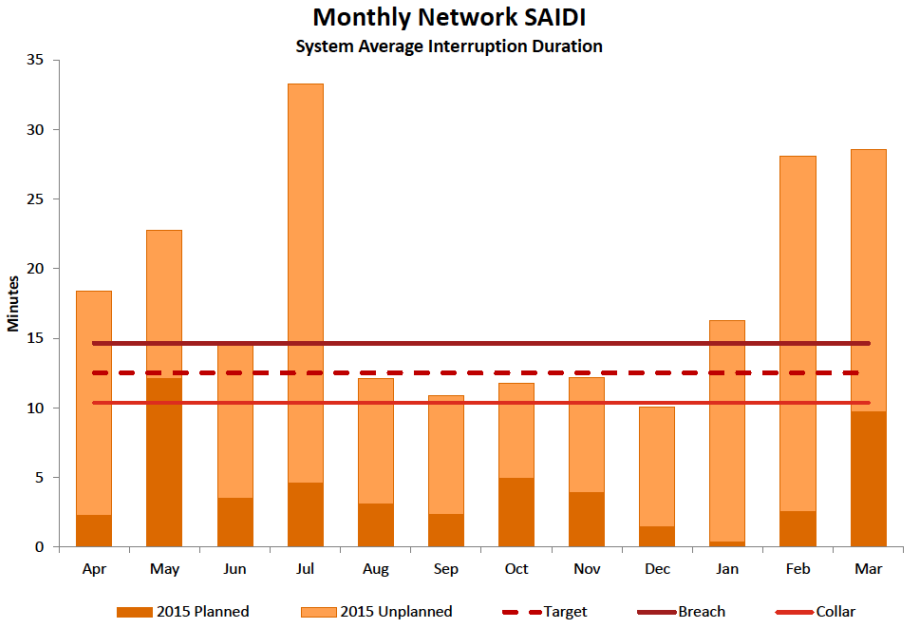
[14] 3.38 Horizon Networks Quality Standards Explanatory Report, page 19

[15] Ibid

[16] 3.38 Horizon Networks Quality Standards Explanatory Report to the Commission 201, page 5

were; adverse weather (16.7 SAIDI), defective equipment (5.6 SAIDI and vegetation (4.26 SAIDI).The main issues in adverse weather were due to overhead line faults and trippings.

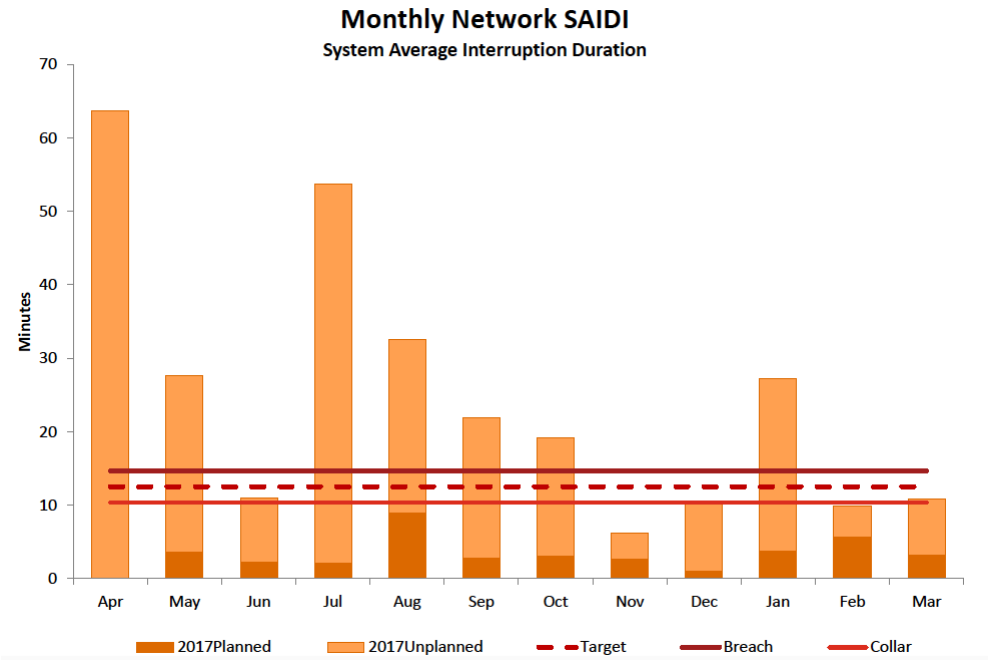
Figure 8: Extract 6 SAIDI by month for AP 2017



Source: Horizon 5.1 Monthly Network SAIDI SAIFI (March 2014.15.16,17, 18 documents)

85. Figure 9 shows the planned and unplanned SAIDI for AP 2018. The chart supports Horizon's statements that planned work on storm repairs increased planned SAIDI in subsequent months; i.e. elevated SAIDI in August following the May and July storms.

Figure 9: Extract 6 SAIDI by month for AP 2018



Source: Horizon 5.1 Monthly Network SAIDI SAIFI (March 2014.15.16,17,18 documents)

Note that the vertical axis scale on this chart is double that in Figure 8.

4.6. Summary of Horizon's explanation for non-compliance

86. Our understanding of Horizon's explanation for its non-compliance can be summarised as follows:

    a. exceedance of the SAIDI limit in AP 2017 was due to two MED attributed to weather and defective equipment both beyond the reasonable control of Horizon; and

    b. exceedance of the SAIDI and SAIFI limit in AP 2018 due to seven adverse weather related MED events, beyond the reasonable control of Horizon, and the subsequent spill-over unplanned SAIDI and the need for planned outages to undertake repair work.

87. Horizon considers that the limit exceedance in AP 2017 and AP 2018 were not due to deterioration of its network assets.

88. Horizon has provided discussion to the Commission on its concerns that the *current normalisation process does not adequately normalise for weather related events*.[17] As this was outside the scope of this review, we have not addressed the normalisation adequacy issue.

5. Our assessment of Horizon's reasons for non-compliance

89. In this section, we address the Commission's questions relating to Horizon's explanation for its non-compliance, specifically;

    a. whether those reasons were valid;

    b. how much of an impact those reasons had on SAIDI and SAIFI for the 2017 and 2018 Assessment Periods; and

    c. having regard to a weather report provided by the Commission, the extent to which weather contributed to Horizon's failure to comply with the annual reliability assessments for the 2017 and 2018 Assessment Periods relative to the reference period.

90. For point C, we note that the Commission did not provide a weather report to Strata, we therefore relied on the weather data, reports and investigations that Horizon provided during the review.

91. The key findings and opinions in this section are:

    a. Horizon's reasons for the exceedances of limits are valid and supported by evidence,

    b. the impact of the reasons given by Horizon were material to non-compliance, and in their absence, Horizon's performance would have been compliant;

    c. adverse weather contributed to, but was not the primary reason for the exceedance of the SAIDI limit in AP 2017; and

    d. adverse weather was the primary contributor to Horizon's exceedance of its limits in AP 2018 and therefore its contravention of the Quality Standard in AP2018; and

[17] 3.38 Horizon Networks Quality Standards Explanatory Report, page 16

e. the information and data provided by Horizon, including the independent reports that it commissioned in 2018, provide sufficient evidence for us to conclude that the number and severity of adverse weather events in the Bay of Plenty region during AP 2017 was exceptional.

92. We set out a summary on how we formed our opinions below.

5.1. We identified focus areas for our assessment

93. We used our consideration of the SAIDI and SAIFI data together with information and explanation provided by Horizon for its non-compliance in annual reliability assessments to identify focus areas for our review.

94. For AP 2017 we considered the:

1. MED on 10 April 2016 surge arrestor on the 33kV Snake Hill feeder from Edgecumbe supplying the Galatea area that Horizon attributed to lightning damage; and
2. MED 17 February 2017 failed insulator on the 11kV Factory feeder.

95. For AP 2018 we considered the:

1. impact of the AP 2018 weather related MED on both SAIDI and SAIFI; and
2. spill-over effect from weather related MED.

96. In addition, we considered if defective equipment related faults were a contributing factor to Horizon's contravention of the Quality Standard.

5.2. Our assessment of the AP 2017 focus areas

10 April 2016 surge arrestor failure

97. We accept Horizon's explanation that the 10 April 2016 was a MED that made a material contribution to its exceedance of the SAIDI limit in AP 2017. We have investigated why the impact of this event on SAIDI was so material and whether Horizon could have mitigated the impact.

98. The key aspects of the 10 April 2016 MED are:

1. why an insulator failure led to the high SAIDI;
2. the reasons for the vulnerability of supply to the region; and
3. supply reliability risks had not been mitigated earlier.

Why the surge arrestor failure led to the high SAIDI

99. The 10 April 2016 outage that affected 1713 customers occurred on the Snake Hill feeder supplying the Galatea area. Horizon suspected that the outage was due to lightning that damaged a surge arrestor. The pre-normalised SAIDI for 10 April 2016 was 20.1316 (normalised to 10.77) and pre-normalised SAIFI 0.0691 (normalisation not required).

100. In its 2018 AMP, Horizon provides the following description of the Galatea region:

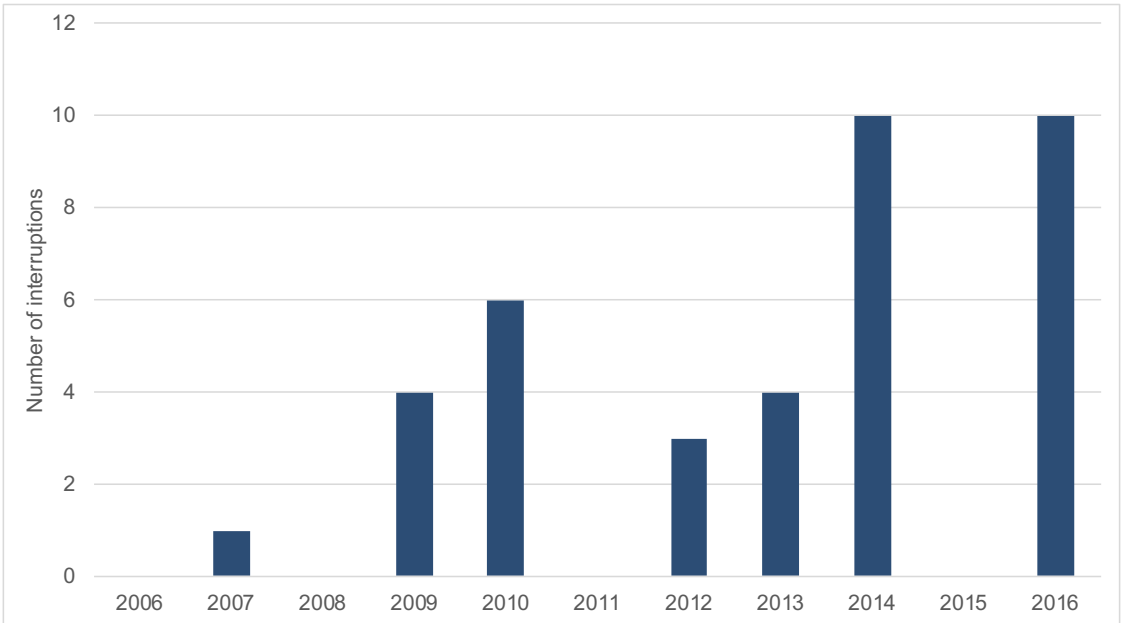
> *Situated approximately 100km inland from Whakatāne, the Galatea region is the most inland portion of our network, situated high on the Urewera plateau. The terrain in this region includes the pastoral plateau as well as rugged steep mountainous terrain clad with indigenous forests. The region is supplied by two 33kV zone substations and is connected to the national grid via the Aniwhenua Power Station. There is also a backup supply to the Edgecumbe GXP via the Snakehill feeder.*

Galatea is somewhat isolated and the closest depot to the region is 100km away. While the Galatea plains are accessible by road, a large portion of the network feeds the settlement of Ruatahuna, passing through exotic forestry blocks and the high mountain ridges of the Ureweras. This makes a certain portion of the network accessible by helicopter only.[18]

101. The first paragraph describes the current network configuration which includes a series of linked projects that have improved reliability in the region since 2014. In April 2016, reliability in this region was significantly lower due to the limited redundancy in network design and the loss of Aniwhenua generation as a primary or backup facility.

102. Figure 10 indicates that interruptions due to lightning strikes were visible to Horizon; and that these had increased since 2009. Clearly, the events in 2014 and 2016 were exceptional and would likely have increased the risks of interruptions occurring on the Snake Hill feeder.

Figure 10: Interruptions attributed to lightning on the Horizon overhead distribution network



Source: Horizon V1.0_InterruptionsAnalysis_Operations_Combined

Note that the horizontal axis is calendar years not Assessment Periods

Horizon requested that the title of the above chart clearly state that the data is for faults attributed to lightning strikes across the entire network and not just in the Galatea region.

103. We agree with Horizon that lightning was the most probable trigger for the outage, but consider that the extended duration and associated MED was due to the low reliability situation that had persisted on this region's network since 2009.

[18] Horizon 2018 AMP, chapter 2, page 7

The MED on 21 January 2014 is relevant

104. On 21 January 2014, Horizon experienced outages on the 33kV line supplying the Galatea area. The outage was due to a failed pin insulator, and at the time, generation from Aniwhenua was not available. The project for the Galatea 33kV outdoor bus upgrade was completed during 2016 and the Galatea area is now supplied from Aniwhenua generator with Edgecumbe as a backup (switched n-1).

105. On the morning of 21 January 2014 at 5:47am, the supply was lost to the Galatea, Murupara, and Kaingaroa areas and beyond due a 33kV fault[19]. A February 2014 Board memo explains the supply reliability situation to Galatea at that time stating that: *Snake Hill feeder faults cause a loss of supply to Galatea due to the continuing supply from Edgecumbe over rugged terrain, being supplied by a single feeder circuit instead of the normal supply from the Aniwhenua generator*[20].

106. Horizon's 2014 AMP provides further background on the issues they were facing in this region:

> *During most of 2009-11 Galatea loads were connected to the Edgecumbe GXP following the failure of a transformer at Aniwhenua. This added around 4-5 MVA onto the Edgecumbe bus. This is not a normal configuration and was restored to the normal configuration briefly in August 2011, but was subsequently returned to Edgecumbe to allow work on the second Aniwhenua transformer;*[21]

107. Our understanding is that prior to 2009, Aniwhenua generation (operated by Nova Energy) had provided electricity supply to Galatea with Horizon's network providing back up via the Snake Hill feeder from Edgecumbe. During 2009, damage was caused to the Aniwhenua transformers which had to be repaired under Nova Energy's insurance. Following repairs, Nova Energy was reluctant to provide supply to Galatea through the repaired transformers as further damage would not be covered under its insurance.

108. The 10 January 2014 MED again highlighted supply reliability issues relating to the vulnerability of the single feeder supply and the lack of Aniwhenua generation options.

109. Whilst we acknowledge that between 2014 and 2016, Horizon developed and implemented sound technical and commercial solutions that will have substantially improved supply reliability to the Galatea region, in our opinion, the issues should have been resolved earlier. Had this been achieved, the effects of the outage during the 2014 MED could have been reduced, and the impact of the 10 April 2016 event could have been mitigated.

110. Whilst we accept that lightning strike was the likely trigger of this AP 2017 MED, we consider that Horizon's AP 2017 Compliance Statement should have identified the ongoing supply vulnerability issues in the Galatea region as the primary factor for the 10 April MED.

111. We discuss the Galatea supply reliability issue further in section 7 and in Appendix K.

17 February 2017 failed insulator on the 11kV Factory feeder

112. On 17 February 2017 a failed insulator on the 11kV Factory feeder caused an extended outage. The impact on SAIDI was 12.08 minutes which, when normalised, added 10.77 SAIDI minutes to its assessed SAIDI in AP 2017.

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[19] Horizon 3.7 10 February 2014 - Board Memo Snake Hill Outage January 2014doc

[20] Horizon 2014 AMP page 54

[21] Horizon 2014 AMP page 105

113. Horizon explained that the fault was on the coast section of the Factory feeder between Opotiki and Hawai and that the outage affected 571 customers. Horizon explained that *the line route being away from the main road, with no back-feed capability and the terrain contributed to delays in restoration.*

114. We accept Horizon's explanation on the vulnerability of this section of the Factory feeder given its remoteness and coastal location. We have reviewed the interruptions due to insulator failures and have not identified a trend that might indicate systemic deterioration of the insulator assets beyond normal age and wear and tear.

115. We have concluded that 17 February 2017 was a type failure event that would normally be expected to occur periodically on insulators, and especially in this coastal location. The remoteness of this section of the Factory feeder contributed to the extended SAIDI which caused the MED.

116. We note that Horizon previously identified a project that would provide an alternative supply to the part of the Factory feeder and that this can now proceed as it was dependent on Horizon developing the option to supply Te Kaha at 33kV.

5.3. Our assessment of the AP 2018 focus areas

117. In this section, we consider Horizon's explanation that exceedance of the SAIDI and SAIFI limits in AP 2018 were due to seven adverse weather related MED events beyond its reasonable control.

118. We also assess Horizon's view that the impact of subsequent spill-over of unplanned SAIDI from MED, and the effects of planned outages required to undertake repair work from the MED made material contributions to its exceedance of the AP 2018 SAIDI limit.

Impact of high wind speeds on network performance

119. Horizon provided extensive evidence of the damage to its assets that occurred during the Debbie and Cook cyclone events. It also provided its research and analysis on the coincidence of network interruptions and high wind speeds. We have considered this information when forming our opinions on the performance of the network during the AP 2018 MED.

120. Horizon has engaged National Institute of Water & Atmospheric Research Ltd (NIWA) on several occasions to analyse power outages over the Horizon network with the New Zealand Convective Scale Model (NZCSM) which models maximum wind gust and weather forecasts. The analysis was used to:

    a. determine the correlation between wind, rain and lightning with outages on the network;
    b. highlight areas of the network more prone to these events; and
    c. explore sensible thresholds for advanced alerting purposes.

121. NIWA's November 2017 report[22] confirmed that there was some correlation between modelled high wind speeds and interruption events (SAIDI and SAIFI).

122. In its addenda report, NIWA noted that:

> *There is strong efficacy for NIWA's NZCSM to identify where some Horizon sites could have outages associated with extreme winds (and potentially*

[22] 3.15 NIWA-Horizons_Report_Final_updated

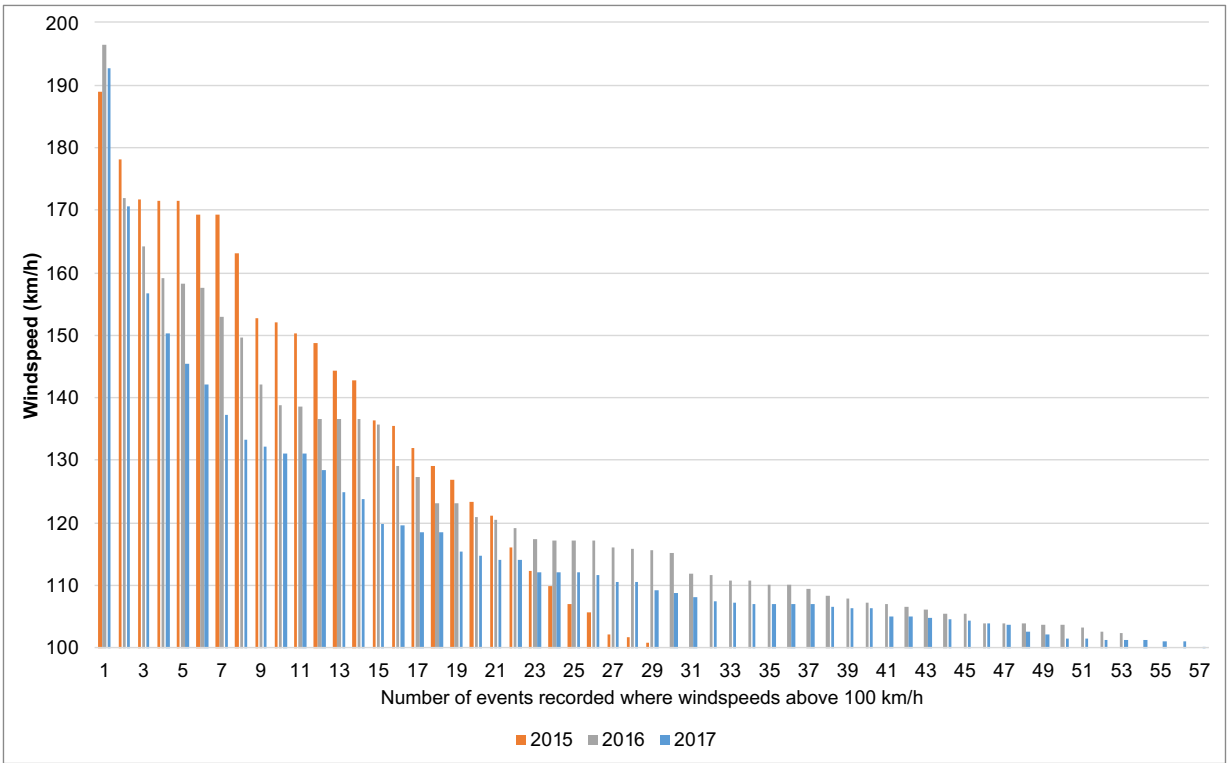
associated weather phenomenon that accompanies strong winds, like lightning). The advance notice might range from one to three days based on these results.[23]

123. It is important to note that the wind data used in the NIWA analysis is 'modelled' and not actual wind speed data. Horizon told us that the wind monitoring stations in the Bay of Plenty are limited to a single station situated at Whakatāne Airport.

124. Despite its potential limitations, we consider that the NIWA modelled wind speed data provided an opportunity to establish the potential severity and duration of high wind events likely to be seen in the Bay of Plenty.

125. Using the NIWA data, we developed a profile of the modelled wind data for the number of events where winds reached more than 100km/h. The data for three years was available. Figure 11 provides the output from this analysis.

Figure 11: Modelled wind speeds for the Bay of Plenty



Source: Strata chart developed using WIWA modelled wind speed data

Note that the horizontal axis is calendar years not Assessment Periods

126. The NIWA data indicates that 2016 and 2017 were similar years with 2016 having the highest wind speed of the three years. Interestingly, 2015 data indicated fewer >100km/h events, but a higher number of winds at the higher speeds.

[23] 3.15 NIWA-addenda report Horizon_network_NZCSM_wind_gusts_DL

127. Given that there was only one weather related MED during these three years, the wind data indicates that the Horizon network has been performing within its reliability limits under normal wind conditions. As Figure 10 shows, normal conditions include several occasions where wind speeds will be expected to exceed 100km/h and exceed the design limits of overhead lines on some occasions.

128. The AP 2018 MED weather data would be very interesting to apply to this chart and would presumably show a much higher incidence of winds in the upper regions of the chart over a longer period. Unfortunately, Horizon could not provide this data and explained that, during one of the cyclones, the wind measuring device at Whakatāne Airport was damaged and therefore no actual readings were available. Horizon informed us that it does not have any wind measuring devices of its own.

129. In the absence of weather data for AP 2018, we have had to form our view from other information available, this included:

    a. Horizon management, operations and field reports;

    b. post event reports and papers;

    c. impacts on adjoining distribution networks;

    d. documented and photographic evidence of damage to network assets, landscape and vegetation; and

    e. news reports and articles.

130. During our site visit to the Bay of Plenty, Horizon discussed and provided evidence of the severity of the weather events in AP 2018 and the cumulative effects of the several events that occurred over the course of AP 2018. Much of the cumulative effects were due to major flood events causing saturated ground conditions followed by severe wind events placing pressure on weakened foundation structures, drainage and sloping land.

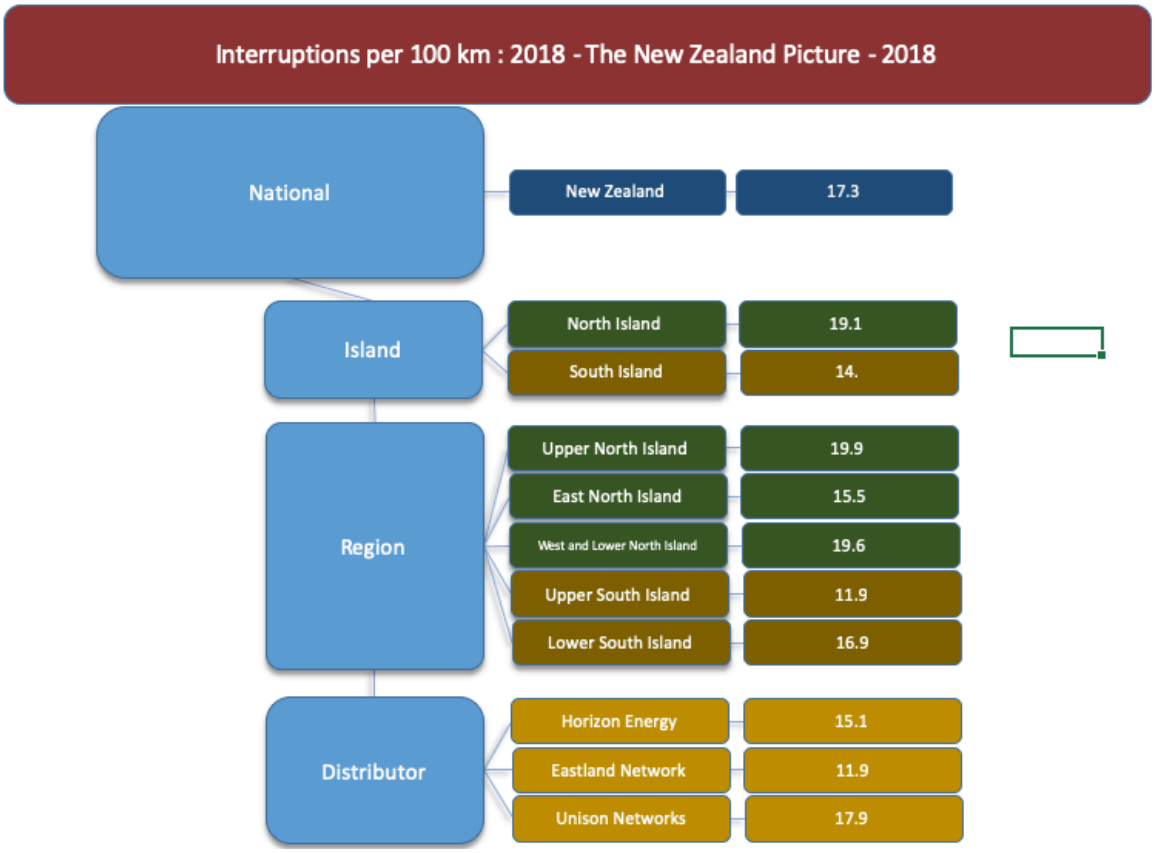
131. We visited several sites where major outages had been caused. Whilst we challenged assumptions and asked questions, the evidence of major disruption due to adverse weather was apparent. The challenges Horizon field crews faced during the cyclone Debbie and Cook events were significant with restoration having to be appropriately called off overnight due to the severity of winds and dangers of debris and landslides.

132. In appendixes C and D, we provide comparisons of the interruptions occurring per 100km on Horizon’s network with contiguous networks and the national and regional performances. The analysis indicates that on a per 100km basis, Horizon’s network has had fewer interruptions than neighbouring distribution networks, and compared to national and regional interruptions, in each for the three Assessment Periods prior to AP 2018.

133. In AP 2018, Horizon's performance on interruptions per network km was higher than Eastland Network but still lower than Unison Network, National, North Island and East Coast of the North Island interruptions/100km.

134. The comparison for AP 2018 is provided in Figure 12.

Figure 12: AP 2018 Interruptions per network km



Source: Strata chart developed using Information Disclosure data

135. We also considered information from other sources including news and weather reports alongside the impact on other infrastructure in the region. We found that the information supported Horizon's evidence on the unusual frequency and ferocity of the weather events that occurred in the Bay of Plenty in AP 2018.

136. Based on the evidence we have reviewed, we have no doubt in concluding that both cyclones Debbie and Cook caused major disruption and were correctly included in the MED normalisation. We also consider that the events were so severe that it is likely that the impact continued over several days and potentially weeks following the storms. If this was the case, then Horizon's performance data would be expected to provide evidence.

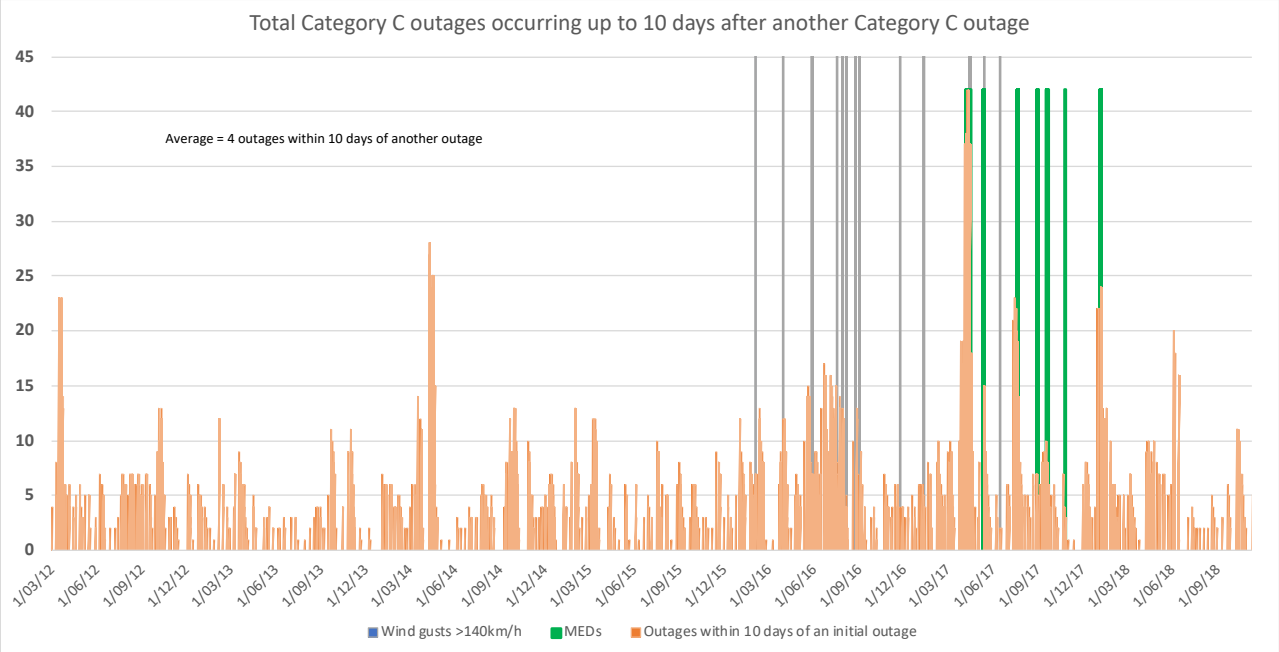
Spill-over effect appears to be significant

137. As Horizon pointed out to the Commission in its explanation paper, it is possible for the impact of extreme weather to 'spill-over' into days following a MED. Such a spill-over may create high SAIDI and SAIFI either side of a MED as the weather builds and falls prior to and post the main event. We have tested the extent to which this occurred in AP2018.

138. In addition to reviewing Horizon's conclusion that 78% of SAIDI occurred on one day either side of the MED, we looked at the interruptions attributable to weather, vegetation and defective equipment within 10 days of an MED (i.e. calculating a rolling average of interruptions. To do this, we calculated the number of outages occurring within 10 days after an unplanned (Category C) outage.

139. Figure 13 shows the results of our analysis. The chart indicates quite clearly that outages were clustered around high wind speed days (>140km/h) and MED. The chart shows that after an outage, on average, we can expect to see four further interruptions within the next ten days. We can see that on the MED in AP 2018, the average interruptions within ten days after the MED is much higher than the average.

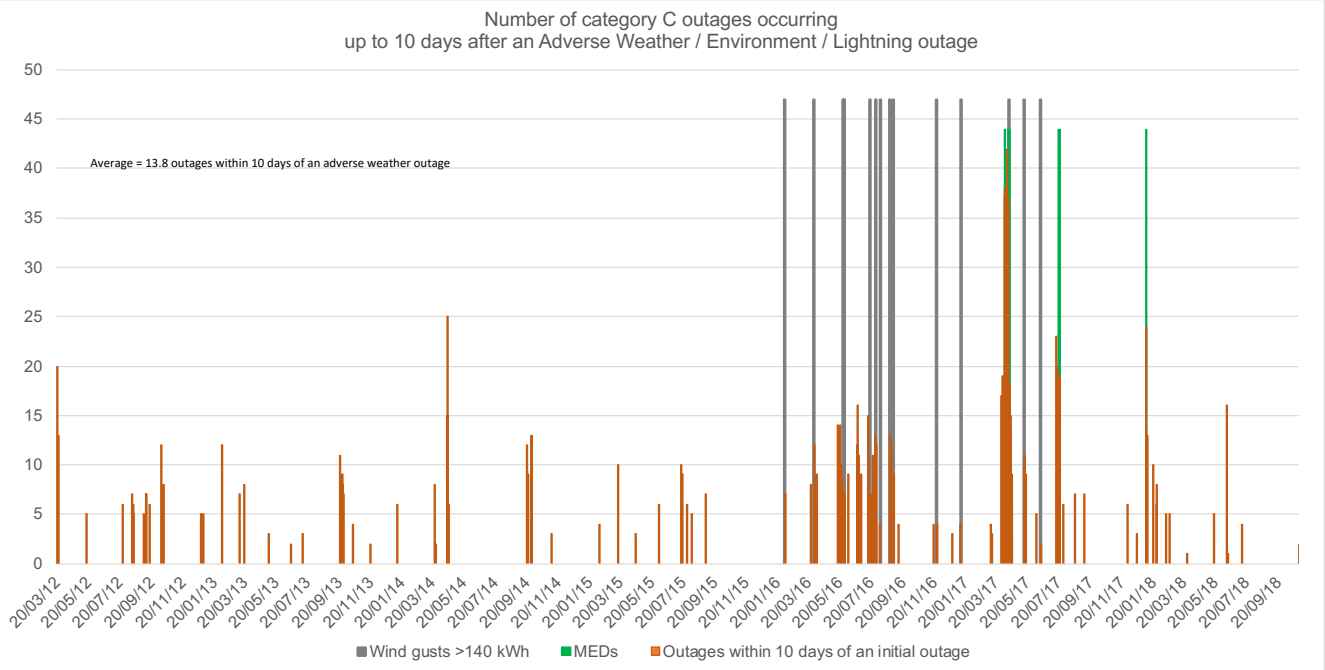
Figure 13: Analysis of spill-over effects



Source: Strata chart developed using Information Disclosure data

140. We also produced more granular analysis for outage attributed to weather, vegetation and defective equipment. We found the strongest indication of spill-over effect for interruptions attributed to weather, environment and lightning (see Figure 14).

Figure 14: Analysis of spill-over effects due to adverse weather



Source: Strata chart developed using Information Disclosure data

141. Our analysis is consistent with Horizon's explanation that, for AP 2018, there was a material spill-over effect from the weather related MED that had a material impact on its exceedance of the reliability limits in that Assessment Period.

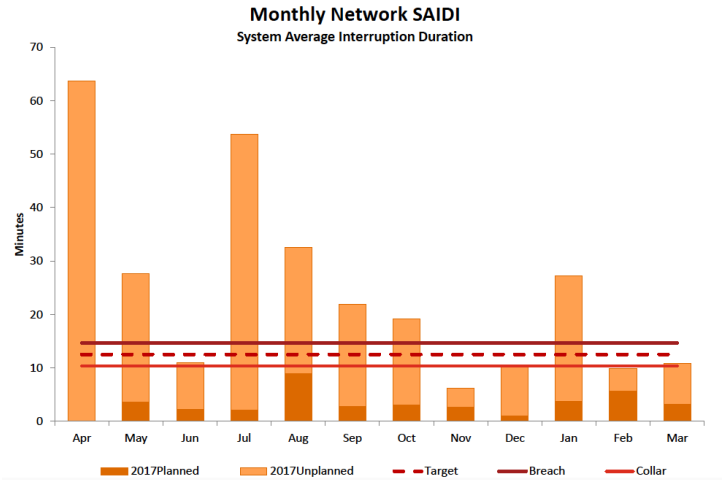
142. Further, we consider that, had the spill-over effect not occurred, Horizon is likely to have remained within its reliability limits in AP 2018 and would therefore have avoided non-compliance.

The coincidence of planned work and MED was not a material factor in AP 2018

143. Horizon provided its monthly SAIDI and SAIFI for AP 2014 to AP 2018. We have reproduced the charts in Appendix D. The monthly SAIDI profile for AP 2018 can also be seen in Figure 15.

144. From our analysis, we have concluded that whilst deferment of planned work can sometimes be a legitimate action to take to manage compliance, in this case, Horizon could not have avoided its non-compliance by deferring planned work during AP 2018.

Figure 15: Monthly planned and unplanned SAIDI in AP 2018



Source: Horizon 5.1 Monthly Network SAIDI SAIFI (March 18)

5.4. If defective equipment related faults were a contributing factor

145. In this section, we consider the validity of Horizon's claim that the limit exceedances in its AP 2017 and AP 2018 reliability assessments were not due to deterioration of its network assets.

146. In our opinion, neither of the MED occurring in AP 2017 were symptomatic of greater than normal network deterioration. We also consider that the weather related MED and the associated spill-over effects in AP 2018 were not due to underlying deterioration of the network. In our opinion, the use of underground distribution in urban areas, together with the extensive installation of concrete poles is likely to have lessened the damage and associated interruptions during adverse weather.

147. Notwithstanding the above, removal of the MED from Horizon's SAIDI in both AP 2017 and AP 2018 indicates that limit exceedances would still have occurred. Whilst we acknowledged that spill-over from the major storms in AP 2018 will have contributed to this, there is a possibility that some underlying network issues could have made a contribution. As the Commission requested, we have undertaken an assessment to identify if this was the case.

Was Horizon investing to maintaining network performance?

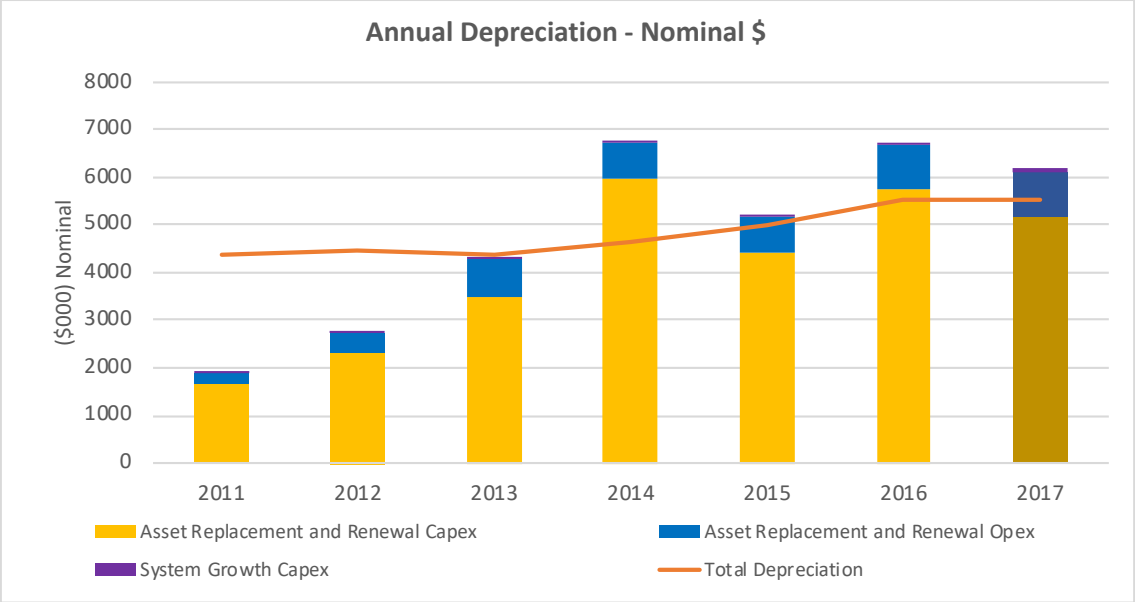
148. Electricity distribution assets, particularly those exposed to corrosive coastal environments require ongoing investment to maintain or replace them. In information disclosures, EDB publish data that can be useful in providing indications of the appropriateness of historical expenditure.

149. One indicator is the level of capital expenditure (capex) related to asset replacement compared to the depreciation of the network assets. It is important to note that this is an indicator only, there are several legitimate reasons why EDB might not be investing at depreciation rates; for example, the network might, on average, be relatively new or generally performing well and in good health.

150. Figure 16 presents a view of the level of asset renewal and replacement related expenditure that Horizon is making compared to the annual depreciation of its network assets. The chart

suggests that Horizon's historical asset replacement expenditure could have been low in 2012/3 but that this has been addressed since 2013.

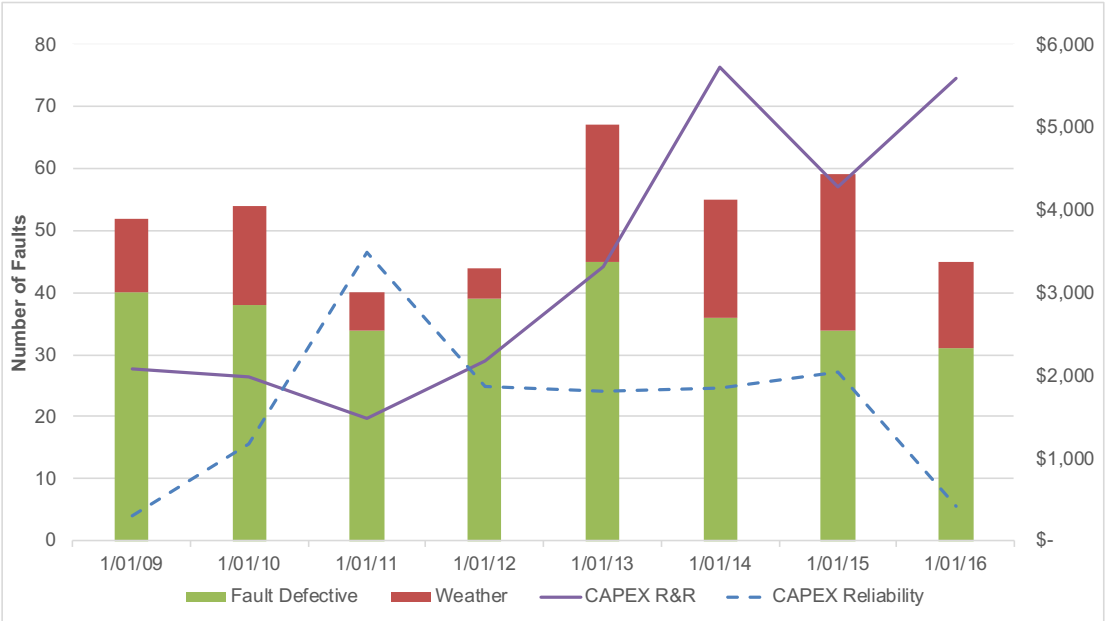
Figure 16: Annual depreciation and asset replacement expenditure



Source: Strata chart using Horizon's information disclosure data

151. The chart in Figure 17 was produced from data and analysis provided by Horizon on the correlation of its replacement and renewal capex and defective equipment and weather fault events. The chart supports the perspective given in Figure 16 that since 2013, Horizon has increased its investment in the replacement and refurbishment of its assets.

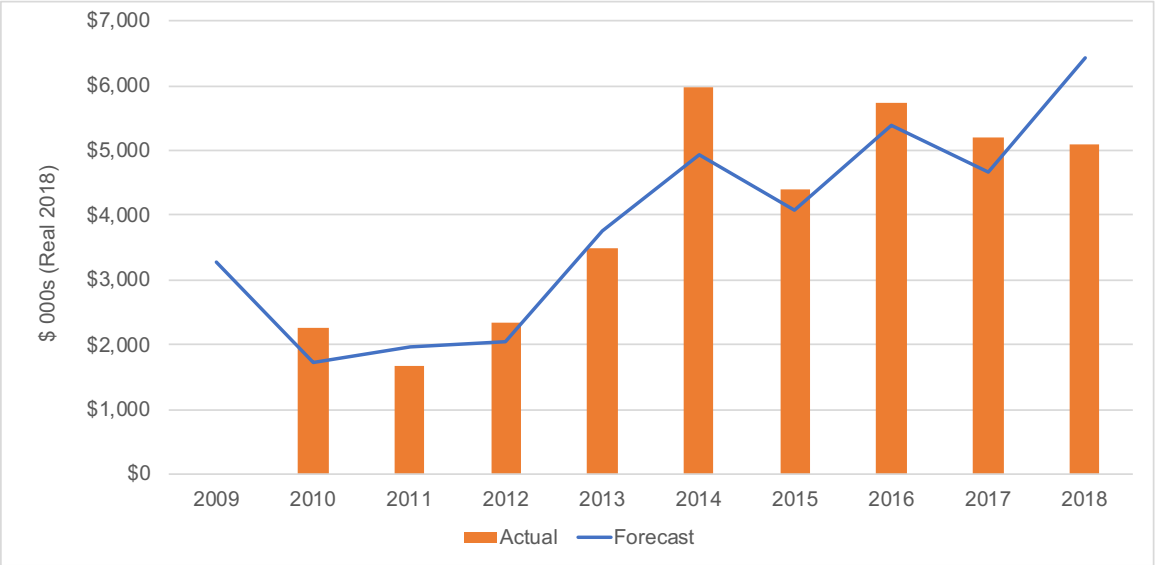
Figure 17: % Defective Equipment Faults (Per Annum) v Capex



Source: Horizon data from 3.18 CAPEX v Feeder Performance V1

152. We have also seen that Horizon has been forecasting its replacement and renewal capex reasonably consistently in each of its annual AMPs. In addition, there is evidence that Horizon's actual expenditure has been aligned with its forecasts (see Figure 18). Horizon has increased its forecast asset replacement and refurbishment expenditure since 2010 and has, in most years (other than in 2018), achieved or exceeded its forecast. In our experience, it is quite unusual for a distributor to consistently achieve its forecast capex for asset replacement and renewal. Given this position, the appropriateness of the forecast is the next component to consider.

Figure 18: Asset replacement and renewal capex forecast and actual

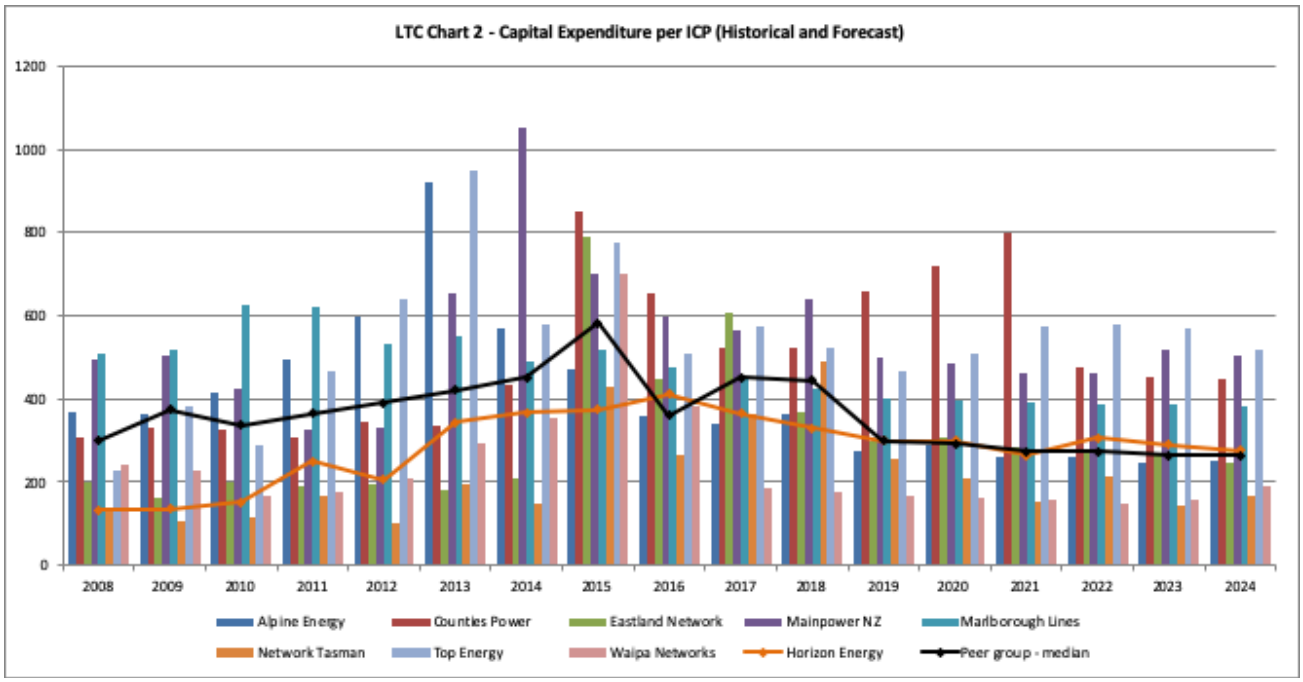


Source: Horizon 2.5.1 Forecast Capex 2018 constant dollars (2) and 2.1 Capex Actuals in 2018 constant dollars

153. Since November 2014, Horizon has been undertaking benchmarking that compares its expenditure against that of other EDB. The benchmarking indicated Horizon's historical actual capital expenditure was tracking below that of its peers. Figure 19 shows an extract from Horizon's benchmarking against a peer group of EDBs for annual capex per ICP. The benchmarking provides a similar perspective to our observations on disclosed data; - that since 2013, Horizon has been stepping up its network related capex.

154. Whilst a similar increase can be seen in the peer group median, this is largely due to periodic step change increases in individual peer EDB. We consider that the chart indicates that Horizon is not underspending in comparison to its peer EDB group. Given that its network is relatively well constructed (i.e. undergrounding urban areas and concrete poles), the benchmarking does not indicate that the 2014 forecast levels of capex were out of step with other comparable EDB and, as we have seen in Figure 18, Horizon's replacement and renewal capex since 2014 has been at its forecast levels.

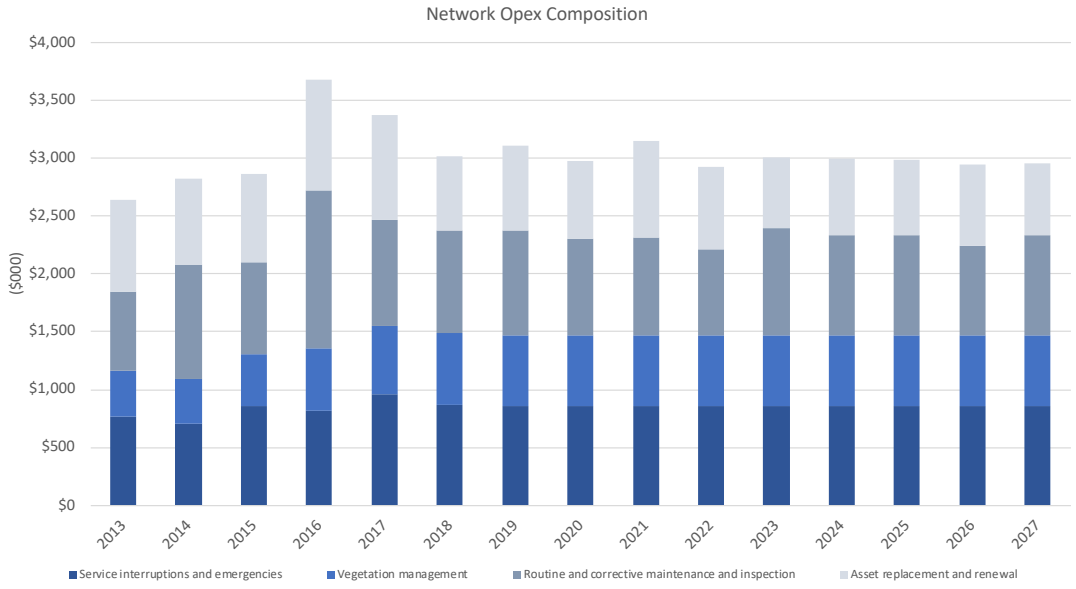
Figure 19: 2014 Comparison of EDB capital expenditure per ICP



Source: Horizon 3.4.1-3 19 November 2014 - Comparative Performance Report

155. Horizon's operational expenditure opex expenditure indicates increased routine and corrective maintenance and inspection was also being stepped up since 2013, rising to a peak in 2016. This change is largely driven by increases in routine and corrective maintenance and inspection in 2016.

Figure 20: Horizon's network opex actual and forecast



Source: Strata chart drawn from Horizon information disclosure data

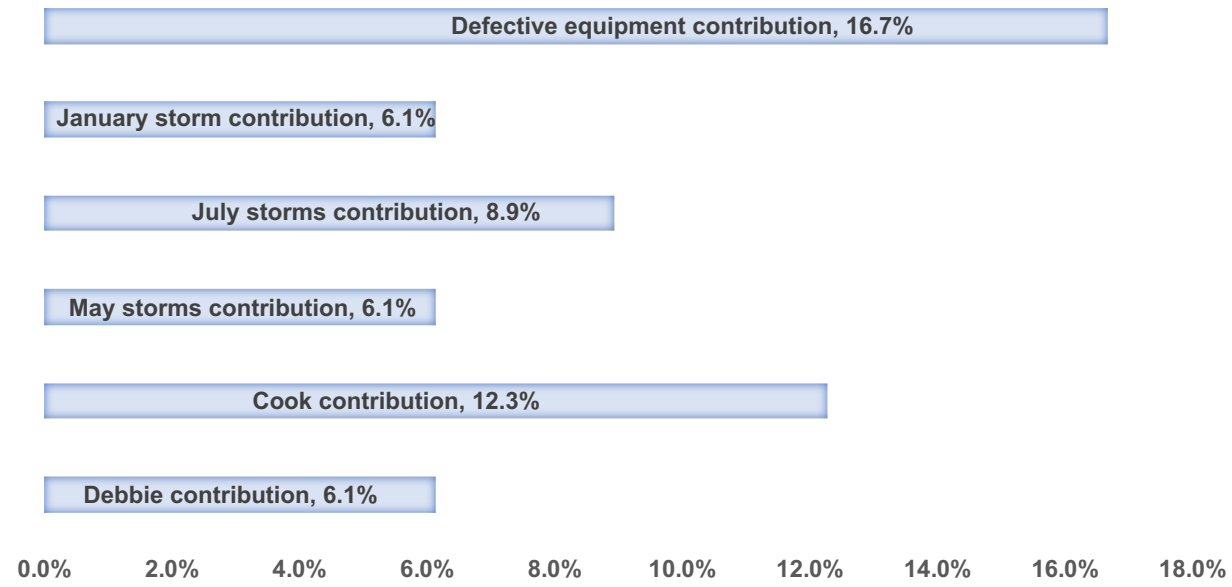
156. We consider that the high level indicators and Horizon's benchmarking suggest that, prior to 2013, Horizon was potentially investing less than it should have been in replacement and renewal capex. However, the urban undergrounding and prominence of concrete poles together with the condition and performance of the assets may have justified a lower level of replacement and renewal on Horizon's network. To test this, we reviewed how Horizon's network was performing and the health of its network assets.

Horizon was monitoring interruptions on its network

157. Figure 21 shows the percentage, by cause, that each MED contributed to the SAIDI limit in AP 2018. For example, the chart shows that normalised SAIDI for MEDs attributed to a defective equipment cause contributed 16.7% towards the SAIDI limit. Normalised SAIDI attributed to cyclone Cook contributed 12.6% to the SAIDI limit.

158. Given the relative contribution of the defective equipment SAIDI, we considered if this reflected potential weakness or deterioration of the network.

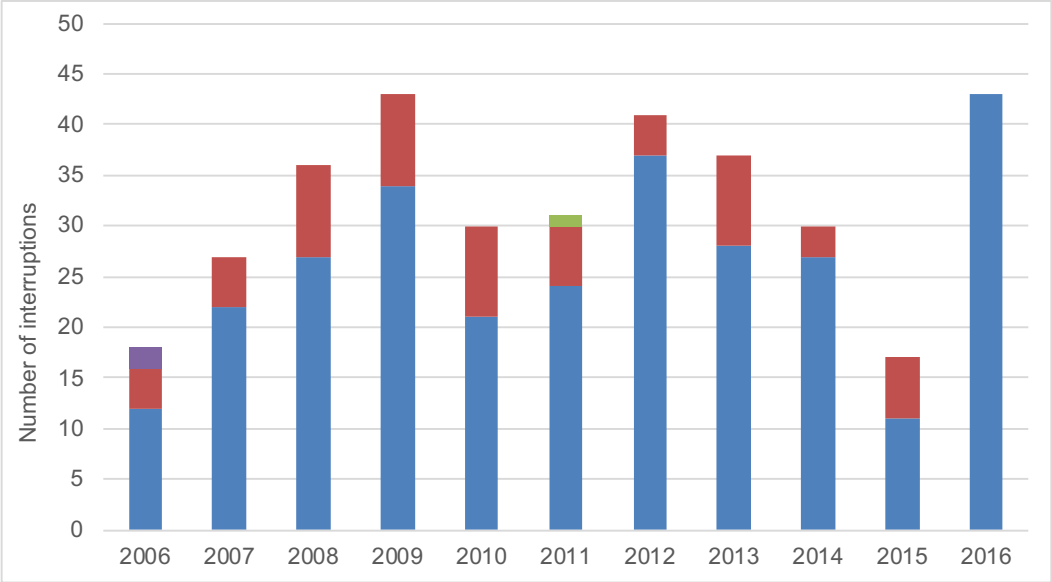
Figure 21: Normalised MED SAIDI as a percentage of the SAIDI limit



Source: Strata chart developed using Horizon 3.42-43 Horizon Network Quality Standards Explanatory Report, Table 6

159. Horizon provided data on the historical performance of its network for the ten years preceding AS 2018. Our assessment of that data can be seen in Appendix B. Figure 22 indicates that interruption numbers are predominantly attributed to the overhead network and that between 2012 and 2015, Horizon had been experiencing an improving trend in its number of overall interruptions due to defective equipment.

Figure 22: Interruptions attributed to defective equipment

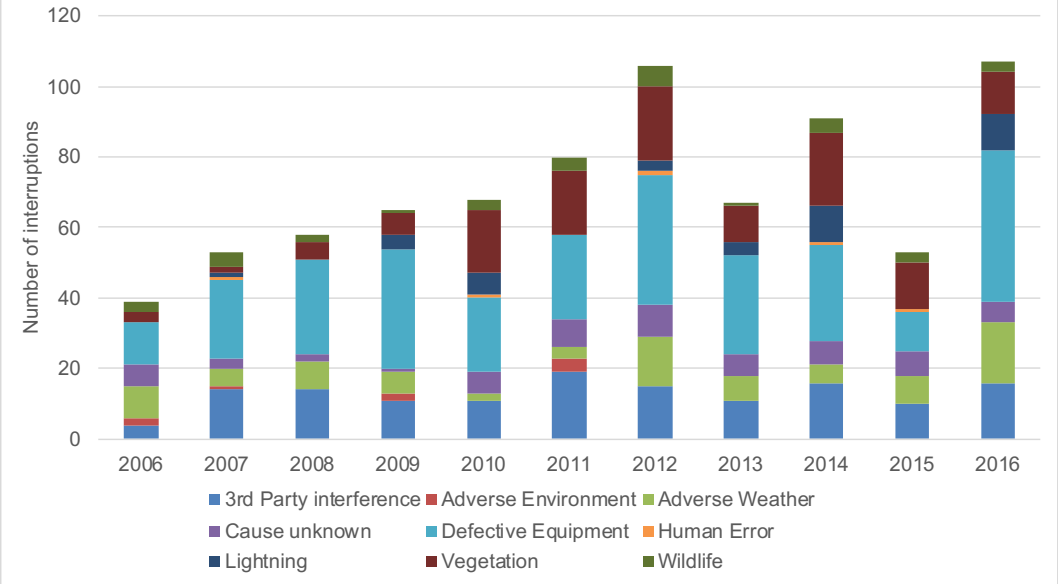


Source: Horizon V1.0_InterruptionsAnalysis_Operations_Combined

Note that the horizontal axis is calendar years not Assessment Periods

160. The causes of the interruptions on overhead distribution can be seen in Figure 23.

Figure 23: Causes of interruptions on the overhead distribution network



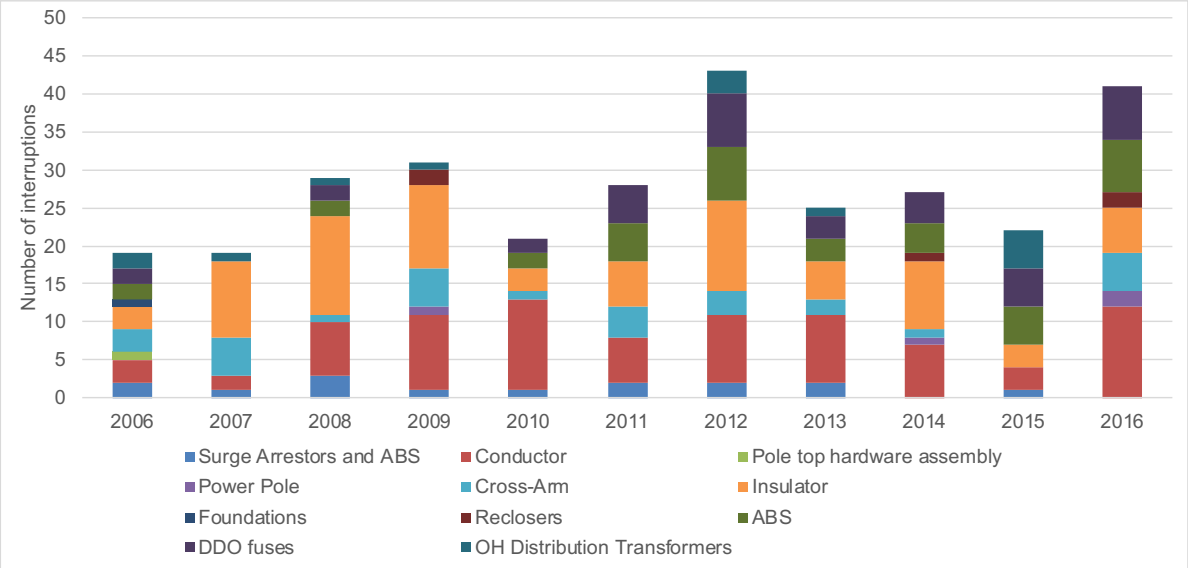
Source: Horizon V1.0_InterruptionsAnalysis_Operations_Combined

Note that the horizontal axis is calendar years not Assessment Periods

161. Figure 18 indicates that a steep upwards trend in overhead network interruptions occurred between 2006 and 2012. Much of this is due to the increase in interruptions attributed to vegetation and adverse weather. Post 2012, the performance becomes more variable and on average is just over the 2011 interruptions level.

162. Figure 19 provides the breakdown of causes attributed to defective equipment. The chart indicates that defective equipment interruptions on the overhead network are quite variable with no obvious trends other than potentially deteriorating trends between 2006 and 2012, and improving performance between 2012 and 2015 - which unfortunately was followed by a major increase in 2016.

Figure 24: Causes of interruptions on the overhead distribution network attributable to defective equipment



Source: Horizon V1.0_InterruptionsAnalysis_Operations_Combined

Note that the horizontal axis is calendar years not Assessment Periods

163. The interruptions attributed to equipment failure shown in Figure 24 provide an indication that distribution dropout fuses (DDO) and air break switches (ABS) were making increasing contributions since 2012. In the information provided and during our site visit, Horizon demonstrated that they were aware of this and had initiated appropriate asset management actions to address the issues.

164. In addition, Horizon provided evidence based demonstrations that it had good processes for analysing asset performance and applying asset management knowledge and skills to address emerging issues. An example of this is the development of composite crossarm structures to ameliorate issues detected in existing wooden crossarms.

Asset management was being applied to maintain asset health

165. To obtain a further perspective on the underlying condition of the network assets, we reviewed Horizon's data on their age and condition.

166. Horizon has implemented an Asset Health Index (AHI) approach to grading and monitoring the condition of its assets. In addition, it provides asset condition assessment data in its annual information disclosures. We have provided details of Horizon's condition assessments for Assessment Periods in Appendix F.

167. We have reviewed how Horizon collects its asset assessment data through periodic asset inspections. We have also considered Horizon's advice on the reliability of its data. In addition, we undertook a sample based check to better understand how Horizon processed its asset data. We have provided information on Horizon's data quality in Appendix H.

168. Horizon also described its asset management methodology including its Total Asset Life Cycle (TALC) and Condition Based Risk Management (CBRM) approach. Whilst these approaches have yet to fully mature, in our opinion, they provided assurance that Horizon is developing and applying good industry practice asset management including the collection and processing of asset related data.

169. Taking into consideration the interruptions data, the on-site inspections, independent study reports and asset condition data, we have concluded that underlying abnormal deterioration of the network assets was not apparent prior to AP 2017 and AP 2018. Given the current condition and asset health ratings, in our view, it is unlikely that abnormal deterioration of the overhead network contributed to Horizon's non-compliance with its reliability assessment limits in AP 2017 and AP 2018.

5.5. Summary of our opinion on Horizon's explanations for its non-compliance

170. We agree with Horizon that:

a. the ex-tropical cyclone events in AP 2018 made material contributions to its exceedance of the SAIDI limit in AP 2018;

b. the storms in AP 2018 were significant events and that defective equipment related SAIDI will have been impacted by spill-over from these events;

c. spill-over effects from the AP 2018 storms, including increased need for planned repair work had a material impact on Horizon's AP 2018 SAIDI breach; and

d. underlying deterioration of the overhead network assets was not a factor in Horizon's non-compliance.

171. We disagree with Horizon that the lightning strike which damaged a surge arrestor on 10 April 2016 was the primary cause of this MED. Our opinion is that the primary cause was the ongoing reliance on the single, vulnerable Snake Hill feeder for supplies to the Galatea region. In our opinion, this situation should have been remedied in the seven years since it first arose.

Part B: Assessment and opinions on whether Good Industry Practice was applied

172. In Part B, we provide our assessment and opinion on whether the steps taken by Horizon, prior to its non-compliance, met good industry practice including findings as to whether or not there was evidence that it had not appropriately addressed network deterioration and/or increasing interruptions due to defective equipment.

173. The Commission also asked us to identify any particular instance where any failure to act in accordance with good industry practice was substantial.

174. Through our review of documentation, data and on-site discussions and inspections we have found that:

1. the characteristics of the network, such as its design and construction, mitigated the impact of adverse weather conditions;
2. indications that Horizon's expenditure on maintaining its network was potentially below optimum levels prior to 2013, but saw no evidence that this had made a material contribution to its non-compliance;
3. whilst there was an increase in defective equipment interruptions from 2009, the evidence indicated that this was not due to underlying deterioration of network assets; and
4. Horizon was taking appropriate actions to strengthen the resilience of its network but the timing of the 10 April 2016 MED caught it out.

175. We found that Horizon's asset management practices were generally sound and were in several aspects above the level we have seen in our reviews on other New Zealand EDBs.

176. There are two areas that we identified where evidence indicated that Horizon's practice may not have been at Good Industry Practice:

1. that Horizon did not act with sufficient urgency to rectify the vulnerable electricity supply arrangement for the Galatea region; and
2. post event reviews are insufficient to meet the level required in good practice standards.

177. Before we discuss these points further, we provide a summary of our findings on Horizon's asset management practices.

6. Approach to asset management

178. Through its responses to the Commission's 53zd information request, Horizon demonstrated that it is establishing its asset management practices to meet good industry practice standards. This view was reinforced during our on-site sessions and during the field inspections.

179. An important aspect of asset management is the framework that is used to develop and implement coherent and integrated asset management strategies. The framework must also include the collection and use of reliable data on asset performance and health on which sound investment strategies can be formed. Through documentation, analysis and data , Horizon demonstrated that it had good visibility of the condition of its network assets and how they were performing. We have relied on this information when forming our assessment and evidence can be seen in various appendixes to this report.

180. Asset management practice have evolved significantly over the past twenty years and international standards are providing guidance and references against which good industry practice can be established and measured. We also apply these guidelines and standards when assessing if a business is achieving good industry practice (see Appendix K for further discussion).

6.1. Horizon's asset management framework is aligned with appropriate standards

181. Amongst a range of good industry practice standards, Horizon applies ISO:55000 standards for asset management[24] and ISO:31000 risk management guidelines:

> *The asset management systems underpinning our strategy are also undergoing material overhaul. We are following the lead of other industry players like Transpower and Powerco in seeking to align ourselves with best industry asset management practice. The most widely recognised standard used in the New Zealand electricity distribution industry is now ISO55000. HEDL is committed to achieving broad alignment with this standard by 2021, and achieving certification by 2022.*[25]

182. At the time of this review, Horizon was preparing to test its current asset management maturity levels in an internal workshop facilitated by an ISO55000 alignment specialist. Horizon's intention was to use this workshop to identify areas needing most focus in the lead-up to our application for ISO:55000 certification.

183. To achieve ISO:55000 accreditation standard, an organisation is required to have a high standard of documented policies and procedures including ongoing monitoring and reporting of compliance. Periodic independent audits are made to provide assurance that compliance is being achieved.

184. We found that Horizon had made good progress towards ISO 55000 certifications and that this was reflected in the comprehensive documentation of its asset management systems and practice. Horizon's development pathway to achieve asset management to ISO: 55000 compliance level provides assurance that its overall asset and risk management framework will be at, or above, good industry practice.

185. Horizon also provided evidence that it had engaged independent consultants to review and assess aspects of its asset management practices. In an October 2017 report, Southwest Consulting Group provided this conclusion when summarising the findings of its review of network expenditure:

> *Horizon Networks has an impressive asset management strategy of implementing an Advanced Distribution Management System (ADMS) and Asset Management System (AMS) with field capture.*
>
> *It is particularly encouraging to see the introduction of a Condition Based Reliability Model (CBRM) using both probability of failure and consequence (or criticality). The concept of reliability improvement using self-healing from switching field devices automatically in under 1 minute is also industry*

[24] ISO 55000 provides an overview of the subject of asset management and the standard terms and definitions.

ISO 55001 is the requirements specification for an integrated, effective management system for asset management.

ISO 55002 provides guidance for the implementation of such a management system.

[25] Horizon 2018 AMP, chapter 9, page 2.

leading with the potential to halve reliability loss. Horizon strategy successfully implemented would make it one of the leading Electricity Distribution Businesses (EDBs) in the country.[26]

186. We found that Horizon has continued to build on and mature its asset management practices since Southwest Consulting Group completed its assessment.

Horizon is applying good practices in asset management

187. We looked for examples that demonstrated Horizon's application of good industry practice asset management. We found that Horizon was able to demonstrate that it is actively implementing projects and continuous improvement initiatives targeted at maintaining good practice asset management. Examples we found include:

Area	Example
asset lifecycle management	• Horizon described and demonstrated its development of an asset management framework that includes good practice asset lifecycle management. • Horizon's practices include the use of criticality, asset health and portfolio optimisation analysis when developing asset management strategies and plans. • Horizon has applied benchmarking and repex model analysis against which it tests its asset lifecycle plans. • Fleet asset management plans based on asset lifecycle management. • Planning for the future development and improvement of asset management systems and practices (e.g. risk based asset replacement strategies).
data collection and analysis	• Developed understanding of the base position (pre 2016). • Set out and implemented improvement strategy. • Improvements in data collection and database systems. • Strategy for continuous improvement in asset inspection and in field data collection. • Implementation of asset health data and analysis for some asset fleets with plan to extend to all asset types.

[26] 3.18 Horizon Network Cost Reduction Report_final, Review of Horizon Network Expenditure, October 2017, Authors: Southwest Consulting Limited.

Area	Example
	• Development of analytical skills and application in monitoring and reporting.
identification and implementation of improvement actions	• Asset management practices developed through a long term strategy. • Improved fault response time through fault analysis and automation. • Improved vegetation management practice through the application of technology, systems and practices. • Ongoing commitment to development of systems and platforms. • Investment in systems and tools (e.g. AMS, GIS, Fieldreach). • Development of policies, standards and procedures in asset and workflow management. • Application of risk management framework including the development of controls for identified risks.
collaboration with others	• Membership of the EEA asset management forum and criticality working group. • As several other EDB have done, Horizon has adopted Powerco's suite of policy and procedure documents. Ongoing assimilation of this documentation to meet Horizon's specific requirements is needed.

Horizon has developed and applied security and reliability measures

188. Critical to the management of supply security and reliability is the establishment and use of appropriate measures against which performance can be determined and asset strategies can be formed. In documentation, Horizon explained how it develops and uses key measures relating to the security and reliability of electricity distribution.

189. Horizon provided a summary to the approach it has taken when developing its network including making investments to improve reliability performance:

- *Network built over the last 50 or so years to serve customers at a cost and quality customers are prepared to pay for via capital contributions/vesting;*
- *Different parts of the network have differing levels of performance due to terrain, customer density, proximity to GXPs etc;*
- *Quality for smaller consumers is largely determined by locality of connection;*

- *Large customers determine resilience, redundancy at time of connection;*
  - *Highly cost conscious, most are not prepared to pay for full redundancy of assets*
- *Network enhancements to improve resilience and reliability are assessed in terms of the overall business case – SAIDI/SAIFI saved (as a proxy for VoLL) versus cost of the investment; and*
- *Network performance and security standards applied to identify targeted areas for improvement.*[27]

190. Horizon explained that it sets the performance and security standards to avoid customers opting for the cheapest possible solution. It considered that the issue could occur when the customer is not the end-user; for example, when a developer makes the connection decision on achieving lowest cost rather than considering the future network performance.

191. Horizon's security standards are set out in Figure 25.

Figure 25: Horizon's planning security levels

LEVEL	DESCRIPTION
L1	Fully redundant alternative supply that maintains power without an outage.
L2	Ability to restore load by SCADA controlled switching.
L3	Ability to restore load by switching at sub-transmission or distribution level within two hours.
L4	The outage that is restorable by alternative supply by switching after the faulted element is isolated.
L5	Restoration after repair.

LOAD / CUSTOMER TYPE	PLANNING SECURITY LEVELS
Dual transformer bank zone substation.	L1
Zone substation pair (e.g. Plains and East Bank).	L2
Major Industrial Customers (service level by agreement).	L1 or L2
Major Industrial Customers (standard terms of supply).	L3
Zone substation less than 10MVA.	L3
High-density commercial load.	L3
Urban and rural areas with meshed networks.	L4
Urban and rural areas with no meshing.	L5

Source: Horizon Tranche 3 Compliance Management

192. Horizon explained that the majority of its network is at L4 and L5 security levels and that repair time is based on location, access, resources available etc. This means that failure of a network component in urban and rural areas will generally result in supply interruption.

193. We saw evidence that in the past, Horizon had been making asset management decisions to ensure it achieved its security levels; these include:

- extensive use of concrete poles on the network that provide resilience to adverse weather and provide long life cycles;

[27] Horizon Tranche 3 Compliance Management

- undergrounding supplies in Whakatāne and Edgecumbe providing resilience to adverse weather;
- sectionalising the network through investment in the network and switching capability;
- replacing ageing and unreliable low voltage single strand copper OH line;
- installation of lightning arrestors in high lightning prone areas; and
- undertaking ABS and DDO replacements to address asset health issues and increasing fault events.

194. We also saw evidence that Horizon communicated and used its security standards when consulting with its customers and community on appropriate security standards and price.

195. Horizon sets its own reliability targets for SAIDI and SAIFI based on its assessment of the long-term performance of the network after removing inter-year fluctuations caused by extreme events or other anomalies[28]. Horizon anticipates that, over a five year period "on average", it will have met its performance targets. Horizon's reliability targets for SAIDI and SAIFI are compared with its reliability assessment limits below.

	Reliability Assessment limit	Horizon targets		
		Total	Unplanned	Planned
SAIDI	176	150	125	25
SAIFI	2.21	1.76	1.6	0.16

196. Our understanding is that Horizon sets its targets to exclude the expected impact of extreme events that are outside its reasonable control. In this way, it is similar in intent to the normalisation used to adjust the reliability assessment values for MED. For example, the 26 SAIDI minutes difference between the Reliability Assessment Limit and Horizon's target, is approximately the same as two normalised MED events (10.77 x 2 = 21.54).

197. In its response to Strata's draft report, Horizon informed us that it does not remove all "adverse weather events" when setting its internal targets. In practice, Horizon says that it tracks and reports monthly on raw (un-normalised) SAIDI and SAIFI, and that this provides a direct measure of actual performance against the targets that Horizon considers it can achieve in a normal year.

198. In an abnormal year, Horizon says that it tries to *manage performance to the Commission's "normalised" thresholds*[29] but that it considers this is unlikely to be consistently achievable without over-investing in the network. Horizon applies its targets when setting its maintenance and renewal expenditure allocations and that these are currently based on preserving current levels of service consistent with the results of consultation with customers.[30]

[28] 3.42-43 Horizon Networks Quality Standards Explanatory Report, page 4

[29] Horizon Response to Strata Draft Report 13 August 2019, paragraph 38

[30] Horizon 2018 AMP, page 11

199. The annual Key Performance Indicators (KPI) set for Horizon's CEO[31] include reliability measures at the reliability standard's limits rather than Horizon's targets. We consider that this is appropriate.

Horizon understands the requirements of good industry practice

200. We have concluded that Horizon understands what is required to meet good practice asset management standards and, since at least 2014, has taken steps to improve its asset management. Its current practices are aligned with international and New Zealand standards. Where appropriate, Horizon has engaged independent experts and industry peers to review and advise on its asset management approach and performance.

201. Horizon has set appropriate security standards to meet its customer and community requirements. It has tested these through consultation.

202. We consider that Horizon's application of reliability targets that are lower than its reliability assessment limits is questionable. We recommend that the Commission seeks further explanation from Horizon's on its use of alternative reliability targets and the implications this has on the levels of expenditure applied to asset maintenance and replacement.

7. Did Horizon apply Good Industry Practice?

203. We have concluded that generally, Horizon has been operating at good industry practice and that it is committed to continuing improvement.

204. However, consistent with the Commission's requirements for our investigation, we have identified that Horizon did not apply good industry practice in one aspect of its asset management, and this was a contributing factor in its exceedance of the reliability assessment SAIDI limit in AP 2017 and therefore its contravention of the Quality Standard in AP 2018.

205. In addition, we consider that there is an important action that Horizon needs to take; the way in which it undertakes post event reviews falls short of the standards that Horizon applies to its asset management.

7.1. Failure to address the vulnerability of supply to Galatea

206. In section 5.2, we discussed the 10 April 2016 outage to electricity supply in the Galatea region and the associated 20.13 SAIDI minutes. In its Draft Report to the Commission, Strata provided its findings and opinions relating to Horizon's performance when managing the reliability of electricity supply to Galatea. The Commission provided a copy of Strata's Draft Report to Horizon.

207. In its response to Strata's Draft Report, Horizon stated that it disagreed with Strata's opinion on the Galatea MED claiming that it had done all that it could to achieve the restoration of reliable supplies to Galatea. Horizon claimed that it faced difficulties establishing a solution due to technical, relationship management and contractual issues.

208. The Commission asked Strata to review the issues raised in Horizon's response in more detail. To assist Strata in this review, the Commission sought additional information in its 1st October 2019 notice to Horizon under Sections 98(1) (a) and (b) of the Commerce Act 1986. Horizon provided information in response to the s98 letter in November 2019.

[31] Horizon Energy Distribution and CEO KPIs

209. Strata has reviewed the additional information provided by Horizon and given further consideration to the Galatea electricity supply issue and its relevance to Horizon's non-compliance.

210. In its response to Strata's Draft Report, Horizon made the following request:

> *Should Strata and the Commission chose not to accept our explanation, then Horizon would welcome an explanation from both parties that clearly explains why Horizon's chosen approach was flawed, what more could Horizon have done and more importantly why should Horizon have elected to undertake expenditure that would have been unjustified and uneconomic that would have unduly burdened the community.*[32]

211. In appendix K, we have provided a complete copy of Strata's briefing paper to the Commission addressing the issues Horizon raised in its response to our draft report. The briefing paper includes a full explanation of our findings and conclusions on the Galatea supply reliability issue and supports the opinions set out in this section. A summary is provided below.

212. Strata's opinion, stated in the Draft Report, was summarised in its executive summary as:

> *We disagree with Horizon that the lightning strike which damaged a surge arrestor on 10 April 2016 was the primary cause of this MED. Our opinion is that the primary cause was the ongoing reliance on the single, vulnerable Snake Hill feeder for supplies to the Galatea region. In our opinion, this situation should have been remedied in the seven years since if first arose.*[33]

213. Strata formed its initial opinion on the understanding that the supply issues relating to the reliability of supply at Galatea had been known by Horizon but had not been solved within a seven-year period between 2009 and 2016. In Strata's opinion, the resolution of the Galatea area supply reliability issue should not have taken seven years.

214. Strata considered that issues relating to connection of Aniwhenua generation should have been addressed during the initial four to five years of its unavailability. Strata found that the lack of swift progress during the 2009 to 2014 period was the primary cause of the 10 April 2016 MED.

215. From the additional information provided by Horizon, Strata has subsequently developed a clearer understanding of the following timeline of events:

1. 2008 the interconnection arrangement at Snake Hill Switching station was altered to allow the Snake Hill circuit to be energised from the Edgecumbe to the Galatea substation;
2. 9th August 2009, a transformer at Aniwhenua hydro power station experienced a failure;
3. in 2011, the repaired transformer was returned to service and Aniwhenua again became the primary electricity supply for Galatea;
4. towards the end of 2011, a second transformer failure occurred at Aniwhenua;
5. following the second transformer failure, Nova, the owners of Aniwhenua power station refused to allow its connection for the primary supply to Galatea;

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[32] Horizon Response to Strata Draft Report 13 August 2019

[33] 3568578_Non-compliance report Horizon Energy Distribution 2018 DRAFT (17 June) - Strata Revision, Page 4, paragraph 10.

6. October 2012, Horizon management submitted an expenditure request to its Board for implementation of a solution it had developed to resolve the Aniwhenua issue;
7. January 2014, Horizon produced an options paper setting out three alternative solutions including the one identified in 2012 which was the preferred option; the Options Paper recommended the set-up of a technical meeting between Nova Energy and Horizon Energy to formally identify the key issue at Aniwhenua;
8. 17 April 2014, Horizon and Nova signed a Prudent Discount Agreement (PDA) with Transpower which was supported by a report stating that nothing had changed from the historical arrangement with Aniwhenua providing the primary electricity supply for Galatea;
9. July 2014, Horizon finalised protection settings for the proposed option;
10. 16 July 2014, Horizon completed work that included the solution for the Aniwhenua connection issues;
11. August 2014, Horizon noted key concerns regarding a limited number of remaining issues to be resolved in the negotiations of the Aniwhenua Distributed Generation Connection Agreement (DGCA) with Nova Energy (Nova) – Horizon noted that Nova was not anticipating being able to provide continuous supply from Aniwhenua for a further 12 months;
12. November 2015, the DGCA for Aniwhenua was signed ;
13. 10 April 2016, the Galatea area MED occurred; and
14. September 2016, the Aniwhenua connection was reinstated.

216. We did not find an explanation for why, after decades of service, the Aniwhenua transformers experienced failure. We found evidence that in 2012, Horizon understood the negative effects of fault clearing times on the transformers but there was no discussion on why this emerged as an issue in 2009.

217. Despite the submission of a proposed technical solution for Board approval in 2012, in January 2014 Horizon still appeared to be in the cause identification phase:

> *Nova Energy owns the three winding transformers (110/33/11kV) at Aniwhenua and it is believed the fault clearing time and fault finding has been the issues for not allowing Horizon Energy to use this supply.*
>
> *Based on the above issue there are number of options discussed below. It is recommended to arrange a technical meeting with Nova Energy to outline the issue(s) and address them with best industry practice.*[34]

218. In the same 2014 document, Horizon discusses technical options to resolve the issue at Aniwhenua. The preferred option is essentially the same solution that had been submitted for approval in October 2012.

219. In its Response Document, Horizon presents the Snake Hill feeder situation as standard practice:

> *…the Galatea supply network configuration is not considered unusual for the industry nor is it representative of poor design (or security of supply) practices. Furthermore, much larger communities are run on single circuits of similar length or longer for example Transpower's 110kV single-circuit line*

[34] Aniwhenua supply options_ V1.doc

to Opotiki serving 6,000 ICPs and 10MVA of load. Galatea is 1,800 customers and 6MVA of load by way of comparison

220. This perspective is inconsistent with Horizon General Manager Network's evaluation of the situation in October 2012:

> *Only having one supply available using the Edgecumbe line has drastically increased the exposure to the time delays while faults are located and isolated. BOPE are concerned that their transformers are subject to stress each time Horizon closes in on a fault while segmenting the 33kV and Horizon needs to be able to demonstrate that it is able to minimise this exposure.*[35]

221. The statement is also inconsistent with Horizon's application of $1.3m capex to increase reliability of the Galatea supply. Horizon's documents indicate that the investment required to address the Aniwhenua connection issue was $300k.

222. Horizon also informed the Commission that it had considered alternative options to supply Galatea:

> *Horizon did consider alternative options and initiated press releases advising the community of the issue and investigated an alternative which was to build a new line at an estimated cost of $3,800,000*[36]

223. The only independent report provided by Horizon was contained in an appendix to the April 2014 Prudent Discount Agreement. The estimated cost of the alternative project in the independent report attached to the Prudent Discount Agreement is $3,811,789. However, this option did not include upgrading the Snake Hill line to Galatea. It did include upgrading 15km of the Snake Hill line from 33kV to 110kV between Edgecumbe and Matahina, construction of an 110kV substation at Matahina, and the decommissioning of the remaining length of the Snake Hill feeder to Galatea.

224. The objective of this option was to provide an economic transmission bypass for the Matahina and Aniwhenua hydro generators and not to provide an option for restoring supply reliability to Galatea. Horizon's use of this example as proof that it considered building a new overhead line to Galatea is incorrect.

225. Information provided by Horizon shows that it did complete the investments needed for reinstating Aniwhenua connection in July 2014. Strata considers that the documents and timeline show that, from a technical perspective, the Aniwhenua connection could have been reinstated by mid 2015 (this date allows for protection settings and other remaining technical issues to have been resolved).

226. A year after Horizon completed the capital investments that addressed the Aniwhenua transformer issues, and 18 months after it had signed the PDA, Horizon signed a DGCA with Nova in November 2015. Despite completing the required network investments and signing the DGCA for Aniwhenua, it was a further ten months before the Aniwhenua connection was reinstated in September 2016.

227. The information provided by Horizon to the Commission for this investigation and the publicly available documentation did not provide any details as to why the restoration took a further 10 months from the finalisation of the DGCA. The additional documents and emails provided by Horizon in its response to the s98 letter do not provide explanations for the delay.

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[35] 20 October 2012 Memorandum from Peter Middlemiss to the Horizon Directors, entitled: Galatea Snake Hill 33kV Reliability Stage One

[36] Horizon Response to Strata Draft Report 13 August 2019, page 3

228. Whilst copies of email exchanges indicate some discussion between Nova and Horizon on protection settings, this work could and should have been undertaken much earlier in parallel with other actions. Given the ongoing reduced reliability of supply to the Galatea area, we expected to see a clear paper trail providing very detailed information on, and explanation of, the Board and management's deliberation of the issues. We have not identified such a trail in the information packages provided by Horizon to the Commission.

229. The absence of a clear, evidence based explanation for the time taken to reinstate the Aniwhenua connection following the completion of the capital works and commercial agreements is concerning. Had this delay been avoided, the impact of the 2016 MED would have been significantly reduced.

7.2. We have revised our initial opinion on the Galatea supply reliability issue

230. Strata has revised its original conclusions to the following:

- the resolution of the Aniwhenua generation issue should not have taken seven years during which time the Galatea community had reduced reliability or electricity supply;
- in our opinion, the lack of a robust technical investigation at the time of the first transformer failure in August 2009 extended the time in which a solution was finally installed in July 2014; Strata's view is that it should have been possible for Horizon to have reduced the time to complete the technical solution to less than five years;
- the absence of a clear, evidence based explanation for the time taken to reinstate the Aniwhenua connection following the completion of the capital works and commercial agreements is concerning. Horizon's explanation identifying that complex contractual issues also contributed to the delayed restoration are not supported by the documents and information that it provided. Specifically, the PDA and DGCA were signed before the end of November 2015, yet the reconnection of Aniwhenua took a further 10 months. The timeline of events provided by Horizon fails to provide reasons why the connection could not have been restored soon after the DGCA was signed.

231. Strata remains convinced that the Aniwhenua generation connection to the Galatea electricity supply could and should have been reinstated well before the 10 April MED event on the Snake Hill 33kV distribution subtransmission feeder.

232. In addition, it is our opinion that:

1. in not undertaking a timely and robust post transformer failure event investigation in 2009, Horizon did not meet good industry practice;
2. Horizon could have, but did not identify, install and commission the required solution at the earliest date that it could have; and because of this, missed an opportunity to mitigate the effects of the 2014 and 2016 MED in the Galatea region;
3. if the capital investments required to reinstate the Aniwhenua connection had been undertaken earlier, the 2016 MED would not have occurred. Horizon should have recognised this in its compliance statements but failed to do so.

7.3. Post event reviews and responses

233. In its 53zd request for information, the Commission asked Horizon to provide examples of post event review; in response, it provided the following summary:

> *Horizon Networks records outage information as described in our Annual Default Price Path Compliance Statement (refer to enclosed document*

"Annual Compliance Statement for Assessment Period to 31 March 2018" pages 21 and 22). Operational figures are reported monthly to the Horizon Networks board and a summary of outages that record SAIDI figures above 1 minute are provided. Outage information is reviewed to verify effective switching, correct operation of protective and Scada controlled devices and safety.

All outages are reviewed and any improvement with regards to fault finding and switching sequences are discussed with the Network Controllers.

Any issues relating to incorrect operation of protective and/or Scada controlled devices are investigated further by the Operations Manager and Network engineers. The findings of these investigation are documented and circulated to network and contracting staff with initial recommendations. Identified issues that require immediate action are resolved through the defect process and any additional information that may lead to long term strategic changes such as equipment types and design related changes will be driven by the Asset Management team through Horizon's standards or the Asset Management Plan (AMP).

Outages with higher SAIDI impact (5+ minutes) will lead to reliability assessment. Reliability improvements identified through this process may be actioned in the same or following years depending on the cost or will be included as a major project as part of the 10-year plan in the AMP.

Safety related issues concerning switching and equipment that is identified during this process are recorded in Vault which will trigger the appropriate level of investigation as well as corrective actions and/or a Network Notice will be issued with the appropriate operational controls.[37]

234. The above explanation sets out technical reviews that are undertaken following interruption events and how these are applied in asset planning. The supporting documents provided by Horizon demonstrated that technical reviews and reporting have been undertaken.

235. Horizon also provided numerous examples of post event analysis and investigations it had undertaken. These included the NIWA wind speed/asset fault correlation work and the engagement of Southwest Consulting Group to provide an independent review. These were beneficial actions, but in our view, did not constitute comprehensive post event reviews.

236. We consider that good industry practice reviews of major disruption events present opportunities to avoid or mitigate potential future events by learning what went well and what needed refining. This approach is a key component of risk management approach in ISO:31000 Risk Management Standard (see Appendix K) which clearly identifies the importance of and requirement to use feedback and review loops to continuously monitor and improve risk management practices and performance.

237. To demonstrate that it met the requirements of ISO 31000, we expected Horizon to provide evidence that it had completed comprehensive and rigorous post event reviews following the MED experienced in AP 2017 and AP 2018. The documents and discussions provided by Horizon did not demonstrate sufficient evidence that such reviews had been undertaken.

238. Whilst the absence of a review in AP 2017 is unlikely to have prevented the exceedance of the annual reliability assessment limits in AP 2018 (because the types of events were

[37] 3.38 Post fault investigations & major event days

different), such reviews can improve performance for future events. This is an important area where Horizon can look to make improvements.

239. The Commission asked that, when we form opinions on whether Horizon acted in accordance with Good Industry Practice, we should consider whether Horizon exercised a 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.

240. We consider that formal post event reviews are required to be undertaken to meet good industry practice and act consistently with the ISO:31000 Risk Management Guidelines. We have raised this issue in recent reviews that we have undertaken of other New Zealand EDBs. This experience suggests that the lack of formal, rigorous post event reviews may be common practice for New Zealand EDBs and therefore, could ordinarily be expected by an EDB engaged in the same type of undertaking under the same or similar circumstances.

241. In many respects, we found that Horizon's investigations and reviews following major supply interruption events were more detailed and better recorded than we have seen in reviews of other New Zealand EDBs. Notwithstanding this observation, failing to capture improvement opportunities from major events does not meet the requirements of asset and risk standard practices and does not align with good industry practice.

242. It is difficult to quantify a reduction in SAIDI and SAIFI that could have been achieved from more formal post event reviews; however, in our opinion, the 10 April 2016 MED and associated 20.13 SAIDI minutes (pre normalisation) would have been avoided through such an action.

243. We consider that it is also important that EDBs ensure that lessons from major interruption experiences are shared with other EDBs. Whilst there is evidence that this occurs on an informal basis, in our opinion, a more formal framework would assist in managing common risks.

8. Actions that Horizon intends to take to prevent future non-compliance

244. The Commission asked us to provide:

1. an opinion on the extent to which Horizon has undertaken actions to prevent or mitigate similar events in the future, including a description of those actions, and an assessment of the likely efficacy of those actions; and
2. any recommendations on further actions that Horizon could and should undertake to prevent or mitigate similar events in the future.

245. We have found that Horizon has a well-structured approach when setting policies, strategies and plans for improvement. In doing this, Horizon uses the development of in-house solutions and leverages off external experience and systems. Horizon provided clear descriptions of its development plans for asset management practices and network operations. The explanations indicated that Horizon has set long term strategies and implementation plans for key functions that impact on the reliability of electricity distribution services.

246. In addition, Horizon demonstrated that it has established an innovative culture and provided evidence that this is delivering real and quantifiable improvements. Many of these activities are targeted at the improvement of network reliability.

247. In the following discussion, we provide examples of the initiatives that Horizon is implementing to support our view of the likely efficacy of those actions

8.1. Asset management improvement initiatives

248. In its 2018 explanatory paper to the Commission, Horizon said that over the next three to five years its:

> *focus will shift to gaining a clearer understanding of relative asset risk as a function of asset condition; probability and consequences of failure; and asset criticality. In this way, we will seek to prioritise maintenance and capital expenditure to achieve long term gains in reliability and network resilience.*[38]

249. In its presentations during the on-site sessions, Horizon management and staff presented[39] summaries of their achievements and plans for development of asset management. The following is our assessment of a selection of their initiatives that we consider to be central to Horizon's stated strategy to make targeted improvements to reliability.

Implementation on an AMS

250. During 2017 and 2018, Horizon deployed a new asset management system (Ellipse Select – ABB) and integrated this with its GIS and financial management systems. This is a similar system to that deployed by Alpine Energy. In its explanatory report to the Commission, Horizon provided the following expectation of the impact that this improvement will have on reliability performance:

> *Going forwards a key element of our strategy is the implementation of a new Asset Management System (AMS) that uses existing age data and collected field data to inform the condition of assets and predict their probability of failure. Probability of failure is mapped against asset criticality indices that reflect the consequences of a particular asset failure on customers, safety and environment. The resulting 'risk index' will allow us to prioritise our maintenance activity and invest available capital funds in areas where they are most needed.*
>
> *The AMS will collect more detail on failed assets which will assist with identifying specific asset makes/models that can have a negative effect on reliability. Future plans are to integrate operational information from SCADA into the AMS to increase the accuracy of the assets' condition assessment.*[40]

251. As Horizon populates the AMS with improved quality asset data, being achieved through better data collection processes, its ability to apply its asset management framework will increase. Through the AMS, Horizon will further develop its asset management practices and complete the establishment of total asset management lifecycle asset management that applies:

a. asset health intelligence;
b. asset criticality assessments;
c. asset risk analysis; and
d. comprehensive reporting through business management tools.

252. We consider that the strategic pathway that Horizon has committed to is ambitious but achievable. In our experience, successful implementation of its plans will direct Horizon

[38] 3.38 Horizon Networks Quality Standards Explanatory Report to the Commission 201, page 4

[39] Horizon 5 Asset Management Practices PowerPoint presentation

[40] 3.42-43 Horizon Networks Quality Standards Explanatory Report, page 12

towards best industry practice. Evidence of Horizon's commitment towards this goal is seen in its commitment to achieve ISO: 55000 certification by 2022 and the investment that it is making in AMS deployment.

253. Horizon's expectation is that successful implementation of AMS improvements will bring associated benefits in terms of improved network reliability and lower costs.

254. In a 29 November 2017 PowerPoint slide pack, Horizon began to consider options for reducing its costs:

> *Seeking to manage its BS debt by ensuring that HEDL investment is in line with long run depreciation that does not create additional risks, materially deteriorate reliability and meets the shareholders dividends expectation.*
>
> *Requested 10% and 20% cost-down scenarios to be evaluated*[41]

255. The presentation gave an indication of how Horizon will realise savings without compromising network performance through system and structural changes:

- *Asset management system to drive asset health, criticality and resilience of network*
- *Vegetation Management System to drive risk based cut plans and manage spend levels*
- *Outage / SCADA system to improve resilience of Operations and better communicate with customers*
- *Structure changes – full provision contractor (design and build), HEDL focus on Operations, Maintenance and long-term Asset Management*[42]

256. Horizon engaged Southwest Consulting to provide independent advice on its desire to reduce future network expenditure. In its review, Southwest Consulting considered the implications for reducing expenditure for two options against a base case. The Southwest Consulting report advised Horizon on how it might achieve reductions in capex and opex whilst managing to maintain reliability:

> *Horizon Networks wants to reduce its expenditure but to do this and manage risk it must implement its asset management system effectively and it needs to use team based risk management systems actively.*
>
> *This assignment is to consider expenditure reduction but staff have done limited risk assessments. The assessment of impacts has been limited and without adequate reliability information or detailed condition data.*
>
> *Horizon Networks needs to review its risk assessment system and processes as well as implementing an asset management system if it wishes to manage the impacts of expenditure reduction.*[43]

257. Whilst it is beyond the scope of this review, we consider that a review of the realisation of improved reliability benefits, from the investment in the AMS, should be included in any subsequent non-compliance review that the Commission may undertake. Our expectation is that the business case will set out quantified reliability and cost benefits arising from the improved asset managing practices. The business case should also include a comprehensive

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[41] 3.18 Board Network Scenarios 29.10.17 v1.pptx, slide 5

[42] Ibid, slide 6

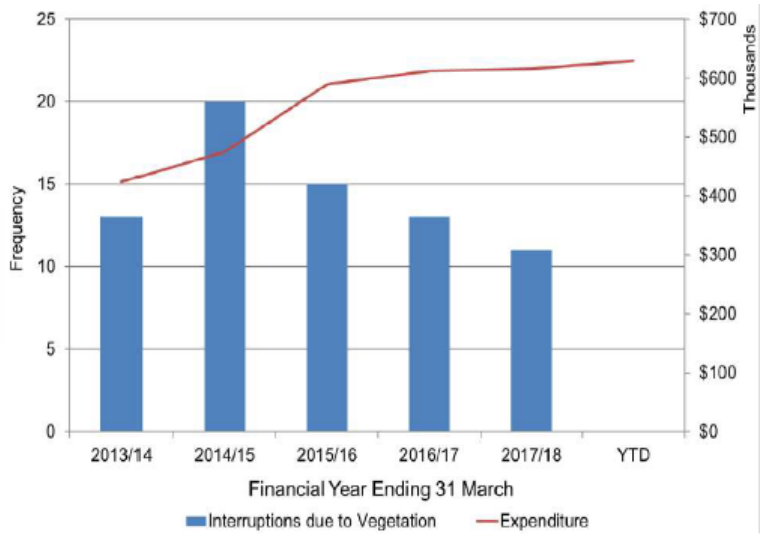
[43] Review of Horizon Network Expenditure, Southwest Consulting Group, 12 October 2017

risk assessment including how the risks identified by Southwest Consulting are being managed.

Vegetation management improvements

258. Horizon explained that between 2017 and 2018 it introduced:
    a. Mobility Devices based Inspection
        i. drones & helicopters
        ii. reliability and performance oriented;
    b. Xivic Vegetation Management System; and
    c. Vegetation Assessment data collection in SQL servers through Xivic.
259. It described its plans to introduce the following in 2019 and onwards, these included:
    a. enhancements to its Xivic Vegetation Management System;
    b. validation and cleansing of its vegetation assessment data;
    c. establishment of a reporting dashboard; and
    d. application of risk based vegetation management budget allocation and forecasting.
260. Horizon presented analysis that it considered provided an indication of the positive impact on network reliability that its improved vegetation management practices and systems had achieved. The results of Horizon's analysis can be seen in Figure 26.
261. It is interesting that a strong downward trend in interruptions attributed to vegetation can be seen from 2014/15. This downward trend continues through AP 2018 when the network experienced seven adverse weather MED including ex-tropical cyclones Debbie and Cook. If this linkage can be reliably established, the approximately $180k increase in vegetation management expenditure will have delivered strong positive benefits.

Figure 26: Horizon's analysis of the benefits of investment in vegetation management



Source: Horizon 5 Asset Management Practicies.pdf

262. We consider that Horizon's initiatives combined with a commitment to continuing levels of forecast vegetation expenditure will bring improved reliability benefits to the network in future years.

8.2. Improved network operations

263. During the on-site sessions, the Horizon operation management team described several improvement initiatives that had been implemented, or were at the planning stage prior to implementation. The following are two examples that we consider to be directly relevant to the causes of the MED and non-compliance in AP 2018.

Weather event management

264. Horizon is working to utilise enhanced computing power to produce more reliable forecasts and predictions of adverse weather impacts. These initiatives include:

a. mapping of lightning strikes in SCADA to link with overhead line locations. The objective is to improve the accuracy of lightning strike data; and

b. in collaboration with NIWA, to develop weather forecasts that are better aligned with Horizon's requirements for higher resolution and more accurate/reliable weather information.

265. We consider that Horizon is taking steps to better understand the environment in which its network is operating. This will not only be important to determine high risk network sections but also to develop a perspective on potential and emerging risks from climate change.

Feeder automation

266. During the field visit, we saw evidence of Horizon's implementation of feeder automation including the installation of automatic switching capability of feeder sections. Horizon's objective for making these investments is to reduce initial response times when faults occur and to improve the customer experience by restoring supplies more quickly.

267. Given the structure of Horizon's network with relatively long rural feeders, the ability to isolate sections of the network remotely and automatically will improve SAIDI performance in the future.

8.3. Other actions that Horizon could take to prevent non-compliance

268. We believe that Horizon should continue its commitment to fully implement the asset management and operational improvements described in its documents and presentations. We have also provided our advice on improvements that we consider Horizon should make in undertaking formal post event reviews that capture lessons from major interruption events.

269. Other than the above, we have identified no other additional actions that we consider Horizon should be taking.

Appendix A Context and information on Horizon Energy

A.1 Horizon's network area

A.2 Horizon views its network as having five geographically separate areas:

(a) Whakatāne;

(b) Opotiki;

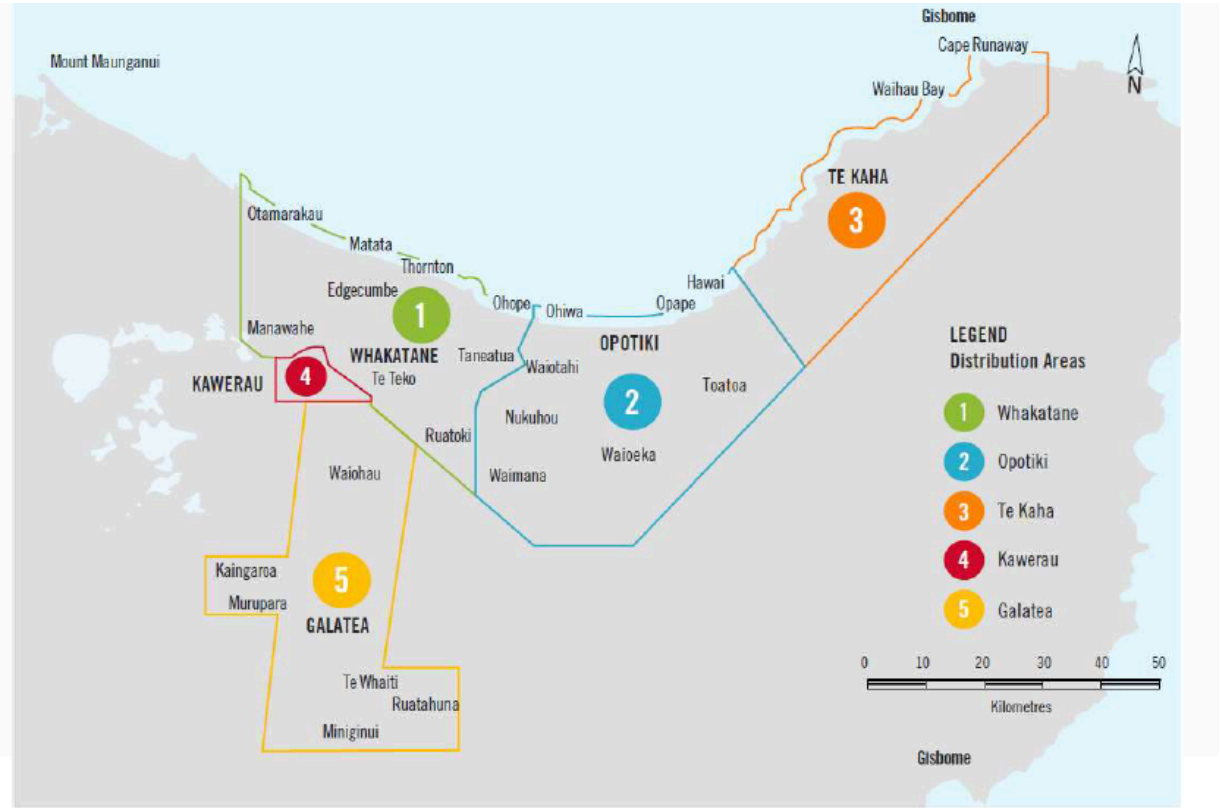
(c) Te Kaha;

(d) Kawerau; and

(e) Galatea.

A.3 During the period where non-compliance occurred, Horizon had four connection points (GXP) to the national transmission network owned and operated by Transpower. Subsequently, Horizon has purchased the 50kV Te Kaha feeder from Transpower and reduced its GXPs to 3.

Appendix Figure 1: Horizon's network areas



Source: Horizon 3 Compliance Management.pdf

A.4 Horizon's network assets

A.5 In its 2016 Asset Management Plan Horizon provides the following description of its network:

Horizon Energy services over 24,500 customers in an area bounded by Whangaparaoa Bay Te Kaha to the North, Pikowai to the East, and Lake Rotoma and Ruatahuna to the South or approximately 8,400km2. There are four separate distribution areas covered - Edgecumbe, Kawerau, Te Kaha, and Waiotahi supplied from Transpower's corresponding Grid Exit Points (GXPs).

The network includes sub-transmission at 33,000 volts (33kV), distribution at 11,000 (11kV) volts and low voltage supply (400/230V) to a mixture of urban and rural customers from over 2700km of conductor. The network currently supports a peak demand of 82 MW, including 3MW of embedded generation, and approximately 539 GWh of electricity was carried by the network. The network consists of over $108M of installed infrastructure to achieve this.[44]

A.6 In its 2018 AMP[45] Horizon provides the following key statistics for its network:

(a) Area Supplied 8,400 km^2

(b) No. of Customers 24,961

(c) Peak Demand 88 MW

(d) No. of Zone Substations 10

(e) Electricity Delivered to Customers 532 GWh

(f) Embedded Generation 3MW + 25MW under construction

(g) No. of Distribution Feeders 42

(h) Overhead Circuit Length 1,963 km

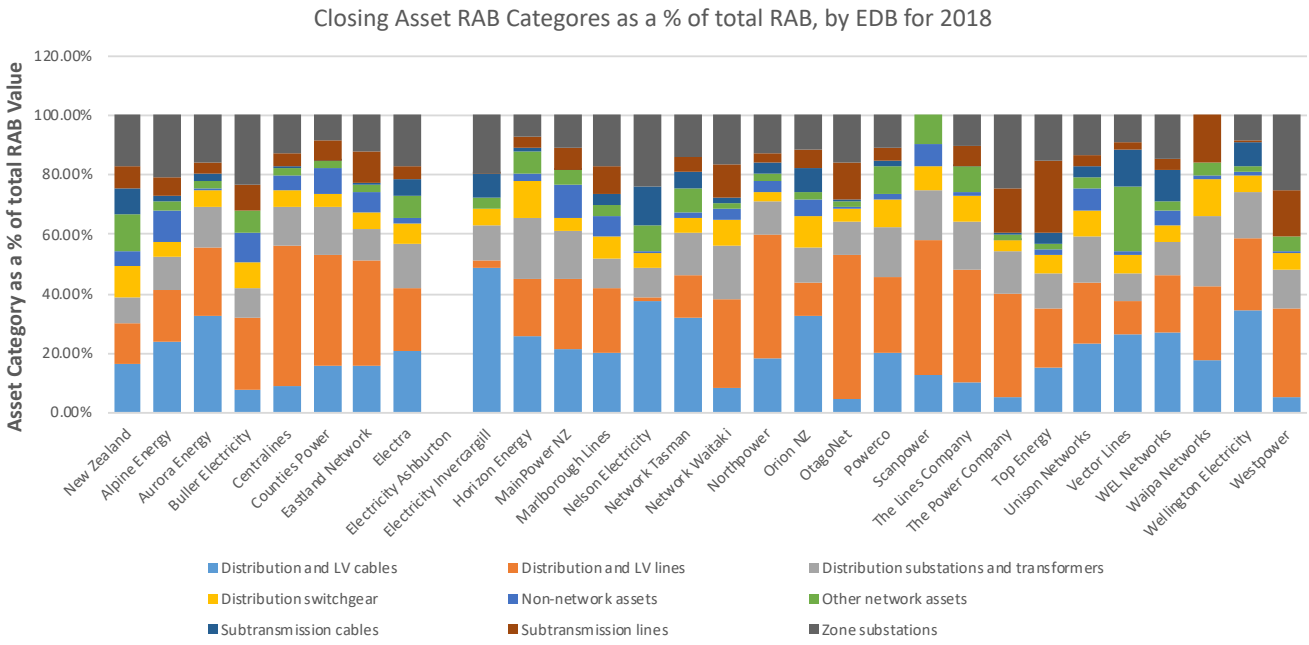
(i) Underground Circuit Length 557 km

A.7 Figure 2 below shows the proportions of assets that contribute to Horizon's RAB compared to other EDBs. Horizon has an asset base that has a relatively high proportion of underground cable assets when compared to other, predominantly rural EDBs.

[44] Horizon 2016 AMP, page 1

[45] Horizon 2018 AMP, page 6

Appendix Figure 2: AP 2018 Interruptions per network km



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix B Data on historical interruptions

B.1 Horizon provided its analysis for the probability of asset failure in the form of an Excel workbook V1.0_InterruptionsAnalysis_Operations_Combined.xlsx. The analysis provided drew from interruptions data that Horizon had collected from 2006 to 2016. We therefore assume that the analysis provided was undertaken in AP 2017.

B.2 We consider the information provided by Horizon in this analysis is relevant because:

(a) it provides evidence of the information that Horizon had available prior to AP 2017;

(b) demonstrates how Horizon was using the interruption data as a risk based assessment tool;

(c) allows assessment of the actions that Horizon was taking (e.g. levels of capex and opex) against the information that Horizon held at the time of making those decisions.

B.3 We have reproduced the information relevant to the AP 2017 and AP 2018 events below.

Appendix Table 1 Overhead distribution Interruptions

				#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
OH Distribution	*	*	*	3rd Party interference	5, Almost Certain	4	14	14	11	11	19	15	11	16	10	16
				Adverse Environment	4, Likely	2	1	0	2	0	4	0	0	0	0	0
				Adverse Weather	5, Almost Certain	9	5	8	6	2	3	14	7	5	8	17
				Cause unknown	5, Almost Certain	6	3	2	1	6	8	9	6	7	7	6
				Defective Equipment	5, Almost Certain	12	22	27	34	21	24	37	28	27	11	43
				Human Error	4, Likely	0	1	0	0	1	0	1	0	1	1	0
				Lightning	5, Almost Certain	0	1	0	4	6	0	3	4	10	0	10
				Vegetation	5, Almost Certain	3	2	5	6	18	18	21	10	21	13	12
				Wildlife	5, Almost Certain	3	4	2	1	3	4	6	1	4	3	3
				Total (Year)	**5, Almost Certain**	**39**	**53**	**58**	**65**	**68**	**80**	**106**	**67**	**91**	**53**	**107**

B.4 The table above shows that total interruptions had been trending upwards over the decade. Defective equipment was consistently the largest contributor to interruptions. Third party interference and vegetation were the second and third largest contributors to interruptions.

B.5 Relevant to the AP 2017 SAIDI non-compliance is that historically, interruptions attributed to lightning were only 4.8% of the total overhead line interruptions.

B.6 Horizon also provided its interruptions data separated by asset types. The contributors most relevant to the review of the AP 2017/18 non-compliance are reproduced below.

Appendix Table 2 Conductor interruptions history

				#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
OH Distribution	Distribution Lines	Line Hardware (Conductor, Assemblies, Joi	Conductor	3rd Party interference	5, Almost Certain	2	3	8	2	4	10	5	3	3	7	3
				Adverse Environment	4, Likely	0	1	0	0	0	2	0	0	0	0	0
				Adverse Weather	5, Almost Certain	8	4	4	4	2	2	6	4	2	3	8
				Cause unknown	4, Likely	1	0	0	0	0	0	1	0	1	1	1
				Defective Equipment	5, Almost Certain	3	2	7	10	12	6	9	9	7	3	12
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	3, Moderate	0	0	0	0	1	0	1	0	0	0	0
				Vegetation	5, Almost Certain	3	2	5	6	17	16	20	9	17	12	12
				Wildlife	5, Almost Certain	3	4	2	1	3	4	5	0	2	2	1
				Total (Year)	**5, Almost Certain**	**20**	**16**	**26**	**23**	**39**	**40**	**47**	**25**	**32**	**28**	**37**

B.7 36% of conductor related interruptions was attributed to vegetation, 24% to defective equipment, 15% to third party interference and 14% to adverse weather.

Appendix Table 3 Pole interruptions history

OH Distribution	Distribution Lines	Pole Assemblies	Power Pole	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	5, Almost Certain	2	11	5	6	5	4	8	6	11	1	13
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	4, Likely	0	1	0	0	0	0	1	0	1	1	1
				Cause unknown	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Defective Equipment	4, Likely	0	0	0	1	0	0	0	0	1	0	2
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Vegetation	4, Likely	0	0	0	0	1	0	1	0	1	1	0
				Wildlife	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Total (Year)	**5, Almost Certain**	**2**	**12**	**5**	**7**	**6**	**4**	**10**	**6**	**14**	**3**	**16**

B.8 The very low incidence of pole failures due to defective equipment is likely to be attributable to the high proportion of concrete poles on the Horizon network. The low pole failure history is relevant to the AP 2018 non-compliance which saw a number of pole failures during the storms.

Appendix Table 4 Crossarm interruptions history

OH Distribution	Distribution Lines	Pole Assemblies	Cross-Arm	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	4, Likely	0	0	0	2	0	0	1	0	0	0	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	4, Likely	0	0	3	2	0	0	0	1	0	1	2
				Cause unknown	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Defective Equipment	5, Almost Certain	3	5	1	5	1	4	3	2	1	0	5
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Vegetation	4, Likely	0	0	0	0	0	1	0	0	2	0	0
				Wildlife	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Total (Year)	**5, Almost Certain**	**3**	**5**	**4**	**9**	**1**	**5**	**4**	**3**	**3**	**1**	**7**

B.9 Horizon had experienced a reducing trend in crossarm related failures between 2009 and 2015; however, in 2016 the crossarm failures were at the peak annual level of 5. We note the work that Horizon has undertaken in the development of improved composite crossarms and consider that this was an appropriate and innovative response to reduce crossarm failure in normal and averse operating conditions.

Appendix Table 5 Insulator interruptions history

OH Distribution	Distribution Lines	Pole Assemblies	Insulator	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	3, Moderate	0	0	1	0	0	0	0	0	1	0	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	3, Moderate	0	0	0	0	0	0	0	0	1	1	0
				Cause unknown	4, Likely	3	1	0	0	0	0	0	0	0	0	0
				Defective Equipment	5, Almost Certain	3	10	13	11	3	6	12	5	9	3	6
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	4, Likely	0	0	0	2	1	0	0	0	0	0	0
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Wildlife	3, Moderate	0	0	0	0	0	0	1	0	0	0	0
				Total (Year)	**5, Almost Certain**	**6**	**11**	**14**	**13**	**4**	**6**	**13**	**5**	**11**	**4**	**6**

B.10 Interruptions due to insulator failure have a decreasing trend since 2008. Most insulator failures are due to defective equipment rather than adverse weather.

Appendix Table 6 DDO Fuses interruptions history

OH Distribution	Switchgear	Switches	DDO fuses	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	3, Moderate	0	0	0	0	0	0	0	0	0	1	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	4, Likely	0	0	0	0	0	0	0	0	0	1	3
				Cause unknown	4, Likely	1	0	0	0	0	2	3	0	2	1	1
				Defective Equipment	5, Almost Certain	2	0	2	0	2	5	7	3	4	5	7
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	5, Almost Certain	0	1	0	2	0	0	1	1	5	0	7
				Vegetation	4, Likely	0	0	0	0	0	1	0	1	1	0	0
				Wildlife	3, Moderate	0	0	0	0	0	0	0	1	0	0	0
				Total (Year)	**5, Almost Certain**	**3**	**1**	**2**	**2**	**2**	**8**	**11**	**6**	**12**	**8**	**18**

B.11 Distribution drop-out fuses have been a continuing problem for Horizon. Horizon has initiated a DDO replacement programme in response to this.

Appendix Table 7 Distribution transformer interruptions history

OH Distribution	Voltage Regulation	OH Distribution Transformers	OH Distribution Transformers	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	3, Moderate	0	0	0	0	0	0	1	0	0	0	1
				Cause unknown	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Defective Equipment	5, Almost Certain	0	2	1	1	1	0	0	3	1	0	5
				Human Error	3, Moderate	0	0	0	0	0	0	1	0	0	0	0
				Lightning	4, Likely	0	0	0	0	3	0	0	1	4	0	1
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Wildlife	3, Moderate	0	0	0	0	0	0	0	0	0	0	1
				Total (Year)	**5, Almost Certain**	**0**	**2**	**1**	**1**	**4**	**0**	**2**	**4**	**5**	**0**	**8**

B.12 2016 appears to be an exception.

Appendix Table 8 Underground distribution interruptions

UG Distribution	*	*	*	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	4, Likely	0	1	0	0	2	1	1	2	0	0	2
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Cause unknown	4, Likely	0	0	0	0	0	1	0	0	0	1	1
				Defective Equipment	5, Almost Certain	4	4	5	9	9	9	6	4	9	3	6
				Human Error	3, Moderate	0	1	1	0	0	0	0	0	0	0	0
				Lightning	4, Likely	0	0	0	1	0	0	0	1	0	0	1
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Wildlife	3, Moderate	0	0	0	0	0	0	0	0	0	0	1
				Total (Year)	**5, Almost Certain**	**4**	**6**	**6**	**10**	**11**	**11**	**7**	**7**	**9**	**4**	**11**

B.13 As would be expected, Table 8 shows that a total of 68 interruptions on the underground distribution network had been 24% of interruptions on the overhead network. Defective equipment was consistently the largest contributor to interruptions on the underground distribution network.

B.14 The highest contributor to defective equipment causing 50% of the interruptions in this category was underground cables.

Appendix Table 9 Underground cable interruptions

UG Distribution	Distribution Lines	UG Cables	UG Cables	#REF!	Likelihood	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	4, Likely	0	0	0	0	2	1	1	2	0	0	1
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Cause unknown	3, Moderate	0	0	0	0	0	0	0	0	0	0	1
				Defective Equipment	5, Almost Certain	4	0	0	2	2	5	4	3	7	3	4
				Human Error	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Lightning	3, Moderate	0	0	0	0	0	0	0	1	0	0	0
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0	0
				Wildlife	3, Moderate	0	0	0	0	0	0	0	0	0	0	1
				Total (Year)	**5, Almost Certain**	**4**	**0**	**0**	**2**	**4**	**6**	**5**	**6**	**7**	**3**	**7**

B.15 Cable terminations and joints had been an issue between 2007 and 2011 causing 12 interruptions in that period. No interruptions due to terminations and joints were recorded following this period.

Appendix Table 10 Cable terminations and joints

UG Distribution	Distribution Lines	UG Cables	Terminations and Joints	#REF!	Likelihood	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	1, Rare	0	0	0	0	0	0	0	0	0	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	1, Rare	0	0	0	0	0	0	0	0	0	0
				Cause unknown	1, Rare	0	0	0	0	0	0	0	0	0	0
				Defective Equipment	5, Almost Certain	2	2	3	2	3	0	0	0	0	0
				Human Error	3, Moderate	1	0	0	0	0	0	0	0	0	0
				Lightning	1, Rare	0	0	0	0	0	0	0	0	0	0
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0
				Wildlife	1, Rare	0	0	0	0	0	0	0	0	0	0
				Total (Year)	**5, Almost Certain**	**3**	**2**	**3**	**2**	**3**	**0**	**0**	**0**	**0**	**0**

B.16 The other main contributor to UG interruptions was Ring Main Units (RMU) which caused 31% of underground distribution interruptions.

Appendix Table 11 RMU interruptions

UG Distribution	Switchgear	Ring Main Units	RMU	#REF!	Likelihood	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
				3rd Party interference	1, Rare	0	0	0	0	0	0	0	0	0	0
				Adverse Environment	1, Rare	0	0	0	0	0	0	0	0	0	0
				Adverse Weather	1, Rare	0	0	0	0	0	0	0	0	0	0
				Cause unknown	3, Moderate	0	0	0	0	1	0	0	0	1	0
				Defective Equipment	5, Almost Certain	2	2	4	5	1	2	1	2	0	2
				Human Error	3, Moderate	0	1	0	0	0	0	0	0	0	0
				Lightning	1, Rare	0	0	0	0	0	0	0	0	0	0
				Vegetation	1, Rare	0	0	0	0	0	0	0	0	0	0
				Wildlife	1, Rare	0	0	0	0	0	0	0	0	0	0
				Total (Year)	**5, Almost Certain**	**2**	**3**	**4**	**5**	**2**	**2**	**1**	**2**	**1**	**2**

B.17 The other main contributor to UG interruptions was Ring Main Units (RMU) which caused 31% of underground distribution interruptions.

Appendix C Horizon's interruption history compared to others

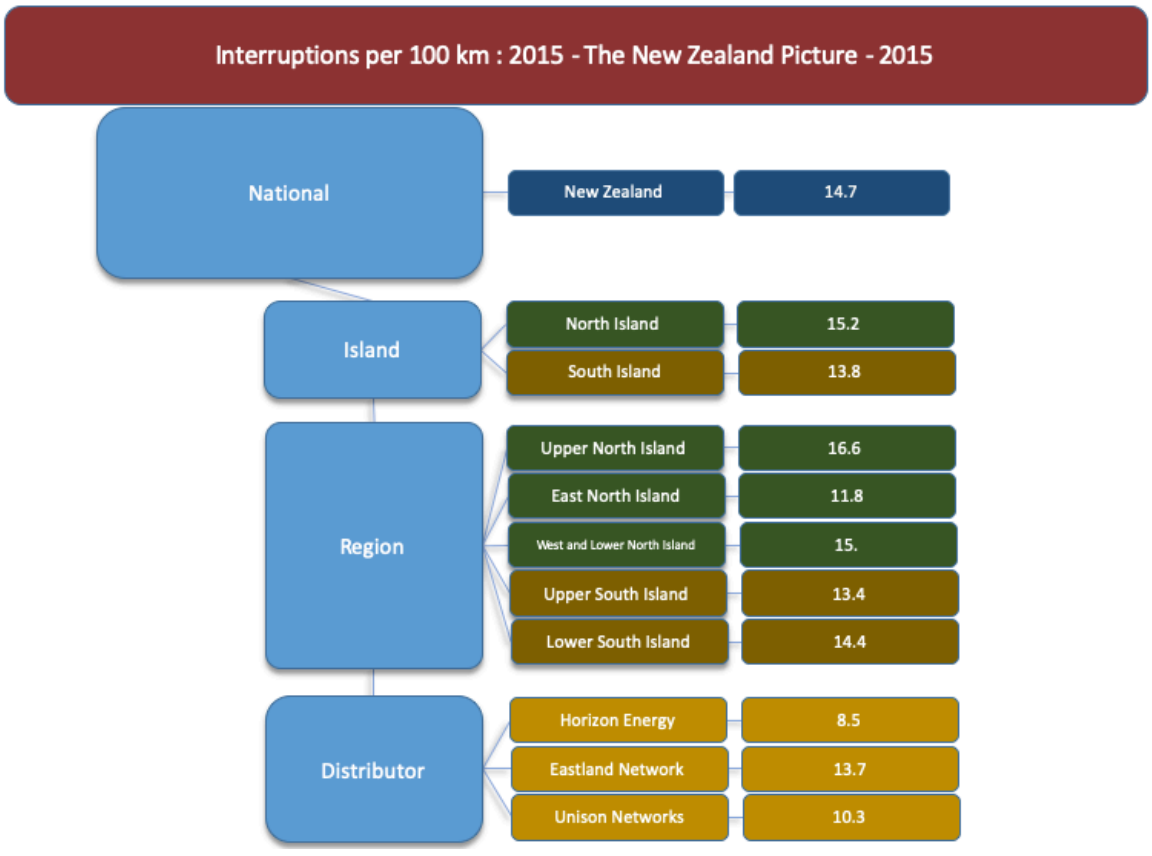
C.1 Comparison on an interruptions per 100 network km is relevant as it provides a view of the relative performances of networks across the country in the same years. We selected Unison and Eastland networks for comparison as they are distribution networks located close to Horizon and are likely to have experienced similar frequency of weather events.

C.2 The following charts show results for four years from 2015 to 2018. All charts are derived using Strata's EDB Dashboard which uses data sourced from distributor information disclosures available from the Commerce Commission web site.

C.3 The sequence of charts shows that Horizon's performance on this metric in all Assessment Periods other than AP 2018, was better than Eastland Network, Unison Networks, national, North Island and East Coast of the North Island.

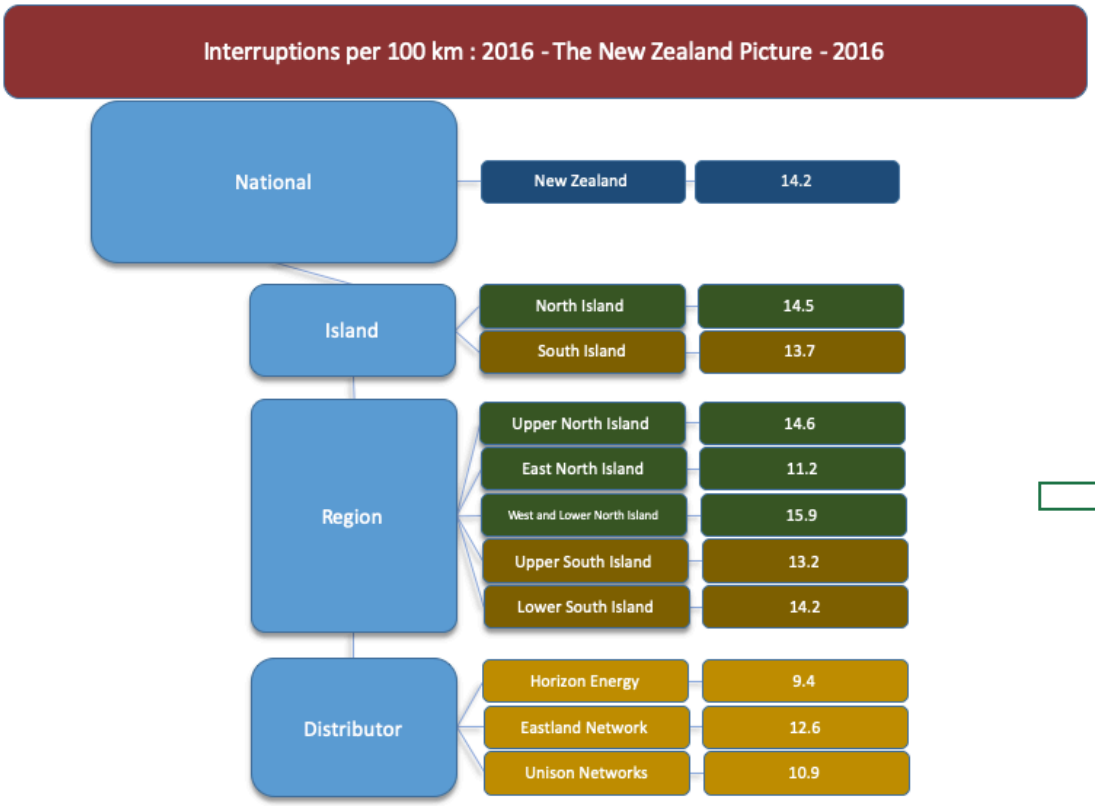
C.4 In AP 2018, Horizon's performance on this metric was higher than Eastland Network but still lower than Unison Networks, national, North Island and East Coast of the North Island interruptions/100 network km.

Appendix Figure 3: AP 2015 Interruptions per network km



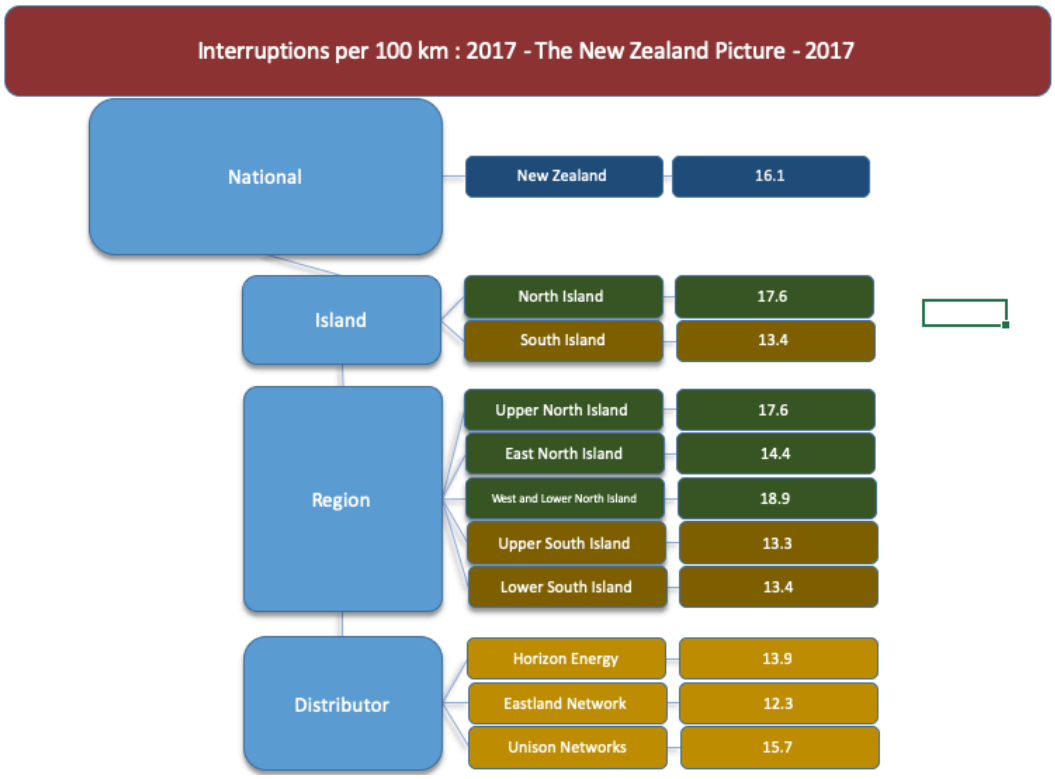
Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 4: AP 2016 Interruptions per network km



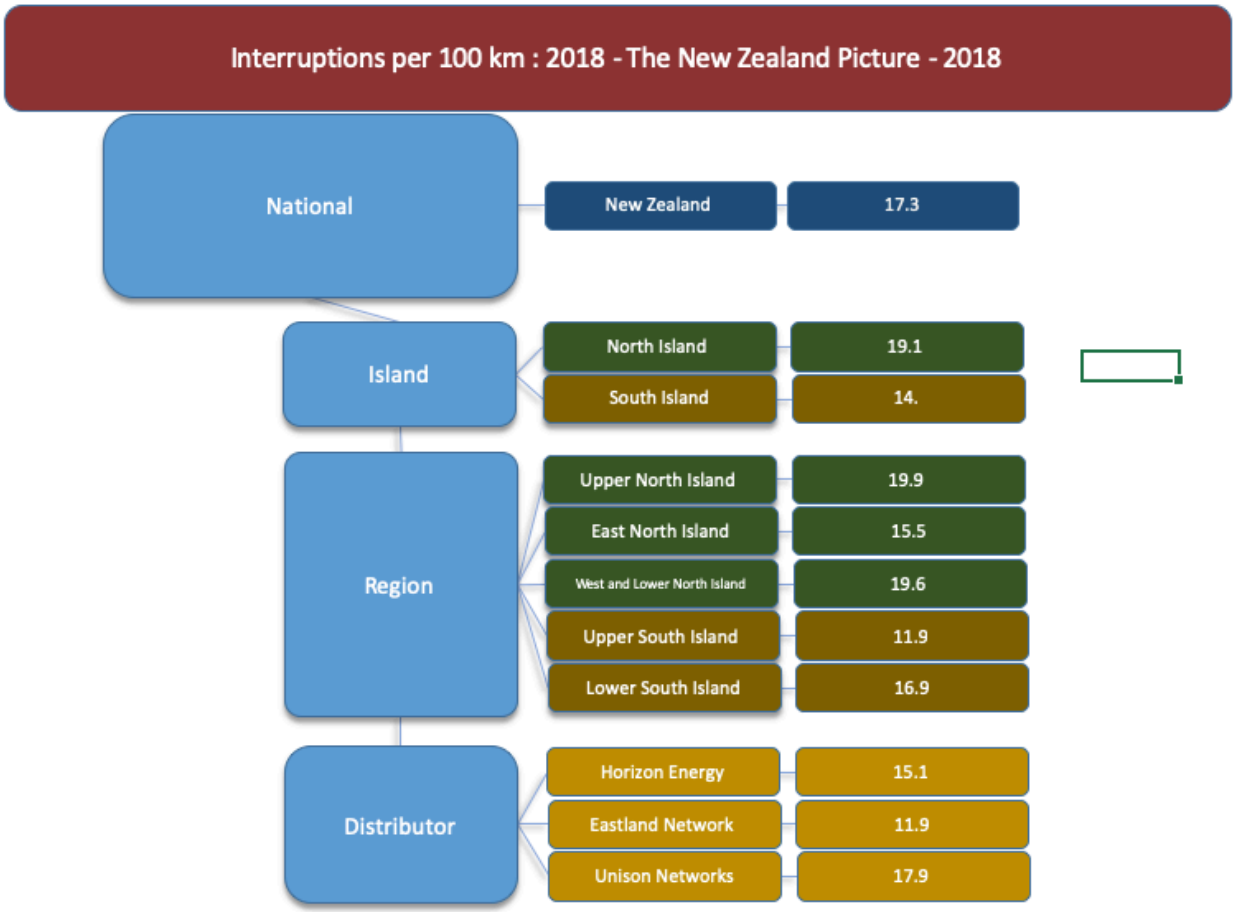
Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 5: AP 2017 Interruptions per network km



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 6: AP 2018 Interruptions per network km



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix D Horizon's worst performing feeders

D.1 The term 'feeder' is used to describe the high voltage overhead lines and underground cables that distribute electricity from zone substations to the broader supply area. The performance of the feeders contributes directly to SAIDI and SAIFI. Assessment of the contribution to SAIDI and SAIFI from each feeder can reveal the location of feeders that are experiencing the greatest number of failure events.

Horizon's worst performing feeder assessment

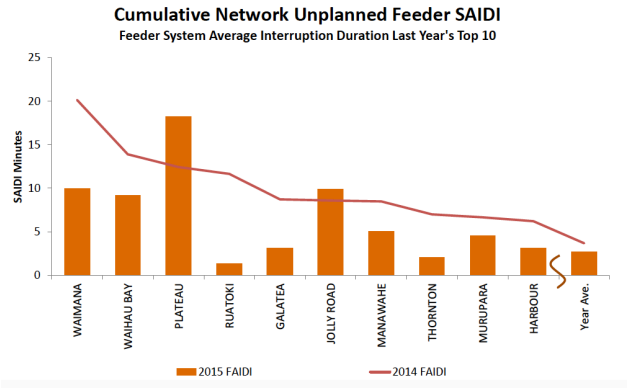
D.2 Data collected on the frequency and duration of interruptions at a feeder level can provide valuable information on the relative performances of feeders. The information can be used by distributors to consider targeting actions at feeders that are consistently worst performers.

D.3 In its *Submitted Tranche 3 part three 29 April* package, Horizon provided the following charts on feeder performance for 2016 to 2018. Charts were not provided for earlier years.

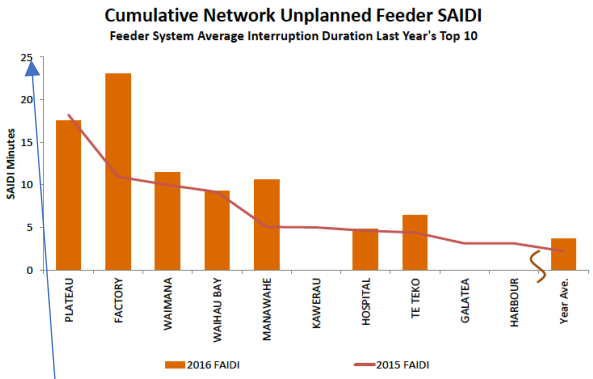
D.4 The feeder average interruption duration index (FAIDI) provides a view of the worst performing feeders in each year. Consistent with normal practice, Horizon determined the top ten worst performing feeders by FAIFI in each of the three years.

Appendix Figure 7:Top ten worst performing Feeders by Feeder AIDI (FAIDI)

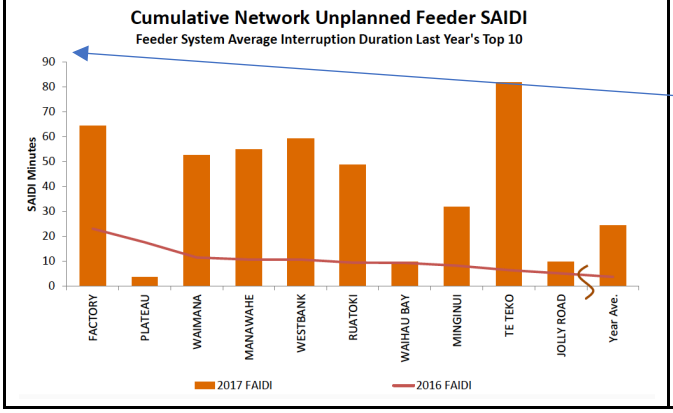
AP 2016 Unplanned FAIDI



AP 2017 Unplanned FAIDI



AP 2018 Unplanned FAIDI



It is important to note that the vertical axis on the 2018 chart is more than treble that on the 2017 chart.

Source: Horizon 4.5 Monthly Network CAIDI March (2016, 17 and 18)

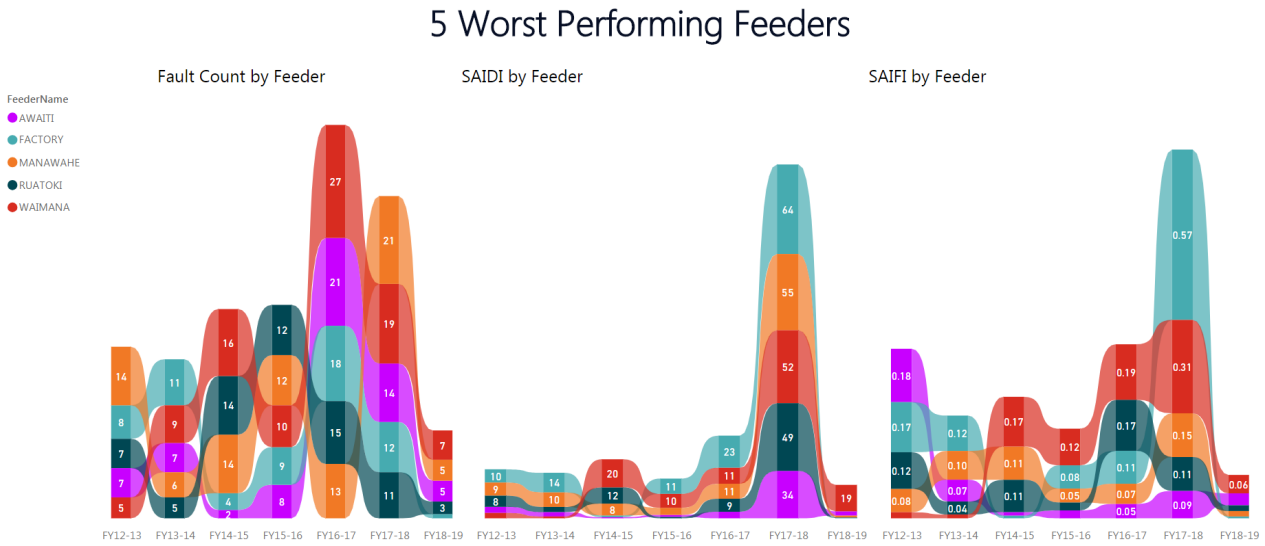
D.5 Horizon also provided its worst performing feeder assessment and analysis in the Breach Report[46] that it supplied to the Commission in its 53zd response.

D.6 To identify the worst performing feeders, Horizon applied three different metrics (Fault count, SAIDI, and SAIFI) to the five feeders that featured highest by each metric. Colours were kept consistent across all three graphs to assist in identifying commonalities. Horizon explained that its analysis did not take into account the feeder's length, which, it noted, would provide a better indication of the feeder's underlying performance.

D.7 The charts from Horizon's analysis are reproduced below.

[46] 2.1.6 2.17 Breach Report.xlsx

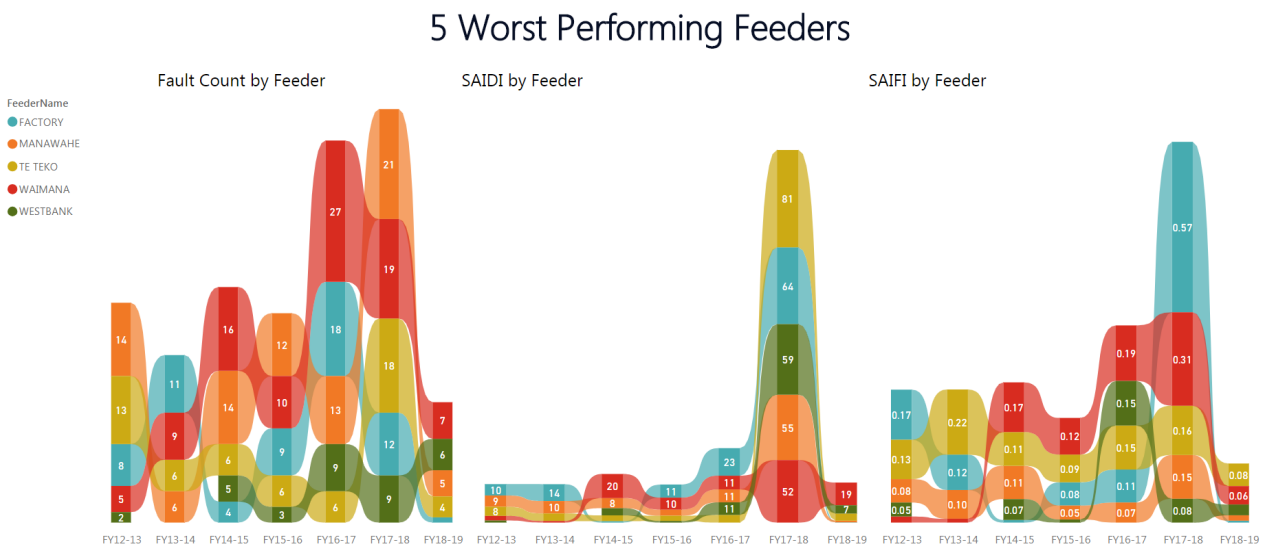
Appendix Figure 8: 5 worst performing feeders selected by fault count over non-compliant years



FeederName	Count of ReportNo	SAIDI	SAIFI
WAIMANA	46	63.67	0.50
AWAITI	35	38.67	0.14
MANAWAHE	34	65.44	0.21
FACTORY	30	87.24	0.68
RUATOKI	26	57.92	0.28

Source: Horizon 2.1.6 2.17 Breach Report.xlsx

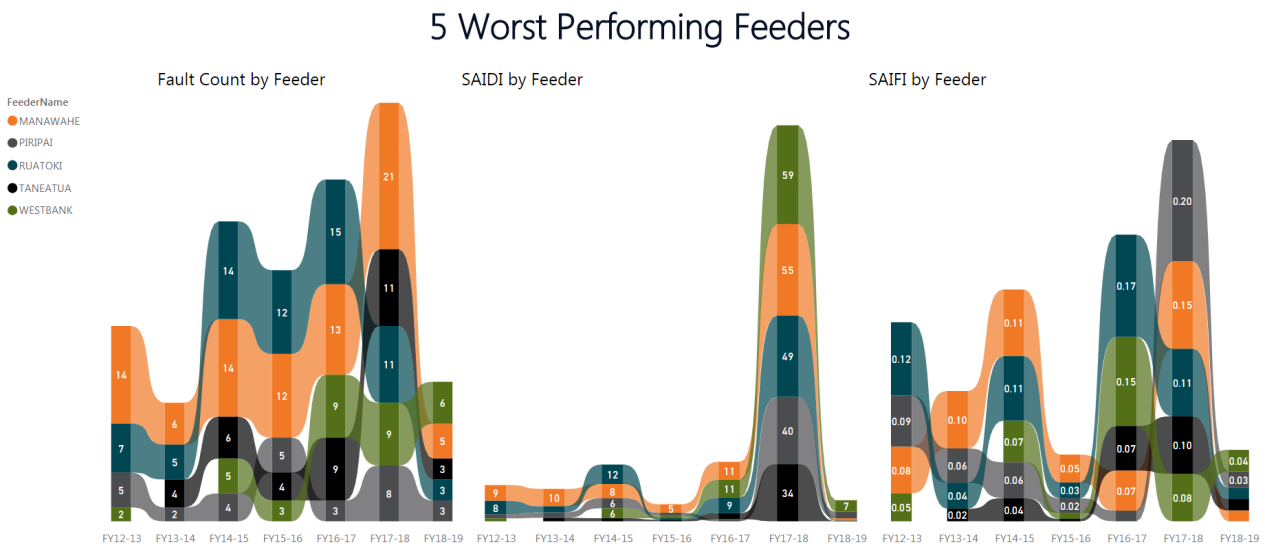
Appendix Figure 9: 5 worst performing feeders selected by SAIDI over non-compliant years



FeederName	Count of ReportNo	SAIDI	SAIFI
TE TEKO	24	87.76	0.31
FACTORY	30	87.24	0.68
WESTBANK	18	69.55	0.23
MANAWAHE	34	65.44	0.21
WAIMANA	46	63.67	0.50

Source: 2.1.6 2.17 Breach Report.xlsx

Appendix Figure 10: 5 worst performing feeders selected by SAIFI over non-compliant years

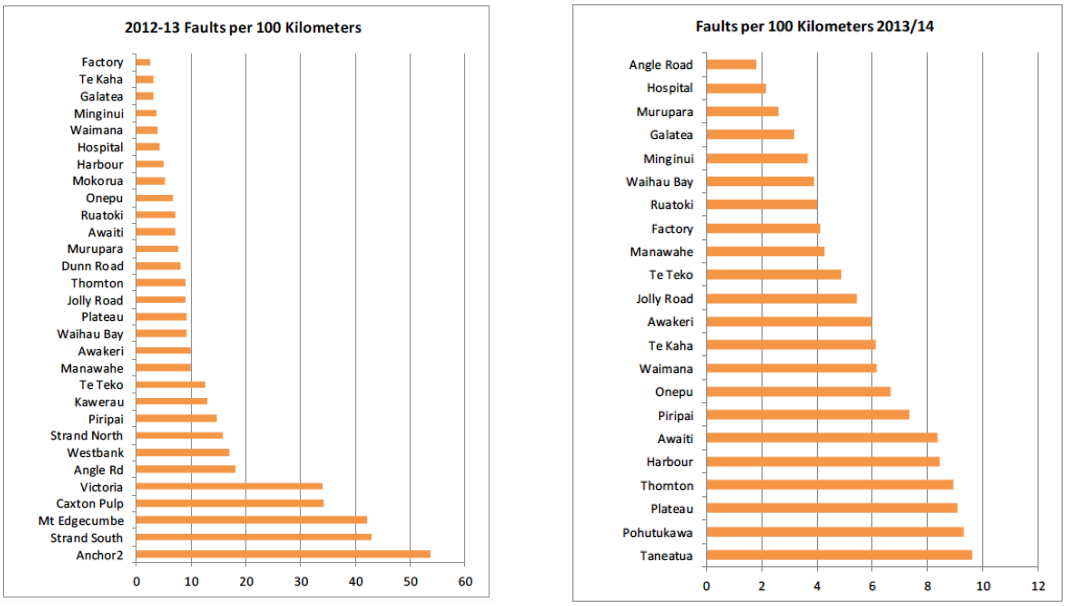


FeederName	Count of ReportNo	SAIDI	SAIFI
RUATOKI	26	57.92	0.28
WESTBANK	18	69.55	0.23
PIRIPAI	11	41.50	0.22
MANAWAHE	34	65.44	0.21
TANEATUA	20	37.67	0.17

Source: Horizon 2.1.6 2.17 Breach Report.xlsx

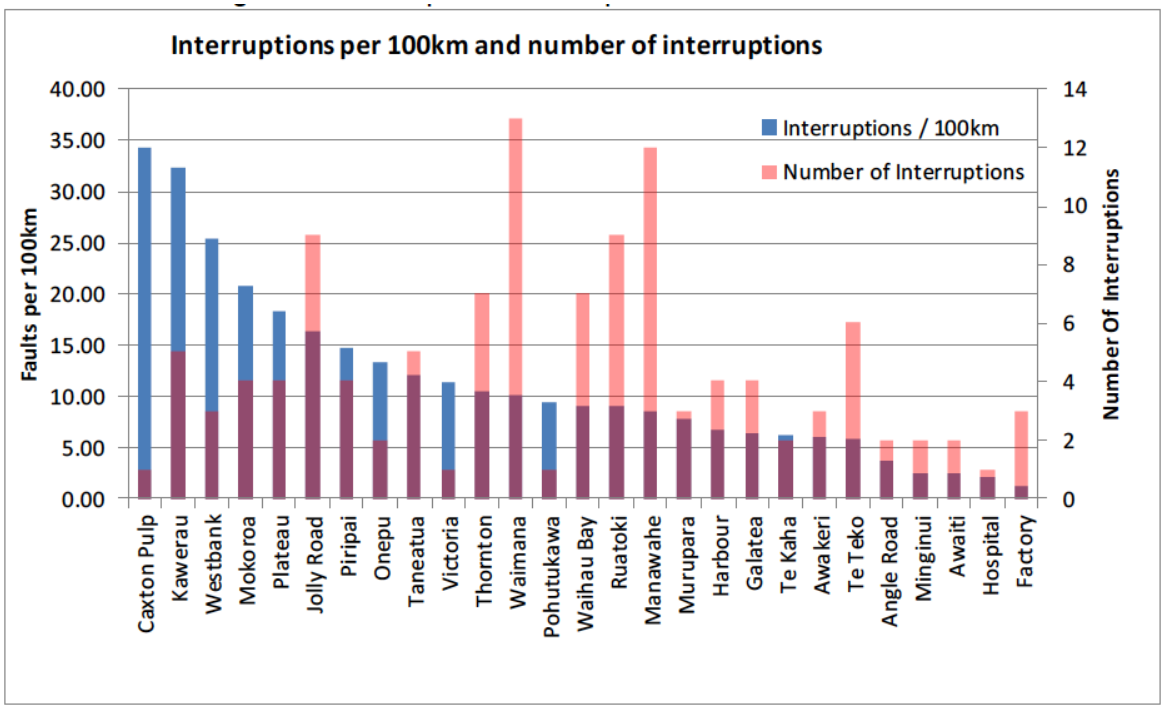
D.8 In its annual asset management plans, Horizon provided the relative performance of its feeders. Between 2012 to 2014, this was indicated in faults per 100km, between 2015 and 2018, interruptions per 100 km was used. Horizon's 2017 asset management plan was an update of its 2016 asset management plan and did not include this information. Horizon's charts are reproduced below.

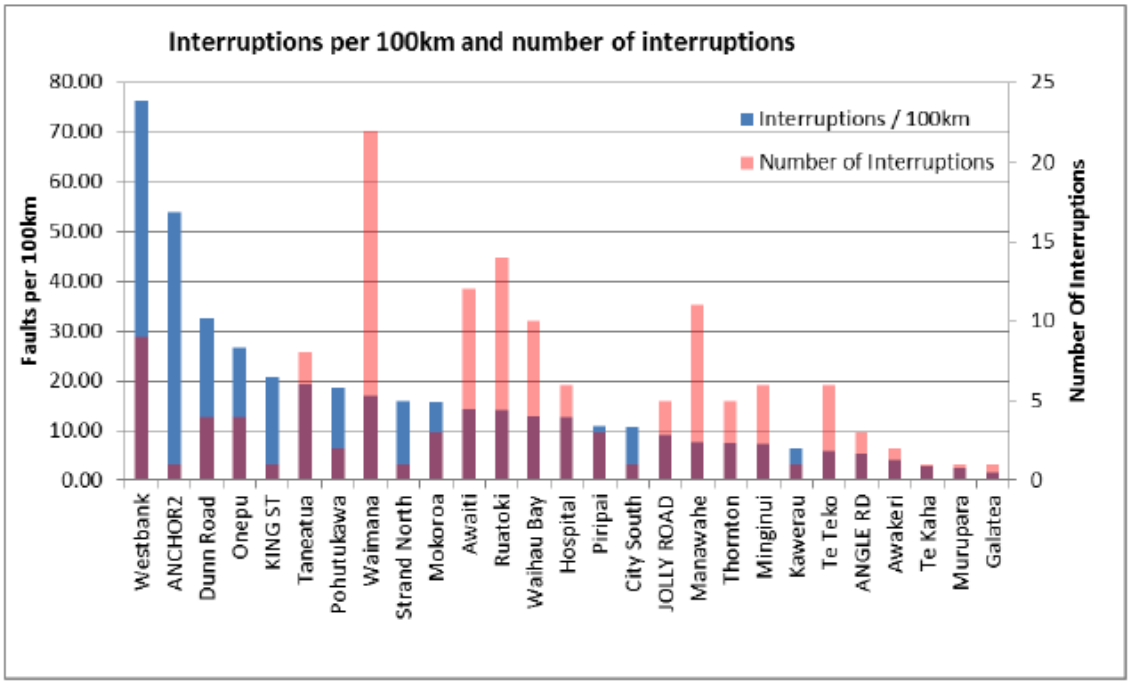
Appendix Figure 11: Feeder faults per 100km 2012 to 2014



Source: Horizon 2014 and 2015 AMPs

Appendix Figure 12: Feeder faults per 100km 2016 and 2018





Source: Horizon 2016 and 2018 AMPs

D.9 In its Breach Report, Horizon concluded that:

> *Overall analysis shows the Factory, Waimana, Ruatoki, and Westbank feeders appear in two of the three rankings, while the Manawahe features in all three. Despite this, no one feeder is shown to be consistently bad across multiple metrics. Factory feeder, which consistently ranked as one of the highest by SAIDI, hardly features at all in FY18-19 to date across all metrics. This is due to work undertaken by Horizon to address the poor performance of the feeder. Selecting the 5 worst performing feeders by total across all financial years results in a similar set, except excluding the Manawahe feeder. This suggests that although the Manawahe feeder is the only one to feature across all three metrics described above, it performed significantly worse during the breach years than in prior years.*[47]

D.10 We agree with Horizon that the feeder data indicates that performance across years is variable and also variable across different measures. Because of this, the analysis of feeder performance would need to be deeper by applying fault causes such as weather conditions etc. We note that Horizon has been developing capability to undertake this analysis including an initiative to apply NIWA weather forecasting data.

[47] 2.1.6 2.17 Breach Report tab 5 worst feeder analysis

Appendix E Horizon's SAIDI, SAIFI and FAIDI performance

E.1 The following charts were provided by Horizon as part of its *Submitted Tranche 3 part three 29 April* package. The documents are in PDF format and the charts have been copied directly from the documents relevant to each year.

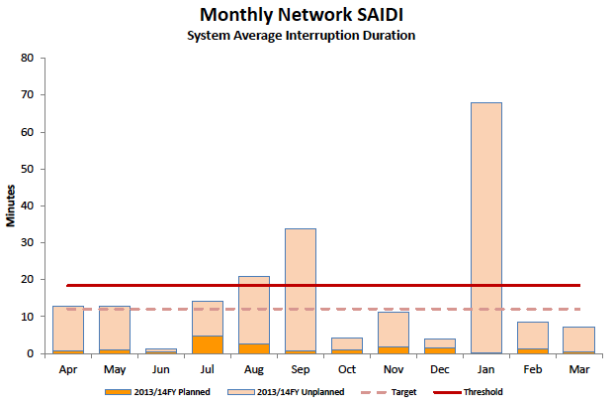
E.2 It is important to note the different vertical axis scales when comparing these charts.

E.3 Also, dates given in the legends are incorrect on some charts. We have assumed that this is due to Horizon's use of a template which was not updated when producing these charts. As we were not provided with the data from which the charts were produced, we checked the total SAIDI indicated by the bars and found that they aligned with the total assessed SAIDI in each year. Horizon subsequently provided what it considered to be corrected versions of the 2016 SAIDI and SAFI charts. Unfortunately, the revised charts also appear to be incorrect as Horizon applied the 2016 axis label to 2017 data.

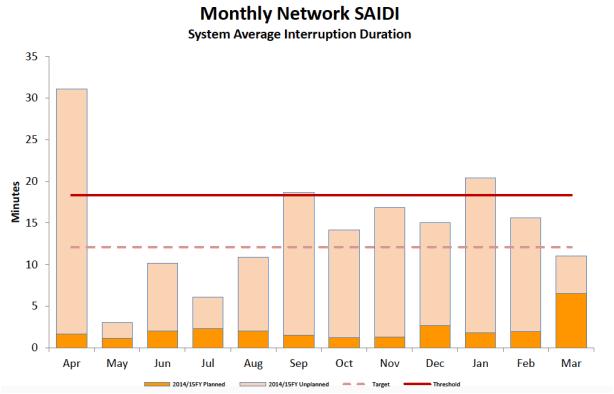
E.4 Accordingly, we have left the initial charts in this appendix so readers should take note of the incorrect labels.

Appendix Figure 13: Monthly SAIDI 2014 to 2018

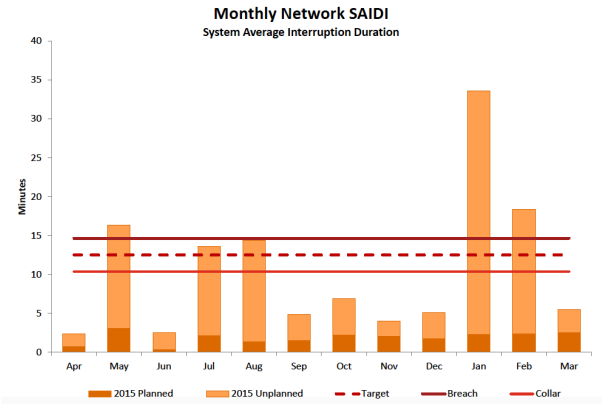
AP 2014 SAIDI



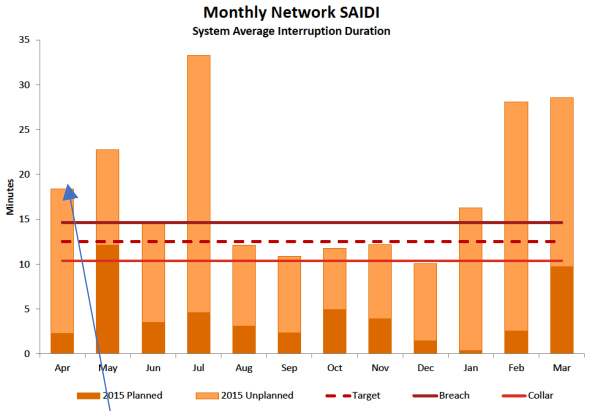
AP 2015 SAIDI



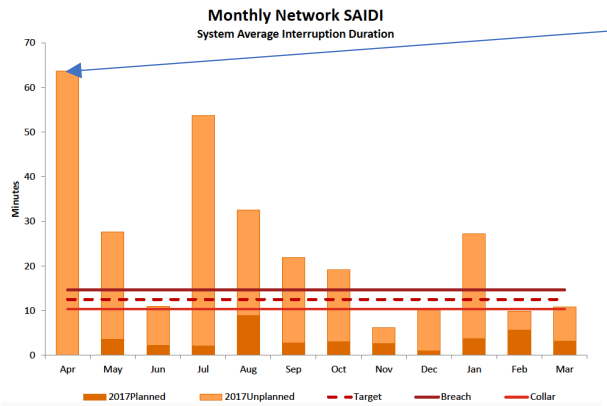
AP 2016 SAIDI



AP 2017 SAIDI



AP 2018 SAIDI

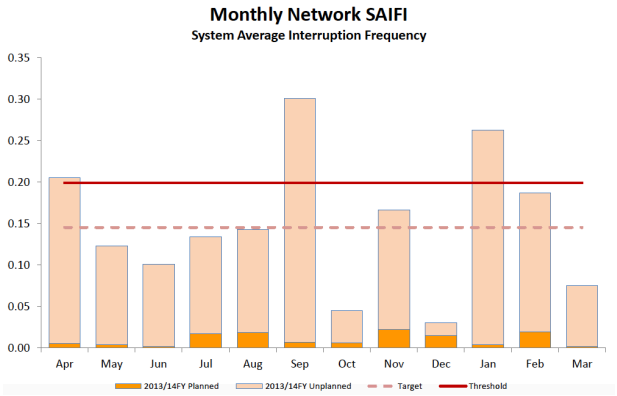


It is important to note that the vertical axis on the 2018 chart is double that on the 2017 chart.

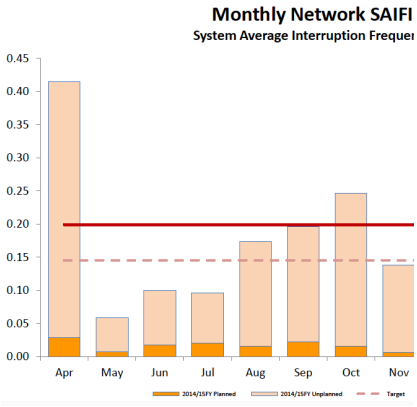
Source: Horizon 5.1 Monthly Network SAIDI SAIFI (March 2014.15.16,17, 18 documents)

Appendix Figure 14: Monthly SAIFI 2014 to 2018

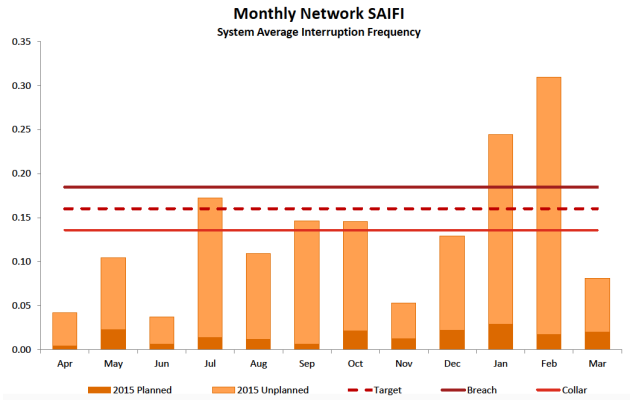
AP 2014 SAIFI



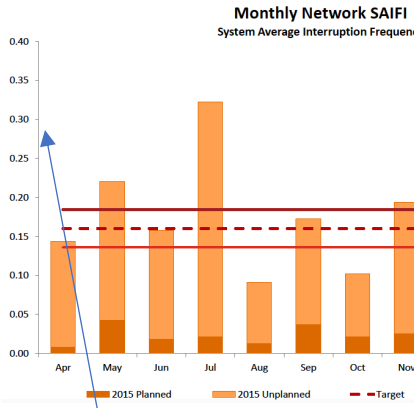
AP 2015 SAIFI



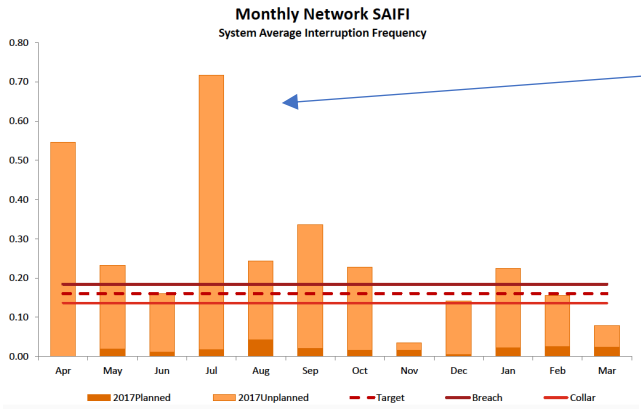
AP 2016 SAIFI



AP 2017 SAIFI



AP 2018 SAIFI



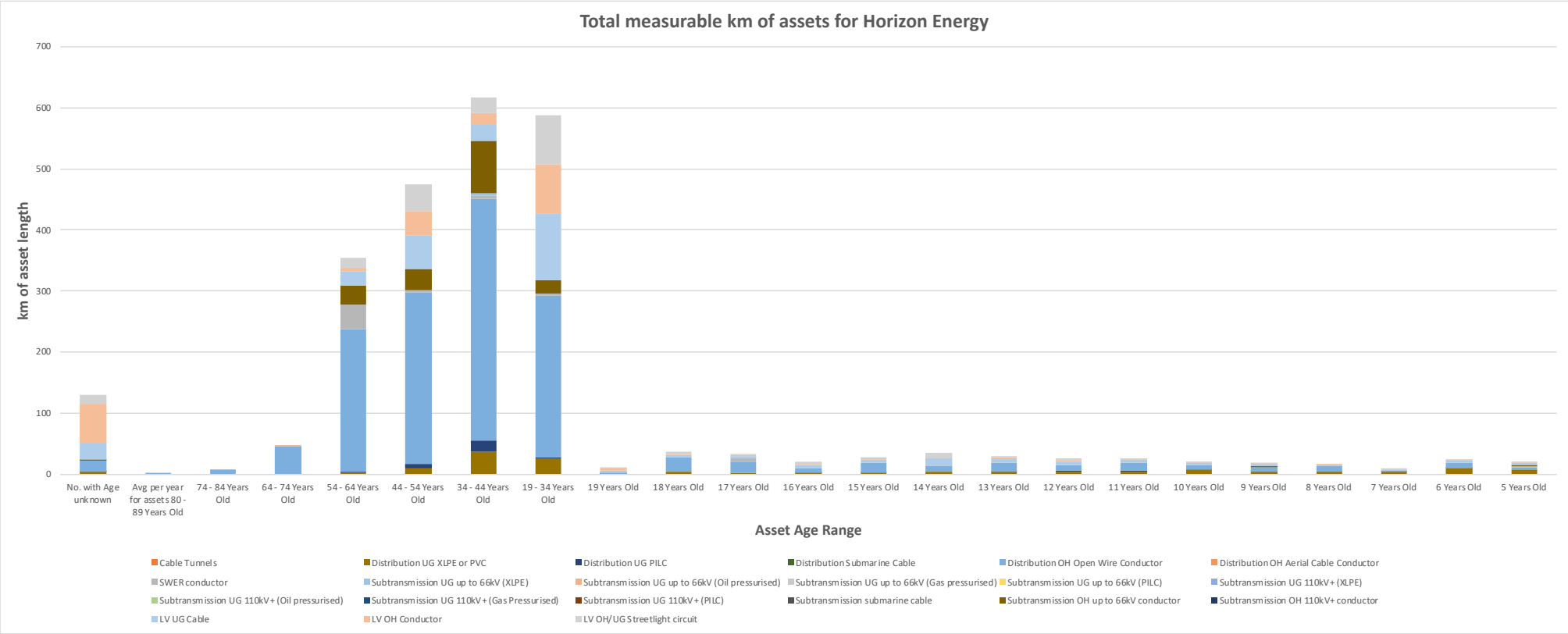
It is important to note that the vertical axis on the 2018 chart is double that on the 2017 chart.

Source: Horizon 5.1 Monthly Network SAIDI SAIFI (March 2014.1

Appendix F The health of Horizon's assets

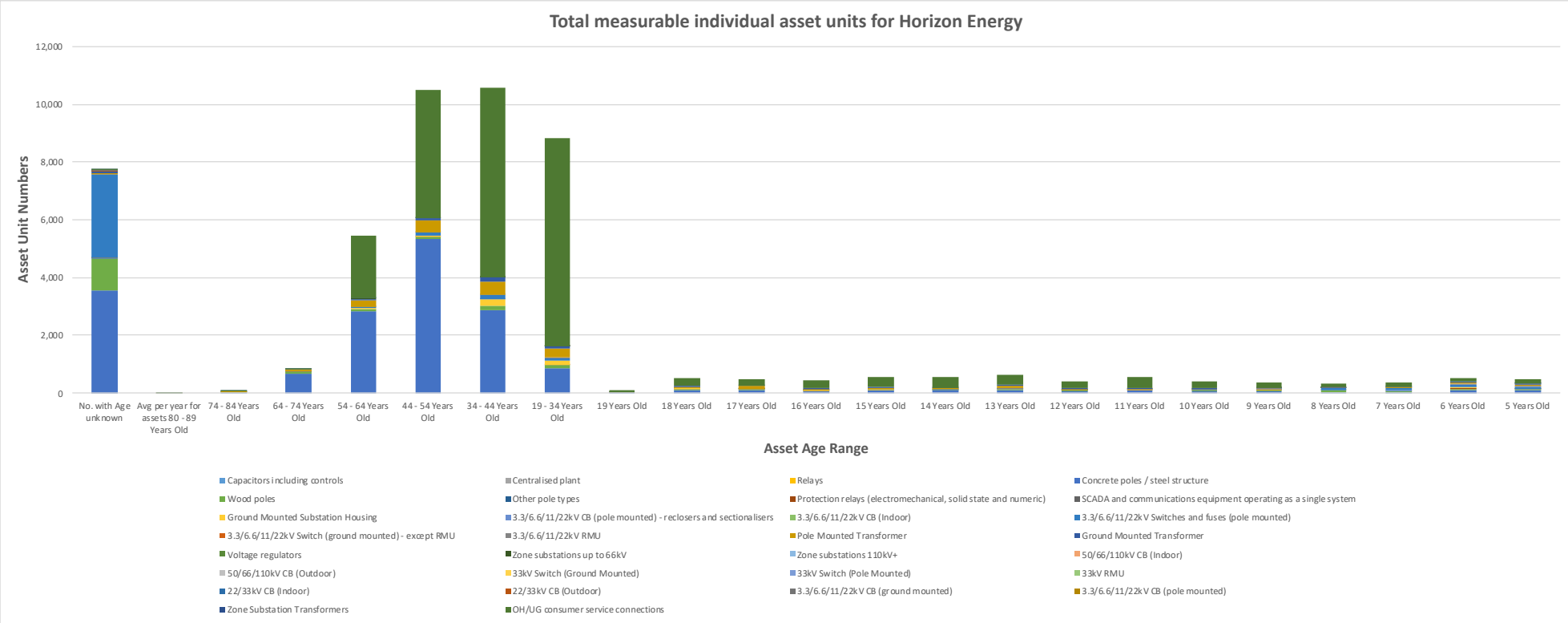
F.1 The following information is drawn from data provided in Horizon's annual information disclosures.

Appendix Figure 15: Asset age profile (assets measured by km)



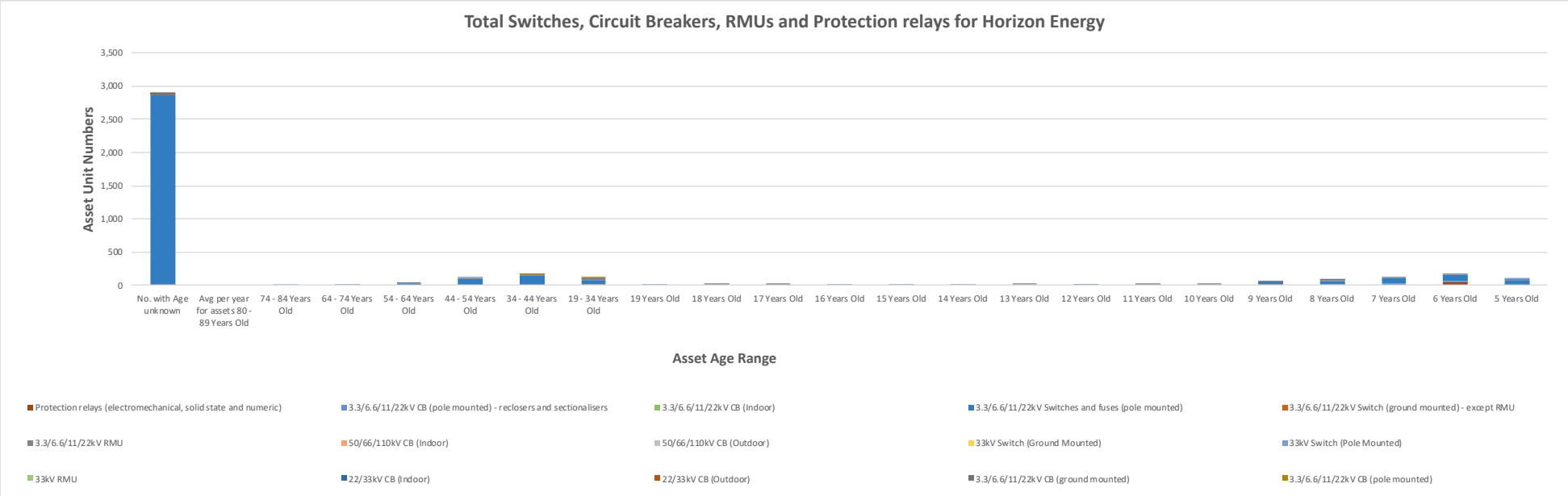
Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 16: Asset age profile (assets measured by units)



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 17: Asset age profile (Switches, circuit breakers, RMU and protection relays)



Source: Strata EDB Dashboard, data from Commerce Commission

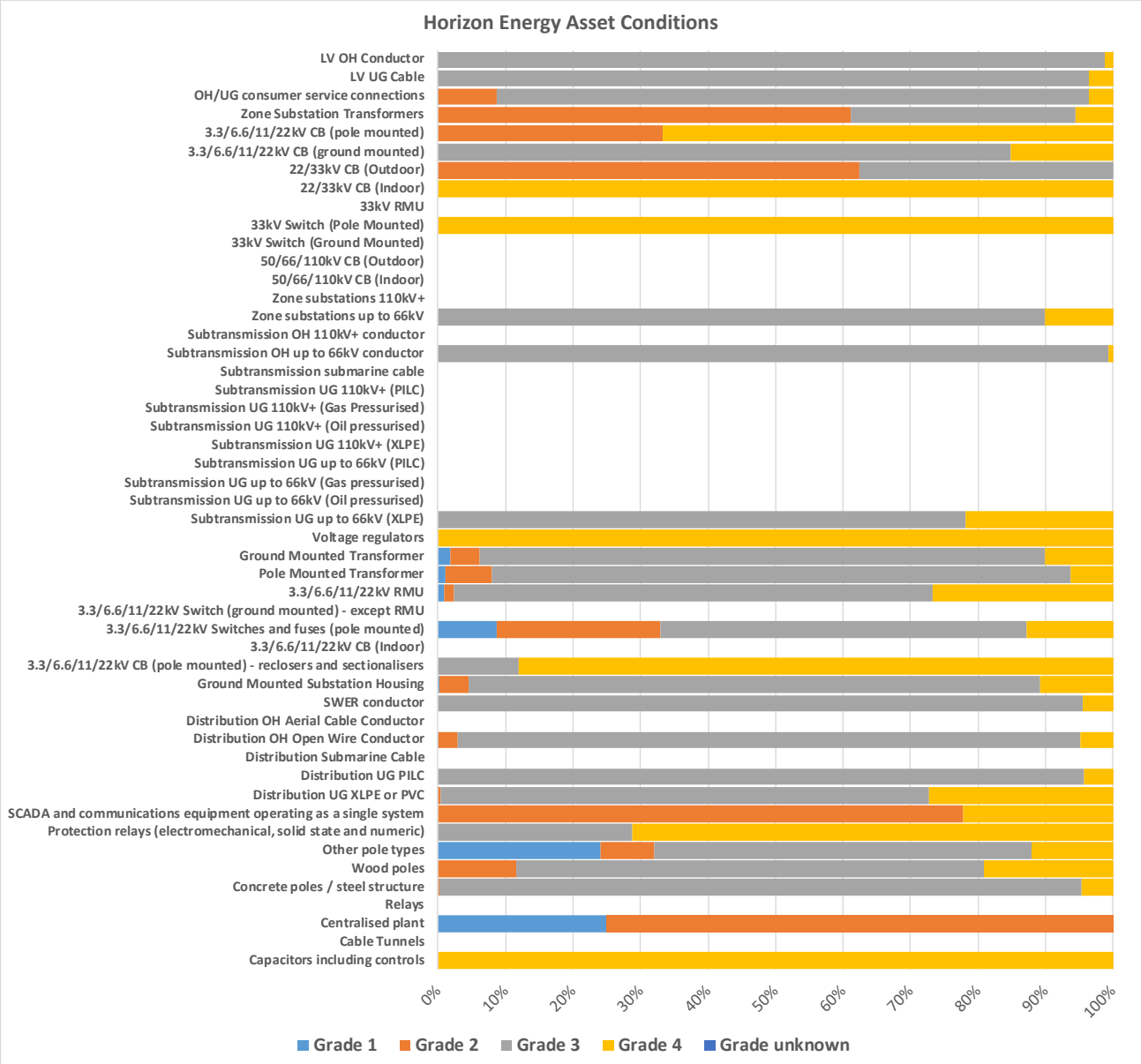
F.2 We noted that the quantity of 'age unknown' assets is quite large, especially for switches, circuit breakers etc. Discussion on this issue if provided in Appendix H where we comment on the reliability of Horizon's data and information.

Asset Condition

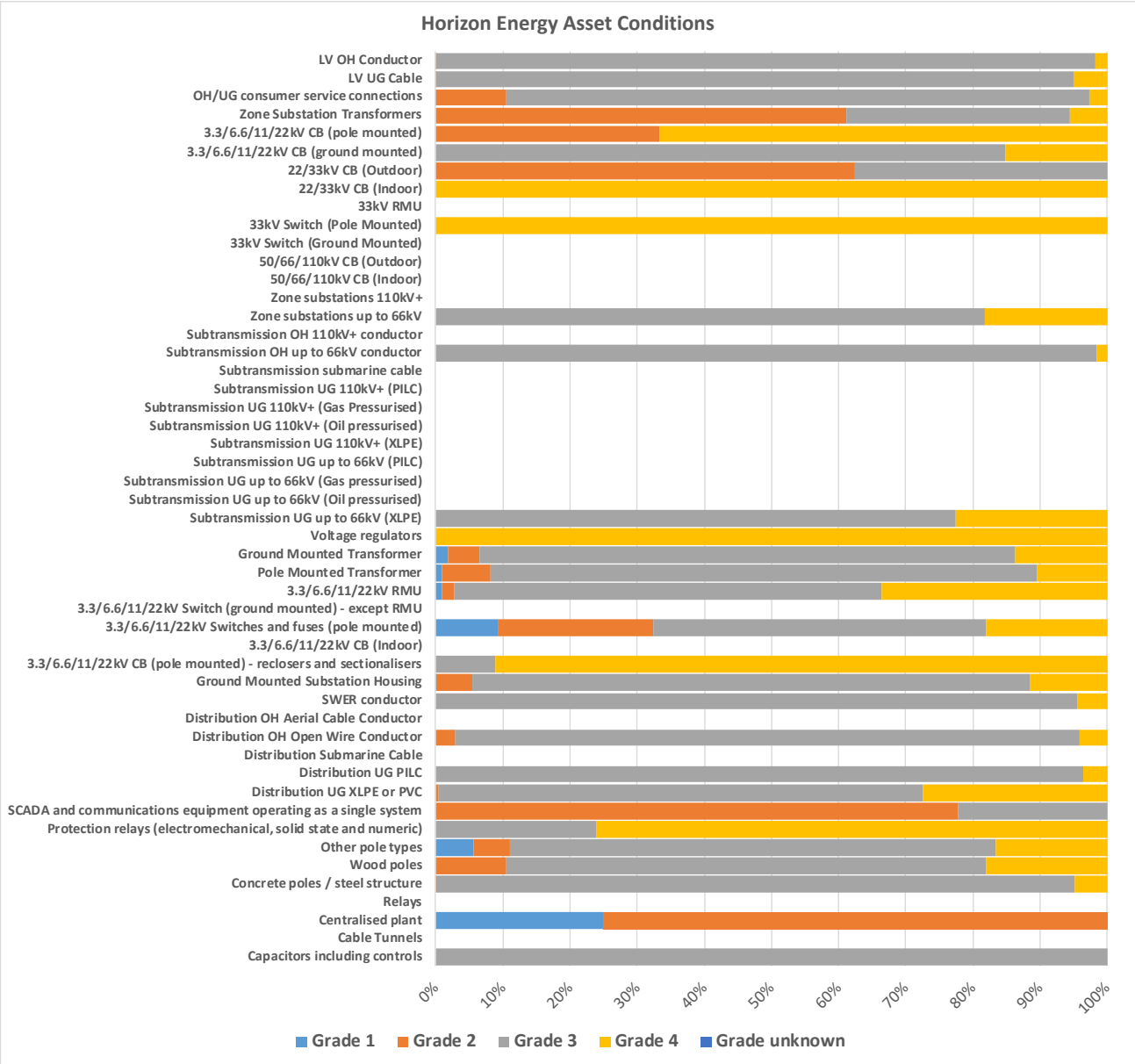
F.3 The following charts are a collation of Horizon's asset condition grades (based on the Commission's 1 – 4 grade) provided in its Information Disclosures for the relevant years.

F.4 Horizon also provided asset health using its five point grading framework. This also included current and future asset health scores; we consider that this is a very useful indicator of the appropriateness of forecast repex and opex.

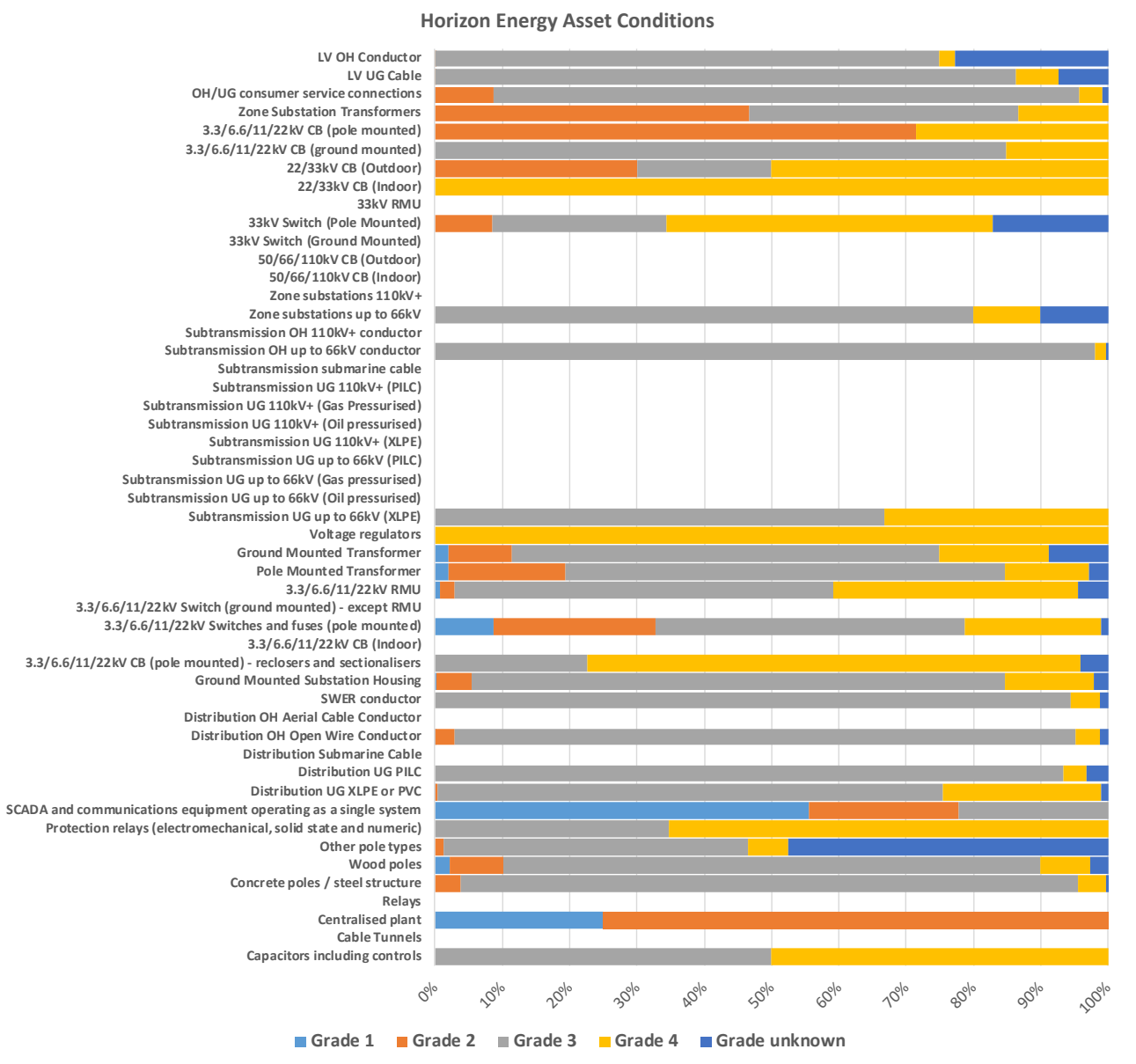
F.5 Asset Condition 2015



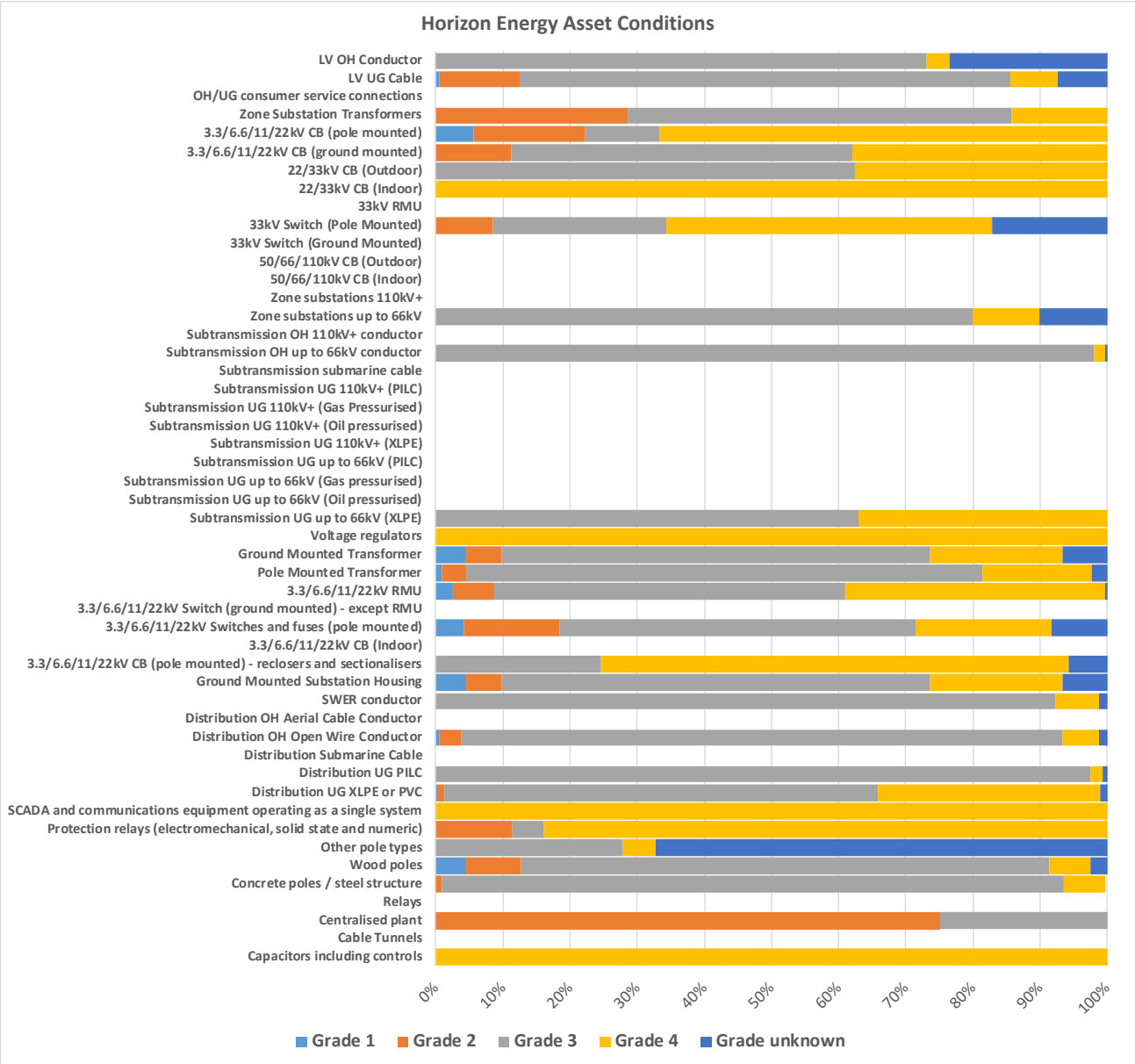
F.6 Asset Condition 2016



F.7 Asset Condition 2017



F.8 Asset Condition 2018



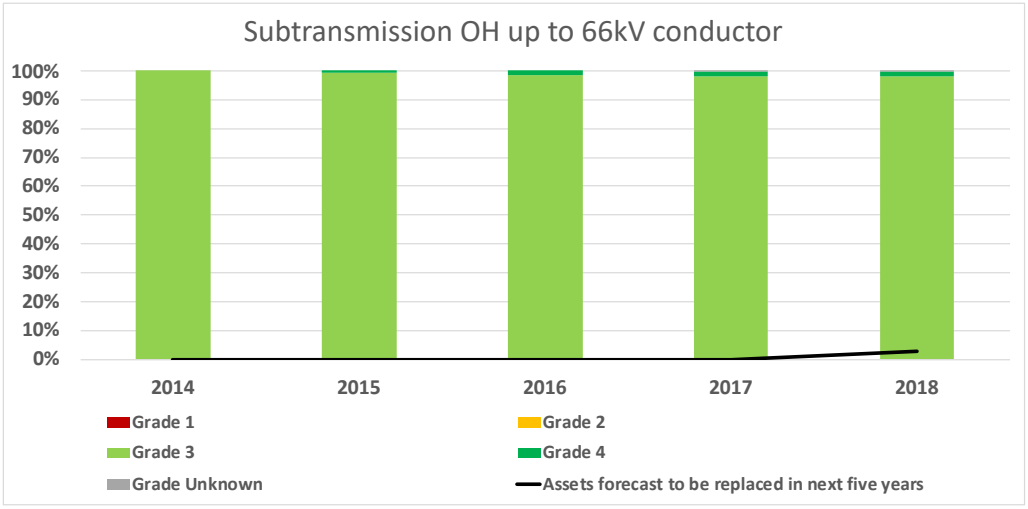
Appendix G Horizon's investment in maintaining the network

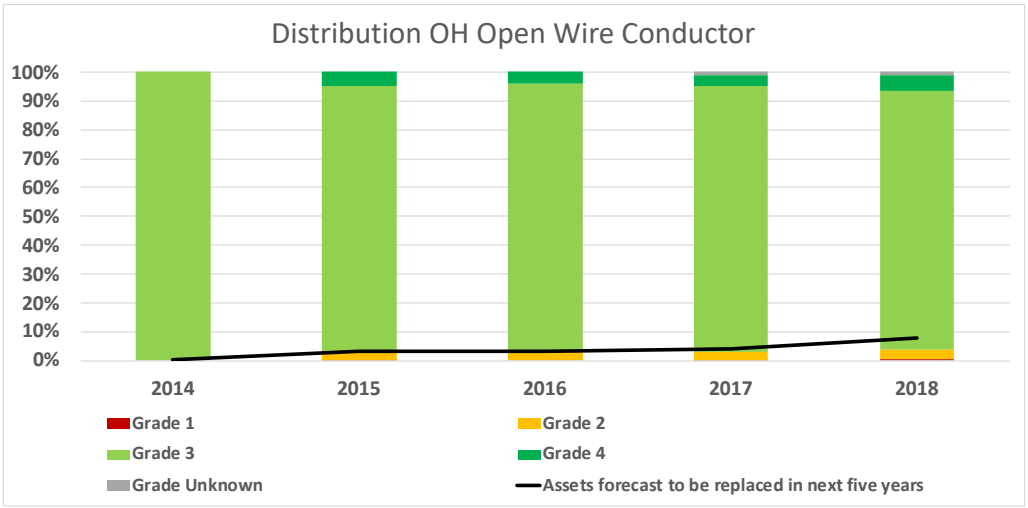
G.1 The charts below use data on asset condition and forecast replacement volumes (e.g. number and length) sourced from Horizon's annual information disclosure data.

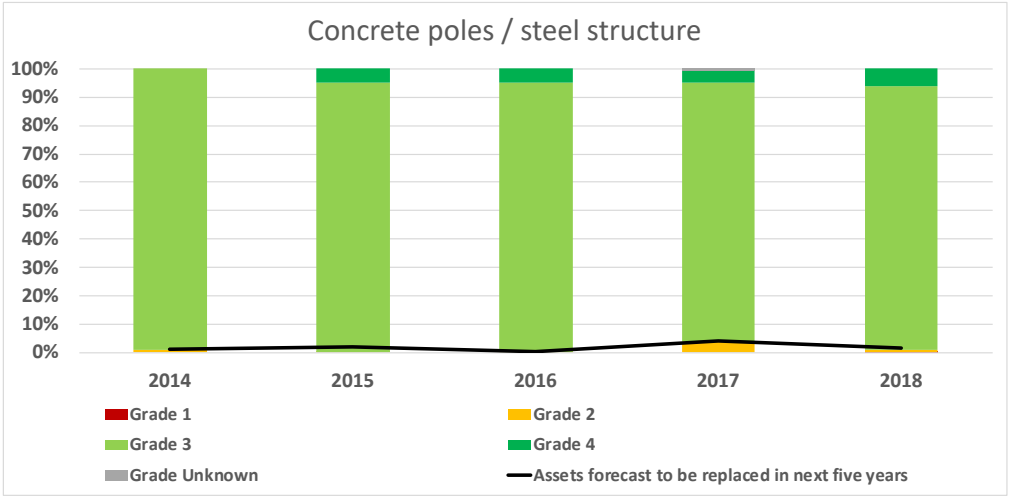
G.2 The charts provide an indication of the average condition of Horizon's asset fleets against the Commerce Commission's grading criteria. Adding the replacement line provides an indication of how Horizon has responded through asset replacement when assets are at grades 1 and 2.

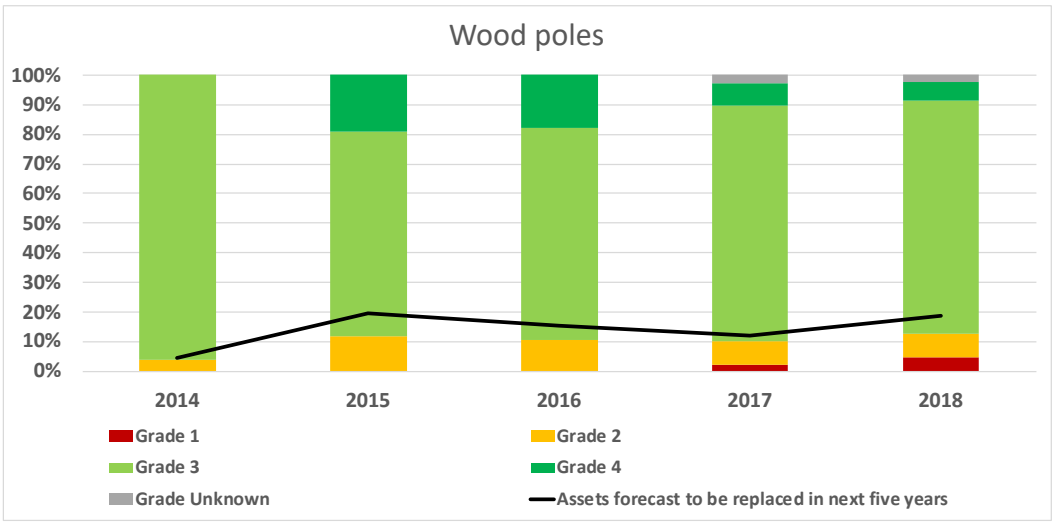
G.3 It is apparent when viewing the charts that Horizon has assessed its assets as being in good condition. Where assets are seen to be in grades 1 and 2, Horizon has forecast increased replacement. It is also apparent from the asset condition in the year following the increased replacement volumes, that the asset condition improves. This indicates that Horizon actually made its forecast replacements. This effect is particularly clear for SCADA and communications equipment.

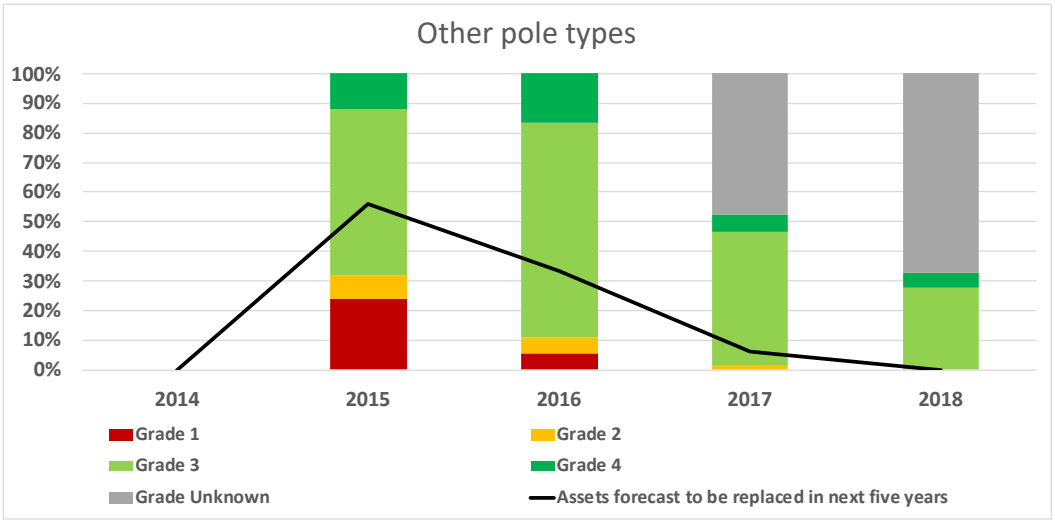
Appendix Figure 18: Asset condition and replacement forecasts

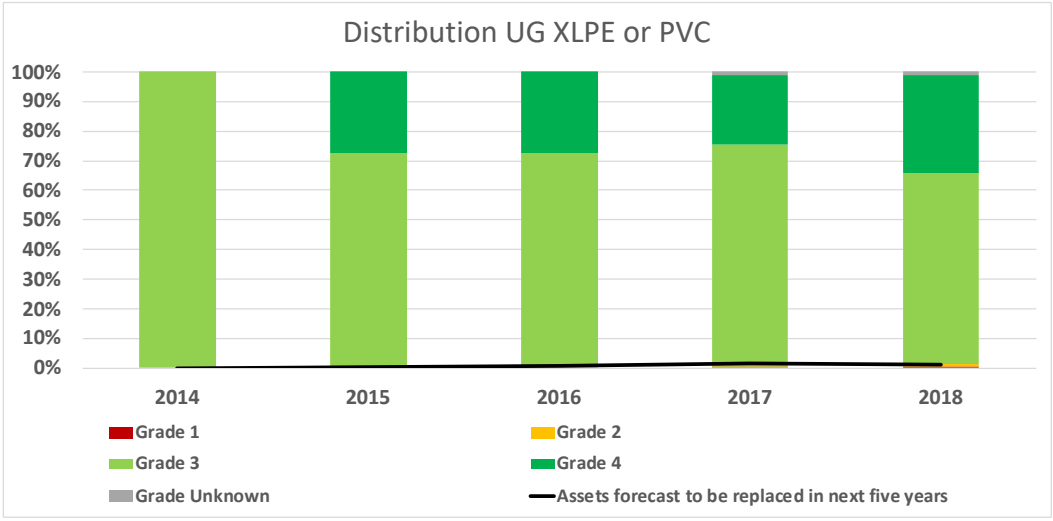


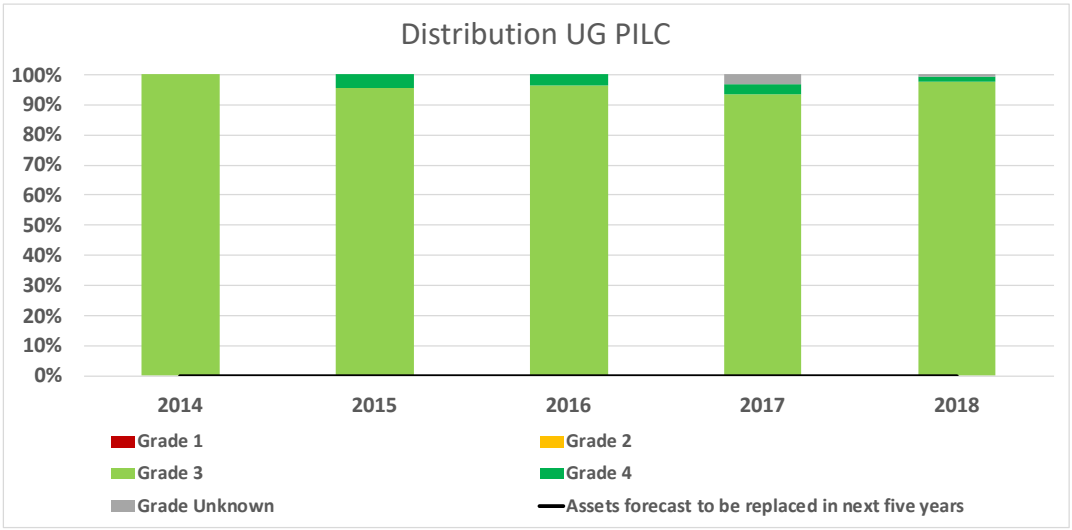


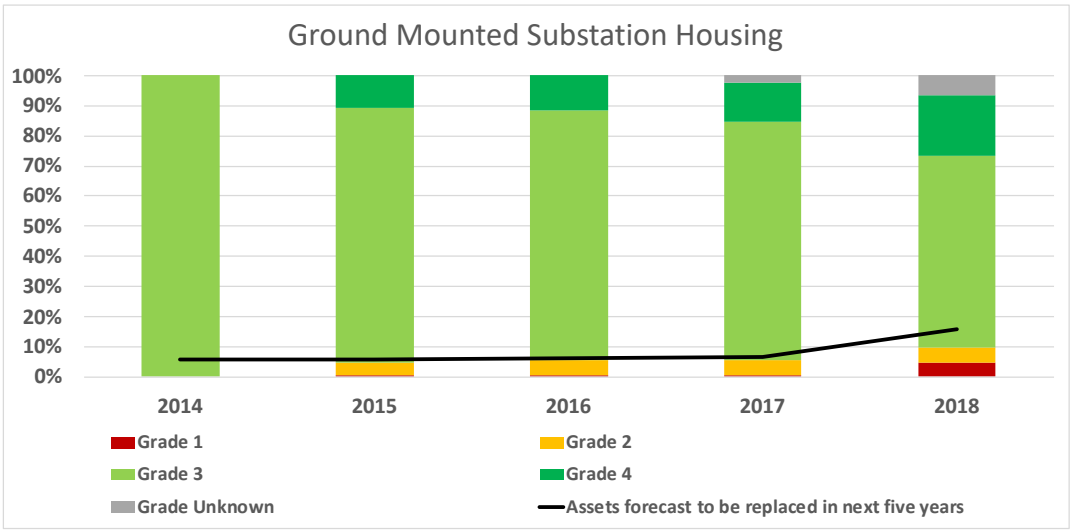

Concrete poles / steel structure
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

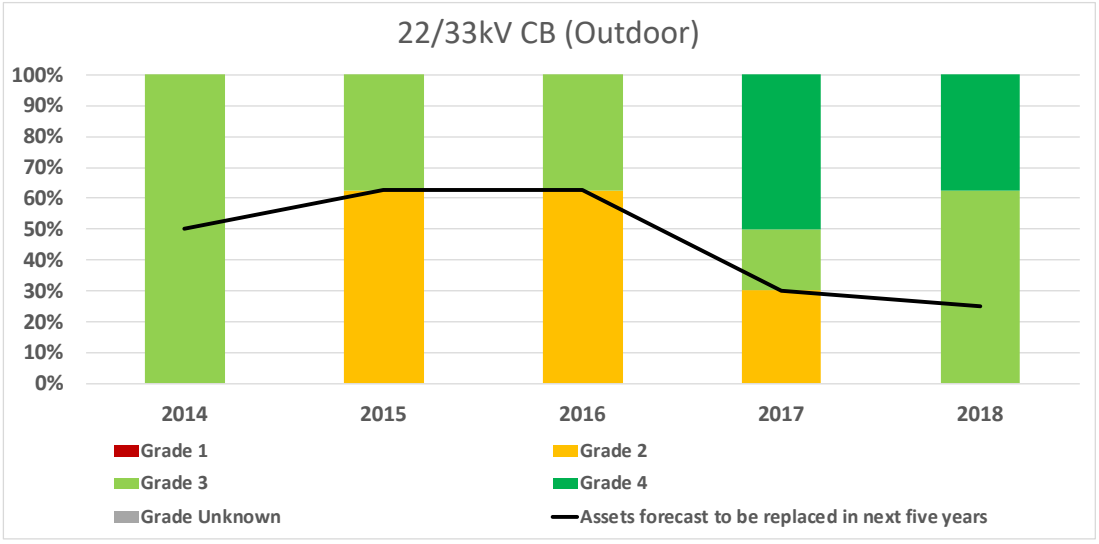

Wood poles
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

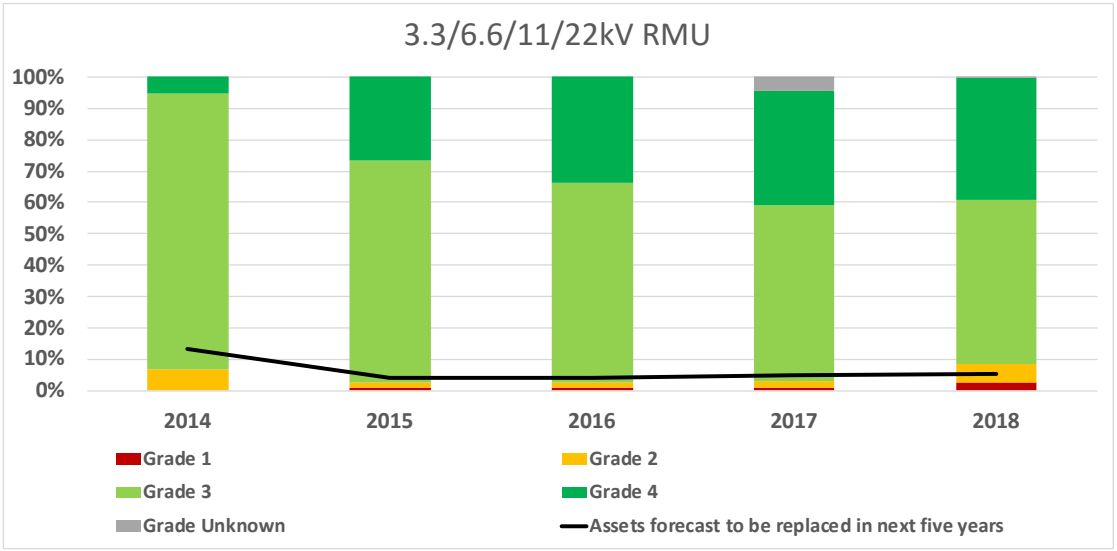

Other pole types
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

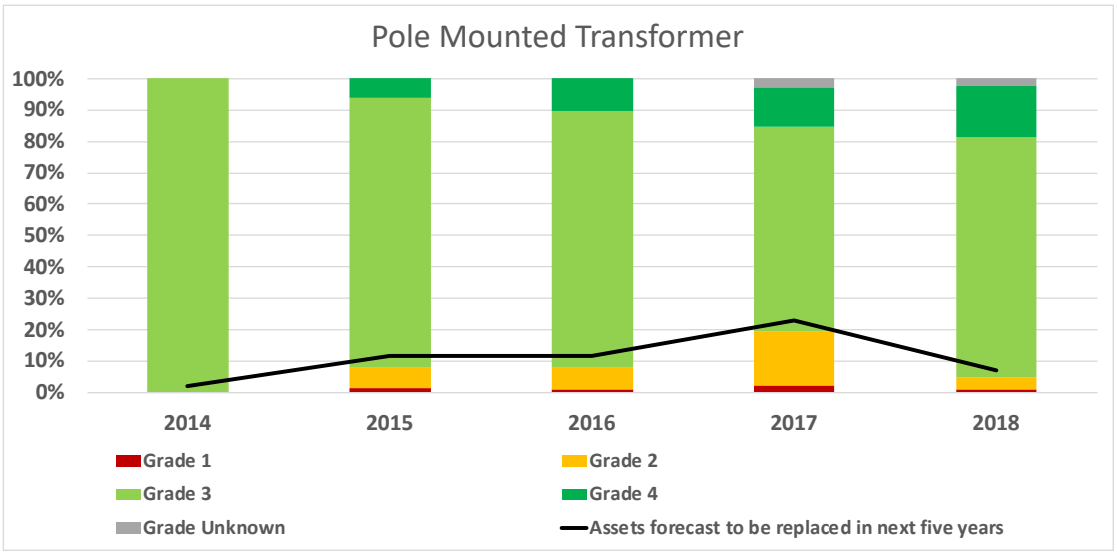

Distribution UG XLPE or PVC
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

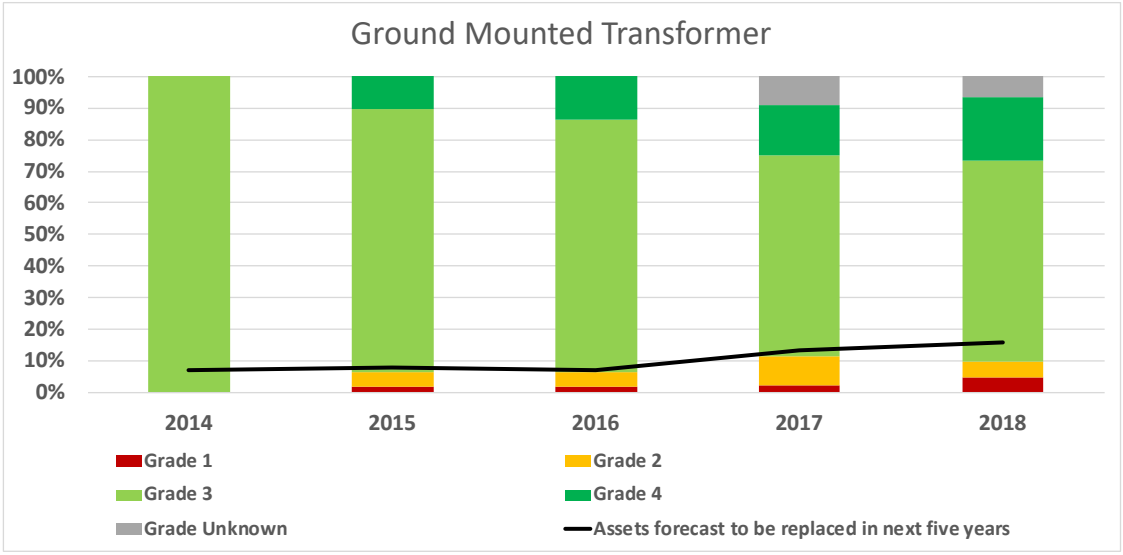

Distribution UG PILC
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

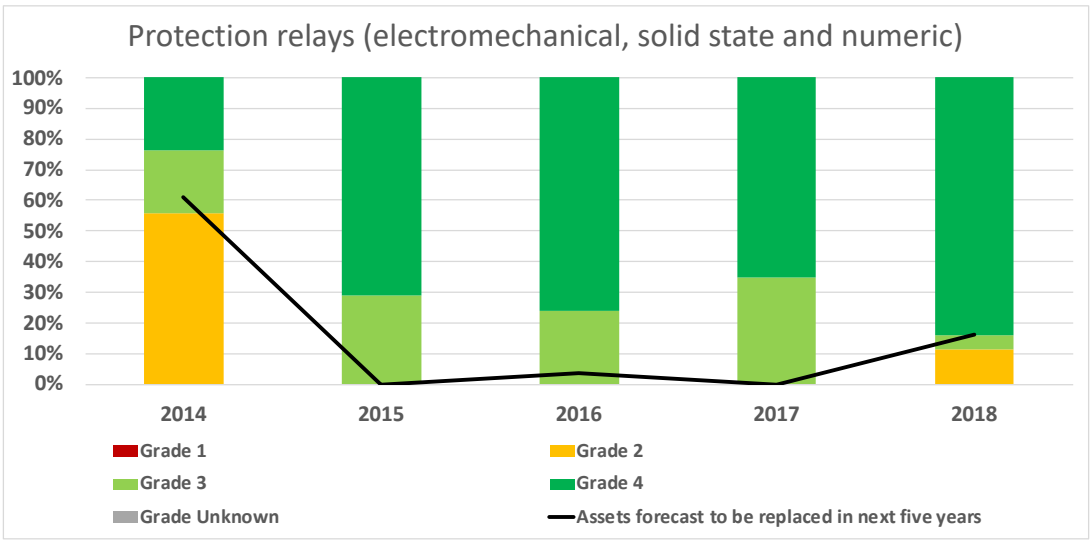

Ground Mounted Substation Housing
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years

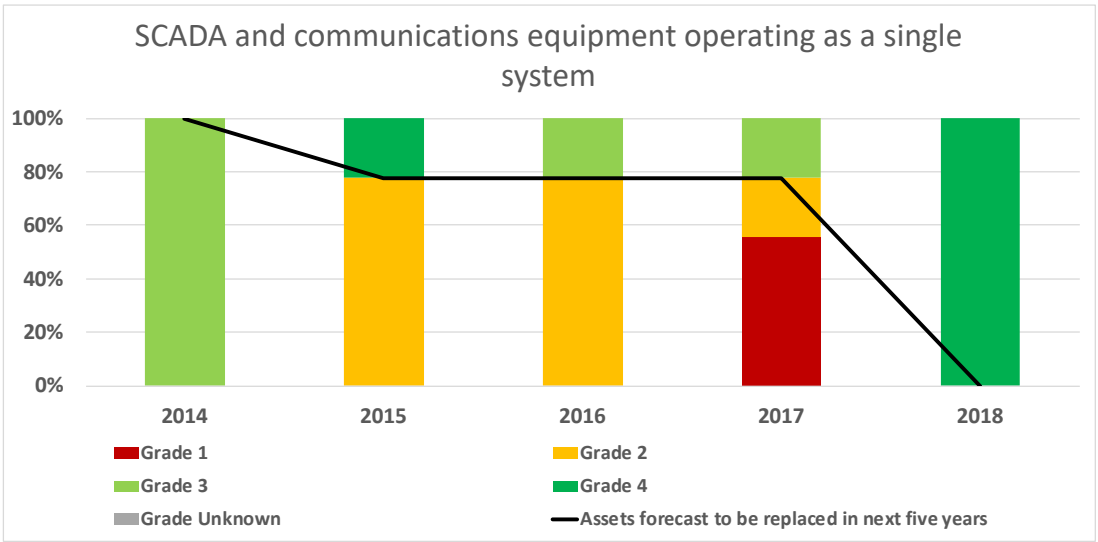

22/33kV CB (Outdoor)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years


3.3/6.6/11/22kV RMU
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years


Pole Mounted Transformer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2014
2015
2016
2017
2018
Grade 1
Grade 2
Grade 3
Grade 4
Grade Unknown
Assets forecast to be replaced in next five years







Source: Strata EDB Dashboard, data from Commerce Commission

Appendix H The reliability of Horizon's data and information

Horizon's assessment of its data quality

H.1 In its annual information disclosures, Horizon provides assessments of the quality of its disclosed data. The Commission's four point scale against which EDB assess their data quality is provided below.

Data Accuracy Score	Commerce Commission Interpretation
1	Good quality data is not available for any of the assets in the category and estimates are likely to contain significant error
2	Good quality data is available for some assets but not for others and the data provided includes estimates of uncounted assets within the category
3	Means that data is available for all assets but includes a level of estimation where there is understood to be some poor quality data for some of the assets within the category
4	Means that good quality data is available for all of the assets in the category

H.2 The tables below provide a collated summary of Horizon's self-assessment of the data accuracy in its Information Disclosures.

Appendix Table 12: Asset age data quality

	2013	2014	2015	2016	2017	2018
Capacitors including controls	4	4	4	4	4	4
Cable Tunnels	0	0	0	0	0	0
Centralised plant	4	4	4	4	4	4
Relays	0	0	0	0	0	0
Concrete poles / steel structure	3	2	2	2	2	2
Wood poles	3	2	2	2	2	2
Other pole types	2	2	2	2	2	2
Protection relays (electromechanical, solid state and numeric)	3	3	3	3	3	3
SCADA and communications equipment operating as a single system	4	4	4	4	4	4
Distribution UG XLPE or PVC	3	2	2	2	2	2
Distribution UG PILC	3	2	2	2	2	2
Distribution Submarine Cable	0	0	0	0	0	0
Distribution OH Open Wire Conductor	3	3	3	3	3	3
Distribution OH Aerial Cable Conductor	0	0	0	0	0	0
SWER conductor	3	3	3	3	3	3
Ground Mounted Substation Housing	2	2	2	2	2	2
3.3/6.6/11/22kV CB (pole mounted) - reclosers and sectionalisers	3	3	3	3	3	3
3.3/6.6/11/22kV CB (Indoor)	0	0	0	0	0	0
3.3/6.6/11/22kV Switches and fuses (pole mounted)	1	1	1	1	1	1
3.3/6.6/11/22kV Switch (ground mounted) - except RMU	0	0	0	0	0	0
3.3/6.6/11/22kV RMU	2	3	3	3	3	3
Pole Mounted Transformer	3	3	3	3	3	3
Ground Mounted Transformer	3	2	2	2	2	2
Voltage regulators	4	4	4	4	4	4
Subtransmission UG up to 66kV (XLPE)	4	4	4	4	4	4
Subtransmission UG up to 66kV (Oil pressurised)	0	0	0	0	0	0
Subtransmission UG up to 66kV (Gas pressurised)	0	0	0	0	0	0
Subtransmission UG up to 66kV (PILC)	0	0	0	0	0	0
Subtransmission UG 110kV+ (XLPE)	0	0	0	0	0	0
Subtransmission UG 110kV+ (Oil pressurised)	0	0	0	0	0	0
Subtransmission UG 110kV+ (Gas Pressurised)	0	0	0	0	0	0
Subtransmission UG 110kV+ (PILC)	0	0	0	0	0	0
Subtransmission submarine cable	0	0	0	0	0	0
Subtransmission OH up to 66kV conductor	1	1	1	1	1	1
Subtransmission OH 110kV+ conductor	0	0	0	0	0	0
Zone substations up to 66kV	4	3	3	3	3	3
Zone substations 110kV+	0	0	0	0	0	0
50/66/110kV CB (Indoor)	0	0	4	0	0	0
50/66/110kV CB (Outdoor)	0	0	2	0	0	0
33kV Switch (Ground Mounted)	0	0	4	4	4	4
33kV Switch (Pole Mounted)	2	1	1	1	1	1
33kV RMU	0	0	0	0	0	0
22/33kV CB (Indoor)	4	4	0	1	2	2
22/33kV CB (Outdoor)	3	2	0	1	2	2
3.3/6.6/11/22kV CB (ground mounted)	4	4	4	4	4	4
3.3/6.6/11/22kV CB (pole mounted)	4	4	4	4	4	4
Zone Substation Transformers	3	4	4	4	4	4
OH/UG consumer service connections	3	3	3	3	3	3
LV UG Cable	2	2	2	2	2	2
LV OH Conductor	2	2	2	2	2	2
LV OH/UG Streetlight circuit	2	2	2	2	2	2

Source: Horizon Information Disclosures (2014 to 2018)

Appendix Table 13: Asset condition data quality

	2013	2014	2015	2016	2017	2018
Capacitors including controls	4	4	4	4	4	4
Cable Tunnels	0	0	0	0	0	0
Centralised plant	3	3	4	4	4	4
Relays	0	0	0	0	0	0
Concrete poles / steel structure	3	3	2	2	2	2
Wood poles	3	3	2	2	2	2
Other pole types	3	3	2	2	2	2
Protection relays (electromechanical, solid state and numeric)	4	4	3	3	3	4
SCADA and communications equipment operating as a single system	3	3	4	4	4	4
Distribution UG XLPE or PVC	2	2	2	2	2	2
Distribution UG PILC	2	2	2	2	2	2
Distribution Submarine Cable	0	0	0	0	0	0
Distribution OH Open Wire Conductor	3	3	3	3	3	3
Distribution OH Aerial Cable Conductor	0	0	0	0	0	0
SWER conductor	3	3	3	3	3	3
Ground Mounted Substation Housing	3	3	2	2	2	2
3.3/6.6/11/22kV CB (pole mounted) - reclosers and sectionalisers	3	3	3	3	3	3
3.3/6.6/11/22kV CB (Indoor)	3	3	0	0	0	0
3.3/6.6/11/22kV Switches and fuses (pole mounted)	2	2	1	1	1	2
3.3/6.6/11/22kV Switch (ground mounted) - except RMU	0	0	0	0	0	0
3.3/6.6/11/22kV RMU	3	3	3	3	3	3
Pole Mounted Transformer	2	2	3	3	3	3
Ground Mounted Transformer	3	3	2	2	2	2
Voltage regulators	4	4	4	4	4	0
Subtransmission UG up to 66kV (XLPE)	3	3	4	4	4	4
Subtransmission UG up to 66kV (Oil pressurised)	0	0	0	0	0	0
Subtransmission UG up to 66kV (Gas pressurised)	0	0	0	0	0	0
Subtransmission UG up to 66kV (PILC)	0	0	0	0	0	0
Subtransmission UG 110kV+ (XLPE)	0	0	0	0	0	0
Subtransmission UG 110kV+ (Oil pressurised)	0	0	0	0	0	0
Subtransmission UG 110kV+ (Gas Pressurised)	0	0	0	0	0	0
Subtransmission UG 110kV+ (PILC)	0	0	0	0	0	0
Subtransmission submarine cable	0	0	0	0	0	0
Subtransmission OH up to 66kV conductor	3	3	1	1	1	3
Subtransmission OH 110kV+ conductor	0	0	0	0	0	0
Zone substations up to 66kV	3	3	3	3	3	3
Zone substations 110kV+	0	0	2	2	0	0
50/66/110kV CB (Indoor)	0	0	0	0	0	0
50/66/110kV CB (Outdoor)	0	0	0	0	0	0
33kV Switch (Ground Mounted)	0	0	0	0	0	0
33kV Switch (Pole Mounted)	3	3	1	1	1	1
33kV RMU	0	0	0	0	0	0
22/33kV CB (Indoor)	4	4	4	4	4	4
22/33kV CB (Outdoor)	4	4	2	2	2	3
3.3/6.6/11/22kV CB (ground mounted)	3	3	4	4	4	4
3.3/6.6/11/22kV CB (pole mounted)	3	3	4	4	4	4
Zone Substation Transformers	4	4	4	4	4	3
OH/UG consumer service connections	3	3	3	3	3	0
LV UG Cable	2	2	2	2	2	2
LV OH Conductor	2	2	2	2	2	2
LV OH/UG Streetlight circuit	2	2	2	2	2	2

Source: Horizon Information Disclosures (2014 to 2018)

H.3 Horizon's assessment indicates that, over time, its data has been improving across some asset fleets. This was reinforced during our on-site sessions. For some asset fleets, the earlier condition forecasts appear to have been over-optimistic (e.g. moving from a 3 to a 2 grade). This is understandable as improved asset information becomes available.

A potential issue with the accuracy of Horizon's disclosures

H.4 In appendix F, we noted a potential issue relating to Horizon's disclosed asset age profiles. The quantity of age unknown appears to be high given that level of knowledge we would expect to have seen if an EDB was operating at good industry practice.

H.5 The following extract from an independent consultant's report also highlights this concern:

> *Horizon Networks have disclosed considerable volumes of assets with ages unknown or assumed. Given the sophistication of tools in use within Horizon Networks this dichotomy would be obvious to a skilled asset manager reviewing the Horizon network plans and systems. There are red flags in the recent Commerce Commission distribution disclosures for Horizon (as there are for a number of businesses). Breaching two years in*

> *a row may trigger a Commerce Commission investigation. Horizon Networks should carefully consider its regulatory disclosure accuracy and alignment with its internal systems, including tools it uses to demonstrate prudent expenditure. Recent media criticisms of maintenance levels and expenditure may lead to heightened regulatory interest. A clear assessment of this risk seems prudent. It is the reviewer's opinion that Horizon Networks is risking its regulatory reputation and ultimately, it's public reputation disclosing differently to its known asset data.* [48]

H.6 During our on-site discussions, Horizon explained that when its parent organisation was split up in 1999, it had inherited varying aged asset types with limited or no records. It had since taken steps to continuously improve asset information with significant improvement achieved through the 2009-2012 full inspection cycle.

H.7 Horizon expects to have continuing challenges in improving accuracy levels due to difficult terrain and assets without nameplate information and also accuracy around Information such as conductor/poles/DDOs' ages where information accuracy is believed to be in low to mid-range.

H.8 We reviewed Horizon's asset data collection process and systems. We undertook a review of documentation for a very limited sample of assets. We found that Horizon's explanation for the data issue was reasonable. We consider that Horizon will need to continue to invest in improving the quality of its data if it is to manage asset risks and secure the full benefits from its investment in total asset life cycle management.

H.9 The inclusion of progress reports on data quality improvement in Horizon's annual asset management plans will be important to provide confidence to stakeholders.

[48] 3.18 Horizon Network Cost Reduction Report_final, Review of Horizon Network Expenditure, October 2017, Authors: Southwest Consulting Limited, Page 14.

Appendix I Revenue and expenditure comparisons

I.1 The following charts show comparisons of key financial metrics in $ per ICP for the five Assessment Periods from AP2015 to AP 2018. Whilst there are many reasons why distributors' values can be different, the comparison can provide insights.

I.2 In the tables, the columns from left to right are:

(a) Line charge revenue/ICP

(b) Regulatory profit/ICP

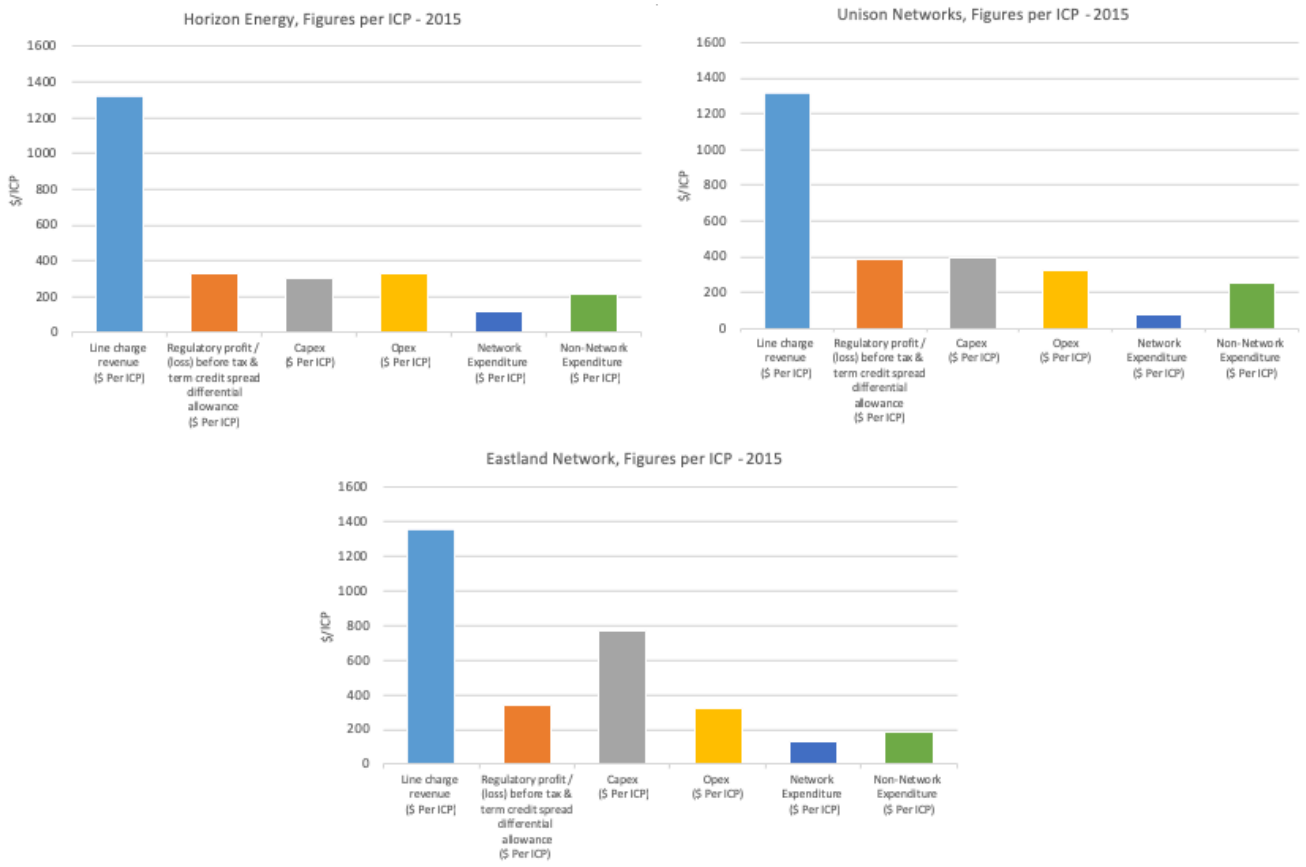
(c) Capex/ICP

(d) Opex/ICP

(e) Network expenditure/ICP

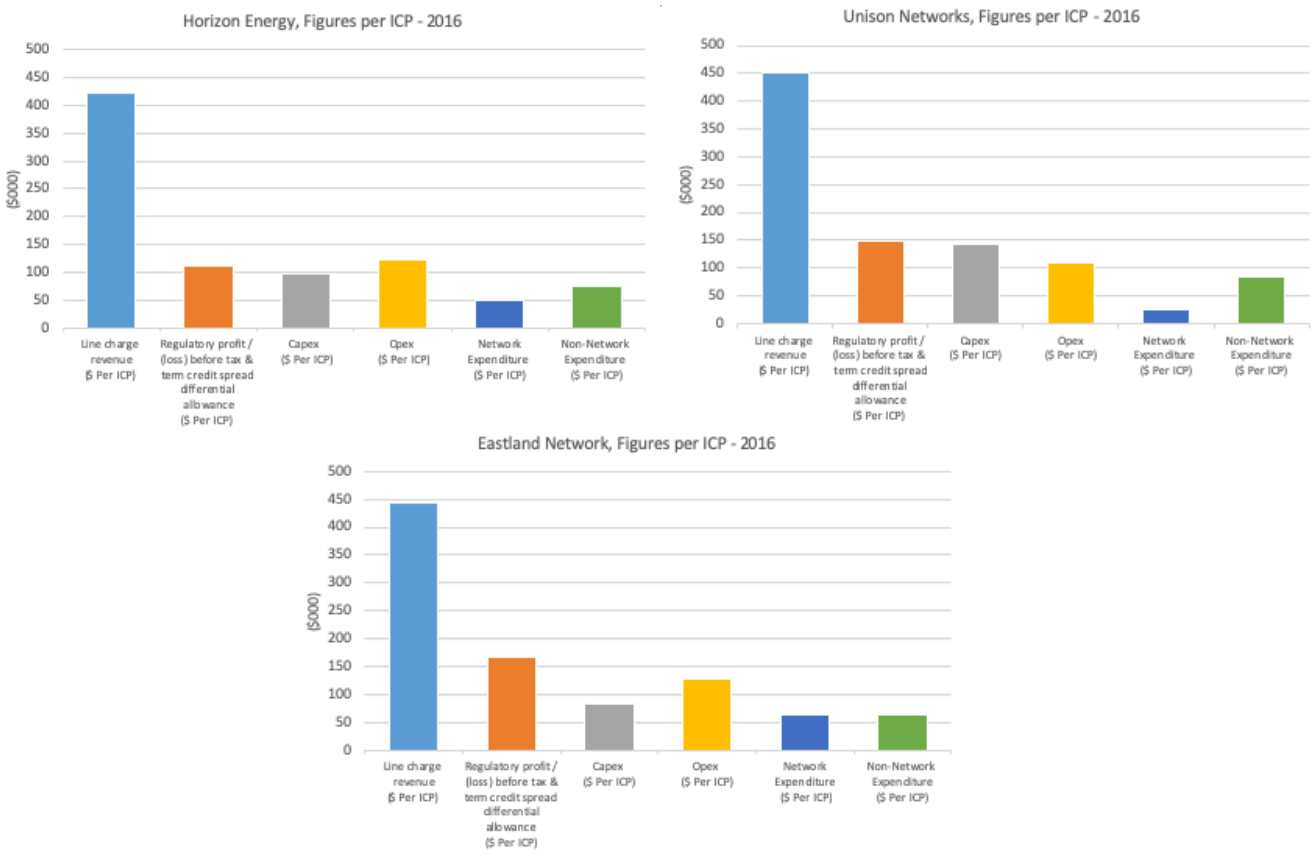
(f) Non-Network expenditure/ICP

Appendix Figure 19: AP 2015 Revenue and expenditure proportions



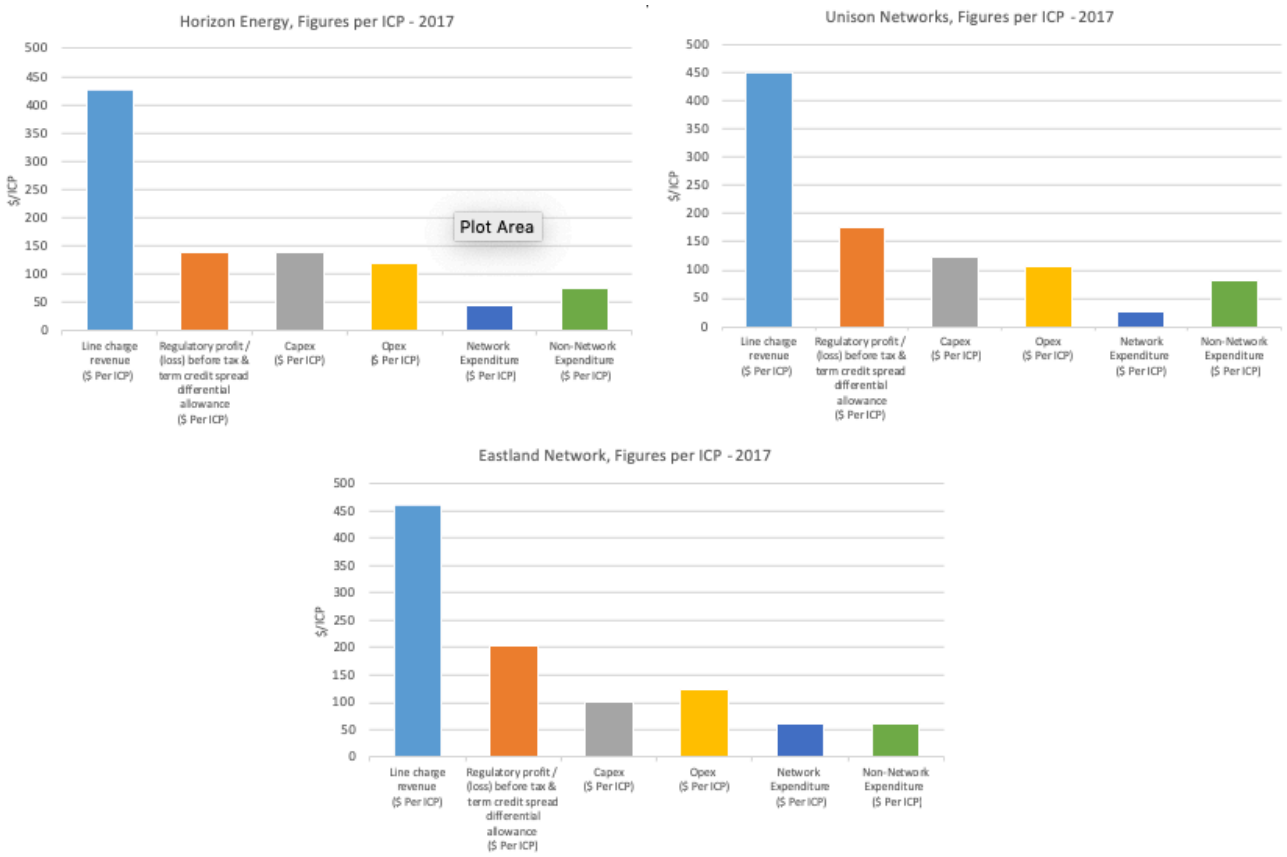
Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 20: AP 2016 Revenue and expenditure proportions



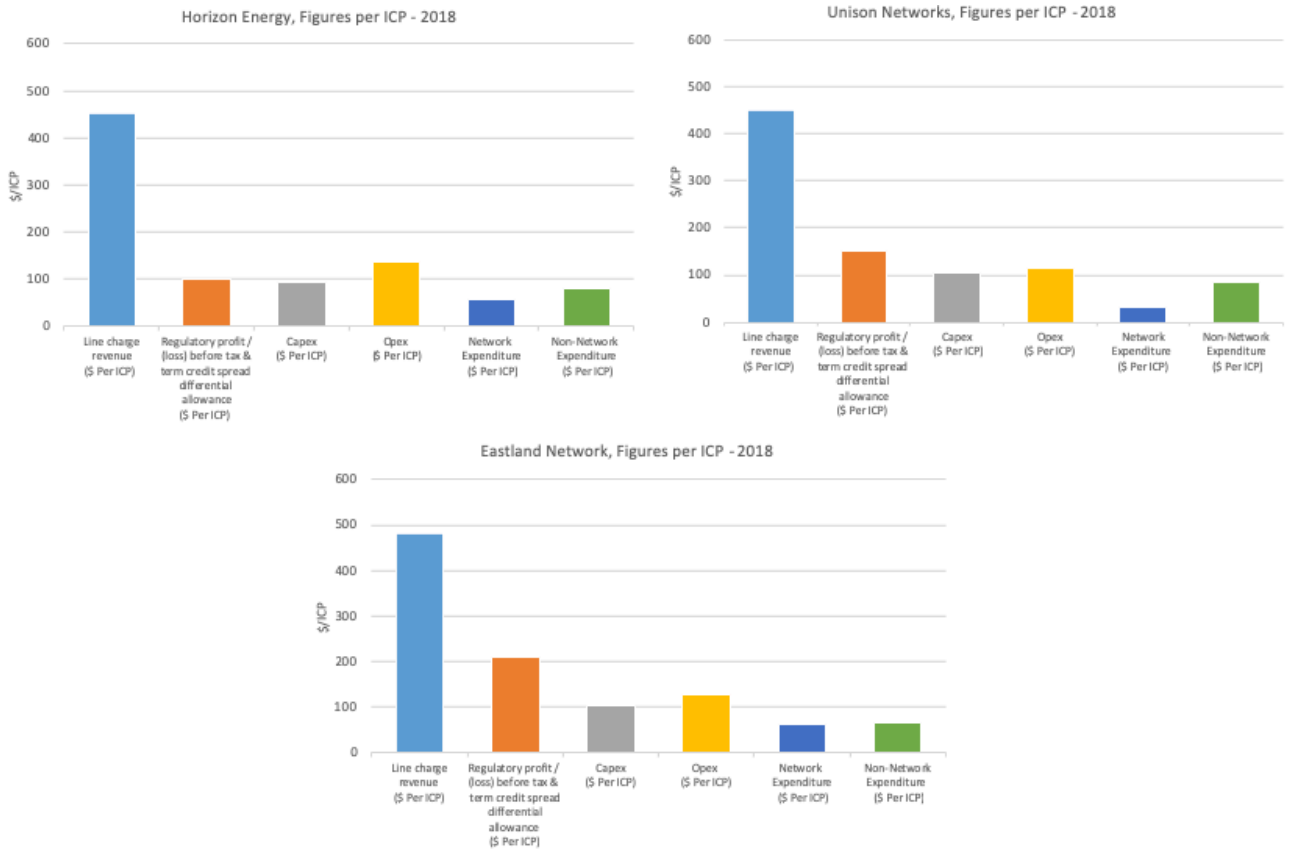
Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 21: AP 2017 Revenue and expenditure proportions



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix Figure 22: AP 2018 Revenue and expenditure proportions



Source: Strata EDB Dashboard, data from Commerce Commission

Appendix J Glossary

Act	Part 4A of the Commerce Act 1986
AHI	Asset health index
AMMAT	Asset Management Maturity Assessment Tool
AMP	Asset Management Plan
AMS	Asset Management System
AMIP	Asset Management Improvement Programme
AP	Assessment Period
APR	Accelerated pole replacement programme
Capex	Capital Expenditure
CBD	Central Business District
Commission	The Commerce Commission
CPP	Customised Price Path
DDO	Distribution drop-out fuse
DGA	Dissolved Gas analysis
DGCA	Distributed Generation Connection Agreement
DPP	Default Price Path
EDB	Electricity Distribution Business
EEA	Electrical Engineer's Association
FMEA	Failure mode effects analysis
GIP	Good Industry Practice
GWh	Gigawatt-hour, a unit of electrical energy

Horizon	Horizon Energy Distribution Limited
HSWA	The Health and Safety at Work Act 2015
ICP	Installation Connection Point
ID	Information disclosure
kmh	Kilometres per hour
kV	Kilovolts (= 1000 volts), a unit of electrical voltage
MPL	Maximum practicable life
MPT	Mechanical pole testing
MVA	Megavolt-ampere, a unit of electrical power
MW	Megawatt, a unit of electrical power
Nova	Nova Energy Limited
OOU	Onset of unreliability
Opex	Operational expenditure
PILC	Paper insulated lead covered
PDA	Prudent Discount Agreement
RMU	Ring Main Unit
SCCP	SCADA communication control and protection
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAMP	Strategic asset management plan
Strata	Strata Energy Consulting Limited

TALC	Total Asset Lifecycle
Transpower	Transpower New Zealand Limited
WorkSafe	WorkSafe New Zealand
XLPE	Cross-linked polyethylene

Appendix K Strata's advice on Horizon's response to its Draft Report

9 December 2019

[redacted]

Strata Energy Consulting (Strata) advice to the Commerce Commission regarding Horizon Energy

Summary of this briefing paper

This briefing paper addresses an alleged factual error that Horizon Energy (Horizon) considers Strata Energy Consulting (Strata) made in its 20th September Draft Quality Non-Compliance Report. The alleged error relates to Horizon's management of the electricity supply to the Galatea area between 2009 and 2017.

This paper is an update of the advice that Strata provided to the Commission in an 11th September 2019 briefing paper.

At the Commerce Commission (Commission) request[49], Horizon has provided documents including emails, papers, reports and contracts relating to its management of the electricity supply to Galatea during the relevant periods. Horizon also provided additional narrative on its view of the salient points of circumstances and actions it took between 2009 and 2010.

From the information provided by Horizon, Strata has developed a clearer understanding of the following relevant facts. These are:

1) on 9th August 2009 , a transformer at Aniwhenua hydro power station (Aniwhenua) experienced a failure;
2) in 2011, the repaired transformer was returned to service and Aniwhenua again became the primary electricity supply for Galatea;
3) towards the end of 2011, (no specific date provided in the Horizon documentation), a second transformer failure occurred at Aniwhenua;
4) following the second transformer failure, Nova, the owners of Aniwhenua power station refused to allow its connection for the primary supply to Galatea;
5) in October 2012, Horizon management submitted an expenditure request to the Board for implementation of a solution it had developed to resolve the Aniwhenua issue;
6) in January 2014, Horizon produced an options paper setting out three alternative solutions, including the one identified in 2012 which was the preferred option;
7) the Options Paper, recommended the set-up of a technical meeting between Nova Energy and Horizon Energy to formally identify the key issue at Aniwhenua;
8) on 17 April 2014, Horizon and Nova signed a Prudent Discount Agreement (PDA) with Transpower which was supported by a report stating that nothing had changed from the historical arrangement that Aniwhenua provided the primary electricity supply for Galatea;
9) in July 2014, Horizon finalised protection settings for the proposed option;

[49] 1st October 2019 notice to Horizon under Sections 98(1)(a) and (b) of the Commerce Act 1986

10) on 16 July 2014, Horizon completed work that included the solution for the Aniwhenua connection issues;
11) in August 2014, Horizon noted key concerns regarding a limited number of remaining issues to be resolved in the negotiations of the Aniwhenua Distributed Generation Connection Agreement (DGCA) with Nova Energy (Nova) – Horizon noted that Nova Energy was not anticipating being able to provide continuous supply from Aniwhenua for a further 12 months;
12) the DGCA for Aniwhenua was signed in November 2015;
13) 10 April 2016 Galatea area MED; and
14) the Aniwhenua connection was reinstated in September 2016.

Following our review of the additional information provided by Horizon and the above timeline of events, Strata has revised its original recommendation to the following:

The resolution of the Aniwhenua generation issue should not have taken seven years during which time the Galatea community had reduced reliability or electricity supply.

In our opinion, the lack of a robust technical investigation at the time of the first transformer failure in August 2009 extended the time in which a solution was finally identified and implemented in July 2014. Strata's view is that it should have been possible for Horizon to reduce the technical solution's installation time to at least one year.

The absence of a clear, evidence based explanation for the time taken to reinstate the Aniwhenua connection following the completion of the capital works and commercial agreements is concerning. Horizon's explanation identifying complex contractual issues as a contributing factor to delayed restoration is not supported by the documents and information that it provided.

Specifically, the PDA and DGCA were signed before the end of November 2015, yet the reconnection of Aniwhenua took a further 10 months. The timeline of events provided by Horizon fails to provide any explanation for the reason that the connection could not have been restored soon after the DGCA was signed. The absence of an explanation and supporting evidence is of concern.

Strata remains convinced that the Aniwhenua generation connection to the Galatea electricity supply could and should have been reinstated well before the 10 April MED event on the Snake Hill 33kV distribution subtransmission feeder.

Strata has reviewed its opinion on the April 2016 MED at Galatea

The Commission gave Strata's Draft Quality Non-Compliance Report to Horizon to enable Horizon to identify any factual errors. Horizon responded in a paper entitled 'Horizon Response to Strata Draft Report 13 August 2019' (response document).

The Commission asked Strata to review and provide advice on the validity of the points raised by Horizon in its response document.

A summary of Strata's advice on the points raised by Horizon is provided in Attachment B which also identifies how the issues have been addressed in our Final Quality Non-Compliance Report.

Horizon also identified what it considered to be a key factual error[50] relating to actions taken by Horizon in its management of the Galatea electricity supply during 2009 to 2014. Horizon did not dispute that the problem with supply to Galatea commenced in 2009 and was resolved in 2016, its primary assertion was that it could not have taken any other actions and the options available to it were economically unjustifiable. To support its position, Horizon provided a Prudent Discount Agreement (PDA) dated 17 April 2014. Horizon claims that the Electronet report attachment to the

[50] Horizon Response to Strata Draft Report 13 August 2019, page 2

PDA provides evidence that alternative options to address the supply issues at Galatea were uneconomic.

Strata considered the information in Horizon's response document and provided the Commission with its initial advice in an 11th September briefing paper. On the Galatea issue, Strata found that, rather than resolving the matter, the information Horizon provided raised additional issues that were sufficiently important to warrant more detailed review.

Subsequently, the Commission asked Strata to review the additional issues. To assist Strata in this further review, the Commission sought additional information in its 1st October 2019 notice to Horizon under Sections 98(1) (a) and (b) of the Commerce Act 1986. Horizon provided its response to the Commission's information request in November 2019.

Strata has reviewed the relevant documents and information provided by Horizon and has reconsidered its original advice on the Galatea issue. We have also updated our Draft Report (now the Third Version) to reflect our final views and opinions on this matter.

The following sections provide our revised opinions together with discussion on how we formed them.

Summary of Strata's original opinion

Strata's view was summarised in its executive summary as:

> *We disagree with Horizon that the lightning strike which damaged a surge arrestor on 10 April 2016 was the primary cause of this MED. Our opinion is that the primary cause was the ongoing reliance on the single, vulnerable Snake Hill feeder for supplies to the Galatea region. In our opinion, this situation should have been remedied in the seven years since if first arose.*[51]

Strata formed its opinion on the understanding that the supply issues relating to the reliability of supply at Galatea had been known by Horizon but had not been solved within a seven year period between 2009 and 2016. In Strata's opinion, the resolution of the Galatea area supply reliability issue should not have taken seven years.

Horizon's 2016 AMP[52] recorded that the issue began in 2009 and from this date, the Galatea region had a lower level of reliability, higher system losses and lower system spare capacity:

> *As a result of the failure of one of the supply transformers at Aniwhenua in 2009, the Galatea region has been predominantly supplied from Edgecumbe via the Snake Hill circuit instead of the preferred supply from Aniwhenua. This causes a lower level of reliability, higher system losses, and lower system spare capacity.*

In the same section, the 2016 AMP noted that the Aniwhenua transformer was returned to service in 2013 but supply would only be restored from April 2016:

> *The Aniwhenua transformer was returned to service in mid-2013 and supply has been agreed to be restored to Aniwhenua from April 2016.*

Strata considered that issues relating to Aniwhenua's generation should have been addressed during the initial four to five years of its unavailability. Strata found that the lack of swift progress during the 2009 to 2014 period was the primary cause of the 10 April 2016 MED.

[51] 3568578_Non-compliance report Horizon Energy Distribution 2018 (17 June) - Strata Revision, Page 4, paragraph 10.

[52] Horizon 2016 AMP page 4

Strata noted in its report that since 2014, Horizon *accelerated*[53] a number of planned projects to improve the reliability of this regional supply. Clearly, the AMP statement that projects were accelerated implies that the projects could have been implemented earlier. Had this been achieved, the effects of the outage during the 2014 MED could have been reduced, and the impact of the 10 April 2016 event could have been mitigated.

Horizon's objection to Strata's opinion

Horizon disagrees with Strata's views that the situation should have been resolved earlier than it was and that in not doing so, Horizon acted inconsistently with Good Industry Practice.

Horizon categorically rejects the statement that "In our opinion, between 2009 and 2016 Horizon could, but did not, complete actions to remedy the vulnerable distribution arrangement supplying the Galatea community. Horizon did not meet good industry standards by failing to act with sufficient urgency."[54]

Horizon disputes Strata's inference that during 2009 through to 2013, no progress or action was made or that there was a lack of urgency to address the Galatea reliability issue.[55]

Network Reconfiguration

To support its view, Horizon quoted various AMPs and presented these as a list of events demonstrating actions it had taken. The following is Strata's summary of the actions Horizon maintains that it took:

August 2009 - Following the failure of A34 transformer at Aniwhenua, the Galatea load was connected to the Edgecumbe GXP *via the Snake Hill feeder.*

August 2012 - AMP Supply to Galatea from Aniwhenua was reinstated in August 2011.

Horizon notes that the voltage variations experienced on the 33kV network while using the Snake Hill circuit reinforced the need for a stronger supply from Aniwhenua.

2013 the Galatea system was still being supplied from Edgecumbe via the Snake Hill circuit instead of the normal supply from Aniwhenua. *Horizon notes that this causes a lower level of reliability, higher system losses, and lower system spare overhead capacity. The Nova transformer is expected back in service mid 2013.*

September 2016 supply was restored from Aniwhenua.

Investment in network assets

2013- 2014 Horizon installed Air Circuit Breakers ABSs in preparation for Snake Hill Circuit Breaker (CB) and the Galatea substation upgrade.

2014-2015 Horizon installed 33kV CBs at Snake Hill.

2014 Horizon states that, as part of the Prudent Discount application (see below), it considered an option to install a second line from Edgecumbe. The estimated cost was approximately $3.8m; Horizon considered that the consenting and build timeframe would be around four years.

2016 Horizon approved a new 33kV CB Installation at Galatea to improve fault isolation and restoration times; this was completed the same year.

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[53] Horizon 2017 Update AMP page 2

[54] Horizon Response to Strata Draft Report 13 August 2019, page 2

[55] ibid

Commercial arrangements

2013- 2014 Horizon sought to indemnify Nova to restore supply from Aniwhenua.

April 2014 a New Prudent Discount Agreement ('PDA') was signed between Horizon, Transpower, Trustpower and Nova.

The supply configuration to Galatea

Horizon stated its current view that the Galatea supply network configuration was not unusual and did not represent poor design (or security of supply) practices. To support this view, Horizon noted that much larger communities are run on single circuits of similar length or longer. Horizon provided a transmission example of such an arrangement.[56]

In its response document, Horizon did not provide an explanation for how it justified the $1.3m invested in reinforcement of the network if, as it now asserts, the configuration and design was appropriate. The information provided in response to the Commission's s98 letter included several documents relating to the capital projects. Review of these documents revealed that the project cost for addressing the technical issues preventing the Aniwhenua connection was approximately $300k. The remainder of the $1.3m was spent on asset renewal and upgrade projects to replace ageing and/or problematical assets and to improve the general reliability of supplies to Galatea.

Strata's initial consideration of Horizon's points.

Consideration of the actions taken by Horizon between 2009 and 2014

Strata's initial consideration indicated that Horizon had failed to adequately identify and disclose to the Commission that its decision to defer actions to address Galatea supply quality and reliability was the primary cause of the MED that occurred on 10 April 2016. If the supply reinforcements had been undertaken earlier, the MED and Horizon's breach of Clause 9.1 of the DPP Quality Standard in FY2018 would not have occurred. Horizon should have recognised this but failed to do so.

On the technical aspects, nothing that Horizon provided in its response document has changed our opinion that, from a technical perspective:

> *The resolution of the Aniwhenua generation issue should not have taken six years. In our opinion, the lack of swift progress during the 2009 to 2014 period was the primary cause of the 10 April 2016 MED. In forming this opinion, we acknowledge that Horizon identified, implemented and completed projects that have now improved reliability in the Galatea region.*

Matters relating to contractual issues and Horizon's investment deferral decision were also not identified or discussed by Horizon during the on-site session.

Because of the lack of information, Strata's preliminary conclusion on the contractual aspects is that Horizon has not demonstrated that its decision to defer the Galatea supply reinforcement investment was aligned and consistent with good industry practice.

Horizon must provide clear evidence that it applied good industry practice process when making its deferral decision. Strata has provided to the Commission a list of additional information that it considers Horizon would need to produce to support its investment deferral decision.

In the absence of clear evidence, Strata's opinion remains that resolution of the Aniwhenua generation issue should not have taken six years.

[56] Transpower's 110kV single-circuit line to Opotiki serving 6,000 ICPs and 10MVA of load. Galatea is 1,800 customers and 6MVA of load by way of comparison.

The following subsections present Strata's reconsideration of the technical aspects and its original opinion based on its review of the information provided by Horizon in its response to the Commission's s98 letter.

We then provide our consideration of the commercial aspects based on additional information provided by Horizon and information included in its response to the Commission's s98 letter.

Strata has reconsidered the technical aspects relating to its opinion

Strata has reconsidered whether Horizon could and should have done anything more than it did to resolve the reliability of supply issues related to the Aniwhenua connection arrangement. To form our views and opinions, we have considered:

1. the investigations that Horizon took following the transformer failure;
2. the steps Horizon had taken to understand the causes of the issues with the Aniwhenua connection – i.e. the problem that had to be solved;
3. how Horizon developed solutions to resolve the problems, and if these could have been progressed more swiftly;
4. the timing of the solution that Horizon implemented; and
5. why the implementation of the solution did not prevent the 2016 MED.

No evidence of a post event investigation

None of the narratives, letters and summaries provided by Horizon offer a clear overview of the problems that had to be fixed and the steps needed to fix them. The timelines provided by Horizon are scrapbook-like assemblies of 'cuts and pastes' from sections of papers, reports and emails. There is no evidence that Horizon undertook a post event investigation into the transformer failures.

It is possible that Horizon did not do this because the Transformers were owned by Nova. However, such an investigation was critical to Horizon gaining an understanding of the causes and remedies for the loss of Aniwhenua supplies to Galatea. If Nova did not initiate an investigation, then Horizon should have taken the lead.

A key question that the investigation could have addressed would have been; 'after many years of operation, why did the transformer fail at that point in 2009?'. For example, Horizon's letter provided in its s98 letter[57] identifies a change made to the network configuration in 2008:

> *The AMP 2010-2020 also noted that during 2008 the interconnection arrangement at Snake Hill Switching station was altered to improve the operation of the network. The arrangement allowed the Snake Hill circuit to be energised from the Edgecumbe end all the way to Galatea substation.* [58]

Due to the lack of a robust investigation and report, we don't know if the above change contributed to the 2009 and 2011 transformer failures, nor do we know if between 2009 and 2012, Horizon had any understanding of the underlying cause.

Strata considers that, following the first transformer failure in 2009, Horizon, in conjunction with Nova, should have undertaken an investigation to determine the problem and options available to resolve similar future issues. Horizon has provided no evidence that such an investigation took place. Good industry Practice would have been to initiate such an investigation and record findings and recommendations in a report.

[57] Horizon Response to Notice to Supply Information under Sections 98 1 a & b, Page 3

[58] Horizon Response to Notice to Supply Information under Sections 98 1 a & b, Page 3

We have also seen no evidence of a robust post event review following the failure of the second transformer in 2011. Given that the second failure led directly to Nova's refusal to reinstate the Aniwhenua connection, we would have expected Horizon to initiate an investigation at that time. The documents provided by Horizon do not include a report from such an investigation.

In Strata's opinion, the absence of the initial post event investigation has been the root cause of the extended time taken to address the restoration of the connection of Aniwhenua to Galatea. Had the cause been identified following the failure of the first transformer in 2009, it is probable that failure of the second transformer in 2011 could have been prevented.

Importantly, a post event investigation would have established a clear understanding of the problem that Horizon had to address to restore the Aniwhenua connection.

The problem with the Aniwhenua connection

To obtain a clear understanding of the problem, Strata had to review the documents provided in Horizon's response to the s98 letter. The exercise has been similar to piecing together a jigsaw puzzle without access to a picture and with pieces from other puzzles in the box.

The following is Strata's understanding of what the underlying problem was with the Aniwhenua Connection – note that we still do not know why the transformer problems emerged in 2009.

On 9th August 2009[59], a transformer at Aniwhenua hydro power station (Aniwhenua) experienced a failure. The failure was due to the performance of the Horizon network under fault conditions. Essentially, when a fault occurred on the 33kV Snake Hill feeder, the transformers experienced stress linked to the transformer failures.[60] This issue was exacerbated when Horizon undertook fault finding on the 33kV network.

In 2011, the repaired transformer was returned to service and Aniwhenua again became the primary electricity supply for Galatea. Towards the end of 2011, (no specific date was provided in the Horizon documentation), a second transformer failure occurred at Aniwhenua.

Following the second transformer failure, Nova, the owners of Aniwhenua power station, refused to allow its connection for the primary supply to Galatea. Nova did allow short-term use of the connection under specific conditions; this was conditional on Horizon indemnifying Nova for damage to the Aniwhenua transformers.

The first indication we have found of a clear definition of the underlying problem with the Aniwhenua connection arrangement was in an October 2012 memorandum to the Horizon Board[61] which provides the following summary of the problem:

> *Only having one supply available using the Edgecumbe line has drastically increased the exposure to time delays while faults are located and isolated. BOPE are concerned that their transformers are subject to stress each time*

[59] There are conflicting dates for the transformer failure events in Horizon's information (e.g. Horizon timeline gives August 09 as the first failure and 2011 as the second; yet Horizon's public presentation Galatea Public Discussion 21 Feb 2014 gives the first failure as 2008 and the second as 2012).

[60] 2014 Horizon report Protection Settings for EDG-GALA 33kV line reclosers states that *Nova Energy owns the three winding transformers (110/33/11kV) at Aniwhenua and it is believed the fault clearing time and fault finding have been the issues for not allowing Horizon Energy to use this supply*.

[61] 20 October 2012 Memorandum from Peter Till to the Horizon Directors, entitled: Galatea Snake Hill 33kV Reliability Stage One.

> *Horizon closes in on a fault while segmenting the 33kV and Horizon needs to minimise that it is able to minimise this exposure.*[62]

Nova's ongoing concerns regarding the potential damage to its assets under fault conditions were set out clearly in a 2012 email[63] to Horizon's Network Manager:

> *BOPE agree to provide Horizon with 33kV supply to Galatea from Aniwhenua Power Station for approximately 8 hours tomorrow (Thu 29 March) only while key maintenance work is undertaken on the Edgecumbe-Snakehill section of your 33kV line, on the following conditions/understanding:*
>
> a. *Horizon will provide BOPE personnel a debrief of results/findings from line inspections undertaken by Horizon in the Galatea network area*
> b. *To the full extent practicable, Horizon will minimise the duration on BOPE supply*
> c. *BOPE reserves right to withdraw supply option / interrupt supply at any time without notice (e.g. lightening / high winds / storm conditions present/forecast, etc)*
> d. *CB A34 will be set and remain on single shot (i.e. no auto-reclose)*
> e. *CB A34 protection settings have been set to significantly faster earth-fault clearance times (EF Definite Time reduced from 0.7s to 0.1s, the latter being the prior setting back in 1997), increasing Horizon risk of loss of supply from BOPE (i.e. CB A34 protection may operate before Horizon protection)*
> f. *Horizon will not connect any part of Edgecumbe-Snakehill section of line to the BOPE 33kV supply*
> g. *Under no circumstances will BOPE 33kV supply be used by Horizon for network fault-finding*

Sixteen months later, a January 2014 options paper suggests that Horizon was still not certain of the problem it needed to solve:

> *Nova Energy owns the three winding transformers (110/33/11kV) at Aniwhenua and it is believed the fault clearing time and fault finding has been the issues for not allowing Horizon Energy to use this supply.*[64]

In a January 2014 email to Horizon, Nova very clearly stated its issue with reinstatement of the Aniwhenua generation connection:

> *As has been relayed to Ajay, unfortunately due to the high number of historic transformer failures experienced while connected to the local Galatea network and technical concerns raised following an independent review of those failures Nova Energy is not in a position to provide Horizon the requested supply from Aniwhenua Power Station unless Horizon can indemnify Nova for the cost of repair in event we suffer a transformer failure*

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[62] Ibid, Page 1

[63] 28 March 2012 RE_ Connection of Aniwhenua.msg - Nova to Horizon

[64] Aniwhenua supply options_ V1, Entitled: Aniwhenua 33kV Point of Supply to Horizon Energy – Options 28 January 2014

> *while providing the Horizon supply. A further transformer failure would highly likely be an uninsurable event for Nova.*[65]

In 2014, Horizon must have had a clear understanding of the issues with the connection of the Aniwhenua transformers to enable it to propose the following indemnity to Nova:

> *Horizon Energy Distribution Limited (HEDL) agrees to indemnify NOVA Energy (NOVA) against any damage that is caused to its Aniwhenua power transformers as a result of providing a supply to HEDL's 33kV network.*[66]

In Strata's opinion, between 2009 and 2014, Horizon did not take sufficient steps to gain a clear understanding of the underlying issues preventing the restoration of the Aniwhenua connection. In our view, had Horizon established a clear view of the problem, it could have progressed the solution more swiftly.

Horizon's solution for the Aniwhenua connection

In its response to the s98 letter, Horizon states that its 2010 and 2011 AMPs:

> *Demonstrate that Horizon had planned investments for the Galatea supply including switchgear upgrades, the installation of balancing tap change control equipment, new protection and metering in conjunction with substation communication system upgrades.*[67]

Whilst the 2010 and 2011 AMPs discuss a number of upgrades for the Galatea region, neither specifically address the cause of the transformer failure at Aniwhenua nor provide information on any actions to avoid similar future issues.

The first information on the cause and solution to the Aniwhenua problem is given in an October 2012 memorandum to the Horizon Board of Directors.[68] The memorandum noted that the proposed project was not included in the 2011 AMP and:

> *has been brought into focus by the difficulty in obtaining a supply from BOPE's Aniwhenua generating station as a result of transformer failures*

The memorandum sought approval for an estimated $180k capex to:

> *install three reclosers at the Snake Hill site so that supply can be switched between Aniwhenua and Edgecumbe remotely and either of the two lines between Snake Hill and Galatea can be isolated remotely and in most cases automatically.*
>
> *Later stages will provide another three circuit breakers at Galatea, a secure 33kV Bus and better bank protection.*

The benefits envisaged included that the sectionalising of the network would allow faulty sections to be isolated with only partial loss of supply.[69]

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[65] 21 Jan 2014 RE_ Supply from Aniwhenua.msg

[66] 18 Feb 2014 RE_ Indemnity for Aniwhenua Transformer.msg

[67] Horizon Response to Notice to Supply Information under Sections 98 1 a & b, paragraph 18

[68] Board Memo Snake Hill 20121024, Page 1

[69] Ibid, Page 2

A solution is discussed in a 28 January 2014 document entitled Aniwhenua 33kV Point of Supply to Horizon Energy – Options.[70] This document sets out the options to address fault clearing time and fault finding that Horizon considers as Nova's *issues for not allowing Horizon Energy to use this supply*.[71]

The preferred Option 3 in the January 2014 options document essentially sets out the same solution as the 2012 memorandum, specifically:

> *This option involves installation of three reclosers at Snake Hill switching station to provide n-1 supply to Galatea and Kaingaroa substations. This will also isolate the faulty 33kV line during fault on either of the 33kV lines to Galatea without tripping the Aniwhenua A34 circuit breaker.*
>
> *For minimising the impact of fault at Aniwhenua three winding transformers and improving the fault finding, installation of fibre would be required for implementing the line differential protection scheme.*

The 2014 options document concludes that:

> *Basically this option addresses the issue and would clear the downstream faults at Snake Hill reclosers prior to Aniwhenua A34 protection operation.*
>
> *This report specifically addresses the Nova Energy's concern of fault clearing time, low fault levels and fault finding using their supply.*

The 2014 options document also notes that; *the proposal of installing 33kV reclosers at Snake Hill and Galatea had been approved by Horizon Network team and would be installed in near future.*[72]

Despite the proposed solution being recommended and approved, the 2014 options report concludes with the following recommendation:

> *It is to be noted that this report addresses the Nova Energy's issue (believed) of high impact on their three winding transformers at Aniwhenua for faults at Horizon Energy's 33kV network. It is recommended to set up a technical meeting between Nova Energy and Horizon Energy to formally identify the key issue at Aniwhenua.*[73]

Which again indicates that, four years after the first transformer failure, Horizon was still not confident that it fully understood the issues it was trying to solve.

The recloser solution is again discussed six months later in a 10 July 2014 document entitled Edgecumbe – Galatea 33kV line Reclosers Protection settings.[74] The document considered essentially the same solution as that identified in the October 2012 memorandum:

> *network improvements at Snake Hill switching station include installation of three reclosers and two line circuit breakers at Galatea substation*[75]

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[70] Aniwhenua supply options_ V1

[71] Ibid, Page 3

[72] Aniwhenua supply options_ V1, page 5

[73] Ibid, Page 8

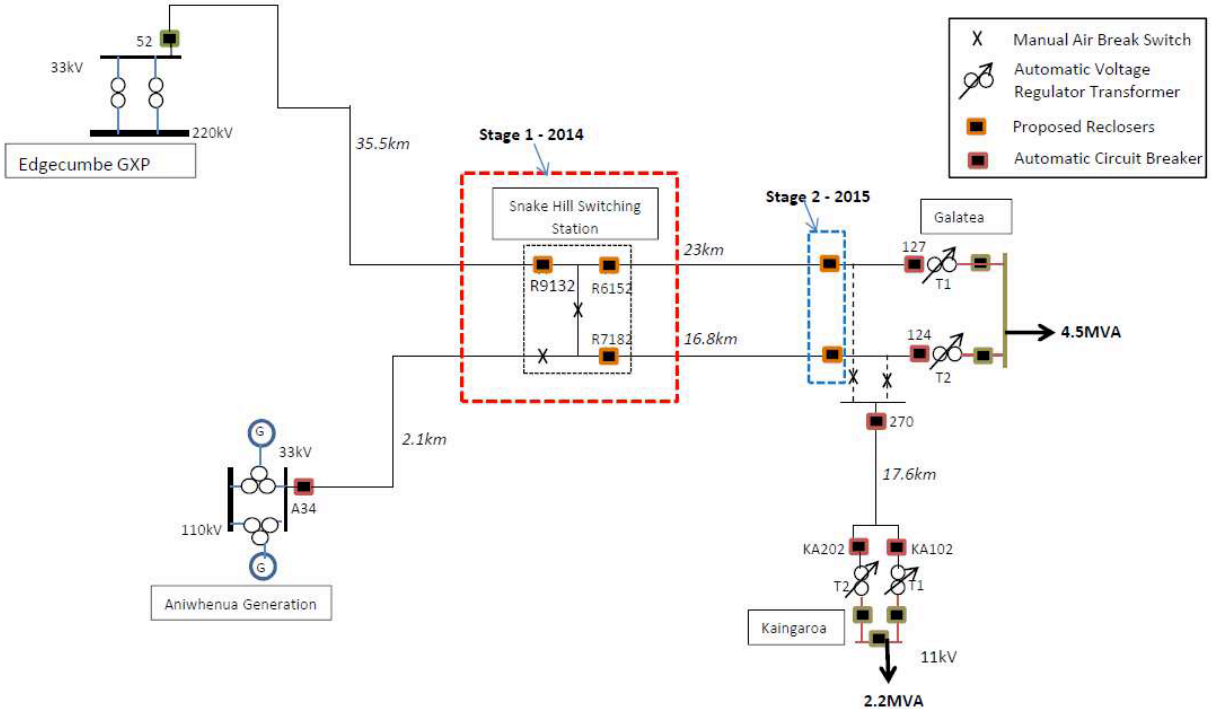
[74] 'Edgecumbe to Snake Hill reclosers Final V4_Nova'

[75] Ibid, Page 2

The 2014 protection setting document notes that *Stage 1 of this project involves installation of three reclosers at Snake Hill switching station and is planned to be completed in 2014.*[76] Stage 2 included:

> *installing two line circuit breakers at Galatea substation. The proposed line circuit breakers would be installed upstream of Kaingaroa tie at Galatea which will allow supplying Kaingaroa from both circuits. The directional protection at proposed line circuit breakers would isolate the faulty line without interrupting supply to Galatea and Kaingaroa substations.*[77]

The 2014 protection setting document included the following diagram that sets out the staged components of the solution:



Source: Horizon, Protection Settings for EDG-GALA 33kV line reclosers

The 2014 protection setting document states that Stage 1 would be completed by the end of 2014 and Stage 2 in 2015.

This indicates that the solution for the restoration of Aniwhenua would have taken less than a year following the finalisation of the option to implement at a cost of approximately $270k.[78]

Commissioning of the preferred solution

The timeline provided by Horizon in its information package notes that on the 16 July 2014:

> *The Snake Hill reliability project has been completed, the control room has SCADA visibility and operation of the three new reclosers. This ties in with*

[76] Ibid

[77] Ibid

[78] Aniwhenua supply options_ V1, Page 7

> *the new 33kV VT's we installed at Galatea in conjunction with the Galatea 11kV switchboard and protection upgrade*[79]

This indicates that the risk issues Horizon had identified as being the cause of Nova's reluctance to provide supply to Galatea had been resolved following the January 2014 options paper and the preferred option installed and commissioned by 16 July 2014.

The timeline also indicates that, had the recommendations of the 2012 memorandum been progressed urgently, the solution could have been implemented in mid 2013. Had this happened, the effects of the 2014 and 2016 MED at Galatea could have been mitigated.

Following the completion of the capital works for Aniwhenua, negotiations for the DGCA appear to have affected the progress towards completing the connection reinstatement. In August 2014, Horizon noted the following:

> *Key Concerns Negotiations regarding the Aniwhenua contract continue with a limited number of remaining issues to be resolved. However Nova Energy are not anticipating being able to provide continuous supply for another 12 months.*[80]

It was a further 16 months before Horizon and Nova signed the DGCA for Aniwhenua on 15 November 2015.

However, Horizon's timeline indicates that the Aniwhenua arrangement was not reinstated until 14 November 2016, which was 27 months after the technical solution had been installed and commissioned and 12 months after the DGCA had been signed.

> *14 November 2016 Secured a permanent 33kV supply from Aniwhenua following negotiations with Nova*[81]

In forming our original opinion, our understanding was that the asset investments required for the reinstatement of Aniwhenua included other work than that completed in July 2014.

Our original opinion was that the action to reinstate the Aniwhenua connection could have been undertaken within the five-year period between 2009 and 2014. Our review of the additional information and documentation provided in Horizon's response to the s98 letter shows that the technical solution was actually completed in 2014/15 and could have been completed at least a year earlier.

Strata's consideration of commercial issues

In its September 2019 briefing paper, Strata set out its understanding that Horizon delayed commencing the Galatea capital investments needed to reinstate Aniwhenua generation connection until it had considered alternatives and engaged with Nova to secure the DGCA. However, the additional information provided by Horizon shows that it did complete the investments needed for reinstating Aniwhenua connection in July 2014.

Further capital works continued after this date; however, the documents provided by Horizon show that these investments were generally for replacement/refurbishment of aged or problematic assets. For example, the project that accounted for $330k of the $1.3m Horizon has invested in the Snake Hill and Galatea network since 2013 was Project 1504 – Galatea 33kV CB Replacements. This project was driven by:

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[79] Galatea Timeline Oct 2019, Row 64 Column F

[80] Galatea Timeline Oct 2019, Row 65 Column F

[81] Galatea Timeline Oct 2019, Row 84 Column F

- assets at programmed end-of-life replacement;
- assets with oil leaks;
- problematic motorised actuators; and
- reliability benefits.[82]

Whilst these investments were made to improve the general reliability of supply to Galatea, they were not required to be completed for the reinstatement of the Aniwhenua generation connection. Strata considers that the documents and timeline show that, from a technical perspective, the Aniwhenua connection could have been reinstated by mid 2015 (this date allows for protection settings and other remaining technical issues to have been resolved).

The documents provided by Horizon reveal that the negotiation of the PDA with Transpower was not a constraint of the reinstatement of the Aniwhenua connection. The original generation embedding agreement for Aniwhenua reached the end of its term on 31 March 2014 and the new PDA was executed on 17 April 2014 with a commencement date of 1 April 2014.

The PDA has a term of 15 years and provides substantial net Avoided Cost of Transmission (ACoT) benefits (approximately $3.7m/year) that are shared between Horizon, Nova and Trustpower. Horizon provided a signed, but undated, copy of its agreement with Nova and Trustpower setting out how the ACoT benefits would be shared. The commencement date of this agreement was 1 April 2014.

The basis of Transpower reducing its charges via a PDA is that the other parties have a lower economic cost option to connecting to the transmission network. The PDA avoids the stranding of Transpower's assets if the lower cost option is implemented. Essentially, Transpower drops its price to the cost of the alternative.

The alternative proposed by Horizon, Nova and Trustpower is set out in a report[83] attached to the PDA. The report shows that the alternative required a redirection and upgrade of the Snake Hill Feeder between Edgecumbe and Matahina. Galatea supply would then be dependent on the connection at Aniwhenua.

There are two issues arising from Strata's reviews of the PDA arrangement:

1. that the negotiation of the PDA and the signing of the agreement did not materially constrain the reinstatement of the Aniwhenua connection; and
2. that Horizon and Nova signed the PDA in full knowledge that the economic transmission bypass option, on which it depended, could not have been implemented in practice at that time[84].

The second issue is not within the scope of this review; however further information on this has been included in an appendix for the Commission's information.

A year after Horizon had completed the capital investments that addressed the Aniwhenua transformer issues, and 18 months after it had signed the PDA, Horizon signed a Distributed Generation Connection Agreement with Nova in November 2015.[85]

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[82] Galatea 33kV Switchgear Project Memorandum, Pages 1 and 2

[83] Prudent Discount Agreement 17 April 2014, Electronet Feasibility Study, Page 4

[84] The PDA and its schedules do not provide any information on the issues with the Aniwhenua connection at that time. However, the Electronet report attached to the PDA *reaffirms that the underlying benefits supporting the physical bypass of grid assets have not changed since the construction and notional embedding of the Aniwhenua Power Station in the 1970's*. Given the issues with the Aniwhenua connection, this statement was clearly incorrect.

[85] Galatea Timeline Oct 2019, Row 79 Column D

Despite completing the required network investments and signing the DGCA for Aniwhenua, it was a further ten months before the Aniwhenua connection was reinstated in September 2016.

The information provided by Horizon to the Commission for this investigation and the publicly available documentation do not provide any details on reasons why the restoration took a further 10 months from the finalisation of the DGCA. The documents and emails provided by Horizon in its response to the s98 letter do not provide any reasons or grounds for the delay.

Whilst the copies of email exchanges indicate some discussion between Nova and Horizon on protection settings, this work could and should have been undertaken much earlier in parallel with other actions. Given the ongoing reduced reliability of supply to the Galatea area, we expected to see a clear paper trail providing very detailed information on, and explanation of, the Board and management's deliberation of the issues. We have not identified such a trail in the information packages provided by Horizon to the Commission.

The absence of a clear, evidence based explanation for the time taken to reinstate the Aniwhenua connection following the completion of the capital works and commercial agreements is concerning.

We have not changed, but have added to, the technical aspects of our initial opinion

Nothing that Horizon provided in its response document packages has changed our opinion that, from a technical perspective:

> *The resolution of the Aniwhenua generation issue should not have taken seven years. In our opinion, the lack of swift progress during the 2009 to 2014 period was the primary cause of the 10 April 2016 MED. In forming this opinion, we acknowledge that Horizon identified, implemented and completed projects that have now improved reliability in the Galatea region.*

In addition, we consider that:

1. in not undertaking a timely and robust post transformer failure event investigation in 2009, Horizon did not meet good industry practice;
2. Horizon could have, but did not identify, install and commission the required solution at the earliest possible date, and because of this, missed an opportunity to mitigate the effects of the 2014 and 2016 MED in the Galatea region;
3. if the capital investments required to reinstate the Aniwhenua connection had been undertaken earlier, the MED in FY2017 would not have occurred. Horizon should have recognised this but failed to do so.

The documents that Horizon has provided clearly identify that the technical solution to the Aniwhenua reinstatement was completed in July 2014, well before the 2016 MED. Yet the Aniwhenua connection was only reinstated in November 2016. The reason for this delay clearly contributed to the impact of the 2016 MED in the Galatea area but Horizon has failed to provide a reasonable explanation or any evidence to support its view that the delay was outside of its control.

In the absence of clear evidence to the contrary, Strata's opinion remains that resolution of the Aniwhenua generation connection issue should not have taken seven years and that Horizon failed to act consistently with good industry practice in its management of the Aniwhenua connection restoration.

Other issues

Strata's views on Horizon's claims of its identification of uneconomic options for supplying Galatea

Strata has not changed its opinion that Horizon's advice to the Commission on options analysis that it says it undertook during 2013/14 was misleading.

Horizon stated that:

> *Horizon did consider alternative options and initiated press releases advising the community of the issue and investigated an alternative which was to build a new line at an estimated cost of $3,800,000 based on independent reports provided to Horizon which equated to $2,100 per customer (1,800) connected for N-1 supply, an uneconomic outcome for consumers (independent report attached). This option came with caveats in respect to timing and assuming the cost benefit was ignored at best it would have taken two years for consent and two years to build as a minimum period. In Horizon's view this option was completely unreasonable to provide this solution as this option did not warrant this quantum of investment.*[86]

As we advised the Commission in our September 2019 briefing paper, the only independent report provided by Horizon was contained in an appendix to the April 2014 Prudent Discount Agreement. The estimated cost of the alternative project in the Electronet report attached to the Prudent Discount Agreement is $3,811,789.[87]

Strata found that the intention of the alternative option in the Prudent Discount Agreement was not to address the supply issues at Galatea. The option was developed to demonstrate that Aniwhenua and Matahina generation could efficiently bypass the transmission network by connecting directly to the Edgecumbe substation and thereby becoming 'embedded' in Horizon's network.

The option developed for the Prudent Discount Agreement did not include upgrading the Snake Hill line to Galatea. It did include upgrading 15km of the Snake Hill line from 33kV to 110kV between Edgecumbe and Matahina. The estimated cost of $3.8m included a 110kV substation at Matahina. The existing Snake Hill line is 35.5km and does not include a 110kV substation. The option considered by Electronet was not an alternative, or even comparable to what was needed to improve quality and reliability at Galatea.

Strata also advises that Horizon's investment of $1.3m to improve the supply reliability at Galatea included the upgrade of old and problematic assets. As stated earlier, the investment required to address the Aniwhenua connection issue was $300k.

[86] Horizon Response to Strata Draft Report 13 August 2019, page 3

[87] Prudent Discount Agreement 17 April 2014, Electronet Feasibility Study, Page 8

Appendix L Defining and measuring Good Industry Practice asset management

L.1 The Commission asked that, when we form opinions on whether Horizon acted in accordance with Good Industry Practice, we should consider whether Horizon exercised a 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.

L.2 Good Industry Practice can be determined through the requirements placed on electricity distributors through legislation, regulations, standards and guidelines.

Requirements of legislation and regulations

L.3 Electricity distributors are subject to a range of legislative instruments (legislation, regulations, standards, and codes of practice) of direct relevance to management of its assets as it imposes certain compliance obligations. These instruments include:

- Electricity Act (1992);
- Commerce Act Part 4;
- Electricity Distribution Information Disclosure Determination 2012;
- Electricity Distribution Services Default Price-Quality Path Determination 2015;
- Electricity Industry Participation Code (2010);
- Energy Companies Act 1993;
- Electricity Industry Act (2010);
- Public Works Act (1981);
- Electricity (Safety) Regulations (2010);
- Health and Safety at Work Act (2015);
- Electricity (Hazards from Trees) Regulations 2003;
- Health and Safety at Work Regulations (various); and
- Resource Management Act (1991).

Requirements of relevant industry standards

L.4 Good industry asset management practice is established with reference to a number of industry standards, including:

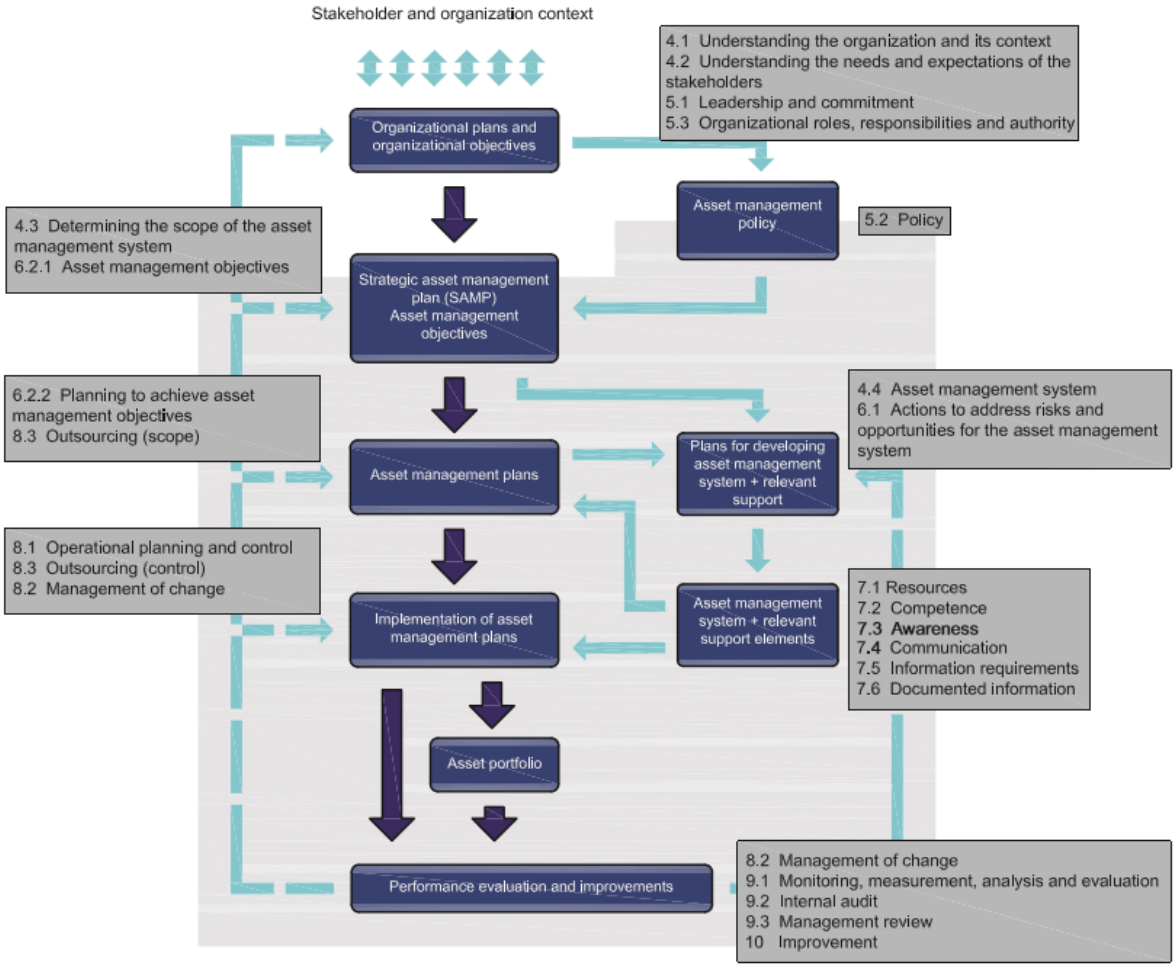
- AS/NZS – ISO55001 – which specifies requirements for an asset management system;
- AS/NZS-ISO31001 – which specifies requirements for risk management;
- AS/NZS-ISO14001 – which specifies requirements for environmental management; and
- NZS 7901 – which specifies the requirements for safety management systems for public safety in the electricity and gas industries.

L.5 There are other standards that apply to specific asset classes, such as AS/NZS 7000 (for overhead line design) and AS/NZS 60076 (for power transformers).

Asset management system

L.6 The foundation of Good Industry Practice in asset management is the development of an asset management system (AMS) which provides '*a set of interrelated and interacting elements of an organisation, whose function is to establish the asset management policy and asset management objectives, and the processes, needed to achieve those objectives.*[95] The diagram below shows the relationship between the key elements of an asset management system according to the internationally-recognised ISO 55000 (Asset Management System) suite of standards.[96]

Appendix Figure 23: ISO 55000 – Asset management system key elements



Source: ISO 55000, section 2.5.1

L.7 Asset management plans (AMP) are a central element of the ISO 55000 asset management system. The Commission has recognised that AMP provide important information on how the

[95] ISO 55000, section 2.5.1

[96] There are also internationally recognised guidelines to complement the ISO 55000 suite, such as the International Infrastructure Management Manual (IIMM)

electricity network businesses intend to manage assets to meet consumer demands in the future. As part of its regulatory role, the Commission reviews AMPs to assess the extent to which they comply with the disclosure provisions of the Electricity Distribution (Information Disclosure) Determination 2012 (as amended in 2017).

Asset management objectives

L.8 Consistent with the principles in ISO 55000, asset management objectives for electricity utilities are typically based on delivering safe, reliable and efficient services to meet the present and future needs of its customers at the least whole-of-life cost. The asset objectives must be consistent with the organisational plans and objectives and the organisation's asset management policy.

Asset renewal decision methodologies

L.9 Good asset management decision making in the context of reliability performance is based on minimising asset life cycle cost by selecting the appropriate action for an individual asset (or 'fleet' of assets). This requires reliable asset data and involves an economic choice between doing nothing and renewing (i.e. refurbishing[97] or replacing) the asset(s).

L.10 Justification for renewing individual assets or asset fleets[98] therefore requires demonstration that:

1. there is an impending need to refurbish or replace the asset(s) (e.g. due to its assessed condition or performance);
2. the prudent and efficient action (i.e. scope and cost) has been selected through options analysis, and is designated to occur at the economically optimum time; and
3. the proposed action (scope, timing, cost) is justified considering broader network plans and the capability of the EDB to deliver the work efficiently.

L.11 Depending on the specific circumstances, the three elements of the decision-making process may be iterative.[99] The principles for establishing that there is a bone fide case for the impending need to retire an asset or asset fleet include:

4. evidence that the asset condition monitoring and assessment is robust (i.e. not biased towards overstating the likelihood of asset failure); and

[97] This is essentially a life extension strategy and includes, for example, reinforcing wooden poles at the base or replacing components such as seals in switchgear.

[98] If the assessment is applied to an asset 'fleet', then there should be sufficient evidence that the condition assessment and assessment of risk of failure is applicable to the asset fleet.

[99] For example, an asset may be identified as no longer being fit for purpose, but after considering the broader plans for the network, asset replacement is not justified because the asset will no longer be required due to network reconfiguration (i.e. the asset can be retired without replacement or refurbishment).

5. for cases in which pending asset obsolescence is cited as the trigger for action:
   - evidence from the manufacturer regarding the expected life, and of service and/or spare parts availability;
   - evidence that asset performance is declining (e.g. defect trends).

L.12 Leading industry practice is to quantify the risk of failure to enable comparison with the cost of the various options. This is typically referred to as condition-based risk management (CBRM), in which the risk calculation is based on combining the probability of failure[100] value with the consequences of failure.[101] Each consequence is given a monetary value. The risk-cost avoided by implementing the project is a benefit that is an input to the economic assessment model along with any additional quantifiable benefits and costs to determine the net present value (NPV) for the project.

L.13 The relative importance of individual assets can be accounted for by defining the 'criticality' of the asset separately in each of the categories. This allows all investment projects to be ranked on the basis of cost/benefit.

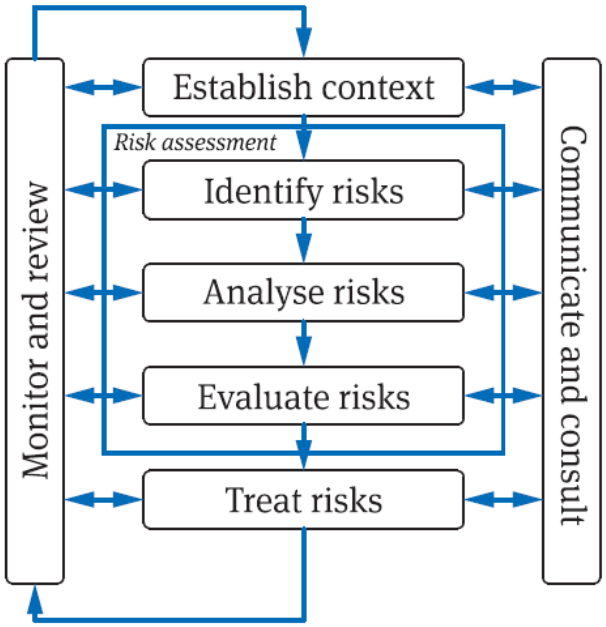
ISO 31000 – Risk management

L.14 A fundamental aspect of asset renewal (and network augmentation) decision-making is risk assessment. The ISO 31000 international standard on risk management is widely referred to as the reference for Good Industry Practice providing a framework and process for managing risk.

[100] The probability of failure of an asset is modelled as a function of time and can be derived from industry experience rather than the organisation's asset history, although calibration of the industry statistics with the organisation's own data is good practice.

[101] The consequences of failure are defined in several categories, typically network performance, safety, financial and environmental and can be derived from industry-wide data rather than just the individual organisation's data.

Appendix Figure 24: ISO: 31000 Risk Management framework



Source: ISO: 31000 Risk Management

Asset Health Indices

L.15 AHI is an asset score which is designed to reflect or characterise asset condition and thus likely asset performance in terms of the asset's role. Different organisations apply different approaches, but a common requirement is a link between the available raw data (e.g. condition monitoring or asset history or maintenance and operational data) through to likely failure modes, or issues which will affect asset performance. The AHI should:

- provide a clear indication of the suitability of the asset for ongoing use; and
- contain objective and measurable characteristics of asset condition (with other factors such as age and location only used in the absence of direct measurable data).

Asset Management Plans

L.16 Asset strategy[102] and the needs identification, options analysis and option selection (scope, cost and timing) for each asset class is typically contained within AMPs (one for each asset class). The asset management plans should identify the operational expenditure (opex) (e.g.

[102] For example, run-to-fail, proactive replacement based on condition, proactive replacement based on obsolescence

maintenance activity) and capital expenditure capex (e.g. replace, refurbish) for each asset class or category.

L.17 AMPs need to be updated regularly to take into account new asset information and to respond to actual asset performance.

Portfolio optimisation

L.18 At an organisational level, the deliverability and affordability of the portfolio of work needs to be assured with adjustments made to the portfolio to ensure the appropriate balance between risk management, efficient delivery, and the impact on tariffs. This is usually undertaken as a 'top-down' challenge of the proposed 'bottom-up' work programme using a decision-support tool based on quantified risk reduction vs cost.

Implementation of asset management plans

L.19 Once the asset management plans are ratified, approved projects need to be delivered according to the agreed scope, time and cost. Good governance includes comprehensive monitoring and control with the organisation instigating appropriate corrective and/or preventive actions to ensure that the planned work is delivered.

Performance evaluation and improvements

L.20 Good asset management practice includes continuous evaluation of the effectiveness of asset management strategies, plans, and implementation in achieving the asset and organisational objectives.

L.21 A valuable source of feedback is post-incident reviews, with the emphasis on failure mode and effects analysis (FMEA).

L.22 From this analysis, and from comparison with Good Industry Practices, organisations should be able to demonstrate to stakeholders that they are investing prudently and efficiently in the network and/or continually improving their methods. This assessment is required across the whole asset life cycle.

AMMAT assessment areas and levels of maturity

L.23 The Commerce Commission requires EDBs to complete and disclose an Asset Management Maturity Assessment Tool (AMMAT) report each time they disclose a full AMP.[103] The AMMAT allows for assessment of an EDBs' asset management practices against recognised Good Industry Practice.

L.24 The AAMAT is a somewhat simplified assessment of the alignment of EDB's asset management systems and practices against the requirements of the PAS 55 Asset Management Methodology[104] which was superseded in 2014 by the ISO 55000 suite.

[103] Under Part 4 of the Commerce Act 1986

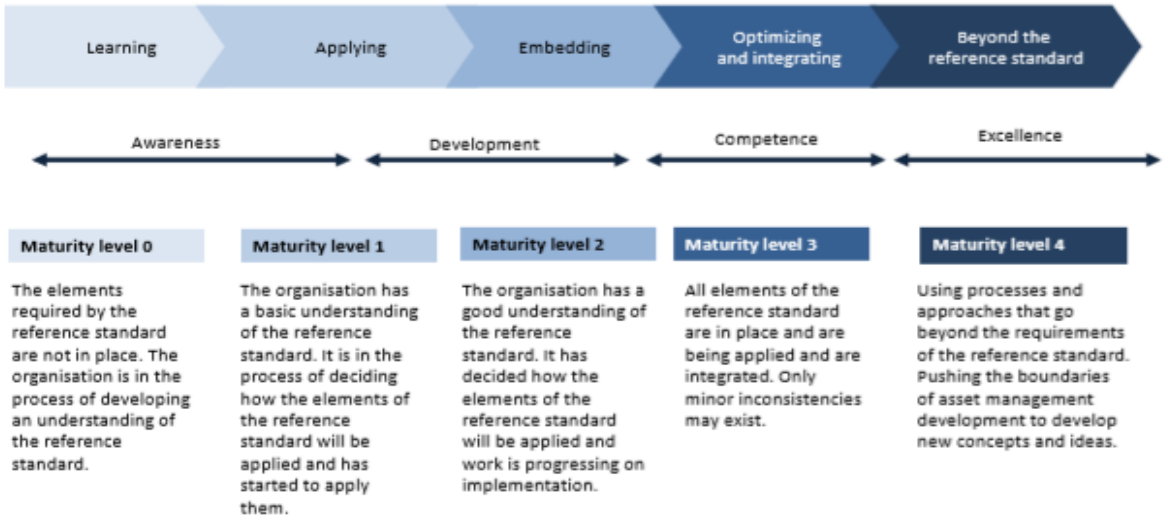
[104] Publicly Available Specification, published by the British Standards Institution in 2004

L.25 The AMMAT consists of 31 questions for which assessment scores are assigned. The questions are designed to cover the full range of asset management activities, designated in Figure 55, via six assessment areas:

- asset strategy and delivery;
- documentation, controls, and review;
- systems, integration and information management;
- communication and participation;
- structure, capability and authority; and
- competency and training.

L.26 The diagram below shows the generic description of the different AMMAT maturity levels.

Appendix Figure 25: AMMAT asset maturity levels



Source: Commerce Commission, How mature are electricity distributors' asset management practices[105]

Assessing if GIP has been applied

L.27 GIP in asset management is not an absolute measurement; as the AMMAT demonstrates, an organisation can be considered to be applying GIP even if some of its practices are assessed as being relatively immature. GIP changes over time as technology, knowledge and systems development mature and improve. For example, whilst it is still possible for paper based asset

[105] Commerce Commission, *How mature are electricity distributors' asset management practices*, EEA Conference and Exhibition, 2013, page 3

records to be used effectively, the adoption of electronic capture, storage and analysis is becoming widely used and accepted as GIP.

L.28 When forming an opinion on whether GIP has been applied, it is necessary to consider all the above instruments measures and scales alongside the practices of others that are considered to operate at GIP. An organisation that demonstrates GIP management in many areas may still be failing to apply GIP in others.