Meeting Date: 1 June 2022

GRID OWNER ASSET MANAGEMENT AND RISK

SECURITY AND RELIABILITY COUNCIL

This paper provides the SRC with information about the grid owner's approach to asset management and risk, as part of the SRC's role to ensure reliable and secure energy for consumers.

Note: This paper has been prepared for the purpose of the Security and Reliability Council (SRC). Content should not be interpreted as representing the views or policy of the Electricity Authority.

Grid Owner Asset Management and Risk

1.1.1 As part of its theme of asset management and risk, the SRC has asked the secretariat to provide information on the grid owner's approach.

1.1.2 The aim for this work is to provide the SRC with better understanding of the grid owner's approach to asset management and risk; including how it manages its assets to maximise security/reliability and to minimise restoration time.

1.1.3 When initiating this paper, the grid owner has advised it is currently undertaking a periodic review of its asset management plan. The grid owner's presentation is higher level and does not include detail of the asset management plan. The grid owner will present an update at the SRC's October 2022 meeting that will detail any material changes to asset management from the security and reliability perspective resulting from the review.

1.1.4 The grid owner paper in Appendix A provides a broad context for the grid owner's approach, drawing on key documents they produce as part of their regulatory reset process such as their strategic asset framework and asset management plans.

1.1.5 The grid owner paper includes information about the grid owner's approach to ensuring reliability and resilience of the HVDC infrastructure.

1.1.6 This paper complements other papers and a case study on distributor asset management, being presented at this meeting.

1.1.7 Representatives from Transpower (in its role as grid owner) will attend and present and be available for questions.

Questions for the SRC to consider

The SRC is asked to consider the following general questions.

Q1. What questions does the SRC have for the grid owner to consider, as it finalises its asset management plan?

Q2. What further information, if any, does the SRC wish to have provided to it by the secretariat or the grid owner for the October meeting?

Q3. What advice, if any, does the SRC wish to provide to the Authority?

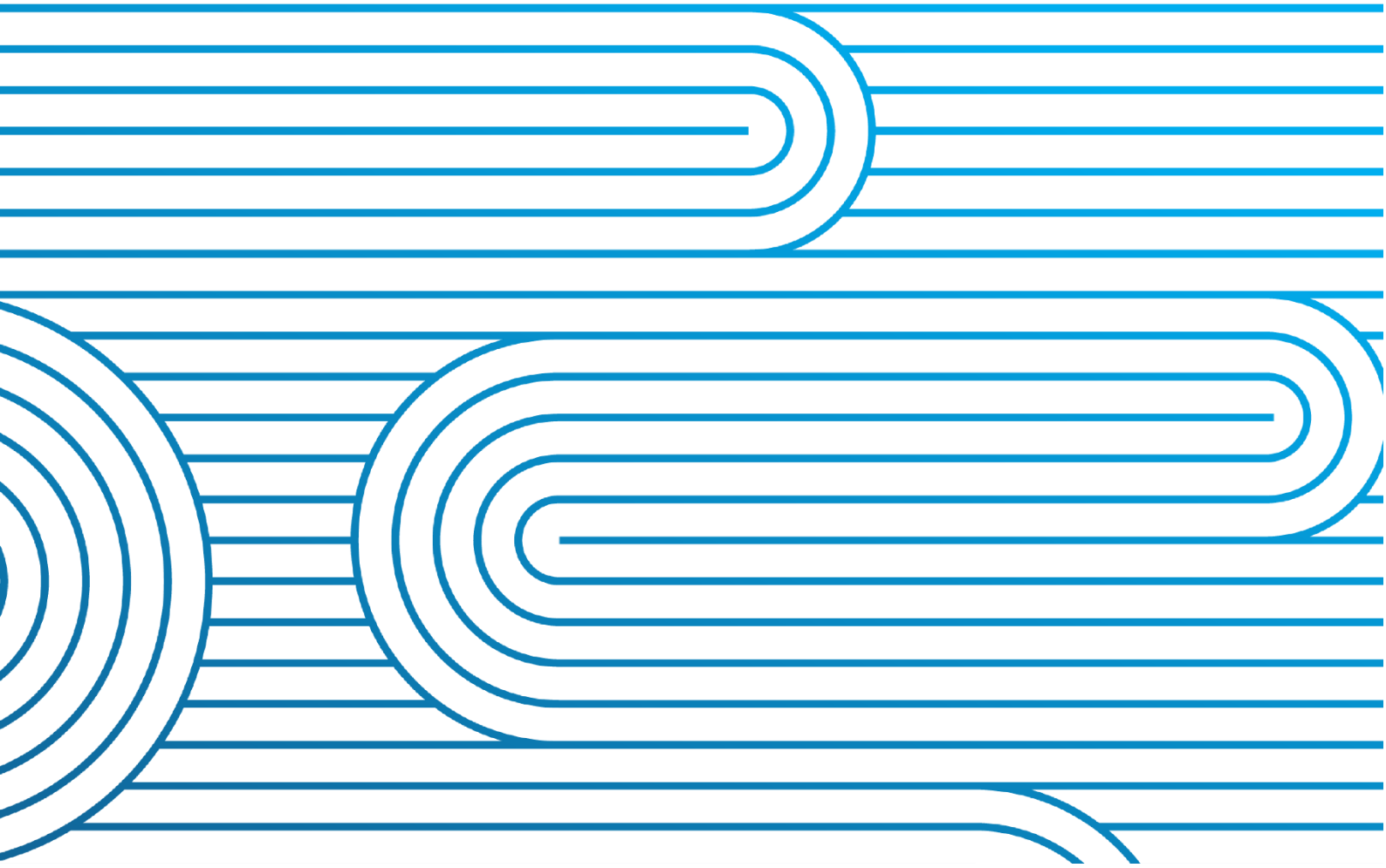
Appendix A: Grid owner - Asset Management and Risk

TRANSPOWER

Transpower's approach to Asset Management and Risk

Presentation and Paper to Electricity Authority Security and Reliability Council

Date: June 2022



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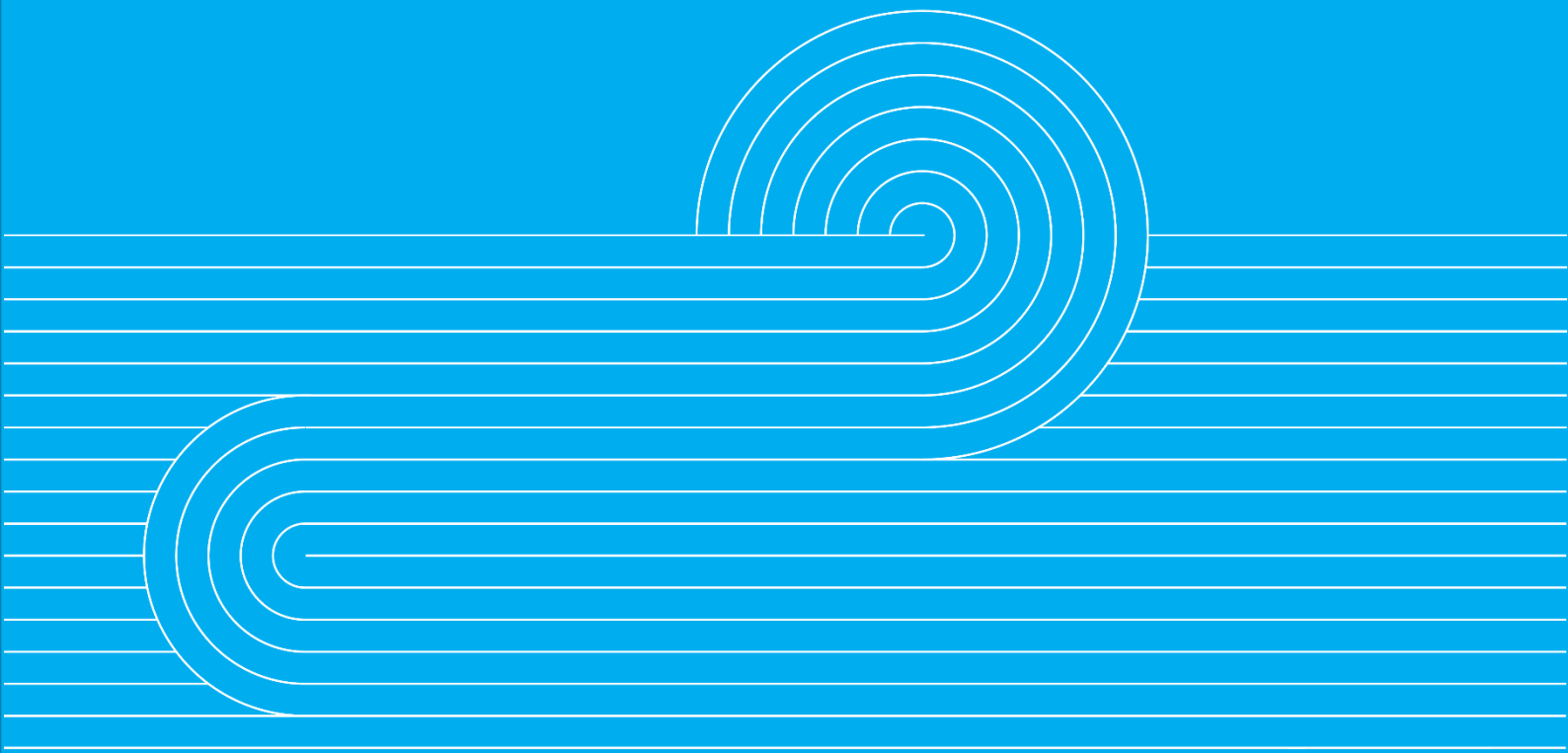


1.1 Introduction and Context

As requested by the SRC Secretariat in this short paper and attached slides we have set out Transpower's approach to Asset Management and Risk. This is a very wide subject, in this material we have focused on the direct management of grid (power system) assets and risk. Other areas such as Information Technology risks have not been covered. For ease of reading the slides have also been inserted on this narrative overview.

The background to this request is to provide the SRC on the Grid owners practices and approach. This is to support the SRC's work programme to understand how the distribution sector is addressing key elements of asset management and risk. The material provided here is an overview drawn from existing supporting material. We can provide further details in specific areas if requested by the SRC.

Critical Risks

1.2 Regulatory framework and assurance

Transpower's grid expenditure is regulated by the Commerce Commission. Under the wider total allowance approved for our current regulatory period from 2020 to 2025 (RCP3), there is ~$1.2bn for direct capital expenditure on grid assets to maintain them in a serviceable state and ~$0.6bn for maintenance. Major Investment in new assets to provide added grid capacity is funded separately on the project-by-project basis.

Grid Owner Asset Plans

Integrated Transmission Plan– Suite of documents including

- Asset Management Plan framework, portfolio plans with expenditure forecasts
- Transmission Planning Report identifying grid investment needs
- Service Measures and Targets
- Regulatory disclosures

Under our regulatory framework Transpower produces an annual integrated Transmission Plan (slide 3) that draws together its asset management and expenditure plans, Transmission Planning report on future system needs and Grid performance and reliability reporting.

In developing our request for grid expenditure every five years, we apply our grid asset management framework to identify the expenditure required to maintain a safe and reliable network. We also consult with our 46 customers on the level of service they require. Our funding submission to the Commission is reviewed by an Independent Verifier. The Verifier reviews our plans and performance to advise if the planned expenditure is prudent and reflects good electricity industry practice.

We report to customers and the Commission on our performance through an agreed basket of grid service measures including the number of outages and availability of the grid. Some of these grid service measures are linked to an incentive regime to ensure our expenditure is targeted to maintain and improve service levels, and the overall asset health of our fleet.

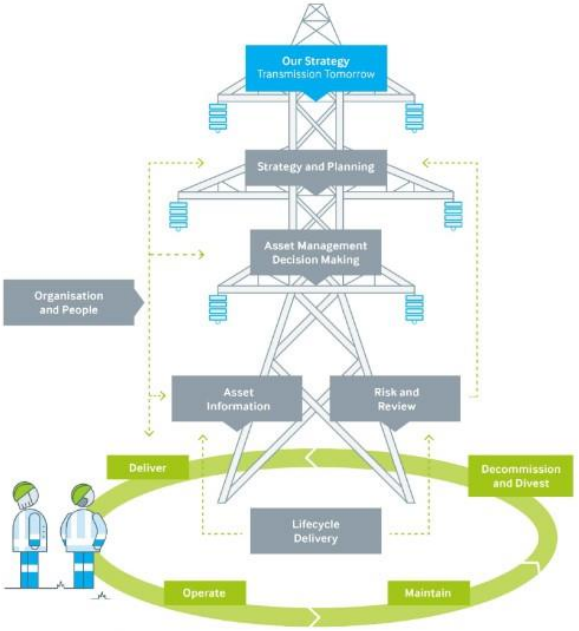
We are well into the development of our submission for the next five-year regulatory period from 2025-2030. We will be consulting on the grid service measures, hosting workshops on key asset expenditure areas over the next 6 months before submitting our draft proposal to the Independent Verifier in early 2023. We welcome feedback from the SRC along with other stakeholders as part of our consultation process.

1.3 Asset Management Framework

Transpower's Grid Asset Management framework

Our Grid Asset Management framework ensures line of sight from our strategy, Transmission Tomorrow, through to how we plan, design, build and maintain the Grid Assets to deliver services and customer value.

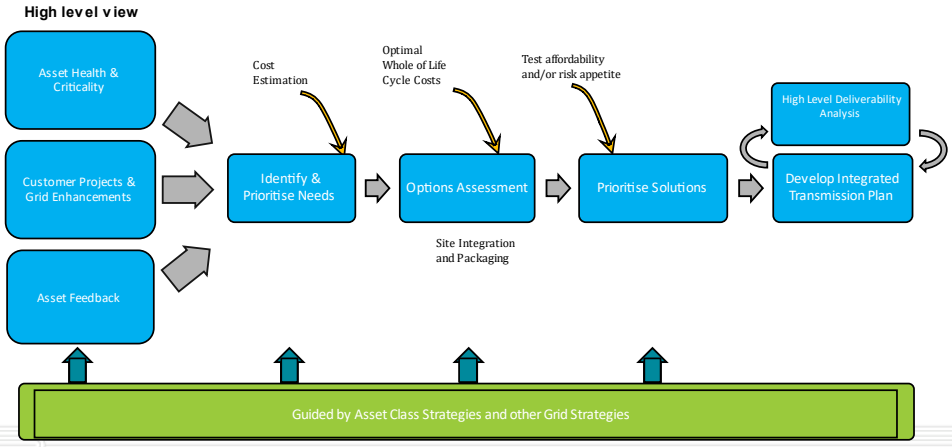
Our asset management system aligns with ISO 55001, and sound asset management helps us achieve good electricity industry practice in line with our peers. This provides confidence to the independent verifier and the Commerce Commission that we are managing performance, risks and costs.



Our overall grid Asset Management framework in slide 4 provides a clear line of sight from strategy to lifecycle delivery. It is supported by a decision framework in slide 5 to ensure repeatable whole of life least cost decision that balance service needs. The outputs from the process are used to develop our asset portfolio plans for our transmission lines and substations as well as the secondary systems that monitor and protect grid equipment.

Asset planning decision framework

The decision framework, within the Asset Management decision making stage of our Grid Asset Management Framework provides a consistent, repeatable riskbased approach for asset planning decisions. The key drivers for investment are safety, network performance, future demand, risk of asset failure, and cost performance. The framework principles apply to all grid capital and relevant grid operating expenditure.



Our asset management approach underpins the development of our Asset Management Plan.

Asset Management plan

- Increasing need to integrate replacement needs with the forecast increase in grid enhancement to support electrification and renewable connections
- Also to consider resilience, as well, in addressing climate change and grid service expectations

The Asset Management Plan also identifies the likely expenditure by asset class. Slide 7 captures the funding allowance for replacement and refurbishment works over the 5 years in RCP3

The allowance can be spent where it will have the greatest effect on meeting service and performance expectations. We do have an aging asset base and face significant ongoing renewal programmes. Innovation initiatives have resulted in a significant reduction in the need for transmission line renewals over that forecast, however we are needing to spend more than envisaged on our substation renewals. This earlier replacements for electrification needs.

Overview of Replacement and Refurbishment Expenditure 2020-2025

Capital Expenditure as per ComCom RCP allowance by super portfolio

Is fungible – objective is to spend to deliver service and performance required

Maintenance expenditure ~ $100m per year

Maintenance includes reactive predictive preventative works

Portfolio	Total RCP3 Yrs
AC Substations	**297.0**
ACS Reactors, Capacitors	119.2
ACS Buildings, Grounds, Seismic	58.6
Transmission Lines	**441.1**
Secondary Assets	222.5
Grid R&R Capex	**1,138.4**
Grid Enhancement &Development	101.4
Total Grid Base capex	**1.239.8**

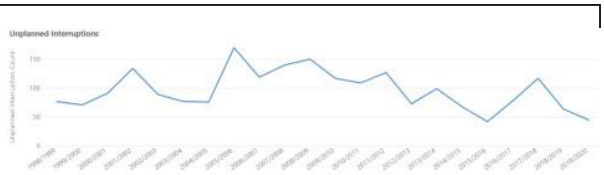
Slide 8 shows how we monitor and report on trends in individual asset portfolios. These trends allow us to identify the need for additional capital or maintenance interventions, revisions to asset class strategies, standards or service specifications and maintenance procedures.

Asset Class Performance

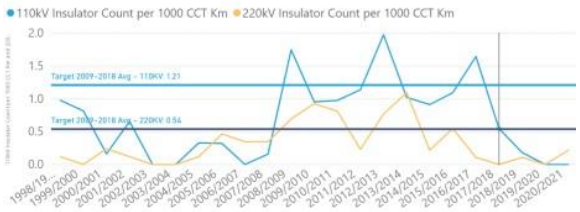
Event recording and reporting supports:

- Service measures
- Asset class metrics
- Probability of failure curves
- Strategy reviews
- Reliability reviews

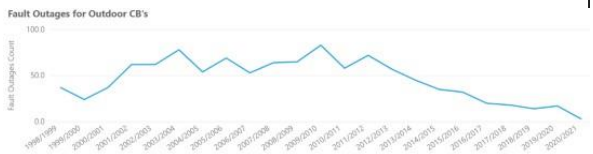
Updates presented to our regulator every 6 months and performance shown within our yearly Asset Management Plan.



Grid performance.



Insulator performance.



Outdoor Circuit Breaker performance.

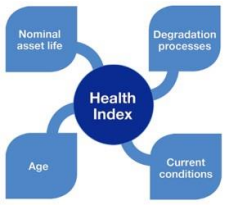
Quantitative information on risks or costs within this slide pack is to be used for illustrative purposes. For wider release contact Julian Morton julian.morton@transpower.co.nz

1.4 Asset Health, Criticality and Network Risk

Over the past ten years we have developed asset health models for most major asset portfolios. These health models help inform us when replacement criteria are met or the need for specific interventions to provide life extension of the asset. See Slide 9.

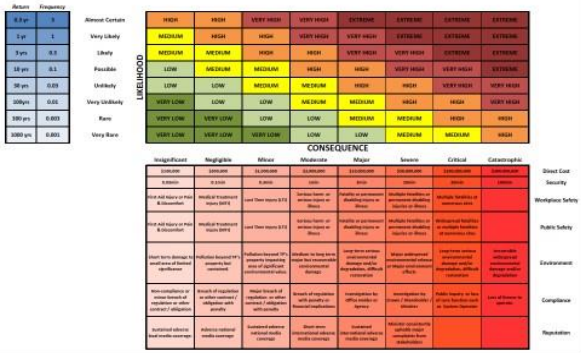
Asset Health

- Our Condition Based Asset Health Models calculatea score of 0-10 for current asset health and this is an indicator of likely remaining life
- It is a consistent, auditable and logical means of combining complex information and consistent with international practice
- Uses the asset age, nominal life, degradation processes, and current observed and measured condition data to develop current and future Asset Health Index which allows forecast
- Hygiene factor with respect to critical risks– dissatisfaction is high if service is impacted from not maintaining our asset base.
- It is still an area for the industry and Transpower to mature



In the last five years we have introduced an asset criticality view to our asset management approach, as set out in slide 10. This allows us to prioritise expenditure on replacement or life extension across asset portfolios, and to target specific high risk failure modes. We also developed Condition Base Failure risk modelling shown in slide 11. This enables us to monetise the risk of failure for some asset classes. The use cases for the monetised approach are listed.

Criticality

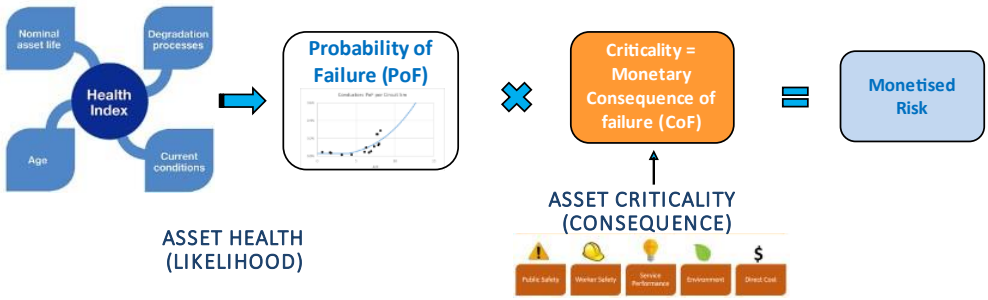


We use our risk matrix to compare and monetise different kinds of risk…
Probabilise consequence of a major asset failure across 5 dimensions

Societal costs such as:

- Economic loss due to probabilised unserved energy using our power system models
- Economic impact from serious harm or fatality from public safety using GIS queries

Condition Based Failure Risk



The use cases for monetised risk include:

- compare different investment scenarios and understand risks (solution prioritisation)
- different criteria within design standards based on risk (e.g., foundation strengthening)
- prioritisepredictive maintenance work orders (WORP tool)
- prioritise urgent replacements where a manufacturing fault was found (e.g., certain batch of CT failures)

This monetised risk based on Asset Health and Criticality models only focuses on the "condition-based failures" contribution to network risk and has many limitations and inaccuracies. It is a useful tool and will improve with our maturity in modelling and calibration, but it is not, in our opinion, a sound metric to be used in service measures.

In a specific recommendation from our last regulatory review, the Commission supported our efforts to build a linkage between Asset Health and Network Risk. This is to further refine and target our interventions to address asset condition and maintain overall grid performance. Our emerging work is covered in slide 12.

Our maturity in asset health and network risk is evolving

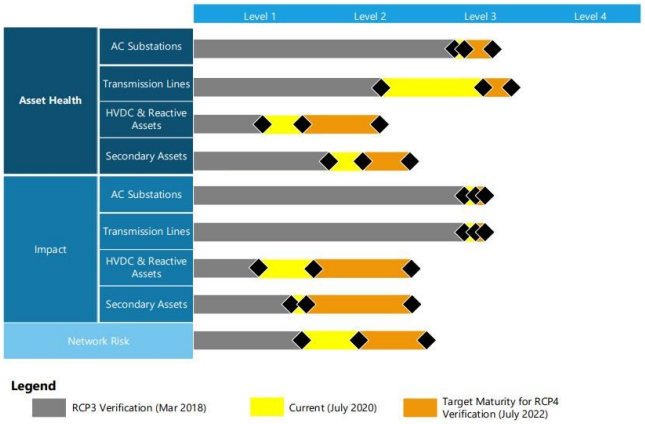
KPMG delivered a report on how similar overseas infrastructure utilities were addressing Asset Health and Network Risk (AHNR) in early 2020.

Using a maturity model we developed an AHNR roadmap in 2020 and there is an expert opinion on our roadmap progress scheduled in Aug 2022.

Enablers for AHNR include:

- Using our Asset Management Planning System that captures the 25 year plan.
- Asset Data improvements
- Tracking our performance and having targets for each asset class
- Investigations into failures and new technology

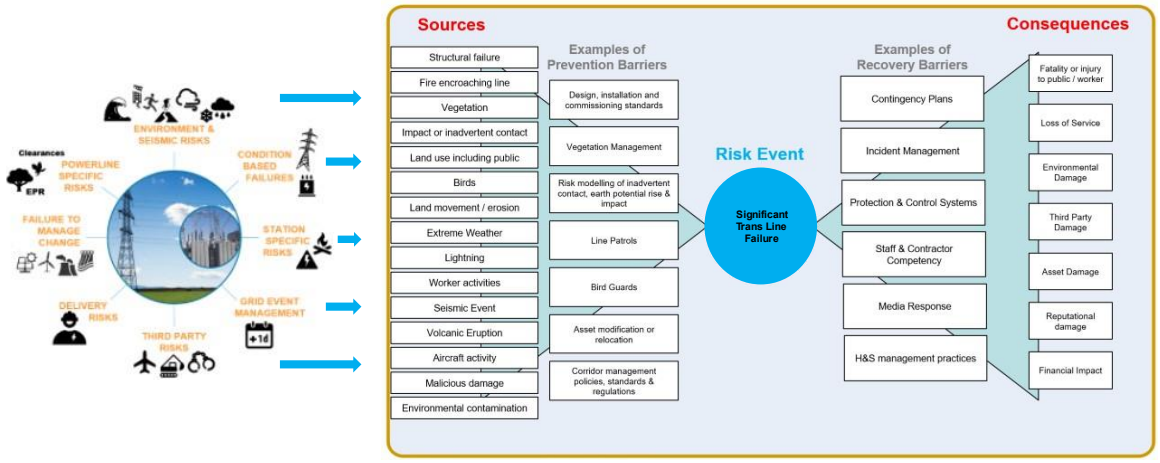
Improving AHNR has improved our asset and system planning.



1.5 Asset Risks

Our grid asset risk approach is shown on slide 13. For specific risks we use the “Risk Bowtie” where preventive and mitigative controls are identified each side of the risk event. This allows us to identify the “critical controls”, the common risk controls across multiple risk events. Knowing these we can target improvements on the common control given they will have a more significant impact in risk reduction. This can be to either reduce the likelihood or reduce the impact or duration of the consequent of a risk event.

Risk Sources and Controls– “Bowtie” approach to specific risks



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We assess our critical controls and develop improvement plans as part of the assessment process. These bow tie risks and control assessments are reported to our Board Risk Committee as part of our risk governance and assurance.

We have a specific programme to review the risks at each substation, including the risk posed by assets belonging to our customers that by necessity must be located at our site. This programme was reframed as one of the recommendations from the October 2014 Penrose Substation fire event.

1.6 Design Standards

A major risk control is our design standards shown on slide 14. These standards address the role of the national grid as critical infrastructure. Seismic design standards are for a 1:2500 return event, with an active programme of reviews of the seismic capability of existing facilities. Wind loading for transmission towers is for a 1:300 return event with existing lines brought up to current standards when major upgrades are undertaken. There are extensive provisions to manage the risk of fire at substations both from a transformer failure and in on site control rooms.

Design Considerations

Design standards are a critical preventive control.

Standards reflect the role of the national grid as critical infrastructure that must be resilient to seismic, environmental and fire risks

We work with the EEA and international transmission standard organisations (CIGRE) to inform asset strategies and standards– including safety.

Remediation programme to bring existing assets to current standards when warranted

To inform our standards we engage and support the Electricity Engineers Association in its work on standards across the industry. This includes standards that ensure the safe operation and maintenance of electricity supply assets. We are also actively involved in the standards work of international “CIGRE” group of transmission and distribution operators.

1.7 Managing Unexpected Asset Failure

We identify minimum stock levels of strategic spares and hold these in our warehouses ready for distribution to our service providers.

We have invested in strategically located spare power transformers across New Zealand to manage the impact of failures of these bespoke and large, long lead time items. We have a target time of four weeks to replace a failed major interconnecting or supply transformer to restore n-1 redundancy at the site. At the few smaller customer supply sites with single transformers we have contingency plans agreed with our customer for transformer failure. This includes the deployment of our mobile substation. Slide 15 summarises key spares holdings.

Contingency planning for unexpected failure

Contingency planning is a critical mitigative control. Investing in contingency planning, spares and equipment can at times be more effective than hardening infrastructure

Our spares include:

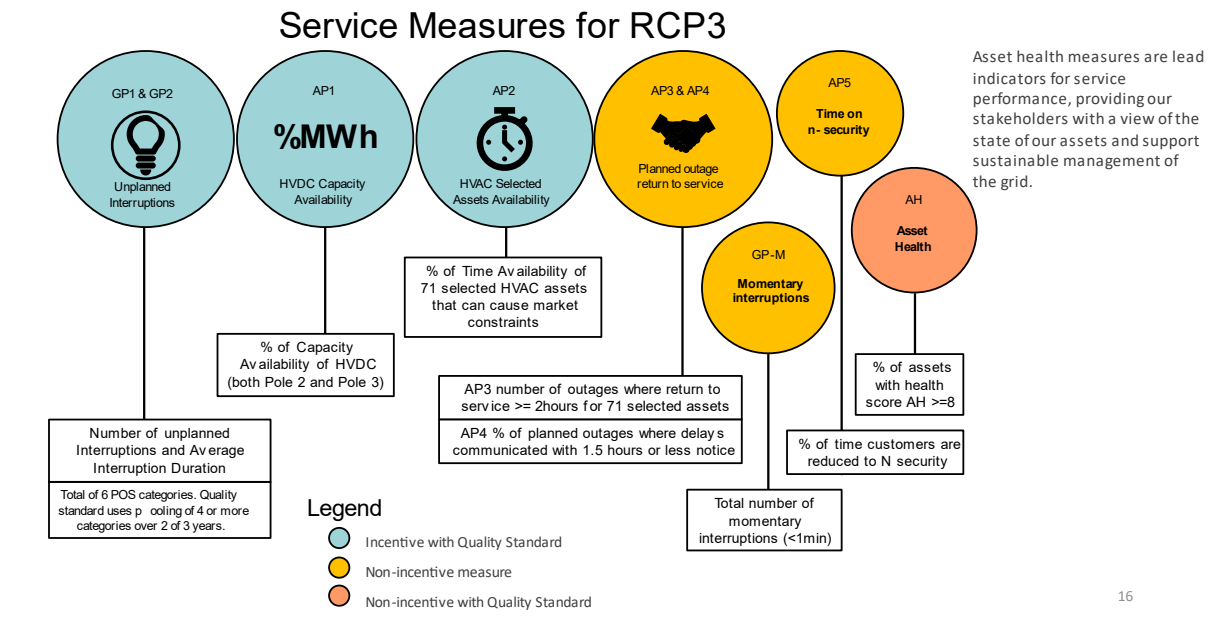
- emergency mobile 33/22/11 kV switch room that can be deployed at short notice
- mobile substation (15 MVA 110 kV/33 -22-11 kV) which can be used at N sites where sites are pre- enabled.
- 19 strategic spare transformers which provide coverage for 98% of our current and future 3 phase fleet
- a minimum of two circuit breakers per make & model
- spare cables, cable joints and cable terminations.
- spare conductor, insulators and hardware.
- spare emergency structures and poles strategically located throughout the country
- HVDC emergency spares for bespoke components
- Protection relay spares for various makes and models
- Specialist tools and equipment to complete emergency work

The HVDC Convertors have bespoke components including large bushings and ancillary devices. HVDC spares that were provided as part of the original build projects and are presently being refreshed as part of our Pole 2 mid-life refurbishment work in RCP3. These are stored in our warehouses and these spare components regularly tested and inspected for serviceability.

We have spare and emergency transmission line tower structures, located to be readily deployed in the event of a transmission line failure. We have reviewed our holdings of transmission line conductor following the December 2019 Rangitata flooding event where nine towers were damaged or washed away.

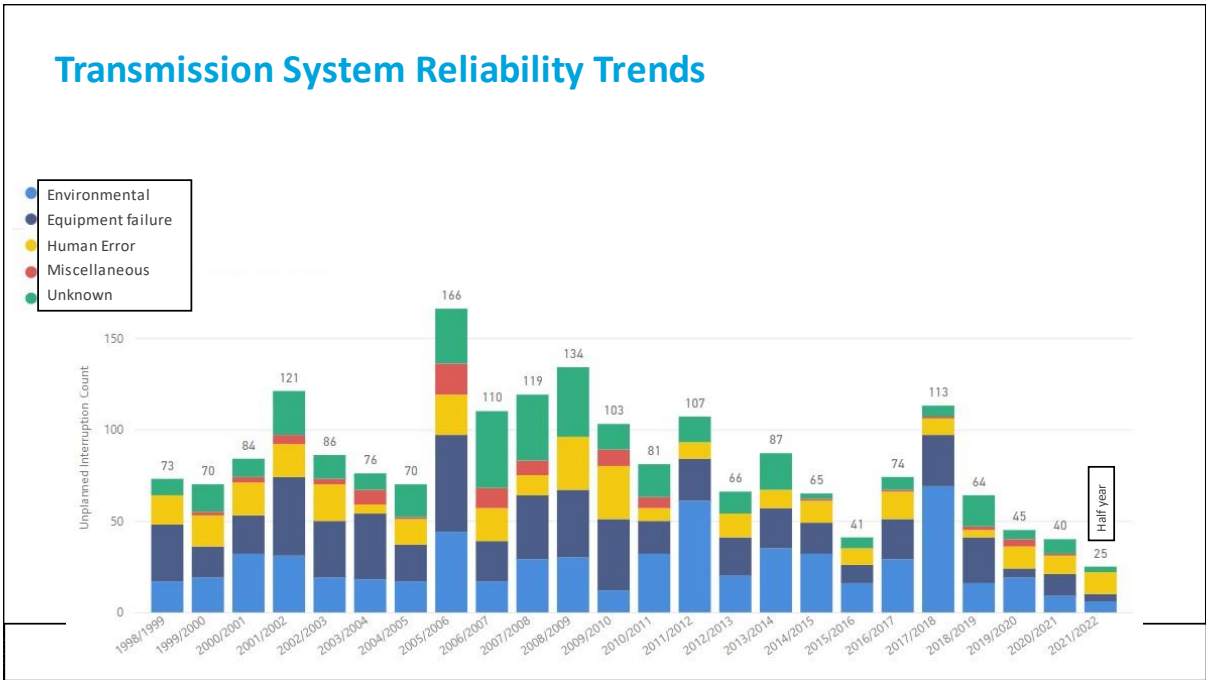
1.8 Grid Performance and Performance Incentives

Grid Service Measure incentives



As our funding allowance is fungible, we have an incentive and reporting regime to ensure the level of grid service is maintained and improved. Slide 16 lists the current grid service measures. Some are linked to revenue incentives. Slide 17 shows the generally downward trend in number of grid outages by key cause over the last 20 years.

Transmission System Reliability Trends



1.9 Reliability and Resilience

With climate change bringing more serve events we are placing a greater focus on resilience, the ability to recover quickly from more extreme events that do not justify other measures such as asset redundancy. Slide 18 describes our approach. Regulated grid owners in the UK and Australia have struggled to gain regulator acceptance for funding resilience programmes. We will propose a resilience programme to harden the grid against extreme events including from climate change in our RCP4 proposal. We would be able to share this when further developed later this year.

Resilience and Reliability

Resilience: The state of being able to avoid utility supply outages, or maintain or quickly restore service delivery, when high impact events occur.
Resilience and Reliability are intertwined.

Our Major Hazards program collates information to provide a consolidated view of the likelihood of major hazard risks applicable to our sites. We review these risks with out resilience criteria and evaluate options for mitigations.

Resilience is an emerging area for Transpower. Social risk appetite for resilience is changing and our assets are coming under increased pressure with climate change. We have identified the need to develop resilience programmes and test resilience investment with our customers for RCP4.

1.10 Increases in demand – need for additional grid capacity and connection

Forecasting Growth
Transmission Planning Report

- Transmission Planning Report - analyses the grid development opportunities to addressforecast changes in demand and generation.
- Core grid investment needsare developed into Major Capital Proposals. Separate consultation and approval processes. Includes consideration of Non Transmission Solutions
- Smaller core grid enhancements, under $20m, funded as part of our RCP allowance. Connection enhancement are customer funded
- Delivery challenge is commissioning new capacity ahead of need given the timing of consenting, property purchase, logistics and materials supply.

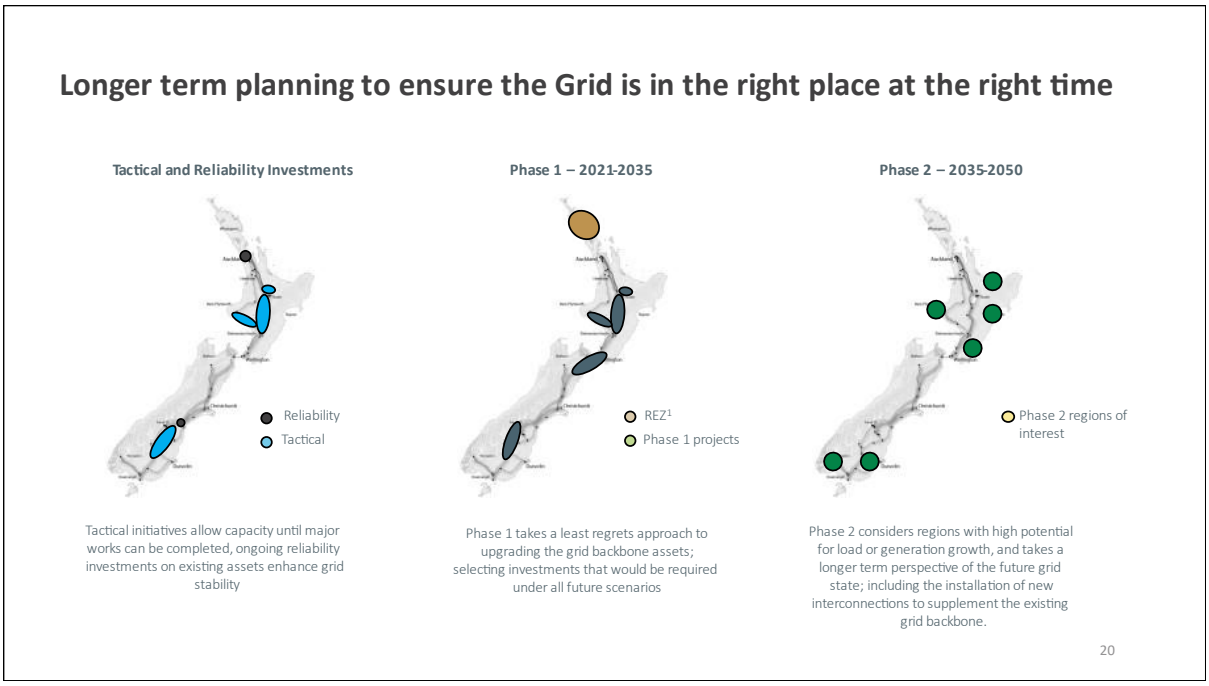
Every year we compile our Transmission Planning Report. This analyses the grid development opportunities to address demand and generation connection changes as in slide 19. Customer input and forecasts are included as well as our own central forecast. If core grid investment needs are identified these are developed into separate Major Capital Proposals to the Commission. They have their own consultation and approval processes. One example is the $147m approved for the Waikato Upper North Island (WUNI) to ensure grid reliability standards are met as demand for electricity grows and thermal generation is retired. The investment process includes seeking out viable non transmission alternatives to either defer or replace the grid investment need. We are currently seeking Request for Proposals for one key component of the approved WUNI investment. The services of a Grid Scale Battery could be offered as an alternative to a grid funded device to meet a voltage stability need.

Smaller enhancements, under $20m are funded as part of our RCP allowance.

Where the enhancement to the grid must be customer funded, we work with our customer on the timing. There are provisions to require a customer to invest if default standards are not being met but these have not had to be used.

In forecasting the need for new grid capacity, we develop forecasts and scenarios to economically assess the investment needs. The wide range of possible changes in supply and demand with electrification and renewables creates uncertainties. We address this through sensitivities and ability to deploy tactical and low regrets investments in the interim. This is important given the long lead times for new infrastructure.

The delivery challenges with new grid investment is the ability to deliver projects ahead of need given the timing of consenting, property purchase, logistics and materials supply. We are actively involved and engaged with regulatory and legislative processes to reform the RMA to ensure projects can be delivered in a timely manner and retain the current processes that enable the upgrading of existing lines. Slide 20 is a graphical overview of future grid developments and needs looking out to 2050.



1.11 HVDC Case Study

Slides 22-25 share our assessment of the asset health of the three HVDC cables. Laid in 1990, these are approaching end of life. While in good condition and regularly surveyed, we expect to replace them by the early 2030's. This is supported by the asset health and criticality modelling covered in the four slides.

1.12 HVDC Cable failure impact

In 2017 we provided the SRC with a report on the impact of an HVDC cable failure. Both the threats and repair arrangements are detailed in section 1 of that report. The report then provides an assessment of the Security of Supply implications and response to such an event from the System Operator.

1.13 COVID 19

Transpower COVID19 response continues to be governed by out Incident Management Team. From the Grid Owners perspective, we have been able to continue our maintenance and refurbishment programmes with only modest impacts on delivery of our work. This has been possible though extensive collaboration with our service providers.

We are facing Covid related supply chain challenges and are currently working through these with our suppliers on a case-by-case basis.

Transpower also has the role as electricity industry liaison with the National Emergency Management Centre. During the lockdown phases of the pandemic this ensured the industry was able to function effectively with appropriate protocols.

1.14 Sustainability and Climate Change

While the grid will play a key role in enabling the energy sector to address climate change, Government climate change mitigation and adaption legislation will also influence our asset management approach. This includes reducing climate change impacts of materials used in the grid and added resilience to impacts

TRANSPOWER

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