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29 August 2023

Attention: Sean McCready
Commerce Commission
P O Box 2351
Wellington 6140

Email: Sean.McCready@comcom.govt.nz

Dear Sean

INTRODUCTION TO TOP ENERGY LIMITED'S NON-COMPLIANCE REPORTING AS REQUIRED UNDER THE ELECTRICITY DISTRIBUTION SERVICES DEFAULT PRICE-QUALITY PATH DETERMINATION 2020 (DETERMINATION)

Top Energy has not complied with regulated Unplanned SAIDI and SAIFI targets for FY2023. As a result, as required under the Determination, it is required to provide non-compliance reporting to the Commission.

The last two years have seen an unprecedented number of weather events across the network. Notwithstanding these events, the Board has sought to understand the drivers of the breach and what can be done to maintain our historically improving levels of network reliability. Further, the Board has had full discussions and has the full agreement of the Top Energy Trustees around our approach to improving network reliability. This breach has been taken very seriously by Top Energy Management, the Top Energy Board and Trustees. You can be assured that it has our full attention.

Notwithstanding the extreme nature of the weather last year as a result of the following papers, external reviews, and Board discussions, the following actions have been taken:

- Completed extensive data analysis from data mined across all our management systems to determine root causes and ensure our actions are best fitted to the true causes of outages.
- Commenced gathering more complete data on the network through a comprehensive LV data project over the next three years.
- Increased our network spend on vegetation to enable an additional 2 man crew to proactively identify and clear high risk vegetation.
- Revised programmes of work to spend $3m p.a. more on 11kV projects to improve resilience and reliability at this voltage level as worsening performance trends were identified and 110kV and 33kV projects had been previously completed.
- Approved increases in staff numbers over coming years, with a commitment to increase field resources by 12 (23%) over the next 12 months to improve our fault response during severe weather events.

This letter and annexures and the document entitled "Non-Compliance Reporting" and the appendices to it, together constitute Top Energy's non-compliance reporting for the purposes of the Determination.

By way of explanation, the content of this introduction provides information not required to be provided under the Determination, but which the directors consider important to provide to the Commission. In order to provide this information, Top Energy has included and referred to documents in this letter as "Annexures". Some (but not all) of these documents are duplicated in the document entitled "Non-compliance Reporting". All documents attached to the document entitled "Non-compliance Reporting" whether they duplicate the Annexures or not, are each referred to as an "Appendix".

As also required under the Determination, a copy of that report will be uploaded to the company's website.

A background into the last two-years shows:

FYE22 started trending unfavourably from May 2021 through the following months. With such high SAIDI being recorded, focus was applied to the performance and the Board was kept abreast of the situation. Year-end saw SAIDI at 339 minutes. This exceeded the Regulatory Target of 302 but was well under the 380 Cap. SAIFI was under the regulatory limit.

FYE23 With the continued adverse weather, network performance saw us breach both unplanned SAIDI and SAIFI for the regulatory period.

The following timeline shows papers informing the Board of the performance and actions that were taken in response to the unfavourable trends over the two financial years:

August 2021. With the poor SAIDI performance results for the start of the financial year, a "*SAIDI SAIFI Performance Review YE22 to 15 August 21"* (Annexure 1) information paper was produced for the Board. The paper alerted the Board of the performance, analyzed the causes, and projected that TE would exceed the Target but be below the Cap.

November 2021. With the previous August and September results well above target, management initiated both an internal and an independent critical review of the past 2 years unplanned SAIDI including the 6 months to date of that current year. The external review was undertaken by Ergo.

Their report was tabled in November *"Unplanned SAIDI Performance – Independent Review and Remedial Actions"* (Annexure 2*)* along with the internal review/response covered 4 specific questions:

1. What is driving the high unplanned SAIDI figures compared to the declining trend in previous years, e.g. is it more faults, more customers affected, longer repair time, failure of automation, network design.
2. Has faults > 2 SAIDI Minutes changed.
3. What are the root or common causes of the faults and/or high SAIDI impact.
4. What actions should be implemented to rectify the situation immediately and in the future.

The comprehensive report recommendations comprised short- and longer-term initiatives with implementation responses provided by Top Energy to the Board.

April 2022. Following the results of the FYE22 performance and leading on from the Ergo report Top Energy further reviewed how successful the current asset management strategy was, and the findings showed that with no further potential to improve the sub-transmission reliability, they looked to accelerate the reliability of the 11kV distribution network. A paper *"Management of Distribution Network Reliability"* (Annexure 3) provided at the April Board meeting advised that they were seeking endorsement to revise the 11kV network asset replacement and development plan by deferring the Wiroa substation build. The Board endorsed the revision.

May 2022. A paper entitled *"AMP Work Programme Review"* (Annexure 4) was presented to the Board seeking our approval to initiate future 11kV reliability projects to improve the 11kV reliability of the distribution system by deferring the Wiroa substation build. The plan incorporated a number of strategies identified in the Ergo report. The Board approved the initiation of the work.

July 2022. A **monthly** paper entitled "*Network Unplanned SAIDI Including 11kV Project Initiatives"* (Annexure 5) was presented to the Board to provide regular updates on Network unplanned outage performance for each month and included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

The Board requested Management consider if there was value in approaching the Commerce Commission to see if Top Energy SAIDI and SAIFI boundary values and limits are appropriate and would they be more meaningful (and advantageous for unplanned results) if they were set using fault data over the five-year reference period FYE 2018-22 rather than the ten-year period FYE 2010-19. In a paper entitled "*Impact of Reference Period on Normalization",* (Annexure 6) after careful analysis on two options presented the recommendation was the Directors accept the recommendation that Top Energy ensures that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

August 2022. "*Network Unplanned SAIDI Including 11kV Project Initiatives"* (Annexure 7) - A monthly paper was presented to the Board providing regular updates on Network unplanned outage performance for each month and included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

"*AMP Due Diligence Part 1 – Asset Performance and Review"* (Annexure 8) contained a comprehensive review of FYE22 reliability performance broken down into transmission, sub-transmission, and distribution categories. It highlights the worst-served feeders and the improvement strategies assigned to them.

September 2022. A paper *"AMP Unplanned Interruption Targets"* (Annexure 9), was presented to the Board in September seeking approval to reset the internal reliability targets in the AMP (including engaging with the Trust to amend the SCI) after the FYE22 network reliability review paper was presented in August as part of the AMP Due Diligence paper. This reset was sought to amend levels to better reflect current performance under normal weather conditions and include the improvements expected with the 11kV reliability projects approved in May. The Board debated various options and left it to management to come back to them with a recommended option to employ.

"*Network Unplanned SAIDI Including 11kV Project Initiatives"* (Annexure 10) – The monthly paper was presented to the Board, providing regular updates on Network unplanned outage performance for the month and included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

October 2022. Following the September meeting, management presented the *"AMP Unplanned Interruption Update"* paper (Annexure 11) in October. The paper sought approval to reset the internal targets as discussed in September. The summary included customer business behaviours and the impact on customers where price is deemed more important than reliability. The targets presented were based on determined realistic figures across the voltage ranges over the past 5 years, which then have the estimated impact of the 11kV reliability work being undertaken. The Board approved the presented plan.

"*Network Unplanned SAIDI Including 11kV Project Initiatives"* (Annexure 12) - The monthly paper was presented to the Board providing regular updates on Network unplanned outage performance for the month and included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

November 2023 - *Network Unplanned SAIDI Including 11kV Project Initiatives"* (Annexure 13) - The monthly paper was presented to the Board providing regular updates on Network unplanned outage performance for the month and included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

December 2022. A comprehensive paper, *"Unplanned SAIDI – Focus and Actions",* was presented to the Board (Annexure 14), informing us of the focus that had been applied to Unplanned SAIDI in YE's22 & 23. The paper included 13 attachments of papers that had been presented over the periods.

December 2022 to March 2023
Network Unplanned SAIDI Including 11kV Project Initiatives. (Available upon request) - The monthly papers were presented to the Board, providing regular updates on Network unplanned outage performance for the month. They included progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade.

August 2023 *"AMP Due Diligence Part 1 – Asset Performance and Review" (*Annexure 15) is included as it includes a comprehensive internal review of FYE 2023 reliability.

Last year was an exceptional year for extreme weather events. Analysis by NIWA indicates that we had the most extreme weather days and 2nd most extreme precipitation days since records began in 1940. As well, an analysis of the number of coincident strong wind and very wet days is also instructive. The results show that the incidence of such days was around two-to-three times higher and up to ten times higher in the past regulatory year than over the previous 4 regulatory years.

I have attached their reports for your information (Annexure 16) – Niwa Extreme Weather Days and (Annexure 17) – Niwa Complimentary Weather Analysis.

As you can see from this programme of work, this breach is and has been taken very seriously by both Top Energy Management and the Top Energy Board, and you can be assured that it has our full attention.

David Sullivan
Chairman
Top Energy Limited

Annexure 1

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Memo to	**Richard Krogh** **Nicole Anderson** **Jason McDonald** **David Sullivan** **Simon Young**
From	**Russell Shaw**
Date	**August 2021**
Subject	**SAIDI SAIFI Performance Review YE22 to 15 August**

Purpose

This is an information paper. The document is to inform the Board of the analysis, decisions and direction being taken by Network management to remediate current unplanned SAIDI and SAIFI performance forecast.

Background

Network reliability performance FY22 has not commenced well with both the unplanned SAIDI and SAIFI metrics behind where they would be expected at this stage of the year. Projecting forward to end of year results suggest that the internal SAIDI targets will be exceeded by some margin, and total SAIDI for the year will be above the Regulatory Target but well below the Regulatory Cap. SAIFI will also above target but will be well below the Regulatory Limit.

FY22 Current Network Performance

Excluding April's Unplanned SAIDI result (good), the other months of this financial year (April to 15 August) shows Network unplanned reliability performance has been worse than budget, therefore assuming subsequent months will be on budget, we are projecting the Regulatory Target for unplanned SAIDI at year end will be exceeded by approximately 30 SAIDI minutes but be well within the Regulatory Cap.

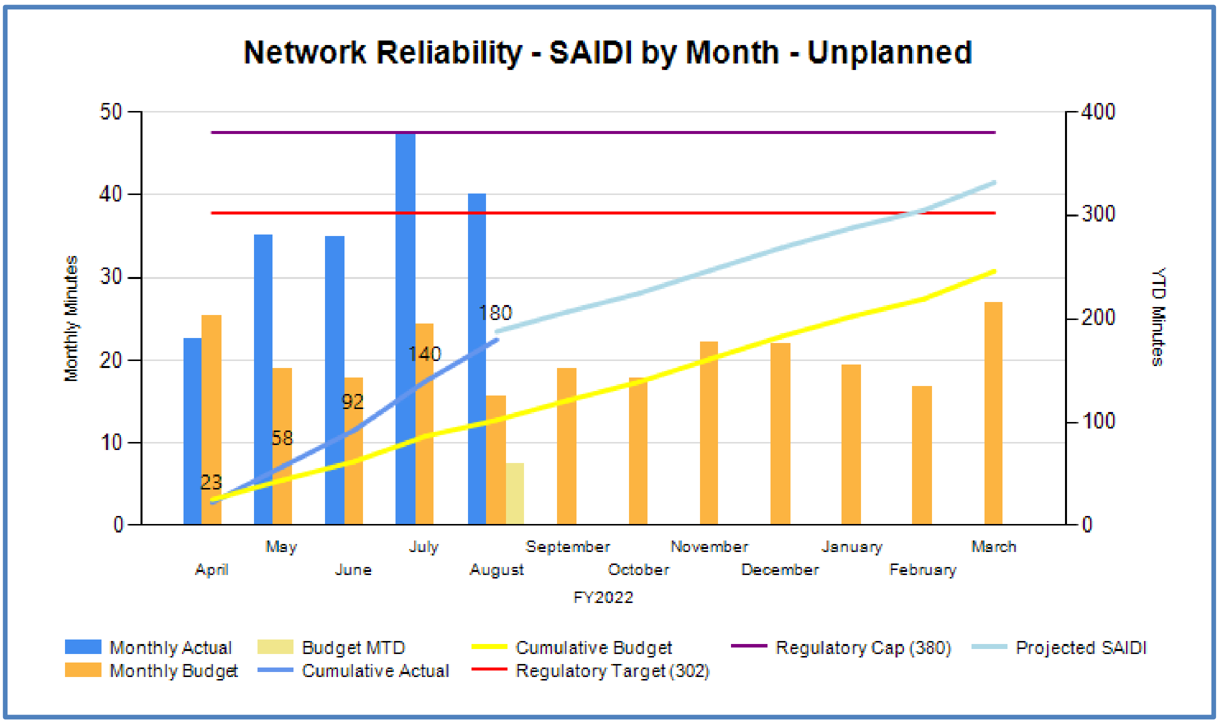
SAIFI is also tracking higher than budget and assuming subsequent months will be as budgeted the Target for unplanned SAIFI at year end will be exceeded by around 0.636 SAIFI outages, but well within the Regulatory Limit. (Table 1 below).

YE22	Budget	Projected	Regulatory Target	Regulatory Cap
SAIDI	246	332	302	380
SAIFI	2.98	3.616	NA	5.07

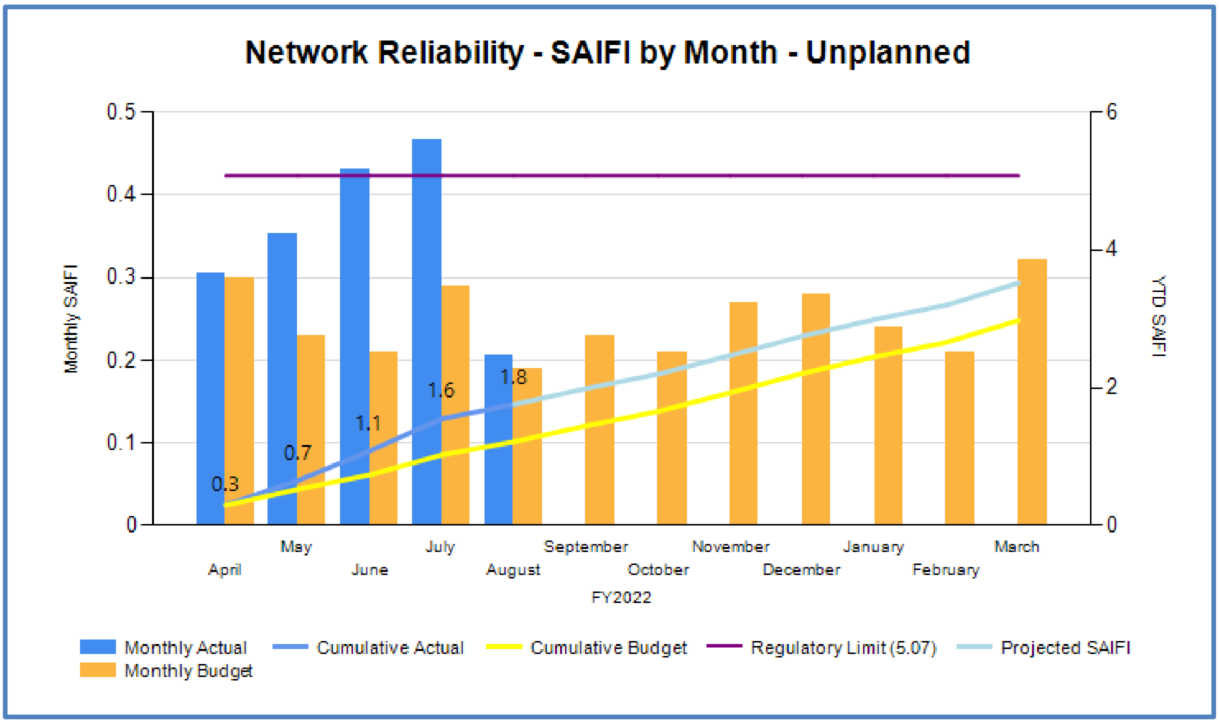
Table 1: Projected versus Target

This is the second regulatory period where planned and unplanned outages have been disaggregated with planned outages no longer contributing toward performance against annual regulatory targets if unplanned SAIDI performance is poor. It will be very difficult to claw back the divergence between the budget line and the year-to-date actual performance as unplanned outages are difficult to predict and mitigate against in the short term.

For monthly results to date refer to Graphs 1 and 2 below.



Graph 1: Network reliability – SAIDI by Month. Unplanned



Graph 2: Network Reliability SAIFI Unplanned

YTD (August 15th, 2021) has seen 187 unplanned outages. 26 of these were greater than 2 SAIDI minutes totalling 120.5 minutes (not normalised). The number of these events is slightly higher than the previous year as demonstrated in the following table.

FIN Year	April	May	June	July	August	Total
2021		2	6	9	3	**20**
2022	3	6	5	7	5	**26**

Table 2: Over 2 SAIDI minutes Incidents by Month

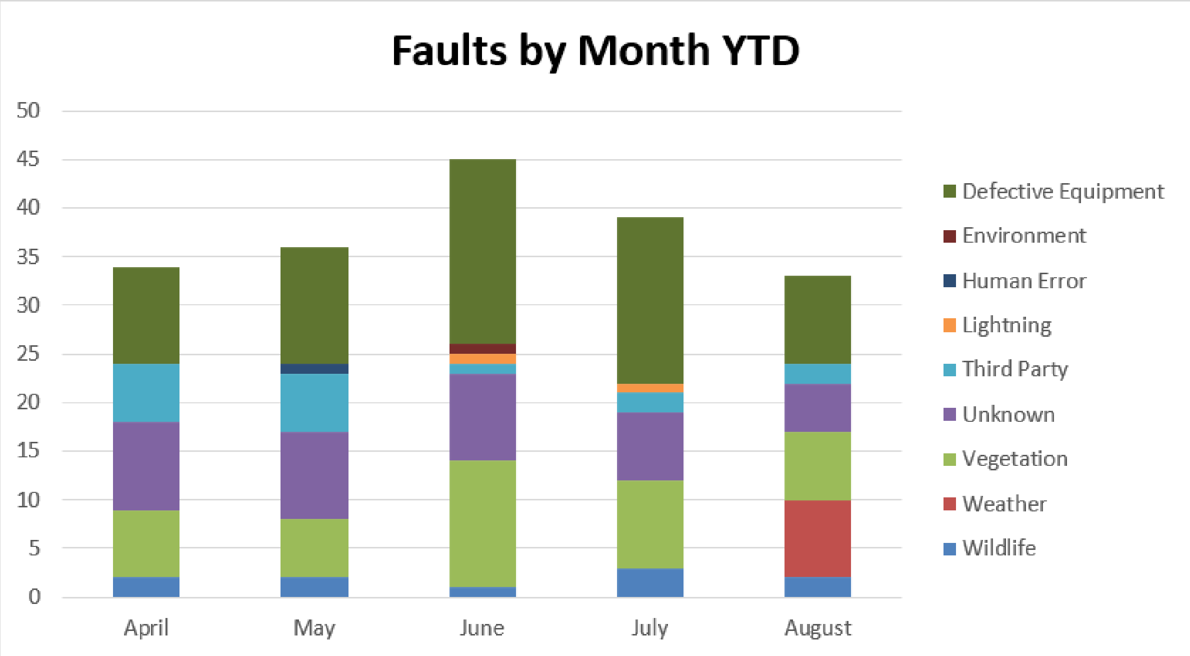
In August 2021 there was a SAIDI major event with normalisation as shown in Table 3 below.

INCIDENT	START DATE	CAUSE	INCIDENT DESCRIPTION	SAIDI Original	SAIDI Normalised
INCD-8560-F	03/08/2021 04:53	Unknown	RUNARUNA ROAD, S1003 Trip	1.12	0.582
INCD-8566-F	03/08/2021 09:25	Tree (Fall on line)	PAWARENGA ROAD, tree on line	3.02	0.582
INCD-8581-F	03/08/2021 10:34	Storm	T03138 Structure, KOHUMARU ROAD	1.49	0.582
INCD-8587-F	03/08/2021 12:25	Corrosion/Rot	SH12 OMANAIA, broken suspension insulator	1.46	0.582
INCD-8593-F	03/08/2021 11:28	Storm	Conductor down, WHANGAPE ROAD	0.82	0.582
INCD-8596-F	03/08/2021 14:49	Tree Contact	FAR NORTH ROAD, Branch on Line	1.07	0.582
Grand Total				**8.99**	**3.49**

Table 3: SAIDI and SAIFI Major Events

Fault Count

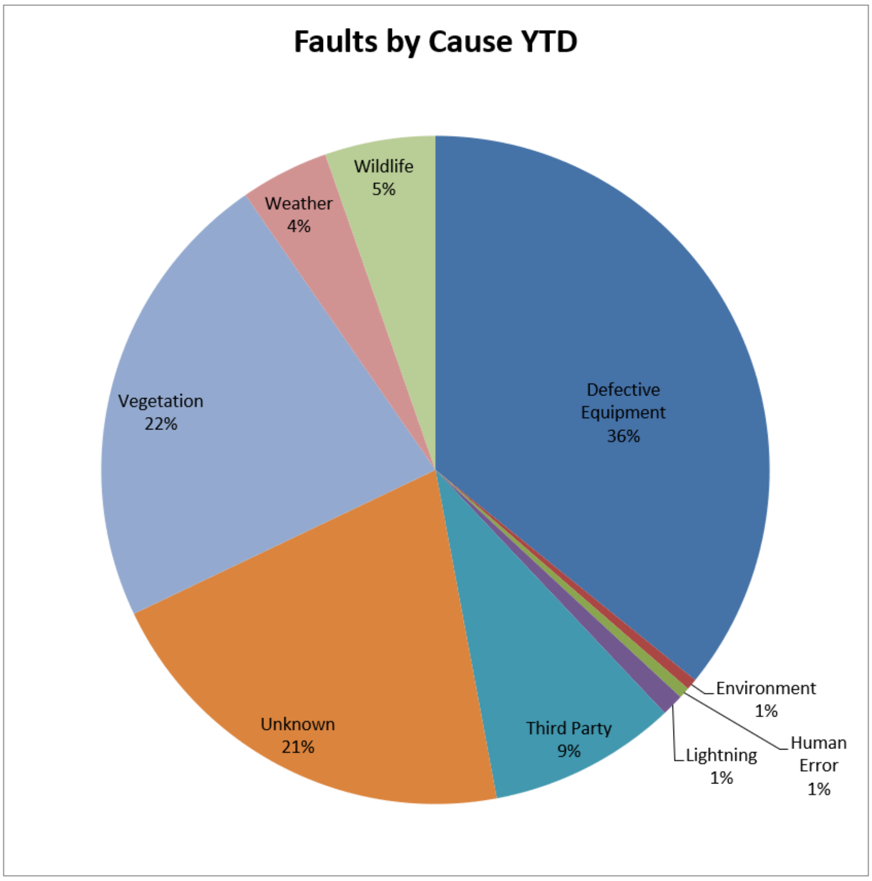
Analysing fault count is useful to determine the prevalence of fault causes. It is far easier to determine and address the high likelihood events than to predict where and when a low likelihood event will occur. Incident count indicates a consistent pattern of fault numbers and mix of faults by fault cause.



Graph 3: Number of Incidents by Month by Cause

Faults by Cause

Comparing this year's (YE22) SAIDI performance to date against historical SAIDI (last 10 years) by Fault Cause and as a percentage of total SAIDI, categories have tracked fairly consistently with previous years. The graph below shows the faults by cause YTD.

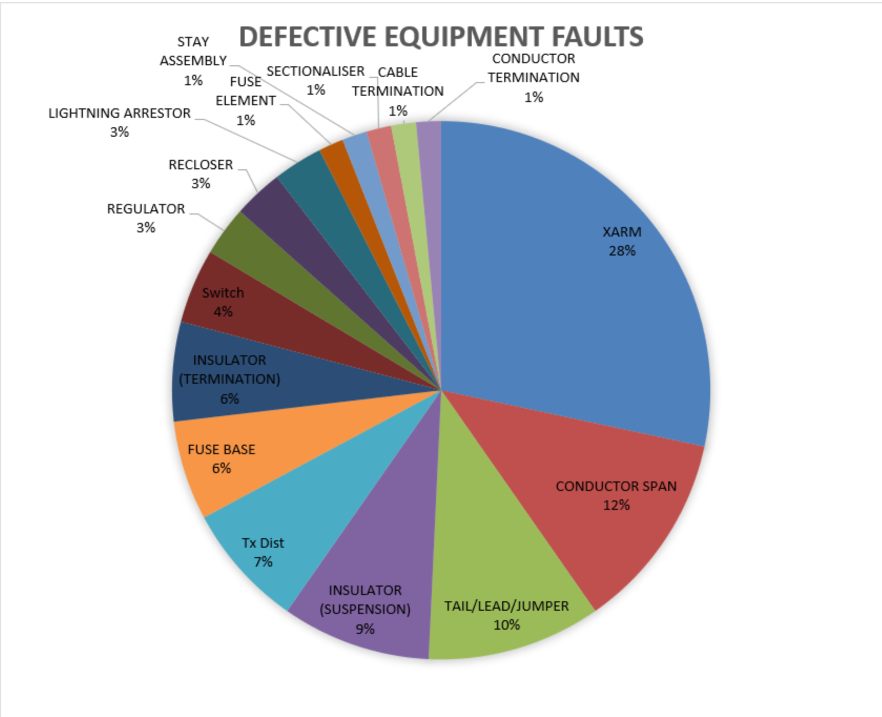


Graph 4: Fault by Cause YTD

Faults of Unknown Cause
There have been three unknown faults over 2 SAIDI minutes – Kaitaia 33kV, at 11.4 SAIDI minutes and Kaeo and Taipa, totalling 17 SAIDI minutes. The further number of smaller outages (35) for which a cause has not been found have accumulated to produce the result of 21% fault by cause year to date totalling a further 13.6 SAIDI minutes. This is despite the effort trying to establish the reason for the outages. Unknown cause faults were scattered around the network with no obvious pattern to them.

Weather
As with last year the Network generally stood up well to the storm events that have presented so far in YE2022, the exception being the weather front at the beginning of August affecting the Far North where we experienced severe weather including sustained periods of high winds resulting in a SAIDI count of 32 minutes, (normalised to 26.5 minutes). A lightning storm did contribute 3.7 SAIDI minutes during June.

Defective Equipment
Defective equipment makes up the majority of unplanned outages (36%). Equipment failure as a category in outage summaries includes conductor, crossarms, insulators, poles as well as discrete plant including transformers, switches, circuit breakers and the like. To analyse defective equipment further it is broken down to component or assembly level as represented in the following graph. This enables us to determine the main contributing equipment failure types.



Graph 5: Defective Equipment by Type

Cross-arm Assembly Failure
At 28%, crossarm failures are the leading cause of outages due to defective equipment. These failures were distributed all over the Network and were not attributable to any area, feeders, or particular weather event.

Insulators are a component of cross-arm assemblies. Of note, six faults were due to suspension insulators failing which has contributed 9.3 SAIDI minutes to date. These insulators are normally used on large spans and often in remote areas. The failures were random across the network; however the components are of a similar vintage.

Generally cross-arm defects are not seen from the ground-based visual inspections and it has been recognised that cross-arm failures need to be addressed. This has been planned over the long term as parts of the Network are rebuilt and so will continue to feature in incident reports in the medium term.

Conductors
Conductor failure has been examined at length as there is always the thought that they fail due to age and condition. Most conductors stand up well in service and it is predominantly vegetation that causes conductor to fail, with a study across the network last year showing 67% of conductor failure is due to vegetation. The majority of trees that cause the damage are outside the regulatory zones, but within falling distance of the lines.

Tail/Leads/Jumpers
With many thousands of conductor joints and terminations across the network at all voltages, failures of these components are a common occurrence. The joints and terminations are categorised in the Asset Management Plan in Overhead Conductor. Failure is generally due to loosening or corrosion of the joint or connection, or failure when subjected to fault current. Substations and critical lines are subject to periodic heat or corona inspections; however the majority of joints are only visually inspected during line patrols and are considered as run to failure components.

Responses to the results
Although the Network performance so far in 2022 has trended higher than budgeted, we are not noticing any major deviation from trends by cause and being only slightly higher by count for incidents over two minutes compared to this time last year.

With unknown faults we continue to try and determine a fault cause in every instance, although this is not always successful.

We have a robust process to ensure that all outages greater than 2 SAIDI minutes are reviewed, to identify improvements to our response and implement procedures to mitigate future reoccurrence. This includes control room actions, information, communications, and field staff response.

Also due to the higher trends, huge focus has been put on resilience through reporting and managing known operational devices and technology problems that can directly affect SAIDI and SAIFI. A working group comprising Network, Contracting and ICS has formed to ensure procedures and processes are in place to capture and record all outstanding issues so that they are resolved, and failed devices are repaired with priority.

As has been previously stated, replacement programmes for pole top hardware are firmly embedded in the Asset Management Plan; and crossarm and insulator replacements on distribution lines have commenced and will be ongoing for the foreseeable future. With the random nature of pole top failures, the replacement programme will not have a significant impact on SAIDI reduction or the reduction in the numbers of outages from this cause in the short to medium term.

Conductor replacement programmes continue, however most conductor failure is due to other causes, (predominantly vegetation). Therefore, the programme is specifically targeted at particular conductor types that are known to show age embrittlement and corrosion and are inclined to fail such as copper and steel conductors.

Vegetation practices have been well established and are producing expected results. A report submitted to the Board last year (AMP Due Diligence Asset Performance and Review Part 2) showed that approximately 20 SAIDI minutes could be saved per annum through reducing tree contact events. In order to achieve this, we would need to increase vegetation spend by an additional $1.5m per annum for 5 years. Total vegetation expenditure over that period would be $3.3m p.a. and to continue to be successful, rely on legislation changes or enforcement to ensure the owner pays in the future or the gains would not be ongoing.

Such expenditure would leave $4m for everything else. The conclusion was that the option was unrealistic. The asset management strategy and work programme we have in place with vegetation work has been developed to provide the optimal balance between levels of expenditure, safety and performance outcomes and the recommendation still is that we carry on with the robust practise currently in place whilst continuously monitoring and analysing network performance and any pending changes in legislation.

In summary we are predicting that provided the rest of the year follows near to the budgeted figures the Regulatory Target for unplanned SAIDI will be exceeded by around 30 SAIDI minutes but well below the Regulatory Cap; with SAIFI finishing higher than budget but still well below the Regulatory Limit at year end.

Recommendation
That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Annexure 2

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Memo to	**Richard Krogh** **Jason McDonald** **David Sullivan** **Nicole Anderson** **Simon Young**
From	**Russell Shaw**
Date	**November 2021**
Subject	**Unplanned SAIDI Performance - Independent Review and Remedial Actions**

Purpose

This is an information paper to advise the Board of the actions taken to ensure all measures are being put in place to understand and stem the unplanned network outage performance this financial year.

Background

Unplanned SAIFI results have been trending downward for a number of years as resilience has been built into the network and network sectionalising has reduced the numbers of customers affected by a fault outage. FY21 was a particularly good year for SAIFI with the lowest unplanned for 10 years. SAIDI however came in just under the Regulatory target of 302 minutes, however that total did include a single protection failure at Kaikohe substation and an operational failure also at Kaikohe contributing 31 SAIDI minutes on their own.

This year has seen a spike in unplanned SAIDI minutes on a monthly basis. With the high trends, a SAIDI - SAIFI Performance Review YE22 to 15 August was presented to the Board in August where we predicted that provided the rest of the year followed near to the budgeted figures the Regulatory Target for unplanned SAIDI would be exceeded by around 30 SAIDI minutes but well below the Regulatory Cap; with SAIFI finishing higher than budget but still well below the Regulatory Limit at year end. However August results ended very high at 28.695 minutes which was 13.185 minutes above budget.

September results also finished high at 70% above budget with the circumstances to date prompting an independent critical review of the past 2 full years unplanned network outage performance and including the six months of this financial year.

Method

Due to the unplanned outage performance to date for this financial year Top Energy initiated external and internal reviews. The results of these reviews, recommendations and actions are covered below.

External Review

Top Energy engaged Ergo Consulting to undertake a critical unplanned outage review. Ergo were asked to analyse and review fault data spanning the 2 previous financial years as well as this year's performance and provide recommendations on:

1. What is driving the high unplanned SAIDI figures compared to the declining trend in previous years e.g. is this more faults, more customers affected, longer repair time, failure of automation, network design.
2. Has faults > 2 SAIDI minutes changed.
3. What are the root or common causes to the faults and/or high SAIDI impact.
4. What actions should be implemented to rectify the situation, immediately and in the future.

Report

The report analyses the outage types and the worst performing feeders, concluding that unplanned SAIDI appears to be trending upwards due to:

- Defective equipment on the distribution network
- Vegetation related outages
- Unknown events
- Weather

Ergo recommends initiating a programme that focuses on the worst performing feeders stating that they expect the benefits will not be immediate and only become evident over the long term, in the same manner as the benefits associated with the YE020 Project.

The recommendations are made up of short- and long-term initiatives. The short-term initiatives will be implemented with the longer-term suggestions incorporated and prioritised in the AMP to see what projects both this financial year and the following years need to be reprioritised to accommodate the targeted feeders.

Recognised recommendations and Top Energy responses are:

Recommendation	Response	Implementation
Install more reclosers and sectionalisers to reduce consumer outage numbers	Project created to re-purpose reclosers and sectionalises in order to further improve the reliability and security of the Network. This project will link the devices back to ADMS	Stage 1 - Issued for installation during FY-22 Stage 2 - Six reclosers which are being removed from Waipapa Substation (ex 11kV feeders) will be available for use on the worst performing feeders. This will be completed during FY-23
Installing additional line fault indicators (identify fault locations and reduce restoration times)	Project underway for the assessment of locations and subsequent installation of fault indicator devices to improve fault location times.	Implementation during FY-23 Provision will be made for subsequent financial years if required

	This project will also revisit recent assessments of fault indicator device requirements and install a number into key locations on the Network and link back to ADMS	
Higher levels and/or more focused vegetation management	Focus has been put on the worst performing feeders through patrolling and rectification	Immediate
Targeted replacement of equipment reaching end of life (particularly cross-arms)	FY-22, divert some funds from wood pole replacement project to replace cross-arm on worst performing feeders FY-23, Reprioritise fund allocation for replacements of pole assemblies and cross arms focussing first on worst performing feeders as identified in the report	Implementation, remainder of FY-22 Implementation, FY-23 (then ongoing)
Installation of additional feeders	Although additional feeders are not part of the 10-year plan, projects have been identified to create back-feed interconnection between feeders to improve security of supply With feeder interconnection coupled with additional reclosers and sectionalises installed in feeders these methods contribute to reducing consumer outage numbers in a similar manner as the installation of additional feeders taking into account price quality balance	Implementation FY-23 (then ongoing)
Upgrading existing lines	Various projects identified for pole replacements and hardware refurbishment to improve reliability including conductor upgrade of identified feeders	Implementation during FY-23 (then ongoing)
Ongoing use/expansion of ADMS to improve information	Install Distribution Power Flow	FY23

management and implementation of distribution automation)	Adaptive Power Restoration System (automatic) & Switching Advisor (initially 3 feeders for trial)	FY25
Investigate the underlying reasons for the increasing unplanned SAIDI minutes reported as unknown	This action cannot be retrospective as we failed to establish an outage cause. Going forward it is imperative that the cause for unplanned outages are discovered	Immediate . A detailed written instruction has been developed covering line patrolling to upskill field operatives - Roll out December 21
Investigate the underlying reasons for the increasing unplanned SAIDI minutes reported as Vegetation data infers restoration times associated with Conductor span are increasing	Recent data for these outages will be analysed to understand whether there is a reason that can be determined that may focus change or practises to stop the occurrence rather than speed restoration/repair times	Operations and Planning teams to investigate and determine outcome by April 22
Detailed investigation and reporting of all unplanned SAIDI events that exceed 1 minute	We have reviewed all of the faults over two minutes and implemented recognised improvements. Our goal is to not only investigate > 1 minute but all outages	Awaiting control operator appointment – March 22 implementation

Internal Review
Top Energy carried out an internal review of actions that will focus on and improve the unplanned SAIDI minute trend.

2 SAIDI minutes are recorded investigation and findings actioned, documented & rolled out
We have gone back over the faults over 2 SAIDI minutes and completed the reviews that were missed due to changes in management. The revision includes implementing and recording outcomes from the reviews which have included registering faulty field devices and rearming a feeder section. We are currently in the process of putting the reviews in Assura to enhance reporting, including dashboard viewing. – *Complete.*

Review the calculation methodology relating to SAIDI, in relation to major SAIDI/SAIFI events
Management have reviewed the calculation methodology relating to SAIDI, in relation to SAIDI/SAIFI major events to ensure that all allowances are recognised, as per the current methodology set out in the Commission's 2020 DPP Determination. – *Complete.*

There has been one major SAIDI event and no major SAIFI events this financial year. The major SAIDI event occurred on 3rd August and was made up of outages due to bad weather. Our review found that two of the individual interruptions within the 24-hour period were not correctly normalised. Our normalisation model has now been updated so this should not be an ongoing issue. Correction of this error reduced the normalised SAIDI for August by 20.7 minutes.

Protection study and implementation - Ongoing
This study, due to come out in November has been assigned to an engineer and findings will be prioritised and actioned promptly. The actions include checking all substation feeder and field device settings. – *Ongoing*

Field response

1. For feeder faults - dispatch the closest resource that can be made available by looking at smart track and discussing with Contracting supervisors. From a contracting perspective all staff participate in afterhours calls, so they are competent to assist with patrolling or switching. A communication will be put out to staff that they could be called away to assist in power restoration during normal hours provided they leave the site they are working on in a safe condition. If Contracting have staff involved on shuts, they will be expected to release 1 person to start the fault-finding process - *Implemented*

2. For afterhours especially in the Southern region we will consider calling the rostered Technician out to assist with feeder faults when deemed necessary – *Implemented*

3. In the interim Contracting will put vegetation staff on call after hours as many faults have been vegetation related. They can also be utilised to assist line teams in emergency situations (non-electrical work) - *Implemented*

Network constraint due to faulty field devices
To ensure these devices are treated as priority a new fault category has been created to list the devices for repair/replacement. This ensures that they do not sit as defects and will be promptly attended.

Control response including Dispatch

1. Concentrate on reinstating 11kV first including 11kV backbone before reinstating any 11kV spurs/ends of line or 230/400V - *Implemented*

2. Consider in all cases limiting the outage area by opening jumpers or for large areas cutting in breaks - *Implemented*

3. Consider adequacy of field resource response in each fault and escalate for more responders as necessary - *Implemented*

Recommendation
That the Directors accept this paper for information.

Russell Shaw
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Network Reliability

Unplanned SAIDI Review

Top Energy

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ERGO CONSULTING

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Revision details

Revision	Details
A	Issued for client comment
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Table of Contents

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List of Tables

List of Figures

1. Executive Summary

Top Energy Ltd (TEN) owns and operates the electricity network in the northern most part of New Zealand's North Island. The network comprises some 4,500 kilometres of overhead and underground lines and cables, which services over 31,500 power consumers in an area that covers some 6,822 square kilometres throughout the Far North region.

Over the period 1999 through 2020 TEN's reported SAIDI has varied significantly, with its annual SAIDI (planned and unplanned) varying from 329 minutes (2001) to 1,838 minutes (2015) with an average of 575 minutes. In the last decade, in an effort to stabilize its SAIDI performance, TEN has invested a significant amount of capital on its network. This expenditure was formulated in its TE2020 Project that has mostly focused on its sub-transmission network. The TE2020 Project has yet to be completed.

TEN's year ending SAIDI results for 2021 (YE2021) came in just under the Regulatory Target of 302 minutes, and although April of the current year (YE2022) started out well the SAIDI results for the ensuing 6 months to September have well exceeded the budgeted values. If the present trend continues there is a possibility TEN will breach its Regulatory Cap of 380 minutes for YE2022.

Given the above backdrop, TEN engaged Ergo Consulting (Ergo) to undertake a critical review of its unplanned network outage performance over the past two full regulatory years (YE2020 and YE2021), including the six months of this regulatory year (YE2022) which includes the period 1st April 2019 to 30th September 2021. This report documents Ergo's findings and recommendations.

1.1 Findings

The following summarises Ergo's investigations of TEN's YE2020/YE2021/YE2022 unplanned SAIDI data:

- TEN's sub-transmission network[1] has contributed ≈15% to its unplanned SAIDI performance. There is evidence that sub-transmission SAIDI has trended downwards during the period, which infers that the TE2020 Project is delivering value.
- TEN's distribution network[2] has contributed the vast majority of ≈85% to its unplanned SAIDI performance.
- The unplanned SAIDI in TEN's network during YE2020 and YE2021 was of a similar magnitude.
- The April-September YE2022 data infers that the final year-end unplanned SAIDI could be higher than the unplanned SAIDI recorded in YE2020 and YE2021.[3]
- Over the period YE2020/YE2021/YE2022 the following are the outage types that have contributed to TEN's unplanned SAIDI:
    - *Defective equipment* (39%).
    - *Vegetation* (22%).
    - *Third Party* (18%).
    - *Unknown* (12%).
    - *Weather* (3%).
    - *Human Error* (2%).
    - *Wildlife* (2%)

[1] 110kV and 33kV.
[2] 6.35kV, 11kV and 22kV.
[3] This view is based on doubling the six months of YE2022 SAIDI and the fact that the unplanned SAIDI over the months of April-September in YE2020 and YE2021 contributed 38% and 49% respectively to the year-end totals.

  - *Lightning* (2%).
  - *Environment* (0%).
- Over the entire YE2020/YE2021/YE2022 period the five worst performing sections of TEN's network have been associated with the following substations (in order of poor performance):
  - Kaikohe.
  - Okahu Rd.
  - Taipa.
  - Pukenui.
  - Omanaia.
- Over the entire YE2020/YE2021/YE2022 period the five worst performing feeders on TEN's network have been (in order of poor performance):
  - **Tokerau feeder** (CB1205) fed from the Taipa zone substation. A high proportion of unplanned SAIDI on this feeder has been due to *defective equipment*.
  - **South Road feeder** (CB1105) fed from the Okahu zone substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *vegetation* and the unplanned SAIDI is trending upwards.
  - **Te Kao feeder** (131142) fed from the Pukenui zone substation. A high proportion of unplanned SAIDI on this feeder has been due to *defective equipment* and the unplanned SAIDI is trending upwards.
  - **Horeke feeder** (CB0111) fed from the Kaikohe zone substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *defective equipment* and the unplanned SAIDI is trending upwards.
  - **Oruru feeder** (CB1206) fed from the Taipa substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *vegetation* and *third party* and the unplanned SAIDI is trending upwards.

  Collectively the above five feeders contributed 36% of TEN's unplanned SAIDI.
- Over the entire YE2020/YE2021/YE2022 period the top five equipment categories that have contributed to 71% of TEN's unplanned SAIDI are (in order of magnitude):
  - **Conductor span (28%)**. The major causes of outages in this category (70%) relate to vegetation *Tree (Fall on Line)* and *Tree Contact*. The SAIDI minute contributions of this category appears to be trending upwards due to the number of events and the time to restore.
  - **Pole (17%).** The major cause of outages in this category (88%) related to *Vehicle-vs-Pole*. This category appears to be trending downwards.
  - **Unknown (11%).** As the category name indicates the cause of the SAIDI events is unknown. The SAIDI minutes due to this category appears to be trending upwards, although the number of events has trended downwards.
  - **X-arm (10%).** The major causes of this category are *X-arm Failure* and *Corrosion/Rot.* The SAIDI minutes appears to be trending upwards. The time to restore has trended downwards, but the number of failures appears to be increasing.
  - **Tail/Lead/Jumper (5%)**. The major causes of outages in this category are *Conductor Tail Blown Off*, *Conductor Failure* and *Joint Failure*. This category appears to be trending downwards.

- There is clear evidence that the SAIDI contributions of the higher value unplanned SAIDI events (i.e. 0.5 minutes to 5 minutes) have been larger in YE2022 than in the previous YE2020 and YE2021 periods. This is demonstrated by the fact that the 90th percentile YE2022 SAIDI event contributed 2.7 minutes as opposed to 2.0 minutes in YE2020 and 1.6 minutes in YE2021. We note that this increase is not clearly demonstrated in the event restoration/repair times and the data indicates that the majority of outage types that have contributing to the increase in the higher value SAIDI events during YE2022 are as follows:
    - *Weather*.
    - *Unknown*.
    - *Vegetation*.

1.2 Recommendations

Ergo recommends that TEN consider the following actions:

- Initiating a project/programme that focuses on the worst SAIDI performing distribution feeders (for example, the five feeders discussed above), which could include the following initiatives:
    - The installation of additional line fault indicators (LFIs) to assist with the identification of fault locations and reduce restoration/repair times.
    - The installation of reclosers and/or sectionalisers to reduce the number of consumers exposed to faults and to improve restoration times. This should involve targeting the number of ICPs to be sectionalised by the devices.
    - Higher levels of and/or more focused vegetation management.
    - Targeted replacement of equipment reaching end-of-life, particularly cross-arms as the number of failures appears to be increasing.
    - Installation of additional feeders in order to reduce the number of ICP's supplied by individual feeders.[4]
    - Upgrading existing lines or installing new lines in order to improve feeder back-feed options and reduce consumer restoration times.
    - Ongoing use/expansion of TEN's ADMS[5] to improve information management and implementation of distribution automation.
- Investigate the underlying reason for the increasing unplanned SAIDI minutes that have been reported against the outage type of *Unknown*. There is not sufficient information in the SAIDI database for Ergo to determine the underlying reasons for the increase, but we note that the number of the *Unknown* events has been decreasing.
- Investigate the underlying reason for the increasing unplanned SAIDI minutes that have been reported against the outage type of *Vegetation*. This category is a major contributor to TEN's unplanned SAIDI reported in the *Device Affected* category of *Conductor Span* and the data infers that restoration/repair times associated with *Conductor Span* related *vegetation* outages are increasing.
- Detailed investigation and reporting of all unplanned SAIDI events that exceed, say, 1 minute, which would typically involve investigating ≈120 events/annum. A less onerous regime could involve SAIDI events that exceed 2 minutes and ≈50 events/annum. The output from these investigations should inform TEN's future SAIDI initiatives.

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[4] For example, the Tokerau feeder supplies the highest number of ICPs (≈1500) and was the worst performing feeder over the 2020/2021/2022 period.

[5] Advanced Distribution Management System.

Given the size of the distribution network Ergo is of the view that TEN needs to initially focus its efforts on the worst performing sections/feeders. Furthermore, based on our previous experiences, we recommend that TEN ensure that any initiatives (and expenditure) are closely tracked and reported against to ensure that they are delivering benefit (i.e. SAIDI reductions). We expect that the benefits will not be immediate and only become evident over the long term, in the same manner as the benefits associated with TEN's TE2020 Project.

2. Introduction

Top Energy Ltd (Top Energy) owns and operates the electricity network in the northern most part of New Zealand's North Island. The network comprises some 4,500 kilometres of overhead and underground lines and cables, which services over 31,500 power consumers throughout the Far North region. Figure 1 and Figure 2 illustrate Top Energy's Northern and Southern sub-transmission networks that deliver electrical supply to an area that covers some 6,822 square kilometres.

Over the last decade TEN has invested a significant amount of capital on its network in an effort to stabilize its SAIDI performance. This expenditure was formulated in a project referred to as the TE2020 Project and which included the following:

- Installation of unit/differential protection across all sub-transmission lines.
- The construction of a new 110kV double circuit line between Kaikohe and Wiroa, and a new 33kV switching station at Wiroa.
- The construction of a new 33/11kV zone substation at Kerikeri.
- The construction of a new 33/11kV zone substation at Kaeo.
- The installation of 14 diesel generator units with a rated capacity of 16.2MW.
- Refurbishment of the 33kV lines supplying the Pukenui and Taipa 33/11kV zone substations.
- Replacement of one of the 110/33kV transformers at the Kaitaia substation.
- Replacement of Kaikohe outdoor 33kV switchyard with an indoor switchboard/switchroom.

TEN's year ending SAIDI results for 2021 (YE2021) came in just under the Regulatory Target of 302 minutes, and although April of the current year (YE2022) started out well the SAIDI results for the ensuing 6 months to September have well exceeded the budgeted values. If the present trend continues there is a possibility Top Energy will breach its Regulatory Cap of 380 minutes for YE2022.

Given the above backdrop, Top Energy engaged Ergo Consulting (Ergo) to undertake a critical review of the past two full regulatory years (YE2020 and YE2021) unplanned network outage performance, including the six months of this regulatory year (YE2022) which includes the period 1st April 2019 to 30th September 2021. This report documents Ergo's findings and recommendations.

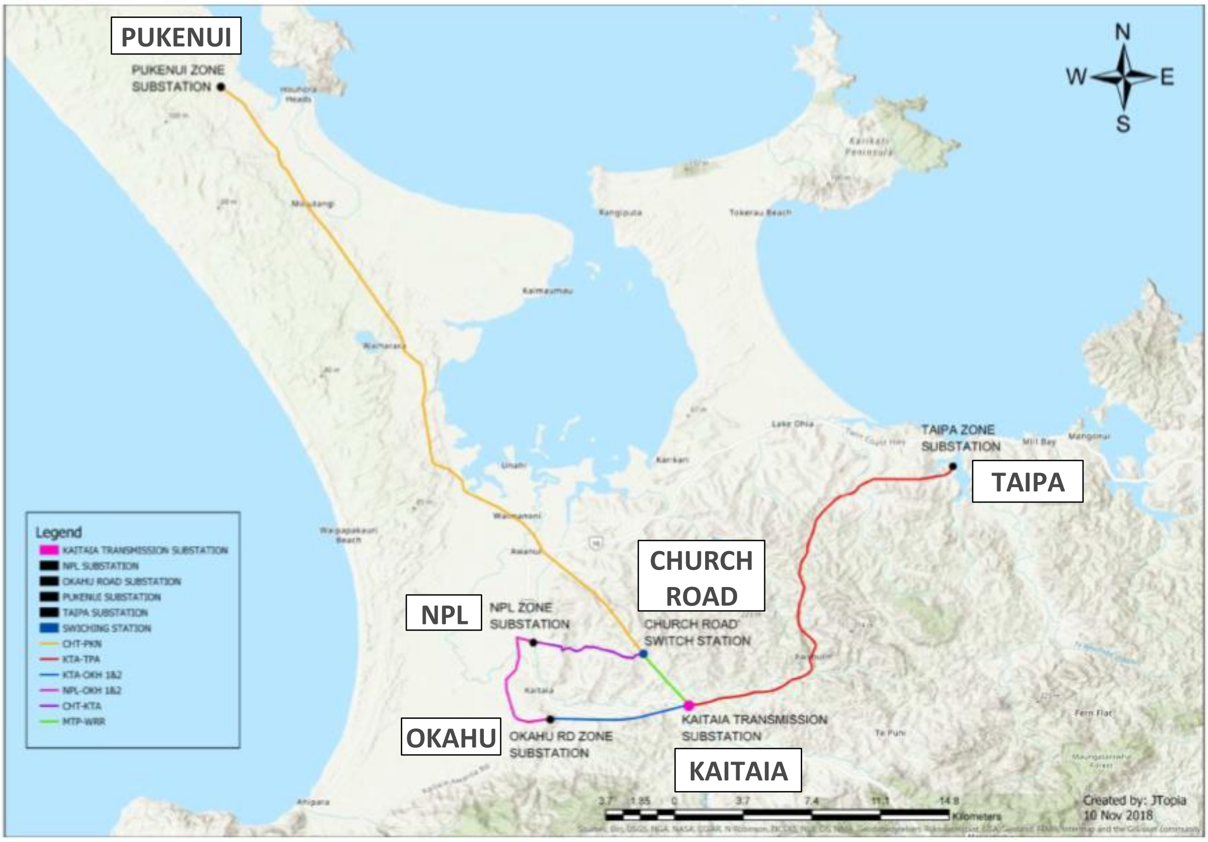

Figure 1 Northern sub-transmission network

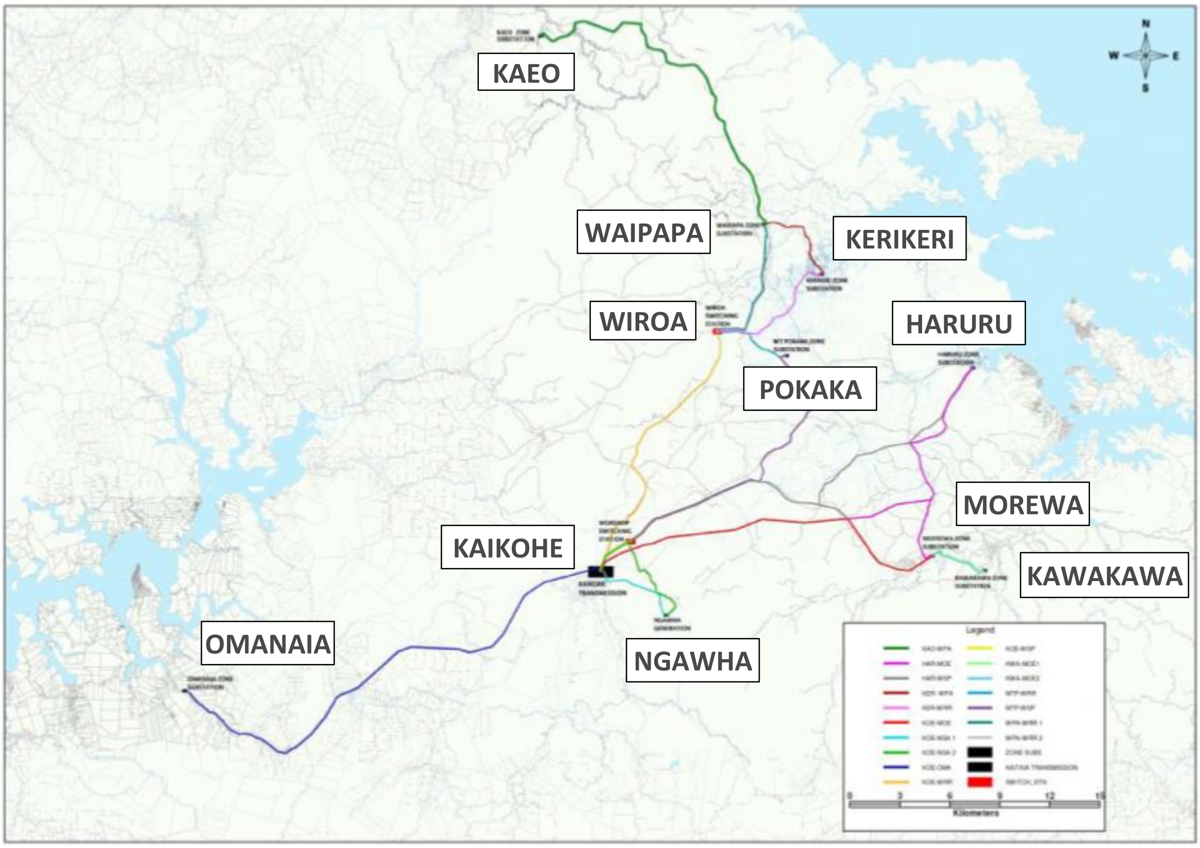

Figure 2 Southern sub-transmission network

3. Scope of the Work

The following is Top Energy's requested scope of work:

Undertake a critical review of the past 2 full financial years unplanned network outage performance, including the six months of this financial year (1 April 2019 to 30 September 2021). Top Energy will provide the fault data for analysis and review to provide recommendations on: 1. What is driving the high unplanned SAIDI figures compared to the declining trend in previous years (e.g. is this more faults, more customers affected, longer repair time, failure of automation, network design)? 2. Has faults > 2 SAIDI minutes changed? 3. What are the root or common causes to the faults and/or high SAIDI impact? 4. What actions should be implemented to rectify the situation, immediately and in the future?

4. Methodology/Approach

Ergo has taken the following approach to its investigative review:

- Read the historical documents supplied by TEN, as noted in Section 5.
- Reviewed the YE2020/YE2021/YE2021 SAIDI data that TEN supplied (Item 1 in Section 5).
- Focused on the unplanned SAIDI as per the scope of work.
- Reviewed TEN's long-term historical disclosed SAIDI.
- Analysed the database supplied and summarised the short-term YE2020/YE2021/YE2021 SAIDI performance in terms of:
    - Zone substation
    - Feeder
    - Equipment
    - Cause

  This activity has helped Ergo develop a clear understanding of the factors that have contributing to TEN's recent SAIDI results.

- Focused in on the network equipment and causes that have made the highest contribution to TEN's SAIDI.
- Documented its findings.
- Made recommendations.

5. Background Information

The following documents/files/information was supplied to Ergo for its review.

Table 1: Input Data

No.	Document/File	Description	Source
1	Incidents by Date YE2020-2022.xlsx	MS-Excel file containing SAIDI & SAIFI records for the period April 2019 through to September 2022.	Top Energy
2	SAIDI Review 2020.pdf	SAIDI SAIFI Performance Review YE2021 to August.	Top Energy
3	SAIDI Review August 2021.docm	SAIDI SAIFI performance review YE2022 to 15 August.	Top Energy
4	Network Development Paper.docm	TEN paper discussing a 10 year Network Development Plan referred to as TE2020.	Top Energy
5	2021 Asset Management Plan.pdf	Top Energy's 2021 Asset Management Plan	Internet

6. Long-term Historical SAIDI Performance

The following Figure 3 illustrates TEN's disclosed SAIDI (both planned and unplanned) for the last two decades. It shows that the company has experienced some significant variations in its reported SAIDI with a clear downward trend subsequent to the significant SAIDI result experienced in 2015 and the execution of its TE2020 Project. The downward trend in unplanned SAIDI is shown in the following Figure 4.

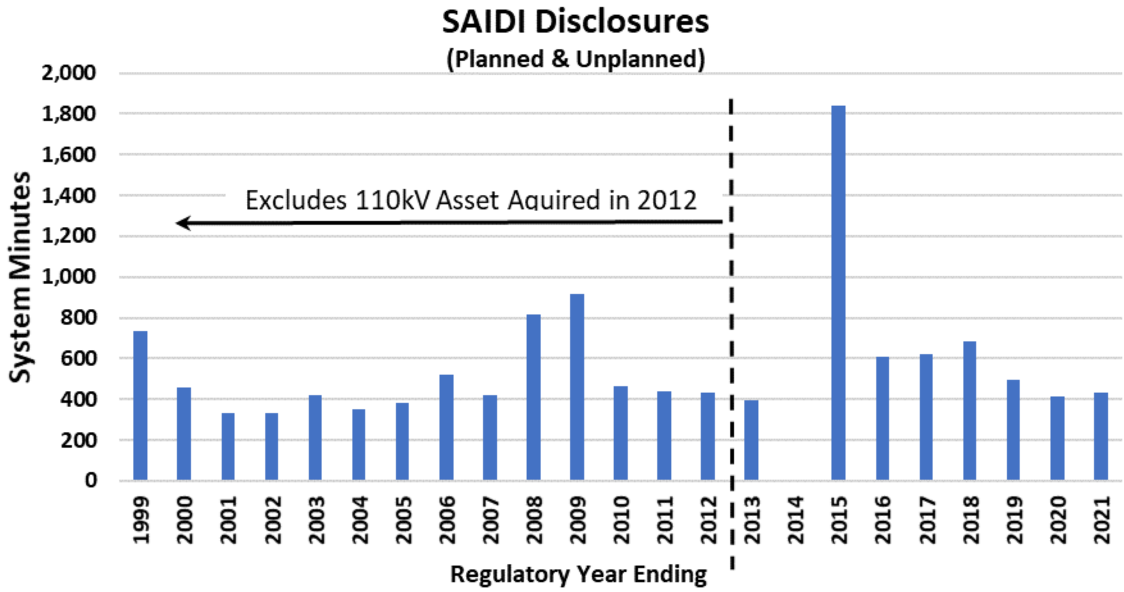

Figure 3 Historical disclosed SAIDI performance[6] (Source: PriceWaterhouseCooper's information disclosure compendiums[7]).

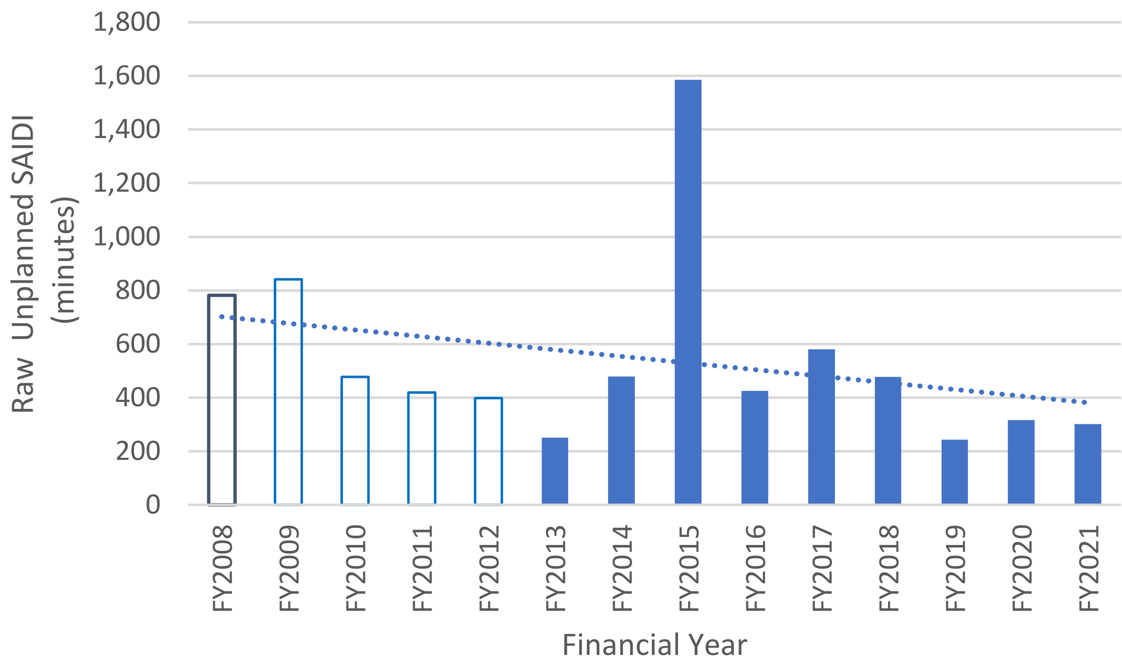

Figure 4 Historical unplanned SAIDI performance (Source: Item 4 in Section 5).

[6] Ergo does not have access to the 2014 SAIDI disclosure information.
[7] https://www.pwc.co.nz/insights-and-publications/2020-publications.

7. Short-term Historical Performance

The following Table 2 summarises TEN's recent unplanned SAIDI network performance (by substation) over the period YE2020, YE2021 and the first six months of YE2022six months of YE2022. Table 2 shows the following:

- Network performance in YE2020 and YE2021 was relatively similar.
- The first six months of YE2022 results clearly infer that the year-end unplanned SAIDI will be higher than YE2020 and YE2021. Although, we note that the set of data available includes the winter period which is typically subject to higher levels of rain/wind/etc.
- The sub-transmission network contributed a relatively small amount of ≈15% to TEN's SAIDI. Although, we note that sub-transmission SAIDI can vary significantly due to high-impact-low-probability (HILP) events. For example, TEN's Kaitaia 110/33kV substation supplies ≈30% of TEN's consumers and is supplied via a single 110kV line. Outages of this 110kV line has the potential to contribute significantly to TEN's SAIDI performance.
- The distribution network contributed a large amount (≈85%) of TEN's SAIDI.

Table 2: Summary: Unplanned SAIDI by substation for YE2021/YE2020/YE2022

	UNPLANNED SAIDI (minutes)						
YE2020	Network Voltage					Sub-Totals	
Substation	6.35kV	11kV	22kV	33kV	110kV	Totals	% of Total
CHURCH RD TEE							0%
HARURU		3.5		0.8		4.2	1%
KAEO		18.3		3.5		21.8	7%
KAIKOHE	0.6	55.5	0.1	33.3		89.4	28%
KAIKOHE 33kV							0%
KAITAIA 33KV							0%
KAWAKAWA	0.3	8.7		2.5		11.5	4%
KERIKERI		4.4		0.3		4.7	1%
MOEREWA		1.5		4.1		5.7	2%
MT POKAKA		1.1		0.0		1.2	0%
NPL		7.9				7.9	3%
OKAHU RD	0.8	38.5				39.2	12%
OMANAIA	0.4	28.1				28.5	9%
PUKENUI		22.2				22.2	7%
TAIPA	1.0	55.1				56.1	18%
WAIPAPA		23.6				23.6	7%
Grand Total	**3**	**268**	**0**	**44**	**0**	**315.9**	100%
% of Total	1%	85%	0%	14%	0%	100%	

	UNPLANNED SAIDI (minutes)						
YE2021	Network Voltage					Sub Total	
Substation	6.35kV	11kV	22kV	33kV	110kV	Grand Total	Percentage of Total
CHURCH RD TEE				0.8		0.8	0%
HARURU		3.3		0.1		3.4	1%
KAEO		9.4				9.4	3%
KAIKOHE	1.9	54.6	1.2			57.6	19%
KAIKOHE 33kV				24.1	18.0	42.2	14%
KAITAIA 33KV							0%
KAWAKAWA	1.9	28.8				30.8	10%
KERIKERI		3.2				3.2	1%
MOEREWA		5.4				5.4	2%
MT POKAKA		4.3				4.3	1%
NPL		7.9		0.5		8.4	3%
OKAHU RD	1.6	53.4				55.0	18%
OMANAIA	0.3	21.6				21.9	7%
PUKENUI		19.3				19.3	6%
TAIPA	0.4	29.5				30.0	10%
WAIPAPA		9.1				9.1	3%
Grand Total	**6**	**250**	**1**	**26**	**18**	**301**	100%
% of Total	2%	83%	0%	8%	6%	100%	

	UNPLANNED SAIDI (minutes)						
YE2022*	Network Voltage					Sub Total	
Substation	6.35kV	11kV	22kV	33kV	110kV	Grand Total	Percentage of Total
CHURCH RD TEE				8.3		8.3	4%
HARURU		0.2		0.1		0.3	0%
KAEO	0.7	23.8				24.5	11%
KAIKOHE	0.3	20.2	4.1			24.7	11%
KAIKOHE 33kV				7.7		7.7	3%
KAITAIA 33KV				11.4		11.4	5%
KAWAKAWA	2.5	12.3				14.8	7%
KERIKERI		2.9				2.9	1%
MOEREWA		1.1				1.1	0%
MT POKAKA		2.8				2.8	1%
NPL		5.8				5.8	3%
OKAHU RD	1.2	30.1				31.4	14%
OMANAIA		14.2				14.2	6%
PUKENUI		33.3		0.2		33.5	15%
TAIPA		32.2				32.2	14%
WAIPAPA	0.5	9.6				10.1	4%
Grand Total	**5**	**189**	**4**	**28**	**0**	**226**	100%
% of Total	2%	84%	2%	12%	0%	100%	

* The YE2022 summary table above is only for the six-month period April through September 2021.

7.1 Short-term Performance by Zone Substation

Figure 4 illustrates, graphically, the unplanned SAIDI performance (over the period YE2020, YE2021 and the first six months of YE2022) by substation, sorted from highest to lowest. The graphs show that, for the period considered, the five worst performing sections of TEN's network have been associated with the following substations (in order of performance):

- Kaikohe
- Okahu Rd
- Taipa
- Pukenui
- Omanaia

The networks associated with these substations include substantial rural distribution feeders. Also, the last three substations are supplied via single, overhead, 33kV lines. Having said this these lines did not contribute materially to the SAIDI performance, possibly due to the backup diesel generators that TEN has installed at these stations.

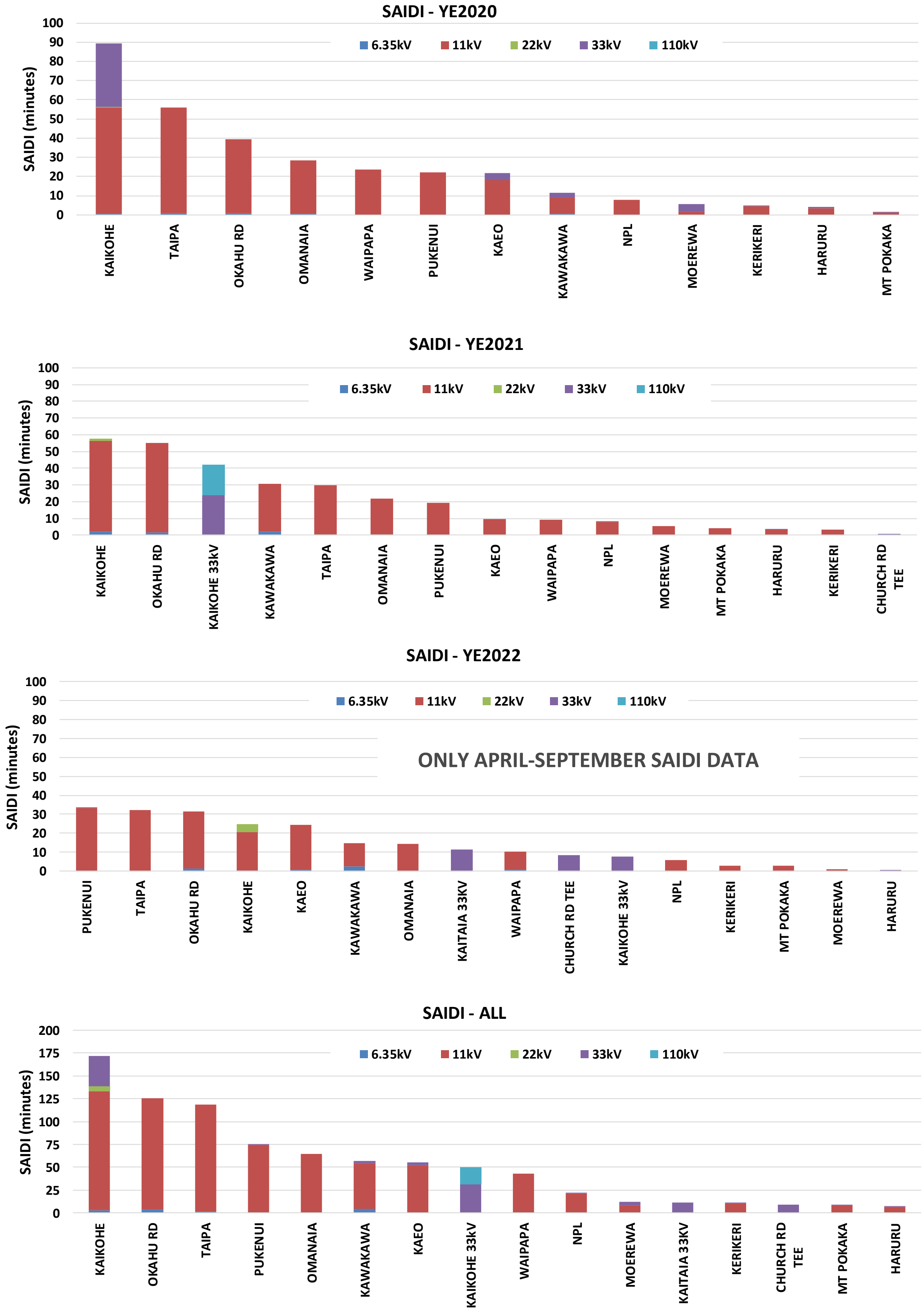

Figure 5 Unplanned SAIDI by substation for YE2021/YE2020/YE2022 and summarised for ALL three periods.

7.2 Short-term Performance by Cause

The following Table 3 summarises the sub-transmission, distribution and all unplanned SAIDI by the outage *cause*. The information in Table 3 is presented in terms of each of the YE2020, YE2021 and YE2022 periods, and is sorted from high to low in terms of the SAIDI contributions. Also included in Table 3 are the percentage SAIDI contributions, the cumulative percentage and a TREND column indicated whether the contribution is trending UP or DOWN. The trends have been established by calculating the SAIDI trend-line for each of the *causes* over the three periods (YE2020, YE2021 and YE2022) and if the slope is significantly positive or negative indicating the trend is UP or DOWN respectively. For the calculation we have doubled the YE2022 data because it only covers six months. This view is based on the fact that the unplanned SAIDI over the months of April-September in YE2020 and YE2021 contributed 38% and 49% respectively to the year-end totals.

Examination of Table 3 indicates the following:

- The top five causes of ALL unplanned SAIDI have been due to the following causes (in order of magnitude):
  - *Defective equipment*.
  - *Vegetation*.
  - *Third party*.
  - *Unknown*.
  - *Weather*.
- ALL unplanned SAIDI appears to be trending upwards due to the following causes:
  - *Defective equipment* on the distribution network. This is contrasted by the sub-transmission SAIDI due to *defective equipment* that appears to be trending downwards.
  - *Vegetation* related outages.
  - *Unknown events*.
  - *Weather*.
- There has been very little unplanned sub-transmission SAIDI due to the following:
  - *Lightning*.
  - *Wildlife*.
  - *Vegetation*.
  - *Third party*.

The information in Table 3 generally indicates that TEN's focus on its sub-transmission network (i.e. its TE2020 Project discussed in Section 2) is yielding benefits. However, the major contributor of its unplanned SAIDI, the distribution network, appears to be trending upwards.

Table 3 Unplanned SAIDI by Cause for YE2021/YE2020/YE2022

110kV / 33kV SUB-TRANSMISSION UNPLANNED SAIDI

		Unplanned SAIDI (minutes						
No.	**Cause**	**YE2020**	**YE2021**	**YE2022***	**Grand Total**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Defective Equipment	33.3	22.3	0.0	55.6	48%	48%	DOWN
2	Unknown	1.2	8.0	11.7	20.8	18%	66%	UP
3	Human Error	0.1	12.9	0.1	13.0	11%	77%	
4	Wildlife	9.2	0.0	2.7	11.9	10%	88%	
5	Weather	0.0	0.0	8.3	8.3	7%	95%	UP
6	Vegetation	0.0	0.0	5.0	5.0	4%	99%	UP
7	Lightning	0.5	0.4	0.0	0.9	1%	100%	
8	Third Party	0.2	0.0	0.0	0.2	0%	100%	
9	FOREIGN INTERFERENCE	0.0	0.0	0.0	0.0	0%	100%	
10	Environment	0.0	0.0	0.0	0.0	0%	100%	
	Grand Total	**44.5**	**43.5**	**27.7**	**115.8**	**100%**		UP

22kV / 11kV / 6.35kV DISTRIBUTION UNPLANNED SAIDI

		Unplanned SAIDI (minutes						
No.	**Cause**	**YE2020**	**YE2021**	**YE2022***	**Grand Total**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Defective Equipment	88.8	118.2	64.1	271.1	37%	37%	UP
2	Vegetation	81.2	44.4	54.9	180.6	25%	25%	UP
3	Third Party	59.5	56.8	28.9	145.1	20%	20%	
4	Unknown	20.6	32.1	27.2	79.9	11%	11%	UP
5	Weather	2.5	0.3	16.3	19.1	3%	3%	UP
6	Lightning	7.2	3.4	5.6	16.1	2%	2%	
7	Wildlife	4.1	1.4	1.0	6.5	1%	1%	
8	Human Error	4.2	0.7	0.0	4.9	1%	1%	
9	FOREIGN INTERFERENCE	3.3	0.0	0.0	3.3	0%	0%	
10	Environment	0.0	0.0	0.0	0.0	0%	0%	
	Grand Total	**271.4**	**257.3**	**198.0**	**726.7**	**100%**		UP

ALL UNPLANNED SAIDI (SUB-TRANSMISSION & DISTRIBUTION)

		Unplanned SAIDI (minutes						
No.	**Cause**	**YE2020**	**YE2021**	**YE2022***	**Grand Total**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Defective Equipment	122.1	140.5	64.1	326.7	39%	39%	UP
2	Vegetation	81.2	44.4	59.9	185.6	22%	22%	UP
3	Third Party	59.7	56.8	28.9	145.4	17%	17%	
4	Unknown	21.8	40.1	38.8	100.7	12%	12%	UP
5	Weather	2.5	0.3	24.6	27.4	3%	3%	UP
6	Wildlife	13.4	1.4	3.7	18.5	2%	2%	DOWN
7	Human Error	4.3	13.6	0.1	18.0	2%	2%	
8	Lightning	7.7	3.8	5.6	17.0	2%	2%	
9	FOREIGN INTERFERENCE	3.3	0.0	0.0	3.3	0%	0%	
10	Environment	0.0	0.0	0.0	0.0	0%	0%	
	Grand Total	**315.9**	**300.8**	**225.7**	**842.4**	**100%**		UP

* The YE2022 summary results above are only for the six-month period April through September 2021. Note that the trend has been established by doubling the YE2022 unplanned SAIDI.

7.3 Short-term Performance by Distribution Feeder

Figure 6 illustrates, graphically, the unplanned SAIDI performance (over the period YE2020, YE2021 and the first six months of YE2022) by feeder, sorted from highest to lowest. The graphs show that, for the period considered, the five worst performing feeders on TEN's (in order of performance):

- Tokerau feeder (CB1205) fed from the Taipa zone substation (shaded red).
- South Road feeder (CB1105) fed from the Okahu zone substation (shaded yellow).
- Te Kao feeder (131142) fed from the Pukenui zone substation (shaded green).
- Horeke feeder (CB0111) fed from the Kaikohe zone substation (shaded purple).
- Oruru feeder (CB1206) fed from the Taipa substation (shaded black).

Ergo understands that these feeders are substantial overhead/rural and collectively they contributed 36% to TEN's SAIDI. In contrast, the top ten feeders contributed 56% to TEN's SAIDI.

Reducing the ICPs count on feeders has the potential to reduce unplanned SAIDI, for example, by installing new feeders, automated sectionalisers or distribution automation. For this reason Ergo has graphed, in Figure 7, unplanned SAIDI versus ICP number for TEN's distribution feeders. We have also coloured the five worst performing feeders red/yellow/green/purple/black.

Ergo have also looked at the unplanned SAIDI trends on each of the distribution feeders and the results are illustrated in Table 4, sorted from highest to lowest in terms of SAIDI contribution. Again, we have coloured the five worst performing feeders and they are thus at the top of the table. We have also included a TREND column using the methodology discussed in Section 7.2.

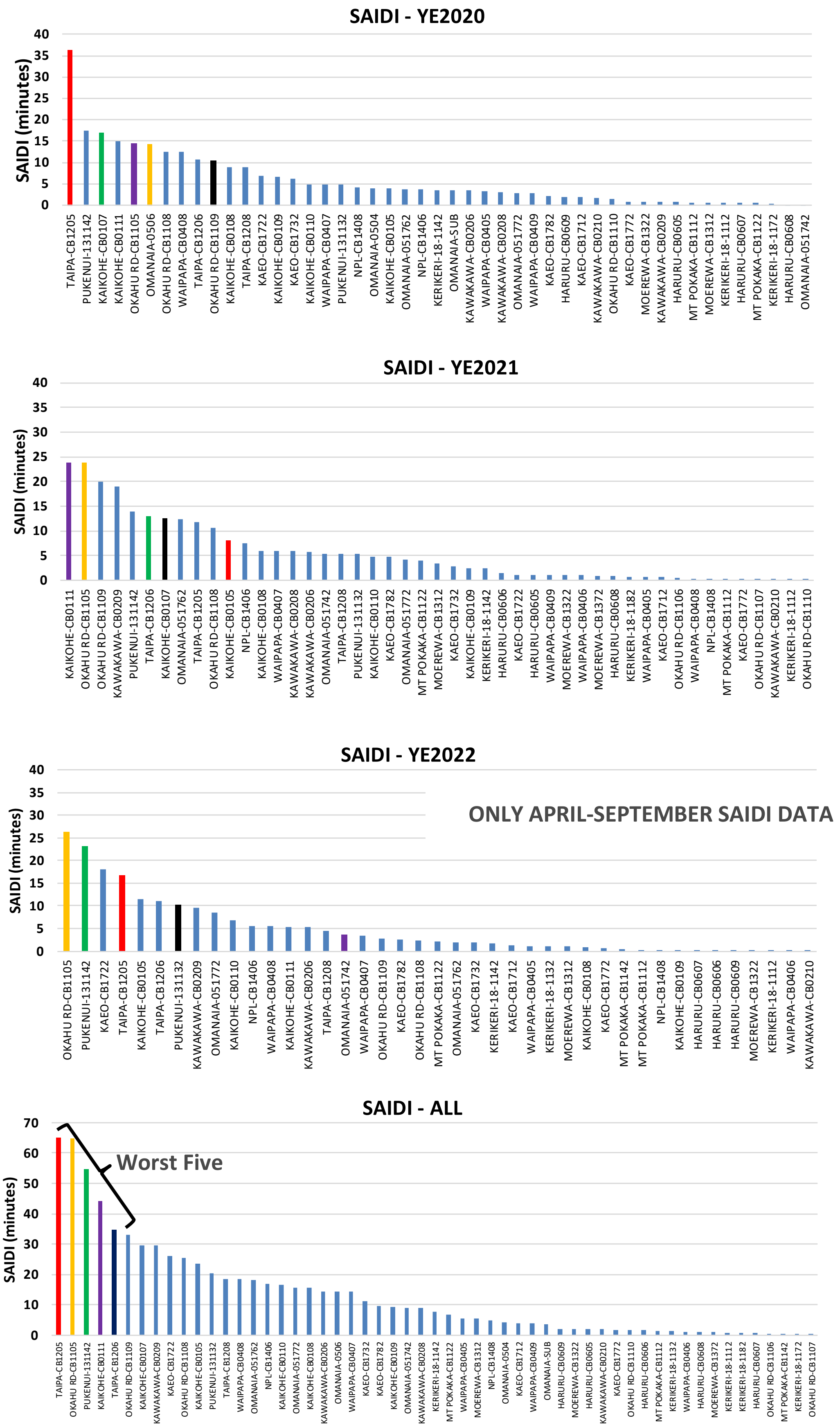

Figure 6 Unplanned SAIDI by distribution feeder for YE2021/YE2020/YE2022.

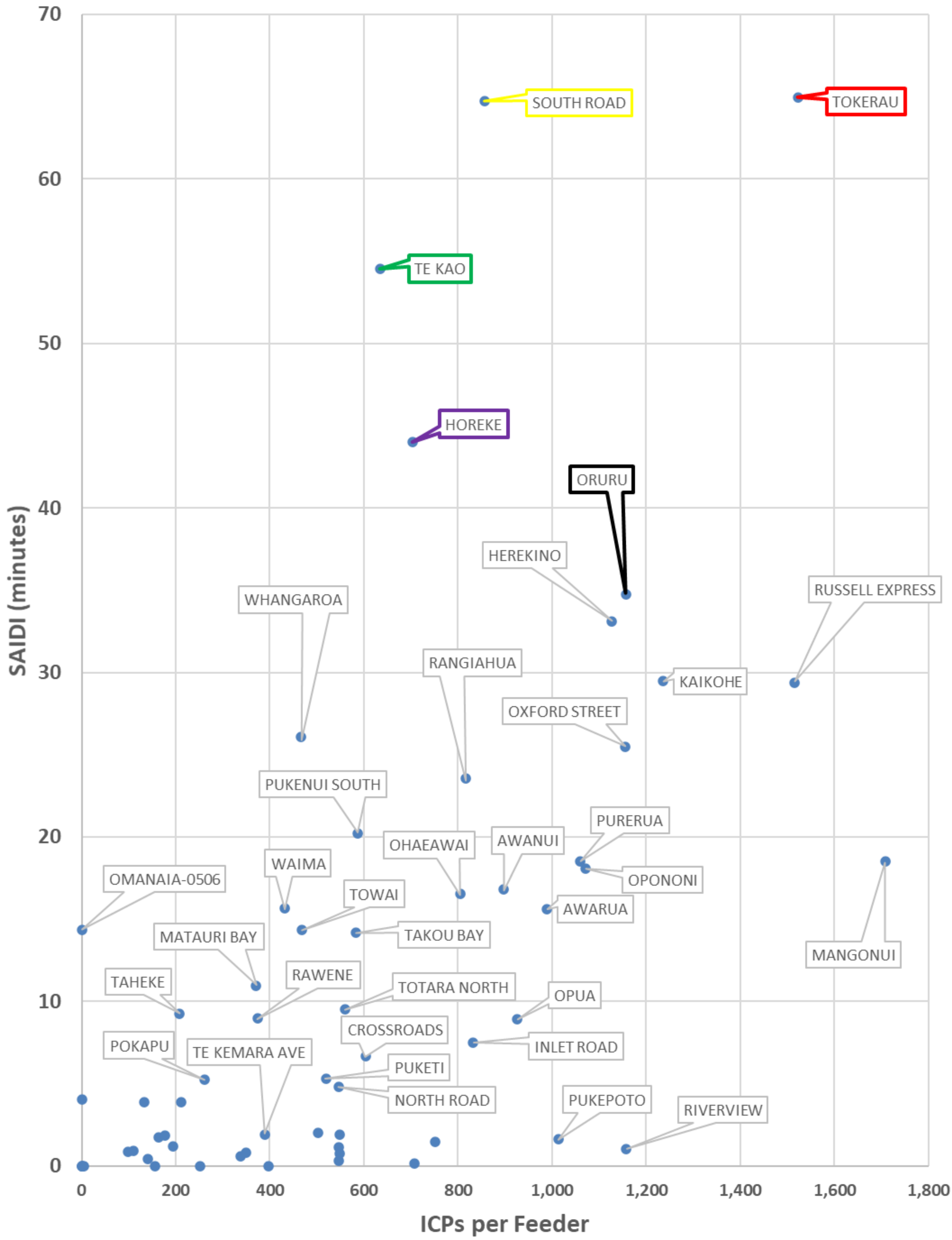

Figure 7 Unplanned SAIDI vs ICPs for distribution feeders over the period YE2021/YE2020/YE2022.

Table 4 Distribution feeders sorted by Unplanned SAIDI for YE2021/YE2020/YE2022 period: Including trend & upward rank

			Unplanned SAIDI (minutes)					UPWARD
No.	Substation - CB	Feeder Name	YE2020	YE2021	YE2022*	ALL	TREND	RANK
1	TAIPA-1205	**TOKERAU**	36.5	11.7	16.8	65.0		
2	OKAHU RD-1105	**SOUTH ROAD**	14.6	23.8	26.3	64.8	UP	**1**
3	PUKENUI-131142	**TE KAO**	17.4	14.0	23.2	54.6	UP	**2**
4	KAIKOHE-0111	**HOREKE**	14.9	23.8	5.3	44.0	DOWN	
5	TAIPA-1206	**ORURU**	10.8	12.9	11.0	34.7	UP	**8**
6	OKAHU RD-1109	HEREKINO	10.5	19.9	2.7	33.1	DOWN	
7	KAIKOHE-0107	KAIKOHE	16.9	12.5	0.0	29.5	DOWN	
8	KAWAKAWA-0209	RUSSELL EXPRESS	0.8	19.0	9.6	29.4	UP	**5**
9	KAEO-191722	WHANGAROA	7.0	1.1	18.0	26.1	UP	**3**
10	OKAHU RD-1108	OXFORD STREET	12.6	10.6	2.3	25.5	DOWN	
11	KAIKOHE-0105	RANGIAHUA	3.9	8.1	11.6	23.6	UP	**4**
12	PUKENUI-131132	PUKENUI SOUTH	4.8	5.3	10.1	20.2	UP	**6**
13	TAIPA-1208	MANGONUI	8.8	5.3	4.4	18.5		
14	WAIPAPA-0408	PURERUA	12.5	0.4	5.6	18.5		
15	OMANAIA-051762	OPONONI	3.7	12.3	2.0	18.1		
16	NPL-1406	AWANUI	3.6	7.6	5.6	16.8	UP	
17	KAIKOHE-0110	OHAEAWAI	5.0	4.7	6.8	16.5	UP	**9**
18	OMANAIA-051772	WAIMA	2.9	4.2	8.6	15.7	UP	**7**
19	KAIKOHE-0108	AWARUA	8.8	6.0	0.8	15.6	DOWN	
20	KAWAKAWA-0206	TOWAI	3.4	5.7	5.2	14.4	UP	
21	OMANAIA-0506	OMANAIA-0506	14.3	0.0	0.0	14.3	DOWN	
22	WAIPAPA-0407	TAKOU BAY	4.8	6.0	3.3	14.2		
23	KAEO-191732	MATAURI BAY	6.3	2.8	1.9	11.0		
24	KAEO-191782	TOTARA NORTH	2.2	4.7	2.6	9.5		
25	KAIKOHE-0109	TAHEKE	6.6	2.5	0.2	9.3	DOWN	
26	OMANAIA-051742	RAWENE	0.0	5.3	3.6	9.0	UP	
27	KAWAKAWA-0208	OPUA	3.0	5.9	0.0	8.9		
28	KERIKERI-181142	INLET ROAD	3.5	2.3	1.7	7.5		
29	MT POKAKA-171122	CROSSROADS	0.5	4.0	2.2	6.7		
30	WAIPAPA-0405	PUKETI	3.4	0.8	1.2	5.3		
31	MOEREWA-031312	POKAPU	0.7	3.5	1.1	5.3		
32	NPL-1408	NORTH ROAD	4.3	0.3	0.2	4.8		
33	OMANAIA-0504	OMANAIA-0504	4.1	0.0	0.0	4.1	DOWN	
34	KAEO-191712	OMAUNU ROAD	1.9	0.6	1.4	3.9		
35	WAIPAPA-0409	AERODROME ROAD	2.8	1.0	0.0	3.9		
36	HARURU-0609	JOYCES ROAD	2.0	0.0	0.0	2.0		
37	MOEREWA-031322	MOEREWA NO 1	0.9	1.0	0.0	1.9		
38	HARURU-0605	TE KEMARA AVE	0.8	1.1	0.0	1.9		
39	KAWAKAWA-0210	KARETU	1.7	0.2	0.0	1.9		
40	KAEO-191772	OROTERE	0.9	0.2	0.7	1.7		
41	OKAHU RD-1110	PUKEPOTO	1.6	0.0	0.0	1.6		
42	HARURU-0606	TI BAY	0.0	1.4	0.1	1.5		
43	MT POKAKA-171112	BULLS GORGE	0.7	0.3	0.2	1.2		
44	KERIKERI-181132	COBHAM ROAD	0.0	0.0	1.1	1.1		
45	WAIPAPA-0406	RIVERVIEW	0.0	1.0	0.0	1.0		
46	HARURU-0608	ONEWHERO	0.2	0.8	0.0	0.9		
47	MOEREWA-031372	TAU BLOCK	0.0	0.9	0.0	0.9		
48	KERIKERI-181112	KERIKERI ROAD	0.6	0.1	0.0	0.8		
49	KERIKERI-181182	HONE HEKE ROAD	0.0	0.8	0.0	0.8		
50	HARURU-0607	PUKETONA	0.5	0.0	0.1	0.6		
51	OKAHU RD-1106	KAITAIA WEST	0.0	0.4	0.0	0.4		
52	MT POKAKA-171132	TIMBER MILL	0.0	0.0	0.4	0.4		
53	KERIKERI-181172	RANUI AVENUE	0.3	0.0	0.0	0.3		
54	OKAHU RD-1107	REDAN ROAD	0.0	0.2	0.0	0.2		

* The YE2022 summary results above are only for the six-month period April through September 2021. Note that the trend has been established by doubling the YE2022 unplanned SAIDI.

7.4 Short-term Equipment Performance

Table 5 summarises the unplanned SAIDI performance (over the period YE2020, YE2021 and the first six months of YE2022) by equipment categories, sorted from highest to lowest. Table 5 also shows the percentage contributed by the individual equipment types and we have also assessed whether the SAIDI contributions appear to be increasing using the following:

- Doubling the YE2022 SAIDI figures (as the data supplied only includes 6 months). This view is based on the fact that the unplanned SAIDI over the months of April-September in YE2020 and YE2021 contributed 38% and 49% respectively to the year-end totals.
- Linearly trending the data over the three periods.
- Indicating an upward trend if the slope of the trend-line is significantly positive.

Examination of the values in Table 5 indicates the following:

- The top five equipment categories contribute 70% of TEN's unplanned SAIDI and are:
  - Conductor Span.
  - Pole.
  - Unknown.
  - X-arm.
  - Tail/Lead/Jumper
- The top ten equipment categories contribute 90% of TEN's unplanned SAIDI.
- Increasing SAIDI contributions from the following equipment categories:
  - Conductor Span.
  - Unknown.
  - X-arms.
  - Insulators (pin and termination).

Given the significant contribution due to top five equipment categories Ergo has continued to review, in more detail, the reasons for the failures of equipment failures categories in the sections that follow.

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Table 5: Unplanned SAIDI by equipment for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	**Equipment**	**YE2020**	**YE2021**	**YE2022***	**SUBTOTAL**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Conductor Span	106.1	59.0	70.0	235.2	28%	28%	UP
2	Pole	62.5	47.7	29.2	139.4	17%	44%	
3	Unknown	21.6	36.1	35.2	92.9	11%	55%	UP
4	Xarm	17.3	49.8	21.1	88.2	10%	66%	UP
5	Tail/Lead/Jumper	28.4	8.9	5.8	43.2	5%	71%	
6	Circuit Breaker	0.1	33.9	2.0	35.9	4%	75%	
7	Insulator (Pin)	0.6	18.1	15.5	34.1	4%	79%	UP
8	Insulator (Suspension)	11.8	9.7	10.3	31.8	4%	83%	
9	Binder	8.7	4.8	8.3	21.8	3%	86%	
10	Tx Dist	6.1	8.9	4.9	20.0	2%	88%	
11	Insulator (Termination)	3.0	0.6	9.5	13.2	2%	90%	UP
12	Regulator	9.5	0.0	3.1	12.6	1%	91%	
13	Cable	4.4	2.7	1.1	8.2	1%	92%	
14	Cable Termination	1.2	5.8	0.0	7.0	1%	93%	
15	Conductor Termination	5.0	0.2	1.6	6.7	1%	94%	
16	Switch	5.2	1.2	0.0	6.4	1%	95%	
17	Sectionaliser	1.3	3.1	1.6	6.0	1%	95%	
18	Link	4.4	0.8	0.2	5.4	1%	96%	
19	Conductor Joint	0.6	4.7	0.0	5.2	1%	97%	
20	TX SWER INS	4.1	0.0	0.0	4.1	0%	97%	
21	Switch	1.1	1.4	1.4	4.0	0%	98%	
22	Fuse Base	1.6	1.3	0.8	3.8	0%	98%	
23	Lightning Arrestor	2.4	0.5	0.3	3.2	0%	98%	
24	Fuse Element	0.1	0.3	2.6	3.0	0%	99%	
25	Recloser	1.6	0.5	0.8	2.9	0%	99%	
26	STRUCTURE TX	1.8	0.0	0.0	1.8	0%	99%	
27	Stay Assembly	1.2	0.1	0.0	1.4	0%	99%	
28	Tx SWER Isolating	0.9	0.2	0.0	1.1	0%	100%	
29	CONDUCTOR ROAD XING	0.9	0.0	0.0	0.9	0%	100%	
30	Tx Dist	0.7	0.0	0.1	0.8	0%	100%	
31	Other	0.6	0.1	0.0	0.8	0%	100%	
32	Circuit Breaker	0.6	0.0	0.0	0.6	0%	100%	
33	COMMS EQUIPMENT	0.3	0.0	0.0	0.3	0%	100%	
34	Other	0.0	0.2	0.0	0.2	0%	100%	
35	CONTROL EQUIPMENT	0.1	0.0	0.0	0.1	0%	100%	
36	SUB STN TX	0.0	0.0	0.0	0.0	0%	100%	
37	Fuse Base	0.0	0.0	0.0	0.0	0%	100%	
	TOTALs	**315.9**	**300.8**	**225.7**	**842.4**	**100%**		

* The YE2022 summary results above are only for the six-month period April through September 2021.

7.4.1 Conductor Span Performance

The following Table 6 illustrates the causes of Conductor Span related SAIDI during the period YE2021/YE2020/YE2022, which shows the following:

- The top three causes accounted for 84% of the SAIDI.
- 70% resulted from tree/vegetation related interference.
- 10% resulted from conductor failure.
- Tree related SAIDI appears to be increasing.

Table 6: Summary: Conductor Span related unplanned SAIDI by cause for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	Equipment	YE2020	YE2021	YE2022*	SUBTOTAL	% of TOTAL	Cumulative %	TREND
1	Tree (Fall on Line)	47.1	17.0	30.5	94.6	40%	40%	UP
2	Tree Contact	25.4	26.3	19.5	71.2	30%	70%	UP
3	Conductor Failure	15.3	8.2	7.6	31.1	13%	84%	
4	Bird Strike	6.1	0.4	2.9	9.4	4%	88%	
5	Possum Damage	6.2	0.3	0.6	7.2	3%	91%	
6	External Tree Works	0.2	4.8	1.8	6.8	3%	94%	
7	Binder Failure	3.8	0.0	0.0	3.8	2%	95%	
8	Tree (Fall on Structure)	0.0	0.0	3.8	3.8	2%	97%	UP
9	Fault on Customer Premises	0.8	0.1	1.8	2.7	1%	98%	
10	Storm	0.0	0.3	1.0	1.3	1%	99%	
11	Machine Contact Lines	0.0	0.6	0.3	0.9	0%	99%	
12	Cause Unknown	0.0	0.8	0.1	0.9	0%	99%	
13	Xarm Failure	0.5	0.0	0.0	0.5	0%	100%	
14	Suspension Clamp Failure	0.4	0.0	0.0	0.4	0%	100%	
15	Joint Failure	0.2	0.0	0.0	0.2	0%	100%	
16	Lightning Strike	0.0	0.1	0.0	0.1	0%	100%	
17	Network Security/Safety 3RD Party Interference	0.0	0.1	0.0	0.1	0%	100%	
18	Internal Tree Works (Line Contact)	0.0	0.1	0.0	0.1	0%	100%	
19	Vehicle Vs Lines	0.0	0.0	0.0	0.0	0%	100%	
20	Ground Conditions/Slips	0.0	0.0	0.0	0.0	0%	100%	
21	Other Equipment Failure	0.0	0.0	0.0	0.0	0%	100%	
	TOTAL	106.1	59.0	70.0	235.2	100%		

* The YE2022 summary results above are only for the six-month period April through September 2021.

Ergo has “dug deeper” into the data to examine, in more detail, the top three causes of Conductor Span related SAIDI. Table 7 illustrates the total number of incidents and the mean time to restore/repair (MTTR). Again, we have assessed the trend using the methodology outlined in Section 6 (page 9), which infers the following:

- Tree related incidents are relatively static (i.e. no significant trends).
- The restoration/repair times associated with tree incidents appears to be trending upwards.
- Conductor failures appear to be remaining relatively static.

Table 7: Conductor Span: Top three causes: Mean-time-to-restore/repair (MTTR) and number of incidents

	Tree (Fall on Line)		Tree Contact		Conductor Failure	
Year	MTTR (hours)	Count	MTTR (hours)	Count	MTTR (hours)	Count
YE2020	5.1	51	2.5	35	11.1	26
YE2021	5.9	24	4.4	47	13.2	13
YE2022*	9.3	20	3.6	23	10.9	12
TREND	UP	DOWN	UP	UP	-	-

* The YE2022 summary results above are only for the six-month period April through September 2021.

7.4.2 Pole Performance

The following Table 8 illustrates the causes of Pole related SAIDI during the period YE2021/YE2020/YE2022. Table 8 shows the following:

- The majority of incidents have been vehicle related at 88%.
- The second highest cause at 6% has been tree/vegetation related.
- Pole related SAIDI does not appear to be increasing, and vehicle related incidents appears to be trending downwards.

Table 8: Summary: Pole related unplanned SAIDI by cause for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	Equipment	YE2020	YE2021	YE2022*	SUBTOTAL	% of TOTAL	Cumulative %	TREND
1	Vehicle Vs Pole	52.4	46.8	23.7	123.0	88%	88%	DOWN
2	Tree (Fall on Line)	3.7	0.0	4.0	7.8	6%	94%	
3	External Tree Works	2.8	0.0	0.0	2.8	2%	96%	
4	Storm	2.3	0.4	0.0	2.7	2%	98%	
5	Pole Failure	0.3	0.0	1.5	1.7	1%	99%	
6	Other Equipment Failure	0.7	0.1	0.0	0.7	1%	99%	
7	Tree (Fall on Structure)	0.0	0.5	0.0	0.5	0%	100%	
8	VEHICLE VS OVERHEAD WIRES	0.1	0.0	0.0	0.1	0%	100%	
9	Insulator Missing/Hanging	0.1	0.0	0.0	0.1	0%	100%	
10	Ground Conditions/Slips	0.0	0.0	0.0	0.0	0%	100%	
11	Tree Machine Contact Lines	0.0	0.0	0.0	0.0	0%	100%	
	TOTAL	62.5	47.7	29.2	139.4			

* The YE2022 summary results above are only for the six-month period April through September 2021.

Table 9 illustrates the total number of incidents and the mean time to restore/repair (MTTR) for the main cause of Pole related SAIDI. Again, we have assessed the trend using the methodology outlined in Section 6 (page 9). Table 9 infers that the MTTR for Vehicle vs Pole has remained relatively stable, whilst the number of incidents is indicating a slight upward trend.

Table 9: Conductor Span: Top cause: Mean-time-to-restore/repair (MTTR) and number of incidents

	Vehicle Vs Pole	
Year	MTTR (hours)	Count
YE2020	6.84	18
YE2021	6.27	18
YE2022*	6.32	12
TREND	-	UP

* The YE2022 summary results above are only for the six-month period April through September 2021.

7.4.3 Unknown Performance

The following Table 10 illustrates the third highest contributor to unplanned SAIDI which is categorised as “unknown” during the period YE2021/YE2020/YE2022. This category is clearly indicated to be trending up and we note that TEN recently mentioned this upward trend in company reports (refer to Item 3 in Section 5).

Table 10: Summary: Unknown related unplanned SAIDI by cause for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	Equipment	YE2020	YE2021	YE2022*	SUBTOTAL	% of TOTAL	Cumulative %	TREND
1	Cause Unknown	21.7	35.7	35.0	92.4	99%	99%	UP
2	Lightning Strike	0.3	0.4	0.0	0.8	1%	1%	
3	Storm	0.2	0.0	0.2	0.4	0%	0%	
	TOTAL	22.3	36.1	35.2	93.6			

* The YE2022 summary results above are only for the six-month period April through September 2021.

Again, we have examined the core data relating to the unknown category and found that the mean time to restore has remained relatively constant and surprisingly the number of events is indicated to be trending down (refer to Table 11), which appears to contradict the information in Table 10. However, on further investigation Ergo has determined that the average SAIDI associated with the unknown category of events has trended up significantly and this is shown in Table 11.

Table 11: Unknown: Top cause: Mean-time-to-restore/repair (MTTR) and number of incidents

	Cause Unknown		
Year	**MTTR (hours)**	**Count**	**Average SAIDI per event (mins)**
YE2020	2.26	69	0.31
YE2021	2.00	41	0.87
YE2022*	2.21	26	1.35
TREND	-	DOWN	UP

* The YE2022 summary results above are only for the six-month period April through September 2021.

7.4.4 X-Arm

The following Table 12 illustrates the causes of x-arm related SAIDI during the period YE2021/YE2020/YE2022. Table 12 shows the following:

- 95% has been due to *x-arm failure* or *corrosion/rot*.
- There has been a small amount due to *vandalism* / *intentional-damage*.
- X-arm related SAIDI does appear to be trending slightly upwards.

Table 12: Summary: X-arm related unplanned SAIDI by cause for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	**Equipment**	**YE2020**	**YE2021**	**YE2022***	**SUBTOTAL**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Xarm Failure	16.2	41.2	19.5	76.9	87%	87%	UP
2	Corrosion/Rot	0.0	5.4	1.3	6.7	8%	95%	
3	Vandalism/Intentional Damage	0.0	3.1	0.0	3.1	4%	98%	
4	Tree (Fall on Line)	1.2	0.0	0.0	1.2	1%	100%	
5	Insulator Missing/Hanging	0.0	0.0	0.3	0.3	0%	100%	
6	Tree Contact	0.0	0.1	0.0	0.1	0%	100%	
	TOTAL	**17.3**	**49.8**	**21.1**	**88.2**			

* The YE2022 summary results above are only for the six-month period April through September 2021.

We have examined the core data relating to the x-arm SAIDI and found that, for the major contributor of *x-arm failure*, the mean time to restore has consistently reduced but the number of events is indicated to be trending upwards (refer to Table 13). This infers that TEN's performance in relation to restoration/repair has improved but the number of failures is increasing.

Table 13: X-arm: Top cause of *x-arm failure*: Mean-time-to-restore/repair (MTTR) and number of incidents

	Xarm Failure		
Year	**MTTR (hours)**	**Count**	**Average SAIDI per event (mins)**
YE2020	5.42	23	0.70
YE2021	3.09	32	1.29
YE2022*	2.26	23	0.85
TREND	DOWN	UP	-

7.4.5 Tail/Lead/Jumper

The following Table 14 illustrates the causes of Tail/Lead/Jumper related SAIDI during the period YE2021/YE2020/YE2022. Table 14 shows the following:

- 78% was due to the category *Conductor Tail Blown Off*. This category has trended downwards.
- 10% was due to conductor failures.
- 8% was due to joint failure, although all occurring in YE2022.

Table 14: Summary: Tail/Lead/Jumper related unplanned SAIDI by cause for YE2021/YE2020/YE2022

		SAIDI (minutes)						
No	**Equipment**	**YE2020**	**YE2021**	**YE2022***	**SUBTOTAL**	**% of TOTAL**	**Cumulative %**	**TREND**
1	Conductor Tail Blown Off	28.1	4.4	1.3	33.7	78%	78%	DOWN
2	Conductor Failure	0.3	3.9	0.2	4.4	10%	88%	
3	Joint Failure	0.0	0.0	3.7	3.7	8%	97%	UP
4	Corrosion/Rot	0.0	0.0	0.7	0.7	2%	99%	
5	Tree Contact	0.0	0.5	0.0	0.5	1%	100%	
6	Normal Aging/Degradation	0.0	0.2	0.0	0.2	0%	100%	
	TOTAL	**28.4**	**8.9**	**5.8**	**43.2**			

* The YE2022 summary results above are only for the six-month period April through September 2021.

7.5 Restoration Times & SAIDI vs Event Numbers

In Section 7.4 Ergo noted that restoration/repair times appeared to be trending upwards, particularly in relation to Conductor Span events involving vegetation (refer to Section 7.4.1). We have thus examined the restoration/repair times for unplanned SAIDI and Figure 8 illustrates a graph of the percentage of events versus restoration/repair times for the three period of YE2020, YE2021 and YE2022. Examination of Figure 8 shows the following:

- The percentage of incidents restored/repaired within a given time is relatively consistent with some small variation.
- In YE2020 90% of events were restored/repaired within ≈15 hours, compared with YE2021/YE2022 when 90% of events were repaired with ≈12 hours.
- In YE2020/2022 80% of events were restored/repaired within ≈7.5 hours, compared with YE2021 when 90% of events were repaired with ≈4.5 hours

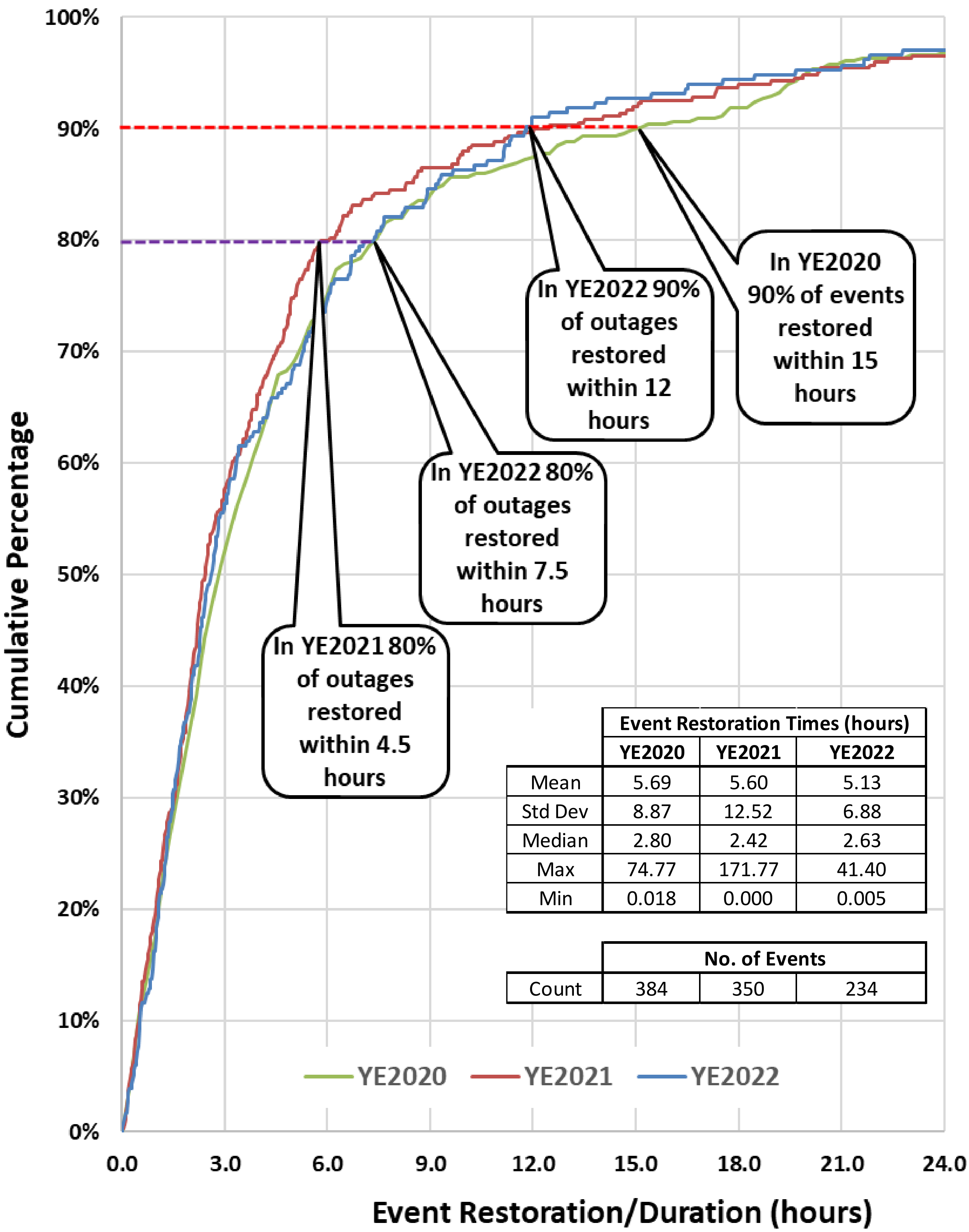
On face value Figure 8 does not provide evidence of any significant trends and we note that there is not a "linear translation" between event restoration/repair times and SAIDI due to each outage involving different amounts of consumers.

A more "definitive picture" is gained by examining the percentage of incidents versus SAIDI contribution which is illustrated in Figure 9. Figure 9 shows that in YE2022 the top 50% of SAIDI contributing events (i.e. greater than the median value) consistently contributed larger SAIDI amounts than that in YE2020 and YE2021. We note that this statement does not apply to ALL of the top 50% of events as, for example, in YE2020 there was a single event that contributed the most SAIDI of 25.36 minutes for the entire YE2020/YE2021/YE2022 period. These large events are typically limited to sub-transmission outages that occur rarely and impact a significant number of consumers (i.e. the Kaikohe-Kaitaia 110kV overhead line). We also note that Figure 9 does not necessarily support an "increasing trend" as the best performance occurred in YE2021 were the top 50% of SAIDI events where consistently lower.

Ergo has summarised the top 50% of SAIDI events by outage type in Table 15 and included a possible outcome involving the doubling of the recent six months of YE2022 SAIDI. Table 15 infers increases in SAIDI associated with the outage types of weather, unknown and vegetation.

There is the possibility that Figure 9 is not a fair comparison due to the fact that the YE2022 data only includes the autumn/winter/spring period. Given this fact, Ergo has repeated the results shown in Figure 9 but this time, in all cases, comparing the YE2020/YE2021/YE202 SAIDI data only for the period April through September. The results are shown in Figure 10 and they further confirm that the top 50% of YE2022 SAIDI contributing events consistently contributed larger SAIDI amounts than that in YE2021 and YE2020.

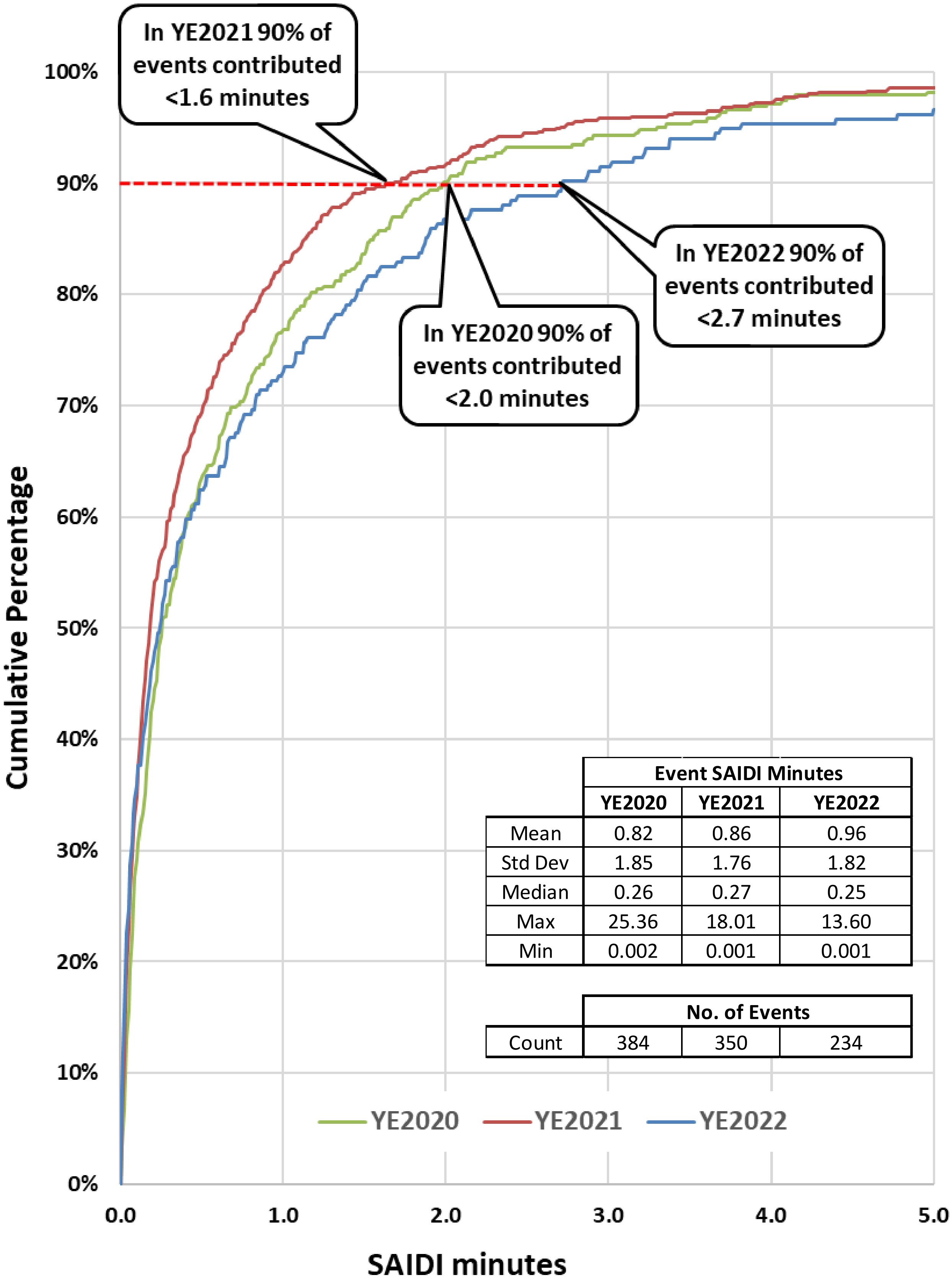
Ergo notes that TEN installed an Advanced Distribution Management System (ADMS) in 2020, which is used to calculate its SAIDI data. We recommend that TEN confirm that modifications to this system have not affected TEN's recorded unplanned SAIDI.



	Event Restoration Times (hours)		
	YE2020	YE2021	YE2022
Mean	5.69	5.60	5.13
Std Dev	8.87	12.52	6.88
Median	2.80	2.42	2.63
Max	74.77	171.77	41.40
Min	0.018	0.000	0.005

	No. of Events		
Count	384	350	234

Figure 8 Unplanned SAIDI events: Cumulative percentage vs outage time for YE2021/YE2020/YE2022.



	Event SAIDI Minutes		
	YE2020	YE2021	YE2022
Mean	0.82	0.86	0.96
Std Dev	1.85	1.76	1.82
Median	0.26	0.27	0.25
Max	25.36	18.01	13.60
Min	0.002	0.001	0.001

	No. of Events		
Count	384	350	234

Figure 9 Unplanned SAIDI events: Cumulative percentage vs SAIDI minutes for YE2021/YE2020/YE2022.

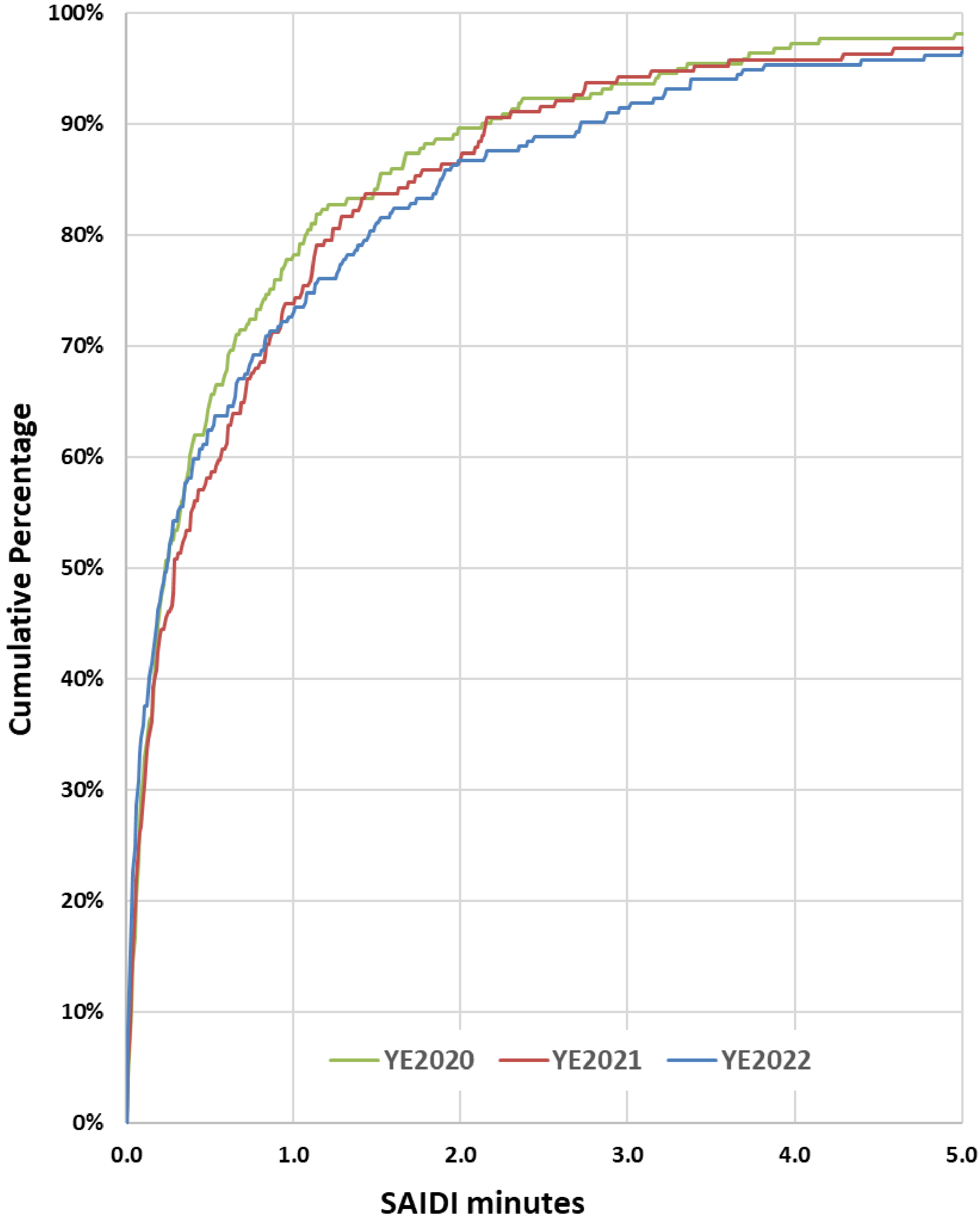


Figure 10 Unplanned SAIDI events: Cumulative percentage vs SAIDI minutes for YE2021/YE2020/YE2022 (All based on the April to September period).

Table 15: Summary: Top 50% unplanned SAIDI events by outage for YE2021/YE2020/YE2022

	YE2020				YE2021				YE2022				YE2022 - Doubled	
	SAIDI		Number		SAIDI		Number		SAIDI		Number		SAIDI	Number
Outage Type	mins	%	Count	%	mins	%	Count	%	mins	%	Count	%	mins	Count
Weather	2.3	1%	1	1%	0.3	0%	1	1%	24.2	11%	4	3%	48.4	8
Unknown	16.8	6%	24	13%	37.9	13%	31	16%	36.4	17%	20	17%	72.7	40
Vegetation	76.7	26%	56	30%	41.8	14%	43	22%	57.9	27%	26	23%	115.7	52
Defective Equipment	115.1	39%	70	37%	137.2	47%	89	45%	61.0	28%	44	38%	122.0	88
Environment	0.0	0%	0	0%	0.0	0%	0	0%	0.0	0%	0	0%	0.0	0
Third Party	58.1	20%	21	11%	56.0	19%	23	12%	28.7	13%	17	15%	57.5	34
Lightning	6.9	2%	6	3%	3.2	1%	3	2%	5.6	3%	2	2%	11.1	4
Human Error	4.0	1%	2	1%	13.3	5%	2	1%	0.0	0%	0	0%	0.0	0
Wildlife	13.0	4%	8	4%	1.1	0%	4	2%	3.2	1%	2	2%	6.3	4
TOTAL	**293.0**	**100%**	**188**	**100%**	**290.8**	**100%**	**196**	**100%**	**216.9**	**100%**	**115**	**100%**	**433.7**	**230**

7.6 Worst Feeder Performance by Cause

Section 7.3 presented the performance of TEN's distribution feeders. The following sections examine the causes of the unplanned SAIDI on TEN's five worst performing feeders (over the period YE2020/YE2021/YE2020).

7.6.1 Tokerau Feeder (Taipa Substation CB1205)

The following Table 16 illustrates the unplanned SAIDI recorded on the Tokerau feeder, which indicates a significant amount (50%) has been due to defective equipment (mostly x-arm failures). Third party damage has also contributed significantly (38%). There has been a small amount (5%) due to vegetation. The information in Table 16 infers that TEN should be focusing on refurbishing the equipment on the Tokerau feeder, particularly the x-arms.

Table 16 Unplanned SAIDI: Tokerau Feeder

Tokerau Feeder	**Unplanned SAIDI (minutes)**				
Tapia Substation CB1205	**YE2020**	**YE2021**	**YE2022**	**Sub-total**	
Defective Equipment	12.8	9.7	10.0	32.5	50%
Cable Termination	0.0	1.4	0.0	1.4	
Conductor Joint	0.3	0.0	0.0	0.3	
Fuse Base	0.3	0.0	0.0	0.3	
Lightning Arrestor	0.0	0.0	0.3	0.3	
Link	0.1	0.0	0.0	0.1	
Sectionaliser	1.1	0.0	0.0	1.1	
Tail/Lead/Jumper	0.0	2.1	0.0	2.1	
Xarm	10.9	6.2	9.7	26.7	
Third Party	19.3	0.1	5.4	24.8	38%
Pole	19.3	0.0	5.4	24.6	
Stay Assembly	0.0	0.1	0.0	0.1	
Unknown	0.6	1.8	1.3	3.7	6%
Unknown	0.6	1.8	1.3	3.7	
Vegetation	2.9	0.1	0.0	3.0	5%
Conductor Span	2.9	0.1	0.0	3.0	
Wildlife	0.9	0.0	0.2	1.1	2%
Conductor Span	0.0	0.0	0.2	0.2	
Link	0.9	0.0	0.0	0.9	
Grand Total	**36.5**	**11.7**	**16.8**	**65.0**	

7.6.2 South Road Feeder (Okahu Rd Substation CB1105)

Table 17 illustrates the unplanned SAIDI recorded on the South Road feeder, which indicates a significant amount (48%) has been due to *vegetation*. A lower contribution has been due to *defective equipment* (21%), *unknown* (16%) and t*hird party* (13%).

The information in Table 17 infers that TEN should be focusing on managing vegetation adjacent to the South Road feeder.

Table 17 Unplanned SAIDI: South Road Feeder

South Road Feeder	Unplanned SAIDI (minutes)				
Okahu Rd Substation CB1105	YE2020	YE2021	YE2022	Sub-total	
Defective Equipment	1.1	9.2	3.0	13.3	21%
Binder	0.2	0.6	0.0	0.9	
Conductor Joint	0.1	0.0	0.0	0.1	
Conductor Span	0.1	0.6	0.2	0.9	
Fuse Base	0.0	0.0	0.0	0.0	
Insulator (Pin)	0.0	0.3	0.0	0.3	
Insulator (Suspension)	0.5	5.6	0.0	6.1	
Link	0.0	0.2	0.0	0.2	
Regulator	0.0	0.0	2.3	2.3	
Tail/Lead/Jumper	0.0	0.9	0.2	1.1	
TX POLE MOUNT	0.0	0.0	0.0	0.0	
TX SWER DIST	0.1	0.0	0.0	0.1	
Xarm	0.1	1.0	0.2	1.2	
Lightning	2.0	0.0	0.0	2.0	3%
TX SWER INS	1.9	0.0	0.0	1.9	
Unknown	0.2	0.0	0.0	0.2	
Third Party	0.6	4.2	3.3	8.1	13%
Conductor Span	0.0	4.2	0.0	4.2	
Pole	0.0	0.0	3.3	3.3	
Stay Assembly	0.6	0.0	0.0	0.6	
Unknown	3.8	3.1	3.6	10.5	16%
Fuse Element	0.0	0.0	0.7	0.7	
Sectionaliser	0.0	0.1	0.0	0.1	
Unknown	3.8	3.0	2.9	9.7	
Vegetation	7.0	7.2	16.5	30.8	48%
Conductor Span	5.9	7.2	13.5	26.6	
Pole	0.0	0.0	3.0	3.0	
Xarm	1.2	0.0	0.0	1.2	
Wildlife	0.0	0.0	0.0	0.0	0%
Conductor Span	0.0	0.0	0.0	0.0	
Grand Total	**14.6**	**23.8**	**26.3**	**64.8**	

7.6.3 Te Kao Feeder (Pukenui Substation CB131142)

Table 18 illustrates the unplanned SAIDI recorded on the Te Kao feeder, which indicates the majority of SAIDI (66%) has been due to *defective equipment*. A moderate contribution has been due to *weather* (25%) and a small amount due to *vegetation*.

The information in Table 18 infers that TEN should be focusing on refurbishing the equipment on the Te Kao feeder, particularly x-arms and insulators.

Table 18 Unplanned SAIDI: Te Kao Feeder

Te Kao Feeder	Unplanned SAIDI (minutes)				
Pukenui Substation CB131142	**YE2020**	**YE2021**	**YE2022**	**Sub-total**	
Defective Equipment	16.4	10.3	9.5	36.2	66%
Binder	1.7	1.5	0.0	3.2	
Conductor Span	3.4	0.0	0.0	3.4	
Conductor Termination	3.2	0.0	0.0	3.2	
Fuse Base	0.1	0.0	0.0	0.1	
Insulator (Termination)	1.5	0.0	6.1	7.6	
Link	0.0	0.0	0.1	0.1	
MULTIPLE ITEMS	4.1	0.0	0.0	4.1	
Sectionaliser	0.0	0.0	0.0	0.1	
Stay Assembly	0.0	0.0	0.0	0.0	
Tx Dist	0.0	3.5	0.2	3.8	
TX POLE MOUNT	1.2	0.0	0.0	1.2	
TX SWER INS	1.1	0.0	0.0	1.1	
Xarm	0.0	5.2	3.1	8.4	
Lightning	0.0	0.0	0.0	0.0	0%
Fuse Base	0.0	0.0	0.0	0.0	
Unknown	1.0	0.4	0.0	1.5	3%
Link	0.0	0.1	0.0	0.1	
Sectionaliser	0.0	0.0	0.0	0.0	
Unknown	1.0	0.3	0.0	1.3	
Vegetation	0.0	3.2	0.0	3.2	6%
Conductor Span	0.0	3.2	0.0	3.2	
Weather	0.0	0.0	13.6	13.6	25%
Insulator (Pin)	0.0	0.0	13.6	13.6	
Wildlife	0.0	0.1	0.0	0.1	0%
Conductor Span	0.0	0.1	0.0	0.1	
Grand Total	**17.4**	**14.0**	**23.2**	**54.6**	

7.6.4 Horeke Feeder (Kaikohe Substation CB0111)

Table 19 illustrates the unplanned SAIDI recorded on the Te Kao feeder, which indicates a significant amount (53%) has been due to *defective equipment*. A lower contribution has been due to *third party* (19%) and *vegetation* (19%).

The information in Table 19 infers that TEN should be focusing on refurbishing the equipment on the Te Kao feeder and, to a lesser extent, vegetation management.

Table 19 Unplanned SAIDI: Horeke Feeder

Horeke Feeder	Unplanned SAIDI (minutes)				
Kaikohe Substation CB0111	**YE2020**	**YE2021**	**YE2022**	**Sub-total**	
Defective Equipment	1.7	18.8	2.7	23.2	53%
Conductor Span	0.1	0.0	0.0	0.1	
Fuse Base	0.0	0.9	0.0	0.9	
Insulator (Suspension)	0.0	2.2	2.7	4.9	
Link	0.0	0.0	0.0	0.0	
MULTIPLE ITEMS	1.4	0.0	0.0	1.4	
Recloser	0.0	0.0	0.0	0.0	
Tail/Lead/Jumper	0.1	0.1	0.0	0.2	
Tx Dist	0.0	0.0	0.0	0.0	
Xarm	0.1	15.6	0.0	15.7	
Environment	0.0	0.0	0.0	0.0	0%
Conductor Span	0.0	0.0	0.0	0.0	
Human Error	0.0	0.0	0.0	0.0	0%
Switch	0.0	0.0	0.0	0.0	
Lightning	0.0	0.0	0.0	0.0	0%
Fuse Element	0.0	0.0	0.0	0.0	
Third Party	3.9	4.0	0.3	8.2	19%
Cable Termination	0.0	0.0	0.0	0.0	
Conductor Span	0.0	0.0	0.3	0.3	
Pole	3.9	4.0	0.0	7.9	
Unknown	0.1	0.0	2.2	2.4	5%
Fuse Element	0.0	0.0	0.0	0.0	
Sectionaliser	0.0	0.0	0.9	0.9	
Unknown	0.1	0.0	1.4	1.5	
Vegetation	7.4	0.9	0.0	8.3	19%
Conductor Span	7.4	0.9	0.0	8.3	
Wildlife	1.8	0.0	0.0	1.8	4%
Conductor Span	1.8	0.0	0.0	1.8	
Fuse Element	0.0	0.0	0.0	0.0	
Grand Total	**14.9**	**23.8**	**5.3**	**44.0**	

7.6.5 Oruru Feeder (Tapia Substation CB1206)

Table 20 illustrates the unplanned SAIDI recorded on the Oruru feeder, which indicates a significant contribution (33%) has been due to *vegetation* and *third party* (26%). A lower contribution has been due to *defective equipment* (19%) and *unknown* (14%).

The information in Table 20 infers that TEN should be focusing on managing vegetation adjacent to the Oruru feeder, reviewing pole related third party damage and undertaking targeted refurbishment of the line equipment.

Table 20 Unplanned SAIDI: Oruru Feeder

Oruru Feeder	Unplanned SAIDI (minutes)				
Tapia Substation CB1206	**YE2020**	**YE2021**	**YE2022**	**Sub-total**	
Defective Equipment	1.8	2.7	1.3	5.8	17%
Conductor Span	0.0	0.3	0.0	0.3	
Other	0.0	0.2	0.0	0.2	
Switch	0.0	0.2	0.0	0.2	
Tail/Lead/Jumper	0.0	1.4	0.0	1.4	
TX POLE MOUNT	1.7	0.0	0.0	1.7	
Xarm	0.1	0.6	1.3	2.0	
Lightning	1.9	0.1	0.0	2.0	6%
Tx Dist	0.0	0.1	0.0	0.1	
TX POLE MOUNT	1.9	0.0	0.0	1.9	
Third Party	0.4	7.9	0.9	9.2	26%
Cable	0.4	0.0	0.0	0.4	
Pole	0.0	4.7	0.9	5.6	
Xarm	0.0	3.1	0.0	3.1	
Unknown	0.9	0.9	3.1	4.9	14%
Fuse Element	0.0	0.0	0.7	0.7	
Unknown	0.9	0.9	2.4	4.2	
Vegetation	5.8	1.4	4.2	11.4	33%
CONDUCTOR ROAD XING	0.9	0.0	0.0	0.9	
Conductor Span	4.8	1.4	4.2	10.4	
Weather	0.0	0.0	1.5	1.5	4%
Pole	0.0	0.0	1.5	1.5	
Grand Total	**10.8**	**12.9**	**11.0**	**34.7**	

8. Summary/Recommendations

Ergo has reviewed the information supplied and noted the following:

- Over the period 1999 through 2020 TEN's reported SAIDI has varied significantly, with its annual SAIDI (planned and unplanned) varying from 329 minutes (2001) to 1,838 minutes (2015) with an average of 575 minutes.
- Over the last decade TEN has invested a significant amount of capital on its network in an effort to stabilize its SAIDI performance. This expenditure was formulated in its TE2020 Project that has mostly focused on its sub-transmission network. The TE2020 Project has yet to be completed, but the expenditure appears to be delivering the benefits intended.

We have also analysed TEN's recent unplanned SAIDI data (YE2020, YE2021 and YE2022[8]) and have determined the following for the period considered:

- TEN's sub-transmission network has typically contributed ≈15% to its unplanned SAIDI performance. However, we note that the sub-transmission SAIDI can vary significantly due to high-impact-low-probability (HILP) events and its contribution could be higher from time-to-time.
- TEN's distribution network has typically contributed the vast majority of ≈85% to its unplanned SAIDI performance.
- Overall the unplanned SAIDI performance in YE2020 and YE2021 has been very similar.
- The April-September YE2022 data infers that the year-end unplanned SAIDI could be higher than the unplanned SAIDI recorded in YE2020 and YE2021. This view is based on doubling the YE2022 data and the fact that the unplanned SAIDI over the months of April-September in YE2020 and YE2021 contributed 38% and 49% respectively to the year-end totals.
- Over the period YE2020/YE2021/YE2022 the following are the outage types that have contributed to TEN's unplanned SAIDI:
    - *Defective equipment* (39%).
    - *Vegetation* (22%).
    - *Third Party* (18%).
    - *Unknown* (12%).
    - *Weather* (3%).
    - *Human Error* (2%).
    - *Wildlife* (2%)
    - *Lightning* (2%).
    - *Environment* (0%).
- The five worst performing sections of TEN's network have been associated with the following substation supplies (in order of performance):
    - Kaikohe substation.
    - Okahu Rd substation.
    - Taipa substation.
    - Pukenui substation.
    - Omanaia substation.
- The five worst performing feeders on TEN's (in order of performance):
    - **Tokerau feeder** (CB1205) fed from the Taipa zone substation. A high proportion of unplanned SAIDI on this feeder has been due to *defective equipment*.

[8] The data for this year only includes the period April 2021 through September 2021 (i.e. a six-month period).

- **South Road feeder** (CB1105) fed from the Okahu zone substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *vegetation* and the unplanned SAIDI is trending upwards.
- **Te Kao feeder** (131142) fed from the Pukenui zone substation. A high proportion of unplanned SAIDI on this feeder has been due to *defective equipment* and the unplanned SAIDI is trending upwards.
- **Horeke feeder** (CB0111) fed from the Kaikohe zone substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *defective equipment* and the unplanned SAIDI is trending upwards.
- **Oruru feeder** (CB1206) fed from the Taipa substation. A high proportion of the unplanned SAIDI reported against this feeder has been due to *vegetation* and *third party* and the unplanned SAIDI is trending upwards.

Collectively the above five feeders contributed 36% of TEN's unplanned SAIDI.

- The top five equipment categories that have contributed to 71% of TEN's unplanned SAIDI are (in order of magnitude):
  - **Conductor span**. The major causes of outages in this category (70%) relate to vegetation *Tree (Fall on Line)* and *Tree Contact*. The SAIDI contributions appears to be trending upwards.
  - **Pole.** The major cause of outages in this category (88%) related to *Vehicle-vs-Pole*. This category appears to be trending downwards.
  - **Unknown.** As the category name indicates the cause of the SAIDI event is unknown. This category is trending upwards.
  - **X-arm.** The major causes of this category are *X-arm Failure* and *Corrosion/Rot* and they appear to be trending upwards.
  - **Tail/Lead/Jumper**. The major causes of outages in this category are *Conductor Tail Blown Off*, *Conductor Failure* and *Joint Failure*. This category appears to be trending downwards.
- There is clear evidence that the SAIDI contributions of the higher value unplanned SAIDI events (i.e. 0.5 minutes to 5 minutes) have been larger in YE2022 than in the previous YE2020 and YE2021 periods. This is demonstrated by the fact that, for example, the 90th percentile YE2022 SAIDI event contributed 2.7 minutes as opposed to 2.0 minutes in YE2020 and 1.6 minutes in YE2021. The increase is not clearly demonstrated in the event restoration/repair times and the data indicates that the majority of outage types contributing to the increase in the higher value unplanned SAIDI events during YE2022 are as follows:
  - *Vegetation*.
  - *Unknown*.
  - *Weather*.

8.1 Recommendations

Ergo recommends that TEN consider the following actions:

- Initiating a project/programme that focuses on the worst SAIDI performing distribution feeders (for example, the five feeders discussed above), which could include the following initiatives:
  - The installation of additional line fault indicators (LFIs) to assist with the identification of fault locations and reduce restoration/repair times.
  - The installation of reclosers and/or sectionalisers to reduce the number of consumers exposed to faults and to improve restoration times. This should involve targeting the number of ICPs to be sectionalised by the devices.
  - Higher levels of and/or more focused vegetation management.
  - Targeted replacement of equipment reaching end-of-life, particularly cross-arms as the number of failures appears to be increasing.
  - Installation of additional feeders in order to reduce the number of ICP's supplied by individual feeders.[9]
  - Upgrading existing lines or installing new lines in order to improve feeder back-feed options and reduce consumer restoration times.
  - Ongoing use/expansion of TEN's ADMS[10] to improve information management and implementation of distribution automation.
- Investigate the underlying reason for the increasing unplanned SAIDI minutes that have been reported against the outage type of *Unknown*. There is not sufficient information in the SAIDI database for Ergo to determine the underlying reasons for the increase, but we note that the number of the *Unknown* events has been decreasing.
- Investigate the underlying reason for the increasing unplanned SAIDI minutes that have been reported against the outage type of *Vegetation*. This category is a major contributor to TEN's unplanned SAIDI reported in the *Device Affected* category of *Conductor Span* and the data infers that restoration/repair times associated with *Conductor Span* related *vegetation* outages are increasing.
- Detailed investigation and reporting of all unplanned SAIDI events that exceed, say, 1 minute, which would typically involve investigating ≈120 events/annum. A less onerous regime could involve SAIDI events that exceed 2 minutes and ≈50 events/annum. The output from these investigations should inform TEN's future SAIDI initiatives.

Given the size of the distribution network Ergo is of the view that TEN needs to initially focus its efforts on the worst performing sections/feeders. Furthermore, based on our previous experiences, we recommend that TEN ensure that any initiatives (and expenditure) are closely tracked and reported against to ensure that they are delivering benefit (i.e. SAIDI reductions). We expect that the benefits will not be immediate and only become evident over the long term, in the same manner as the benefits associated with TEN's YE2020 Project.

[9] For example, the Tokerau feeder supplies the highest number of ICPs (≈1500) and was the worst performing feeder over the 2020/2021/2022 period.

[10] Advanced Distribution Management System.

9. Appendices

Appendix 1 Glossary

ADMS	Advanced Distribution Management System
kV	Kilovolts
MW	Megawatts
MVArs	Mega Volt Amps Reactive
MVA	Mega Volt Amps
p.u.	per-unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index

Annexure 3

TOP ENERGY
Te Puna Hihiko
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Memo To: **Richard Krogh**
Nicole Anderson
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From: **Russell Shaw**

Date: **April 2022**

Subject: **Management of Distribution Network Reliability**

Purpose

This is an information paper that discusses an asset management strategy review that we are currently undertaking to improve the reliability of supply provided by our 11kV distribution network.

Introduction

In the FYE22 financial year our network experienced two severe weather events, the first in August 2021 and the second in February 2022. After the first event, there was a concern of the risk of breaching the quality threshold set by the Commerce Commission under our price-quality path for the RP3 regulatory period Ergo were engaged to undertake a critical review of the then current and past 2 years unplanned network outage performance. This report was presented to the Board in November 2021.

Following the subsequent weather event, we undertook a further internal review of how successful our current asset management strategy has been in achieving its reliability objective. We found that there is no potential to further improve the reliability of our subtransmission network and that any further reliability improvement will come from improvements in the reliability of the 11kV distribution network.

This paper advises the Board that we are reviewing our asset management work programme that would accelerate the improvement in the reliability of the 11kV distribution network without exceeding the approved network expenditure level. This will involve deferring the Wiroa substation build and possibly implementing interim measures to manage the network capacity risk. The expenditure allocated to Wiroa, less the cost of any interim measures, would be reallocated to the maintenance and development of the 11kV network.

Background

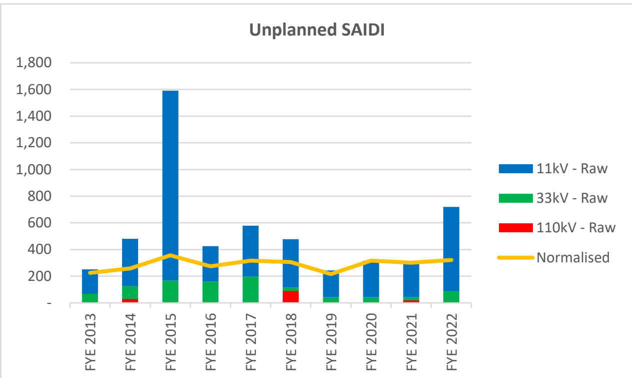
In 2011 the Board approved TE2020, a network development plan designed to achieve three overarching objectives:

- Elimination of annual nine-hour planned supply interruptions in the northern area to allow maintenance on the incoming 110kV line. This has been achieved through the installation of diesel generation, rather than though the second incoming circuit envisaged when TE2020 was conceived.

- Increasing network capacity as required to meet the localised growth in demand in the Kerikeri area. Our network was developed at a time when economic activity in our supply area was centred around Kaikohe and Kaitaia, and the transmission substations in our supply area were located accordingly. Over the last thirty years there has been a significant demographic shift and demand growth on our eastern seaboard has been substantial. We have built a new double circuit 110kV line between Kaikohe and Wiroa (currently operating at 33kV), a 33kV switching station at Wiroa and new 33/11kV substations at Kerikeri and Kaeo. However, localised load growth in the area remains high and, notwithstanding these investments, there remains an emerging constraint where there could be insufficient network capacity to supply the peak demand in the Kerikeri area under a worst-case N-1 contingency. A new 110/33kV substation at Wiroa would address this constraint and provide ample network capacity to meet the foreseeable network demand well beyond our 10-year AMP planning period. Engineering design of this new substation is in progress and construction work is planned to commence in the current year.
- Improvement in network reliability to a level comparable to that provided by other New Zealand EDBs supply rural communities. Expenditure to date has focused on improving the reliability of the 33kV network and we have been very successful in achieving this objective. The price quality trade off means that we would not increase reliability to those target levels over the RP3 period, however the next logical step is to increase the development of the 11kV distribution network.

Overall Network Reliability

Figure 1 shows the actual (raw) reliability of the network over the period FYE2013-22[1] and compares it with the normalised metric currently used by the Commission in assessing compliance with the quality threshold in our regulated price-quality path. Normalisation is used to limit the impact of extreme weather conditions and the normalised measure is designed to better reflect the level of reliability that can reasonably controlled by network managers. Top Energy uses the Commission's normalised measure for setting reliability targets and reporting reliability outcomes.[2]



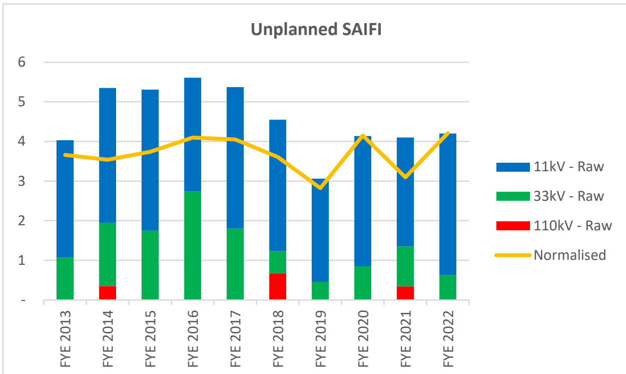


Figure 1: Raw and Normalised Network Reliability FYE 2013-22

1 FYE 2022 reliability does not include the impact of interruptions that occurred in March 2022.

2 The current normalisation methodology was developed by the Commission in late 2019 to apply for the RYE 2021-25 regulatory period (RP3). We have "reverse engineered" prior year reliability by applying the currently approved normalisation algorithm to the actual reliability experienced each year.

The graphs in Figure 1 indicate the following:

- The high levels of raw SAIDI experienced in FYE 2015 and FYE 2022 were due to abnormally severe storm events. If these are treated as outliers, there has been an overall improvement in actual network reliability over the period. However, this improvement is not reflected in the normalised measure, or in the raw reliability experienced in the most recent four-year period.
- Unplanned interruptions of the 110kV network are infrequent, and expenditure on eliminating extended planned 110kV line maintenance interruptions in the northern area have not had a material impact on unplanned network reliability.
- Almost all the reliability improvement experienced to date is due to the significant improvement in the reliability of the 33kV subtransmission network experienced after FYE 2017. This was due to the completion of a programme to upgrade to the protection systems on the 33kV network to allow two 33kV lines supplying a single substation to operate in parallel. As most of our zone substations have two incoming supplies, most 33kV faults no longer cause a supply interruption.[3]
- We have now reached the point where the reliability of the 33kV network is as good as we can realistically achieve. *Any further improvement in overall network reliability will come from an improvement in the performance of the 11kV distribution network.*

Distribution Network Reliability

In its last two regulatory reviews the Commission has set its reliability thresholds on the basis that an EDB should not allow its reliability, on average, to fall below the average reliability delivered during the most recent 10-year historic period for which data is available. Figure 2 shows the trend in the impact of 11kV interruptions (outside of major event periods) over the review period. Using only 11kV data, both SAIDI and SAIFI exhibit a rising trend. With that in mind we are looking at focusing on replacement and development of the 11kV network.

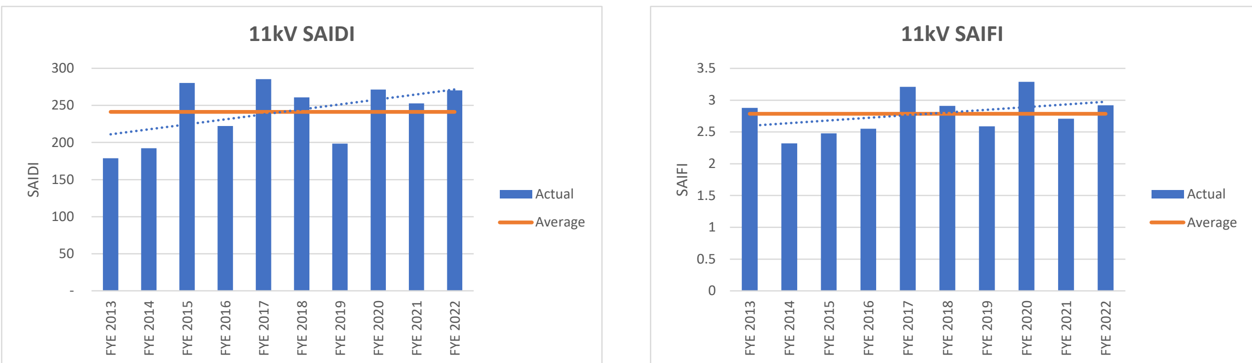


Figure 2: 11kV Reliability FYE 2013-22

[3] This is the reason that most major events requiring normalisation occurred in the early years of the period. Prior to FYE 2018, a 33kV fault would likely have triggered a major event requiring normalisation whereas, after completion of the protection upgrade, the same fault does not even cause a supply interruption.

Interruptions caused by faults on the distribution network now account for more than 80% of our normalised SAIDI and SAIFI. Improving the reliability of our 11kV distribution network is challenging for the following reasons:

- The distribution network has a much higher fault exposure than the subtransmission network. We have approximately 2,600km of overhead distribution line compared to 330km of subtransmission line. Reliability improvement initiatives such as asset renewal or vegetation management have only a localised incremental impact on overall reliability.
- The network in rural areas is characterised by long feeders, each with a high number of connected customers. The network has a total of 60 feeders, 18 of which have more than 1,000 connected consumers. This is a legacy issue; the network was designed to provide an electricity supply to a remote, sparsely populated rural area, with little regard to measuring supply reliability.
- Much of our rural network has always been uneconomic to serve. This has made it difficult to justify substantial investment in this part of the network. There is little evidence that customers in the more remote, less well served parts of our supply area are prepared to pay more for an increased reliability of supply.

The Ergo report recommended that we initiate a programme that focuses on the worst SAIDI performing distribution feeders and provided as a guide, various recommendations and initiatives.

These options have differing levels of cost and effectiveness. We are in the process of preparing a distribution network reliability improvement plan that will optimise the application of the different options to suit the specific requirements of our network balancing reliability improvement and cost. The rate at which we can implement this improvement plan will depend on the availability of funding.

Reallocation of Expenditure

The capital expenditure forecast in the 2022 AMP Update is heavily weighted toward the transmission and subtransmission network. A total of $80.3 million (59%) of the $136.3 million capital expenditure (excluding customer driven expenditure relating to new connections and reactive expenditure on fault and defect remediation) over the period FYE 2023-32 is on the transmission and subtransmission network. The bulk of this expenditure is allocated to two large projects, the Wiroa 110/33kV substation and the construction of the Wiroa-Kaitaia 110kV line.

The design of the Wiroa substation is well advanced, and construction is due to start this year. The cost of this project in the 2022 AMP Update capital expenditure forecast is $9.6 million to be spent over the period FYE 2023-25. However, this cost does not include known cost increases after FYE 2023. If construction of this project could be deferred the funding would be immediately available for the development and renewal of the 11kV network. If the substation was constructed later in the planning period it could be then funded from expenditure allocated to the new 110kV Wiroa-Kaitaia line, which now appears likely to be largely funded by capital contributions. Based on the actual cost of construction of the 110kV line to evacuate the power from OEC4 at Ngawha, the provision in the forecast for the construction of the 110kV line is likely understated by a significant margin.

The following section considers the implications of deferring the Wiroa substation build and evaluates the risk of this strategy to Top Energy.

Deferral of Wiroa Substation

The driver for the construction of the Wiroa substation is Top Energy's deterministic planning criterion for the subtransmission network, which requires there be sufficient network capacity to ensure that supply is not interrupted during an outage of a single transmission element. We presented a paper to the Board in August 2020 that demonstrated how the 33kV voltage at Kaeo was affected if the 110kV construction line between Kaikohe and Wiroa was removed from service. This is shown in Figure 3. The paper forecast that by 2024 the voltage at Kaeo would fall below the voltage limit in this scenario, which would mean that the voltage supplied to consumer on the fringe of the network would fall below the statutory minimum. The construction of the Wiroa substation has been timed to prevent this situation arising.

Peak demand in the Kerikeri area has been growing since FYE2016. In the 2015 winter the sum of the actual peak demands of the substations in the Kerikeri Area was 17.4MVA but by 2020 this had risen to 20.9MVA[4], a growth rate of 4%. There is no sign of this growth abating, and we are aware of a number of potential developments in the Kerikeri area that will increase the electricity demand if they proceed.

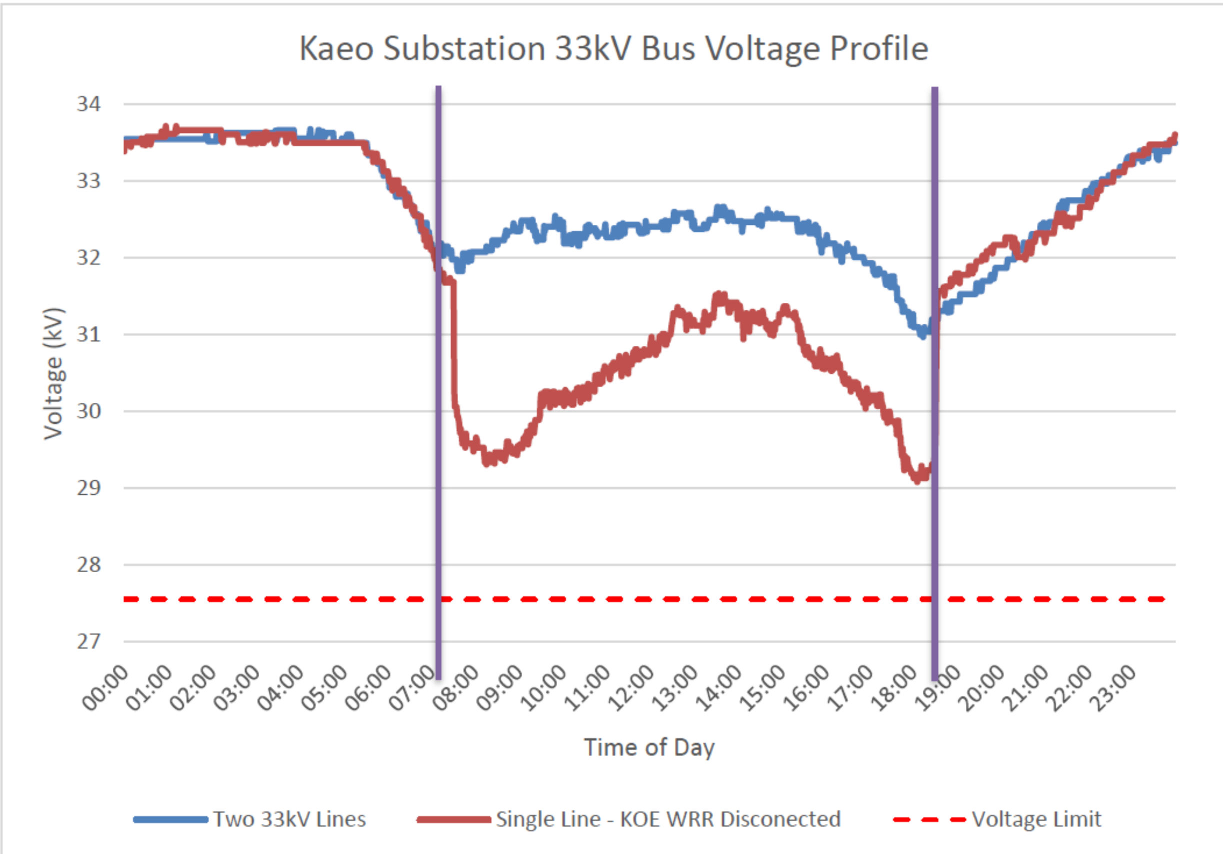


Figure 3: Impact of Kaikohe-Wiroa Line Fault on Kaeo 33kV Voltage

4 Data taken from the 2016 and 2021 AMPs.

While good electricity industry practice has traditionally required this type of deterministic assessment to drive development, best practice is now to take a probabilistic approach to network planning. This risk-based approach permits deterministic planning criteria to be breached, provided a proper risk assessment is undertaken and any residual risk, after mitigation, is acceptable to the business and its stakeholders. Risk is a combination of both probability and consequence. In this case, the following factors are relevant.

Probability

- The situation does not arise if the lower capacity Kaikohe-Mt Pokaka-Wiroa line is out of service, as the direct 110kV construction line has ample capacity to supply the load.
- There is only a concern if the direct 110kV construction line supply is lost at times of peak demand. This is for a period of about six weeks in July/August and then only between about 8-10am and 5-7pm on weekdays. Outside this window, the Kaikohe-Mt Pokaka circuit has sufficient capacity to meet the demand.
- The probability of an unplanned Kaikohe-Wiroa line outage at any time, is very low. The most probable fault causes are vegetation or a pole top hardware failure. The vegetation risk can be actively managed, and the risk of a pole top hardware failure is low as all hardware is relatively new.

Consequence

Should there be an unplanned interruption of the Kaikohe-Wiroa line at a time of peak demand the control room operator would need to ensure that the maximum demand on the Kaikohe-Mt Pokaka-Wiroa circuit was not exceeded. Some load, such as the load on the Totara North feeder, could be transferred to substations not normally supplied from Wiroa, but this transfer capacity is limited. The operator would also ensure that all controllable load, such as water heating was turned off, but this is likely to be the case during peak demand periods. Any further excess demand would need to be shed by the operator until the peak demand period was over, but there would be potential to rotate the interruptions to limit the time any one consumer is without power. The maximum demand that would need to be interrupted would be the difference between the actual demand and the demand that could be supplied through the Mt Pokaka circuit.

Comment

In the short term (3 to 5 years) we consider the risk to Top Energy of deferring the Wiroa build to be low, given the small probability of an event occurring, the limited amount of load that would need to be shed and the relatively short window before demand would drop below the reduced network capacity. In the unlikely event that a situation did arise where load shedding was required, the impact on consumers would be minimal. It is unlikely such an event that would cause widespread stakeholder concern.

The consequences will increase as demand in the area increases over time, as more load would need to be shed potentially for a longer period and there is little doubt that a 110kV substation will eventually be required.

However, it may be possible to mitigate the risk and even further defer the need for the Wiroa build by installing a switched 33kV capacitor bank to provide voltage support. We are investigating the cost of this and modelling the impact. Once the 110kV Wiroa substation was commissioned, the capacitor bank would be redeployed to Kaikohe to replace the existing bank there, which will be due for replacement in about ten years.

A possible non-network solution that could also defer the need for the Wiroa substation build would be a battery installed in conjunction with a solar farm connected to the 33kV subtransmission network supplied from Wiroa.

Recommendation
That the Directors accept this paper for information and endorse our plan to revise our 11kV network asset replacement and development plan to be funded by deferring the Wiroa build.

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Prepared by:
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Annexure 4

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Memo To: **Richard Krogh**
Nicole Anderson
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From: **Russell Shaw**

Date: **May 2022**

Subject: **AMP Work Programme Review**

Purpose

The paper is seeking Board approval to initiate further 11kV reliability improvement projects to improve the reliability of supply provided by our 11kV distribution network by deferring the Wiroa substation build (as presented as a paper titled *Management of Distribution Network Reliability)*. This paper discusses details of an asset management strategy planned to realize the improvements. ***This paper seeks approval of the plan to revise our 11kV network asset replacement and development plan, funded by deferring the Wiroa substation build.***

Introduction

The purpose of this document is to outline our capital expenditure plan for improving the reliability of the distribution network. The plan utilizes a number of reliability strategies identified in the recent ERGO report Network Reliability – Unplanned SAIDI Review and is focused on those parts of the network where the reliability is known to be poor. Whereas the ERGO report focused solely on SAIDI, our plan includes initiatives designed to improve both SAIDI and SAIFI.

We see this plan as a boost to our distribution network reliability improvement journey. The projects in the first year of the plan address identified problem areas in the network, and conceptual designs for most projects have already been completed. We plan to undertake further analysis into the cause and location of faults in our network and use this as a basis for developing a more detailed plan going forward. While the more detailed plan will be included in our 2023 AMP, this document outlines our current development.

Note that network diagrams are appended.

Vision

Our vision is to progressively improve our network reliability as reported to the Commerce Commission and used to determine our compliance with the quality threshold in our price-quality path. As we have extracted all the realistically achievable reliability improvements from our transmission and sub-transmission networks, this must be achieved by improving the reliability of the distribution network.

Executive Summary

This paper introduces the strategies to be employed, the initial areas we will target, and the estimate of potential SAIDI/SAIFI impact we aim to achieve from deferring the 2022 AMP Update capital expenditure forecast for the construction of the Wiroa substation of $3,089,000 (FYE23 budget) and funding 11kV reliability projects at an estimated cost of $2,935,000.

The strategies are planned for FYE 23 to FYE 25 and with continual monitoring of eastern seaboard loading has the potential to extend out further dependent on load growth and whether alternative technologies *(ref Management of Distribution Network Reliability)* are suitable to be utilized to defer the Wiroa substation build out further.

Projects as scheduled in this paper for the current year are firm. The designs for these projects are, in most cases, substantially complete and we are currently developing more accurate cost estimates prior to the preparation of the relevant Board Papers seeking expenditure approval where required.

Projects scheduled for subsequent years are tentative, pending completion of designs, cost estimates and analysis of the expected reliability impacts. Over the next 9 months these will be worked on, and a firm project stream will be included in the 2023 AMP.

Our strategies include:

- Distribution automation
- Splitting of feeders/new Injection points
- Interconnection and tie points
- Asset renewals

Wiroa Budgeted Costs:

FYE23	*FYE24*	*FYE25*
$3,089,143	$3,543,331	$2,946,413

Planned costs ($000's) for the current financial year are:

South Road feeder distribution automation - construction	$300
Horeke feeder distribution automation	$300
Rangiahua – South Rd feeder interconnection - design	$50
Whangaroa – Matauri Bay feeder interconnection - construction	$885
Te Kao feeder asset renewals	$550
Tokerau feeder asset renewals	$600
Ground mounted feeder asset replacements	$500
Total	**$2,935**

Estimated Reliability Impact

The estimated SAIDI and SAIFI impacts of these initiatives are summarised in the Tables below. It is assumed that the impacts will not be apparent until the year following the completion of each project. The figures presented include current deterioration. Whereas the impacts of the project improvements do not change, on average from year to year, the impact of the underlying deterioration is additive. The full impacts are presented in tables 19 and 20 in the full summary.

Overall impact of SAIDI improvements

	FYE 2024	FYE2025	FYE2026	FYE2027
Estimated SAIDI improvement	**14.51**	**15.85**	**28.56**	**21.98**

Overall impact of SAIFI improvements

	FYE 2024	FYE2025	FYE2026	FYE2027
Estimated SAIFI improvement	**0.114**	**0.187**	**0.340**	**0.340**

Strategic Overview

The following broad strategies are available to improve network reliability:

- *Prevent the occurrence of a fault.* This can be achieved through more aggressive vegetation management, potentially by using automated segmented protection to isolate a faulted zone and increased expenditure on asset renewal.
    - More aggressive vegetation management can be effective as locations within the network that are most susceptible to vegetation interruptions can be identified and targeted. However, vegetation management must be sustained to avoid the impact of regrowth. As vegetation management is an operational rather than capital expenditure, it is not part of the capital expenditure plan described in this paper.
    - Expenditure on asset renewal may not have an immediate impact in reliability because of the very large number of assets that make up the network and the random location of asset failures. That said, the overall reliability of the network will increase over time if the rate of asset renewal is greater than the natural deterioration of network assets. Conversely, insufficient expenditure on asset reliability will cause network reliability to deteriorate, although this deterioration may not be immediately apparent.

- *Reduce the number of customers interrupted when a fault occurs.* Two strategies are available:
    - Introduce shorter feeders with fewer connected customers. This typically requires the construction of new substations and can be cost prohibitive. Alternatively, an 11kV “sub-transmission” line, with no connected customers, could be constructed to supply an 11kV switching station that would serve as the injection point for local feeders. This would avoid the cost of power transformers and 33kV switchgear.
    - Optimize the number, location, and grading of protection devices on a feeder to minimize the number of customers connected upstream of a fault location that are interrupted when a fault occurs. This strategy, which is also referred to as feeder automation, can be a cost-effective way of improving the reliability of long rural feeders.

- *After a fault occurs, reduce the time taken to locate the fault and restore supply to customers outside the faulted zone.* This approach includes:
    - Increasing the number of fault indicators throughout the network. There is already provision for this in the FYE2023 workplan,
    - Installing remote controlled switches across the network. This is an approach that has already been used extensively by Top Energy.
    - Increasing the number of normally open connection points between adjacent feeders. This allows customers downstream of a fault location to be supplied from an adjacent feeder while a fault is repaired. These can be costly as they involve the construction of new lines.

A disadvantage of this strategy is that it has no SAIFI impact as it does not reduce the number of customers affected by an interruption.

Our plan utilizes the following reliability improvement strategies:

- Distribution automation
- Splitting of feeders/ new Injection points.
- Interconnection and tie points
- Asset renewals

For each strategy we have developed a potential project stream, as discussed in the sections below. Projects scheduled for the current year are firm. The designs for these projects are, in most cases, substantially complete and we are currently developing more accurate cost estimates prior to the preparation of the relevant Board Papers seeking expenditure approval. Projects scheduled for subsequent years are tentative, pending completion of designs, cost estimates and analysis of the expected reliability impacts. A firmer project stream will be included in the 2023 AMP.

1. DISTRIBUTION AUTOMATION

Distribution automation involves optimizing the number, location, and grading of the protection devices on a feeder. Distribution automation is perhaps the most cost-effective way of improving the reliability of the long rural feeders that characterize much of our 11kV network and have the highest SAIDI and SAIDI impact. For this reason, our distribution automation project stream focuses on the five worst performing feeders identified in the ERGO report. These are shown in Table 1.

Table 1 – Worst five feeders identified in the ERGO report

			Unplanned SAIDI			
No	**Substation-CB**	**Feeder Name**	**FYE2020**	**FYE2021**	**FYE2022[1]**	**All**
1	Taipa-1205	Tokerau	36.5	11.7	16.8	65
2	Okahu RD - 1105	South Rd	14.6	23.8	26.3	64.8
3	Pukenui-1331142	Te Kao	17.4	14	23.2	54.6
4	Kaikohe-0111	Horeke	14.9	23.8	5.3	44
5	Taipa-1206	Oruru	10.8	12.9	11	34.7

Note 1: FYE 2022 SAIDI impact is for the first six months of the year only.

1.1 South Road Feeder:

We have chosen the South Rd feeder as the initial focus of our distribution automation reliability improvement strategy. It is our longest feeder and supplies most of the North Hokianga area. Historically, this has been our worst performing feeder and our planning section has considered how its reliability might be improved over a number of years. Hence design work for the upgrade is complete. With funding available, the project can be implemented relatively quickly. The estimated cost is below $500,000, and provided the Board accept the recommendation, we could proceed with this project without submitting a Board Paper requesting formal approval.

Table 2:- Proposed build year and estimated cost

FYE2023	Protection equipment	$300,000

Estimated SAIDI/SAIFI impact

We have assumed that feeder automation will improve the reliability of the South Rd feeder by 20%, net of the gains obtained through the new Kaitaia injection point, but caution that there is currently a high level of uncertainty around this assumption. Based on the average SAIDI over the FYE 2018-22 period, the estimated reliability improvement is shown in the table below.

Table 3: Estimated Reliability Impact of South Rd Feeder Automation

Network Section	**SAIDI Reduction**	**SAIFI Reduction**
South Rd Feeder	3.54	0.026

1.2 Horeke Feeder

We are currently designing a network automation scheme for the Horeke feeder. While the design and cost of this work have still to be finalised, we have allocated $300,000 from the FYE 2023 capital expenditure budget to allow this project to commence in the current year. The project will be completed in FYE 2024.

Table 4:- Proposed build year and estimated cost

FYE2023	Protection equipment	$300,000
FYE2024	Protection equipment	TBA

Estimated SAIDI/SAIFI impact

We have assumed that feeder automation will also improve the reliability of the Horeke feeder by 20%, but again caution that there is currently a high level of uncertainty round this assumption. Based on the average SAIDI over the FYE 2018-22 period, the estimated reliability improvement is shown in the table below.

Table 5: Estimated Reliability Impact of Horeke Feeder Automation

Network Section	*SAIDI Reduction*	*SAIFI Reduction*
Horeke Feeder	*5.63*	*0.054*

1.3 Other Feeders

As shown in Table 3 we are planning to progressively install feeder automation on the remaining worst performing feeders, as identified in the ERGO report over the next four years. Design work on the Horeke feeder is in progress and we are looking to commence this work in the current year. The reliability impacts are estimated on the basis of a 20% reduction on the average normalised SAIDI and SAIFI impacts over the FYE2018-22 period.

Table 6: - Ongoing distribution automation programme:

		Cost	SAIDI Reduction	SAIFI Reduction
Tokerau	Proposed: FYE2024	TBA	3.23	0.036
Te Kao	Proposed: FYE 2025	TBA	2.71	0.020
Oruru	Proposed: FYE2026	TBA	2.17	0.025

2. SPLITTING OF FEEDERS & NEW 11KV SUPPLY POINTS

2.1 Russell Reinforcement

The Russell peninsula is currently supplied through a submarine cable under the Waikare inlet. This cable is supplied from the Kawakawa substation by an 11kV overhead "express" line. There is a backup submarine cable under the Veronica Channel between Opua and Okiato Point, supplied from Haruru substation via the Joyces Rd feeder. This cable currently supplies the Okiato Point settlement and has a normally open connection to the Russell Express feeder. Downstream of this connection point there is a single radial feeder.

We are currently halfway through a two-stage project that will allow the Joyces Rd feeder to share the peninsula load. This involves shifting the normally open point between the two feeders to the Rawhiti spur connection point and installing a remotely controlled switching station at the new connection point. An 11kV cable between the old and new normally open connection points was installed last year (FYE2022) and the switching station is being installed in the current year to complete the project and allow the two feeders to operate in parallel.

This is not a new project as funding is already provided for in the current work plan. It is included in this paper for completeness, as the SAIDI/SAIFI improvements have still to be realised.

Estimated SAIDI/SAIFI impacts

The estimated SAIDI impact is 50% of the average annual SAIDI on the Russell Express feeder over the FYE2018-22 period.

Table 7: Estimated reliability impact of Russell Reinforcement project

Network Section	*SAIDI Reduction*	*SAIFI Reduction*
Russell peninsula	*4.69*	*0.073*

2.2 Kaitaia 11kV Distribution Substation

The 40MVA 110/33kV transformer installed some years ago at the Kaitaia transmission substation has an 11kV tertiary winding that is not currently being utilised. It is planned to connect this winding to a new ground-mounted, outdoor 11kV switching station comprised of ring-main circuit breakers to provide a new injection point into the South Rd and Oxford St feeders. This will split the South Road feeder into three shorter feeders, and the Oxford St feeder into four, each with fewer connected consumers.

The Kaitaia substation is only about 13km from the Okahu Rd substation and most of the faults on the South Rd feeder occur downstream of the new injection point. However, about 7km of the line between Okahu Rd and the Kaitaia substation runs along State Highway 1 where there have been a significant number of vehicle vs pole events. These currently have a high SAIDI and SAIFI impact as the whole feeder is affected and each incident generally requires a pole replacement. A new downstream injection point will significantly reduce the impact of such events.

Table 8: Proposed build year and installed cost:

FYE2024	*Substation*	*$700,000*
FYE2025	*Feeder Connections*	*$600,000*

Estimated SAIDI/SAIFI impacts
This project will improve the SAIDI/SAIFI impact of faults on the relatively short section of the South Rd feeder between Okahu Rd and the Kaitaia substation and on all of the Oxford St feeder. It will also result in a slight reduction in the impact of faults downstream of the Kaitaia substation due to the marginally smaller number of connected customers interrupted by faults between the Kaitaia substation and the sectionaliser at Broadwood. For this estimate we have assumed that there are 50 connected customers between the Okahu Rd and Kaitaia substations.

There have been only four faults over the last 5 years (FYE2018-22) on the South Rd feeder upstream of the Kaitaia substation. The average annual SAIDI/SAIFI impact of these faults over the period has been 0.87 and 0.020 respectively. Prior to this project each fault impacted all 840 customers on the feeder. On completion of the project this section of line will be split into two and so each fault on this section of feeder is assumed to impact only 25 customers.

We have also assumed that the SAIDI/SAIFI impact on the Oxford St feeder will be reduced by 70% as a result of this project.

Using the average annual normalised SAIDI over the 5-year FYE2018-22 period as a baseline, our estimate of the reliability impact of this project is shown in Table 9 below.

Table 9: Estimated reliability impact of Kaitaia 11kV substation:

Network Section	SAIDI Reduction	SAIFI Reduction
South Rd feeder – Okahu Rd-Kaitaia	0.85	0.019
South Rd feeder – Kaitaia-Broadwood	0.29	0.021
Oxford St feeder	7.22	0.118
Total	**8.36**	**0.158**

3. FEEDER INTERCONNECTION AND TIE POINTS

These projects involve the construction of new 11kV lines to provide normally open interconnections between adjacent feeders. After a fault is located, the normally open interconnecting switch can be closed to restore supply to customers downstream of the faulted feeder switching zone.[1] The objective of installing additional feeder interconnections is to reinforce the network to increase the likelihood of being able to restore supply to downstream customers after a fault occurs. As noted above, this intervention does not reduce the number of customers initially affected by a fault and so has no impact on SAIFI.

There are a number of interconnection projects that have been recognised in the AMP for some years. With funding available, it is planned to proceed with the following two projects, for which the design is substantially complete.

3.1 Rangiahua & South Road feeders

This project involves the construction of an 11kV line to provide an interconnection with the South Rd feeder at Broadwood. On the South Rd feeder, it will allow supply to be restored downstream of

1 A switching zone is a section of feeder in between two adjacent isolating points. When a fault occurs it is normally possible to restore supply to upstream consumers before the fault is repaired and, depending on the network configuration, it may be possible to restore supply to downstream consumers. Consumers within a faulted switching zone normally have to wait until the fault is repaired before supply is restored.

switching zones located between Broadwood and Okahu Rd, but not downstream of switching zones located south of Broadwood[2]. On the Rangiahua feeder it will allow the restoration of supply downstream of most of the feeder, apart from the relatively short section north of Mangamuka.

Due to the length of both feeders, there is a need to install a voltage regulator to provide voltage support when the two feeders are interconnected. Design work for this has still to be completed.

Table 10:- Proposed build year and estimated installed cost:

Rangiahua & South Rd	FYE2023 FYE2024 FYE2025	Volt Reg Design Line build stage 1 Line Build Stage 2	$50,000 $757,000 $885,000

Estimated SAIDI/SAIFI impact

This project will allow for the back-feeding of switching zones between Broadwood and Kaitaia on the South Rd feeder north of Okaihau on the Rangiahua feeder. We have assumed a 90% reduction in SAIDI for faults in these parts of the network. As noted above, interconnections will not prevent the initial customer interruptions so there will be no impact on SAIFI.

Table 11: Estimated reliability impact of Rangiahua-South Rd feeder interconnection:

Network Section	**SAIDI Reduction**	**SAIFI Reduction**
South Rd Feeder	4.41	-
Rangiahua Feeder	5.98	-
Total	**10.39**	**-**

3.2 Whangaroa and Matauri Bay Feeders.

These feeders are supplied from the Kaeo substation, and both have long backbones and relatively short spurs. The new line will interconnect the ends of the two backbones to form a ring, split into two radial feeds by a normally open interconnection. With this configuration it will be possible to restore supply to all downstream consumers, irrespective of the location of the faulted switching zone.

Table 12:- Proposed build year and estimated installed cost:

Whangaroa & Matauri Bay	FYE2023	Design Done. Line Build	$875,000

Estimated SAIDI/SAIFI impact

We have assumed a SAIDI reduction of 90% of the average FYE2020-22 normalised SAIDI reduction across the two feeders. In this case SAIDI has only been averaged over three years since the network has only been in its current configuration since the commissioning of the Kaeo substation.

Table 13: Estimated reliability impact of Whangaroa-Matauri-Bay feeder interconnection:

Network Section	**SAIDI Reduction**	**SAIFI Reduction**
Whangaroa and Matauri Bay feeders	11.24	-

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2 Broadwood is located approximately halfway along the South Road feeder.

3.3 Other Feeder Interconnections and Tie Points

A number of other potential interconnections have been identified for potential implementation going forward. These include (with possible years):

- Rangiahua and Oruru: – FYE25/26
- Awanui and Oxford St: - FYE26/FYE27
- Aerodrome Rd and Puketi: – FYE26
- Puketona and Moerewa: – FYE24/25.

Further work is required on each of these projects to confirm line routes and develop designs, prepare estimates of the cost and the SAIDI impact of each project. At this stage it would appear that in each case the SAIDI impacts will be significantly lower than the impacts of the above two projects.

4. ASSET RENEWAL

4.1 Te Kao Feeder

Table 14:- Proposed build year and installed cost:

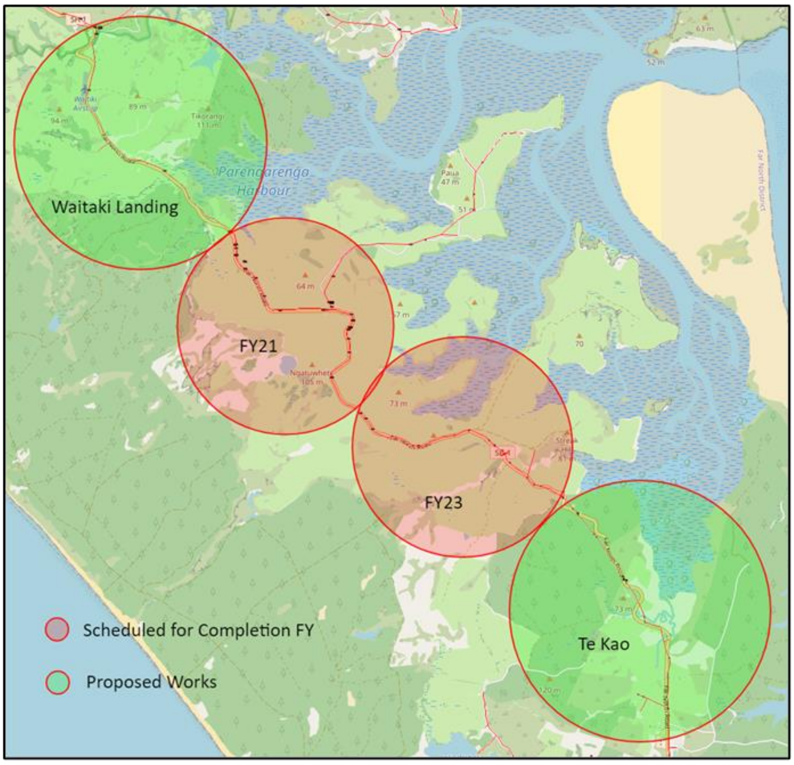
Te Kao Area	FYE2023	Asset Renewal	$550,000
Waitaki Landing area	FYE2024	Asset Renewal	$600,000

In the late 1960s concrete poles were used in the construction of the 11kV Te Kao Feeder. These poles are on high ground, exposed to severe coastal winds and are exhibiting signs of end of life due to spalling and exposed reinforcing steel. The associated hardware, crossarms, shackles, pins and armbraces exhibit similar signs of degradation and are overdue for replacement. The problem is exacerbated by the remote location of the feeder and the travel time required to attend to a fault.

Over the past few years there has been a staged process to address the renewal requirements. There is increasing urgency as the SAIDI implications are becoming more apparent. In 2017, after regular field reports, the worst structures were targeted, and 28 red tagged poles were completed for a cost of $176,600. Following completion of this first phase, closer inspection identified that the scope of works was much larger than anticipated. In FY2021 another 54 structures were replaced for $298,400 and there is an approved scope of works for FY2023 to complete a further 70 structures for approximately $450,000. In addition, there is also a requirement to continue the remediation of the line to this area south. The area labelled as Te Kao in Fig 1 below is the next logical section to target with funding available, it is planned to also undertake this work in the current financial year.

A Concept Design Report (CDR), for the section identified as Waitaki Landing in Fig 1, has been prepared and is planned for implementation in FYE2024.

Fig 1: Works areas on Te Kao feeder.



Estimated SAIDI/SAIFI impact

Over the FYE2018-22 period there have been an average 8.4 defective equipment faults per year on the Te Kao feeder with an average per fault SAIDI and SAIFI impact of 1.23 and 0.009 respectively. If we, perhaps optimistically, assume a reduction of two interruptions per year the expected reductions in SAIDI and SAIFI would be **2.46** and **0.017**.

4.2 Tokerau Feeder

Table 15:- Proposed build year and installed cost:

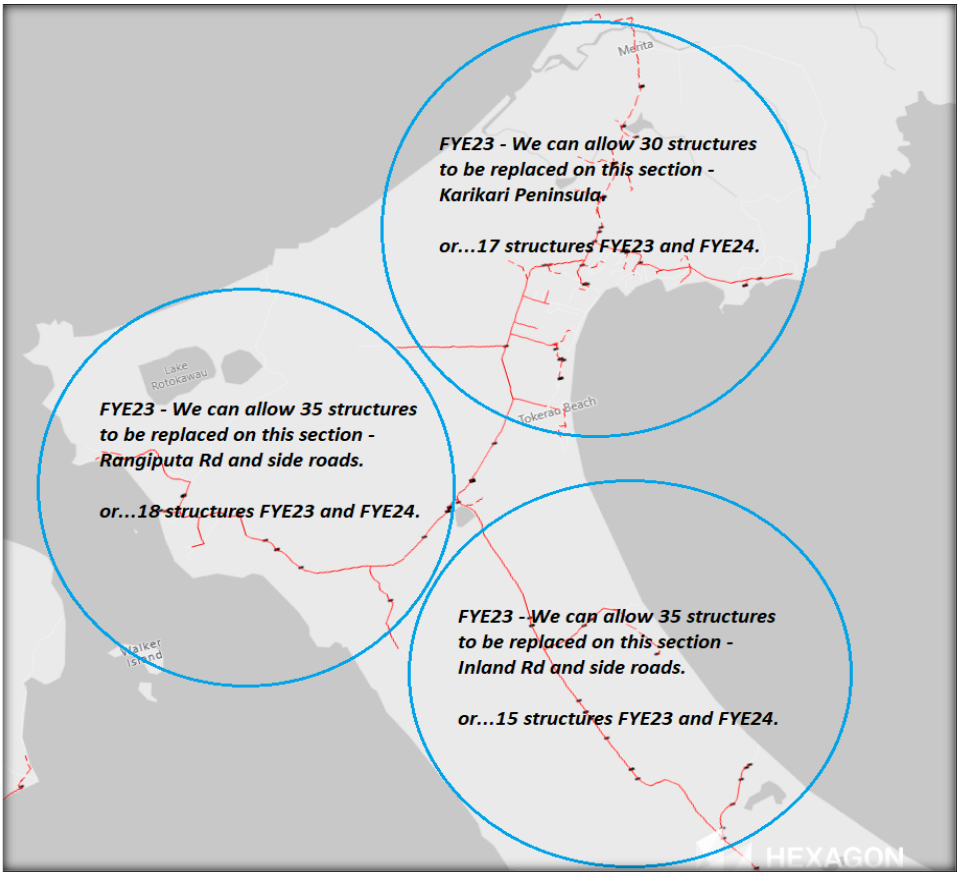
Tokerau	FYE2023	Asset Renewal	$600,000

From 1965 to 1976, cast concrete poles, which were at the time manufactured internally by Top Energy, were used to construct the 11kV Tokerau feeder. These structures are more than 50 years old and are exhibiting signs of the end of life. Most of the concrete poles are Class B defects which means we are continually assessing them.

The structures are of the standard design of the period. A list of fifty structures, which were most critical for replacement, were replaced in FYE2022. These were located along Inland Rd & side roads, Rangiputa Rd & side roads, and Karikari Peninsula, as shown in Fig 2. During recent asset inspections, it was found that a large number of the remaining assets are also defective. In particular, king bolts and insulator pins are rusted, wood cross arms are rotten, and Top Energy manufactured concrete poles are spalling with steel reinforcement rusted and exposed.

We are planning to replace 100 structures from the three locations shown in Fig 2 in FYE 2023 for an estimated cost of $600,000.

Fig 2: Proposed regions of Tokerau Feeder for asset replacements:



Estimated SAIDI/SAIFI impact

Over the FYE2018-22 period there have been an average 5 defective equipment faults per year on the Tokerau feeder with an average per fault SAIDI and SAIFI impact of 1.71 and 0.104 respectively. If we, assume a reduction of 1 interruptions per year the expected reductions in SAIDI and SAIFI would be **2.56** and **0.031**.

4.3 Ground Mounted Switchgear

Table 16:- Proposed build year and installed cost:

Ground mounted switchgear	FYE2023	Asset Renewal	$250,000

We are currently gathering data on the ground mounted switchgear that needs replacing and are in the process of prioritising a replacement programme which will augment the ongoing renewal programme that we currently have. This is a rolling programme that occurs each year to cater for planned renewals.

Based on condition assessments we currently have a backlog of 10 ground mounted switchgear units to be replaced. This list is likely to grow as we complete our inspection programme.   Our estimated cost allows for the replacement of up to 6 units.

While the probability of an asset failure is low, the consequences are high as the SAIDI impact could be high, due to the potential replacement time involved.

Estimated SAIDI/SAIFI impact
Nil, given the low probability of an asset failure occurring.

5. SUMMARY

To initiate further 11kV reliability improvement projects to improve the reliability of supply provided by our 11kV distribution network funding provision can be realized by deferring the Wiroa substation build (as presented as a paper titled *Management of Distribution Network Reliability)*. Deferred costs available are presented in Table 17 below.

Table 17 Wiroa Budgeted Costs

FYE23	*FYE24*	*FYE25*
$3,089,143	*$3,543,331*	*$2,946,413*

Estimated FYE2023 Costs

Our proposed 11kV reliability improvement programme for the current year, FYE2023, is summarised in Table 10 below. This work is in addition to the reliability improvement initiatives already included in the AMP workplan.

Table 18:- FYE 2023 reliability improvement programme and estimated cost ($000)

South Road feeder distribution automation - construction	$300
Horeke feeder distribution automation	$300
Rangiahua – South Rd feeder interconnection - design	$50
Whangaroa – Matauri Bay feeder interconnection - construction	$885
Te Kao feeder asset renewals	$550
Tokerau feeder asset renewals	$600
Ground mounted feeder asset replacements	$500
Total	**$2,935**

This is slightly less than the provision of $3,089,000 in the 2022 AMP Update capital expenditure forecast for the construction of the Wiroa substation.

Estimated Reliability Impact
The estimated SAIDI and SAIFI impacts of these initiatives are summarised in Tables 19 and 20 below. It is assumed that the impacts will not be apparent until the year following the completion of each project. The distribution network SAIDI and SAIFI is currently deteriorating at an assessed rate of 8.75 and 0.025 per year respectively and this deterioration needs to be offset against the improvements achieved from the above projects. Whereas the impacts of the project improvements do not change, on average from year to year, the impact of the underlying deterioration is additive.

Table 19: Overall impact of SAIDI improvements:

	FYE 2024	FYE2025	FYE2026	FYE2027
South Rd feeder distribution automation	3.54	3.54	3.54	3.54
Horeke feeder distribution automation		5.63	5.63	5.63
Tokerau feeder distribution automation		3.23	3.23	3.23
Te Kao feeder distribution automation			2.71	2.71
Oruru feeder distribution automation				2.17
Russell reinforcement	4.69	4.69	4.69	4.69
Kaitaia 11kV substation			8.36	8.36
Rangiahua-South Rd feeder interconnection			10.39	10.39
Whangaroa-Matauri Bay feeder interconnection	11.24	11.24	11.24	11.24
Te Kao feeder asset renewal	1.23	2.46	2.46	2.46
Tokerau feeder asset renewal	2.56	2.56	2.56	2.56
Totals	**23.26**	**33.35**	**54.81**	**56.98**
Less expected deterioration at current rate	8.75	17.50	26.25	35.00
Estimated SAIDI improvement	**14.51**	**15.85**	**28.56**	**21.98**

Table 20: Impact of SAIFI Improvements

	FYE 2024	FYE2025	FYE2026	FYE2027
South Rd feeder distribution automation	0.026	0.026	0.026	0.026
Horeke feeder distribution automation		0.054	0.054	0.054
Tokerau feeder distribution automation		0.036	0.036	0.036
Te Kao feeder distribution automation			0.020	0.020
Oruru feeder distribution automation				0.025
Russell reinforcement	0.073	0.073	0.073	0.073
Kaitaia 11kV substation			0.158	0.158
Rangiahua-South Rd feeder interconnection			-	-
Whangaroa-Matauri Bay feeder interconnection	-	-	-	-
Te Kao feeder asset renewal	0.009	0.017	0.017	0.017
Tokerau feeder asset renewal	0.031	0.031	0.031	0.031
Totals	**0.139**	**0.237**	**0.415**	**0.440**
Less expected deterioration at current rate	0.025	0.050	0.075	0.100
Estimated SAIFI improvement	**0.114**	**0.187**	**0.340**	**0.340**

Recommendation

That the Directors approve the presented plan to revise our 11kV network asset replacement and development plan, funded by deferring the Wiroa substation build.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Appendix 1 Network Diagrams

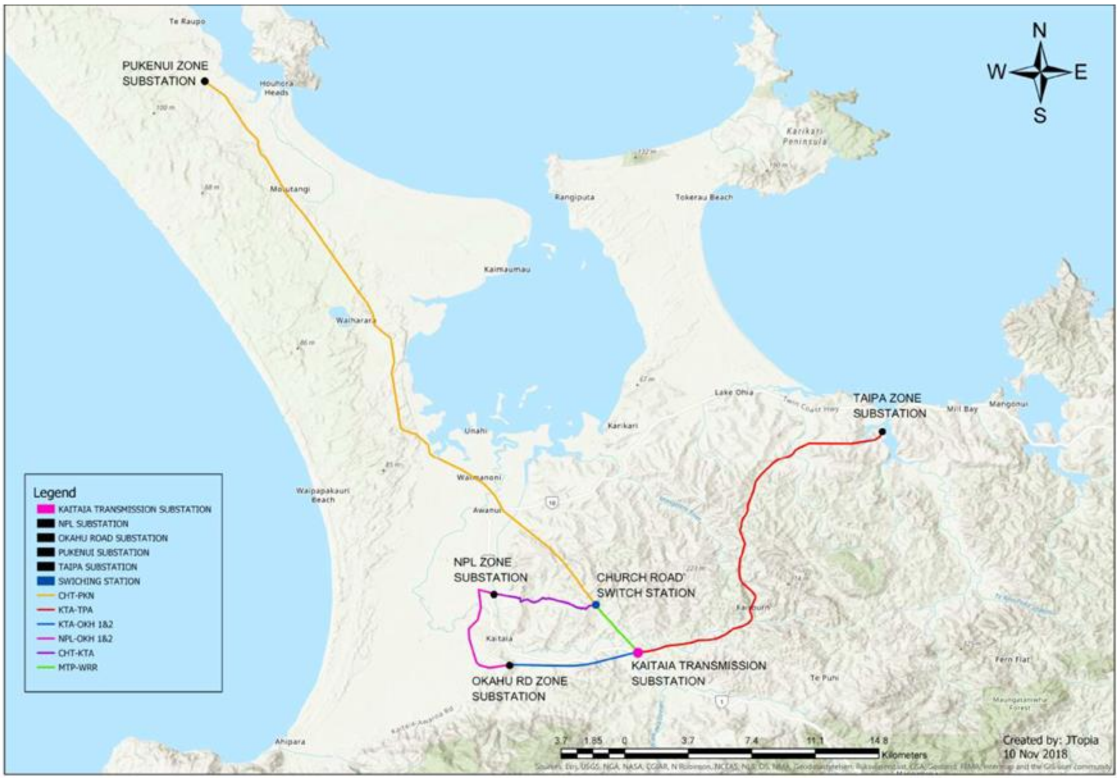


Figure 1: Sub-transmission Network – Northern Area

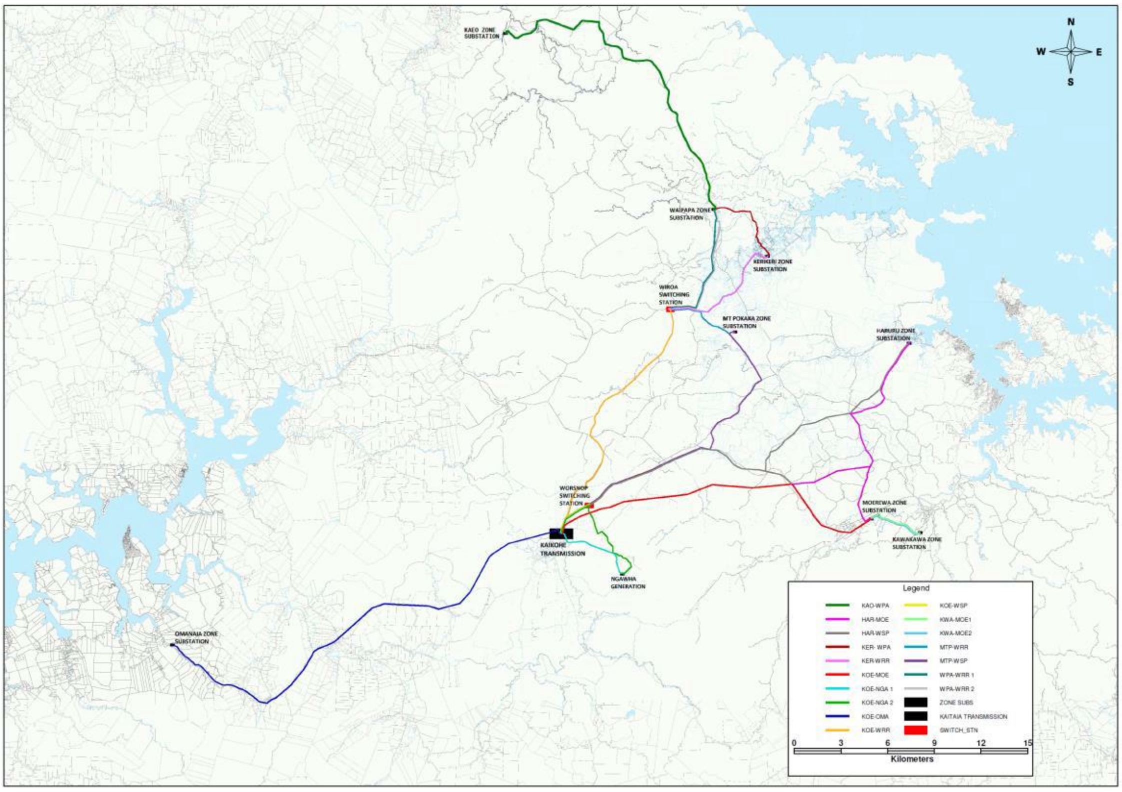


Figure 2: Sub-transmission Network – Southern Area

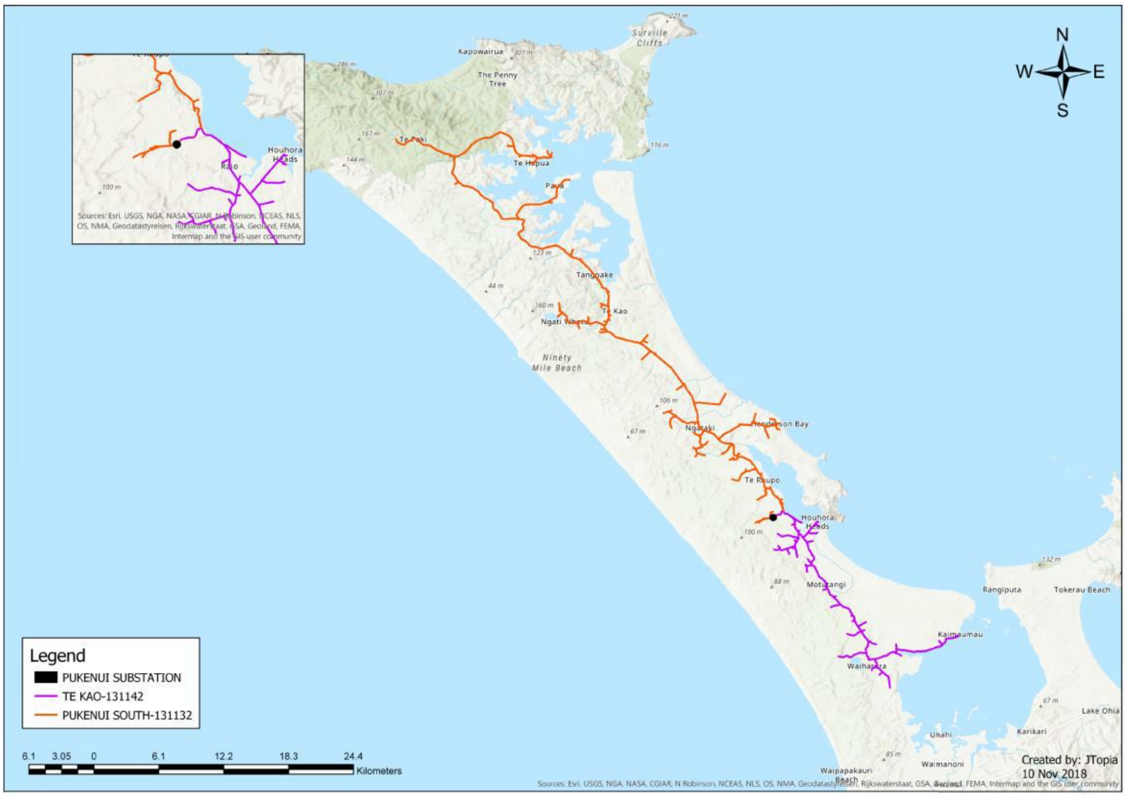


Figure 3: Geographic diagram of the Pukenui zone substation

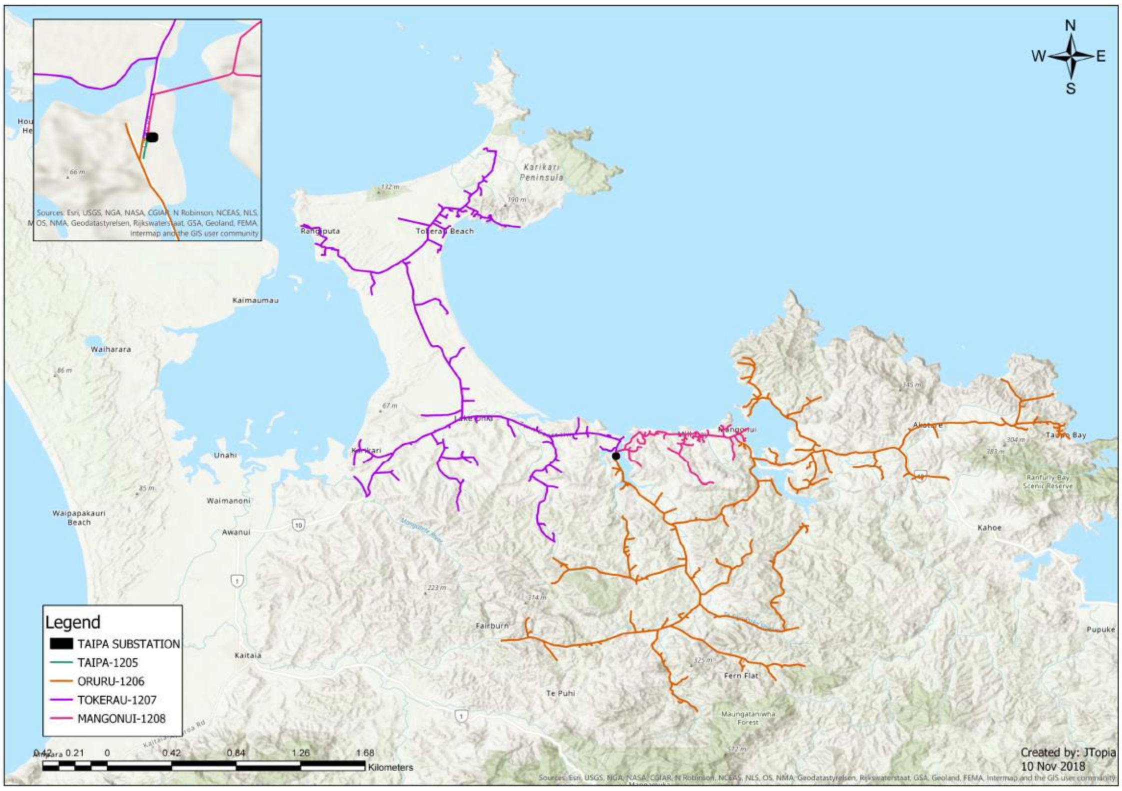


Figure 4: Geographic diagram of the Taipa zone substation

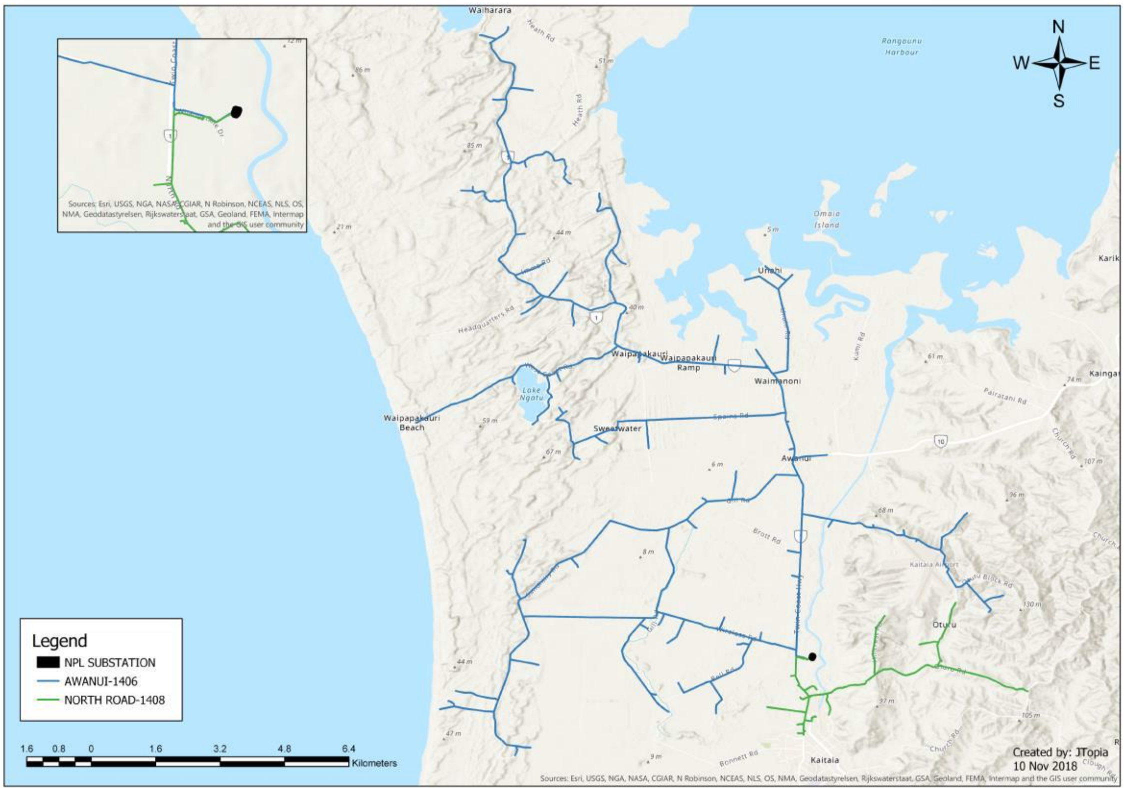


Figure 5: Geographic diagram of the NPL zone substation

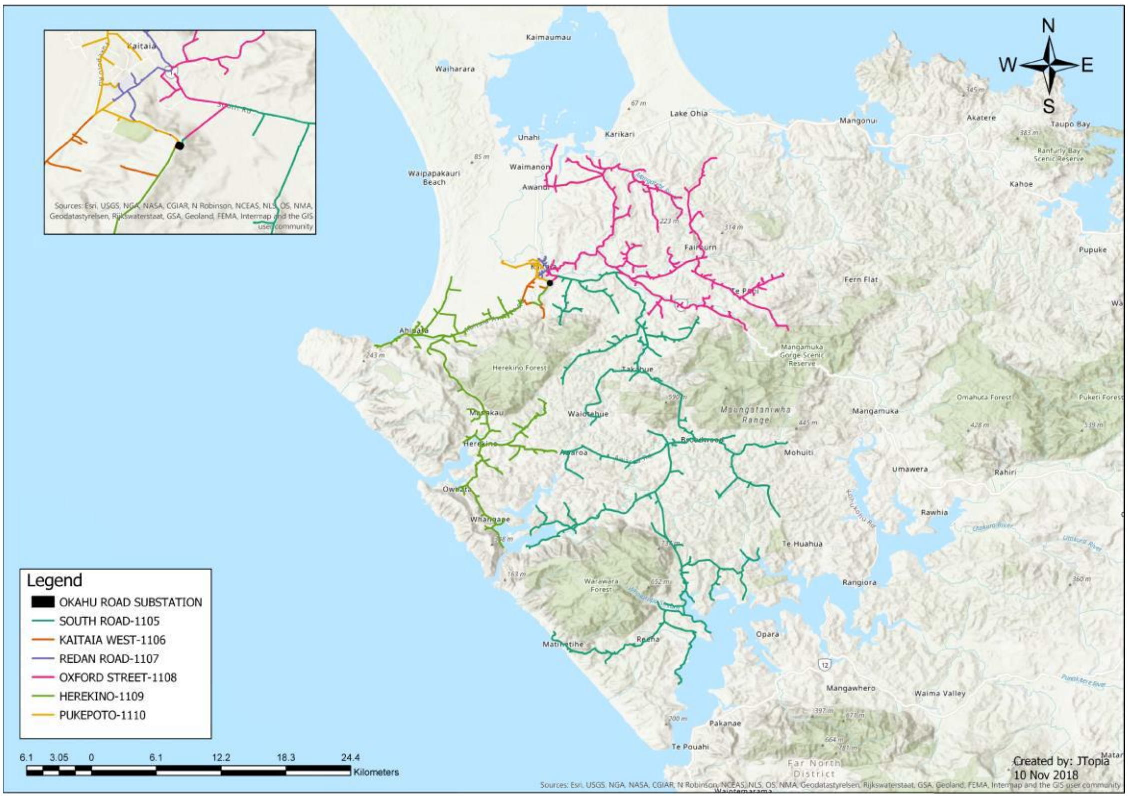


Figure 6: Geographic diagram of the Okahu Road zone substation

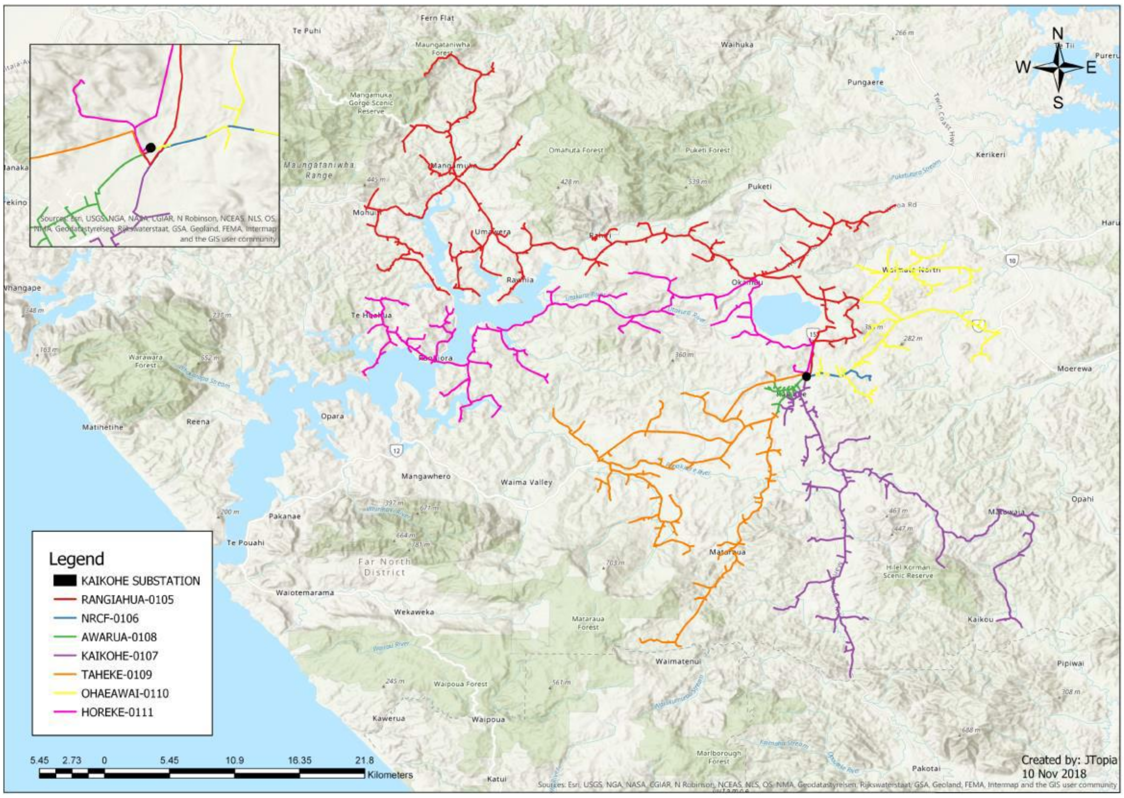


Figure 7: Geographic diagram of the Kaikohe zone substation

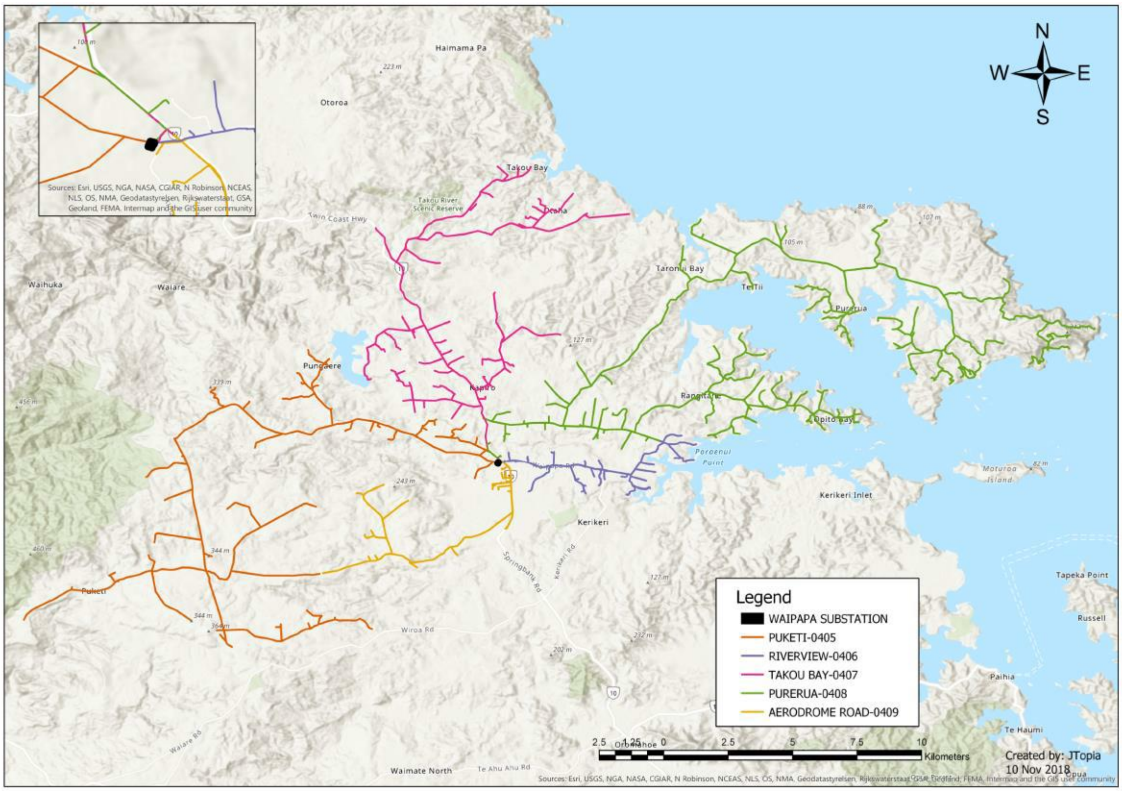


Figure 8: Geographic diagram of the Waipapa zone substation

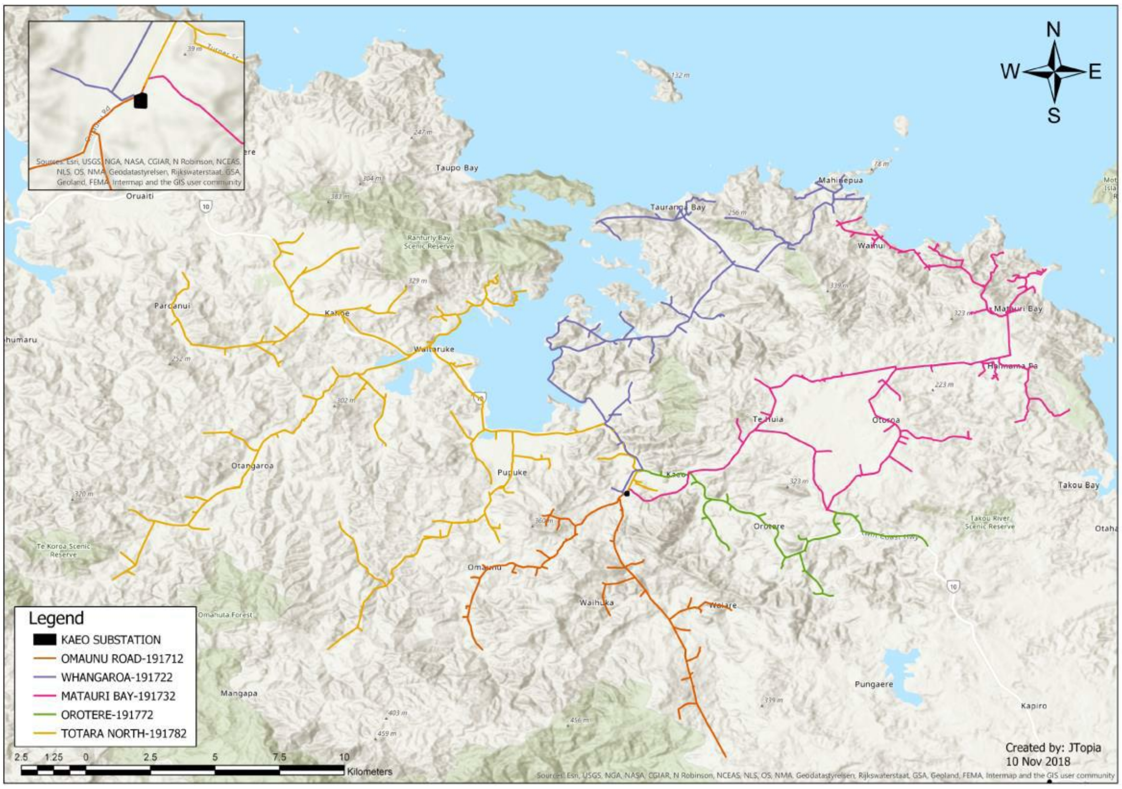


Figure 9: Geographic Diagram of the Kaeo Substation

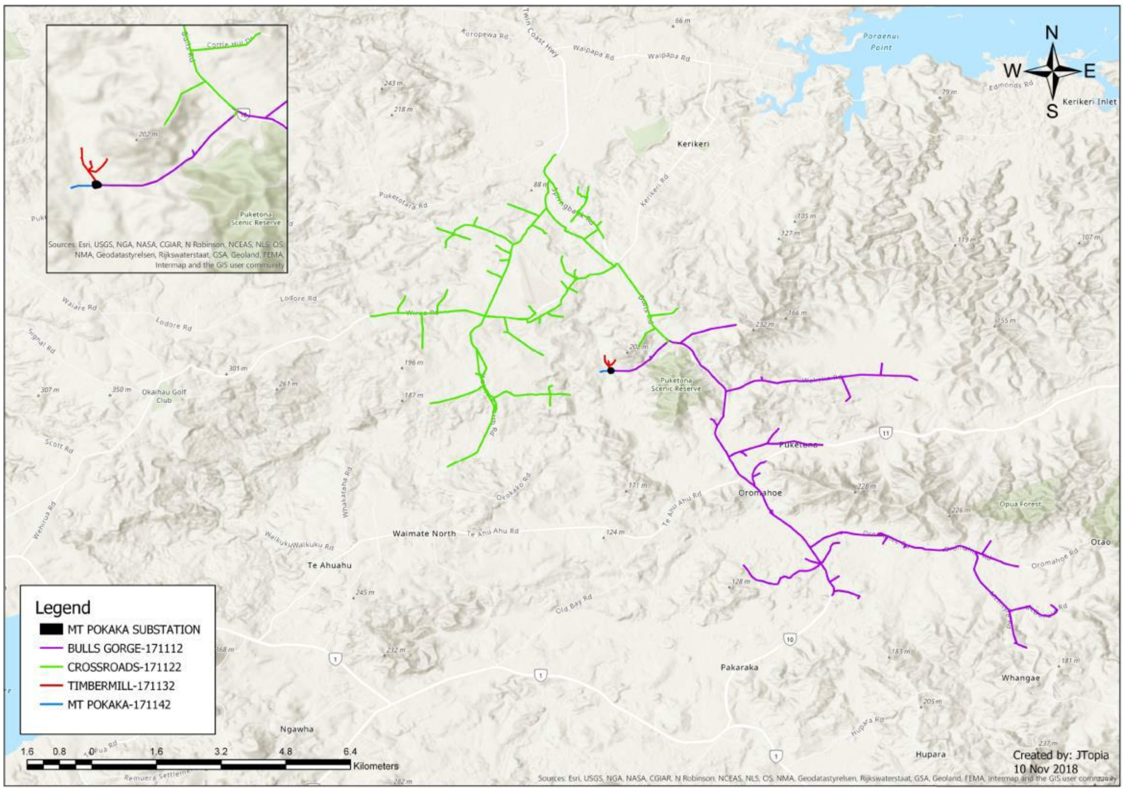


Figure 10: Geographic diagram of the Mt Pokaka zone substation

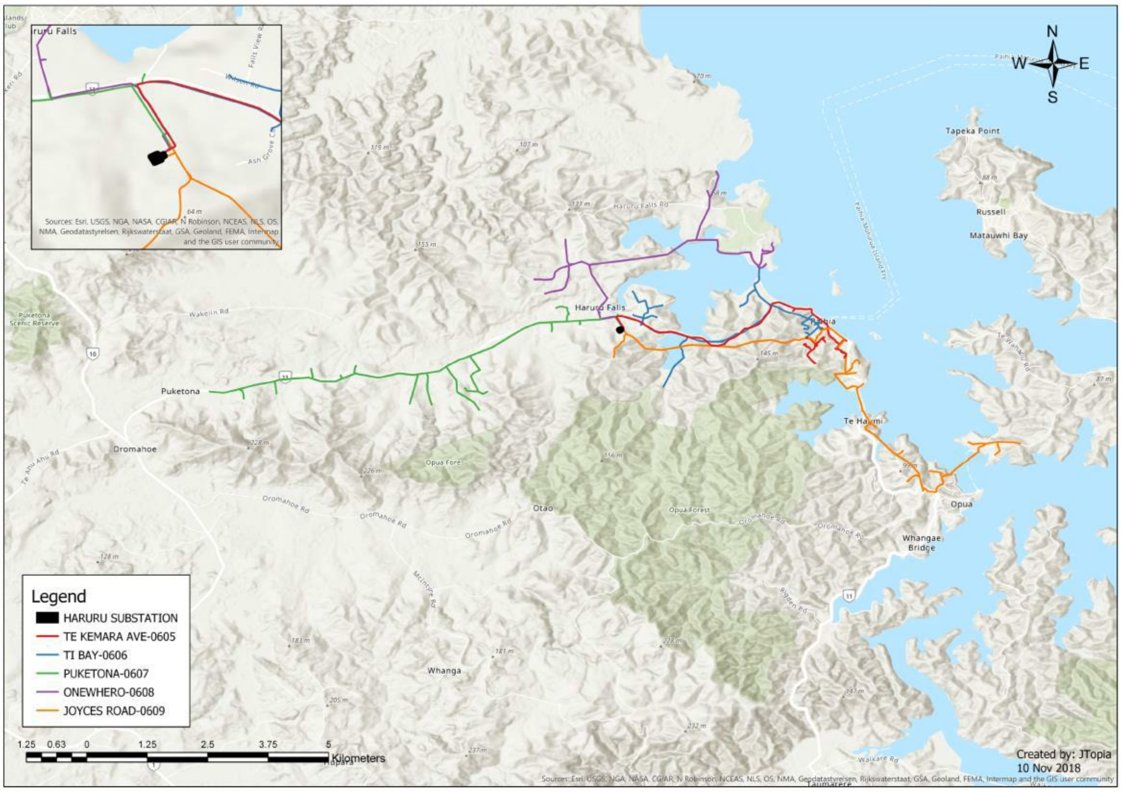


Figure 11: Geographic diagram of the Haruru zone substation

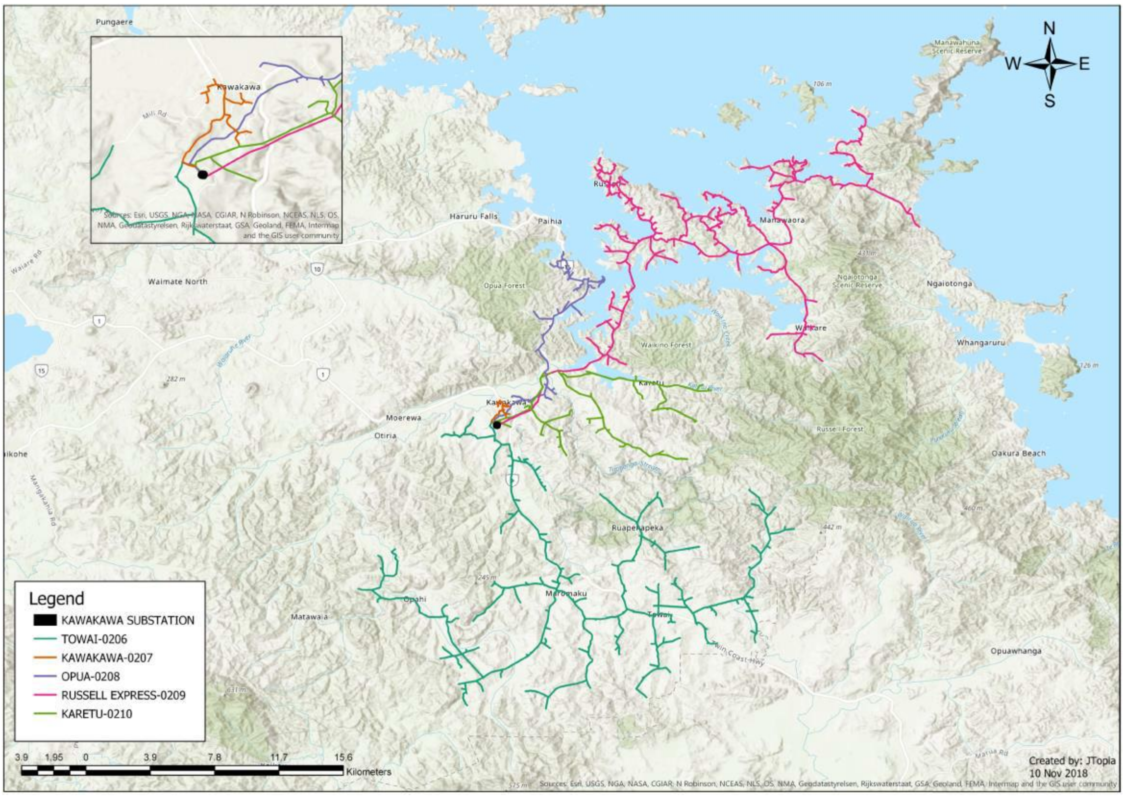


Figure 12: Geographic diagram of the Kawakawa zone substation

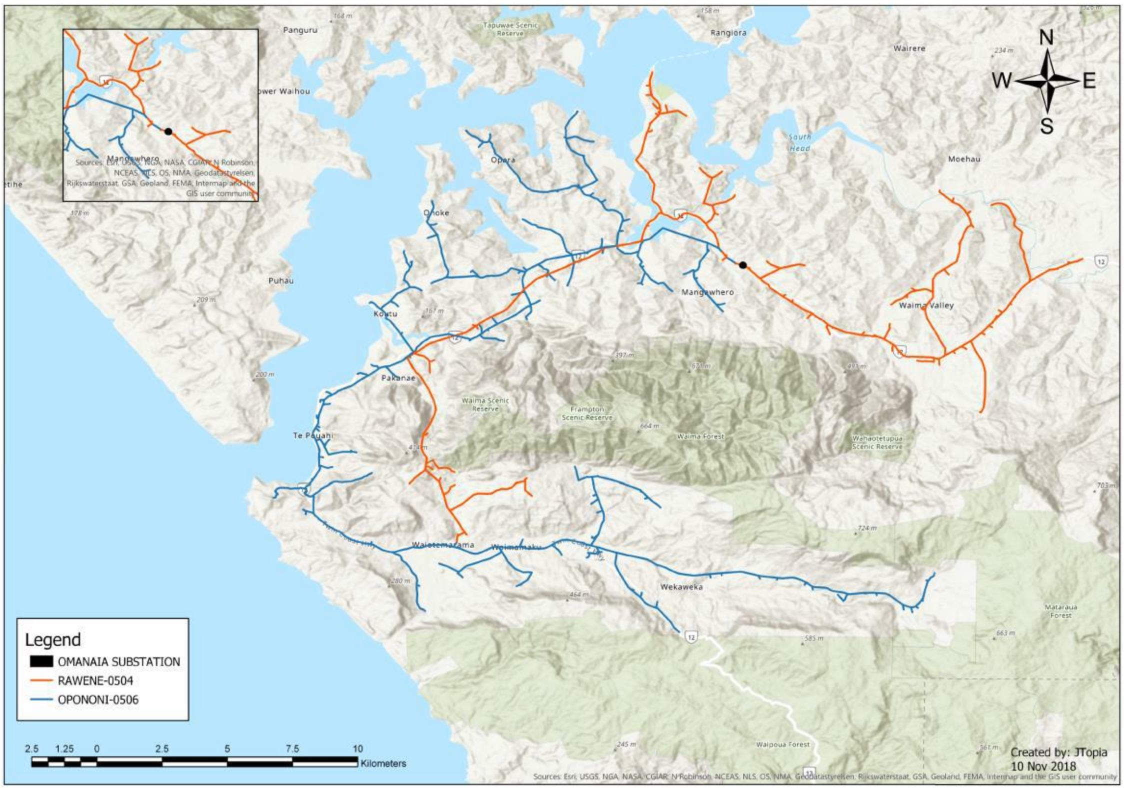


Figure 13: Geographic diagram of the Omanaia zone substation

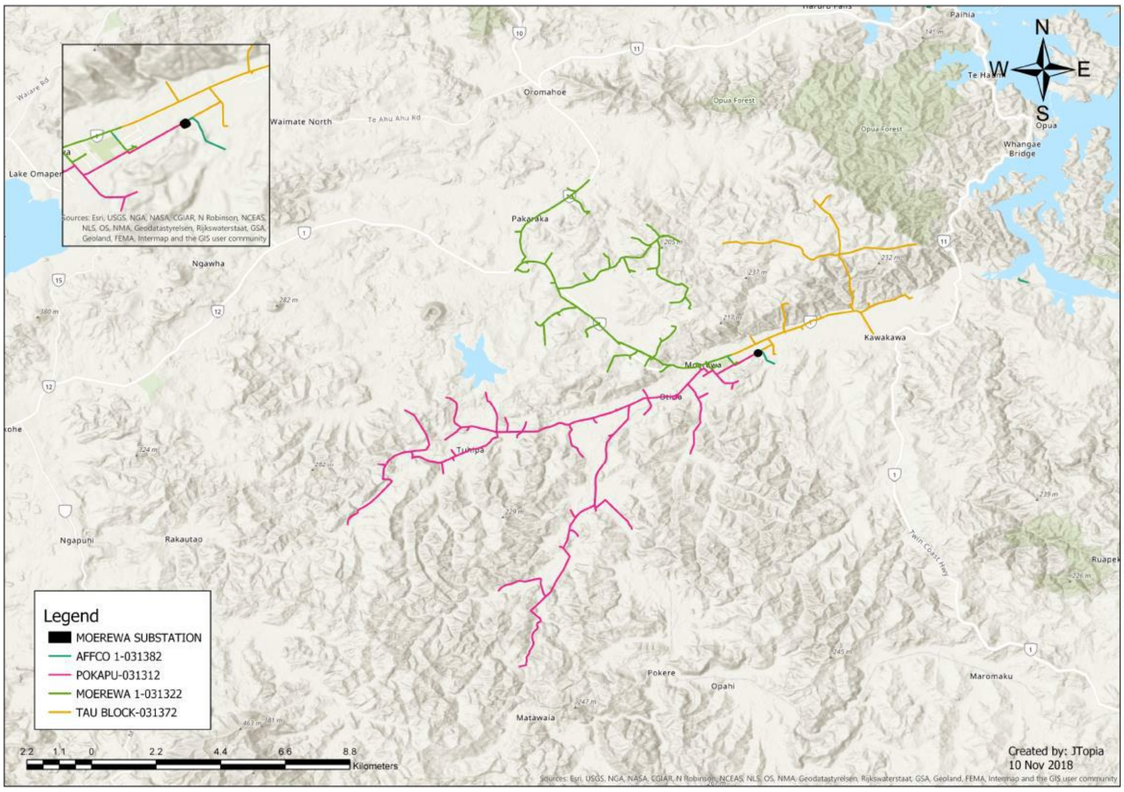


Figure 14: Geographic diagram of the Moerewa zone substation

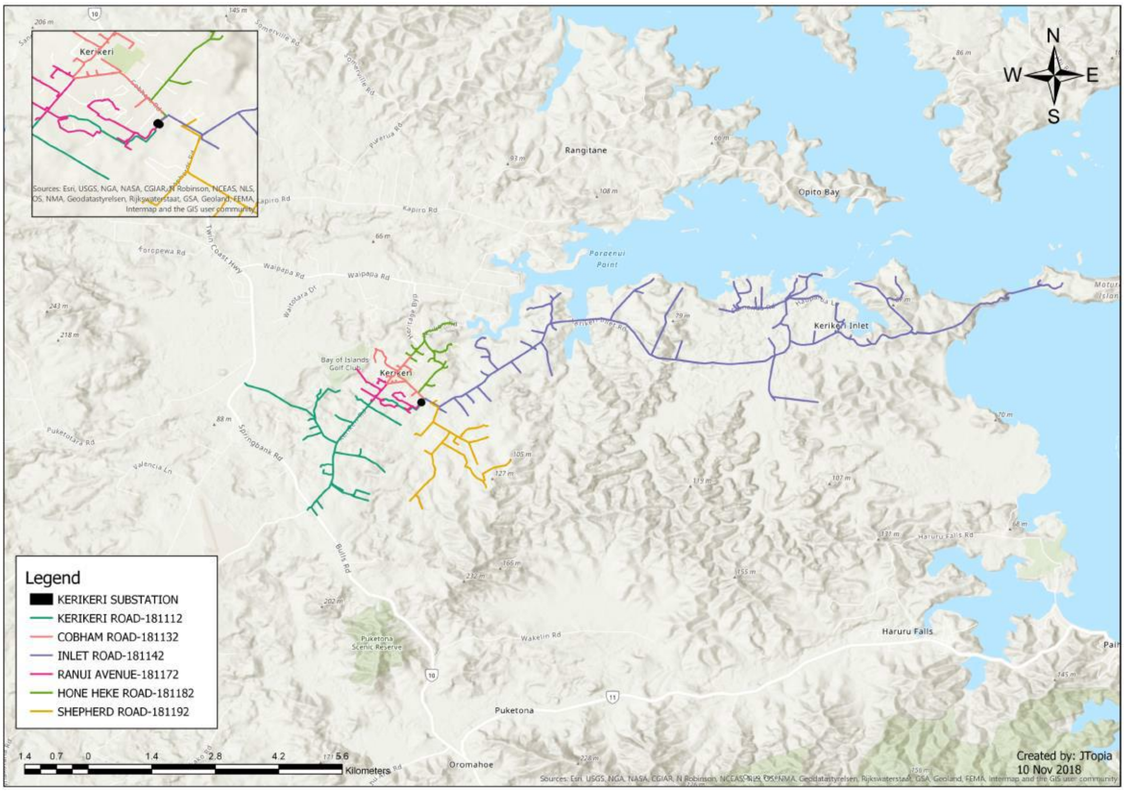


Figure 15: Geographic Diagram of the Kerikeri Zone Substation

Annexure 5

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **July 2022**

Subject: **Network Unplanned SAIDI June 2022 Including 11kV Project Initiatives**

Purpose

The purpose of this paper is to provide a regular update to the Board on Network unplanned outage performance for the month and including progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade. This paper is for information.

Background

FYE23 outage results for the first quarter have shown poor performance, with unplanned outage figures well above the budgeted targets. Due to last year's results being well above our internal targets we introduced a series of 11kV initiatives into the works programme in an effort to reduce the trend. These monthly reports will update the outage results and programmed work progress.

SAIDI - SAIFI Results (June)

Bad weather played its part in June with 22 of the 50 outages marked as high winds and storm as the contributary cause.

Unplanned SAIDI for June totalled 35.966 against a budget of 18. We are currently 94% higher than the YTD target.

Unplanned SAIFI for June totalled 0.401 against a budget of 0.21 we are currently 53% higher than the YTD target.

There were 7 outages with a SAIDI count higher than 2 minutes. Three of these were attributed to high wind conditions.

Current expectations are that if we do not exceed budget in the following 9 months, we will achieve a SAIDI of approximately 300 unplanned minutes, this result is over our internal budget of 240, well short of the Regulatory Cap of 380. Likewise, SAIFI forecast to be 3.4 would be well under the Regulatory Limit of 5.07.

Conversely if the trending weather events do continue as in the first quarter, with extreme fronts hitting the country on a monthly basis there is a very real possibility of exceeding the upper limit of 380 Unplanned SAIDI minutes.

In order to ensure we are doing whatever we can to reduce the number of outages and ensure the shortest response times to them we are continuing with our planned Control Room and Field response actions, and longer-term mitigation comes from the 11kV asset replacement and development programme extra to the planned works which includes distribution automation, splitting of feeders, interconnection/ties, and asset renewals.

11 kV Initiatives - Program of Work

Earlier this year the Board approved the reallocation of funds to further improve the reliability of supply of Top Energy's 11kV distribution network.

11kV Projects identified for construction during FY-23 are listed in the table below.

Project Description	Status	Planned Budget	Planned Construction Period	Comments
South Rd Feeder Distribution Automation	planning & design	$300,000	January 23 – March 23	to be outsourced
Horeke Feeder - Distribution Automation	planning & design	$300,000	January 23 – March 23	to be outsourced
Rangiahua – South Rd Feeder Interconnection (design only)	planning & design	$50,000	FY-23	network planning
Whangaroa & Matauri Bay Feeder Interconnection Stage 1	planning & design	$885,000	October 22 – December 22	to be outsourced
Paua 11KV Refurbishment (Te Kao Feeder) (Stage 2)	planning & design	$550,000	October 22 – December 22	to be outsourced
Tokerau 11KV Feeder Refurbishment (Stage 2)	planning & design	$600,000	October 22 – December 22	to be outsourced
Replacement/Refurbishment of SD RMUs (Stage 6)	design complete	$500,000	staggered complete by FYE	in-house construction
TOTAL		$2,935,000		

Once all detailed designs are complete, Project Delivery and Procurement will call for external tenders for the construction of projects identified to be outsourced.

Initial contact was made with three external contractors. Two of these contractors have subsequently advised they are unable to accommodate any additional work.

Recommendation

That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Annexure 6

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **July 2022**

Subject: Impact of Reference Period on Normalisation

Purpose

This paper is written in response to the Board's request to understand the value in considering approaching the Commerce Commission (Commission) to see if Top Energy SAIDI and SAIFI boundary values and limits are appropriate, and would they be more meaningful (and advantageous for unplanned results) if they were set using fault data over the five-year reference period FYE 2018-22 rather than the ten-year period FYE 2010-19. To understand what the values, limits and importantly the impacts would be over that period a full analysis of the data was undertaken and this paper provides the results of the review. We are seeking Board approval to wait until the RCP4 regulatory reset (Option 1 of this report).

Executive Summary

In order to understand the worth in approaching the Commission regarding using data from the past 5 years rather than the FYE 2010 – 2019 reference period, Top Energy engaged an engineering consultant to carry out a detailed analysis of the data sets to determine the results and impact of seeking such a consideration.

The Commission used a statistical analysis programme called *Stata* for the statistical analysis on which it based the boundary values and limits it set for RP3. We were unable to open the *Stata* files on the Commission's website, so we undertook an equivalent Excel analysis. We validated our analysis by applying the FYE 2010-19 dataset used by the Commission for its RP3 analysis and achieved the same outputs published by the Commission for all parameters.

If the statistical analysis is based on the FYE2018-22 dataset the boundary values and limits would change as shown in Table 1 below.

	SAIDI		SAIFI	
	Boundary Value	**Limit**	**Boundary Value**	**Limit**
FYE 2018-22 dataset	17.29	335.97	0.1591	3.9547
FYE 2010-19 dataset[1]	27.92	380.24	0.2284	5.0732

Table 1: Boundary Values and Limit Changes

Note 1: The limits for the FYE 2010-19 dataset both include an upward adjustment to meet a side constraint that limited the extent of any change between RP2 and RP3. See Section 3 below. We have not included a similar adjustment to the limit derived from the FYE 2018-22 dataset.

The extent of the reduction in limits when the FYE 2018-22 dataset is used can more than offset the benefit of the lower boundary value. Our analysis indicates that in FYE 2022, had the lower boundary values and limits been in play, Top Energy would have become uncomfortably close to breaching the revised SAIDI limit.

If the lower boundary values are applied to the interruption dataset, the storm on 17-18 April 2022 would have been a major SAIDI/SAIFI event. However, this would not mitigate the risk of a SAIDI limit breach at the end of the year because of the lower limit that would apply.

From the analysis undertaken we are able to make a recommendation as to the Board as to what action to take, based on the following options:

- Option 1 – Wait until the RCP4 Reset and ensure that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

- Option 2 – Peer Review the Data and put Proposal to the Commerce Commission

Recommendation.
That Top Energy wait until the RCP4 regulatory reset (Option one of this report) and ensure that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

Background
Top Energy Networks is subject to quality standards under the Commerce Commission's price-quality regulation. A breach of the standards would trigger an investigation by the Commission, which could lead to a financial penalty, if the Commission found that deficiencies in our asset management practices contributed to the breach. The Board recently discussed the value in considering approaching the Commerce Commission to see if Top Energy SAIDI and SAIFI boundary values and limits would be more meaningful if they were set using fault data over the five-year reference period FYE 2018-22 rather than the ten-year period FYE 2010-19 as well as therefore being advantageous to unplanned SAIDI and SAIFI results.

For RCP3 (FYE 2021-25) the SAIDI and SAIFI quality standards that apply to Top Energy are based on the network reliability over the historic reference period FYE 2010-19. These standards will be breached if, in any financial year during RCP3, the aggregate of the normalised SAIDI and SAIFI value arising from unplanned interruptions due to faults within our network exceed the following levels.

SAIDI	380.24
SAIFI	5.0732

Table 2: RCP3 SAIDI and SAIFI Limits

The limits in Table 2 are determined by adding a buffer or dead zone to the average annual normalised SAIDI/SAIFI over the historic reference period to cater for year-on-year volatility. If these limits are to be recalculated for an alternative reference period, it is necessary to recalculate the impact of the new reference period on:

- Normalisation
- The magnitude of the buffer.

The underlying premise applied by the Commission in setting the limits was that, over time, there should be no deterioration in reliability below the average level over the reference period. In order that networks with an improving reliability were not unduly disadvantaged, in setting the limits the Commission also applied a side constraint. This required that the RCP limits should not vary more than 5% from the limits that would hypothetically have been set if the RP3 calculation methodology had been applied to the RP2 reference period FYE 2004-13 interruption dataset. As Top Energy's reliability improved over this timeframe, the limits shown in Table 1 include an upwards "scaling adjustment" that ensured this side constraint was not breached. This is shown in Table 3:

	Pre-adjustment	Post-adjustment
SAIDI	371.13	380.24
SAIFI	4.8043	5.0732

Table 3: Impact of Side Constraints on RCP3 SAIDI and SAIFI Limits

Normalisation

In setting the reliability standard for RCP3 the Commission changed the normalisation methodology. Under the revised methodology:

- Network interruptions that commence in the same half-hour interval (beginning on the hour and half-hour) are aggregated for analysis purposes.
- If the aggregated SAIDI or SAIFI in any rolling 24-hour period exceeds its pre-set boundary value, then in the normalised dataset the maximum SAIDI/SAIFI in any interval within the 24-hour period is capped at $^1/_{48}$ of the boundary value.[1]
- SAIDI and SAIFI are analysed independently. A rolling 24-hour period that triggers normalisation is termed a major SAIDI or major SAIFI event. A major SAIDI event does not automatically imply a major SAIFI event and vice-versa. A major event can last longer than 24 hours where successive interruptions cause the boundary value to be exceeded during overlapping 24-hour periods.

The SAIDI and SAIFI boundary values are therefore the key parameters that determine the impact of the normalisation process – all else being equal, a lower boundary value will result in a lower normalised SAIDI/SAIFI. For RCP3, the Commission has set the boundary value on the basis that, in an average year there will be 2.3 major SAIDI and 2.3 major SAIFI events, consistent with the approach taken in RP2. To this end it has set the major event boundary value as the 1,104th highest rolled 24-hour period within the historical data set.[2]

Table 4 shows the SAIDI and SAIFI boundary values determined by the Commission for RP3 and the impact of using these values on the reference dataset. We have verified these parameters through our own analysis of the FYE 2010-19 fault dataset to satisfy ourselves of the robustness of the methodology we used to analyse the alternative dataset.

FYE 2010-19	SAIDI	SAIFI

1 There are 48 half hourly trading intervals in a 24-hour period. This approach ensures that in the most extreme situation the total SAIDI in any 24-hour period cannot exceed the boundary value.

2 There are 175,200 half-hour trading intervals in a 10-year reference period (ignoring leap years). 1,104/175,200 is equivalent to 2.3 days in a 365-day year.

Average annual raw value	543.08	4.9122
Boundary value	27.92	0.2284
Average annual normalised value	293.05	3.8640

Table 4: Impact of Side Constraints on RCP3 SAIDI and SAIFI Limits

Limit

For RP3 the Commission set the pre-adjustment limit[3] at *two* standard deviations above the average annual normalised value shown in Table 4. A quality standard breach will occur if a limit is exceeded in any financial year. This was a significant change from the RP2 approach where the limit was set at *one* standard deviations above the average annual normalised value with the proviso that an EDB would only breach a quality standard if it exceeded the limit in two of any three successive financial years.

The Reasons Paper issued in parallel with the Commission's RP3 price-quality path determination was very vague about how the standard deviation was to be derived. It merely stated that the standard deviation was derived by annualising daily data, which was the same method that was derived for the two previous regulatory periods. It further noted that the use of annualised daily data was not fully consistent with the normalisation methodology, which used annualised half-hourly data. However, it decided to use daily data because it had sufficient data points for statistical robustness and there was a risk that half-hourly data could produce errant results because that may not be independent (e.g., during storm events that last several hours).

The Commission used the statistical analysis software, Stata, to calculate its standard deviations. Since we were unable to open the Stata files on the Commission's website, we went back to Schedule 4B of the RP2 Price-Quality Path Determination, which was issued in November 2014. This indicated that, for the RP2 regulatory period, the difference between the SAIDI limit and the SAIDI average value would be assessed by the formula:

$$\text{Difference} = \text{SAIDI}_{\text{deviation}} \times (\text{Square-root of } 365)$$

Where the $\text{SAIDI}_{\text{deviation}}$ is the standard deviation of a reference dataset comprising the normalised SAIDI values for each calendar day in the reference period, including zero values.
For SAIFI, the equivalent formula was used. While we note the inconsistency in the meaning of the term "'standard deviation", as used in the RP3 Reasons Paper and the above formula, as noted above it is very clear that the difference between the average value and limit in RP3 is twice that which applied during RP2.

We have not researched the statistical theory underpinning the above formula. However, as stated in the RP3 Reasons Paper, the Commission's normalisation approach is broadly based on the IEEE normalisation methodology, which assumes that network reliability is more accurately represented by a "log-normal" distribution rather than the more typical "normal" distribution. This is because most of the SAIDI/SAIFI impacts of network faults are caused by the relatively few interruptions that occur during major events. As the standard deviation formulae in Excel assume a normal distribution, an adjustment is needed when it is applied to a log-normal distribution.

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3 The pre-adjustment limit is the calculated limit prior to the application of the side constraint adjustment discussed above.

Importantly, we have tested this approach by applying it to the Top Energy FYE 2010-19 fault database and duplicated the same results as the Commission for both SAIDI and SAIFI. We are therefore confident in the validity of the approach we used to calculate the SAIDI and SAIFI limits in our analysis of the more recent FYE 2018-22 fault database. The outcome of this analysis is presented in Section 5 below.

Analysis of Alternative Scenario

We have used the methodology described in the above sections to analyse the impact of basing the Commission's normalisation approach on the network reliability over the five-year FYE2018-22 period. However, the boundary value has been determined by the 552nd highest rolled 24-hour period within the data set, given that the dataset covers only five years, rather than the ten years used by the Commission in its analysis.

Table 5 compares the outcome of our analysis using the FYE 2018-22 interruption dataset with the Commission's analysis of the FYE2010-19 dataset.

	SAIDI (FYE 2018-22)	**SAIDI (FYE 2010-19)**	**SAIFI (FYE 2018-22)**	**SAIFI (FYE 2010-19)**
Average annual raw value	439.02	543.08	4.4683	4.9122
Boundary Value	17.29	27.92	0.1591	0.2284
Average annual normalised value	269.27	293.05	3.2540	3.8640
Standard deviation	33.35	39.04	0.3503	0.4702
Limit (pre-adjustment)	335.97	371.13	3.9547	4.8043
Limit (post adjustment)	-	380.24	-	5.0732
Normalised value (FYE 2018)	299.30	304.60	3.2401	3.6085
Normalised value (FYE 2019)	196.71	216.33	2.6395	3.7714
Normalised value (FYE 2020)	248.70	316.48	3.5214	4.1499
Normalised value (FYE 2021)	266.45	300.83	3.0977	3.1020
Normalised value (FYE 2022)	335.17	342.71	3.7714	3.9556

Table 5: Normalisation Impact of both Datasets

It can be seen from Table 5 that the use of the FYE 2018-22 reliability dataset lowers the normalised value in all instances. However, use of the FYE 2018-22 dataset had a relatively small impact on the normalisation of the FYE 2022 SAIDI to the point that, in the absence of a side-constraint adjustment to the SAIDI limit, a SAIDI breach would have been only marginally avoided.

To better understand the reasons for this, the next section examines the impact of normalisation of the FYE 20922 SAIDI under both scenarios.

SAIDI Normalisation FYE 2022

Table 6 shows the major SAIDI events and their normalisation impact under both scenarios.

Event Start Date	FYE 2018-22			FYE 2010-19		
	Event SAIDI		No of Normalised Faults	Event SAIDI		No of Normalised Faults
	Raw	Normalised		Raw	Normalised	
2 Aug 21	34.20	4.01	8	34.20	5.78	8
11 Feb 2022[4]	385.89	9.94	26	385.89	15.50	26

Table 6: SAIDI Normalisations Under Both Scenarios – FYE 2022

[4]Cyclone Dovi

FYE 2022 was characterised by relatively mild weather interspersed with two abnormally severe storm events including Cyclone Dovi, the most severe storm to impact our network since 2014. Under both normalisation scenarios the two major storms were the only major SAIDI events, and the number of normalised faults was the same. Outside of these two events the highest fault SAIDI was 11.60, well below the boundary value of 17.29 required to trigger further normalisations had the FYE 2018-22 dataset been used.

While FYE 2022 situation may be atypical, it does demonstrate that reducing the boundary value is not risk free. Situations can arise when the reduction in the limit is greater than the reduction in the normalised reliability in a particular year, and this can in turn increase the risk of a threshold breach.

FYE 2023

Table 7 shows the impact of normalisation for the first quarter of FYE 2023 under both scenarios. If the normalisation is based on the FYE 2010-19 dataset there are no major events and if based on the FYE 2018-22 there is one major SAIDI event, which was also a major SAIFI event. This occurred on 17-18 April. During this major event seven individual faults were normalised for SAIDI and six for SAIFI. Table 6 also shows a hypothetical annualised situation for each scenario, where it is assumed that the first quarter outcome is repeated for the next three quarters. The resulting annualised normalised value is compared with its corresponding limit. The table shows that:

- The SAIDI limit would be breached under both normalisation scenarios.
- While the SAIFI limit would not be breached under either scenario, the gap between the annualised normalised SAIFI and the SAIFI limit is relatively narrow for the FYE2018-22 dataset. This is consistent with the above conclusion that using a more aggressive approach to normalisation is not without risk.

	SAIDI (FYE 2018-22)	SAIDI (FYE 2010-19)	SAIFI (FYE 2018-22)	SAIFI (FYE 2013-19)
Raw value	114.29		1.1333	
Normalised value	90.82	114.29	0.9596	1.1133
Limits[5]	335.97	380.24	3.9547	4.8043
Normalised values x 4 (annualised)	363.28	457.16	3.8384	4.5332

Table 7: Impacts of Normalisation

[5]The normalised limits for the FYE2018-22 dataset do not include a side-constraint adjustment.

We also note there were 120 unplanned supply interruptions during the first quarter of FYE 2023, only one of which was due to a fault on the 33kV network. There were 29 vegetation faults which accounted for 36.46 SAIDI minutes. Six of these vegetation faults, accounting for 15.36 SAIDI minutes occurred during 17-18 April event referenced above.

Summary

Options

Option 1 – Wait until the RCP4 regulatory reset and ensure that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

- While in the first quarter FYE 2023 SAIDI is tracking towards a limit breach, this situation is not inevitable. A couple of good quarters would turn the situation around. If there is no breach the Commission is unlikely to take any action. The Compliance Statement is not due until August 2023, at which time the Commission will be busy preparing for the RCP4 regulatory reset. It does have power to investigate and ask questions – it did so a couple of years ago when it asked questions relating to adverse vegetation and unknown fault SAIDI trends – but it is considered unlikely to do so at that time even if we do not breach by the narrowest of margins.

- If there is a breach it will have to investigate. However, by then Top Energy will have submitted our 2023 AMP, which will pre-emptively acknowledge the trend and set out a strategy to turn things around. A good AMP may soften the impact and mitigate the consequence of the investigation. Any criticism is likely to be more muted, if Top Energy has shown that it is already taking appropriate remedial action.

Option 2 – Peer Review the Data and put Proposal to the Commerce Commission

- The Commission is obliged to act in a way that maintains the integrity of its regulatory process. It will require an application for reconsideration of the quality standard in the DPP to be submitted in accordance with Section 4.5.5 of the Electricity Distribution Services Input Methodologies Amendment Determination No 2 2019 (attached), which sets out the rules for the price-quality regulation process. There would be need for public consultation and an Engineer's report.

Conclusion

Looking at the current year FYE 2023 to date shows that Top Energy would currently breach the SAIDI limit in both boundary value scenarios but, unlike last year, the use of the lower boundary value would reduce the extent of the breach. The hypothetical annualised situation shows that the magnitude of the potential limit breach is lower if the lower boundary value is used, which is consistent with what you would normally expect.

The lesson here is that using a lower boundary value can improve the situation, but this need not always be the case. In some scenarios (which may be atypical) the lower boundary value can lead to a perverse outcome. For example had Top Energy persuaded the Commission last year that its price-quality path compliance assessment should be based on the lower boundary values, it would have become perilously close to scoring an own goal.

Setting boundary values and limits using the Commission's current methodology and based on the FYE 2018-22 dataset will not always leave Top Energy any better off, due to the magnitude of the limit reduction. Table 4 of the paper shows that had the lower boundary value been in play last year, the normalised SAIDI would have been 335.17, only 0.8 SAIDI minutes below the revised limit of

335.97. Under the current parameters the SAIDI was 342.71, giving a buffer of 37.53 SAIDI minutes below the current limit.

The 2023 AMP will be the last full AMP to be submitted before the Commission resets the default price-quality path for RCP4. It is therefore likely to be scrutinised more closely than would otherwise be the case and needs to be written with this in mind.

Recommendation
That Top Energy go for Option 1 Wait until the RCP4 regulatory reset and ensure that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
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Annexure 7

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **August 2022**

Subject: **Network Unplanned SAIDI July 2022 Including 11kV Project Initiatives**

Purpose
The purpose of this paper is to provide a regular update to the Board on Network unplanned outage performance for the month and including progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade. This paper is for information.

Background
FYE23 outage results for the first quarter have shown poor performance, with unplanned outage figures well above the budgeted targets. Due to last year's results being well above our internal targets we introduced a series of 11kV initiatives into the works programme in an effort to reduce the trend. These monthly reports will update the outage results and programmed work progress.

SAIDI - SAIFI Results (July)
Bad weather continued in July with severe weather watches and warnings issued by MetService on the 12th and again on the 24th of July when we experienced powerful winds and heavy rain. It was the second wettest July on record for Kerikeri (with 572 mm of rain recorded).

Normalised unplanned SAIDI for July totalled 51.264 against a budget of 24. This put us 98% higher than the YTD target. Raw SAIDI was 87.175 prior to normalisation.

Unplanned SAIFI for July totalled 0.552 against a budget of 0.29 This put us 63% higher than the YTD target.

There were 8 outages with a SAIDI count higher than 2 minutes. These outages accounted for 22.35 normalised SAIDI compared to the full month target of 24.

If we do not exceed budget in the following 8 months, we will achieve a SAIDI of approximately 323 unplanned minutes, this result is over our internal budget of 240, and still short of the Regulatory Cap of 380. Likewise SAIFI, forecast to be 3.6 would be well under the Regulatory Limit of 5.07.

Conversely if the trending weather events do continue as in the first third of the year, with extreme fronts hitting the country on a monthly basis there is a very real possibility of exceeding the upper limit of 380 Unplanned SAIDI minutes.

Work continues to ensure we are doing whatever we can to reduce the number of outages and respond in the quickest manner. We are continuing with our planned Control Room and Field response actions, and longer-term mitigation comes from the 11kV asset replacement and development programme extra to the planned works which includes distribution automation, splitting of feeders, interconnection/ties, and asset renewals.

11 kV Initiatives - Programme of Work
Earlier this year the Board approved the reallocation of funds to further improve the reliability of supply of Top Energy's 11kV distribution network.

11kV Projects identified for construction during FY-23 are listed in the table below.

Project Description	Status	Planned Budget	Planned Construction Period	Comments
South Rd Feeder Distribution Automation	planning & design	$300,000	January 23 – March 23	We have been advised of a 6-month lead time on reclosers for these projects. In anticipation of the late delivery, we plan to install all hardware and potentially isolating fuses as an interim measure.
Horeke Feeder - Distribution Automation	planning & design	$300,000	January 23 – March 23	
Rangiahua – South Rd Feeder Interconnection (design only)	planning & design	$50,000	FYE-23	No construction planned for FY-23
Whangaroa & Matauri Bay Feeder Interconnection Stage 1	planning & design	$885,000	October 22 – December 22	Awaiting detailed design, in final stage of negotiations with landowner to be outsourced
Paua 11KV Refurbishment (Te Kao Feeder) (Stage 2)	estimating	$550,000	October 22 – December 22	To be outsourced
Tokerau 11KV Feeder Refurbishment (Stage 2)	planning & design	$600,000	October 22 – December 22	Awaiting detailed design to be outsourced
Replacement/Refurbishment of SD RMUs (Stage 6)	construction	$500,000	staggered complete by FYE	in-house construction underway
TOTAL		$2,935,000		

As previously covered, initial contact was made with [redacted] external contractors. [redacted] the Project Delivery Manager to express interest in tendering for any 11kV work for the rest of this financial year and a meeting has been scheduled to discuss the projects with them. [redacted]
Once all detailed designs are complete, Project Delivery and Procurement will call for external tenders for the construction of projects identified to be outsourced.

Recommendation

That the Directors accept this paper for information.

Russell Shaw
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Top Energy Group

Prepared by:
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Annexure 8

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Memo to	**David Sullivan** **Nicole Anderson** **Jon Nichols** **Steve Sanderson** **Simon Young**
From	**Russell Shaw**
Date	**August 2022**
Subject	**AMP Due Diligence Part 1 - Asset Performance and Review**

PURPOSE

This is an information paper. It is part 1 of a 2-part Asset Management Plan (AMP) Due Diligence review. The document is to inform the Board of the analysis, decisions and direction being taken by Network management with focus on changes from last year.

BACKGROUND

Top Energy recently published the 2022 AMP Update to the 2021 AMP. As required by the Commerce Commission a new AMP is due for release on 31 March 2023. In order to understand the trade-offs and decisions made in covering capital and maintenance expenditure drivers the Board, as part of due diligence, has asked for information on past and future performance presented in this, and a second paper (Part 2) in September.

EXECUTIVE SUMMARY

The topics raised and questions answered in this paper are presented in the following order:

1. *Review of FYE 2022 reliability*
2. *Changes to network risk (emerging technologies and climate change)*
3. *Proposed Changes to fleet plans for key asset classes*

Review of FY22 Reliability

- There were two major SAIDI events in FYE 2022, a short sharp storm on 3 August 2021 and Cyclone Dovi in mid-February 2022. This latter event had the most severe impact on our network reliability of any storm that we have experienced since 2014. Fortunately, we were able to normalize the impact of these two events using the normalization methodology approved by the Commerce Commission, so that we remained below our price-path threshold of 380 minutes. The first storm was a major SAIDI event but did not trigger a major SAIFI event, so we were not able to normalize out SAIFI performance. Cyclone Dovi was both a major SAIDI and major SAIFI event.
- Nevertheless, our normalized unplanned network SAIDI of 342 minutes was our highest since FYE 2015 (after normalizing our historic performance in accordance with the Commission's current methodology). Our normalized unplanned SAIFI of 4.47 was below our SAIFI threshold of 5.07.
- There were no interruptions of our incoming 110kV supply from Maungatapere and no

unplanned interruptions of our own 110kV transmission system. Using our backup diesel generation, we successfully completed our annual maintenance outage of the 110kV transmission system without interrupting supply to consumers in our northern area.

- The normalized unplanned SAIDI due to faults on the 33kV network was 30 minutes, 9% of the total network SAIDI of 343 minutes. Going forward, we are aiming to reduce the annual normalized unplanned SAIDI on our subtransmission network to below 20 minutes through the remote control of our generation at Taipa and Omanaia.
- The normalized unplanned SAIDI and SAIFI of our 11kV distribution network were 312 minutes and 3.3 respectively. Due to this trend we have identified our worst performing feeders, and these are targeted in the 11kV Reliability Improvement Plan that was approved by the Board last April.

Changes to Network Risk (emerging technologies and climate change)
New solar farms to our network. The connection of solar farms is rapidly approaching, and the 2023 AMP will update the commentary in the 2021 AMP and the 2022 AMP Update. Assuming the solar farm projects for which connection agreements have already been signed proceed, as is highly likely, the amount of generation embedded in our network will be more than double the total consumer demand. The penetration of embedded generation, relative to the size of the network, is currently second highest of New Zealand EDB's. The network will become a hybrid generation-distribution network with two-way energy flows and generation management will likely dominate control room activity. We will need new skills with experience in the operation and management of generation, and these are currently being recruited.

The 2023 AMP will also provide an update on the renewable energy zone (REZ) initiative. Northland is the pilot project for this initiative, which is being led by Transpower. Transpower has released a consultation document and feed-back has been generally supportive of the concept. There is still the problem of funding such a venture to be worked through as with export capacity assigned to current applicant's, any potential renewable generation developers would currently need to fund the cost of the transmission network upgrades required before more renewable generation can be connected. There is potential that the cost of the Wiroa-Kaitaia line would be funded through capital contributions, and provision for the construction of this line will be removed from the capital expenditure forecast in the 2023 AMP. The funds released will be reallocated to the deferred Wiroa substation build, which will almost certainly be required before the end of the ten-year AMP planning period, and to continuation of the 11kV reliability improvement programme. Assuming the line is built, Top Energy will still likely need to fund some of the cost, as it will also eventually be used to supply the new substation at Garton Rd, Oruru, which will replace the existing Taipa substation, where the site is likely to become increasingly vulnerable to flooding as a result of sea level rise.

The 2022 AMP Update noted that with the completion of the Wiroa 110/33kV Wiroa substation, there would be sufficient capacity in the subtransmission network to support a doubling of the current load, subject to the installation of a switching station at Oromahoe and voltage support at Haruru and Kawakawa zone substations. We will therefore have the capacity to connect large new block loads where the cost of connecting to the network will be funded by capital contributions from the developer.

However much of the forecast load growth will be incremental in nature, driven (in part) by electrification of the transport fleet and subdivision growth. Augmentation of network capacity to support this growth cannot be fully funded by capital contribution.

This growth is likely to unevenly spread across the network and by 2050 demand in some areas could be higher than double the current localized peak demand. Supplying these additional loads would require reinforcement of the 11kV distribution network, which could involve the construction of new lines and zone substations. Our current stance is to ensure we investigate providing for increased capacity when replacing or installing new distribution infrastructure.

Management of the Asset Base

The capital expenditure forecast in the 2022 AMP Update accurately reflected the current year (FYE 2023) workplan, as it was at the time the AMP was prepared and before the decision was taken to defer the Wiroa substation build and reallocate this expenditure to improving the reliability of the 11kV distribution network.

However, the forecast for FYE 2024 and beyond was unchanged from the forecast in the 2021 AMP, apart from an increase in the provision for customer driven capital expenditure. Therefore:

- The cost of projects and programmes may be understated since the abnormally high-cost escalations experienced in FY2021/22 and built into the FYE 2023 work were not carried forward to subsequent years.

- It made no provision for the projects and programmes that were deferred either to accommodate work in the approved FYE 2022 work programme that was not completed or to ensure that the abnormally high-cost escalations were accommodated without exceeding the budget envelope.

The capital expenditure budget in the 2022 AMP Update did not account of the deferral of the Wiroa build or the removal of the provision for the construction of the Wiroa-Kaitaia 110kV line. The 2023 AMP capital expenditure budget will therefore need be revised to take account of all these factors.

The revised budget will also have an increased provision for the proactive replacement of crossarms and renewal of pole top hardware as part of the 11kV Reliability Improvement Plan , as failure of these asset components currently accounts for almost 60% of all defective equipment SAIDI.

REVIEW OF FYE 2022 NETWORK RELIABILITY

In FYE 2022 the unplanned reliability of our network, after normalization in accordance with the Commerce Commission’s currently approved methodology was 343 SAIDI minutes and 3.96 SAIFI interruptions. A comparison with our historic performance (after normalization using the current methodology) and our current price-path thresholds is shown in Figure 1.

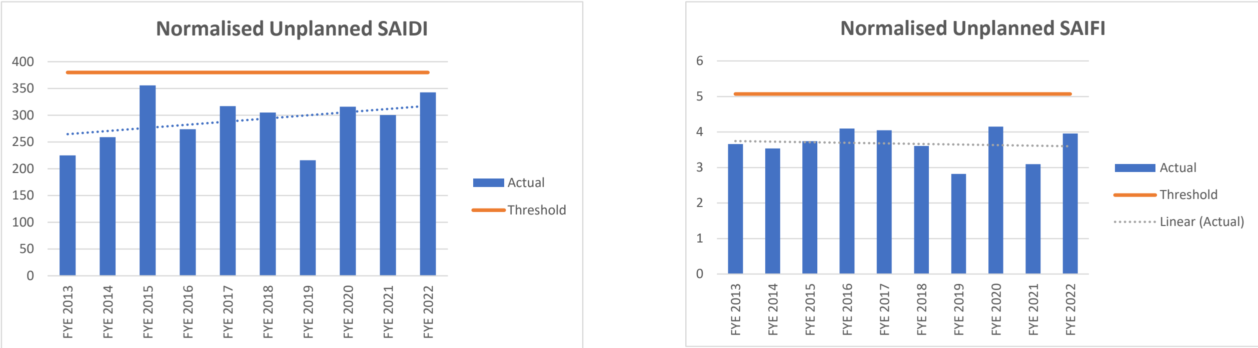

Figure 1: Impact of Unplanned Network Interruptions after Normalization

Major SAIDI Events

There were two major SAIDI events in FYE 2022, a storm on 3 August 2021 and Cyclone Dovi in mid-February 2022. Cyclone Dovi was also a major SAIFI event.

The August event lasted 16 hours and affected the north-west of our supply area, including the far-north peninsula, Kaitaia and Hokianga areas. Over that time there were 14 storm-related 11kV faults with an aggregate raw SAIDI and SAIFI impact of 34.0 and 0.13. As the aggregate raw SAIDI for the event exceeded our boundary value of 27.92 we were able to normalize the SAIDI impact down to 5.5 minutes for assessment against our price path. The SAIFI impact did not exceed the boundary value of 0.23 and so could not be normalized.

Cyclone Dovi took us by surprise as it was forecast to have largely run out of steam by the time it reached New Zealand and was expected to pass east of our supply area. The event affected our whole supply area and had the most severe impact on our network reliability of any storm that we have experienced since 2014. There were 50 faults reported between 3pm on Saturday 12 February and 9pm on Monday 14 February. The storm had a raw SAIDI impact of 390.2 minutes, which we were able to normalize back to 19.8 minutes. The SAIFI impact was 0.63, which we normalized to 0.12.

The only interruption of our 33kV network during Dovi was a tripping of the incoming circuit to the Taipa substation at 1.30am on Sunday 13th, an event which had a raw SAIDI of 53 minutes. While the downstream generation at Taipa was available to mitigate this impact, it was not used until after daylight the next morning for two reasons:

- At the time the tripping occurred the operators were overwhelmed – a total of 17 faults were reported in the four-hour period between 11pm and 4 am.
- There were safety concerns about livening the 11kV without first patrolling the network, as at least one report was received of a wire in the area after it had been isolated by the 33kV fault.

Fortunately, we were able to normalize the impact of these two events using the normalization methodology approved by the Commerce Commission, so our normalized FYE 2022 SAIDI remained below our price-path threshold of 380 minutes. Our FYE 2022 raw SAIFI was 3.96, so the normalization wasn't needed to ensure we remained below the price-quality path threshold of 5.07.

Transmission Network
There were no unplanned interruptions of the 110kV transmission system in 2022. When the system was taken out of service for its annual maintenance shutdown, supply to consumers in the northern part of our supply area was maintained by using our diesel generation.

Sub transmission Network
Figure 2 shows the raw and normalized unplanned SAIDI and SAIFI due to faults on our 33kV network in FYE 2022. In addition to the fault during Cyclone Dovi, there were five faults that exceeded our threshold of 2 SAIDI minutes for detailed investigation into the cause of the fault.

- On 2 July 2021 a fault on the single circuit Kaitaia-Taipa line had a SAIDI of 11.60 minutes. The cause of the fault was not found. At the time the Taipa generation was out of service due to the replacement of a generator transformer.

- On 3 August 2021 there was an outage of the Kaitaia-Pukenui line due to a broken binder securing the conductor on a pole at Waiharara. This fault occurred during the severe August storm and had a SAIDI of 8.41 minutes. This was normalized to 0.58 minutes for assessment against our SAIDI target.

- On 23 May 2021 a tree fell on to the Kaikohe-Omanaia line at Waima, causing a fault with a SAIDI impact of 5.17 minutes. The Electricity (Hazards from Trees) Regulations 2003 limits our ability to manage the risk of tress falling into our lines, where the trees are located outside the clearance zone specified in the Regulations.

- On 1 October 2021 there was another tripping on the Kaikohe-Omanaia line with a SAIDI impact of 3.56 minutes. The cause of this fault was never found.

- On 11 July 2021 there was a bird strike on the Kaikohe-Omanaia line with a SAIDI impact of 2.77 minutes.

These faults all occurred on lines supplying substations with a single incoming 33kV supply. We have now implemented remote control of the generators at Omanaia, and if this had been in place when the faults occurred, we should have been able to mitigate the impact of the faults on this line. We have allocated funds for the refurbishment of the Kaikohe-Omanaia 33kV line, and the first stage of this project is being implemented in the current year.

Going forward, we would expect the normalized SAIDI impact of unplanned interruptions of the sub transmission system to be lower than 20 minutes, provided we are successful in remotely starting generators at Taipa and Omanaia once an interruption occurs at these substations. However, the installation of standby generation will have no impact on SAIFI, as the generators are only started after an interruption occurs. The Pukenui generator is a second-hand unit and has still to be commissioned due to ongoing defects.

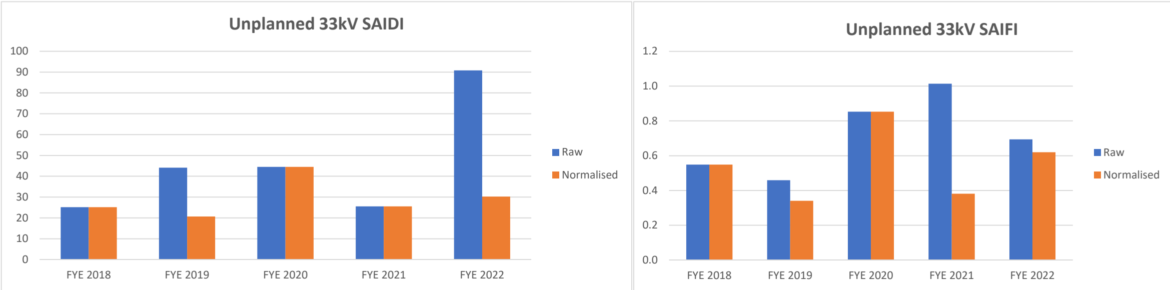

Figure 2: Impact of Unplanned 33kV Interruptions

Distribution Network

Overall Impact of Unplanned Interruptions

Figure 3 compares the impact of unplanned interruptions of the distribution network in FYE 2022 with that experienced over the previous four years. The distribution network accounted for 91% of the total normalized unplanned network SAIDI and 84% of unplanned network SAIFI. The trendlines in Figure 2 confirm our earlier advice to the Board that due to this trend we are addressing it with our recently formulated 11kV reliability improvement programme.

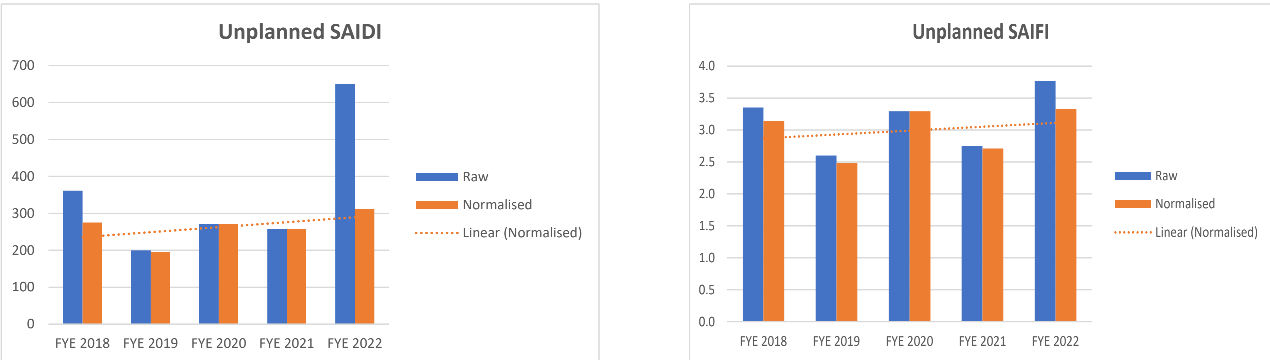

Figure 3: Impact of Unplanned 11kV Interruptions

Causes of Unplanned Distribution Network Interruptions

Over FYE2022, defective equipment accounted for 31% of normalized unplanned SAIDI and 32% of normalized unplanned SAIFI. Similarly, vegetation contributed 29% of SAIDI and 24% of SAIFI. The other major causes of interruptions were third party interference (17% of SAIDI) and faults where the cause could not be found (14% of SAIDI). Car vs pole incidents accounted for 82% of third-party interference SAIDI.

Figure 4 shows the trend of the two main fault causes over the five-year period FYE 2018-22.

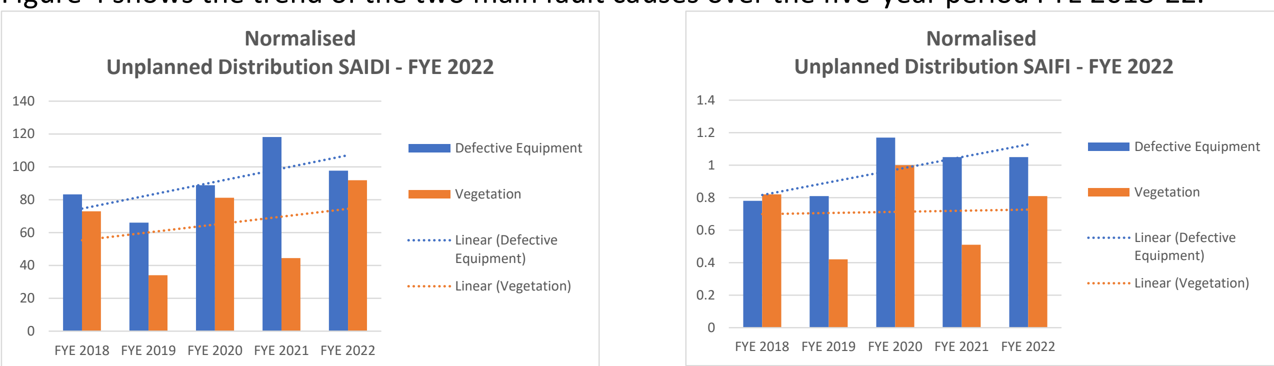

Figure 4: Normalized Impact of Distribution Network Defective Equipment and Vegetation Faults

Worst Served Feeders

Table 1 lists the ten worst served feeders on our network, ranked by normalized unplanned SAIDI in FYE 2022 and, where applicable, describes the strategies that we are putting in place to improve the performance of each feeder. While these feeders represent only 16% of the 63 feeders currently on our network, they caused 59% of the total normalized unplanned distribution network SAIDI in FYE 2022.

Rank	Feeder	SAIDI	Improvement Strategy
1.	South Road	28.88	We are implementing a protection upgrade in the current FYE 2023 year. In FYE 2025 we are planning to install a new injection point at the Kaitaia 110kV substation and also complete an interconnection to the Rangiahua feeder at Broadwood.
2.	Rangiahua	22.10	In FYE 2025 we plan to complete an interconnection to the South Road feeder at Mangamuka.
3.	Whangaroa	20.55	In the current FYE 2023 year we are constructing an interconnection between the end of the Whangaroa feeder and the end of the Mangamuka feeder.
4.	Oruru	20.38	We plan to implement a protection upgrade in FYE 2026.
5.	Te Kao	18.24	We are implementing an accelerated pole and pole top hardware replacement programme in FYE 2023 and 2024 and are planning a protection upgrade in FYE 2025.
6.	Tokerau	18.12	We are implementing an accelerated pole and pole top hardware replacement programme in the current FYE 2023 year and are planning a protection upgrade on this feeder in FYE 2024.
7.	Ohaeawai	15.40	-TBA
8.	Russell Express	14.66	In the current year we are completing the final stage of the Russell Reinforcement project, which will move half the load on the feeder to the Joyce's Rd feeder.
8.	Totara North	13.85	-TBA
10.	Waima	13.04	-TBA

Table 1: Worst Served Feeder Improvement Strategies

CHANGES TO NETWORK RISK

Emerging New Technologies

Renewable Generation

Our 2022 AMP Update noted that we have signed connection agreements for the connection of 63MW of utility scale solar farm capacity in our northern area and 9MW on a site close to the Ngawha geothermal power station. This capacity is the maximum the network can handle due to the limited capacity of the Kaikohe-Kaitaia 110kV line.

At the time of writing, no solar farm developer had accepted our proposal for the construction of the connection assets required to connect their solar farms to the network, so all applications remain on hold. However, we remain in contact with all the developers with whom connection agreements have been signed and the expectation is that all solar farms will proceed to construction.

In signing the connection agreements, we relied on our consultant's modelling that confirmed that all three solar farms can be connected to the northern network without adversely impacting the quality of supply provided to other network users. The consultant has noted that, in all three cases, the equipment to be installed at each site had still to be confirmed and so its modelling used typical electrical parameters for the type of equipment proposed. The consultant recommended that the modelling be reviewed using the design parameters of the actual equipment to be installed at each site, once this data was available. These reviews have still to be undertaken, but no issues are anticipated provided the new generation complies with the applicable industry standards and our own policies on the connection of distributed generation to our network.

The consultant also recommended that the commissioning of the solar farms be closely monitored to confirm that the generation performs in accordance with its approved design parameters. This will assist our operation team familiarize itself with the equipment and its impact on the performance of the network under different network operating conditions. We will engage an independent consultant to assist with this process.

Renewable Energy Zone

The 2022 AMP Update discussed the initiative with Northpower and Transpower to investigate the establishment of a REZ in Northland, with the objective of increasing the capacity of the transmission network to accommodate the connection of additional renewable distributed generation within the Top Energy and Northpower supply areas. These changes could include the construction of the planned Wiroa-Kaitaia 110kV line and a thermal upgrade to increase the capacity of Transpower's double circuit Kaikohe-Kaitaia line.

Transpower has taken responsibility for progressing the REZ.

In the expectation that the Wiroa-Kaitaia line will now be funded (if not fully, then partially) by renewal energy developers, rather than Top Energy, provision for the construction of this project will no longer be included in the capital expenditure forecast in the 2023 AMP. The expenditure will be reallocated to the construction of the 110/33kV Wiroa substation and to projects targeted at improving the reliability of the 11kV distribution network.

Impact of Distributed Generation

Assuming the solar farm capacity in the northern area and OEC5 at Ngawha proceed there will be a total of 164MW of generation embedded in our network comprising:

- 84MW of geothermal plant at Ngawha, operating continuously as a base load generator.
- 63MW of utility scale solar generation in the northern area. This generation output is intermittent and not routinely controlled by the plant operator.
- 17MW of standby diesel generation, which can be run in islanded mode during abnormal network operating conditions.

This is more than double the current peak demand on our network by consumer offtake users. In addition, there is currently almost 8MW of small-scale solar generation connected to our network, most of which is connected to the low voltage network. There is no sign that interest in the installation of small scale, rooftop solar generation will abate.

We are therefore transitioning from a passive network with one-way energy flows to a hybrid generation-distribution network where energy can flow in either direction. We likely already have the highest level of connected distributed generation relative to the size of our network of any EDB in the country. As this trend accelerates, the management of connected generation is going to dominate our control room activity and the skills required to develop and manage our network will change. We are preparing for this transition through the recruitment of a distribution system operations manager with experience in in generation management, and we have installed a state-of-the-art Advanced Distribution Management System (ADMS) to assist with the real time management of both facets of our operation.

Climate Change

Section 7.6 of our 2021 AMP discussed the two main impacts of climate change on the development and operation of our network.

Changes in weather patterns

The main impacts of the change in weather patterns were identified as:

- *An increase in the intensity of ex-tropical cyclones,* which could have a detrimental impact on network reliability. We now have a better understanding the drivers of our network reliability and we have developed the distribution network reliability improvement programme.

- *Sea level rise,* which will progressively increase the flood risk of the Taipa substation site. Our current strategy to mitigate this risk is to relocate the substation to a new site at Garton Rd, Oruru, which would be supplied by a deviation to the planned 110kV Wiroa-Kaitaia line. While the construction of this line will not be included in the 2023 AMP capital expenditure forecast, we still expect the line to proceed, funded by the developers of utility scale solar farms wanting to connect to our network. If the Garton Rd site is to be used for a new substation, we may need to make a contribution to the cost of this line.

Decarbonisation of the Economy

Decarbonisation of the economy is expected to increase the demand for electricity, due to the electrification of transport and process heat. This was discussed in Section 3.5.1 of our 2020 AMP Update where it was noted that Transpower in its Whakamana i Te Mauri Hiko report forecast that electricity demand would increase by 68% by 2050. Since then, the Climate Change Commission has issued its recommendations on decarbonisation of the economy and the Government has released it decarbonisation plan. It is not clear whether this plan will materially change the Transpower demand forecast. We will continue to monitor developments in the national climate change policy and their likely impact on our network.

On the generation side, decarbonization is the main driver for the connection of renewable generation to our network. As noted elsewhere in this paper, our ability to full accommodate this will be dependent on whether we can mitigate our transmission constraints. This is the objective of the REZ initiative discussed above. This situation is still evolving, and we expect to be able provide an update in our 2023 AMP.

On the demand side, we expect to see demand increase due to the electrification of transport (in part) and growth as the eastern seaboard of our supply area is expanding quickly and there is no indication that the rate of growth will reduce. Subdivision demand in the Kerikeri area remains strong. Our supply area has significant untapped potential for economic growth, particularly in the horticulture, industrial and tourism sectors.

As discussed in our 2022 AMP Update, we have tested the capacity of our transmission and sub transmission networks to supply double our current level of demand. We found that there will be sufficient capacity in the network subject to:

- The construction of the 110/33kV substation at Wiroa. While this build has been deferred in the short term, it will almost certainly be required before the end of the ten-year AMP planning period.

- The establishment of a 33kV switching station at Oromahoe and the installation of voltage support at the Kawakawa and Haruru substations to support demand growth at Paihia, Opua and on the Russell peninsula.

Our network backbone is therefore well placed to supply large new block loads, where the cost of connecting to the network will be paid for by the developer.

We think that most of the network augmentation that we will need to fund to support demand growth of this magnitude will be reinforcement of the 11kV network to support incremental demand growth. This will be determined by the nature and location of such growth. While a doubling of demand has been assumed for this exercise, localized growth in some areas could be much higher. Growth driven by the demand for electric vehicle charging is incremental and, while dispersed across the network, is likely to be higher in the higher socio-economic areas.

There is a risk that high incremental growth rates could occur in areas, such as Omapere, the Karikari, Purerua and Russell peninsulas that are not well served by our existing 11kV distribution infrastructure.

These will be monitored as increasing network capacity to supply such areas would require the construction of new lines, which could initially be constructed at 33kV and operated at 11kV, with a view to later installing a new 33/11kV zone substation.

Electrification of existing industrial process heat is less likely as most process heat in our area is associated with wood processing industries and already uses wood-based biofuel. The [redacted] recently replaced it coal fuelled boiler with a wood fired unit.

FLEET MANAGEMENT

AMP Capital Expenditure Forecast

The 10-year capital expenditure forecast in our 2022 AMP Update and submitted to the Commission in Regulatory Schedule 11a can be characterized as follows:

- The forecast capital expenditure on network assets was $192.5 million (at constant FYE 2023 prices) over the 10-year period. However, while the current year forecast was adjusted from the 2021 AMP forecast to account for abnormally high labour and materials cost increases (estimated at 7% and 15% respectively), no changes have been made to the forecasts for FYE 2024 and beyond. The forecasts for these years:
  - The cost of projects and programmes may be understated since the abnormally high-cost escalations experienced in FY2021/22 and built into the FYE 2023 work were not carried forward to subsequent years.
  - Made no provision for the projects and programmes that were deferred either to accommodate work in the approved FYE 2022 work programme that was not completed or to ensure that the abnormally high-cost escalations were accommodated without exceeding the budget envelope

- The forecast included $38.3 million over FYE 2025-30 for the construction of the Wiroa-Kaitaia line. It is now probable that this line, if constructed, will be largely funded through capital contributions by solar farm developers. The $38.3 million provision is now known to be significantly lower than the likely construction cost and the build would likely need to be funded by additional construction costs being spread over more years.

- The forecast included $9.6 million for the construction of the new 110kV Wiroa substation over FYE 2023-25. $3.1 million of this provided for in the current year has now been reallocated to the new 11kV reliability improvement programme. Due to the high labour and materials cost increases (estimated at 7% and 15% respectively) the remaining $6.5 million understates the cost the work it was intended to provide for. While the decision has been made to defer this project, given the load growth in the Kerikeri area there is little doubt that the substation will be required at some stage within the ten-year AMP planning period. However, the timing of the build is uncertain and will depend on the rate of growth in demand.

- A total of $73.6 million in the forecast (38%) has been provided for asset renewal and replacement. Of this $25.3 million is allocated to the distribution network, $10.8 million of which is reactive expenditure incurred responding to faults and the remediation of urgent defects identified during asset inspections.

- A total of $2.4 million has been allocated to the proactive replacement of crossarms. This programme was budgeted to begin until FYE 2026.

The 2023 AMP is required to be a full AMP rather than an update and the capital expenditure forecast will need to be well supported in the text. The forecast will be revised to include the following changes from the forecast in the 2022 AMP Update.

- All years of the constant price forecast will be based on expected FYE 2024 costs.

- Construction costs for the 110kV line will be removed on the understanding that the line will be constructed as a customer driven asset largely funded by capital contributions. Residual costs to fully secure the route will still be included but these are not a material amount.

- The construction of the Wiroa substation will be included as a "placeholder", based on updated information on demand growth and quantitative modelling of the impact of a loss of the Kaikohe-Wiroa line at time of peak demand. The supporting text will clarify that the build may be brought forward or further deferred.

- The forecast will include an updated 11kV reliability improvement plan funded by the deferral of Wiroa substation build and the removal of the Wiroa-Kaitaia line. The need for this plan and its expected impact will be discussed in the text. The new plan will include provision for the proactive replacement of crossarms and other pole top hardware starting FYE 2024.

Impact of Defective Equipment Faults

We monitor the condition of our asset base through our regular asset inspections. All assets are inspected in accordance with a time-based inspection schedule but the interval between the inspection of individual assets will vary. This is determined by:

- The probability of an asset failure. Assets early in their expected life will be inspected less frequently than assets nearing the end of their life that are showing signs of accelerated deterioration, where the inspection interval is determined by an assessment of the assets likely remaining life as determined by the asset's condition.

- The consequences of an asset failure. Consequences are determined primarily in terms of safety risk and the impact of an asset failure on the reliability of the network. Assets with a high consequence of failure are replaced early, while assets where the consequences of failure are low are likely to be left in service until the asset finally fails.

The results of our regular asset inspection are used to formulate an overall assessment of the health of our network asset base using the methodology set out in the Electricity Engineers' Association (EEA) Asset Health Indicator Guide. This Guide categorizes the asset base by asset type and requires an assessment of the number of assets of each asset type that are nearing the end of their expected life and are due for replacement. Where possible the assessment is based on the condition of that asset as determined from our asset inspections. However, for some asset types, such as conductor and cable, asset condition cannot be determined from a visual inspection and asset age is used as a proxy for condition.

This approach assists us utilize an asset replacement and renewal programme that ensures:

- The allocation of expenditure to asset replacement and renewal is sufficient to ensure that the asset base is maintained to a level that will meet our asset management objectives and ensure that our reliability of supply does not deteriorate to a level that is unacceptable to stakeholders.

- This expenditure is appropriately prioritized and targeted appropriately.

The success of our fleet management plans can be determined by evaluating the impact of faults caused by defective equipment on overall network reliability, as measured by SAIDI and SAIFI.

A shortcoming of this approach is that the EEA Guide categorizes the asset base into the asset types generally used for financial reporting when, for some assets, a higher level of disaggregation is more appropriate. Table 2 provides a breakdown of the average annual SAIDI impact of defective equipment failures on the 11kV over the five-year period FYE 2018-22.

Cause	**SAIDI (minutes)**	**Percent of Total**
Crossarms	27.23	30%
Other pole top hardware	25.40	28%
Conductor	14.56	16%
Transformer (incl. regulators)	9.08	10%
Cables	3.63	4%
Switch	3.01	3%
Reclosers / sectionaliser	0.79	1%
Poles	0.34	0%
Circuit breaker	0.24	0%
Other	6.59	7%
Total	**90.88**	**100%**

Table 2: SAIDI Impact of 11kV Defective Equipment Faults

The table shows that 58% of the reliability impact defective equipment faults on the 11kV distribution network were caused by the failure of crossarms or other pole top hardware, which are not categorized as assets under the EEA methodology. However, our proactive asset renewal programme largely focuses on the replacement of "assets" as categorized in the EEA Guide and used for financial reporting purposes. Hence a pole inclusive of its crossarms and other pole top hardware are categorized as an "asset" but the hardware that it supports are merely considered components. This creates an anomaly in that the pole top hardware generally has a shorter life than the associated pole, particularly when the pole is concrete. Until now, we have not had proactive asset renewal programmes specifically targeted at pole top hardware.

While the recently developed 11kV reliability improvement programme does not explicitly include provision for proactive pole top hardware replacements, it allocates $1.75 million for the replacement of concrete poles on the Te Kao and Tokerau feeders in FYE 2023-24. These two feeders had the highest SAIDI impact of crossarm and pole top hardware failures over the FYE 2018-22 period of all the feeders on the network and together accounted for 5.2% of this total impact. Pole replacements routinely include the replacement of pole top hardware. As indicated above, the 2023 AMP expenditure forecast will include provision for an asset renewal programme targeted at the proactive replacement of pole top hardware.

Recommendation

That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
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Annexure 9

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **September 2022**

Subject: AMP Unplanned Interruption Targets

Purpose

The paper is seeking Board approval to reset the internal reliability targets in the Asset Management Plan (AMP) and to engage with the Trust to look to also amend the Statement of Corporate Intent (SCI). It follows on from the review of our FYE 2022 network reliability that we presented to the Board in August and proposes that we reset the internal reliability targets in the Asset Management Plan (AMP) and Statement of Corporate Intent (SCI) to levels that better reflect the current performance of our network under normal weather conditions and the improvements we expect to achieve as we implement the 11kV reliability improvement plan approved by the Board in April 2022.

Executive Summary

Our proposed revised unplanned SAIDI and SAIFI targets are shown in Tables E1 and E2 below.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Proposed Targets										
Transmission	0	0	0	0	0	0	0	0	0	0
Subtransmission	20	20	20	20	20	20	20	20	20	20
Distribution	285	279	274	268	263	257	252	246	241	235
Total	**305**	**299**	**294**	**288**	**283**	**277**	**272**	**266**	**261**	**255**
Current AMP target	235	230	230	230	230	230	230	230	230	-
Quality threshold	380	380	-	-	-	-	-	-	-	-

Table E1: Proposed Network Unplanned SAIDI Targets

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Proposed Targets										
Transmission	0	0	0	0	0	0	0	0	0	0
Subtransmission	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Distribution	3.12	3.03	2.95	2.86	2.78	2.69	2.61	2.52	2.44	2.35
Total	**3.62**	**3.53**	**3.45**	**3.36**	**3.28**	**3.19**	**3.11**	**3.02**	**2.94**	**2.85**
Current AMP target	2.96	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	-
Quality threshold	5.07	5.07	-	-	-	-	-	-	-	-

Table E2: Proposed Network Unplanned SAIFI Targets

Figure E1 compares our proposed SAIDI targets with our actual performance over the FYE 2018-22 period and the current AMP targets.

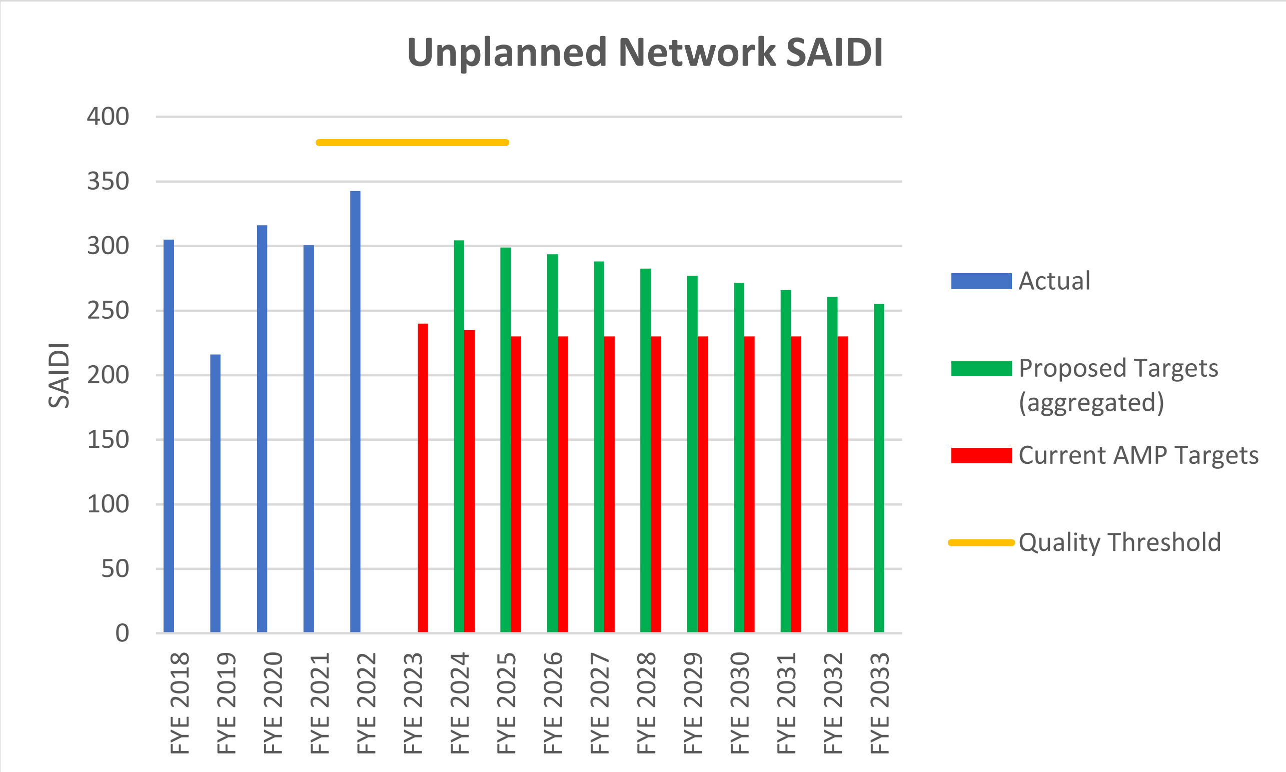

Figure E1: **Comparison of Actual and Targeted Unplanned SAIDI.**

Background

In our AMP we are required to set targets for the expected reliability of our network for each year of the ten-year planning period. For consistency, the reliability targets in the SCI are the same as the corresponding targets disclosed to stakeholders in the AMP.

We measure the reliability our network using the internationally accepted SAIDI and SAIFI indicators. Consistent with the approach taken by the Commerce Commission in assessing our compliance with our price quality path, our AMP targets are set using normalised reliability measures, designed to better reflect the impact of factors we can control, rather than the actual supply reliability experienced by consumers. The normalisation process adjusts the actual reliability by reducing the weighting given to high impact events, such as severe storm activity, on the reported measure. As these high impact events are usually driven by external factors that management is unable to control, the normalised measure is a better reflection of our effectiveness in using the tools and resources that are available to us to manage the reliability of our network.

In setting our targets we have always used the normalisation methodology as the Commission. When the Commission has changed its normalisation approach at the beginning of each regulatory period, we have also changed the way we measure and report the reliability of our network.

Up until the current regulatory period (RP3), which commenced on 1 April 2020, the Commission used a hybrid measure derived from the SAIDI and SAIFI impact of both planned and unplanned interruptions to assess of compliance with the quality threshold of its price-quality path. It no longer uses this hybrid approach and now separately measures the impact of planned and unplanned interruptions. Therefore, our AMP internal reliability targets now only cover the impact of unplanned interruptions.[1]

Our current unplanned SAIDI performance is higher than many other New Zealand EDB's, largely due to legacy factors outside our control. One of the objectives of our network investment over the last decade was to turn the situation around and develop the network to a point we could deliver an acceptable reliability of supply to our customers. We have been successful in eliminating the need for planned interruptions of our northern area so that our 110kV line can be shut down for maintenance and we have also reduced the impact of unplanned interruptions of our 33kV subtransmission network from a typical 150 SAIDI minutes prior to FYE 2016 to about 25 minutes today. Our overall reliability of supply is now led by the impact of faults on the 11kV distribution network. In April this year the Board therefore approved the implementation of an 11kV reliability improvement plan to focus on further improving SAIDI.

Our journey of continual improvement saw us coming from a low cost, low service provider to one of which we will over the next several financial years provide a high standard of service for a price in the lower quarter $/ICP as illustrated in diagram 1 below.

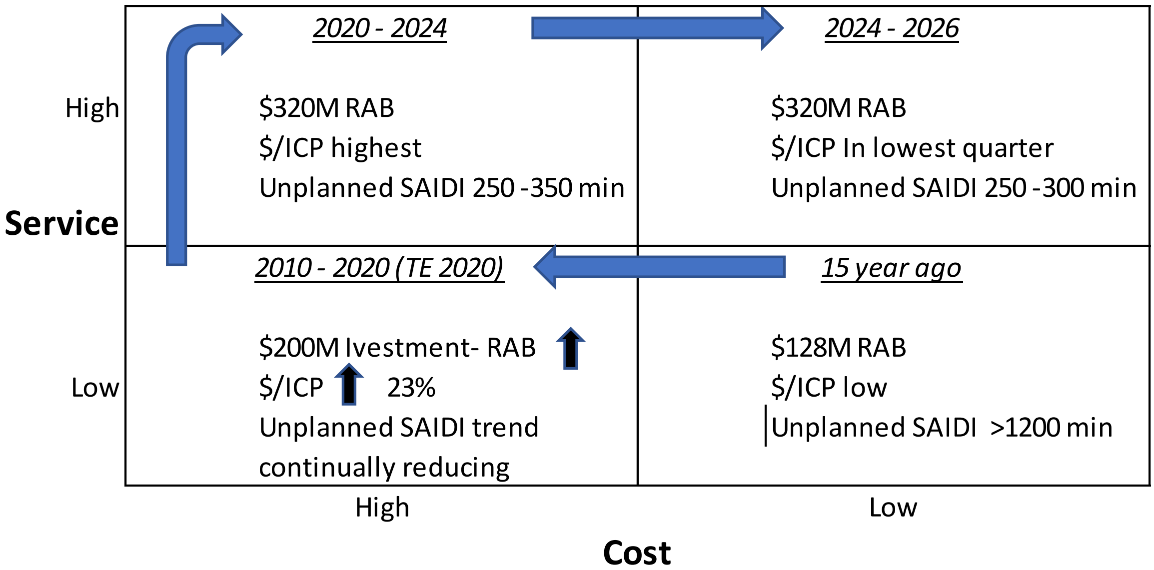

Diagram 1. Improvement path.

[1] While the Commission has also set a threshold for planned interruptions, compliance will be assessed at the end of the regulatory period rather than annually. The threshold for each EDB has been set at a level significantly higher the historic planned interruption impact to avoid limiting prudent network maintenance. In our case the historic impact included the planned 110kV line maintenance interruptions, which we no longer require. We are therefore unlikely to breach our planned interruption threshold and we see little value in setting an internal planned interruption target that could limit network maintenance.

Proposed Unplanned SAIDI and SAIFI Targets

Introduction

In the current AMP our internal unplanned SAIDI and SAIFI targets are set at levels that are well below the levels that the current network is able to deliver in a year of normal weather conditions. This is shown in Figures 1 and 2, where the current unplanned interruption targets are compared to the historic network performance. It can be seen from Figure 1 that we only hit the current SAIDI targets in FYE 2013 and FYE 2019, when the weather conditions were unusually benign. We also only hit our current SAIFI target in FYE 2019. While, notwithstanding the effect of normalisation, there will always be some degree of volatility in the normalised reliability indicator, if our internal targets more realistically reflected the expected performance of the network in a typical year, with prudent management we should expect to meet them on average every second year. Note RIS in graph is the Reliability Incentive Scheme, the component of the Commerce Commission's price-quality regulatory arrangements.

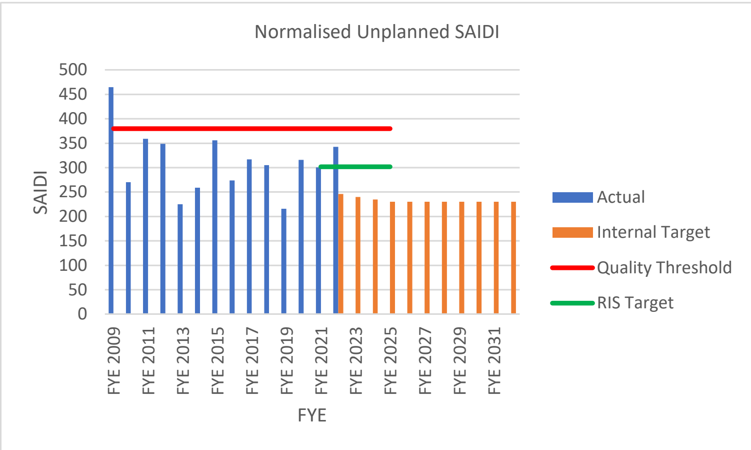

Figure 1: Comparison of Actual and Targeted Unplanned SAIDI (all voltages)

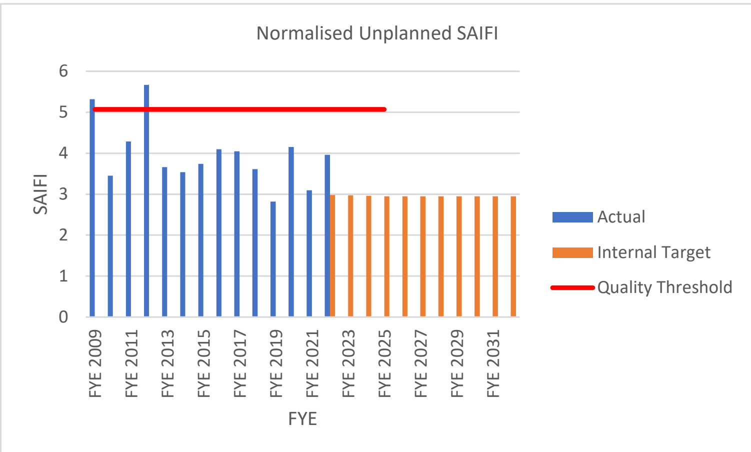

Figure 2: Comparison of Actual and Targeted Unplanned SAIFI (all voltages)

We therefore propose to reset our unplanned SAIDI and SAIFI targets to levels that better reflect the current performance of the network and the expected outcomes of our 11kV reliability improvement plan.

Our proposal assumes that the forecast reliability improvements from the 11kV reliability improvements are achieved but, apart from that, a business-as-usual asset management strategy is implemented.

Transmission System Reliability Target
Unplanned interruptions due to faults on the 110kV Kaikohe-Kaitaia line are infrequent – there have been only four such interruptions since FYE 2013. As our objective is to avoid such interruptions, our proposed target transmission network SAIDI and SAIFI targets are both **zero** in each year of the planning period.

Should an interruption occur, all consumers in the northern part of our supply area would lose supply and the SAIFI impact would be about 0.3 on the basis that 30% of our consumers would be affected. The SAIDI impact would depend on how long it took our control room operators to start the generators in the northern area, connect them to the network and put them on load. While we have successfully started and synchronised the generators before disconnecting the 110kV line for a planned interruption, we have not tested the connection of the Kaitaia generators to a dead network after an unplanned line interruption, such a test would first require the disconnection of numerous consumers and bring them on in stages to avoid too much in-rush current on the generators.

Subtransmission Network Reliability Target
The raw and normalised SAIDI and SAIFI of the 33kV subtransmission network of the most recent five-year FYE 2018-22 period is shown in Figures 3 and 4 respectively.

The average normalised SAIDI over the period was 29.2 minutes. However, in FYE 2020 a single fault due to a a conductor tail blowing off one of the two lines supplying the Moerewa/Kawakawa /Haruru/ substations when the second line was out of service for maintenance had a SAIDI of 25.4 minutes, marginally under our SAIDI boundary value of 27.9 minutes. Had the second line not been out of service when the fault occurred there would have been no interruption and, had the raw SAIDI exceeded the boundary value, the SAIDI impact would have been normalised to 0.58 minutes. In this event the normalised SAIDI for the year would have been the lowest of the period rather than the highest.

To determine a reasonable SAIDI target, based on recent network performance we have treated this fault as an outlier and removed it from the analysis. This reduces the average SAIDI for the period to 24.2 minutes. However, this figure does not fully take account of the following projects that should reduce further reduce SAIDI. These are:

- The installation of diesel generators at Omanaia and Pukenui substations.
- The refurbishment of the Kaikohe-Omanaia 33kV line.

If the impact of these to projects is to be allowed for a SAIDI target of 20 minutes would seem reasonable.

If the FYE 2020 fault is not included the analysis for the average 33kV unplanned SAIFI over the period was 0.51. The installation of generation will not provide any improvement as the generators are not started until after the supply has been lost. However, the refurbishment of the Omanaia line should prevent most defective equipment faults form occurring. As the SAIFI due to a fault on the Omanaia line is only 0.05, a 33kV unplanned SAIFI target of 0.50 would seem reasonable.

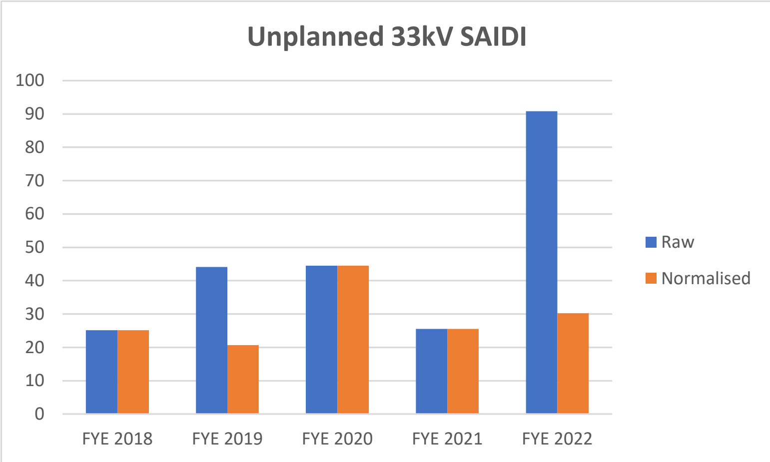

Figure 3: Raw and Normalised Unplanned 33kV SAIDI (FYE 2018-22)

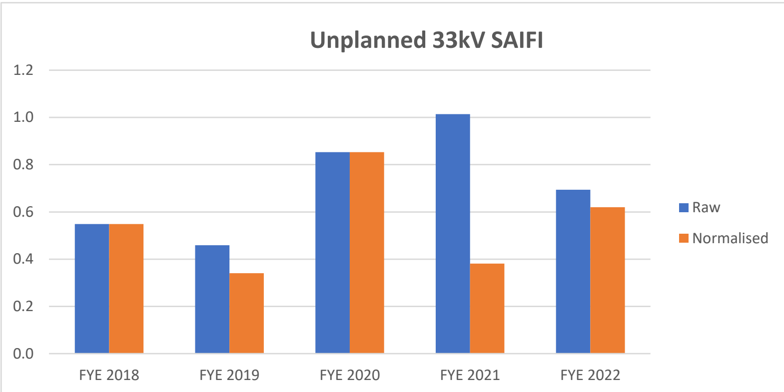

Figure 4: Raw and Normalised Unplanned 33kV SAIFI (FYE 2018-22)

Our proposed reliability targets for the 33kV subtransmission system are therefore:

Unplanned SAIDI	20 minutes
Unplanned SAIFI	0.5

As there is little scope for further 33kV network reliability improvements, these targets would remain unchanged for each year of the ten-year planning period.

Distribution Network Reliability Targets – Main Proposal

Our raw and normalised unplanned 11kV network SAIDI and SAIFI over the period FYE2018-22 is shown in Figures 5 and 6 respectively.

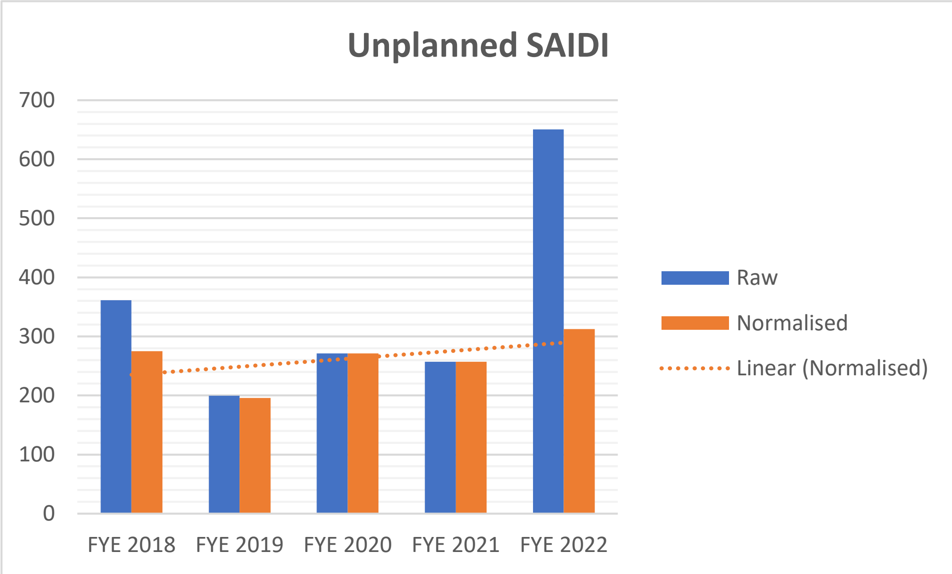

Figure 5: **Raw and Normalised Unplanned 11kV SAIDI (FYE 2018-22)**

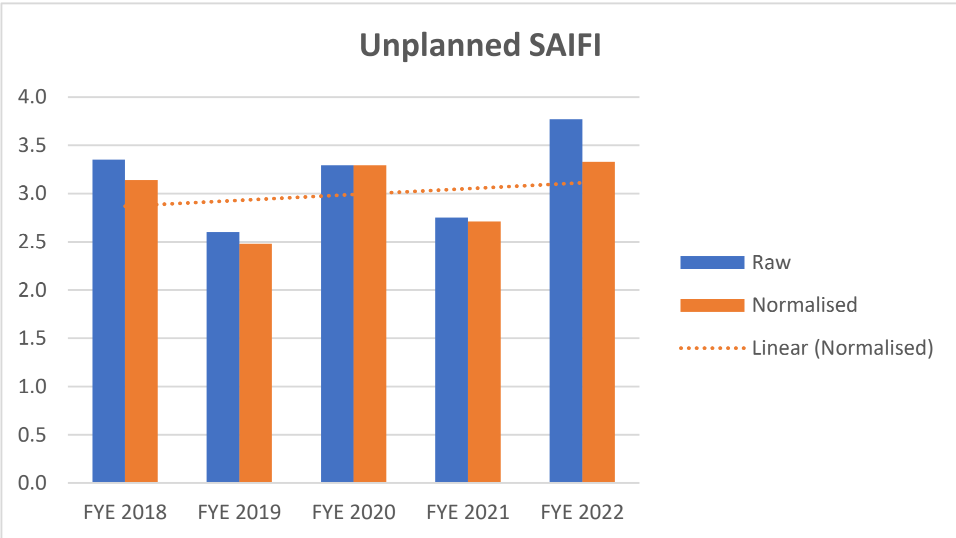

Figure 6: **Raw and Normalised Unplanned 11kV SAIFI (FYE 2018-22)**

It can be seen from the linear trendlines in the above two figures that the normalised 11kV SAIDI is currently trending upward by approximately 8.75 minutes per year and the SAIFI is also trending up by approximately 0.025[2].

We have taken the following approach to determine realistic unplanned SAIDI and SAIFI targets for the 11kV distribution network.

- As the 11kV reliability improvement plan only targets localised areas, we have assumed that this trend will continue across the rest of the network and the new targets will need to account for this deterioration, overlaid with the expected impact of the improvement plan.

- The impact of the reliability improvement plan will not be apparent until FYE2024. Based on the trend lines shown in Figures 5 and 6, we have assumed an expected unplanned 11kV SAIDI of 290 minutes for FYE2023 and a SAIFI 3.20.

- In our May 2022 paper, management forecast accumulative 11kV unplanned SAIDI impact of 56.98 by FYE2027 and a cumulative SAIFI impact of 0.44 due to the proposed reliability improvement investment In setting the targets we have levelized this to an average annual SAIDI improvement of 14.25[3] minutes and an annual SAIFI improvement of 0.11.

Based on these assumptions our proposed revised 11kV unplanned SAIDI and SAIFI targets are shown in Table 1.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
SAIDI	285	279	274	268	263	257	252	246	241	235
SAIFI	3.12	3.03	2.95	2.86	2.78	2.69	2.61	2.52	2.44	2.35

Table 1: Proposed Distribution Network Unplanned SAIDI and SAIFI Targets

Summary of Proposed Targets

SAIDI

Table 2 shows all our proposed unplanned SAIDI targets and compares the aggregated targets with the current targets AMP target, which covers the whole network and is not disaggregated. The table also shows the current Commerce Commission quality threshold which applies through to FYE2025. We expect the Commission to set a new threshold for the FYE2026-30 regulatory period.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Proposed Targets										
Transmission	0	0	0	0	0	0	0	0	0	0
Subtransmission	20	20	20	20	20	20	20	20	20	20
Distribution	285	279	274	268	263	257	252	246	241	235
Total	**305**	**299**	**294**	**288**	**283**	**277**	**272**	**266**	**261**	**255**
Current AMP target	235	230	230	230	230	230	230	230	230	-
Quality threshold	380	380	-	-	-	-	-	-	-	-

Table 2: Proposed Network Unplanned SAIDI Targets

Figure 7 presents the information in Table 2 in graphical form and, for comparison, also shows the actual normalised unplanned SAIDI of the network over the period FYE 2018-22.

[2] This was discussed in our assessment of the SAIDI and SAIFI impact of the reliability improvement plan in our May 2022 Board Paper. To clarify, this is the impact of the reliability improvement investments only.

[3] The measured reliability of the network would include both this improvement offset by the expected deterioration in the reliability of the rest of the network.

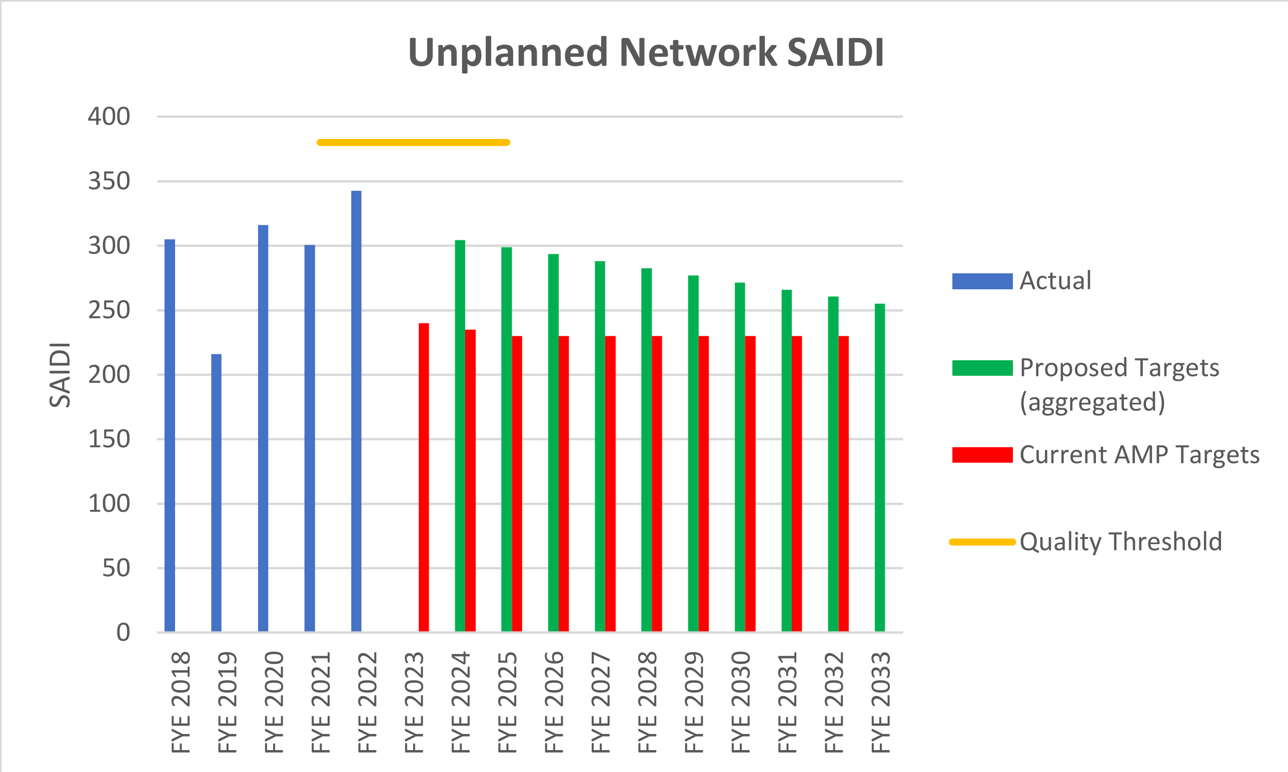

Figure 7: Comparison of Actual and Targeted Unplanned SAIDI.

SAIFI

Table 3 shows all our proposed unplanned SAIFI targets and compares the aggregated targets with the current targets AMP target, which covers the whole network and is not disaggregated. The table also shows the current Commerce Commission quality threshold which applies through to FYE 2025.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Proposed Targets										
Transmission	0	0	0	0	0	0	0	0	0	0
Subtransmission	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Distribution	3.12	3.03	2.95	2.86	2.78	2.69	2.61	2.52	2.44	2.35
Total	**3.62**	**3.53**	**3.45**	**3.36**	**3.28**	**3.19**	**3.11**	**3.02**	**2.94**	**2.85**
Current AMP target	2.96	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	-
Quality threshold	5.07	5.07	-	-	-	-	-	-	-	-

Table 3: Proposed Network Unplanned SAIFI Targets

Figure 8 presents the information in Table 3 in graphical form and, for comparison, also shows the actual normalised unplanned SAIFI of the network over the period FYE 2018-22.

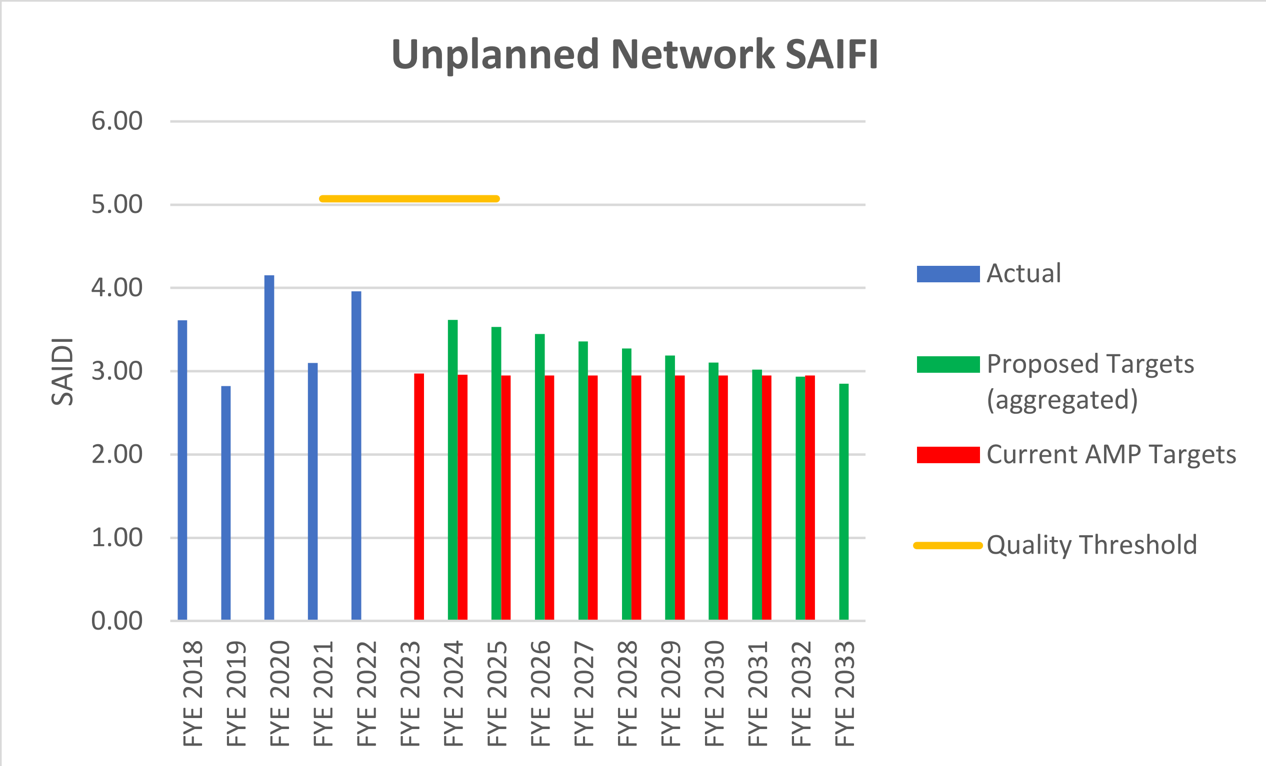

Figure 7: **Comparison of Actual and Targeted Unplanned SAIDI.**

Recommendation

That the Directors approve the presented plan to reset the internal reliability targets in the Asset Management Plan (AMP) and engage with the Trust to also amend the Statement of Corporate Intent (SCI) to levels that better reflect the current performance of our network under normal weather conditions and the improvements we expect to achieve as we implement the 11kV reliability improvement plan approved by the Board in April 2022.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
Network General Manager

Annexure 10

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **September 2022**

Subject: **Network Unplanned SAIDI August 2022 Including 11kV Project Initiatives**

Purpose

The purpose of this paper is to provide a regular update to the Board on Network unplanned outage performance for the month and including progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade. This paper is for information.

Background

FYE23 outage results for the first quarter have shown poor performance, with unplanned outage figures well above the budgeted targets. Due to last year's results being well above our internal targets we introduced a series of 11kV initiatives into the works programme in an effort to reduce the trend. These monthly reports will update the outage results and programmed work progress.

SAIDI - SAIFI Results (August)

Bad weather continued in August with a heavy rain and wind warning issued by MetService on the 10th for Wednesday 17th through to Friday 19th. During that period, we experienced powerful winds and heavy rain across the region.

Omapere Fire Brigade rescued a driver from this car after it was washed down a river near the township yesterday. Photo / Supplied.

Another smaller fast-moving front hit on the 24th- 25th causing pole and conductor damage to numerous customers. On Friday 26th the 33kV to Taipa substation suffered a LOS to 4091 customers. The generators were not able to be brought on immediately due to speed sensor alarms registering on both machines. Customers were eventually restored after discussion with Terracat to bypass the sensors. We located a large pine tree in a forest plantation that had fallen on to the line between

Kaitaia and Taipa and the vegetation team were able to remove the tree safely from the line. The event was normalised with little effect on SAIDI.

Tree over 33kV Taipa

Normalised unplanned SAIDI for August totalled 28.03 against a budget of 15. This put us 87% higher than the YTD target. Raw SAIDI was 98.62 prior to normalisation.

Unplanned SAIFI for August totalled 0.55 against a budget of 0.20. This put us 175% higher than the YTD target.

There were 11 outages with a SAIDI count higher than 2 minutes. These outages accounted for 9.07 normalised SAIDI compared to the full month target of 24.

If we do not exceed budget in the following 7 months, we will achieve a SAIDI of approximately 345 unplanned minutes, this result is over our internal budget of 240, and still short of the Regulatory Cap of 380. Likewise, SAIFI, forecast to be 4.25 would be under the Regulatory Limit of 5.07.

Conversely if the trending weather events do continue as in the first third of the year, with extreme fronts hitting the country on a monthly basis there is a very real possibility of exceeding the upper limit of 380 Unplanned SAIDI minutes.

Work continues to ensure we are doing whatever we can to reduce the number of outages and respond in the quickest manner. We are continuing with our planned Control Room and Field response actions, and longer-term mitigation comes from the 11kV asset replacement and development programme extra to the planned works which includes distribution automation, splitting of feeders, interconnection/ties, and asset renewals.

11 kV Initiatives - Programme of Work

Earlier this year the Board approved the reallocation of funds to further improve the reliability of supply of Top Energy’s 11kV distribution network.

11kV Projects identified for construction during FY-23 are listed in the table below.

Project Description	Status	Planned Budget	Planned Construction Period	Comments
South Rd Feeder Distribution Automation	planning & design	$300,000	January 23 – March 23	Reclosers for these projects have been ordered. We have been advised of a 6-month lead time on reclosers for these projects. In anticipation of the late delivery, we plan to install all hardware and potentially isolating fuses as an interim measure.
Horeke Feeder - Distribution Automation	planning & design	$300,000	January 23 – March 23	
Rangiahua – South Rd Feeder Interconnection (design only)	planning & design	$50,000	FYE-23	Allocation for design only no construction planned for FY-23
Whangaroa & Matauri Bay Feeder Interconnection Stage 1	planning & design request for tender	$885,000	October 22 – December 22	Awaiting detailed design In final stage of negotiations with landowner To be outsourced Tender submissions due 12 September
Paua 11KV Refurbishment (Te Kao Feeder) (Stage 2)	request for tender	$550,000	October 22 – December 22	To be outsourced Tender submissions due 12 September
Tokerau 11KV Feeder Refurbishment (Stage 2)	request for tender	$600,000	October 22 – December 22	To be outsourced Tender submissions due 12 September
Replacement/Refurbishment of SD RMUs (Stage 6)	construction	$500,000	staggered complete by FYE	In-house construction underway
TOTAL		$2,935,000		

RFP’s were sent out to Northpower and ISS.

Below is the schedule of main activities. Further details regarding implementation will be discussed with the successful Vendor/s.

Activity	Planned Dates
Issue RFP to Contractors	Friday 19th August 2022
Respondent Questions	By Friday 26th August 2022
Submit Proposal	By 5pm Monday 12th September 2022
Selection of preferred Vendor	By Friday 16th September 2022
Conclude contractual arrangements	By Friday 23rd September 2022
Work commences	Indicative date of 1st October 2022

Recommendation
That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Annexure 11

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **October 2022**

Subject: AMP Unplanned Interruption Target Update

Purpose

The paper is to inform the Board of the internal network reliability target option we plan to employ following the October Board meeting debate. We propose that we will engage with the Trust and recommend amending the Statement of Corporate Intent (SCI); and then resetting the internal reliability targets in the Asset Management Plan (AMP) to match the Reliability Incentive Scheme (RIS) levels that are set periodically and adjusted at the commencement of each regulatory control period (RCP). i.e. for the current regulatory period a target of 302 minutes and threshold of 380 minutes.

Method

Unplanned SAIDI

Use RIS target and threshold cap and adopt these at each reset, the forward plan will be based on estimates until finalised.

The RIS target is set by the Commerce Commission at a level which they deem appropriate (being the consumer proxy). Performance that is above this level is seen as higher than consumers expectation and is therefore subject to a penalty and ultimately a breach event if you exceed the threshold cap. The objective of setting the RIS for Unplanned SAIDI means that it aligns with the Commerce Commission and also provides a buffer between the quality threshold (Regulatory Cap) and the internal target. This achieves the Regulatory compliance needed and focuses the right behaviors and actions in the business.

Our proposed revised unplanned SAIDI targets are shown in Table 1 below. Noting that from 2026 it is subject to reset, the target shown below is indicative based on the average of the prior 5 years.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Targets										
Proposed SAIDI RIS (and internal target)	**302**	**311**	**311**	**311**	**311**	**311**	**311**	**311**	**311**	**311**
Current AMP target	235	230	230	230	230	230	230	230	230	-
Quality threshold	380	380	385	385	385	385	385	385	385	385

Table 1. Proposed Network Unplanned SAIDI Targets

Figure 1 shows the comparison of past performance (actual) to the proposed target.

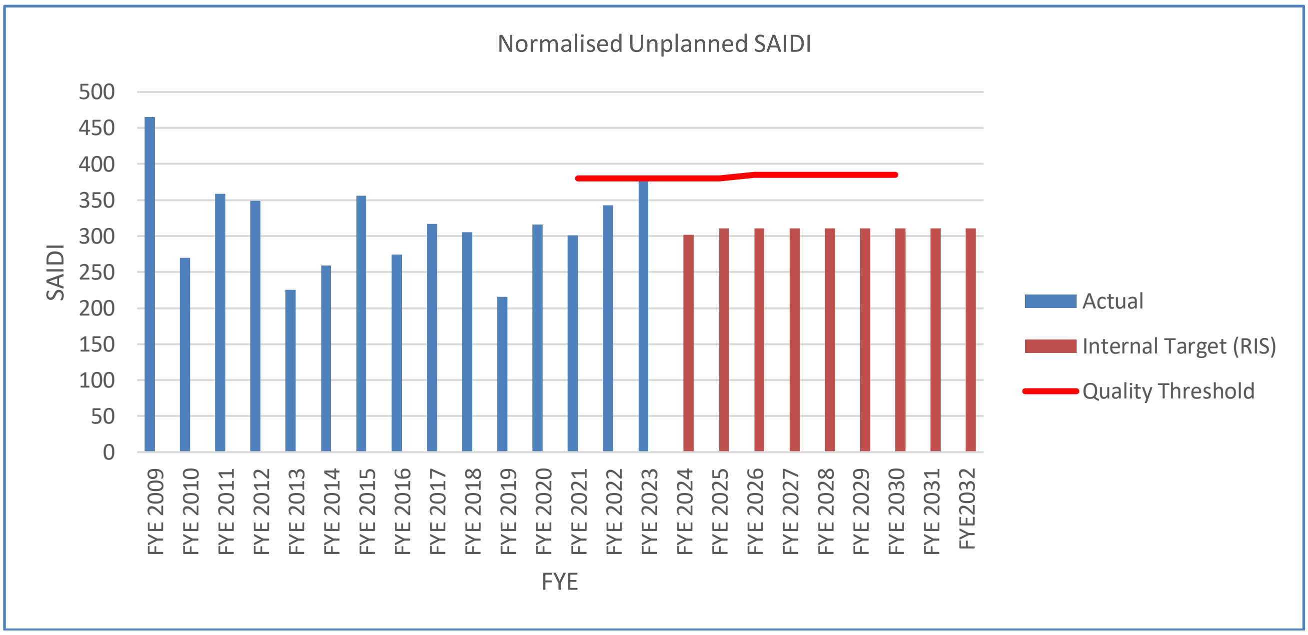

Figure 1. Comparison of Actual and Targeted Unplanned SAIDI

<u>Unplanned SAIFI</u>

Unplanned SAIFI is not subject to an incentive/penalty arrangement but retains a threshold cap which represents a breach. As a result, the internal unplanned SAIFI target has been based on the same percentage differential as utilised in the unplanned SAIDI calculation (20.5% lower than Cap). The Unplanned SAIFI Quality Threshold is currently set at 5.07 with the proposed internal target being 4.03. By adopting this method, the target can be logically adjusted at each reset. This figure reflects the current performance of the network and the expected outcomes of our 11kV reliability improvement plan. It gives us a buffer between the Regulatory threshold and the internal target. This target accomplishes Regulatory compliance and focuses the right behaviors and actions in the business.

Our proposed revised unplanned SAIFI targets are shown in Table 2 below. Noting that from 2026 it is subject to reset.

FYE	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Targets										
Proposed SAIFI	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**	**4.01**
Current AMP target	2.96	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	-
Quality threshold	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07	5.07

Table 2. Proposed Network Unplanned SAIFI Targets

Figure 2 shows the comparison of past performance (actual) to the proposed target.

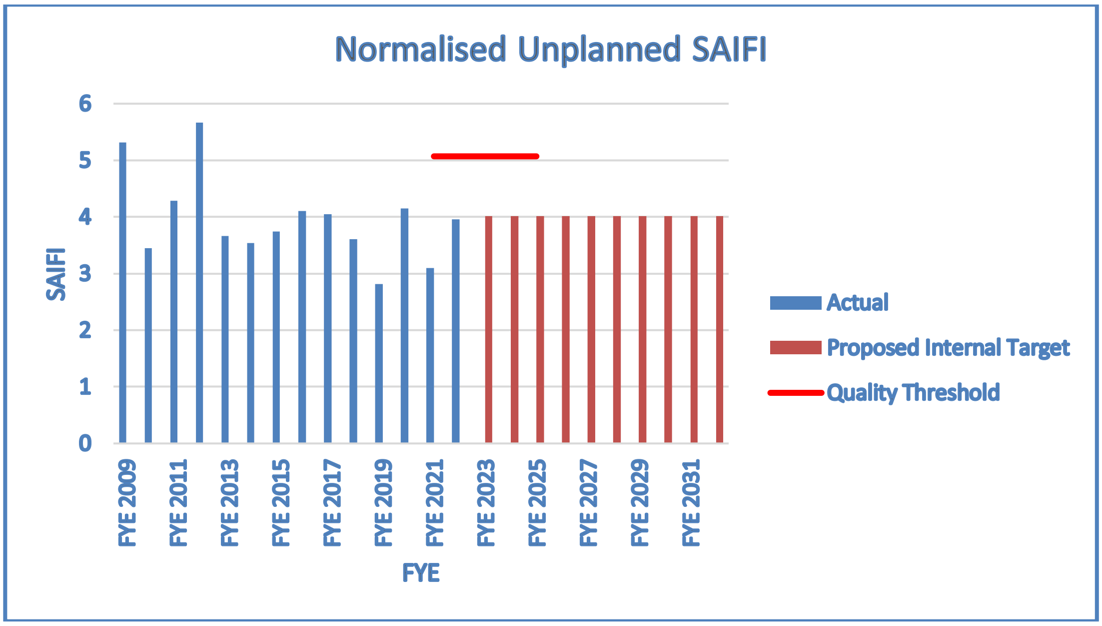

Figure 2. Comparison of Actual and Targeted Unplanned SAIFI

Summary

By adopting the regulatory RIS as the internal target for Unplanned SAIDI and utilising the same formula for Unplanned SAIFI, this better reflects the current performance of the network and is aligned with the regulatory expectations. The internal targets will be adopted at each reset and will provide a buffer between that, and the regulatory caps imposed. This will drive the right behaviours and actions in the business. This paper estimates these values with a 380-minute performance for this financial year resulting in a slight increase in the threshold value from 380 to 385 if the same 5-year average methodology is used with a log standard deviation applied.

A large portion of Top Energy customers live in energy poverty where price is deemed more important than reliability, determining that we should not be focussed on continually improving reliability where the cost trade-off is not acceptable to consumers. There is no point having a reliable supply if customers are unable to afford to use the electricity we provide. The new targets reflect that, whilst ensuring no deterioration in reliability.

In the future, we have the option of applying for a customised price-quality path to maintain prices at an affordable level with targets that are higher than the regulated reliability target. We plan to initiate a survey of customers to determine their views on the price quality trade off. The results of this work will be available to inform the AMP update and approvals in February and March.

Recommendation

That the Directors approve the presented plan to reset the internal reliability targets in the Asset Management Plan (AMP) and engage with the Trust to also amend the Statement of Corporate Intent (SCI). Final approvals with be included as part of the AMP approval process.

These revised levels better reflect the current performance of our network under normal weather conditions and the improvements we expect to achieve as we implement the 11kV reliability improvement plan approved by the Board in April 2022.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
Network General Manager

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **October 2022**

Subject: **Network Unplanned SAIDI September 2022 Including 11kV Project Initiatives**

Purpose
The purpose of this paper is to provide a regular update to the Board on Network unplanned outage performance for the month and including progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade. This paper is for information.

Background
FYE23 outage results for the first quarter have shown poor performance, with unplanned outage figures well above the budgeted targets. Due to last year's results being well above our internal targets we introduced a series of 11kV initiatives into the works programme to reduce the trend. These monthly reports will update the outage results and programmed work progress.

SAIDI - SAIFI Results (September)

Bad weather continued in September with heavy rain and wind pushing through the country on the 5th and 6th. During that period, we experienced powerful winds and heavy rain across the region resulting in 15 unplanned SAIDI with lines and conductors brought down.

Normalised unplanned SAIDI for September totalled 27.96 against a budget of 19. This puts us 98% higher than the YTD target. Raw SAIDI was 27.96 prior to normalisation.

Unplanned SAIFI for September totalled 0.21 against a budget of 0.23 This puts us 84% higher than the YTD target.

There were 4 outages with a SAIDI count higher than 2 minutes. These outages accounted for 0 normalised SAIDI compared to the full month target of 19.

If we do not exceed budget in the following 6 months, we will achieve a SAIDI of approximately 354.78 unplanned minutes. This result is over our internal budget of 240, and still short of the Regulatory Cap of 380. Likewise, SAIFI, forecast to be 4.23 would be under the Regulatory Limit of 5.07.

Conversely if the trending weather events do continue as in the first third of the year, with extreme fronts hitting the country monthly there is a very real possibility of exceeding the upper limit of 380 Unplanned SAIDI minutes.

Work continues to ensure we are doing whatever we can to reduce the number of outages and respond in the quickest manner. We are continuing with our planned Control Room and Field response actions, and longer-term mitigation comes from the 11kV asset replacement and development programme extra to the planned works which includes distribution automation, splitting of feeders, interconnection/ties, and asset renewals.

11 kV Initiatives - Program of Work
Earlier this year the Board approved the reallocation of funds to further improve the reliability of Top Energy's 11kV distribution network.

11kV Projects identified for construction during FY-23 are listed in the table below.

Project Description	Status	Planned Budget	Planned Construction Period	Comments
South Rd Feeder Distribution Automation	Planning & design in progress	$300,000	January 23 to March 23	Reclosers for these projects have been ordered. We have been advised of a 6-month lead time on reclosers for these projects. In anticipation of the late delivery, we plan to install all hardware and potentially isolating fuses as an interim measure.
Horeke Feeder - Distribution Automation	Planning & design in progress	$300,000	January 23 to March 23	
Rangiahua – South Rd Feeder Interconnection (design only)	Planning & design in progress	$50,000	FYE-23	Allocation for design only No construction planned for FY-23
Whangaroa & Matauri Bay Feeder Interconnection Stage 1	Tender evaluation	$885,000	November 2022 to March 2023	To be outsourced In final stage of negotiations with landowner Tender received Finalising pricing with Northpower
Paua 11KV Refurbishment (Te Kao Feeder) (Stage 2)	Tender evaluation	$550,000	November 2022 to March 2023	To be outsourced Tender received Finalising pricing with Northpower

Tokerau 11KV Feeder Refurbishment (Stage 2)	Tender evaluation	$600,000	November 2022 to March 2023	To be outsourced Tender received Finalising pricing with Northpower
Replacement/Refurbishment of SD RMUs (Stage 6)	Construction	$500,000	Staggered across FY, complete by FYE	In-house construction underway
TOTAL		$2,935,000		

RFPs were sent out to Northpower and ISS

Below is the schedule of main activities. Further details regarding implementation will be discussed with the successful Vendor/s.

Activity	Planned Dates
Issue RFP to Contractors	Friday 19th August 2022
Respondent Questions	By Friday 26th August 2022
Submit Proposal	By 5pm Monday 12th September 2022
Selection of preferred Vendor	By Friday 16th September 2022
Conclude contractual arrangements	By Friday 14th October 2022
Work commences	Mid November 2022

After the due date for submissions of proposals, ISS advised they were unable to submit a proposal for Top Energy's work.

Recommendation
That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Annexure 13

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **November 2022**

Subject: **Network Unplanned SAIDI October 2022 Including 11kV Project Initiatives**

Purpose

The purpose of this paper is to provide a regular update to the Board on Network unplanned outage performance for the month and including progress on the 11kV initiatives introduced with the deferral of the Wiroa Substation upgrade. This paper is for information.

Background

FYE23 outage results for the first quarter have shown poor performance, with unplanned outage figures well above the budgeted targets. Due to last year’s results being well above our internal targets we introduced a series of 11kV initiatives into the works programme to reduce the trend. These monthly reports will update the outage results and programmed work progress.

SAIDI - SAIFI Results (October)

Vegetation and defective equipment each contributed approximately 11 SAIDI minutes, most of this occurred during bad weather on October the 1st, 28th, 29th and 30th. Record rainfall over previous months may well have affected ground structure leading to more than expected tree instability and therefore line damage.

Unplanned SAIDI for October totalled 29.89 against a budget of 18. This puts us 94% higher than the YTD target. Raw SAIDI was 29.89 as normalisation was not triggered this month.

Unplanned SAIFI for October totalled 0.28 against a budget of 0.21 This puts us 77.8% higher than the YTD target.

There were 5 outages with a SAIDI count higher than 2 minutes. These outages accounted for 14.6 unplanned SAIDI compared to the full month target of 18.

If we do not exceed budget in the following 5 months, we will achieve a SAIDI of approximately 367 unplanned minutes. This result is over our internal budget of 240, and still short of the Regulatory Cap of 380. Likewise, SAIFI, forecast to be 4.30 would be under the Regulatory Limit of 5.07.

Conversely if the trending weather events do continue as in the first half of the report year, with extreme weather fronts hitting the country regularly there is a very real possibility of exceeding the upper limit of 380 Unplanned SAIDI minutes.

Work continues to ensure we are doing whatever we can to reduce the number of outages and respond in the quickest and most efficient manner. We are continuing with our planned Control Room and Field response actions, and longer-term mitigation comes from the 11kV asset replacement and development programme extra to the planned works which includes distribution automation, splitting of feeders, interconnection/ties, and asset renewals.

11 kV Initiatives - Program of Work

Earlier this year the Board approved the reallocation of funds to further improve the reliability of Top Energy's 11kV distribution network.

11kV Projects identified for construction during FY-23 are listed in the table below:

<table>
<tr><th>Project Description</th><th>Status</th><th>Planned Budget</th><th>Planned Construction Period</th><th>Comments</th></tr>
<tr><td>South Rd Feeder Distribution Automation</td><td>Planning & design in progress</td><td>$300,000</td><td>January 23 to March 23</td><td rowspan="2">Reclosers for these projects have been ordered.

We have been advised of a 6-month lead time on reclosers for these projects.

In anticipation of the late delivery, we plan to install all hardware and potentially isolating fuses as an interim measure.

Field work will commence during November to identify poles to be replaced to accommodate isolation points for group fusing to be installed.</td></tr>
<tr><td>Horeke Feeder - Distribution Automation</td><td>Planning & design in progress</td><td>$300,000</td><td>January 23 to March 23</td></tr>
<tr><td>Rangiahua – South Rd Feeder Interconnection (design only)</td><td>Planning & design in progress</td><td>$50,000</td><td>FYE-23</td><td>Allocation for design only No construction planned for FY-23</td></tr>
</table>

Project Description	Status	Planned Budget	Planned Construction Period	Comments
Whangaroa & Matauri Bay Feeder Interconnection Stage 1	Awarded to Northpower	$885,000	January 2023 to March 2023	This project has been removed from the list of projects to be outsourced due to ongoing negotiations with landowners.
Paua 11KV Refurbishment (Te Kao Feeder) (Stage 2)	Awarded	$676.628	February 2023 to March 2023	Project Awarded to Northpower
Tokerau 11KV Feeder Refurbishment (Stage 2)	Awarded	$723,715	March 2023	Project awarded to Northpower
Replacement/Refurbishment of SD RMUs (Stage 6)	Construction	$500,000	Staggered across FY, complete by FYE	In-house construction underway
TOTAL		**$2,935,000**		

Recommendation
That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Annexure 14

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Memo To: **David Sullivan**
Nicole Anderson
Jon Nichols
Steve Sanderson
Simon Young

From: **Russell Shaw**

Date: **December 2022**

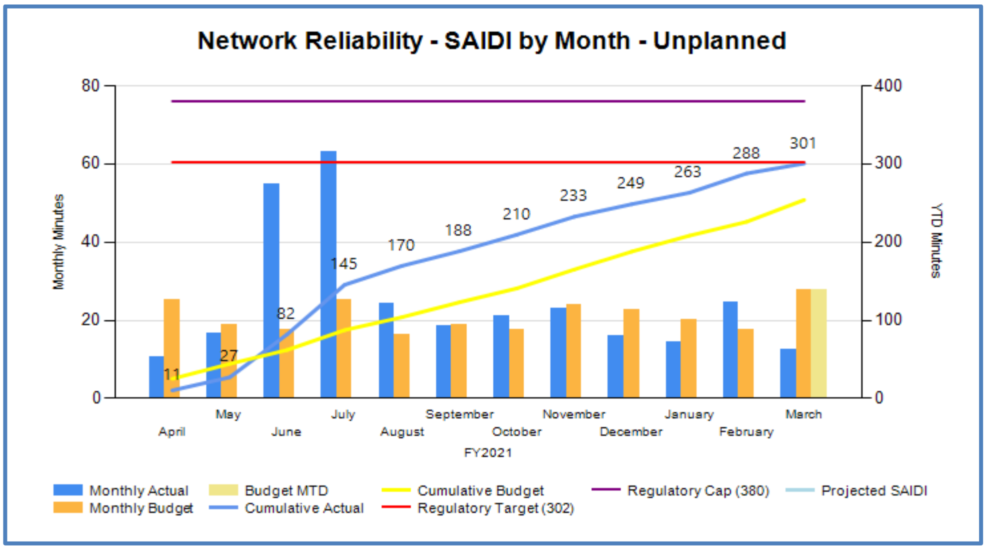
Subject: **Unplanned SAIDI - Focus and Actions**

Purpose

The purpose of this paper is to inform the Board of the focus that has been applied to Unplanned SAIDI in YFE22 and the current year, with the actions and reporting that has occurred.

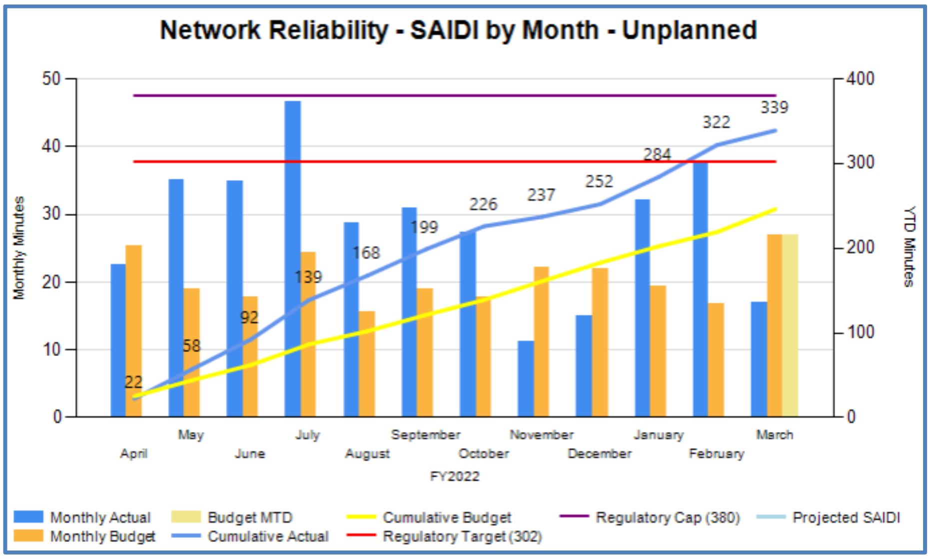
Background

The paper will concentrate on financial years FYE22 and FYE23 (current partial year). FYE21 is excluded as SAIDI came in just under the Regulatory target of 302 minutes, and that total included a single protection failure at Kaikohe substation and an operational failure also at Kaikohe which saw 31 unplanned SAIDI alone. (Graph 1). Those aside the remaining overall performance was not concerning.



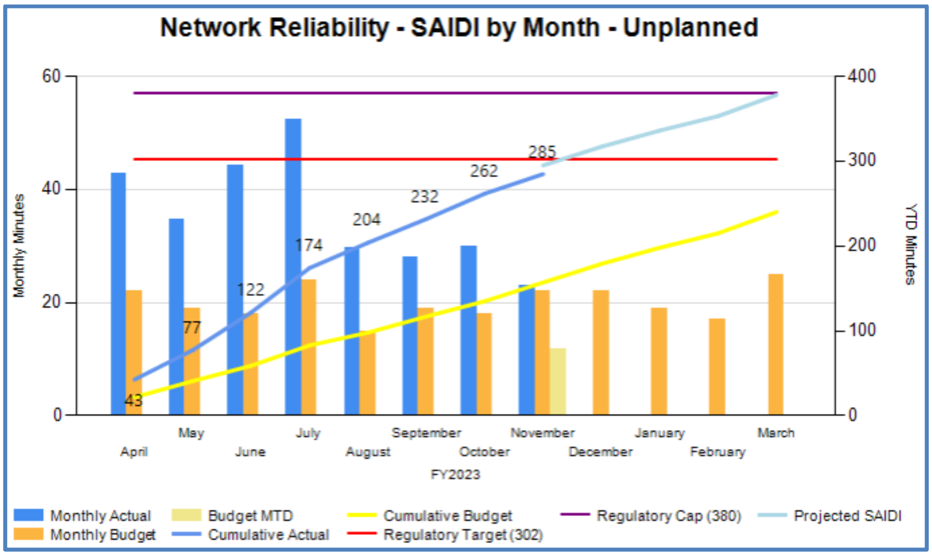
Graph 1 FYE21 Unplanned SAIDI

FYE22 started trending badly from May through the following months. With such high SAIDI being recorded, focus was applied to the performance and the Board was kept abreast of the situation. Year-end saw SAIDI at 339 minutes, (refer Appendix 6 for full breakdown), this exceeded the Regulatory Target of 302, but was well under the 380 Cap. (Graph 2).



Graph 2 FYE22 Unplanned SAIDI

FYE23 to date has not seen any change in the poor performance with YTD unplanned SAIDI approximately double the budgeted figures and if the trend continues for the remainder of the financial year will see us breach the regulatory cap of 380. (Graph 3 to 16 November).



Graph 3 FYE23 YTD Unplanned SAIDI

Method

The following papers are referenced in chronological order to step through the actions and reporting taken in response to the unfavorable SAIDI trends.

August 2021. With the poor SAIDI performance results for the start of the financial year, a "*SAIDI SAIFI Performance Review YE22 to 15 August"* information paper (App.1) was produced for the Board. The paper alerted the Board of the performance, analyzed the causes, and projected that we would exceed the Target but be below the Cap.

November 2021. With the previous August and September results well above target, we initiated both an internal and an independent critical review of the past 2 years unplanned SAIDI including the 6 months to date of that current year. The external review was undertaken by Ergo. Their report was tabled in November *"Unplanned SAIDI Performance – Independent Review and Remedial Actions"* along with the internal review/response, (Appendix 2). Ergo covered 4 specific questions:

1. What is driving the high unplanned SAIDI figures compared to the declining trend in previous years. e.g. is it more faults, more customers affected, longer repair time, failure of automation, network design.
2. Has faults > 2 SAIDI Minutes changed.
3. What are the root or common causes to the faults and/or high SAIDI impact.
4. What actions should be implemented to rectify the situation, immediately and in the future.

The comprehensive report recommendations comprised short- and longer-term initiatives with implementation responses provided by Top Energy.

April 2022. Following the results of the FYE22 performance and leading on from the Ergo report we further reviewed how successful our current asset management strategy was, and the findings showed that with no further potential to improve the sub-transmission reliability we looked to accelerate the reliability of the 11kV distribution network. A paper *"Management of Distribution Network Reliability"* (Appendix 3) provided at the April Board meeting advised that we were seeking endorsement to revise our 11kV network asset replacement and development plan by possibly deferring the Wiroa substation build. The Board endorsed the revision.

May 2022. A paper entitled *"AMP Work Programme Review"* (Appendix 4) was presented to the Board seeking their approval to initiate future 11kV reliability projects to improve the 11kV reliability of our distribution system by deferring the Wiroa substation build. The plan incorporated a number of strategies identified in the Ergo report. The Board approved the initiation of the work.

July 2022. The Board requested management consider if there was value in approaching the Commerce Commission to see if Top Energy SAIDI and SAIFI boundary values and limits are appropriate, and would they be more meaningful (and advantageous for unplanned results) if they were set using fault data over the five-year reference period FYE 2018-22 rather than the ten-year period FYE 2010-19. In a paper entitled "*Impact of Reference Period on Normalisation"* (Appendix 8) after careful analysis on two options presented the recommendation was the Directors accept the recommendation that Top Energy go for Option 1 and ensure that the 2023 AMP incorporates a well-designed and adequately funded 11kV reliability improvement plan.

July - November 2022. In order to keep the Board informed of the progress to date on the initiates as well as reliability performance, monthly update papers were provided *"Unplanned SAIDI 2022 Including 11kV Project Initiatives"* (Appendices 5, 7, 11, 12, 13).

August 2022. *"AMP Due Diligence Part 1 – Asset Performance and Review"* (Appendix 6) is included in this paper as it contains a comprehensive review of FYE22 reliability performance broken down into transmission, sub-transmission, and distribution categories. It highlights the worst served feeders and the improvement strategies assigned to them.

September 2022. A paper *"AMP Unplanned Interruption Targets"* (Appendix 9) was presented to the Board in September seeking approval to reset the internal reliability targets in the AMP (including engaging with the Trust to amend the SCI) after the FYE22 network reliability review paper was presented in August. This reset was sought to amend levels to better reflect current performance under normal weather conditions and include the improvements expected with the 11kV reliability projects approved in May. The Board debated various options and left it to management to come back to them with a recommended option to employ.

October 2022. Following the September meeting, management presented the *"AMP Unplanned Interruption Update"* paper (Appendix 10) in October. The paper sought approval to reset the internal targets as discussed in September. The summary included customer business behaviors and the impact on customers where price is deemed more important than reliability. The targets presented are based on determined realistic figures across the voltage ranges over the past 5 years which then have the estimated impact of the 11kV reliability work being undertaken. The Board approved the presented plan.

Recommendation

That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
General Manager Network

Appendices

1- SAIDI SAIFI Performance Review YE22 to 15 August
2- Unplanned SAIDI Performance – Independent Review and Remedial Actions
3- Management of Distribution Network Reliability
4- AMP Work Programme Review
5- Unplanned SAIDI June 2022 Including 11kV Project Initiatives
6- AMP Due Diligence Part 1 Asset performance and Review
7- Network Unplanned SAIDI July 2022 Including 11kV Project Initiatives
8- Impact of Reference Period on Normalisation
9- AMP Unplanned Interruption Targets
10- AMP Unplanned Interruption Target Update
11- Network Unplanned SAIDI August 2022 Including 11kV Project Initiatives
12- Network Unplanned SAIDI September 2022 Including 11kV Project Initiatives
13- Network Unplanned SAIDI October 2022 Including 11kV Project Initiatives

Annexure 15

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Memo to	**David Sullivan** **Nicole Anderson** **Jon Nichols** **Steve Sanderson** **Simon Young**
From	**Russell Shaw**
Date	**August 2023**
Subject	**AMP Due Diligence Part 1 - Asset Performance and Review**

PURPOSE

This is an information paper. It is part 1 of a 2-part Asset Management Plan (AMP) Due Diligence review. The document is to inform the Board of the analysis, decisions and direction being taken by Network Management with focus on changes from last year.

BACKGROUND

Top Energy published the 2023 AMP on 31 March 2023, which covered a ten-year planning period from 1 April 2023 to 31 March 2033. As required by the Commerce Commission an AMP Update, is due for release on 31 March 2024. In order to understand the trade-offs and decisions made in covering capital and maintenance expenditure drivers the Board, as part of due diligence, has asked for information on past and future performance presented in this, and a second paper (Part 2) in September.

EXECUTIVE SUMMARY

The topics raised and questions answered in this paper are presented in the following order:

1. Review of FYE 2023 reliability
2. Changes to network risk
3. Proposed changes to fleet plans for key asset classes

Review of FYE2023 Reliability

In FYE2023 the raw unplanned SAIDI impact was 1791.6 minutes and 7.05 SAIFI interruptions per consumer. After normalisation in accordance with the Commerce Commission's approved methodology, the normalised measures were 513.96 SAIDI minutes and 5.50 SAIFI interruptions. These were both higher than the Commerce Commission's quality thresholds of 380.24 SAIDI minutes and 5.07 SAIFI interruptions. This was the first year that Top Energy Top Energy failed to comply with the annual Unplanned Interruptions reliability assessments

- There were four major SAIDI events in FYE2023, two storms in July and August 2022 and Cyclone Gabrielle in mid-February 2023. There was also a separate major SAIDI event in August 2022 when a tree fell onto the 33kV Taipa line and we could not start the Taipa generators remotely because of a software fault. Cyclone Gabrielle was our only major SAIFI event. Due to the impact of normalisation, these four events did not appear to make a significant contribution to our normalised SAIDI/SAIFI measures their total normalised SAIDI impact was 52.52 minutes. However the Commerce Commission classifies periods of time as major events that have accrued greater than 27.92 SAIDI minutes over any 24-hour period so Major Events exclude any long tail, which (for example) in Cyclone Gabrielle case extended for an additional two weeks over which 40 SAIDI minutes were accrued.

- During FYE2023, there were 66 interruptions, outside of major events with a SAIDI impact of greater than 2 minutes. Together these interruptions had a SAIDI impact of 246 minutes, which accounted for 48% of our total normalised Unplanned SAIDI for the year. Many of these were attributable to adverse weather.

- There were no interruptions of our incoming 110kV supply from Maungatapere and no unplanned interruptions of our own 110kV transmission system. Using our backup diesel generation, we successfully completed our annual maintenance outage of the 110kV transmission system without interrupting supply to consumers in our northern area.

- The normalized unplanned SAIDI due to faults on the 33kV sub transmission network was 18.99 minutes, 4% of the total network Unplanned SAIDI of 513.96 minutes. As a result of the investment in the sub transmission network, sub transmission faults are no longer a major contributor to our normalised network SAIDI. Going forward, we are aiming to reduce the annual normalized unplanned SAIDI on our sub transmission network to below 20 minutes.

- The normalised SAIDI impact of faults on our 11kV distribution network in FYE2023 was 480.1 minutes, up 54% from the FY2022 impact of 312.43 minutes.

- The three major contributors to our normalised SAIDI impact were faults caused by adverse weather, defective equipment, and vegetation. The aggregated SAIDI impact of these three measures was 380.7 minutes, 77% higher than the corresponding measure in FYE2022.

- The SAIDI impact of vegetation faults on the normalised reliability of the network increased at a significant rate. We estimate from our records that 68 trees fell across and through our 11kV network during Cyclone Gabriele alone. Although the impact of tree contact events is increasing at a faster rate than tree fall events, it is hard to ascertain anything from this due to how the events are reported by individuals. Assuming no improvement in weather patterns however, the normalised reliability of the network is likely to deteriorate further unless we are able to implement a more effective vegetation management strategy not bound by current legislation.

Network Risk

The widespread power outages experienced throughout our supply area during Cyclone Gabrielle have highlighted the need for the electricity distribution sector to increase its focus on resilience and the need to be better prepared for high impact-low probability (HILP) events. We have assessed the maturity of our resilience management using an industry-standard assessment tool and are currently investigating the potential for improvement.

- Land slips that occurred during Cyclone Gabrielle in the vicinity of the route of our 110kV line where it crosses the Maungataniwha Range have highlighted the vulnerability of this line to the failure of a structure foundation. We have completed a geotechnical survey of the route and are planning to relocate two structures considered particularly vulnerable. We are also increasing our preparedness for such an event by developing firm plans and procedures for the restoration of supply following a structure failure.

- While the planned 110kV line would relieve the transmission constraint between Kaitaia and Kaikohe, there is still a constraint south to Maungatapere. We continue to work with Transpower on the establishment of a renewable energy zone (REZ) to overcome these constraints, but progress is slow. We suspect that we will not be able to build the line until the Government develops a policy on the funding of the transmission and distribution system upgrades that will be needed if sufficient renewable generation is to be built to enable New Zealand to meet its 2050 net-zero decarbonisation target.

Fleet Management

We are progressively introducing a more structured and granular approach to the management and use of fleet data, which in time we anticipate will provide a more accurate and complete picture of the condition of our network assets, a more effective asset inspection programme and a robust basis for determining the optimal level of expenditure on the renewal and replacement of each asset fleet.

- We have purchased the software tools we need for this initiative (DataFrame software from Asset Dynamics) and are currently populating these tools with data on our overhead line assets. Data on other asset fleets will be added to the models in due course.

- In parallel with this, we are reviewing our processes for capturing asset condition data and are planning to introduce an asset inspection auditing regime. We are also developing a structured approach to measuring asset criticality so this can be included in the models.

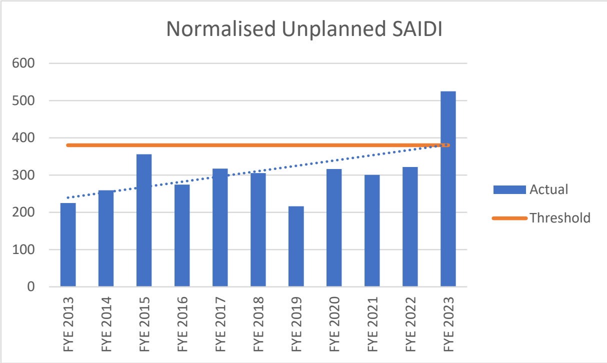
- In the current FYE2024 year, we have increased the resources allocated to our low voltage data capture project, which is currently planned to be completed over a three-year period.

- An external review of our zone substation power transformer fleet has indicated that the condition of some older transformers is worse than indicated by the results of our regular power transformer monitoring tests. We are developing a comprehensive fleet plan for our power transformer assets, which will include a power transformer renewal and replacement strategy, the cost of which will be included in our 2024 AMP expenditure forecast. We have contingency plans in place should a power transformer fail unexpectedly and, while the review has identified an emerging issue that we need to act on, we are well placed to manage the short-term risk.

- Top Energy currently uses an Open Platform Communications (OPC) protocol to control field devices (reclosers, sectionalisers, remote controlled switches and voltage regulators). OPC is unsupported and has been identified for replacement with a modern replacement to address known stability issues. A project has been set up to investigate, fund, and implement a modern DNP3 digital field device communication protocol, for all new devices and the migration of existing equipment and field devices to the new protocol. A business case will be presented to the Board and will be included in the AMP update.

REVIEW OF FYE2023 NETWORK RELIABILITY

A comparison of our normalised network SAIDI and SAIFI in FYE2023 with our historic performance is shown in Figure 1, which shows that we failed to Comply with the Annual Unplanned Interruptions Reliability Assessments:



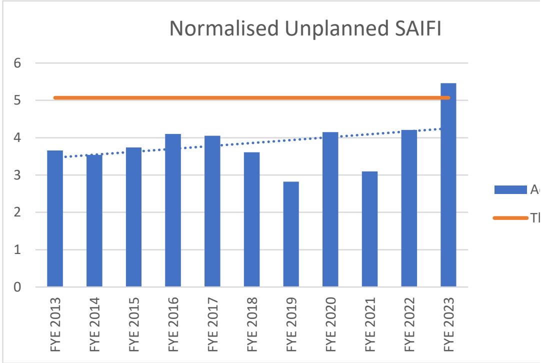


Figure 1: Impact of Unplanned Network Interruptions after Normalization

Major SAIDI and SAIFI Events

There were four major SAIDI events during FYE2023, of which Cyclone Gabrielle had the greatest impact. Cyclone Gabrielle was the only major SAIFI event we experienced. The impacts of these events is shown in Table 1.

Note that with major weather events such as Cyclone Gabrielle not all SAIDI is normalised. The Commerce Commission classifies periods of time as major events that have accrued greater than 27.92 SAIDI minutes over any 24-hour period. So Major Events exclude the long tail which with Cyclone Gabrielle, extended for an additional two weeks over which 40 more Unplanned SAIDI minutes were accrued.

Month	Duration (hrs)	No. Faults	Major Event		SAIDI		SAIFI		Comment
			SAIDI	SAIFI	Raw	Normalised	Raw	Normalised	
July	28	18	Y	N	43.2	8.46	0.243	0.243	Storm
August	34	27	Y	N	42.17	11.71	0.215	0.215	Storm
August	43	5	Y	N	53.83[1]	2.19	0.214	0.2.14	Tree fall on 33kV Taipa line. Control room unable to start generators due to software fault.
February	84	98	Y	Y	1190.9	30.16	1.084	0.215	Cyclone Gabrielle.

Table 1: Major SAIDI/SAIFI Events FYE2023

Note 1: For this table, only those faults that occurred within the rolling 24-hour normalisation window are included. There were also a small number of high SAIDI impact events that occurred in the aftermath of the storms that could not be normalised because they fell outside the rolling 24-hour window defined in the normalisation methodology approved by the Commission.

The storms in July and August were widespread and affected the whole of our supply area. The tree fall event on the Taipa line had a raw SAIDI of 53.83 minutes. An equipment related issue (software) problem prevented the Taipa generators being started remotely. This has now been rectified.

The normalisation process has the effect of eliminating the most severe storms such as Cyclone Gabrielle as major contributors to the unreliability of our network as measured by the Commission for assessment against its quality threshold. The four events with the highest

[1] This includes the SAIDI impact of unrelated faults that occurred within the rolling 24-hour normalisation window.

individual SAIDI impact in FYE2023 had a total raw SAIDI impact of 1,330.1 minutes, but normalisation reduced this to 52.52 minutes.

High Impact Interruptions

Our high normalised SAIDI in FYE2023 was due to the large number of faults with a raw SAIDI impact greater than two minutes that occurred outside of the weather events that triggered normalisation. As shown in Table 2, there were 66 faults with an individual SAIDI impact of greater than 2 minutes that could not be normalised because they occurred outside a normalised storm event. These had an aggregated SAIDI impact of 246 minutes, which was 48% of the total normalised Unplanned SAIDI impact for the year and almost five times the total normalised SAIDI impact of all the interruptions that occurred during Cyclone Gabrielle (if you exclude Cyclone Gabrielle's long tail).

SAIDI Range	No of Interruptions	Total SAIDI
8-9	2	17.03
7-8	2	14.45
6-7	2	13.28
5-6	8	41.93
4-5	8	35.63
3-4	15	52.51
2-3	29	71.18
Total	**66**	**246.01**

Table 2: High SAIDI Impact Faults

Table 3 analyses these 66 faults by fault type. It can be seen that the total normalised SAIDI impact of adverse weather events was 85.98 minutes (33.46 minutes from Table 2 and 52.52 minutes from Table 1[2]).

Fault Type	No of Interruptions	Total SAIDI
Defective Equipment	21	76.96
Vegetation	19	76.07
Adverse Weather	10	33.46
Unknown	7	21.6
Third Party	4	15.05
Lightning	2	13.28
Wildlife	2	5.25
Adverse Environment	1	4.34
Total	**66**	**246.01**

Table 3: High SAIDI Impact Faults

[2] The tree fall event on the Taipa line was categorised as vegetation rather than adverse weather.

Overall SAIDI Impacts by Voltage

Table 4 shows the raw and normalised SAIDI impact over the period FYE2018-23, disaggregated by year and voltage.

FYE	110kV Transmission		33kV Sub transmission		11kV Distribution	
	Raw SAIDI	Normalised SAIDI	Raw SAIDI	Normalised SAIDI	Raw SAIDI	Normalised SAIDI
2018	90.40	4.18	25.17	25.17	361.37	275.25
2019	-	-	44.08	20.69	199.62	195.65
2020	-	-	44.50	44.50	271.74	271.40
2021	18.01	18.01	25.51	25.51	257.30	257.30
2022	-	-	90.83	30.27	650.68	312.43
2023	-	-	123.14	21.18	1,639.12	570.81

Table 4: Disaggregation of SAIDI Impacts by Voltage (FYE2018-23)

It can be seen from the table that:

- There were no supply interruptions in FYE2023 caused by faults on our transmission assets. Nevertheless, the high rainfall over the last two years has exposed the vulnerability of this line to a high-impact, low-probability (HILP) failure, most likely due to ground movement over the Maungataniwha Range undermining a structure foundation.

- The 33kV sub transmission network is also not a major contributor to normalised network SAIDI – in FYE2023 faults on our sub transmission network contributed less than 4% of our total normalised network Unplanned SAIDI. While there was little variation in the impact of these faults on our normalised SAIDI over the period, there was a significant increase in our raw 33kV SAIDI in FYE2022 and FYE2023. These faults mostly occurred during severe weather events and their raw impact was therefore largely normalised out.

- In FYE2023 the normalised 11kV SAIDI was 83% higher than in FYE2022.

Causes of Unplanned Network Interruptions

Table 5 shows the normalised SAIDI Impact of unplanned interruptions over the FYE2018-23 period, disaggregated by the standard fault causes used by the Commission for information disclosure.

FYE	2018	2019	2020	2021	2022	2023
Lightning	2.67	22.19	7.67	3.77	5.64	18.47
Vegetation	83.22	34.68	81.24	44.43	96.97	150.84
Adverse weather	21.48		2.52	0.28	20.76	93.82
Adverse environment		0.04				7.95
Third party interference	66.44	61.70	76.31	56.80	52.60	36.49
Wildlife				1.44	4.29	17.93
Human error	6.09	0.03	4.26	13.57	0.81	0.37
Defective equipment	94.89	66.08	122.12	140.46	97.68	139.22
Unknown	29.81	31.61	21.78	40.07	163.96	48.85

Total	304.60	216.33	315.90	300.82	342.71	513.96

Table 5: Breakdown of Network SAIDI by Fault Cause (FYE2018-23)

Insights from the data in Table 5 are discussed below.

- *Adverse weather*

The Far North experienced two states of emergency, a La Nina weather system, and 12 Notified Severe Weather Events (Table 6). These triggered vegetation damage due to increased soil moisture levels, high winds, and rain. Meteorological data suggests that the weather in both years was abnormally severe. An indication of this can be seen from Table 7, which shows the monthly rainfall recorded by the Kerikeri Weather Station, a private weather station within the Kerikeri town area over the six-year FYE2018-23 review period[3]. While the table only shows data over the six-year review period, the annual rainfall in both CY2021 and CY2022 were both higher than in any full calendar year since the station was established in 2007.

Severe Weather	Date
Cyclone Gabrielle (2nd State of Emergency in Northland)	12th February 2023
Storm (1st State of Emergency in Northland)	31st January 2023
Storm	27th January 2023
Cyclone Hale	10th January 2023
Storm	4th January 2023
Storm's	10th and 23rd November 2022
Storm	27th October 2022
Flooding	5th September 2022
Storm (Loss of State Highway 1 through Mangamuka Gorge)	18th August 2022
Storm's	12th and 25th July 2022
Storm	28th of May 2022
Cyclone Fili	12th April 2022

Table 6 Severe Weather Events (MetService)

	FYE2018	FYE2019	FYE2020	FYE2021	FYE2022	FYE2023
Apr	277.8	89.4	81.0	107.8	157.8	169.6
May	113.4	123.6	63.2	217.0	111.8	171.8
Jun	166.4	206.0	125.2	177.0	287.0	192.2
Jul	153.2	92.8	189.8	253.8	303.2	467.4
Aug	177.2	98.6	124.8	215.8	147.0	316.4
Sept	149.6	107.6	116.4	51.6	239.2	149.4
Oct	80.2	47.2	127.6	59.4	420.8	180.0
Nov	106.2	75.6	75.0	128.8	104.2	284.8
Dec	27.2	71.8	57.0	14.0	88.4	100.8
Jan	141.6	6.8	20.6	68.2	95.2	276.8

3 www.kerikeriweather.co.nz/wxrainsummary.php?r=wxrainsummary.php

Feb	192.6	93.4	14.8	167.4	168.6	223.1
Mar	206.4	88.2	119.8	130.6	198.2	27.4
Total	**1791.8**	**1101.0**	**1115.2**	**1591.4**	**2321.4**	**2559.7**

Table 7: Monthly Rainfall (mm) in Kerikeri FYE2018-23

The normalised SAIDI impact of adverse weather faults was almost five times higher than in FYE2022. Normalisation does not remove either the long tail of major events or the impact of smaller but frequent severe weather fronts, due to the FY23 La Nina weather system. Table 7 is indicative only and does not purport to be the outcome of a comprehensive analysis of the weather conditions in our supply area, The normalised FYE2023 SAIDI attributed to adverse weather is 567% higher than in FYE2022 as reporting was undertaken to capture the prime reason causing faults.

Note that the adverse weather categories do not fully reflect the adverse weather damage.
The Commerce Commission requires that an outage have one cause. Often adverse weather causes vegetation to fall on or contact lines. In order to record accurate vegetation damage they define adverse weather as follows:

…all unplanned interruptions where the primary cause is adverse weather, ***other than those caused directly by lightning, vegetation contact or adverse environment*** [our emphasis].[4]

So much of the vegetation damage can be attributed to severe weather.

The criteria used to categorise an "adverse weather" event has not been consistent over time. In FYE2022 only interruptions that occurred during the rolling 24-hour normalisation window of a major SAIDI/SAIFI event were categorised as adverse weather, whereas in FYE2023 this categorisation was broadened to include the impact of many events outside the normalisation window. If events are not categorised consistently, then trending SAIDI data by cause over time may not be valid. This could lead to inefficient expenditure allocation if trend data is to be used as the basis for the allocation of available financial resources.

The SAIDI "Deep Dive" report by Harmonic Analytics noted:

> *Incident data contains an "extreme weather event" flag, raised by employees manually if they responded to an incident believed to be associated with extreme weather. Previous investigation indicated that this was subjective. There may be utility in a more objective extreme weather definition based on weather data.*[5]

This was due to change in personnel in 2022, and the data was subsequently corrected. However if reading the Hamonic Analytic's report this needs to be taken into consideration.

- *Defective equipment*

The second major SAIDI impact in FYE2023 was defective equipment. Figure 2 trends the SAIDI impact of defective equipment faults on the network over the period FYE2018-23. The figure shows that while there was a step jump in SAIDI input between FYE2019 and FYE2020,

4 The Information Disclosure Determination gives slips and earthquakes as examples to fault causes that should be categorised as adverse environment.

5 *SAIDI Analytics Deep Dive – Summary Report:* Harmonic Analytics, 12 May 2023, p12

there has been little change in the SAIDI impact of defective equipment faults since then. The reason for the significant jump between FYE2019 and FYE2020 is not clear.

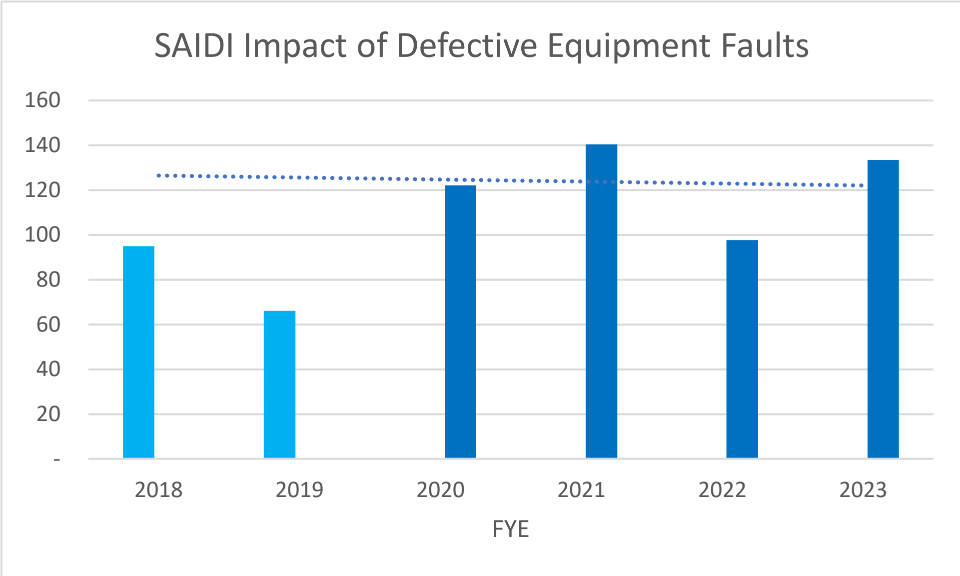


Figure 2: SAIDI Impact of Defective Equipment Faults

- *Vegetation*

The largest fault cause in FYE2023 was vegetation. Figure 3 trends the SAIDI impact of vegetation faults on the network over the period FYE2018-23, further disaggregated into tree contact and tree fall impacts. We estimate we suffered 68 trees fall through or across out lines during Cyclone Gabrielle alone.

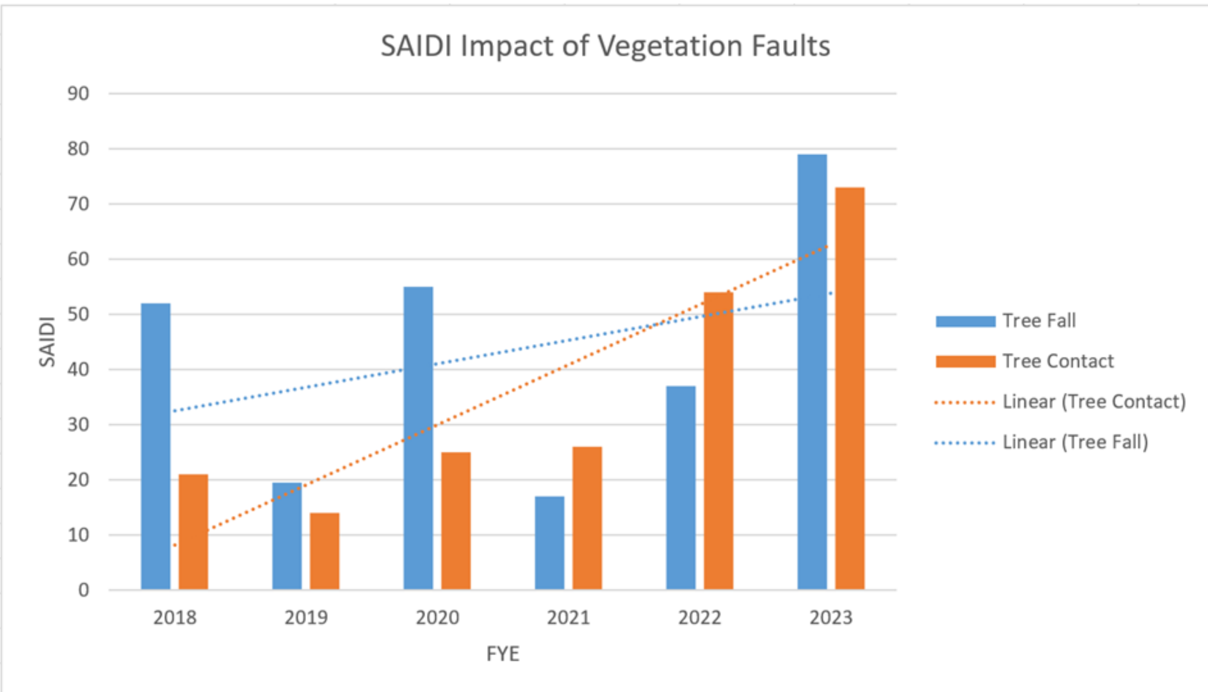


Figure 3: SAIDI Impact of Vegetation Faults

The graph shows a significant increase in both the SAIDI impact of tree-contact events over the review period and an increase in the impact of tree fall events.

Stabilisation Of Distribution Network Reliability

In May 2022 the Board approved management's 11kV network development plan, funded by reallocating the expenditure in the original FYE2023 work plan for the construction of the deferred Wiroa 110/33kV substation. The objective of this changes was to arrest the deterioration in the reliability of the 11kV network and stabilise it to meet the revised network reliability targets set out in the 2023 AMP.

For the current FYE2024 year we went out to open tender with a work package made up of the larger, more significant projects in our works programme. We have identified a suitable external contractor and are currently negotiating a final contract.

NETWORK RISK

Resilience

The normalised measure of reliability discussed above is designed as a measure of how well our asset management strategy meets the expectations of stakeholders, given events that can reasonably be expected to occur in the normal course of business and weather conditions that are typical for our supply area. Cyclone Gabrielle was a timely reminder that atypical events stress the network beyond its design envelope and beyond our fault response capacity. While such events have a severe impact on customers and other stakeholders, the normalisation process means that the impact of such events on the normalised reliability that we measure and report on is generally relatively small.

Nevertheless, we are a lifeline utility providing an essential service and our stakeholders expect us to be prepared and to respond effectively to such events when they do occur. The Electricity Engineers' Association (EEA) has prepared a Guideline on resilience, based on the following 4R's framework.

- **Reduction.** Identifying and analysing long-term risk to human life and property from hazards; taking steps to eliminate these risks if practicable, and, if not, reducing the magnitude of their impact and the likelihood of them occurring.

- **Readiness.** Developing operational systems and capabilities before a major loss event or emergency happens; including self-help and response programmes for the general public, and specific programmes for emergency services, Lifeline Utilities, and other agencies.

- **Response.** Actions taken immediately before, during, or immediately after a major loss event to save lives and protect property, and to help communities recover. In many cases this means activating pre-prepared readiness plans to enable lifeline utility services to be restored to communities.

- **Recovery.** The coordinated efforts and processes to bring about the immediate, medium-term, and long-term holistic regeneration of a community following a major loss event.

The EEA Resilience Guide includes a *Resilience Management Maturity Assessment Tool (RMMAT),* which has a very similar format to the *Asset Management Maturity Assessment Tool (AMMAT)* that is included in our AMP as Schedule 13. We have used this tool to assess our asset management maturity and are currently analysing our weaknesses and developing a programme to improve our resilience maturity. This will involve:

- **Reduction:** We are currently identifying credible high impact events, as well as practicable and economic investments to mitigate their impact that can be incorporated into our expenditure forecasts. It seems clear that the frequency of extreme weather events such as Cyclone Gabrielle is increasing, and climate change predictions for our supply area are that the intensity of such events will be higher. There is an overlap between mitigating the impact of severe weather events such as Gabrielle and managing BAU reliability in that investments designed to manage reliability will also reduce the impact of extreme weather events when they occur.

- **Readiness:** Developing in-house procedures and processes and formalising arrangements and contracts with external parties to enable us to be better prepared for such events, so that we can respond more effectively when they do occur. Lessons learnt from the review of our response to Cyclone Gabrielle be a useful input to this. This will largely involve refocusing our existing network management effort. It will also involve, amongst other things, considering whether we should purchase small diesel generators, which could be used to provide emergency power to community "refuges" in areas that are expected to be without supply for an extended period following a high impact event.

We have documented management's assessment of our current resilience management maturity in a separate Board paper for the August meeting. We are also preparing a separate paper in September that will set our plan for increasing our preparedness for HILP events and improving our response capability.

Vulnerability of the Kaikohe-Kaitaia 110kV Line

This line is arguably our most critical network asset as it is the only connection to the grid for the more than 11,000 consumers in the northern part of our supply area. As indicated in Table 4 the reliability of this line has been excellent - the SAIDI impact of 110kV line faults was very low compared to the impact of our 33kV and 11kV assets.

However, the significant rain in our supply area over the last year has resulted in land slips near two structures where the line crosses the Maungataniwha Range. This has highlighted the vulnerability of this line to the failure of a structure due to its foundation being undermined by unstable ground.

Should such an event occur and cause a loss of supply, the diesel generation in the northern area is available to restore supply to all consumers (apart from the [redacted] until temporary repairs are made to the line. However, while the generators at Taipa have been in place for some years, we have still to test our ability to start the generators at our Kaitaia depot and the Bonnets Rd generator farm when no external power supply is available.[6] In a worst-case scenario it is likely to be days, possibly weeks, before a grid supply can be restored. Operation on diesel for this length of time will be expensive and the generators are designed as standby units and not rated for extended operation.

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6 To date these generators have only been used to cover for a planned interruption. In this situation the procedure is to start the generators before the line is disconnected, so an external supply is available.

One of the lessons from Gabrielle and other recent storm events is that, under storm conditions, generators often cannot be used until the network that it supplies has been patrolled. If a fault such as a tree fall occurs on a line that is already without power due to an upstream fault, our operators will likely be unaware of the situation unless it has been reported by a member of the public.

We are taking the following steps to mitigate this risk.

- We have developed a standard operating procedure for starting the generators when no grid supply is available.

- We have undertaken a geotechnical survey and are planning to relocate two structures located close to ground at risk of erosion.

- We are working toward formalising an arrangement with Transpower for the supply and installation of a temporary structure (tower) at short notice should such an event occur. This arrangement will address and allocate responsibility for all relevant procedures including liaison with the Department of Conservation, transport of the tower, lifting it into position (presumably by helicopter), erection of the tower, attachment of the conductors, and energisation of the line. We also have in stock, suitable poles and conductor to replace many of the structures in the line, without the need for a specialist temporary "tower."

Renewable Generation

Our 2023 AMP noted that we have signed connection agreements for the connection of three utility scale solar farms in our northern area with a total capacity of 67MW. The construction of the 23MW Kaitaia Solar Farm by Loadstone Energy has commenced and we have started construction of the 33kV line that will connect this solar farm to our NPL zone substation. We remain in contact with the developers of the other two solar farms, which we expect to proceed in due course. When commissioned, these three solar farms will fully utilise the capacity of our existing Kaikohe-Kaitaia 110kV line.

The 2023 AMP also deferred the planned 110kV line between Wiroa and Kaitaia from the capital expenditure forecast on the basis that the cost of the line had escalated to the point where it cannot be justified purely on the basis of providing a resilient and reliable electricity supply to consumers in our northern area. While a route for this line has now been confirmed, the installation of diesel generation in the Kaitaia area has addressed some of the issues that triggered our original decision to construct the line.

As the sunshine hours in our northern area are amongst the highest in the country, we continue to receive applications to connect additional solar farm capacity to our network. However, we are unable to connect any further generation since there is no spare transmission capacity available to export the electricity south. There are two constraints – a constraint within our network between Kaitaia and Kaikohe and a constraint in the Transpower network between Kaikohe and Maungatapere.

We continue to work with Transpower and Northpower on the development of a Northland Renewable Energy Zone (REZ), which would assess the transmission system upgrade requirements to meet the demand for the connection of additional renewable generation in Northland from a holistic, area-wide perspective. However, Transpower has identified that further consideration and development is required to develop a REZ concept that is right for New Zealand. Funding of the system upgrades that will be needed if the REZ concept is to be progressed is likely to be a problem and we suspect that we will not be able to build the line until the Government develops a policy on the funding of the transmission and distribution system upgrades that will be needed if sufficient renewable generation is to be built to enable New Zealand to meet its 2050 net-zero decarbonisation target.

The 110/33kV transformer capacity at the Kaitaia substation is a further constraint. The substation has two transformers, a relatively new 40/60MVA unit and an older 22MVA unit. Should the larger unit fail, which is unlikely since it has given reliable service and our power transformer testing programme has shown it to still be in as-new condition, the 22MVA unit has insufficient capacity to accommodate the three new solar farms. Our 2023 AMP expenditure forecast provides for the replacement of this transformer in FYE2030.

FLEET MANAGEMENT

Approach

Fleet plans for our asset classes, (as high-level summaries) are included in Chapter 6 of our AMP. Each of these summaries includes an assessment of asset health, using the five-point framework in the EEA Asset Health Indicator Guide, and a replacement strategy expressed as the number of assets in each fleet that we plan to replace each year. However, the basis on which this replacement strategy was developed requires more attention as our health assessment currently takes no account of asset criticality. The assessment over the overall health of an asset fleet can therefore be misleading if the assets known to be in poor condition are non-critical assets that we would normally run to failure.

We are embarking on a multi-year strategy to develop a more robust and structured approach to our lifecycle asset management. To this end:

- We have purchased the DataFrame software from Asset Dynamics, which we will use to monitor the completeness of the data on each asset component. The software will aggregate this data and assess data completeness "scores" for the various sub-fleets. This will provide our asset managers a more robust assessment of the completeness of the data on different segments of our asset base, highlight those areas where data is less complete and likely less reliable.

  The software will initially be populated with data on our sub transmission and high voltage distribution lines. In particular, it is planned to treat crossarms as a separate asset component, which we don't currently do. Crossarm faults account for over half of our defective equipment failures. While the expected life of a crossarm is about half that of the concrete pole to which they are attached, they are currently not separately monitored, which makes it difficult to develop an effective crossarm replacement strategy. Monitoring crossarm condition separately from that of their associated pole will, over time, lead to more robust management of the asset sub-fleet and a reduction in the number of supply interruptions caused by crossarm failures.

- The data in the DataFrame software will feed directly into our new condition-based risk management (CBRM) model, which was discussed in Section 8.3 of our 2023 AMP. The model will create a risk score for each individual asset, which is the product of the asset's probability of failure and the consequence of failure (criticality). The risk scores for each asset are then aggregated to create a risk profile for each asset class. Based on the rate of deterioration generally observed for each asset type, the model can track the change in risk profile of each asset class over time. We will use the model as a tool that will enable us to evaluate how different rates of asset replacement will impact the risk profile, and this will allow us to quantify the optimal rate of asset replacement to maintain the asset fleet in a condition that is fit for purpose. Over time, a separate CBRM model will be developed for each asset fleet.

- We plan to further develop our documented fleet plans to underpin the CBRM models. These will provide information on, but not necessarily be limited to, the characteristics the assets that make up the fleet (e.g. conductor types and standard sizes), failure modes, fleet management strategy, preventive maintenance, and corrective and reactive maintenance. The fleet plans and their associated CBRM models will drive our asset inspection plans, proactive and reactive maintenance, as well as our capitalised asset renewal and replacement strategy.

Asset Condition Data Quality

The data to be included in the DataFrame software platform relates to an asset's specification, its age, and other known factors, such as distance from the coast, which could influence an asset's expected rate of deterioration.

Data on the condition of an individual asset is maintained in our SAP asset management software platform and is derived from our asset management inspection programme. In parallel with the implementation of the DataFrame and CBRM software platforms, we are reviewing our asset condition data capture processes. This review is looking at:

- Whether the inspection templates for each asset type can be improved and whether the criteria on which inspectors base their assessment of an asset's condition is appropriate.
- The extent to which the asset inspection data should be audited. Currently no formal audits are undertaken. We plan to introduce a formal regime for auditing asset inspections once these positions are filled.
- The framework for defining asset criticality. The CBRM model will require criticality to be defined and assessed in a structured way.

We envisage that the strengthening of our maintenance management support capability, the introduction of the DataFrame and CBRM software platforms and the review of the robustness and appropriateness of our asset condition data will over time provide the information we need to develop a more cost-effective maintenance and asset renewal strategy. However this is a multi-year initiative – purchasing the software and populating it with the data we already have is only the first step in the process. It will be followed by an ongoing process of refinement that will include both improving the quality of asset data and learning to use the software tools more effectively.

Low Voltage Asset Data

A known limitation in the completeness and quality of our asset data relates to our low voltage assets. In FYE2023, we initiated an LV data capture project, which will capture accurate data on our LV assets and their connectivity across the network. As the data comes in, it is being input into our GIS and SAP asset management systems. The project includes opening all service pillars to confirm LV connectivity and has been useful in identifying issues that require remediation, but which would otherwise have gone unnoticed. In the current FYE2024 year, we have increased the resources allocated to this project, which we have planned to be completed over a three-year period.

Power Transformers

Our first comprehensive fleet plan will be for zone substation power transformers. Earlier this year we had an external review undertaken of the condition of our power transformer fleet, which found that many transformers were in worse condition than indicated by our regular condition assessment and testing programme. We are validating the findings of the external report which, when confirmed, will be used as the basis for the new fleet plan, which will include a multi-year power transformer renewal and replacement strategy. The cost of this will be included in our 2024 AMP expenditure forecast.

Power transformers are critical and expensive assets. As the number of units in the fleet is small and each transformer can be assessed individually, a CBRM model is not needed.

While the transformers in the poorest condition have all been assessed as having some finite residual life, there is always a risk that one might fail unexpectedly. The biggest concern is the condition of the transformers at Pukenui and Taipa substations, which both have only one transformer. However, we can cover the unexpected failure of either transformer using the mobile substation in the first instance and then relocating the second transformer at the Moerewa and Kaeo substations respectively to replace the failed unit. The other transformers in poor condition are at two-transformer substations, where the second transformer is available as cover.

Our view is that while the review has identified an emerging issue that we need to act on, we are well placed to manage the short-term risk.

Communication Protocol

Top Energy currently uses an Open Platform Communications (OPC) protocol to control field devices (reclosers, sectionalisers, remote controlled switches and voltage regulators). This protocol is separate from the Distributed Network Protocol 3 (DNP3) that is used to operate sub-station equipment.

OPC is unsupported and has been identified for replacement with a modern replacement to address known stability issues highlighted by a recent incident whereby workshop-based pre-commissioning testing on a new remote terminal unit resulted in an unexpected change in the state the auto reclose function of an in service recloser.

A project is to be set up to investigate, fund and implement a modern DNP3 digital field device communication protocol, for all new devices and the migration of existing equipment and field devices to the new protocol. This protocol will eventually replace both the existing OPC and the proposed Modbus protocols.

The targeted outcome is that all field devices to communicate across a modern supported communications protocol common to similar industry Networks.

Recommendation

That the Directors accept this paper for information.

Russell Shaw
Chief Executive
Top Energy Group

Prepared by:
Ian Robertson
Network General Manager

Annexure 16

Memo

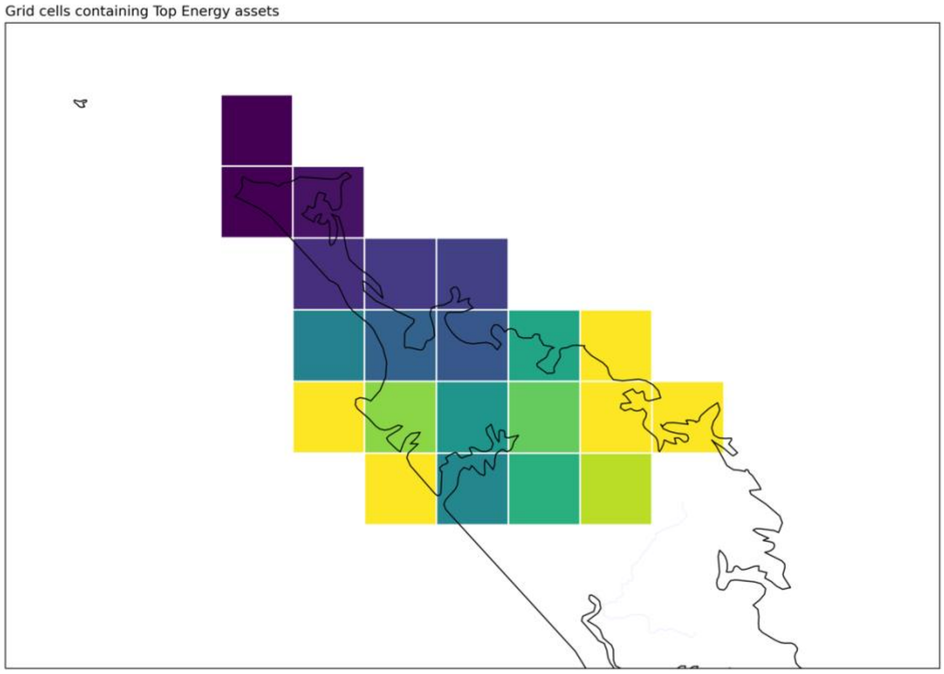
From	**Ben Noll, NIWA meteorologist** **ben.noll@niwa.co.nz**
To	Ian Robertson Top Energy Ltd John Butler Centre, Level 2, 60 Kerikeri Road, Kerikeri Ian.Robertson@topenergy .co.nz
CC	Mark Bojesen-Trepka Richard Turner
Date	18 August 2023
Subject	Extreme weather days

The following information provides a high-level overview of extreme precipitation, wind, and weather days from January 1940 through early August 2023 across Top Energy assets. The dataset used was ECMWF-ERA5, *an atmospheric reanalysis that combines model data with observations from across the world into a globally complete and consistent dataset using the laws of physics*. The dataset has an approximate horizontal resolution of 30 km. This makes it useful for assessing regional trends, but not location specifics.

The attached folder "outputs" contains the spreadsheets described below and images in this report. Inside the folder, there are sub-folders which classify extreme weather upon the 90th and 95th percentile, with respect to the regulatory year (1 April to 31 March).

- Extreme precipitation is defined as average total daily precipitation exceeding the 90th - 95th percentile across Top Energy assets.
  - The days on which extreme precipitation occurred are contained in "very_wet_days.csv". A value of "1" means extreme precipitation occurred, while "0" means it did not.
  - The annual number of days that featured extreme precipitation are contained in "annual_very_wet_days.csv".
- Extreme wind is defined as the average daily wind gust exceeding the 90th - 95th percentile across Top Energy assets.
  - The days on which extreme wind gusts occurred are contained in "high_wind_days.csv". A value of "1" means extreme wind occurred, while "0" means it did not.
  - The annual number of days that featured extreme wind gusts are contained in "annual_high_wind_days.csv".
- An extreme weather day is defined as having both extreme rainfall and extreme wind.
  - The days on which extreme weather occurred are contained in "extreme_weather_days.csv". A value of "1" means extreme weather occurred, while "0" means it did not.
  - The annual number of days that featured extreme weather are contained in "annual_extreme_weather_days.csv".

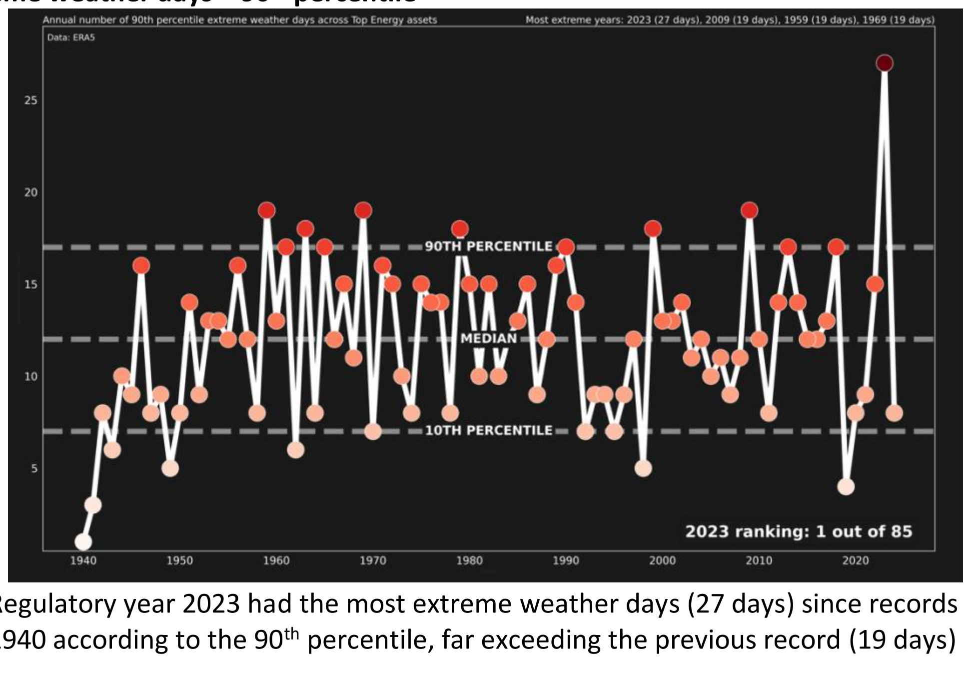
The image below shows the region for which historical data was extracted in order to complete this analysis (inclusive of assets belonging to Top Energy).



The information below is reflective of the regulatory year (1 April to 31 March).

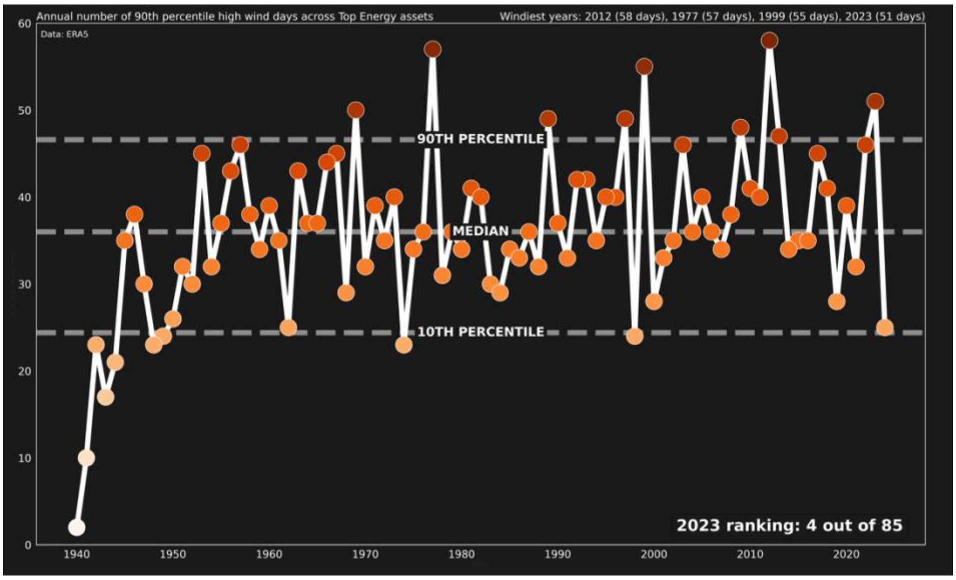
The following sections provide a brief overview of the findings for extreme weather, wind, and precipitation days. The data is presented for both the 90th and 95th percentile.

1. **Extreme weather days – 90th percentile**



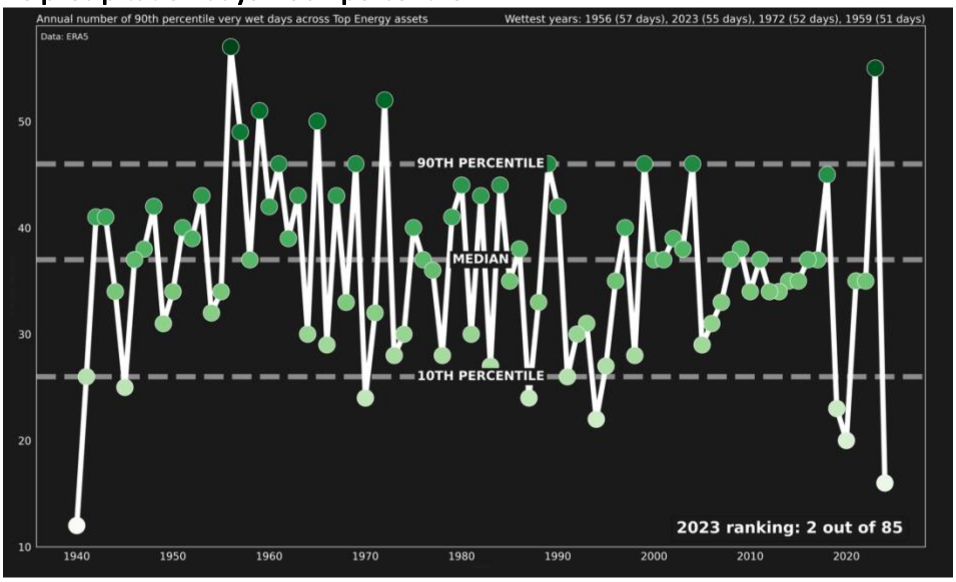
- Regulatory year 2023 had the most extreme weather days (27 days) since records began in 1940 according to the 90th percentile, far exceeding the previous record (19 days)

2. **Extreme wind days – 90th percentile**



- Regulatory year 2023 had the 4th most extreme wind days since records began in 1940 according to the 90th percentile

3. Extreme precipitation days – 90th percentile



- Regulatory year 2023 had the 2nd most extreme precipitation days since records began in 1940 according to the 90th percentile

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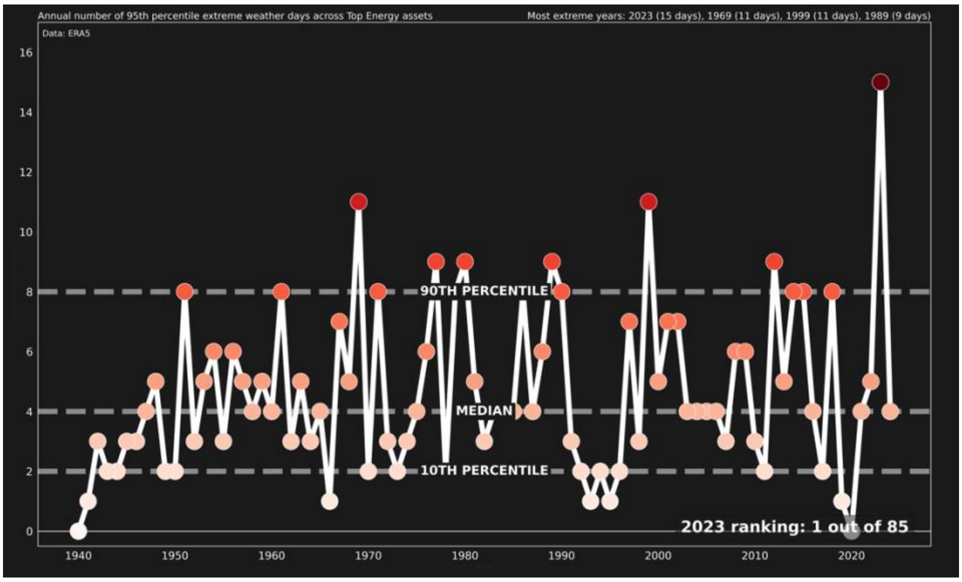
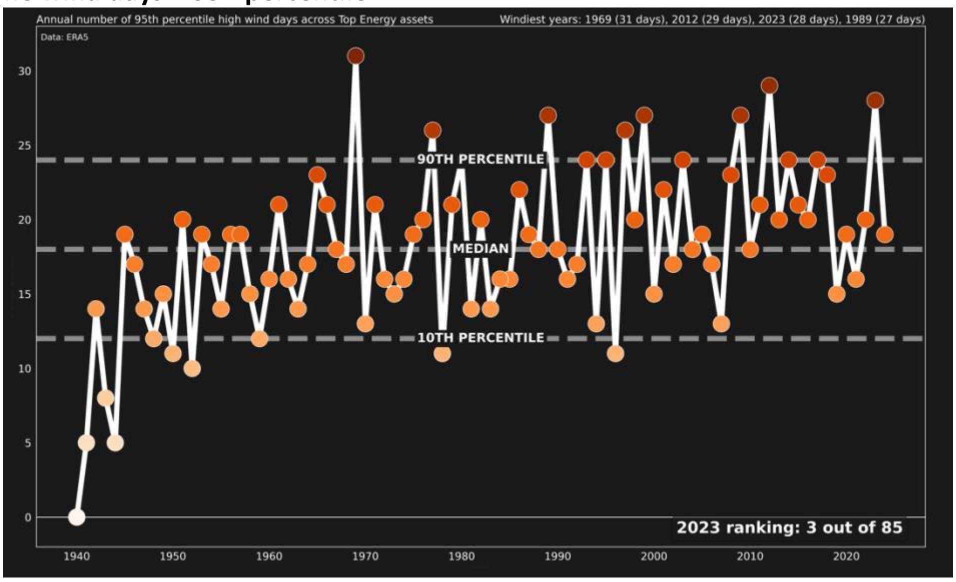
4. Extreme weather days – 95th percentile



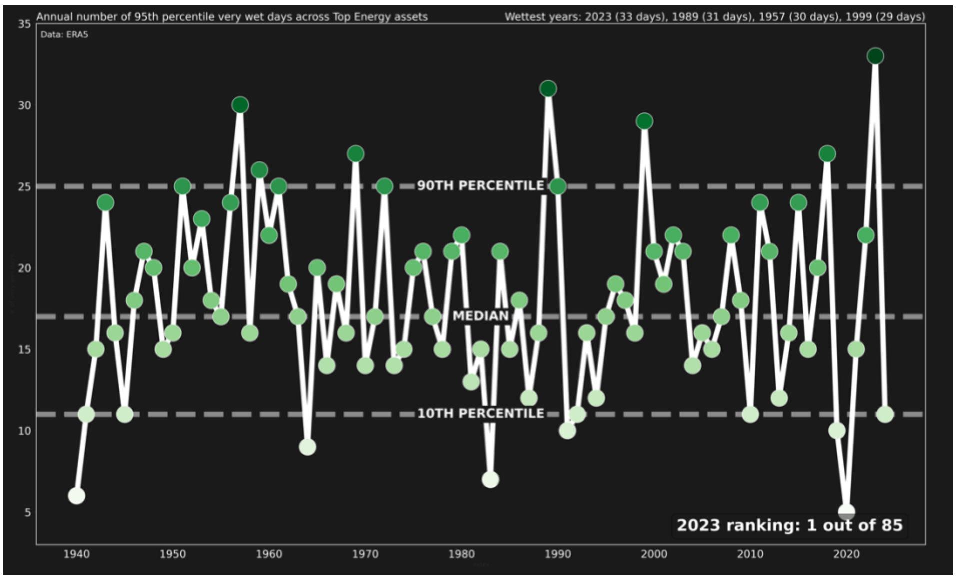
- Regulatory year 2023 had the most extreme weather days since records began in 1940 according to the 95th percentile

5. Extreme wind days – 95th percentile



- Regulatory year 2023 had the 3rd most extreme wind days since records began in 1940 according to the 95th percentile

6. Extreme precipitation days – 95th percentile



- Regulatory year 2023 had the most extreme precipitation days since records began in 1940 according to the 95th percentile

For queries regarding this analysis, please contact Ben Noll (ben.noll@niwa.co.nz).

The other component of this analysis involves a higher-resolution review of weather conditions across Top Energy's area of interest, carried out by Dr Richard Turner (richard.turner@niwa.co.nz).

Annexure 17

Memo

From	**Richard Turner**
To	Top Energy
CC	Mark Bojesen-Trepka Ben Noll
Date	17 August 2023
Subject	Extreme weather days – wind in Regulatory Year 2022-2023
File path *(right click to update)*	*https://niwa-my.sharepoint.com/personal/richard_turner_niwa_co_nz/Documents/Documents/Memo-Winds-Northland-Top-Lines-Company-2022-2023-NIWA.docx*

This is and analysis of severe wind days and coincident strong wind and heavy rain days for the regulatory year April 1, 2022 to March 31, 2023 over the Top Energy region of Northland in comparison to the previous 4-year regulatory years (April 1, 2018 to March 31, 2022). This is complementary to an analysis done by Ben Noll supplied separately.

Stations

The analysis examined wind and rainfall records for several stations in the region, these being;

- Kaikohe
- Kaitaia
- Kerikeri Aero
- Russell
- Cape Reinga
- Trounson(*)
- Dargaville(*)

(*) *Trounson and Dargaville are not within Top Energy's area of operations, however these stations were included as they are reasonably close to the area and observations there are likely to be more representative of conditions on the south western coast and hills of the Top operating area*.

The locations of the stations are marked in Figure 2.

The analysis also makes use of gust wind estimates from the archive of NIWA's high resolution Numerical Weather Model output (the 1.5 km grid spaced New Zealand Convective Scale Model) for the period from Apr 1, 2018 through Mar 31, 2013 including results from simulations of the passage of ex-Tropical Cyclone Gabrielle on 13 and 14 Feb 2023.

Winds:

In Table 1 are shown the number of exceedances of strong wind thresholds in the regulatory year 2022-2023 and how that compares with the average over the previous four regulatory years, (2018/19, 2019/20, 2021/21, 2021/22)

This shows that 5 of the 7 sites had below average number (around 50-90% the number) of strong wind episodes in the 2022/23 year, and 2 sites had above average number of incidences.

Note; due to differences in exposure and the complex terrain of the Northland region, different thresholds of exposure were chosen to identify dates in which winds over a wider area may have been strong – around the 90 – 95th percentile. For example, the Cape Reinga site has steep surrounding slopes and its elevation and far more exposed than the site at Russell – where 95% winds are just under 40 km/h and near 100 km/h at the (See Figure 1)

Table 1: The average number of exceedances of the average over the four regulatory years (2018/19, 2019/20, 2021/21, 2021/22) of strong wind thresholds (in brackets) and those in the regulatory year 2022-2023 and the ratio of last year to the previous 4. The numbers in orange brackets are scaled to the full year for Cape Reinga where there were many missing records – and while consistent are much more uncertain.

Station	Average past 4 years	2022-2023	Ratio
Kerikeri (55)	**15.5**	**25**	**161%**
Kaitaia EWS (80)	**10.0**	**13**	**130%**
Kaitaia Aero (80)	**12.3**	**16**	**131%**
Cape Reinga (100)[1]	*9(14.8)*	*16(24.8)*	*168%*
Russell (40)	**3.5**	**6**	**171%**
Trounson (70)	**0.5**	**24**	**4,800%**
Dargaville (80)	**19.3**	**25**	**130%**

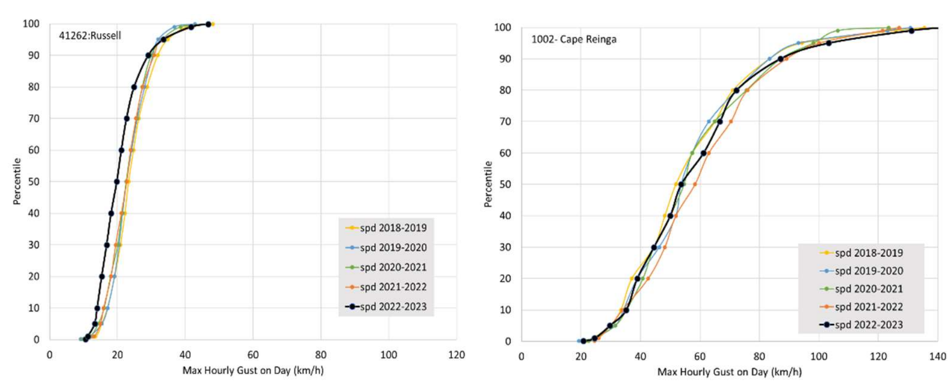


Figure 1: Cumulative distribution of observed gust exceedances at Russell and Cape Reinga over the past 5 regulatory years.

[1] Cape Reinga had 30% missing days of records in 2022/2023

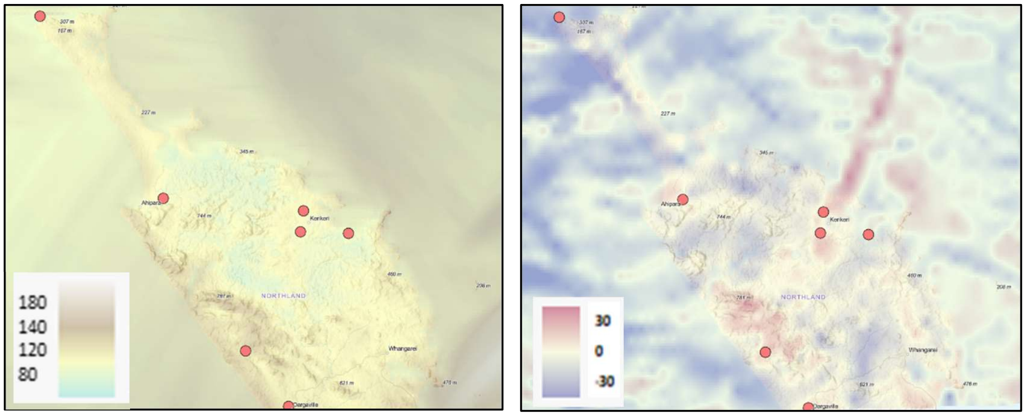


Figure 2: NZCSM (New Zealand Convective Scale Model) estimated maximum 3-s gusts (km/h) during the passage of ex-Tropical cyclone Gabrielle (left) and the difference (km/h) between maximum NZCSM gusts in 2022/23 against the average for the 5-year period Apr 1, 2018, to Mar 31, 2023 (right).

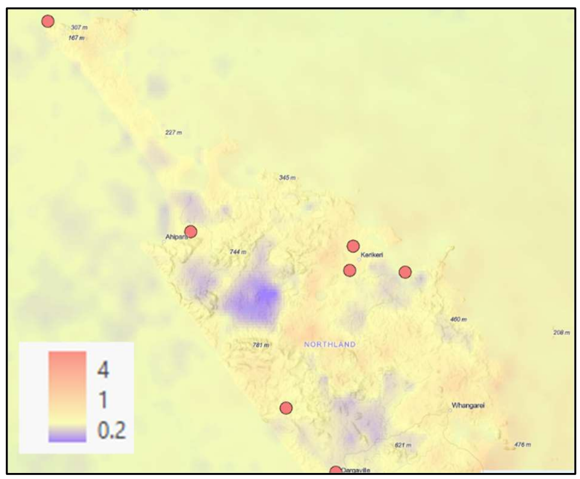


Figure 3: The ratio of days in regulatory year Apr 2022 to Mar 2023 with NZCSM wind gusts exceeding 80 km/h compared to the average over the four regulatory years prior. Red markers indicate location of weather observing stations, showing that many of the observing stations were in relatively less windy locations in 2022/23.

Rainfall

Observed rainfall across the region was abnormally high at all observing sites, being 120-150% above the average of the Apr 2018- Mar 2023. This is shown in Figure 4 and reinforced by the number of very wet days that occurred in 2022/23 - see Table 2.

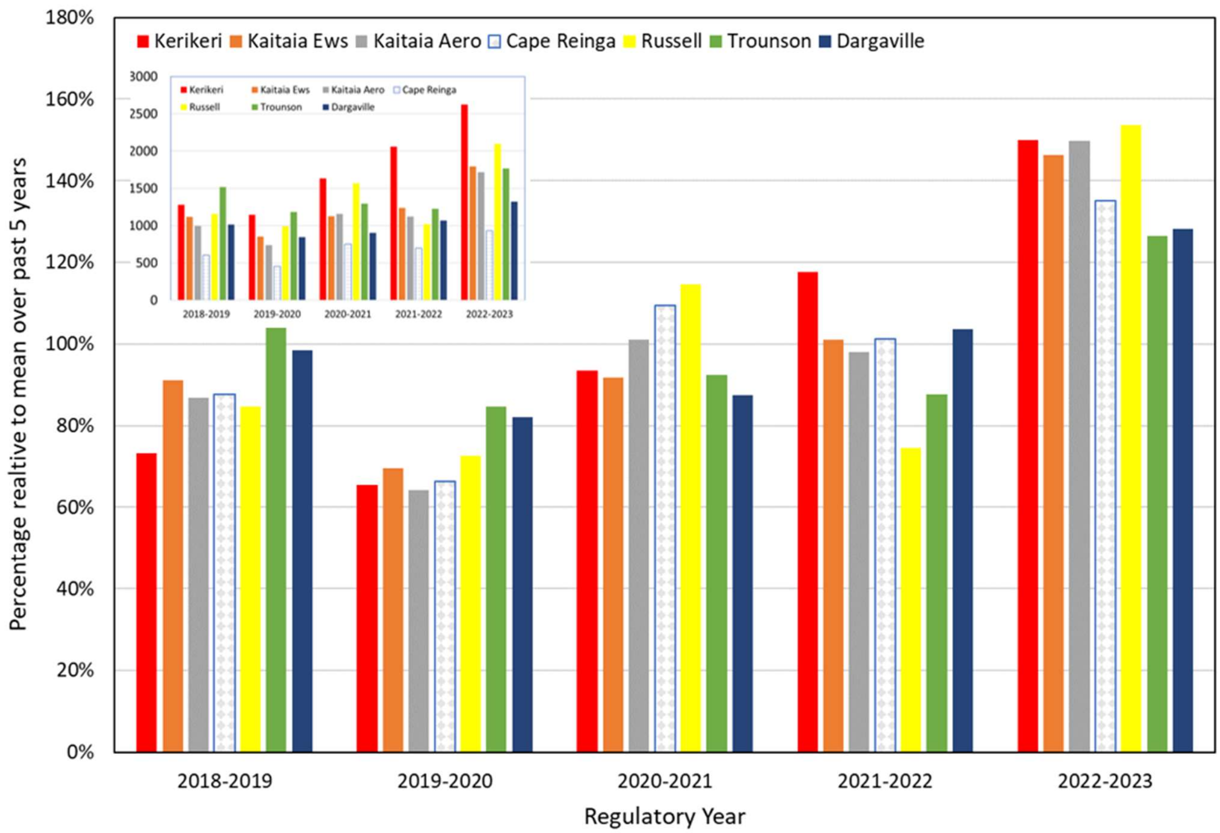


Figure 4: Regulatory Year annual percent of normal of accumulated rainfall at the 7 observing sites. The inset shows the actual totals in mm.

Table 2: The average number of exceedances of the average over the four regulatory years (2018/19, 2019/20, 2021/21, 2021/22) of very wet day thresholds (in brackets) and those in the regulatory year 2022-2023 and the ratio of last year to the previous 4 years.

Station	Average past 4 years	2022-2023	Ratio
Kerikeri (30)	13.3	**30**	**226%**
Kaitaia EWS (30)	**6.8**	**17**	**252%**
Kaitaia Aero (30)	**6.3**	**14**	**224%**
Cape Reinga (30)[1]	2	4	200%
Russell (30)	**9.3**	**22**	**238%**
Trounson (30)	**7.3**	**11**	**152%**
Dargaville (30)	**2.8**	**5**	**182%**

Coincident High Wind and Heavy Rain Events (Observed)

From above it appears that (i) the exceedances for strong wind events were relatively more than the average over the past 4 years, and (ii) there were an abnormal number of rainfall events, and (ii) high winds from those associated with Gabrielle were the strongest that many parts of the region had experienced for several years. Weather impacts from these factors taken separately over the past regulatory year would have been more likely. An additional compounding factor is that in times of prolonged wet and high soil-moisture – winds that would not otherwise cause issues can be damaging due to a higher risk of treefall. Thus, an analysis of the number of coincident strong wind and very wet days is also instructive. The results are summarised in Table 3, which shows that the incidence of such days was around two-to-three times higher and up to ten times higher in the past regulatory year than over the previous years.

Table 3: The average number of coincident high wind and very wet days average over the four regulatory years (2018/19, 2019/20, 2021/21, 2021/22) of very wet day thresholds (in brackets) and those in the regulatory year 2022-2023 and the ratio of last year to the previous 4 years.

Station (Thresholds) **(Wind [km/h]/rain [mm])**	**Average past 4 years [max]**	**2022-2023**	**Ratio**
Kerikeri (55/30)	**3.8[5]**	**14**	**373%**
Kaitaia EWS (70/30)	**11[13]**	**21**	**191%**
Kaitaia Aero (70/30)	**8.3[10]**	**22**	**267%**
Cape Reinga (80/20)[1]	*2.8[4.2]*	*5[7.8]*	*182%*
Russell (40/30)	**1.75[3]**	**5**	**286%**
Trounson (50/20)	**0.75[1]**	**8**	**1,067%**
Dargaville (60/30)	**1.25[2]**	**4**	**320%**