2024—2034

electricity asset management plan

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SECTION 01

Introduction

1 – Introduction

1.1 Abstract

Electricity distribution businesses face the need for unprecedented investment to support future demand, electrification, and be resilient against climate change[1]. These factors are exacerbated by the impacts of high inflation. Our updated capital investment plans covering the full AMP period (2024-2034) total $4.6 billion. This level of investment will ensure we can deliver to our customer growth, reliability and resilience needs. In addition, we've identified further resilience investment of around $300 million, however this has not been included into our plans yet as we continue discussions with customers, communities, and stakeholders to determine the best value for money approach against resiliency goals.

Vector believes the way to achieve more long-term affordability for customers is through getting more out of infrastructure we've already built. For an electricity distribution network, this means considering the use of lower-cost non-wires alternatives where efficient to do so, and effective orchestration of manageable load and injection, over the long term.

Vector is laying the foundations for this in this AMP cycle, through maintaining investment on digital enablement, including systems and capabilities, while also working with specific high-load customers to implement flexible and responsive connections designed to smooth network utilisation at key times and therefore lower customer cost. However regulatory and government legislative support is needed to fully realise the potential customer benefits of a lower cost electrification, in particular ensuring that as a country we dynamically manage the significant new load coming on from electrifying transport.

It's critical to for distribution businesses and their regulatory agencies to work together to set the path for more long-term affordability for customers as demand grows significantly in future. A future where minimal load is orchestrated as demand grows, and non-wires solutions fail to develop, will require significantly more investment in future years to meet unmanageable demand growth. Vector's analysis finds that around $3 billion of costs to customers can be avoided by 2050[2], if the ability to maximise network utilisation is enabled through technology, regulation, and industry practice.

This Asset Management Plan sets out, as at the date of certification, our view of the investments we believe will deliver the best outcomes for our customers, and which also represent a prudent investment strategy. We note that, particularly given the uncertainty over future electricity demand, we are not bound to follow the investments described here as we update our plans and analysis on how to best deliver for our customers. Each investment we make goes through appropriate governance processes to ensure it is delivering against our strategy.

1.2 System growth and achieving orchestration to lower customer costs

The forecast increase in peak demand over this AMP period is driven by large-scale customers driving increased reinforcement investment, such as data centres, public transport electrification (buses and ferries), as well as organic load growth from continued residential development, fuel switching from gas to electricity, and electric vehicle charging.

Electric vehicle charging comes with significant opportunity to reduce peak contribution through orchestration, where peak demand is flattened at all levels of the network, by coordinating and optimising the individual demand from customers. Vector is taking opportunities to implement this strategy as opportunity arises. Examples include contracting with public transport operators to deploy flexible network connections for bus charging depots, where Vector provides a 24-hour ahead forecast of available network capacity over fifteen minute increments, which is then used to optimise bus charging within that envelope, in exchange for lower costs to the customer. By being managed within the envelope provided by Vector, the new load from the bus charging has a less significant impact on requirements for network infrastructure upstream, resulting in a lower cost of connection. It also reduces the depots' bills from time-varying network use-of-system charges.

In other cases which also offer similar potential to lower the customer costs of system growth requirements, such as residential electric vehicle charging, we are not able to implement such a scheme without regulatory support. The specific support needed for smart charging includes industry standards to enable communications with chargers, and the default connection of smart chargers to the distributor's distributed energy resource management system, either directly, or indirectly via a third party's system which itself is connected to Vector's system. We have set connection standards to enable the connection required. However, our ability to monitor and enforce compliance is limited without legislative and regulatory support; this means our confidence to defer investment is challenged and the customer cost of EV adoption risks being higher than it needs to be.

1.3 Cost pressures

The investment outlined in this AMP reflects an environment of several significant cost pressures.

There has been a significant increase in inflation levels, compared to recent history. Vector has advocated strongly in recent times for the Commission to cease forecasting inflation for the purpose of setting DPP revenues. This is due to past Commission forecasts being considerably different to actual outturn inflation, and we've commissioned expert reports[3] which highlight the difficulties in this approach. The Commission will later this year set the revenue Vector can charge its customers for the period 1 April 2025 to 31 March 2030, and the impacts of inflation are set to be significant for Vector's customers, owing to the way the Commission's model treats inflation.

[1] https://www.bcg.com/publications/2022/climate-change-in-new-zealand

[2] Analysis in Vector's 2023 TCFD report quantifies the financial impact of a failure to efficiently manage peak load, based on network build costs that could otherwise be deferred

[3] https://www.vector.co.nz/about-us/regulatory/submissions-electricity

There is also the potential for the Commission's inflators to not represent the pressure on costs for industry participants, for example the cost of distribution transformers that are subject to commodity prices, sea freight prices and exchange rate fluctuations, all of which have combined for a significant price rise over the past year well above the New Zealand inflation indices.

Other cost pressures have driven a lift in operational and capital expenditure forecasts, due to an increase in costs from suppliers, partly due to competition for resources as the amount of wider infrastructure work needing to be done increases, and additional compliance costs such as ecological requirements of consents for activity.

1.4 Removing uncertainty to enable investment

Given the external cost environment, it's even more important to ensure investments are delivering value for money for customers and are being made at the right time. However there is significant uncertainty over some crucial aspects of our regulatory settings which is preventing some investments that customers would benefit from.

The first area of uncertainty concerns our ability to finance an increasing level of investment, to meet growing demand and boost resilience over the long term (during the next DPP period and beyond). Vector's long-term ability to continue making the necessary investments depends on the revenue set by the Commerce Commission, and the debt we can raise. The revenue allowance under DPP4 set by the Commission is therefore critical for our customers, shareholders, and for the future of the electricity network. Globally there's recognition of the need to make these decisions with pace and urgency. The opportunity for the Commission is to create the right environment for Vector, and other lines companies, to invest enough in energy infrastructure so that we are not left playing catch up years down the track, when resilience, electrification and decarbonisation are even more critical and the cost burden on customers could be prohibitive.

The uncertainty over future financeability is driven by a number of specific areas of concern, and we see these as opportunities to work together with the Commission to improve regulation for the benefit of our customers.

- The framework for Capex allowance setting remains uncertain, resulting in delays in terms of committing to investments.
- The method for setting forward looking Opex allowances does not readily accommodate step changes in Opex levels, meaning it's harder to respond quickly and so slows delivery of customer benefits (for example inhibiting the take up of non-wire alternatives).
- A lack of certainty around policy and Government objectives across several areas (financeability settings, EV charging, tree regulations, gas transition, resilience) means EDBs must rely more heavily on reopener processes, which has yet to be proven in terms of timeliness and confidence in outcomes, to accommodate significant changes in investment profiles within the five-year cycle.
- To appropriately understand and improve productivity analysis which also allows for uncontrollable Opex changes and unmeasured outputs.

There is also uncertainty over the rate of EV adoption, which is a contributor to our system growth requirements. This uncertainty can be observed in the falling rates of EV registrations since the removal of the Clean Car Discount. Given this change occurred recently, we note this uncertainty may resolve naturally over time. For this AMP, we've adopted a moderated EV growth forecast, matching what was projected in 2022.

Another area of uncertainty is the tree regulations, where we have consistently advocated for reform to make them more enabling for network companies to reduce network risk from trees, especially during storms and extreme weather. Under current regulatory settings, we have costed investment ready to be committed. However, we consider it's not the right time to make that investment now, if the tree regulations will be updated to enable tree management programmes to be vastly more effective.

We wish to work with the Commission and policy makers to resolve uncertainty that enables additional spend in the long-term interests of consumers.

1.5 Expenditure highlights

1.5.1 DELIVERABILITY

Over recent years, Vector has signalled through our AMP forecasts our intent to increase investment level in order to secure customer benefits. We've also demonstrated capability to successfully deliver these increased activity levels and have met the needs of a strongly growing Auckland consistently. We are forecasting a further step up in activity over 2025-2026, before returning to lower levels of activity.

1.5.2 CLIMATE RESILIENCE

The 2023 Auckland floods and Cyclone Gabrielle were extreme events which prompted a review of future resilience expenditure for the electricity network. In this AMP period we will invest approximately $200 million in projects that will improve the network resilience to climate change, including flood hardening at zone substations, provision of a mobile substation, transferring the load from Ngataringa Bay zone substations to avoid flooding, a third subtransmission cable to Waiheke, network automation, meshing of radial feeders, reconductoring of overhead lines, additional vegetation management, hardening the network against wildfire risk, and an increased provision for storm response costs.

Our model shows that to remove 100% of the climate change related risk from our network, it will cost approximately $1.37 billion (the cumulative cost of all our resilience projects). Despite identifying such potential expenditure, we have not included the full amount in this AMP, because we don't consider it prudent that customers should fund this extra expenditure when movement in Government policy has a potential to change the landscape for these investments materially. See our table on omitted expenditure below.

1.5.3 ASSET HEALTH, AGE-BASED REPLACEMENT, AND OUR CBARM MODEL

We take a whole of life cycle approach to assessing the need for asset replacement to minimise the cost to customers. We apply a risk-based approach to forecasting asset condition, including age profiles, and therefore the expected asset volumes and expenditure required for asset replacement. Condition Based Asset Risk Management (CBARM) models have been developed that consider condition data, age profiles, risk data, as well as environmental conditions and location.

The value and criticality of the asset type determines the complexity of the modelling implemented so that the effort is appropriate for the risk posed to the network. Asset obsolescence, vendor support and/or availability of spare parts are included in the condition assessment of asset types. For example, high value assets such as switchboards are forecasted using CBARM models, whereas low value and low criticality assets such as LV distribution equipment, are forecast using historical trend models and condition assessments.

For some asset classes it is not efficient or possible to gather sufficient condition information to assess the health of individual assets or develop a CBARM model. In these cases we use deterministic factors such as age and type information to predict asset replacement needs.

1.5.4 CONTINUED MIGRATION TO SOFTWARE AS A SERVICE (SAAS)

Our cloud first strategy is ensuring that our business is equipped to meet the trend to SaaS by software platform vendors. Implementing our capability and moving to a SaaS acquisition model has and will continue to shift enabling digital software related expenditure from Capex into Opex. We expect this to accelerate during this AMP period as we continue to maintain and upgrade digital platforms such as SAP.

1.5.5 DECARBONISATION OF ENERGY CONSUMPTION AND GAS SUBSTITUTION

Residential, commercial, and industrial consumers in Auckland use natural gas and LPG as sources of energy to meet their heat processing needs, however the decarbonisation of the economy has the potential drive gas substitution, with users of natural gas and LPG switch to electricity instead. Gas substitution therefore has an impact on the electricity network. Government policy has the potential to accelerate or decelerate the rate of gas substitution. We expect an acceleration in commercial and industrial gas substitution if current government policy remains unchanged.

1.6 Omitted expenditure

We've identified several areas where further investment is available to secure additional customer benefits, beyond what we've included in our expenditure forecasts at this stage. For each, we've identified why these investments have not been included, and what would need to change for them to be introduced into our expenditure forecasts. Should these be included in future, we intend to apply to the Commission under a reopener process.

OMITTED INVESTMENT AND UNREALISED CUSTOMER BENEFIT	WHY WE'RE NOT COMMITTING TO THIS INVESTMENT	WHAT NEEDS TO CHANGE FOR US TO COMMIT TO THIS INVESTMENT
Tree management (Without tree regulation reform) $196 million CAPEX in RY26-30	This investment is significant for customers, and so we are bound to ensure it represents value for money. Reformed tree regulations would provide the opportunity to achieve similar outcomes for $59 million. This would be an OPEX cost.	1. If new modelling demonstrates that the capex investment is required, we would consider applying for an unforeseen project reopener. 2. If the Tree Regulations were to change to enable an Opex solution, we would consider applying for a change event reopener.
Network meshing (In addition to existing strategy) $106 million CAPEX in RY26-30	Uncertainty surrounding the Government's infrastructure resilience strategy and funding options.	Clarification of the Government's infrastructure resilience strategy and funding strategy is required. Based on the outcome we would consider applying for a change event reopener.
Electric vehicle uptake (impact on system growth forecast) $43 million CAPEX in RY26-30 The last two years have seen an acceleration in EV uptake in Auckland. If this trend continues, it will result in the need for network reinforcement.	Significant uncertainty whether prior levels of uptake will continue, given changes in government policy, e.g. incentives and road user charges.	If the observed uptake of electric vehicles aligns with forecast, we would consider applying for an unforeseen project reopener. Note - Policy development around smart home EV charging (as already adopted in the UK) could provide greater confidence in the potential for smart and scheduled management of EV load to reduce the impact of EV charging during network peak (i.e. orchestration) and optimise network reinforcement investment.

1.7 Differences from 53ZD submission

In December 2023 Vector responded to a request from the Commerce Commission, to submit expenditure forecasts for use in setting the next DPP (the s53ZD process). Since that submission, we have further reviewed some expenditure areas for which there is a level of uncertainty and have subsequently made a number of changes. These are set out below.

- System growth projects reviewed and increased to align to 2022 EV profile uptake ($17 million Capex)
- Digital Capex reduced following review (-$29 million Capex)
- Inclusion of 1-in-5-year extreme storm costs (Opex $7.5 million and Capex $8.5 million)
- Inclusion of zone substation flood hardening Capex ($14 million)

1.8 What is in this AMP?

1.8.1 AMP PURPOSE STATEMENT

This AMP is intended to provide transparency to our customers, staff and stakeholders over the context in which we make investment decisions and how our asset management and planning processes support Vector's decision-making process.

1.8.2 AMP PLANNING PERIOD

This AMP covers a 10-year planning period, from 1 April 2024 to 31 March 2034. Consistent with Information Disclosure requirements, a greater level of detail is provided for the first five years of this period.

1.8.3 CERTIFICATION DATE

This AMP was certified and approved by our Board of Directors on 21 March 2024 and publicly disclosed on 28 March 2024.

1.8.4 OVERVIEW OF VECTOR

Vector is an innovative New Zealand energy company, which runs a portfolio of businesses delivering energy and communication services to more than 600,000 residential and commercial customers across New Zealand. Vector has a leading role in creating a new energy future through its Symphony strategy, which puts customers at the heart of the energy system. Vector is listed on the New Zealand Stock Exchange with ticker symbol VCT. Our majority shareholder, with voting rights of 75.1%, is Entrust. For further information, visit www.vector.co.nz.

Vector's electricity distribution network is described in Section 3, and our Asset Management Practice is described in Section 5.

1.8.5 VECTOR'S CORPORATE VISION

Vector's corporate vision is to create a new energy future. Vector's Asset Management Policy supports the achievement of strategic objectives aligned with this corporate vision.

SECTION 02

Future Network Roadmap

2 – Future Network Roadmap

2.1 Symphony Strategy

The Future Network Roadmap (FNR) details the initiatives supporting Vector's Symphony strategy.

The premise of Vector's Symphony strategy is that non-traditional (non-network) solutions, specifically demand side orchestration, will enable an affordable and equitable energy transition as customers deploy distributed energy resources.

Future peak demand on the network is forecast using our Customer Scenario Model, which estimates the impact of growth, customer behaviour, new technology uptake, and fuel substitution on Auckland's electricity peak demand.

Based on the outputs of this model, peak demand across Vector's network is forecast to be predominantly impacted by the electrification of transport (i.e., EV charging including the electrification of public transport), the growth in large, dedicated point loads (e.g., datacenters and commercial developments) and the substitution of gas as residential, commercial and industrial customers decarbonise their energy consumption.

The forecast proliferation of distributed energy resources (DER) such as smart EV charging and smart hot water heating, provide customers with options to respond to price signals and incentives. The energy storage properties of batteries and hot water cylinders therefore allow for load growth to occur outside peak demand times without impacting the utility value to customers.

Orchestration of this demand through Vector's distributed energy resource management platform, synchronised in near real time with the network, can shift this demand growth to occur outside of network peak, providing options to defer and even avoid traditional distribution network infrastructure.

2.2 Future Network Asset Management Objective

The Focus Areas of this objective read as follows:

- Prepare the network for future changes that will be driven by:
  - technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc.
  - environment: climate disruption and network resilience
  - customer: decarbonisation of the economy, electrification of transport, etc.
  - operations: transition to distribution system operator model and whole of system planning
- Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third party flex traders and retailers.
- Facilitate customer adoption of new technology while ensuring a resilient and efficient network.
- Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network.
- Develop digital and data platforms to meet changing customer needs and enable the future network in partnership with new entrants to the energy market.
- Improve our visibility of, and ability to control, the LV network including management of the information required.
- Collaborate with the industry, partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions.

2.3 Future Network Roadmap

The future network roadmap (FNR) consists of three *Pathways* that provide a high-level framework for the new capabilities required to deliver Symphony – Modernisation, Orchestration and Enabling – as shown in Figure 2.1. Each pathway consists of several *Planks* that provide the detailed framework for the new capabilities required under each Pathway (refer Figure 2.1.) across multi-year time horizons – Foundational (the next 5 years), Embed (5-10 years from now), Scale (10+ years from now).

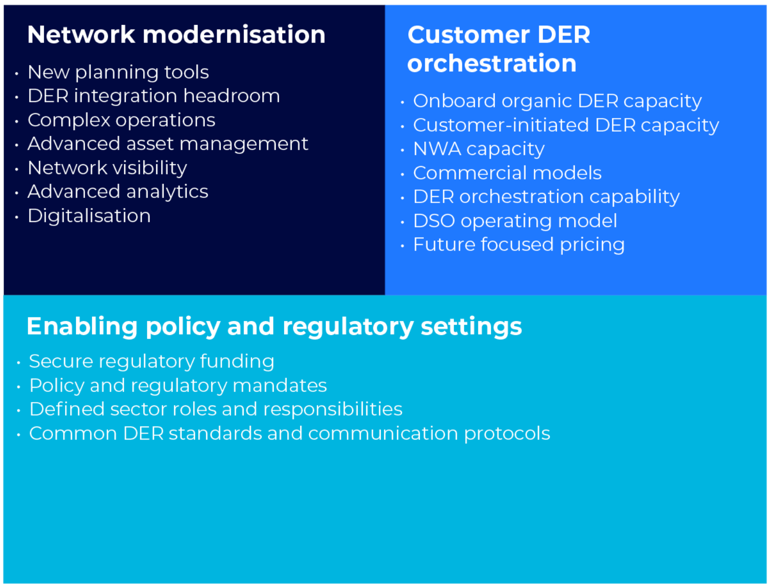


FIGURE 2-1: FNR PATHWAYS AND PLANKS

2.4 FNR key priority areas for this AMP period

The key priority areas for this AMP cycle include **understanding customer needs, increasing our access to DER capacity, building capability** for the management and orchestration of DERs and **achieving supportive regulatory and policy settings**.

- **Understand individual DER customer's needs** and preferences - key to effective DER orchestration, as well as key in ensuring we can safeguard the integrity of supply to all customers.
- **Increasing our access to DER capacity** – through improved visibility of DERs and continued coordination with third parties and directly integrating DERs with our network management systems.
- **Building capability** – by continuing to make no regrets investments in new enabling technologies, continuing to develop commercial arrangements, and understanding the consumer response to load management practices during the first 5 years in preparation for more rapid addition of managed load. As DER deployment evolves there may be circumstances where building distribution network infrastructure will enable greater participation by customers in future markets.
- **Achieving supportive regulatory and policy settings** - during the initial years of this AMP period we will continue to work together with regulators, policy makers, and appliance/network standards agencies to ensure that the regulatory settings enable the orchestration of DERs prior to years 6-10 of this AMP period, where we expect more rapid addition of managed load.

2.5 DER capacity

During the period of this AMP, we will make a significant effort to increase access to DER capacity:

- Signposting the areas that we have identified as best suited to non-network solutions in the AMP to create opportunities for accelerating the growth of managed load in those areas.
- Secure customer buy-in through demonstration projects.
- Continue to develop digital platforms and data management systems.
- Continue to make adequate investment to maintain network security and resilience in the face of climate disruption.

New DER capacity is expected to come from the following categories of load growth:

Organic growth – that is untargeted load from new managed hot water and managed EV charging – including, in both categories, capacity rolled out by retailers and other flex traders. Organic managed load will therefore likely appear dispersed throughout our network. To increase our access to managed load resulting from organic growth during this AMP cycle we will continue our focus on:

- Smart water heating demonstration projects with hot water cylinders on customer premises to validate the use of DER orchestration for constraint management and peak load avoidance/deferral.
- Ongoing implementation and refinement of time-of-use pricing that encourages retailers to work with consumers (and their DER) to proactively shift load out of peak periods.
- Utilising dynamic operating envelopes (DOEs) and other tools to orchestrate smart water heating and EV charging via 3rd party DER managers (e.g. metering/charging equipment providers, retailers, aggregators) to switch and/or throttle DERs. A key aspect of the DOEs that will be developed as part of these demonstration projects, is bringing back the load without causing secondary or unintended network peaks or violating power quality constraints.
- Continuously monitoring where manageable organic load emerges on our network to identify clusters that naturally coincide with our network investment needs.

Customer-driven growth – that is projects where commercial customers actively pursue options for load management at their sites to optimise their connection costs and ongoing energy costs. To increase our access to managed load resulting from customer-driven projects during this AMP cycle we will continue our focus on:

- Commercial agreements with public transport depot customers, implementing Auckland Transport's public transport electrification policy, to reduce customer connection costs and line charges and reduce load growth during peak through the implementation of DOEs via on-premises DER managers.
- Exploring partnerships with private/public electric vehicle charging infrastructure providers providing rapid charging hubs across Auckland, to reduce customer connection costs and line charges to reduce point load growth during peak periods. This will be accomplished through the implementation of DOEs via third party DER managers (e.g. retailers and other flexibility suppliers), or directly to customer-owned rapid chargers.
- Exploring opportunities with customers to reduce customer connection costs and line charges where they are able to reduce ICP-based load growth during peak. This includes private transportation charging infrastructure providers (business carparks, residential apartment block carparks, etc.) operators and customers utilising different types of load management behind the meter (refrigeration, HVAC, battery storage, etc.). This will be accomplished through the implementation of DOEs via third party DER managers, or directly with Vector as the DER manager.

Signposted growth – that is growth in areas that we believe are best suited to deployment of non-network alternatives (solutions that enable "traditional" network projects to be deferred and the CAPEX profile optimised accordingly). To accelerate the growth of managed load in signposted areas in this AMP cycle, we will continue our focus on:

- Implementing the candidate assessment criteria that were developed with the learnings from the recent Warkworth RFP.
- Developing a process to engage on new signpost opportunities with customers, stakeholders, and third parties.
- Publishing interactive online maps to visualize where the network is growing.

2.6 Capability

This AMP period will see a significant effort to strengthen and develop internal capability to support the practical deployment of DER capacity, and orchestration of DERs through third parties and directly. At a high level, it includes the following key focus areas:

- Development of dynamic operating envelopes (DOEs)
- Practical deployment of third-party DER orchestration, including through advanced pricing incentives
- Customer experience initiatives to onboard DERs
- Network modernisation to enable whole of system planning, DER integration, DER detection
- Visibility of the low voltage network, including distribution transformer visibility and DER visibility
- Enabling digital systems, integration protocols, cyber security, and new data platforms
- Development and implementation of smart meter data use cases for LV visibility
- Distribution system operator (DSO) capabilities
- Industry collaboration, operating protocols, and common industry standards
- Ongoing development of our DER tariff
- Further development and refinement of cost-reflective pricing

2.7 Enabling regulatory, market and Government policy

During this AMP period, Vector will continue to advocate for enabling regulatory, market and policy settings to provide confidence that consumer's flexible demand will be shifted outside peak periods with sufficient certainty to defer investment, especially when under management of third parties.

We will continue to advocate for settings that will enable us to continue safeguarding our customers supply, our assets and our people against unintended consequences and risks associated with third parties orchestrating customer load across the network. Key mitigation strategies include DER visibility and connectivity to Vector's DERMS.

Some of the factors we are relying on to have higher levels of demand side response include: equipment standards that require certain consumer devices to have demand response capabilities; obligations on third parties (including aggregators and retailers) who are managing consumer load to inform and enter into load management protocols with distribution businesses; the emergence of pricing plans and flexibility services that encourage consumer adoption of devices capable of shifting energy consumption.

Ultimately our Symphony strategy is about delivering for Auckland consumers and will include those investments that deliver whole of system benefits that result in positive outcomes for Auckland consumers. However, significant advancements in this area will be required in this AMP period to assist EDB's in incorporating and valuing whole of system benefits in the network planning process.

2.8 Innovation to enable network of the future

Vector has been partnering with other distributors, retailers, and our own customers to promote DER integration and build the knowledge needed for an efficient and effective transformation of our network.

Additionally, Vector has been deploying digital tools in collaboration with international expert partners to navigate the transition to a digital energy future such as cyber-physical security solutions, smart meter edge data analytics in collaboration with AWS, a

Distributed Energy Resource Management System (DERMS), Advanced Distribution Management System (ADMS), and the Tapestry collaboration with Google's X, the moonshot factory.

Whereas the focus to date has been on customer behaviour, technology and digital innovation, we are now leveraging this knowledge while we focus on network visibility, DER integration/orchestration, flexibility and network modernisation.

SECTION 03

Network overview

3 – Network overview

3.1 Our network

Vector is the largest distributor of electricity in New Zealand, managing a rapidly expanding energy distribution network across the Auckland region. The Vector network area is centred on the Auckland isthmus, supplying 612,909[4] ICPs between Mangawhai Heads in the north and Papakura in the south, including Waiheke Island in the Hauraki Gulf. Our network is the largest of the electricity distribution businesses in New Zealand in terms of connected customers, peak demand and energy consumption.

The geographical area map in Figure 3-1 shows the GXPs for the entire Vector network area (both the Northern and Auckland network regions) and their supply area boundaries. Neighbouring distribution networks operated by Northpower to the North and Counties Energy to the South can be seen in the figure. Table 3-1 provides a summary of the key network statistics of the Auckland and Northern regions as of 31 March 2023. In addition, Vector owns and operates a zone substation, Lichfield, in the South Waikato that supplies a large industrial customer. The illustration below shows Northern and Auckland network regions (the Lichfield zone substation is not shown in the figure below).

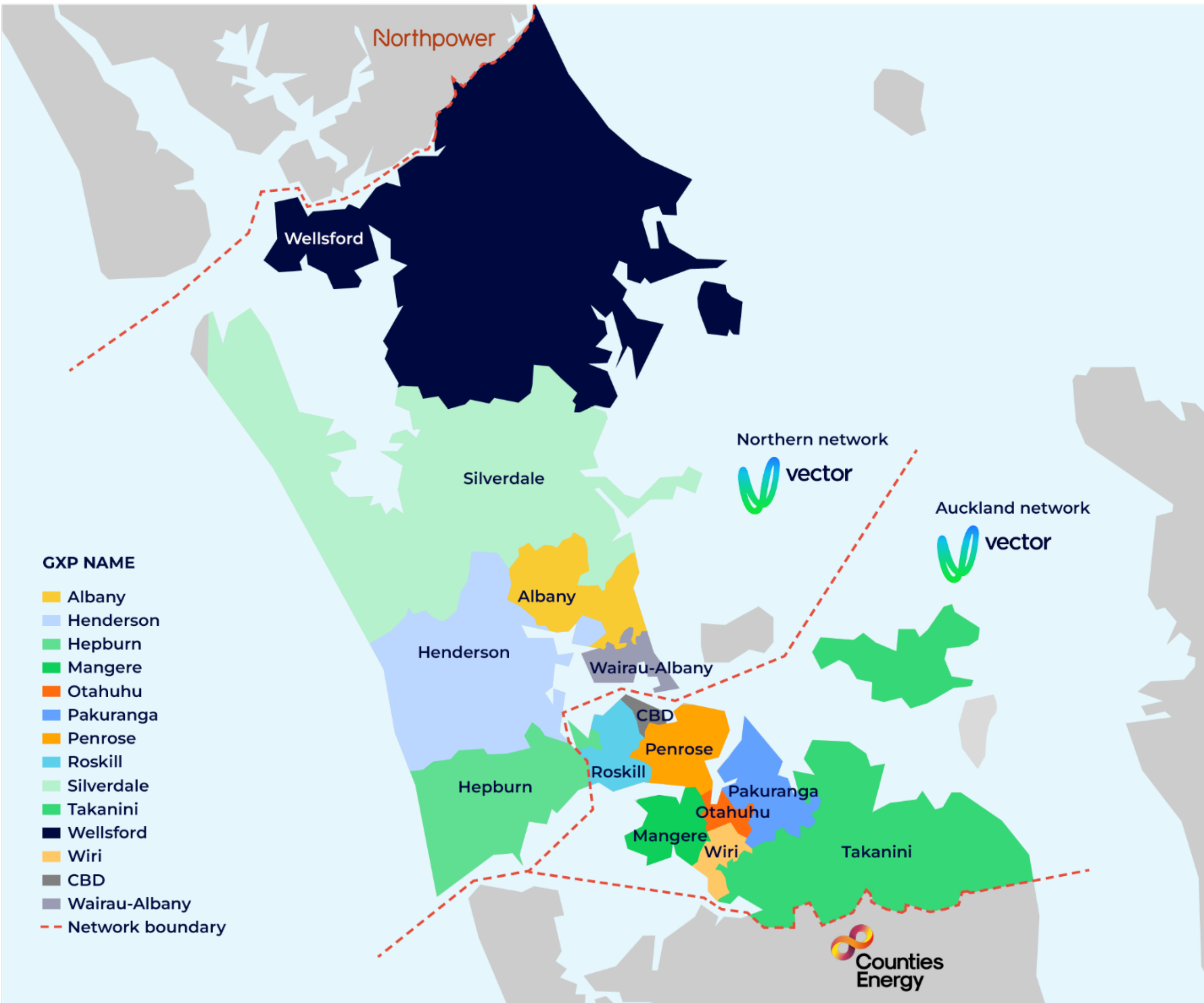


FIGURE 3.1: VECTOR NETWORK GEOGRAPHICAL AREA WITH SUPPLY REGIONS AND GXP AREAS

[4] Number of electricity connections (2023 Annual Report)

MEASURE	AUCKLAND	NORTHERN	VECTOR TOTAL
Customer Connections[5]	356,786	246,917	603,707
Overhead circuit network length (km)	2,822	5,405	8,227
Underground circuit network length (km)	6,806	4,434	11,241
Grid Exit Points (GXP)	8	6	14
Zone substations (zone substation)	58	55	113
Peak Demand (MW)[6]	1,095	674	1,759
Energy throughput (GWh)	5,618	2,845	8,462

TABLE 3-1: KEY NETWORK STATISTICS (YEAR ENDED 31 MARCH 2023)

3.2 Grid exit points

Vector takes supply from the Transpower grid at 110 kV, 33 kV and 22 kV at 15 points of supply[7] known as grid exit points (GXPs). Transpower owns and maintains the GXP equipment but provides current transformers in their switchgear for Vector's protection schemes and power quality measurement. Vector owns the line differential unit protection schemes on the outgoing zone substation supplies. Because unit protection consists of protection relays at the GXP as well as the remote ZSS ends, it makes practical sense for ownership of unit protection by the distributor.

Transpower owns the feeder management relays at the GXPs. The feeder management relays provide backup protection to plant but, as their name implies, they are also used by Transpower to control their circuit breakers. At certain GXPs, most of the subtransmission network switching is required and undertaken by Vector and, under agreement with Transpower, Vector has been enabled to control the subtransmission circuit breakers in GXPs. Where this operational mode has been agreed the communications schemes between Transpower and Vector have been modified to allow this mode of operation by Vector.

3.3 Network configuration

From the grid exit points power is distributed across Auckland to our zone substations via our subtransmission network. The supply is then stepped down through our zone substation transformers and distributed across zone substation supply areas at 11 kV and 22 kV. The supply is stepped down further to 230 V single phase or 400 V three-phase via our overhead and underground distribution transformers and distributed to our customers through our low voltage (LV) network.

We have lines and cables operating in three distinct voltage ranges:

- Subtransmission – predominantly 33 kV but also 22 kV and 110 kV
- Distribution – predominantly 11 kV but also 22 kV
- Low Voltage (LV) – 230 V single phase or 400 V three-phase. Customers use this network to obtain electricity but also to export when excess electricity is generated by customer owned distributed energy resources

We complement our lines and cables with a range of Distributed Energy Resources:

- Two diesel powered emergency generating stations at the far end of two lengthy rural parts of the network (Piha and South Head)
- Seven battery energy supply systems (BESS) are in place across the network ranging in size from 1 MW to 2.5 MW to shave peak demand and provide voltage support. Some can operate in a microgrid configuration and have been specifically designed for that operational mode

The table below gives salient details of our investment in BESS systems.

LOCATION	RATINGS	REGION
Zone Substation Glen Innes	1.0 MW / 2.3 MWh	Auckland
Zone Substation Snells Beach	2.5 MW / 6 MWh	Auckland
22 kV Feeder - Vector Lights	0.25 MW/0.475 MWh	Auckland (Harbour Bridge)
11 kV Feeder - Kawakawa Bay	1 MW / 1.7 MWh	Auckland
Zone Substation Hobsonville Point	1 MW/2.0 MWh	Auckland
Zone Substation Warkworth South	2.0 MW / 4.8 MWh	Northern
11 kV Feeder - Tapora	1.14 MW / 1.254 MWh	Northern

TABLE 3-2: BESS SYSTEMS SUMMARY

[5] Average number of customer connections for disclosure year 2023.

[6] Peak demand in each network region occurs at different times of the day and therefore the coincident Vector total peak demand will not directly equate to the sum of the two distinct regions.

[7] 14 GXPs in Auckland and Northern networks combined plus 1 GXP at Lichfield equals a total of 15 GXPs

3.4 Auckland region

3.4.1 OVERVIEW

Eight GXPs supply 58 zone substations in the Auckland network at connection voltages of 110 kV, 33 kV and 22 kV. The Auckland region can be broken down into three primary zones:

- Central business district (Hobson GXP and Penrose GXP)
- Central Zone (Roskill GXP and Penrose GXP)
- Southern Zone (Mangere, Wiri, Otahuhu, Pakuranga and Takanini GXPs)

The Auckland region consists of residential and commercial developments around the urban areas on the isthmus, concentrated commercial developments in the CBD, industrial developments around Rosebank, Penrose and Wiri areas, and rural residential and farming communities in the eastern rural areas.

3.4.2 CENTRAL BUSINESS DISTRICT (PENROSE AND HOBSON GXPS)

The Auckland CBD is supplied from an extensive substation complex in lower Hobson St in the CBD that also contains a 220 kV GXP with 220 kV switchgear and a 220 kV/110 kV interconnecting transformer. The zone substation has 110 kV, 22 kV and 11 kV distribution nodes. The North Auckland and Northern (NAaN) cable from the Transpower Penrose 220 kV node runs through the Hobson GXP 220 kV node and then northwards to Wairau GXP and from there to Albany GXP. Hobson ZSS 110 kV node connects to the 220 kV/110 kV interconnecting transformer via a 110 kV switchboard at Hobson zone substation.

Two 110 kV feeders run in the Vector tunnel from Penrose GXP to a 110 kV switchboard at Liverpool zone substation. The Hobson zone substation and Liverpool zone substation 110 kV switchboards are interconnected by two 110 kV cables that provide security of supply to each other. A 110kV circuit connected between Roskill GXP 110kV bus and Liverpool 110kV switchboard provides back up supply to CBD. A 22kV circuit connected between Kingsland substation 22kV switchboard and Liverpool substation 22kV switchboard also provides backup supply to CBD.

Two 110 kV cables run from the Hobson 110 kV board and Liverpool 110 kV board respectively to Quay St zone substation. Between Hobson, Liverpool, and Quay bulk supply substations, they supply eight zone substations. To meet growing demand, the distribution network in the CBD is progressively being upgraded from 11 kV to 22 kV.

3.4.3 CENTRAL ZONE (ROSKILL AND PENROSE GXP)

The central zone is supplied from Roskill and Penrose GXPs. Roskill GXP has a 110 kV node and a 22 kV node. From the Roskill 110 kV node two Vector owned 110 kV underground cables connect to two 110 kV/22 kV transformers at Kingsland zone substation. From the Vector 22 kV node at Kingsland, three zone substations are supplied namely, Chevalier, Kingsland itself and Ponsonby.

The Mt Roskill GXP 22 kV node supplies six zone substations, namely Avondale, Hillsborough, Mt Albert, Sandringham, Balmoral and White Swan as well as the Waterview tunnel. The customer base in these areas is largely residential, with industrial customers in the White Swan area. Kingsland, Mt Albert, and Chevalier are undergoing extensive urbanisation with many high-rise apartments being constructed and planned. A number of areas especially around train stations, have been identified in the Auckland Unitary Plan for high-rise intensification that will further drive load demand. A large tract of land that previously formed part of Te Pukenga (Unitec) will be converted to high density housing.

Penrose GXP has a 33 kV node and 22 kV node. Thirteen zone substations are supplied at 33 kV and two are supplied at 22 kV. The customer base in this area is a mix of residential, commercial, and industrial. The industrial customer base in the Penrose area includes some of Auckland's largest industrial customers. It is Vector's largest planning area by demand.

3.4.4 SOUTHERN ZONE (MANGERE, WIRI, OTAHUHU, PAKURANGA AND TAKANINI GXPS)

Five GXPs cover the Southern zone namely Mangere, Wiri, Otahuhu, Pakuranga and Takanini GXPs. Vector takes supply from the listed GXPs at 33 kV except Otahuhu where the grid supply voltage is 22 kV.

Mangere GXP covers the Mangere township and surrounding residential commercial and industrial areas, extending south to the continuously developing commercial areas surrounding the Auckland airport. This supply area includes large logistics centres.

Pakuranga GXP area covers East Tamaki, Pakuranga and Howick and the growth area of Flat Bush to the south. The customer base in these areas is largely residential, with industrial customers in East Tamaki and Greenmount.

Wiri GXP covers the established areas of Manukau, west to the Wiri commercial area and south to the residential area of Clendon. The customer base in this area is a mix of residential, commercial, and industrial.

Takanini GXP covers the urban areas of Manurewa, Takanini, and Papakura township, extending east to the more remote areas of Clevedon, Maraetai, Beachlands, as well as Waiheke Island. The customer base in this area is a mix of mostly residential, with some light commercial and industrial.

Otahuhu GXP covers the Highbrook commercial and industrial area, and the Otara and Bairds areas. The customer base in this area is mainly industrial with some interspersed residential areas.

3.5 Northern region

3.5.1 OVERVIEW

Our network in the Northern region has 55 zone substations which supply a mix of both urban and rural areas. These zone substations are supplied from six GXPs all at a supply voltage of 33 kV. The Northern region can be broken down into three primary zones:

- Albany and Wairau GXPs
- Henderson and Hepburn GXPs
- Silverdale and Wellsford GXPs

ALBANY AND WAIRAU-ALBANY[8] GXP

Thirteen zone substations are supplied at 33 kV from Albany GXP. The Albany supply area includes Albany, North Harbour, Rosedale, Forest Hill, Browns Bay, the East Coast beach enclaves as well as Torbay and Greenhithe. The customer base in this area is predominantly residential but extensive commercial areas exist in Albany and in the Wairau Valley. Extensive and rapid urban infill developments permitted under the Unitary Plan together with large datacentres, are driving load growth in the Albany supply area.

Wairau zone substation is supplied via a 220 kV/ 33 kV interconnecting transformer from the GXP that is co-located at Wairau zone substation. Three Vector 110 kV subtransmission lines from the Albany GXP 110 kV node connect directly to three 110 kV/ 33 kV transformers at Wairau zone substation. The Wairau zone substation supply area includes Wairau Valley, Glenfield, Devonport, Bayswater, Takapuna, Northcote, Birkenhead, and Beach Haven. The customer base in this area is largely residential but many commercial customers exist in the Wairau Valley, Takapuna, and Highbury areas.

3.5.2 HENDERSON AND HEPBURN GXP

Vector takes supply from the Henderson 33 kV bus via two 220 kV/33 kV transformers. Ten zone substations are supplied from this GXP. The supply area covers Ranui, Swanson, Woodford, Hobsonville including Hobsonville Point, Westgate, Te Atatu, Riverhead, Greenhithe[9] and Simpson Rd. The Henderson area is one of the major growth areas in the Auckland region with major residential greenfields developments at Hobsonville Point as well as in Whenuapai, Riverhead, Kumeu, Westgate and Red Hills to the west. The customer base in the Henderson area is largely residential but the Westgate commercial area is rapidly expanding with logistics centres and large datacentres. This is driving rapid and extensive load demand.

Vector takes supply from the Hepburn 33 kV bus via three 110 kV/33 kV transformers. Ten zone substations are supplied from this GXP 33 kV node. The Hepburn supply area includes Rosebank, Green Bay, Ranui, Oratia, Glendene, New Lynn, Titirangi extending westward out to the coast including Laingholm and the beach enclaves south of Laingholm. The customer base in this area is largely residential with commercial customers mainly in the Henderson township and industrial customers in Rosebank.

3.5.3 SILVERDALE AND WELLSFORD GXP

Vector takes supply from the Silverdale 33 kV GXP bus via two 220 kV/33 kV interconnecting transformers at this GXP. Eight zone substations are supplied from this 33 kV GXP node. The Silverdale GXP supply area stretches from Albany in the south to Waiwera in the north and stretches west to Helensville and, all the way to the West coast including South Head.

It covers the greater Orewa emerging city area, Silverdale, and Millwater urban areas as well as the area east of SH1 that comprises Whangaparaoa, Stillwater, Red Beach, Manly, Tindalls Beach all the way to Gulf Harbour. The customer base in this area is largely residential but the Millwater commercial area is rapidly developing and includes new large-scale datacentres, warehouses, and logistics centres. Urban infill permitted under the Unitary Plan is also having an impact on load growth.

The Wellsford area is the most northern in Vector’s network. It stretches from Wellsford to Warkworth and includes the townships of Matakana, Sandspit, Omaha, Snells Beach, and Leigh in the east and the Tapora isthmus in the west. In the North the network stretches to Te Arai and Tomarata. Wellsford GXP supplies four zone substations: Wellsford, Warkworth, Big Omaha and Snells Beach via two 110 kV/33 kV transformers. A fifth zone substation at Sandspit will be commissioned in 2025.

Wellsford and Warkworth zone substations are undergoing refurbishment with complete modernisation of the subtransmission switchgear at Wellsford and installation of an additional subtransmission circuit to Warkworth ZSS to make it ready for the modelled peak demand. The existing 33 kV overhead subtransmission circuits from Wellsford to Warkworth underwent refurbishment in 2023. The customer base consists of urban customers in the rapidly expanding larger townships of Wellsford, Warkworth and Matakana, as well as beach enclaves such as Omaha and Snells Beach that are both expanding. The Wellsford supply area also includes a large rural part of the network that contains the lengthiest 11 kV overhead distribution circuits in Vector’s network. The customer base in this area is largely residential with some commercial customers. Some of the farming customers are extensive operations with high load demands. The Tapora isthmus is equipped with a large-scale battery energy system that can operate in islanded microgrid mode.

[8] The reason for the use of the term Wairau-Albany GXP is because the Wairau zone substation has a 220 kV/ 33 kV GXP connection via the GXP at Wairau zone substation as well as three 110 kV overhead line supplies from a 110 kV GXP node at Albany GXP

[9] Greenhithe is normally supplied from Albany GXP but has a connection to Henderson GXP

3.6 Asset overview

This section provides an overview of the asset portfolio that Vector owns and operates including the overall population of our key assets.

3.6.1 ASSET CLASSES

The asset portfolio owned by Vector is divided into nine asset classes. For each asset class, a strategy document records the asset strategy down to sub-asset class level.

- EEA 100 Subtransmission Switchgear
- EEA 200 Power Transformers
- EEA 300 11 kV – 110 kV Cable Systems
- EEA 400 Overhead Lines
- EEA 500 Distribution Equipment
- EEA 600 Auxiliary Systems
- EEA 700 Infrastructure and Facilities
- EEA 800 Protection and Control
- EEA 900 Distributed Energy Systems

3.6.2 ASSET POPULATIONS

The table below provides an overview of our asset population across our electricity network for the Auckland and Northern regions combined.

ASSET TYPE	POPULATION
Subtransmission Switchgear	
Indoor switches	1,629
Outdoor switches	101
Power Transformers	
Power transformers	221
11 kV – 110 kV Cable Systems	
Subtransmission (km)	608
Distribution (km)	3,898
Overhead Lines	
Subtransmission (km)	390
Distribution (km)	3,707
LV overhead lines (km)	4,121
Poles	125,487
Distribution Equipment	
Transformers	22,685
Switches	21,260
LV cables (km)	6,199
Infrastructure and Facilities	
Buildings (including customer substation buildings)	241
Protection and Control	
Protection relays	3,272
Generation and Energy Storage	
Utility Battery Energy Storage Systems	7

TABLE 3-3: ASSET POPULATION SUMMARY

SECTION 04

Customers & Stakeholders

4 – Customers & Stakeholders

4.1 Customers – beyond the bill payer

In this Asset Management Plan the term 'customer' refers to the 1.7m people and businesses in the Auckland region supplied across 612,909 connection points, all of whom we consider a 'customer'. This extends the definition beyond our contractual relationship with the bill payer (retailers and some large directly billed users with dedicated capacity or non-standard supplies) because, for us to be able to build, operate and maintain a modern, reliable, safe, and affordable network that can support New Zealand's energy transition and decarbonisation goals, we must first understand the needs, values and expectations of the people and organisations who use and rely on electricity and the service we provide.

4.2 Stakeholders

Vector as a critical infrastructure provider operating in New Zealand's largest city has a wide range of stakeholders whom we also engage with regularly. Vector employs different structures and resources across the varying stakeholder groups to ensure that the appropriate type and frequency of engagement is undertaken at the appropriate level within the business.

Stakeholders are wide ranging and include government agencies (both local and central), community-based entities and groups (e.g., business associations, iwi, special interest groups), other utilities and industry groups (including specific industry associations and lobbying groups like MEUG, ERANZ, ENA.). A fuller summary of key stakeholder groups and how Vector engages with them is detailed in section 4.6.3.

4.3 Customer – designed into everything we do

Vector's Symphony strategy is about putting the customer at the centre of the energy system and at the heart of our decision-making. This is about more than delivering great customer service. It is about deeply understanding the ever changing needs, perceptions and expectations of customers and making them a focal point of all decisions.

This customer centric approach is designed into the core of how Vector works and operates. We see it as something that we should always be striving to be better at and something which must always evolve to keep pace and alignment with the growing and changing needs and expectations of the communities we serve.

As an example of how Vector has integrated customer centric thinking into its ways of working, 'customer' takes a central place within Vector' s six core behaviours, which describe the thinking, actions and behaviours we expect of all Vector employees and service partners. The ability to understand, empathise and take action is orientated to deliver on customer outcomes. These behaviours are also integrated into Vector's regular employee engagements and are part of our employee performance framework which includes specific customer satisfaction and regulatory metrics.

FIGURE 4-1: VECTOR BEHAVIOURS

4.4 Customer needs and expectations – always evolving

Globally, the environment that businesses are operating in is changing. Customers are becoming not only more demanding but also more discerning as the power of technology shifts information and decision making away from organisations and into the hands of consumers.

Companies that succeed need to invest in and develop a new set of capabilities focused on what customers care about – experiences. Regulated monopolies are not immune to this. In fact, we would argue customers apply even more scrutiny to those services and products that are critical to their lifestyle ambitions especially where they have limited or no choice.

Research published by Qualtrics (a leader in customer and employee experience management) talks about 'The Human Experience Cycle'. Simply put, they illustrate how expectations for any product or service is shaped by the customer's entire set of lived experiences, impacting customer perceptions and ultimately behaviours.

Put into Vector's context, this means that customers are taking their best experiences from their lives (whether that be with their bank, supermarket, streaming service, favourite coffee shop, etc.) and applying that to what they expect from Vector. This then shapes their perceptions of the experiences / interactions they have with Vector and how they rate us.

Therefore, Vector must be able to continually invest in those things that customers expect from modern businesses including mature digital channels, more personalisation, and access to information that is relevant to them. This requires sustained investment in systems, data and people outside of the traditional network assets and operations.

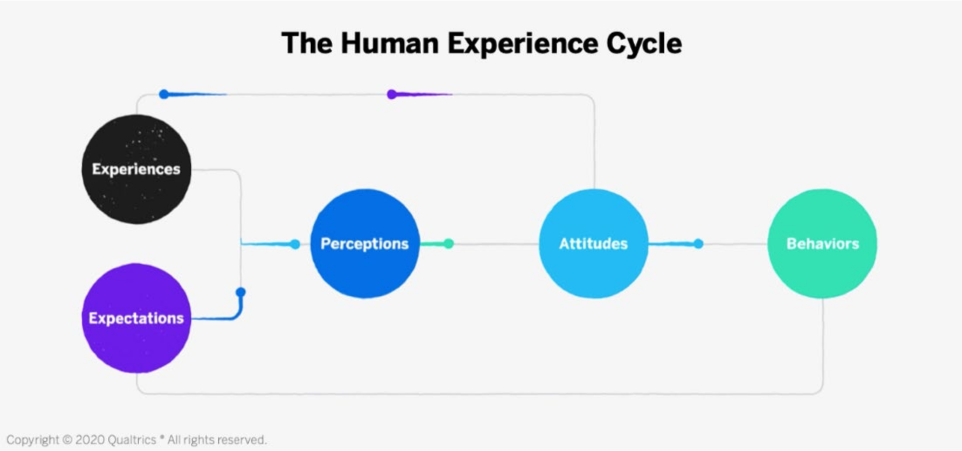


FIGURE 4-2: QUALTRICS' HUMAN EXPERIENCE CYCLE

Source: https://www.xminstitute.com/multimedia/human-experience-cycle/

4.5 Vector's customer centric approach

4.5.1 CONTINUOUSLY EVOLVING WITH A GLOBAL LENS

As previously mentioned, modern customer centric organisations must evolve constantly to meet the ever-changing needs of the customers and communities they serve. This is true of Vector where we are always looking at what can be improved or where specific areas may need more attention for a period.

To ensure we are comparing ourselves to global best practice, Vector regularly engages with a wide range of national and international organisations to evaluate approaches and to seek new ways of doing things. Examples of this include Vector's engagement with Florida Light and Power (FLP) on approaches to storm response and large-scale events. FLP is Florida's largest electricity provider serving approximately 6 million customers and has a wealth of experience managing customer needs and communications whilst responding to destructive hurricanes and storms.

In addition, Vector recently engaged Deloitte to undertake a review of Vector's end to end customer functions, including how insights and performance integrate into wider business decisions. This review is similar in nature to what is regularly done for asset management, further illustrating Vector's commitment to, and importance of, a customer centric approach. Deloitte was selected for their independence and the wealth of experience within the global customer practice. At the time of writing Deloitte have released their preliminary report for management comment. Internally, the intention is to include the Deloitte report and internal reviews and insights into the updating of our customer roadmap and for any discussions relating to optimisation of capability and delivery.

4.5.2 HOLISTIC & CONNECTED APPROACH

Vector takes a holistic approach to ensure that all its operational and strategic elements are aligned to the customer. Considering all elements as a connected system ensures there is a continuous feedback loop between customer input, strategy, operational implementation, and performance monitoring.

A high-level representation of this is depicted below where key business activities and strategies are shown as connected to core customer elements.

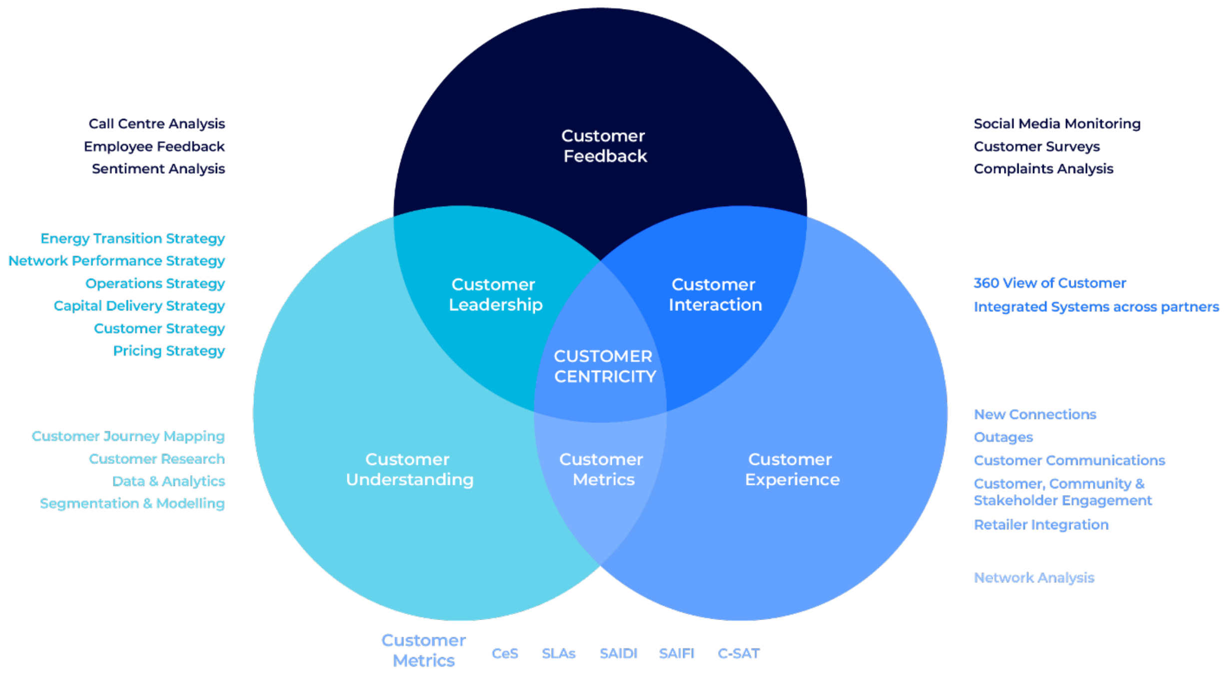


FIGURE 4-3: CUSTOMER CENTRICITY AT VECTOR

4.5.3 EXPERIENCE MANAGEMENT

Vector has a comprehensive Voice of Customer and Engagement Programme covering all customers and key stakeholders. We employ a model adapted from Camorra Research which identifies five core areas - see Figure 4.4. Vector has built robust engagement and reporting programmes across all five types represented in the model and is constantly looking to evolve and improve on these utilising its Customer Insights and Customer Excellence teams.

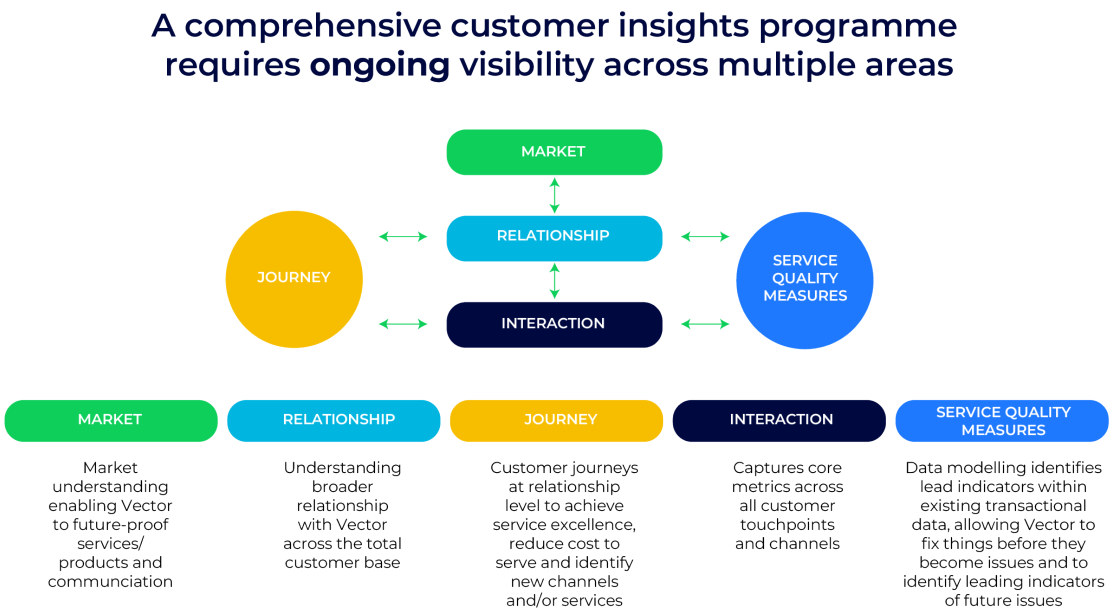


FIGURE 4-4: VECTOR'S CUSTOMER ENGAGEMENT FRAMEWORK – ADAPTED FROM CAMORRA RESEARCH LIMITED

4.5.4 DATA FIRST

Vector employs a data first strategy for understanding our customers and employs a strong privacy and security by design approach to ensure our contractual, legal and ethical obligations to data and privacy are rigorously maintained.

Investments in data collection, management, platforms, and capability means that Vector can connect data of different types across multiple systems and create rich insights across a wide spectrum. Figure 4.5 illustrates the four core data sets utilised within the customer space.

Voice of customer is all the direct feedback from customers about their experiences and satisfaction levels across various customer journeys / interactions and with the provision of overall products and services from Vector.

Conversational data refers to any voice or text conversations between Vector and a customer. Worldwide, companies are turning to advancements in AI and data processing to analyse conversational data. This addresses the issue of a continued decline in customers providing traditional feedback via surveys and pop-up prompts. Not only are these tools ultimately cheaper and more efficient than manually analysing feedback, but they also cover 100% of interactions rather than using sampling techniques and have a range of operational use cases to improve performance and shorten the time to resolution.

Social data refers to any conversation or post about or with Vector across a range of platforms. Vector currently utilises Facebook and X (formerly Twitter) but is also investigating options for more formally gaining visibility into review sites and forums like Reddit, etc.

Operational data refers to the complete set of asset, operational, customer and environmental data from the business

By using our data science capabilities (via a specialist energy systems function) and our dedicated Customer Insights team, we can develop a comprehensive understanding of customer behaviours, trends, and drivers. This sophisticated data and analytics capability is necessary to identify correlations, drivers, and other relevant elements to develop our hypothesises and build deeper understanding of what is, and could be happening, at the granular customer level. We then supplement this with targeted research (e.g., surveys and interviews) which aid in filling in the gaps and providing direct engagement opportunities with customers.

Carrying out targeted research rather than taking a scattergun approach allows us to focus in on the relevant customer groups / segments and use appropriately designed questions and language.

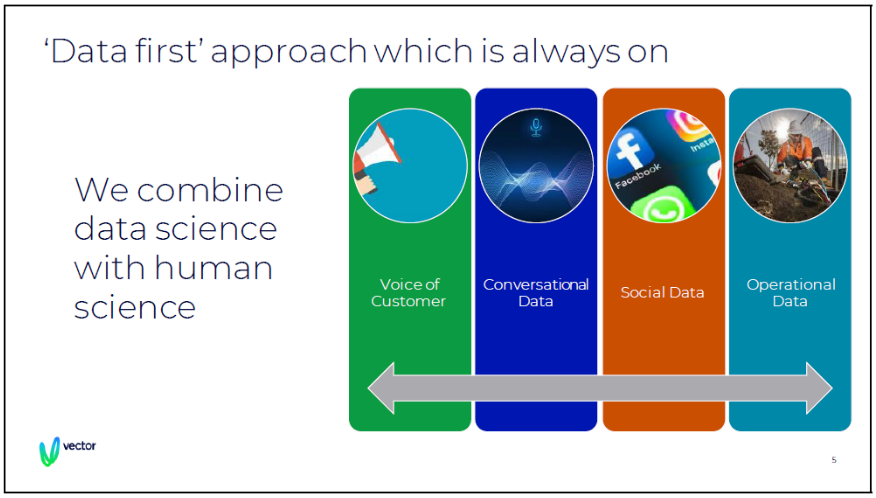


FIGURE 4-5: VECTOR'S 'DATA FIRST' APPROACH

4.6 Vector's Engagement Process

4.6.1 PROCESS & METHODOLOGY – WHAT HAVE WE DONE & WHY CAN PEOPLE RELY ON IT

The 5 yearly regulatory reset process provides an opportunity to employ a deeper and more nuanced engagement with stakeholders and customers to ensure our areas of focus meet the prioritised needs and preferences of the communities that we serve as we progress with the energy transition.

This year is the first in which Vector has undertaken this more detailed approach. We have built up our programme utilising our internal experts as well as reviewing engagement programmes by lines companies in the United Kingdom and Australia – who, unlike New Zealand, work under an engagement framework which has specific regulatory allowances to fund.

During the delivery of our engagement programme we identified some opportunities to extend our reach and have requested a modest uplift in DPP4 regulatory allowances to be able to fund this. We specifically note that we wish to deepen engagement with Iwi and community groups, as well as creating ways to engage with cohorts that we found to be underrepresented – such as young adults. This is consistent with our drive to constantly evolve the customer insight function and ensure it continues to deliver meaningful insights which drive business decisions for the betterment of our customers and communities.

4.6.2 ROBUST SCIENTIFIC APPROACH

Vector heavily utilised its customer research and analytics functions to ensure research was robust, appropriately designed and the results are statistically robust.

The diverse make up of stakeholders and customers across the Auckland region has meant that different methodologies and approaches were necessary. An added complication has been the difficulty or unwillingness of some groups wanting to engage on energy matters applicable to lines businesses . The complex nature of the energy industry is a factor here, but we also observed some reluctance to carve out time to talk about lines business issues. This is not uncommon when dealing with complex commercial organisations where electricity distribution has a lower ranking in importance than other items and where energy decisions involve multiple teams within an organisation.

We have implemented the following principles to ensure our engagement program is robust and effective:

- Thoroughly identifying all customers and stakeholders to be included in our engagement, drawing input from personnel across the organization.

- Conducting a comprehensive comparison of our customer and stakeholder findings with reports issued by energy distribution companies in both Australia and the United Kingdom.
- Validating our findings by comparing them with previous studies carried out internally and third-party research where available, ensuring a well-rounded and robust analysis.
- Ensuring the statistical robustness of survey-based findings by basing results on feedback from a minimum of 1,000 randomly selected respondents.
- Conducting customer and stakeholder discussions through the engagement of a research specialist rather than their immediate working contacts at Vector.
- Allowing interview participants the option of maintaining anonymity at the conclusion of the discussion, should they prefer to do so.
- Validating insights obtained through direct conversations with our major customers, stakeholders, or local government representatives by requiring that at least two independent sources independently mention the specific theme without any prompting.

4.6.3 WHO HAVE WE ENGAGED WITH

There are numerous customers and stakeholders whom Vector engages with. Overtime these groups will evolve and change as new stakeholder and customer segments emerge and others cease. Vector manages this by utilising its 'always on' insights capabilities to capture emerging themes and the emanation of customer segments, as well as by ensuring robust internal coordination across the various business functions to ensure that existing and emerging stakeholder groups are appropriately identified and incorporated into business thinking and processes.

Broadly speaking these can be categorised into seven groups. Within these larger catgories there are many sub-groups which can be dynamic in nature over time. The table below provides an overview of each major category and, where appropriate, some examples:

	RESIDENTIAL & SMALL BUSINESS	LARGE COMMERCIALS & BUSINESS ASSOCIATIONS	LOCAL GOVERNMENT, GOVT. AGENCIES & REGULATORY BODIES	INFRASTRUCTURE PROVIDERS & LIFELINE UTILITIES	RETAILERS & GENTAILERS	COMMUNITY GROUPS, IWI & SPECIAL INTEREST ORGANISATIONS	OWNERS, INVESTORS & WORKERS
Description	All households and small businesses on low voltage connections.	High voltage customers and entities with complex power needs. Includes business and industry associations and lobby groups.	Includes Auckland Council, its various planning bodies and its Council-controlled organisations, Government bodies such as MBIE, Housing New Zeland, Commerce Commission , Electricity Authority etc.	All infrastrucutre providers including transport whether commercial or government controlled. Includes hospitals and health boards.	Independent electricity retailers as well as large vertically integrated generator / retailers.	Includes Iwi, formal residents groups (e.g., Warkworth Area Liaison Group, Pt Wells Community and Ratepayers Association), and organisations with unique insight into the community (e.g., budgeting groups, Pasifika, etc.).	Vector is 75.1% owned by the people of Auckland whose ownership is held in trust by Entrust. The remainder is publicly traded on the NZX.
Interests	Reliable and affordable network that meets existing and future needs.		Creating enabling infrastructure; civil defense and emergency management; resilience and reliablity.	Optimise infrastructure life cycle; coordination; disaster response coordination.	Maintain strong relationships and ensure ease of doing business; promote customer service; facilitate development of new products and services; industry development & coordination.	Reliable and affordable network that meets existing and future needs; strong engagement and working relationships.	Sustainable & prudent business operations and practices (including financial management); risk management; strategic planning and implementation; health and well being of workers; safety of people and community; legal, contractual, ethical and regulatory compliance

TABLE 4-1: VECTOR'S CUSTOMER AND STAKEHOLDER ENGAGEMENT GROUPS AND THEMES

Vector has drawn on its wealth of energy transition and customer research as well as that of third parties both in New Zealand and overseas. This has been enhanced by a programme of targeted discussions (both structured and semi-structured with a researcher) which were undertaken across a range of key stakeholders and customers from within the categories above.

Overall we have:

- Carried out a comprehensive evaluation of all customer feedback collected through our continuous Voice of Customer programme instituted in 2016. This program encompasses:
  - between 2,000 to 4,000 responses collected on an annual basis via our electricity outages customer survey;
  - around 150 to 250 responses collected every year from customers for which Vector has delivered new or alterations to their current electricity small connections;
  - around 50 annual responses from customers with completed project connections;
  - around 36,000 yearly responses provided after an interaction with Vector's call centre;
  - approximately 400 surveys completed per year after Watt the Bot conversations;
  - over 600 pieces of feedback collected annuallyfrom customers after an Outage Centre interaction;
- Reviewed ad-hoc studies carried out by Vector for bespoke business needs over the last several years:
  - over 1,600 customer surveys collected after major weather events (e.g., cyclone Dovi, cyclone Gabrielle);
  - more than 2,600 responses collected from Vector customers living in the gas network area aimed at understanding energy preferences, choice drivers and plans for transitioning between gas and electricity;
  - almost 400 surveys from customers living in the Warkworth area to inform our network development communication strategy;
  - feedback from Vector's annual customer engagement survey carried out pre-COVID-19 where we heard from a representative sample of 1,000 Aucklanders every year.
- Reviewed more than 100 reports released in the public domain by third parties:
  - annual plans and customer engagement reports published by Australian and United Kingdom energy distribution companies (e.g., Ausgrid, Energy Queensland, AU Western Power, Endeavour Energy, Electricity North West, UK Power Networks, UK National Grid);
  - New Zealand Consumer Advocacy Council survey reports – https://www.cac.org.nz/our-work/surveys;
  - EECA research – https://www.eeca.govt.nz/insights/;
  - Kantar Better Futures reports - https://www.kantarnewzealand.com/latest-thinking/better-futures/;
  - New Zealand energy poverty research.
- Conducted an exhaustive analysis to identify 31 distinct customer sub-groups within our electricity network, of which 12 were deemed to not necessitate further direct engagement due to the availability of input collected directly by Vector or by third parties.
- Formulated a mixed methodology approach to facilitate the provision of input from customers comprising semi-structured interview guides and surveys designed to comprehensively explore present and future customer energy needs and objectives, while also eliciting customer feedback on Vector's strategic focus areas.
- Proactively engaged with representatives from the remaining 19 customer groups, seeking input from representatives directly involved in energy decision-making processes.
- Carried out 11 one-to-one customer interviews with representatives that agreed to provide input in this manner.
- Engaged with the remaining customer representatives asking them to provide input via an online survey they could complete at their convenience, of which 5 provided feedback in this manner.

4.7 What our customer insights programme is telling us and what are we doing in response to it

Analysis of the wealth of input and data from customers and stakeholders has identified seven key themes which can be used to describe customer concerns and preferences at a thematic level. In order of priority these are:

1. Affordability
2. Reliability
3. Resilience
4. Customer Service
5. Decarbonisation
6. Network Modernisation
7. New Energy Technology

Table 4.2 below provides a summary of these core themes and provides additional context including the highest-ranking sub-themes. In the last column we have provided a snapshot of how Vector is addressing these via specific initiatives or as part of its ongoing operations and Asset Management Practice (refer to Section 5 for more on our Asset Management Practice).

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
Affordability (cost & pricing)	Customers prioritise affordable energy and are willing to make changes to achieve it but are not confident they are receiving fair energy prices now and in the future.	Customers rate energy affordability as most or second most important (marginally behind reliability) and are increasingly concerned about energy bills.	Vector has developed a pricing impact assessment model that will allow us to look at the real impacts of any proposed pricing or tariff structure changes at the customer level. This is achievable by utilising customer half hour metering data. When combined with our detailed customer model (including deprivation deciles and census data) we are able to generate rich and insightful views on pricing impacts.
		Energy hardship is impacting some residential customer groups more than others: larger, younger households,	Vector takes the issues of affordability and energy hardship seriously. We are supporting a group of

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
		renters and vulnerable consumers are more likely to experience energy bill payment pressures.	engaged cross-discipline employees develop Vector's roadmap and a set of prioritised initiatives. We are looking to meaningfully contribute to knowledge and real outcomes by using our capabilities, research, data, and community engagement either directly or indirectly.
		Customers are open to making changes to lower their electricity bill (e.g., moving energy consumption outside peak time, sharing control of energy technology such as battery storage or solar panels, upgrading appliances and/or moving away from gas).	Vector focusses on triple-duty initiatives (i.e., those that achieve objectives of reliability, affordability, and decarbonisation) that provide customer choice and flexibility which will enable our Symphony strategy to address medium to long term affordability issues. Refer to section 2 for further details.
		New Zealanders have a low level of trust in New Zealand's energy market delivering fair prices now and in the future.	We support and participate actively in policy and regulatory processes which review the status quo and propose changes that will deliver long-term benefits to consumers. Recently, these have included MBIE's consultation on measures to enhance the electricity market through the transition, and the Electricity Authority Market Development Advisory Group's (MDAG) review of wholesale market settings to support a highly-renewable electricity system. In particular, we have expressed strong support for interventions that will increase transparency and build public confidence in the market, especially the suite recommended by MDAG. In parallel, we are participating in the development of an electricity industry framework that will ensure we collectively place customers and customer outcomes at the centre through the transition.
		Energy prices impact Auckland businesses' ability to compete. This group value energy price stability and tariff structure simplicity.	Vector sets prices to earn the level of revenue permitted by the Commerce Commission. Within this constraint, Vector offers prices that reflect the benefit of load shifting from peak times to off peak times. These prices are enablers of Vector's Symphony strategy that focuses on effective load management to reduce the level of network investment, and therefore reduce prices in the long term when compared to the counterfactual. When setting tariff structures, Vector always takes a long-term view to

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
			promote long-term behavioural change, stability and consistency. This can support efficient network investment over time. For the majority of customers, the retailer creates the retail offering that the customer engages with. Vector works with retailers to ensure Vector's tariffs to retailers can support future innovation. For those commercial customers we bill directly, our commercial tariff structures balance simplicity with being cost-reflective and meeting regulatory requirements. Time-varying pricing provides opportunities for customers to reduce their charges through innovation, enhancing their ability to compete. Movements in our price levels and structures are announced ahead of time and are open to consultation and feedback.
		Cost is a significant driver of customer satisfaction for new electricity connections, behind operational factors such as communication & clarity of timeframes and processes or site condition post installation.	Vector has moved away from standard residential connection rates to quoting for each job. This will make each job more transparent and remove any unintended cross subsidisation. Vector has an operational improvement programme based in Lean Six Sigma to improve the end-to-end process for small connections
Reliability	Customers rate reliability as important as, or marginally behind affordability, have a low tolerance for outages, and only one in two trust the electricity market to provide a reliable supply in the future.	Customers define reliability as a steady and consistent electricity supply with minimal disruptions or outages, including reliable communication (e.g., timely updates, with an estimated time to restore).	Vector sets out the specific service levels we measure our performance on to ensure we are delivering for our customers' expectations (including reliability and communication). For more information refer to Section 7.5 of the AMP. Vector continues to invest in its digital Outage Centre platform which enables customers to access information about planned and unplanned outage information in real time and at scale. In Section 11 Vector sets out specific project and initiatives with a specific focus on projects for the improvement and bolstering of network reliability and resilience. Furthermore, Section 12 provides information on the method for replacing assets on our network and lists specific projects and programmes of work aimed

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
			at maintaining network performance.
		Customers have a low tolerance for outages during normal weather (around half do not expect any outages). This tolerance increases during major weather events, but a third still do not expect to be impacted by outages during storms.	Refer to Section 11 as above.
		Customer satisfaction with how Vector handles unplanned outages is most influenced by how quickly we restore power, followed by timeliness and frequency of updates provided.	Section 7 sets out the specific service levels we measure our performance by to ensure we are delivering for our customers and stakeholders. Our service levels include regulatory targets such as SAIDI and SAIFI, as well as those we set ourselves. We are committed to keeping our customers informed when outages occur and we constantly drive improvements in making this happen. Refer to 7.5.1 and Figure 7.3 for recent improvements to our bespoke communication.
		There is a significant gap between current and future reliability perceptions: around four in five New Zealanders and NZ small businesses are satisfied with the reliability of the electricity supply, but less than half are confident the electricity market will provide a reliable supply in the next five years. A proportion of Auckland businesses rate reliability on par with or above affordability as not having power stops them from operating.	Refer to Section 11.
		For Vector's large customers reliability encompasses the ability to access the required amount of power when and where it is needed, serving as a cornerstone in their strategic planning and operations, and they want to be kept informed of network development work that impacts them.	Vector utilises its Key Account Managers to maintain a continuous dialogue with its large customers. This ensures that both parties are across development and future works that could impact them as well as better understanding potential future needs.
Resilience	Customers rate resilience highly, expect Vector to take the lead on implementing resilience solutions, and are becoming increasingly concerned about energy resilience.	Customers rate resilience among their top three energy needs alongside affordability and reliability. Our customers perceive energy resilience as the responsibility of Vector, and few of them have implemented resilience solutions.	The need for increasing levels of investment in Auckland's electricity system in response to the higher frequency and intensity of climate change has never been greater. Refer to Section 11 for reliability and resilience projects.

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
		Extreme weather in 2023 has heightened residential and business consumers' concerns about the electricity system's resilience to extreme weather.	
		Large customers are focused on resilience and lowering their vulnerability to climate change to ensure they can operate under these conditions. They believe resilience can be achieved by Vector partnering with other organisations to develop & test solutions, working with other energy distribution companies to increase network resilience during major weather events, and by undergrounding of lines.	As above. In addition, Vector utilises its Key Account Managers to maintain a continuous dialogue with its large customers. This ensures that both parties are across development and future works that could impact them as well as better understanding potential future needs.
		A notable proportion of large Auckland business customers expect their electricity consumption and resilience requirements to increase in the future, driven by the electrification of transport, moving away from fossil fuels, and/or increasing their operations.	We have ongoing engagements with this customer group via their designated Vector Key Account Managers, who facilitate discussions with relevant internal and external teams to ensure network development work meets current and future customer load requirements.
Customer Service	Customers are interested in receiving more communications from Vector and the energy market about the part of the network they are connected to (especially when it comes to outages) and the sector more broadly. Large customers have broader needs in this area: they value faster speed in delivering projects as well as broadening the current engagement with Vector to drive new initiatives and disseminate learnings.	Our customers prefer to receive electricity outage information via digital channels (emails or SMS/text), and a sizeable proportion contact their retailer when experiencing faults.	Vector continues to invest in its digital Outage Centre platform which enables customers to access information about planned and unplanned outage information in real time and at scale.
		Customers become less satisfied with how Vector manages unplanned outages if they need to use more than one channel to report or find out information about their outage.	Vector continually reviews its channel strategy to ensure it continues to meet evolving customer needs. Vector is looking to improve the timeliness and quality of customer details it receives from retailers to improve the quality and timeliness of customer communication. Customer insights are relayed back into operational parts of the business for action to improve customer experience and satisfaction.
		Proactive notifications can mitigate to some extent customer dissatisfaction with the power supply or Vector's service (e.g., when capacity to restore power is low due to major storms).	
		Communication is mentioned as an underlying theme in a significant proportion of all complaints received by Vector, highlighting the need to improve this area for our customers.	
		Some of Vector's customers prefer a faster speed in delivering projects (e.g., new connections) but are aware this is not always within Vector's control.	Vector is streamlining the process from design and quote to delivery of new connections and upgrades.

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
		To prepare for the future, Auckland business associations and their members want Vector to communicate more widely about its plans and objectives (especially those in their area), the NZ energy market structure, Vector's reliability performance, and issues facing the sector.	Vector is responding to this increased need by expanding the reach and scope of its engagement with customer and stakeholder groups. In addition, we are continuing to publish more information regarding network investments and planned works on our public facing open data portal.
		Most large business customers we have engaged with directly believe Vector is supporting their energy needs/objectives via ongoing engagement. They also want engagement with the wider energy industry to better prepare for the energy transition (including decarbonisation).	Vector participates in and plays a leading role in a wide range of cross-industry initiatives. This includes the Northern Energy Group, Electricity Networks Aotearoa's Future Networks Forum, FlexForum, and the Gas Infrastructure Future Working Group. Vector is also increasing the depth of its engagement and relationships with collaborating industry participants such as Transpower and flex-managing electricity retailers and aggregators.
Decarbonisation	Decarbonisation is rated behind affordability and resilience/reliability in importance by customers (residential as well as business), and environmental strategies need to include cost-efficiencies to increase take-up or buy-in. Businesses value guidance and information sharing to choose, implement and manage environmental solutions (including moving away from fossil fuels).	Decarbonisation is ranked behind affordability and reliability / resilience by New Zealand residential customers and SMEs and customer focus in this area is negatively impacted by cost-of-living concerns.	Vector focusses on triple-duty initiatives (i.e., those that achieve objectives of reliability, affordability, and decarbonisation). Refer to sections 2.1 and 2.2 for further details. How Vector is managing their carbon footprint is set out in section 11.7.
		There is a significant gap between New Zealander's opinions and actions: 53% of Kiwis are concerned about the impact of climate change while only 32% are committed to living a sustainable lifestyle.	Vector has front-footed climate change impacts by conducting extensive weather modelling and has integrated those into our AMP. Refer to Section 11.
		Lower cost to run is a stronger driver of intending to replace appliances than moving to more environmentally friendly options for our customers.	Vector's Symphony strategy aims to keep electricity prices low through the minimisation of capital expenditure, thus enabling electrification. Refer to Section 2.
		Some business and residential customers believe the NZ government needs to provide incentives for investing in decarbonization to increase their uptake (e.g., EV charging, solar panels).	Vector has advocated for decarbonisation and wellbeing initiatives such as 'Warmer Kiwi Homes' and the Government Investment in Decarbonising Industry Fund (GIDI).
		Businesses approach decarbonization differently depending on their size: smaller businesses are keen to lower their carbon	Vector maintains relationships with large industrial consumers to

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
		footprint but want guidance on how to achieve it and manage associated costs, while large organizations generally have more knowledge and resources to decarbonise but value support and knowledge sharing from the energy sector (including Vector).	support their decarbonisation transition.
		While most business customers are willing to move away from gas to electricity, barriers here include: gas being perceived as more reliable, current electricity solutions not being able to deliver high temperatures, and uncertainty regarding additional electricity capacity required when transitioning from gas.	
		Large Auckland organisations are generally uncertain about how much EV charging infrastructure will be needed in the future and believe EV uptake depends on the charging infrastructure available and certainty of the energy supply.	Vector constantly monitors EV uptake and has a range of initiatives in place to understand customer behaviours and preferences, as well as determining actual EV uptake and charging behaviours. We regularly share our findings with other parties and are currently looking at ways to improve discoverability, including publication on vector.co.nz and our Open Data Portal.
Network modernisation (e.g., digitisation / Internet of Things, massive data centres, increasing capacity driven by urbanisation & intensification)	Network modernisation needs to enable energy affordability, resilience & reliability and environmental objectives as well as achieved proactively for customers to support Vector investing in this area. Business customers want Vector to communicate about our network modernisation plans.	Just over one in three New Zealanders are confident the electricity market will provide technology to help customers manage use & costs, lower than the proportion of Kiwis confident in the market providing reliable electricity (one in two people).	The Future Network Roadmap (FNR) details the initiatives supporting Vector's Symphony strategy. The premise of Vector's Symphony strategy is that non-traditional (non-network) solutions, specifically demand side orchestration, will enable an affordable and equitable energy transition as customers deploy distributed energy resources. Refer to sections 2 and 10.1-10.3 for further details.
		Business customers want a proactive modernisation of Auckland's energy network rather than waiting until significant events or failures requiring quick replacements, and they prefer to be notified in advance about electricity disruptions to allow them to plan.	As above. In addition, Vector utilises its Key Account Managers to maintain a continuous dialogue with its large customers. This ensures that both parties are across development and future works that could impact them as well as better understanding potential future needs.

THEME	OVERALL THEME COMMENTARY	KEY SUB-THEMES	SPECIFIC VECTOR INITIATIVES & REFERENCES TO OTHER AMP SECTIONS
		Vector's customers (especially SMEs with smaller ability to absorb costs, or companies that are first to build infrastructure in a new area) want network modernisation to be balanced with investing at the right time and balanced with energy affordability.	
		Vector's business customers support network modernisation if it enables energy affordability, resilience, reliability as well as decarbonisation, and they are interested in receiving more information from Vector in this area.	
		Network modernisation and connecting to newer parts of the network is more important for Vector's large customers that expect their electricity consumption to increase significantly in the future.	
New energy technology (e.g., using customer load, DER)	Like network modernisation, Vector's investments in new energy technology needs to enable energy affordability, resilience / reliability and environmental goals for customers to support it.	New energy technology is rated on par with network modernisation (therefore behind affordability, reliability, resilience and decarbonisation) by Vector's business customers, who are generally more interested in this area than residential customers.	The Future Network Roadmap (FNR) outlines the endeavours that underpin Vector's Symphony strategy. The core principle of Vector's Symphony strategy is that alternative solutions, particularly demand-side orchestration, will facilitate a cost-effective and fair energy transition as customers adopt distributed energy resources. For additional information, see sections 2 and 10.1-10.3.
		The level of investment in technology to achieve energy reliability (e.g., solar PV and batteries) among Vector residential customers is low, but interest in installing these in the future is relatively high, mostly driven by the desire to save on energy costs.	Vector monitors uptake of solar and batteries and has a programme to understand intention to invest in addition to monitoring industry research. Different uptake scenarios are included in our 30 year network modelling.
		Vector's SME customers want support to improve energy investment decision-making as they are not generally resourced to investigate and test new energy technology or decarbonisation solutions.	Vector employs its Key Account Managers to foster an ongoing conversation with its major clients. This guarantees mutual awareness of developments and forthcoming projects that may affect them, while also enhancing comprehension of future requirements.
		Some large Vector organisational customers are looking at implementing new energy technology (e.g., solar, biogas) but they don' expect this to cover most of their energy use and are keen for the energy market / peers to share learnings to manage uncertainty on the viability of biofuels or other new energy sources / technology.	

TABLE 4-2: THEMES AND INITIATIVES FROM OUR CUSTOMER INSIGHTS PROGRAMME

4.8 Managing conflicting interests

With numerous customer segments and stakeholders with diverse interests, it may happen that not all stakeholder interests can be accommodated, or that conflicting interests exist. From an asset management perspective, these are managed by:

- Clearly identifying and analysing any conflicts (existing or potential);
- Seeking an acceptable alternative or commercial solution based on a set of fundamental, consistent and transparent principles;
- Engaging directly with interested groups or more widely if appropriate;
- Effective communication with affected parties to assist them to understand Vector's position, as well as that of other parties or groups that may have different requirements;

In developing solutions where conflicting interests exist, Vector strives to achieve consistency, transparency and fairness.

SECTION 05

Asset management at Vector

5 – Asset management at Vector

This section describes the framework that supports and enables Vector's asset management practice.

Vector's asset management practice is a multi-utility practice that includes electricity, gas and fibre communications assets. Much of the enabling framework applies equally to each of those utility networks, however where a practice at Vector relates specifically to its electricity distribution network it is called out in this section.

5.1 Electricity, Gas and Fibre Strategy

At Vector, we want all our customers to have access to clean, reliable, safe and affordable energy. The electricity, gas and fibre strategy sets the management direction for effective and efficient management of Vector's electricity assets and how it contributes to achieving Vector's vision of "*Creating a new energy future*" . The strategy defines the purpose of the Electricity, Gas and Fibre business to:

Create an affordable, reliable & safe energy system that meets customer needs & efficiently manages network demand.

By collaborating across Vector, the industry and through strategic partnerships we will:

ELECTRICITY, GAS AND FIBRE STRATEGY

1. Operate safely as one team
2. Step change in our service to customers
3. Invest in our networks wisely and efficiently
4. Modernise, systemise & automate processes
5. Enable Auckland's growth & electrification
6. Enable the new energy future

5.2 Asset management policy and principles

Our Asset Management Policy supports our vision of creating a new energy future by setting clear principles (detailed below) to guide the development of Vector's asset management objectives and plans. Our policy principles deliver against all of the element of the electricity, gas and fibre strategy and represent Vector's values, commitments and strategic pillars which apply to all employees and partners (field services providers, contractors and suppliers), involved in the management of Vector's electricity assets.

ASSET MANAGEMENT PRINCIPLES

1. Safety is our highest priority, and we strive to achieve zero harm to employees, contractors, and the public through the management of our assets over their entire lifecycle.
2. We strive to optimise the total lifecycle costs of our assets in ensuring the safe, reliable, resilient, efficient, and affordable provision of energy related services.
3. We comply with internal policies, processes, and established frameworks as well as applicable statutory and regulatory obligations.
4. We use risk models, data, analytics, and market driven insights to make decisions that are in the long-term interests of our customers.
5. We use innovation to accelerate the convergence of traditional and digital assets to manage and meet our customers' evolving expectations.
6. We manage the impact of our assets on the environment while supporting both Vector and our customers' decarbonisation objectives.
7. We engage commercially but collaboratively with our partners by encouraging open and clear communication to leverage diversity of thinking and experience.
8. We align our Asset Management System with industry recognised asset management practices including ISO 55001.
9. We manage risk effectively, and continuously adjust our approaches to manage new and emerging risks such as cybersecurity, privacy, and climate change.
10. We measure the effectiveness of our efforts to ensure we continuously improve our asset management capabilities in delivering our vision.

TABLE 5-1: VECTOR ASSET MANAGEMENT PRINCIPLES

5.3 Asset management objectives

Our Asset Management Objectives have been developed in alignment with the principles set out in our Asset Management Policy, and the Electricity, Gas and Fibre strategy. The objectives provide detailed guidance to asset management practitioners enabling appropriate asset management plans and activities to be developed and set and consider our operating environment and represent specific stakeholder requirements.

FOCUS AREA	OBJECTIVES	AM PRINCIPLES	STRATEGY ELEMENT
Safety, Environment and Network Security	• Prevent harm to workers, contractors and the public through our work practices and assets. • Ensure health and 'safety always' is at the forefront of decision making for the business. • Comply with relevant safety and environmental legislation, regulation and planning requirements. • All staff are competent and trained in their applicable roles with the right equipment available to work safely and effectively. • Asset management activities align with environmentally responsible and sustainable behaviours, in line with industry best practice, enabling wider emissions reductions. • Minimise the impact on the environment with regards to our assets and work practices. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).	1, 6	1, 6
Customers and Stakeholders	• Enable customers' future energy and technology choices. • Provide a high-quality customer service experience across all interactions. • Listen to and learn from our customers to ensure our service offering aligns with customer expectations. • Consider the impact of our operational decisions on customers and minimise the disruption of planned outages and unplanned outage response times. • Ensure the long-term interest of our customers by providing an affordable and equitable network.	2, 4, 5, 6, 7, 9	3, 4, 5, 6
Network Performance & Operations	• Comply with regulatory quality standards set out in the DPP3 Determination. • Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations. • Continual improvement of our asset management system and alignment to ISO 55001. • Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact-based investment profiling. • Utilise clear business case processes, integrate risk management and complete post investment reviews to inform our decision making and analysis. • Maintain compliance with security of supply standards through risk identification and mitigation. • Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. • Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings. • Manage performance of field service providers through effective commercial arrangements and regular review.	2, 3, 4, 5, 7, 8, 9, 10	3, 4, 5, 6
Future Energy Network	• Prepare the network for future changes that will be driven by: – technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc. – environment: climate disruption and network resilience – customer: decarbonisation of the economy, electrification of transport, etc	2, 3, 4, 5, 6, 7, 9, 10	2, 3, 4, 5, 6

FOCUS AREA	OBJECTIVES	AM PRINCIPLES	STRATEGY ELEMENT
	– operations: transition to distribution system operator model and whole of system planning • Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third party flex traders and retailers. • Facilitate customer adoption of new technology while ensuring a resilient and efficient network. • Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network. • Develop digital and data platforms to meet changing customer needs and enable the future network in partnership with new entrants to the energy market. • Improve our visibility of, and ability to control, the LV network including management of the information required. • Collaborate with industry, partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions.		

TABLE 5-2: VECTOR ASSET MANAGEMENT OBJECTIVES

5.4 Asset Management Standard

Vector's Asset Management Standard links the organisational asset management objectives to the tactical asset management practice. The Asset Management Standard creates a clear link between Vector's vision, strategic objectives and asset management plans. The framework for our asset management standard is shown in the diagram below.

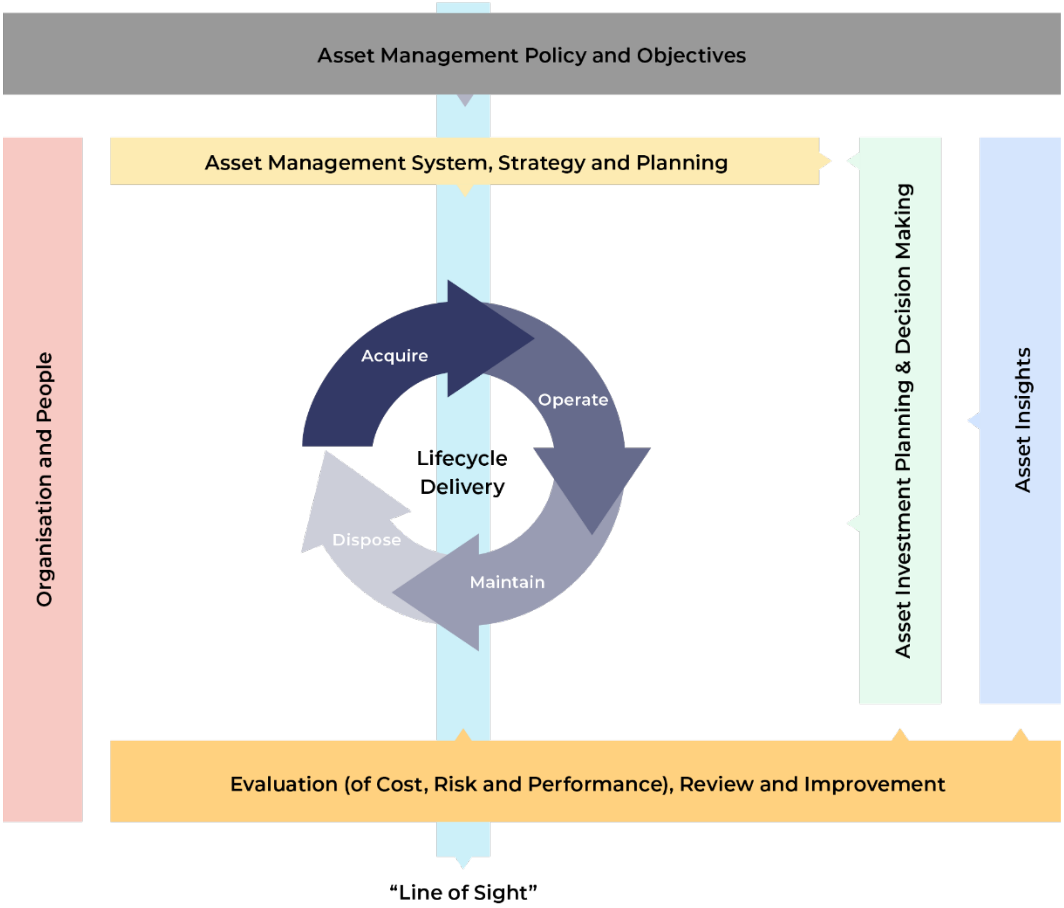


FIGURE 5.1: VECTOR'S ASSET MANAGEMENT STANDARD FRAMEWORK

Continuous improvements in our practices, with supporting cost, risk and performance monitoring, as well as data driven reporting, ensure a full "Line of Sight" throughout the asset management governance structure, from Asset Management Objectives to individual asset level performance. We continuously measure and review progress against Asset Management Objectives to provide assurance and to respond quickly to changes in our operating environment.

Table 5-3 provides an overview of the standards and sub-elements that form the foundation of our asset management standard. Vector is continually advancing its asset management practices to best position ourselves to achieve its objectives and ultimately its vision of a new energy future. This journey includes alignment of our asset management system to ISO 55001.

5.4.1 ASSET MANAGEMENT STANDARDS

ASSET MANAGEMENT STANDARD	DESCRIPTION	ELEMENTS
AMS 01: Asset Management System, Strategy and Planning	Provides the Asset Management System framework and foundational documents.	• Asset Management Framework • Asset Management Policy • Strategic Asset Management Plan
AMS 02: Asset Investment Planning & Decision Making	Documents how asset investment decisions (prioritisation and optimisation) are made to compile the final asset management plans.	• Asset Strategy Management • Network Development Planning • Asset Replacement and Refurbishment Planning • Asset Relocation Planning • Customer Planning • Project Planning • Development of the Asset Management Plan
AMS 03: Lifecycle Delivery	Documents how asset management plans are translated into more detailed work plans, namely project scopes, programme scopes or routine maintenance plans.	• Technical Standards and Legislation • Asset Creation and Acquisition • Asset Performance and Reliability Management • Maintenance Delivery • Capital Programme Delivery • Fault and Incident Response • Asset Decommissioning
AMS 04: Asset Insights	Documents how asset data standards and systems are defined and implemented in line with the Asset Insights Strategy in order to collect, store and utilise meaningful data to drive effective decisions around asset management activities.	• Data and Information Management • Asset Data Standards
AMS 05: Organisation and People	Documents the processes used to develop and maintain competent resources as well as how outsourced activities are aligned to asset management objectives.	• Competence and Behaviour • Supply Chain Management
AMS 06: Evaluation (of Cost, Risk and Performance), Review and Improvement	Documents how continuous evaluation of asset performance takes place to ensure alignment with asset management objectives.	• Asset Management Control, Review, Audit and Assurance • Asset Performance and Health Monitoring • Post Investment Reviews • Stakeholder Engagement • Sustainable Development

TABLE 5-3: VECTOR'S ASSET MANAGEMENT STANDARDS

5.5 Asset management key documents

Vector uses a range of document types to stipulate and control requirements. Each document type is represented in a hierarchy structure to ensure all information is aligned. This approach creates a "system of control" in relation to technical and business risks. The pyramid below represents Vector's document hierarchy.

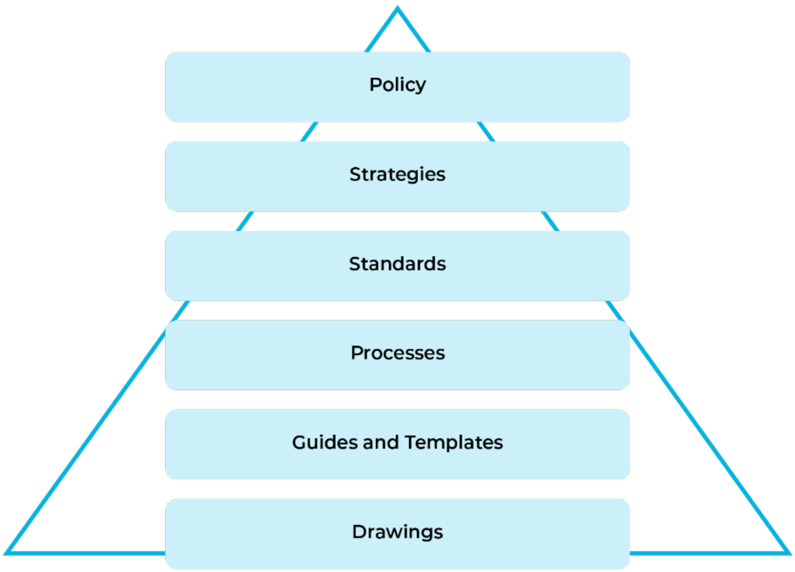


FIGURE 5.2: VECTOR DOCUMENT HIERARCHY

5.5.1 STRATEGIC DOCUMENTS

This table sets out the key strategic documents relating to Vector's asset management framework. Our strategic documents are subject to change control. The change control process obtains feedback and approval of the controlled document and related change impacts prior to publication.

DOCUMENT	ROLE IN ASSET MANAGEMENT PRACTICE
Asset management policy	This policy is Vector's formative asset management document. It defines the principles that guide all aspects of our asset management practice including the development of objectives and plans.
Strategic asset management plan	As part of our working towards alignment with ISO 55001, we are developing and defining the frame which documents our asset management objectives in line with our policy and operating context. The AMP sections 1-7 describe the organisational context, stakeholder needs, asset management scope, system scope and objectives. The requirements of a SAMP are fulfilled by sections 1-7 of the AMP.
Delegated Authority (DA) framework	The DA framework applies to all business activities that have financial or non-financial consequences including contracts and expenses. The DA framework sets out specific approvals for particular transactions and governs the level of financial commitment that individuals can make on behalf of Vector. All decisions within our asset management practice that require expenditure or involve significant risk will be made under this policy and in accordance with Vector's project approval process.
Risk management policy	This policy provides the overarching risk management intent that Vector strives for. Its purpose is to: a) outline our key management objectives and the principles underpinning them, b) provide a framework for optimising opportunities and minimising risks, c) demonstrate Vector's understanding and commitment to promoting a culture of risk awareness throughout the organisation, and d) define key risk management roles, responsibilities, accountabilities and reporting requirements.
Health and safety policy	This policy sets out Vector's commitments and requirements for health and safety. Vector will conduct its business activities in such a way as to protect the health and safety of all workers, the public and visitors in its work environment.
Sustainability policy	This policy provides Vector's framework for managing environmental, social and governance risks and opportunities. It includes commitments to recognised international agreements and sets out the key principles by which sustainability will be adopted within the business.
Supply Chain and Procurement policy	This policy provides Vector's framework for building supplier capacity and capability enabling more effective management of network and supply chain

DOCUMENT	ROLE IN ASSET MANAGEMENT PRACTICE
	risk, realisation of value and assist in achieving Vector's strategy to reduce its carbon footprint
Electricity safety and operating plan	This Safety and Operating Plan has been developed for Vector's electricity network to detail the controls in place to mitigate the risks that have been identified under the hazard and risk assessment processes for minimisation of harm to persons, property, the public and the environment, including emergency response.
Group data and information policy	The purpose of this policy is to govern and guide Vector's key data and information principles and includes everyone's responsibilities regarding data. Data and information refer collectively to all records and documents (both physical and electronic) used to describe and document Vector's business.
Asset header class strategies	These strategy documents facilitate the annual development of the AMP through formally recording asset strategies at the asset header class level for our different asset classes.

TABLE 5-4: VECTOR ASSET MANAGEMENT STRATEGIC DOCUMENTS

5.5.2 STANDARDS

Standards and specifications are an integral part of our asset management framework. These state the levels of service, performance targets, define intervention levels and minimum performance criteria. The table below lists the major standards that support the procurement, supply, commissioning, operation and maintenance of existing, new or replacement assets. Our technical specifications and engineering and maintenance standards are listed in detail in Appendix 2. These documents are improved under a defined change control process and document revision control process as described in Vector standard USD001 Controlled document management. Change control is the flow of documentation and change-related collateral between the document author, our field service providers and all end users in Vector. Change control obtains internal and if our field service providers are involved, external feedback and approval of the controlled document and related change impacts prior to publication.

ASSET STANDARD	ROLE IN ASSET MANAGEMENT PRACTICE
Planning standards (ENS series)	These standards guide the planning and development of Vector's overall distribution network architecture. They work in conjunction with the Security of Supply Standards (SoSS) service level metric to ensure that the network has sufficient capacity and capability to provide the required service levels, enable customer connections, accommodate growth and allow for the orderly and safe connection of distributed generation. These standards also set requirements that enable the appropriate operation of the network in accordance with the Network Operating Standards.
Maintenance standards (ENS and ESM series)	Vector has developed a set of maintenance standards for each major class of asset that detail the required inspections, failure modes, condition monitoring, maintenance and data capture requirements. Where a cyclic maintenance strategy is applied these standards also set out the maximum maintenance cycle frequency.
Network operating standards (EOS series)	These standards define protocols and procedures for operating and controlling Vector's electricity network, including contingency plans. They also inform the minimum requirements for network planning and design practices.
Design and construction standards (ESE and ESS series)	These standards and their accompanying standard design drawings cover the detailed design and installation of Vector's network equipment. They also include the data capture requirements for our asset management systems and plant in Vector's network.
Technical specifications (ENS series)	Technical specifications specify the materials and equipment to be used on the electricity network and the quality and performance requirements with which the materials and equipment must comply.
AS/NZ standards IEC standards	Australian and New Zealand standards as well as International Electrotechnical Commission (IEC) standards are referenced extensively in our standards and scopes of work.

TABLE 5-5: VECTOR STANDARDS

5.6 Asset management and asset management maturity

Developing our asset management maturity is a key focus of continuous improvement for Vector. We review our asset management practices using the Commerce Commission's Asset Management Maturity Assessment Tool (AMMAT).

At an overall level, our asset management maturity compares well with generally accepted New Zealand electricity asset management practices to ensure the ongoing safe and efficient operation of the electricity network. Our approach has matured progressively with our self-assessment improving year-on-year from an overall AMMAT score of 2.77 in 2019, 2.87 in 2021 and 3.01 in 2023. Our current score of 3.03 reflects the effort made to continuously improve our asset management practice.

Our objective as we go forward is to achieve a target score of three on each AMMAT rating criteria to align to ISO 55001 in the longer term. For our latest AMMAT self-assessment, refer to Schedule 13: Report on Asset Management Maturity in the Appendices section (Appendix 12). Set out below is an overview of the primary areas where ongoing improvements in our asset management practise are being implemented.

5.6.1 ASSET MANAGEMENT, ASSET MANAGEMENT STRATEGY AND ASSET MANAGEMENT POLICY

Our asset management policy broadly outlines the principles and requirements for undertaking asset management across the organisation (see 5.1 and 5.1.1 above for the broad outline of our policy). These strategies and goals then translate the strategic intentions into an asset investment strategy. These are documented in the Asset Management Plan. Technical standards, work practices and equipment specifications support the asset management policies, guiding the capital and operational works programmes.

5.6.2 COST, RISK AND SYSTEM PERFORMANCE

Asset management encompasses all practices associated with considering management strategies as part of the asset lifecycle. The objective is to look at the lowest long-term cost rather than short-term savings only. To achieve optimal asset management requires a balance between cost, level of risk and performance of the asset. We utilise a risk-based approach that considers the different failure modes of an asset, its condition, criticality scores, probability of failure, likelihood of consequences and a final risk score (our condition-based asset risk models are described in detail elsewhere).

A combined list of proposed projects and initiatives are then prioritised based on a set of agreed business objectives and values with the constraints of resources taken into consideration. The combined list contains our proposed projects and initiatives, high level cost estimates and estimated risks together with investment prioritisation.

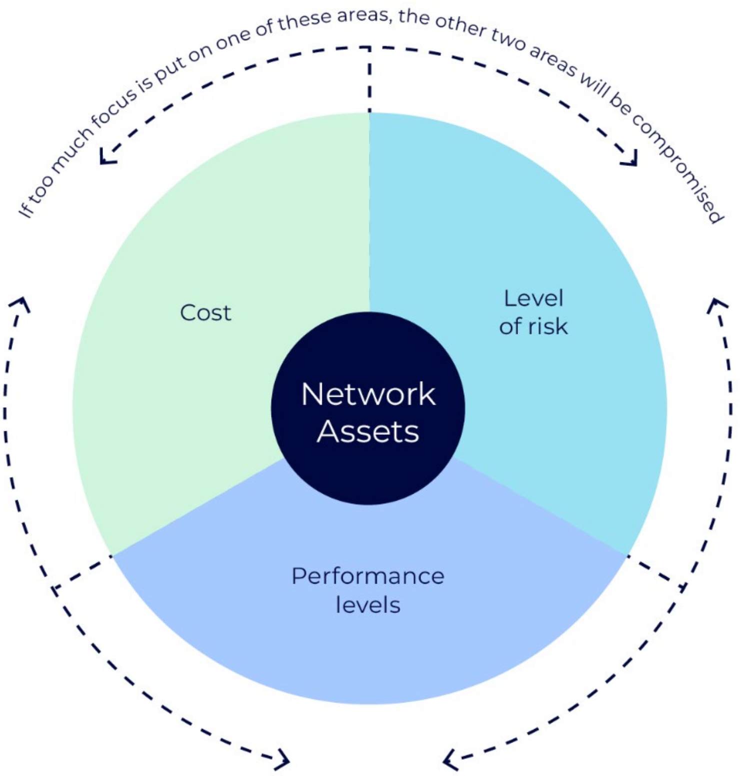


FIGURE 5.3: RELATIONSHIP, COST, RISK AND PERFORMANCE

COST

Improvements have been made to our process for creating business cases and justifications for capital projects to arrange capital budgets. A clear business process with stage gates has been compiled that describes the actions that need to be completed prior to moving past a stage-gate to the next stage in the budget and funding process. Our business cases state the risk and need that drives the requirement for a project, alternative options that were considered and the cost for each option. Our works cost estimates are detailed providing an overview of the total estimated cost of the works, the portion that is required to develop the design of the works, funding required for early procurement of long lead items and the portion required to move to full project funding. Business cases and cost estimates undergo a rigorous peer review process and then a controlled approval process via our SAP business software workflow procedure.

For Vector's internal use, our Project-on-line application enables a live and continuous update of the progress of projects, both physical delivery and financial progress. We have rolled out Project-on-line as the tool to manage and control the delivery of capital projects. This tool allows integrating project time-line forecasts with financial forecast for the delivery of capital projects. It provides a one-stop-shop for improved visibility of projects, associated risks and challenges to the delivery of projects.

A Governance Group is in place with representatives from the Network Performance team and Capital Delivery team that meet on a weekly basis to discuss the asset management plan, challenges, risks, issues, cost, and scope changes. Scope changes are formally recorded.

LEVEL OF RISK

Our risks are registered in our Active Risk Manager (ARM) together with controls, actions, assignment of responsibilities and target dates for assessment, review and completion. We use a risk matrix that considers consequences and likelihood to assess and score risks. The risk scores are assigned in our ARM software application. Initiatives to address a risk could also present itself as an opportunity for new solutions and innovations. In certain instances, risks are accepted within the business and such decisions are recorded in ARM as well as in the corporate risk register.

PERFORMANCE LEVELS

Our performance levels for our network supplies are stated in our Security of Supply standard. Our SAIDI and SAIFI are calculated in our HVSPEC application, and the data is retained for reporting and analysis and reported annually to the Commerce Commission in our compliance statement. Our average network customer base is calculated using our Gentrack billing and revenue system application.

5.6.3 ASSET HEALTH, MODELLING AND INVESTMENT SCHEDULE

For our asset fleet we have developed an asset strategy for each Header Class asset. These strategy documents clearly describe the asset class equipment, their status and condition, challenges, future management, and maintenance and replacement strategies. These strategy documents thus informs and facilitate the annual creation of the capital investment programs and capital budget. They are updated annually to coincide with the development of the annual asset management plan.

The CBARM models have been developed for all distribution assets. These models that uses condition data, risk data, as well as environmental conditions and location, provide a data driven basis for the planning of projects and programmes rather than a pure focus on annual planning within a defined financial budget. The CBARM model incorporates inputs relating to asset configuration, recorded condition data, environmental factors and obsolescence to determine a health score for each asset in the network. A criticality score based on public safety, network impact and environmental impact determines the failure consequences, which when combined with the health score provides a risk profile for each of the modelled asset classes. This risk basis provides a critical input to defining the asset strategies, budget allocations and asset management decisions for capital budgeting, reactive and corrective work. The figure below is a flow diagram for our CBARM models.

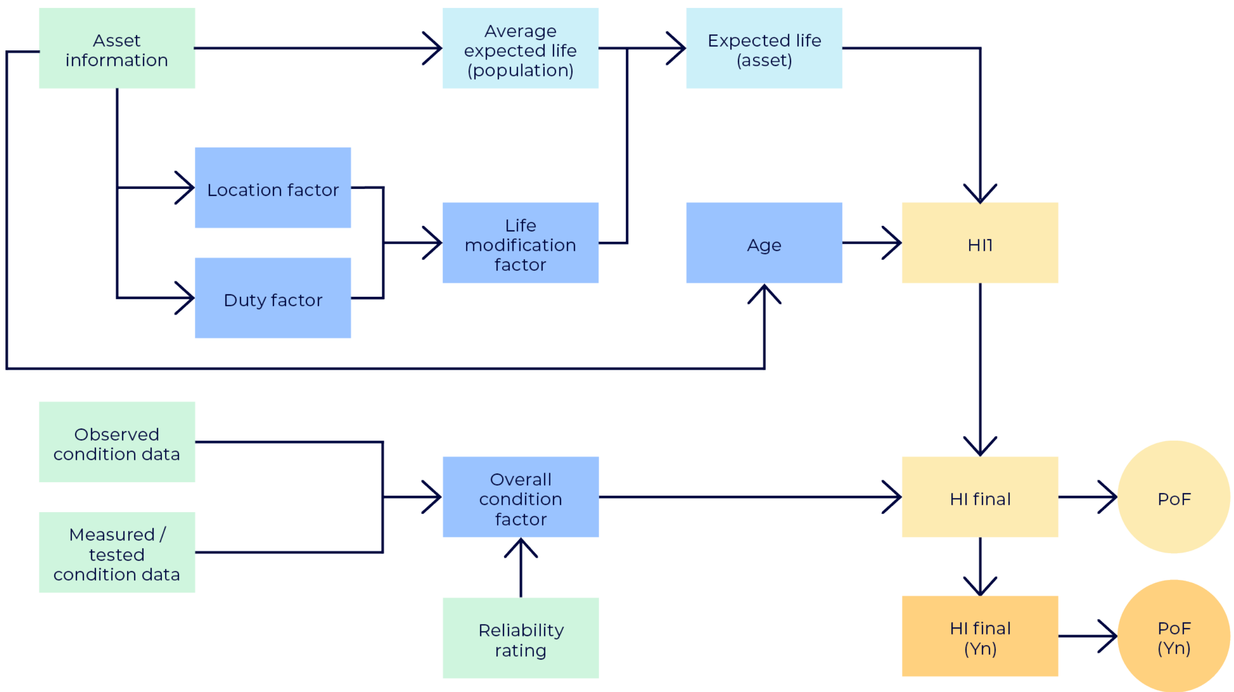


FIGURE 5.4: CBARM MODEL FLOW CHART

5.6.4 SYSTEMS AND INFORMATION MANAGEMENT DATA

Investments have been made to our core systems through the SAP Planned Maintenance (SAP-PM) project which has allowed for a consistent approach to the management and delivery of planned maintenance across our field service providers. The project has delivered a suite of maintenance standards that provide for improved asset data quality and volume.

To move away from a largely supply-driven mindset of the electricity industry, Vector has adopted bottom-up modelling to understand energy-related trends on the customer side and sets the foundation for 'customer centricity' in our electricity distribution network and asset planning, Vector's granular customer model includes all 600,112 customers connected to Auckland electricity network. It can zoom in on specific customer attributes, specific network locations and extreme events, without being exposed to the limitations of small samples. It uses data from Stats NZ (census data) and detailed property information for all rateable buildings in Auckland. Half-hourly metering data is also used as well as a host of other data sources. The granular customer model is the foundation of our scenario model, which assesses the impact of peak demand and energy consumption as a result of new technology adoption. Section 10 describes how the scenario model is used for load forecasting as part of the network planning process.

5.6.5 ASSET MANAGEMENT DOCUMENTATION, CONTROLS AND REVIEW

Document control is stipulated and governed by our standard USD001, Controlled Document Management standard. Policies, strategies, and standards are circulated for reviews and updates via our Sharepoint application including our external partners such as field service providers or consulting engineers. This software platform allows automation in terms of review dates, completion of review dates, review comments etc. It enables a high level of control of the documentation process and a historic record of reviews. Updates of asset management documents, standards, standard drawings are issued via an automated process in this application. Each asset management document has a revision number, current date, and a date at which it needs to be reviewed.

This document control process also applies to outsourced works. The issuing, changes and return of changed documents are controlled via our Meridian software application with a revision recording and history of changes system in place as part of the application.

5.6.6 COMMUNICATION OF THE ASSET MANAGEMENT PLAN

Our website portal (www.vector.co.nz), provides a wide range of asset management information to external parties. It provides information with regard to new connections, connection of distributed generation, outages and faults, work in close proximity to our networks, planned outage notifications, and our asset management plan amongst others. Our asset management plan, for both OPEX and CAPEX are formally communicated with our field service providers via formal meetings and programme of works schedules.

Vector has also launched an Open Data Portal with network asset location information, including distribution and sub-transmission overhead lines and underground cables on Vector's electricity distribution network. The site allows third parties the ability to access location information for electricity and gas feeders electronically. In addition to creating map views, third parties can download the data or connect their systems directly to Vector data. This initiative ensures that infrastructure companies, construction companies and entities like Auckland Council and Civil Defence have access to up-to-date information about Vector assets. This is also another way in which Vector can assist construction companies to prevent third party asset damage.

Our Capital Delivery Team has three team members that act as the main interface between our project management team and contractors and field service providers, to communicate the asset management plan. We also have a quarterly contractor forum meeting that involves external parties over and above field service providers, e.g. design consultants and all other contractors including our panel of civil contractors.

We also have quarterly "All Hands" sessions for the wider Vector team at which the asset management plan is presented and specific topics drilled into.

5.6.7 AUDIT OF THE ASSET MANAGEMENT PLAN

Entrust, Vector's majority shareholder, biennially conducts an independent review of the state of Vector's network that includes an assessment of our asset management plan, targets, and outcomes. With support from external asset management specialists, we use these reviews to address gaps and inform our plans to improve our asset management practice. Vector also undergoes annual safety audits of its network and management practices in terms of NZS7901, Public Safety.

5.6.8 OPERATIONAL MANAGEMENT IMPROVEMENTS

Our current SCADA system has been replaced with an advanced distribution management system (ADMS). This system has been commissioned in August 2023 and has successfully completed stage one of the ADMS project. The ADMS will assist control room personnel with monitoring and control of the distribution system in an optimal manner while improving safety and asset protection. In addition to the traditional SCADA single line diagrams the ADMS also provides a geographical view of the network by being fully linked to our geographical information systems (GIS). ADMS includes the "traditional" SCADA functions of data acquisition and control but has the functionality for near real-time analysis and optimisation of the distribution system. The second stage of the ADMS project will enable us to further build on and implement a state-of-the-art Outage Management System and other advanced applications such as FLISR (Fault Location Isolation and Service Restoration) which will further enhance our SAIDI count and reduce outage times.

SECTION 06

Governance, risk management and information management

6 – Governance, risk management and information management

6.1 Overview

This section provides an overview of Vector's governance and organisational structure, accountable for delivering effective and fit for purpose asset management planning. Fundamental to effective governance is a strong awareness and focus on risk management. Therefore, this section also includes an overview of our enterprise risk management framework, key risk practices and event management documentation that includes emphasis on high impact, low probability risks. Finally, our data and privacy management practices are covered, which includes a summary of information systems and our approach to cybersecurity. These elements are key enablers in ensuring Vector's asset management practice.

6.2 Governance and organisational structure

Vector's asset management governance and organisational structure is shown in Figure 6-1. This structure provides oversight and leads all aspects of our asset management practice.

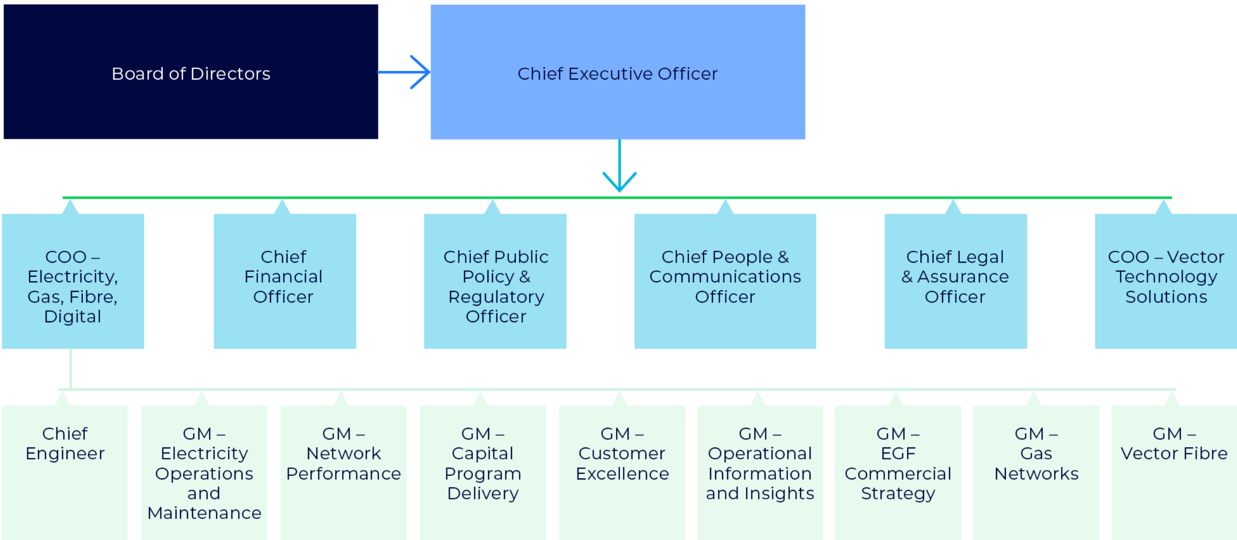


FIGURE 6.1: VECTOR'S ASSET MANAGEMENT GOVERNANCE AND ORGANISATIONAL STRUCTURE

Figure 6-1 pictorially represents the governance and organisational structure accountable for delivering effective and fit for purpose asset management planning for Vector's electricity distribution business. An overview of the asset management accountabilities and responsibilities within three levels of this structure are set out below.

- **Board of Directors** – At the highest level, the Board of Directors provides governance over all aspects of Vector's asset management practices on behalf of Vector's shareholders. The board exercises oversight of the objectives of asset management (refer Asset Management Systems), its strategic direction, process for investment approvals and the customer service level outcomes achieved by Vector's electricity distribution network. Overall budgets, significant expenditures and asset investments are reviewed and approved at the board level.
- Vector's Board of Directors maintains its asset management oversight through the implementation of governing policy, a delegated authority framework, management reporting and periodic reviews including internal and external operational audits. The board also receives performance reporting against key service levels and regulatory reliability targets.
- Full details of Vector's board members, the executive leadership team and our corporate governance structure are available on our website.
- **Chief Executive Officer** – Under the delegated authorities' framework, the approved strategic plan, approved annual budgets, and day-to-day operation of the business is the responsibility of the Chief Executive Officer (CEO). The CEO maintains oversight of Vector's asset management practices, including effective risk management (both strategic and operational), service level outcomes, strategic direction and investment approvals. To assist with this oversight, the CEO receives performance reporting against key metrics and service levels, which include reporting against regulatory reliability targets.
- **Chief Legal and Assurance Officer** – Under delegation from the board and the CEO, the Chief Legal and Assurance Officer is accountable for providing Vector's legal counsel as well as policy, frameworks and governance for enterprise risk and resilience, internal audit, health, safety and environment, compliance and privacy (via a dedicated Privacy Officer). Responsibility for the delivery of these functions at a business unit level is appropriately disseminated and delegated throughout the business through dedicated management functions and ownership models.

- **Chief Operating Officer – Electricity Gas & Fibre** – Under delegation from the board and the CEO, the Chief Operating Officer (COO) has full responsibility for Vector's electricity asset management practice. This includes the establishment and enforcement of Vector's Asset Management Policy, the overall performance of Vector's electricity distribution network, development and implementation of the approved AMP, and budgetary control within the delegated authorities' framework.
- **Chief Engineer** – Integral in strategic business model design and strategic business opportunities, this role works alongside project teams and executive sponsors to ensure Vector's electricity networks and services are of the best practicable quality. This includes using cutting-edge digital technologies to deliver affordable for customers energy safely and effectively.
- **General Manager Electricity Operations and Maintenance** – Vector's field staff are managed through an outsourced contracting model. As such, the GM Electricity Operations and Maintenance is accountable for the contractual relationships and performance of field crews delivering our maintenance programme. Work is centred around the delivery of maintenance plans in accordance with Vector standards and reactive response to outages.
- **General Manager Network Performance** – This role is accountable for future network planning, capital and maintenance investment planning, and developing detailed asset management plans and standards for all asset classes required to achieve Vector's asset management objectives.
- **General Manager Capital Programme Delivery** – This role is accountable for the delivery of the annual capital programme, including project engineering, project management, and procurement and tendering of capital works.
- **General Manager Customer Excellence** – This role is accountable for providing the key link between asset management delivery and Vector's customers. The role leads our relationship with retailers and customers to ensure the relationship is continually strengthened and supported.
- **General Manager Operational Information and Insights** – This role is accountable for managing Vector's electricity information and data assets. The role ensures information compliance with regulatory and privacy requirements and provides supporting business intelligence to inform operational decision making.
- **General Manager Commercial Strategy** – This role supports Vector's commitment to its asset management objectives and vision by driving key reliability and strategic initiatives.
- **General Manager Gas Networks** – This role is accountable for asset management planning and delivery for Vector's gas distribution business. All asset management roles support the enhancement of electricity asset management through synergies and cross-functional skillsets.
- **General Manager Fibre** – This role is accountable for asset management planning and delivery for Vector's Fibre business.

The governance framework overarching each of these roles is supported by the Code of Conduct and Ethics – the Vector Way, Vector's Delegated Authority Framework (DAF), and position descriptions for each role. Vector's Board has delegated specific authorities to the CEO and authorised delegation of certain authorities to other levels of Vector's management. The limits and rules applied to delegations are prescribed in the DAF documentation and govern the authority to commit to transactions or expose Vector to risk.

Vector's Enterprise Resource Planning (ERP) System (SAP) is the primary management system used to implement the DAF. Financial delegations for approvals under the DAF for OPEX and CAPEX are set and managed within Vector's SAP system. A periodic audit of the DAF is undertaken to ensure ongoing compliance. The ERP system also provides control of asset management workflows, as well as the management of information that enables our asset management and project management practices.

6.3 Risk management

6.3.1 ENTERPRISE RISK POLICY AND FRAMEWORK

Risk management practices form an integral part of Vector's asset management processes. Vector's Risk Management Policy establishes clear principles which provide for a purpose-built flexible approach to the application of risk management across Vector.

Our activities in risk:

a) Create and protect value in our organisation;

b) Form an integral part of all organisational processes and decision-making;

c) Explicitly address uncertainty;

d) Are systematic, structured and timely;

e) Are customised to suit our organisational context and individual business activities;

f) Take into account human and cultural factors;

g) Are transparent and inclusive; and

h) Are dynamic and responsive to change.

The above principles form the basis of Vector's risk management approach allowing for the development of risk management objectives and a clear framework that is applicable across the Vector Group. Our Enterprise Risk Management (ERM) framework is based on the international standard for risk management, ISO 31000. It allows for a single, company-wide view of risk, aligning several profiles and contexts across Vector, to support the achievement of our strategic objectives.

Vector's ERM framework (summarised below in Figure 6-2) is focused on understanding, monitoring and proactively treating risks within the business. The management and tracking of identified risks and associated treatment plans are undertaken using Vector's ERM system - Active Risk Manager (ARM).

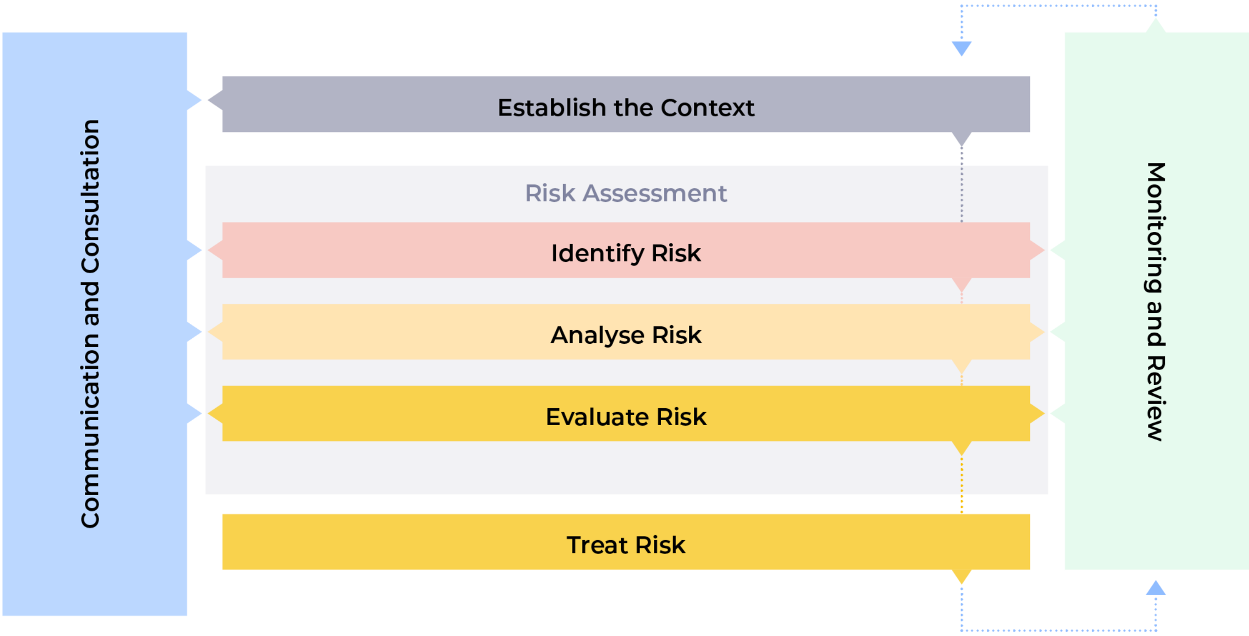


FIGURE 6.2: VECTOR'S ENTERPRISE RISK MANAGEMENT FRAMEWORK

Vector's risk management processes and tools are embedded within its business operations to drive consistent, effective, and accountable decision-making. Consistent with the "Three Lines Model", all Vector people are responsible for applying Vector's ERM framework within their individual roles to proactively identify, analyse, evaluate, and treat risks. This risk mindset has been implemented through:

- Awareness of risk management's value at operational, executive team and Board level;
- Embedding of risk assessments and discussions within key decision-making processes; and
- Continuous development through both internal and external reviews.

6.3.2 RISK PROFILES

Vector operates both a top-down and bottom-up approach to risk management.

At the top level, the board sets the risk appetite and strategic direction for the business. The board has established a Board Risk and Assurance Committee (BRAC)[10] which assists the board in providing oversight of Vector's risk and assurance policies and practices, monitors risk performance concerning Vector's risk appetite and business objectives, provides guidance regarding the development of the ERM framework, and ensures rigorous processes for internal control and legal compliance.

Spanning across Vector's portfolio of businesses, Vector's Group Risk function is tasked with the ongoing development and implementation of the ERM framework and risk processes. In addition to monitoring the changing business landscape and macro-economic trends, this function integrates and works with all Vector business units to facilitate smart risk-based decision-making as well as consistent bottom-up risk analysis and evaluation of risk against Vector's risk appetite. These perspectives inform the development of the Group Key Risk Profile which provides both the board and executive team with a consolidated view of:

(i) the strategically focused risks which could have a significant impact on the long-term value and sustainability of Vector's business; and

(ii) the material operational risks facing Vector as part of its business-as-usual activities which require significant oversight and control.

To inform the Vector Group key risk profile, business unit and operational risk profiles are developed based on the objectives and operating context specific to each business unit. Figure 6-3 shows the alignment of Vector's risk profiling structure.

[10] The BRAC contains at least three members of the board.

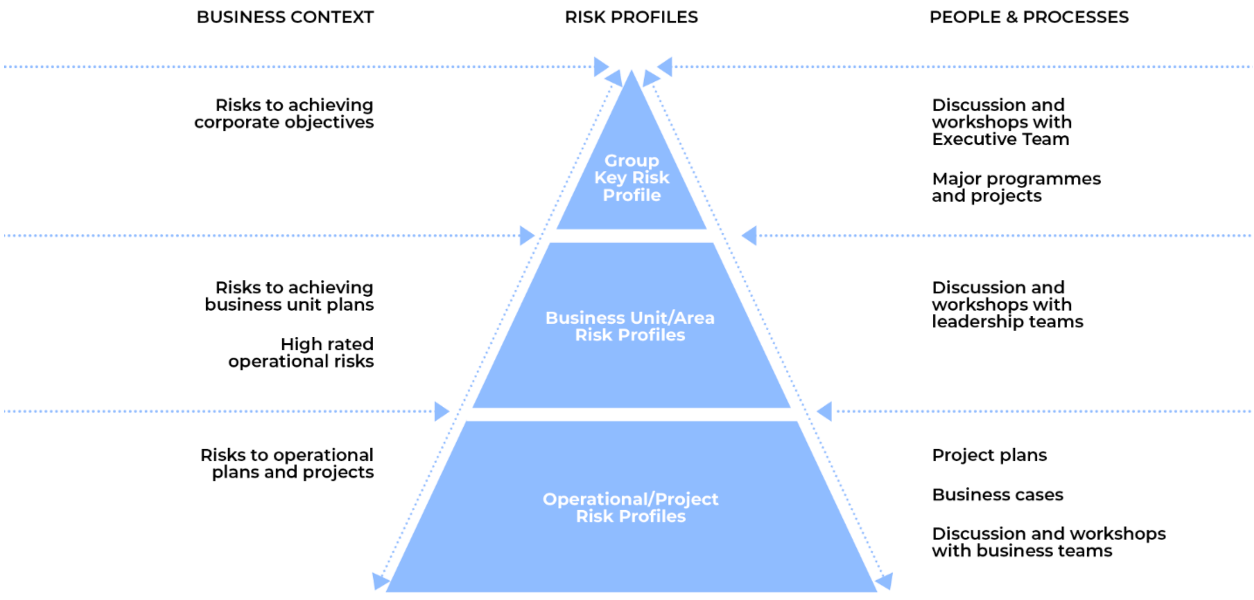


FIGURE 6.3: VECTOR'S RISK PROFILING STRUCTURE

6.3.3 ELECTRICITY DISTRIBUTION RISK MANAGEMENT

The development of Vector's electricity distribution risk profile incorporates the use of risk groupings. Eight risk groupings have been established within Vector's ERM system (Figure 6-4) to consolidate risk across the business unit. This approach avoids the use of siloed team risk registers which often either repeat risks across many registers or neglect them completely. The risk grouping approach also aids in the identification of risk and supports risk activities undertaken throughout the business, such as critical site reviews or High Impact, Low Probability assessments.

FIGURE 6.4: ELECTRICITY DISTRIBUTION RISK GROUPINGS

Risks are analysed and evaluated against Vector's risk criteria and then treated to modify the risk level if required. Risk treatment considers the level of risk tolerability which is informed by applicable legislation and industry standards (including the Health and Safety at Work Act and the Electricity Act).

Vector's risk management processes are integrated into the asset investment process and the development of asset class strategies to ensure appropriate treatment plans (which supplement existing controls) are developed and prioritised. Maintenance standards are linked to asset risks through Failure Mode and Effects Analysis and corrective maintenance activities are prioritised using a Risk Based Approach (RBA). Asset investment considers asset condition and risk through the development of our Condition Based Asset Risk Management (CBARM) model to ensure the health of Vector's asset portfolio remains acceptable.

In line with the Institute of Internal Auditors' Three Lines Model, Vector also operates an internal audit function that establishes an assurance programme to monitor risk management functions and applicable business processes. This independent and objective function conducts and coordinates audits and performance reviews to provide assurance and confidence in the effectiveness of the risk management framework and supporting activities.

6.3.4 HIGH IMPACT LOW PROBABILITY (HILP) RISKS

Included in Vector's electricity distribution risk management process is the identification and treatment of High Impact, Low Probability (HILP) risks. A dedicated risk grouping has been assigned to ensure HILP risks are easily identified and managed. Our risk processes require HILP risks to be treated the same way as other "high" risks and managed accordingly. This ensures that, regardless of likelihood, high-consequence events are appropriately considered.

Network resilience and the ongoing management of HILP risks is a priority for Vector with proactive investment allocated to manage future events. We undertake regular critical site reviews, monitor reference material and global trends, have developed comprehensive event and contingency management plans and have engaged a variety of experts to help influence our planning and management of HILP events.

Identification and management of HILP risks include consideration of both our internal and external operating environment. Figure 6-5 below provides a representation of HILP events influenced by a range of factors that require ongoing and evolving management to both prevent the occurrence and mitigate the impact so far as is reasonably practicable.

Event	Major asset failure at a critical site e.g. Widespread supply loss	Critical safety incident (worker or Public) e.g. Fatality from public accessing restricted area	Health event impacting critical workforce e.g. Essential workforce incapacitated by future pandemic	Climate change creating a hazardous environment e.g. Extreme winds or bushfire created from Vector asset	Loss of system control e.g. Widespread failure of SCADA system	Natural disaster e.g. Volcanic eruption or earthquake	Civil unrest impacting workplace safety e.g. Public riot/ violence
Controls	• Zone substation review programme • Network contingencies and security of supply standards • Major event planning	• Risk and safety management system • Site auditing and assurance management • "Safety in design" standards	• Staff segregation, multiple site configurations and hygiene protocols • Business continuity and contingency planning; risk control strategies	• Enhancing weather modelling capabilities • Developing network climate strategies • Storm response and major event planning	• Cyber security controls and management systems • Control room, SCADA and field worker contingency planning	• Critical site contingency plans • Environmental due diligence on land purchases for major network assets • Major event planning	• Physical site security reviews • Staff safety and evacuation/ lockdown plans • Business continuity planning • Engagement with emergency agencies

FIGURE 6.5: EXAMPLE OF HILP EVENTS

6.4 Event management and emergency response

As a supplier of an essential service to more than 600,000 ICPs across Auckland and a nominated "lifeline utility" under the Civil Defence Emergency Management (CDEM) Act 2002, Vector has developed a suite of documentation that defines our key event management plans and processes (detailed in Table 6-1). This documentation ensures Vector maintains coordinated and clear management protocols to respond to events efficiently and effectively.

DOCUMENT	DESCRIPTION
Business Continuity Management Policy	Formal representation of Vector's commitment to business continuity management, which forms an essential part of Vector's enterprise risk management framework. Defines key business continuity management roles, responsibilities, accountabilities and reporting requirements. Approved by the Board, it is consistent with the following Standards: • AS/NZ 5050:2020 "Managing disruption-related risk" • ISO 31000:2018 "Risk management – Guidelines" • ISO 22301:2019 "Security and resilience - Business Continuity Management System – Requirements" • ISO 22313:2020 "Societal security – Business continuity management systems – Guidance"
Crisis Management Plan	Provides the enterprise-wide framework and structure to assess and respond to any crisis-level incident or event affecting Vector, its customers and/or employees, contractors, and other stakeholders. Takes account of both the operational response and broader considerations including staff, customer and wider stakeholder engagement and support. Includes the Incident Management Guideline, which provides direction on how to categorise incidents - this categorisation determines the appropriate response team, response plan and escalation hierarchy. Crisis management exercises and regular plan reviews are undertaken to ensure usability and understanding and support continuous improvement of the plan.
Crisis Communications Plan	Standalone plan governing the communications and external relations approach and processes during a crisis, emergency or business continuity events.
Networks Event Management and Investigation Process	A formal focused and coordinated process to effectively manage network events. The process defines the approach such that Vector can:

DOCUMENT	DESCRIPTION
	• Recognise, assess and respond to an event quickly and effectively • Notify the appropriate individuals and organisations about the event • Organise response activities • Escalate response efforts based on the severity of the event • Recover from event • Gather evidence to support and complete investigations
Specific Event Response Processes	Individual and detailed processes that ensure Vector is prepared for (and responds efficiently to) specific events that may occur on the network. These events include credible incidents and emergencies, for example storm response.
Business Continuity Plans	Individual business unit / team plans identify the critical functions and services provided by a unit/team and outline the recovery procedures to be undertaken during a disruptive event to maintain or resume these functions.
EOC Emergency Evacuation Plan	Ensures Vector's Electricity Operations Centre (EOC) is prepared for, and responds quickly to, any incident that requires the short, medium or long-term evacuation of the EOC. Vector's network control centre has a fully operational disaster recovery site. Regular evacuation exercises are held to ensure evacuation of the control centre can proceed smoothly.
Switching Plans	Restoration switching plans developed for each zone substation at a feeder level.
Emergency Load Shedding Obligations	Vector is required under the Electricity Industry Participation Code (2010) to provide emergency load-shedding by way of Automatic Under-frequency Load Shedding, to maintain the electricity security of the grid and avoid cascade trippings under emergency conditions.

TABLE 6-1: VECTOR'S EVENT MANAGEMENT PLANS AND PROCESSES

6.5 Privacy

Vector takes its obligations under the Privacy Act very seriously. The volume and potential sources of data which are required to effectively manage and operate the network continue to expand. For example, new network and customer devices generate increasingly important information about consumption patterns, faults, performance and resilience which enables us to manage the network more efficiently and effectively. Vector understands its legal obligations and also its "social licence" to use this information responsibly. Vector has established protocols which define how any personal data is required to be protected, managed, and used by approved personnel.

Our data governance programme takes a holistic view of how data is managed and governed and specifically considers privacy across all areas of our data. A number of roles exist which assist in Vector's adherence to privacy obligations.

FUNCTION	ACCOUNTABILITY
Privacy Officer	Setting policy and supporting privacy-related activities or issues. Dealing with privacy breaches, including any reporting requirements.
Enterprise Data & Information Management	Development and implementation of the Group Data and Information policy. This function supports all aspects of information management and provides operational support to the privacy officer.
Cyber Security	Establishment of systems and processes for the protection of all data.
Operational Information Management	Operational management, quality assurance and improvement of data.
Data Owners	Accountable for ensuring appropriate processes and systems are in place for all sensitive data and for implementing the requirements of data-related policies and procedures.
Data Steward	Responsible for implementing the requirements of data related policies and procedures.

TABLE 6-2: DATA GOVERNANCE ACCOUNTABILITIES

6.6 Asset management information systems

Vector has a suite of information systems that support its asset management practice.

6.6.1 PRIMARY SYSTEMS

Many of Vector's information systems operate through an integration layer that extends across these systems and enables the reporting and data analytics that support Vector's asset management processes. The following table provides an overview of the primary systems and provides insight into how they support asset management.

PRIMARY SYSTEM	FUNCTIONAL OVERVIEW
SAP	SAP is Vector's ERP System. It contains records for all assets and is used for managing the asset lifecycle from procurement and operation to maintenance and disposal. SAP also provides financial management related to asset management and project management
SAP Planned Maintenance (PM)	SAP PM is our asset maintenance management system used for planning, scheduling, executing and recording all maintenance activities on our assets.
GE Smallworld	This system provides the geographic, schematic and connectivity information used in managing Vector's network assets
ARC-GIS	This system provides geospatial visualisation and analytics tools
Siebel	Siebel is Vector's Customer Relationship Management system. This system is used for managing customer requests for new connections, quality of supply complaints management, and fault and outage management
Gentrack	Gentrack provides records for all connected ICP's as well as their regulatory and market attributes. It is used to manage energy consumption, revenue assurance and interfaces with the Electricity Authority registry
Data Analytics Layer	This is a bespoke integration layer that provides reporting, monitoring and associated analytics related to network assets. It is a critical source of information for most of Vector's asset management processes
Siemens Power TG	This is Vector's SCADA system and is used to monitor and control operations on the network as well as provide data on network loading and other critical asset data
GE Power On	This is Vector's ADMS (Advanced Distribution Management System). This system is still in implementation phase 1 and will be replacing Siemens Power TG in RY 2024. It will be used to monitor and control operations on the network, and record and provide critical asset data.
ARM	ARM is Vector's corporate risk management system. Under the Corporate Risk Policy, all asset management risks are recorded, prioritised and managed through this system Also, ARM is used as an enterprise incident management system, which includes recording of incidents and investigations.
Stationware	Stationware is Vector's system to record and manages all protection settings in its primary and distribution networks

TABLE 6-3: PRIMARY SYSTEMS OVERVIEW AND INSIGHTS

6.6.2 OTHER IMPORTANT SYSTEMS

Vector uses several other information systems, computer models and computer-based tools in the management of its electricity distribution assets. In particular:

- **DERMS:** a Distributed Energy Resource Management System, this application is constantly processing and optimising the use of any DERs connected to it. This optimises asset utilisation through, for example, peak management via community battery storage and ripple control. The system has a 24-hour load forecast across the overall network down to a distribution feeder and will automatically dispatch DERs to overcome network constraints or can provide a forecast of network headroom to customers so that they can optimise their DER(s) accordingly. This minimises customer impact, network reinforcement and costs. As more DERs are connected the importance of and reliance on this system will increase.
- **OSIsoft PI:** is a real-time network performance management system that utilises data from various corporate systems (e.g. SCADA – see above) and provides a Microsoft Excel link to support analysis. This tool provides a permanent archive of historical network data
- **Granular Customer Model and Database:** this is a bespoke model implemented as SQL Database that brings together all of Vector customer and energy information with information from third party sources (e.g. socioeconomics)
- **Scenario Model and Network Allocation Model:** this is a bespoke bottom-up customer load model implemented in Microsoft Excel to analyse the impact of future changes on network demand. It is used in Vector's network planning practice to forecast the yearly maximum demand for summer and winter periods at a feeder and zone substation level. It makes use of information from recorded historical demand data, the forecast scenario model and known step loads from large projects
- **Forecast model:** this is a bespoke model implemented in Microsoft Excel. This model established current loading by normalising for natural variability. It then provides load forecasts across network levels by combining scenario model results allocated by network asset, new or upgraded large-scale customer load requests and manual re-adjustments due to changes in topology
- **Network constraint model:** this is a bespoke model implemented in Microsoft Excel. It is used in Vector's network planning practice to forecast the ability to backstop individual feeders or entire zone substations in the event of failure. The model uses the demand forecast, individual feeder/zone substation capacity and backstop points between feeders to highlight any shortfalls in backstop capacity for the period of the AMP

- **Digsilent:** is a network modelling tool that provides network power flow and fault levels analysis. It uses information from Smallworld, the Demand Forecast, the Rating Datasheets and Gentrack to maintain its network model. This includes scripts that enable the automatic execution of certain workflows
- **CYMCAP:** is a software tool that calculates cable ratings based on ground thermal conductivity test results and standardised cable installation practices. It is used to set the ratings of all subtransmission cables
- **HV Spec:** is Vector's system of record for all outage information, including fault interruption and duration data. This system is used to calculate and report on Vector's reliability measures such as SAIDI and SAIFI
- **Rating Datasheets:** this is a Microsoft Excel based database that contains summer and winter ratings for subtransmission plant and considers future network constraints. Our rating datasheet is manually updated on an annual basis.
- **Ion:** Centralised server for data gathering all power quality metering information from zone substations and GXPs
- **Zone Substation Equipment Ratings:** this is a Microsoft Excel based database that contains details of the ratings of the primary plant in our zone substations and at GXPs. It considers N-1 ratings for winter and summer conditions and identifies points of constraint. It is manually updated on an annual basis

6.7 Information and data management

Vector has taken a coordinated approach to the management and governance of its information and data assets. The following five capabilities have been established reflecting the operational, strategic and governance overlaps across the disaggregated functions.

Enterprise Data & Information Management: This function delivers and supports the group data & information management program that manages the people, processes and technology that provide control over the structure, processing, delivery and usage of information required for management and business intelligence purposes. Providing compliance and governance frameworks applicable to both physical and electronic information.

Network Information Management: This function provides governance to the operational application of information and data management across the electricity network's systems of record for assets and operational activities, through the development, execution and supervision of plans, policies, programs and practices that control, protect and enhance the value of data and information assets throughout their life cycles.

Data Platforms: A technical function, this team is responsible for the management and development of the data and analytics application platforms.

Business Intelligence: Primarily a technical function, this team provides the data integration, visualisation and reporting capability to the business.

Analytics & Insights: Provides the technical analytics capability and highly specialised business operational knowledge to support all core functions within the Networks business and to provide the research, advanced modelling and data science capability.

6.7.1 DATA GOVERNANCE

Vector's Group Data and Information Policy and Information Governance Framework are the foundations that set out the governance requirements and operating model for the information lifecycle. This covers both information in electronic and physical form, as well as disciplines for the process of creating, obtaining, transforming, sharing, protecting, documenting and preserving data. In preparing the policy and operating model, Vector has followed the principles and framework as set out in the Data Management Association's body of knowledge [11].

The Group Data and Information Policy is supplemented and supported where necessary by other operational and policy documents including our Privacy Principles and Cyber Security Policy.

[11] DAMA-DMBOK, Data Management Body of Knowledge, Second Edition, DAMA International

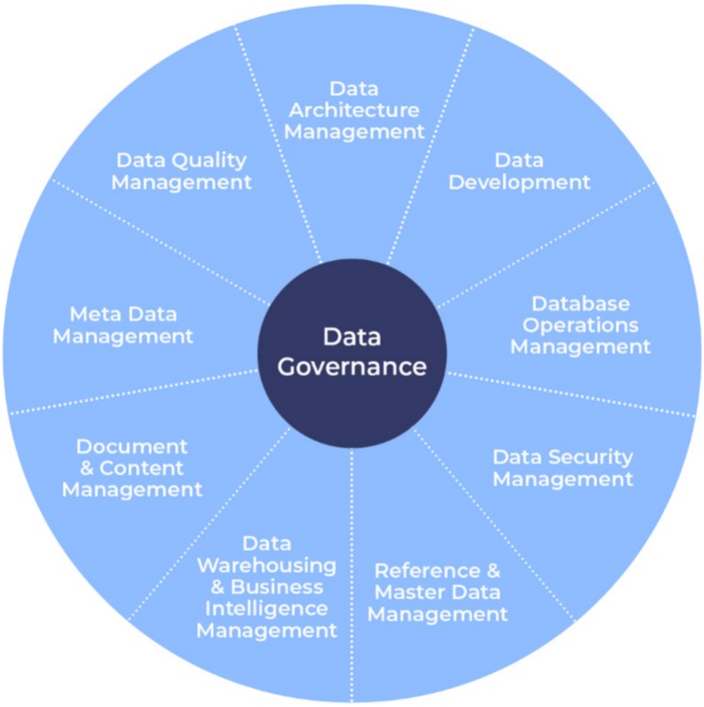


FIGURE 6.6: DATA MANAGEMENT ASSOCIATION FRAMEWORK

6.7.2 OPERATING MODEL

Vector's data and information management model is represented in the diagram below. Operationally, the Enterprise Data & Information Management (EDIM) function within the Digital Centre of Excellence provides capability horizontally across the different business units. Within each business unit, data stewards have been established to work with the defined data owners to ensure that business (i.e. operational) and governance requirements are met for each data set. The data stewards are trained and overseen by Enterprise Data & Information Management.

Vector operates a virtual Information Governance Council responsible for setting and supporting the implementation of the Group Data and Information policy. This includes being the escalation point for data related events and advice on the treatment and usage of data. Importantly the Council is made up of core disciplines and functions from across the business that impact privacy and data management including, but not limited to, Enterprise Data & Information Management, Privacy, Legal, Information Management and Data and Analytics. In addition, Cyber Security and Digital Architecture teams also provide subject matter expertise where required to support the Council in managing risk and maintaining good practice. In line with good governance and given the importance of strong data and information management in the success of our Symphony Strategy, the Council reports directly to Vector's Executive Team.

Operationally, the electricity business maintains a dedicated Networks Information Management team to perform the majority of the data activities as depicted in the box titled "Operations – Information Management". This team is responsible for defining and ensuring the implementation of data standards, as well as managing the data within the System of Record for asset, asset performance, geo-spatial and customer data. Also, the team also manages regulatory reporting (including one off requests) as well as managing other third-party data requests such as location information and asset information.

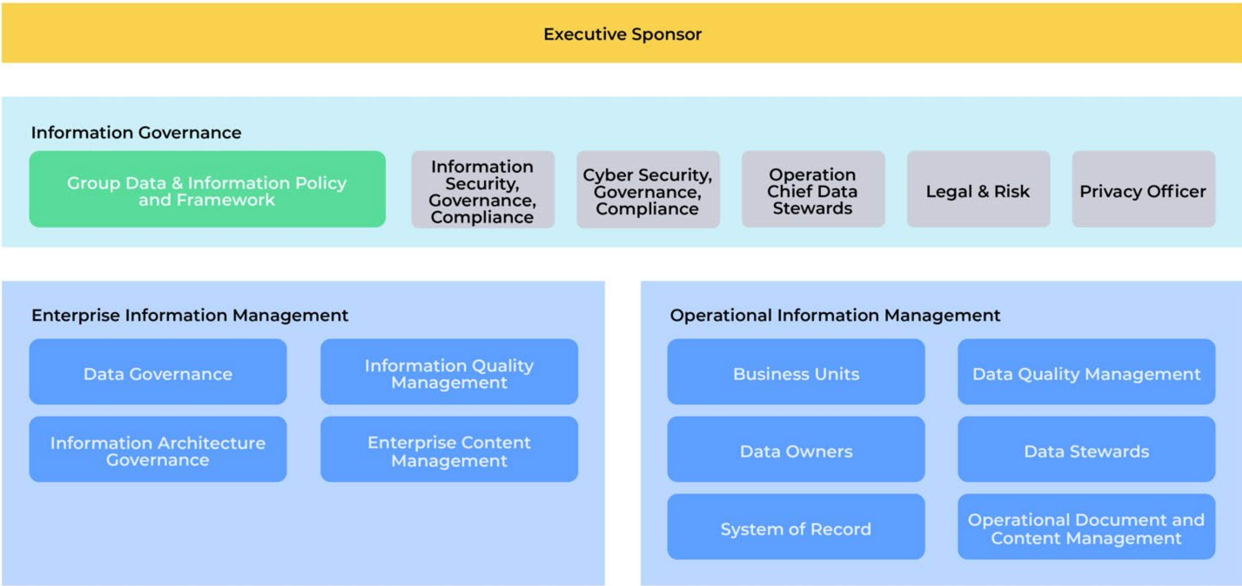


FIGURE 6-7: VECTOR'S DATA AND INFORMATION MANAGEMENT MODEL

6.7.3 DATA QUALITY AND OPPORTUNITIES FOR IMPROVEMENT

The Network Information Management function has an ongoing programme of work relating to the assurance and improvement of data that support the asset management practice. The programme has had a key focus on the alignment of asset management data with operational data, and a number of significant improvements have been completed since the last AMP.

1. Improvement of Customer contact and address data - Completed
2. Improved access to smart meter data from MEPs (Network Operational Data).
3. Improvement of network visibility including LV connectivity, ICP service fuse connection and phase assignments.
4. Enhancement of asset master data.
5. Improved access to Real-Time operational data.
6. Enhancement of OT Timeseries data management.

An ongoing focus remains on improving LV data, with the following key initiatives underway.

7. Improved access to smart meter data from MEPs (Network Operational Data).
8. Improvement of network visibility including LV connectivity, ICP service fuse connection and phase assignments.
9. Enhancement of asset master data.
10. Improved access to Real-Time operational data.
11. Enhancement of OT Timeseries data management.

6.8 Cyber Security

In the context of our Asset Management Plan, our strategy regarding cyber security continues to be focused on addressing two key categories of risk:

8. The protection of critical network assets from unauthorised access that could result in disruptions to service or physical damage
9. Safeguarding and restricting access to any personal/customer data that is used for network management purposes

At the core of this focus is the protection of Vector people, processes, data and systems from cyber security risks. Our operating environment is one where the number, sophistication and impact of malicious cyber security threats continues to grow and change, and we continually monitor how threat actors develop their tactics.

As Vector continues its digital transformation journey, continuing to maintain an effective and mature security posture is a key priority and an area in which we continue to invest sufficiently to ensure we appropriately manage these cyber security risks.

We have continued to improve our ability to detect and prevent potential cyber security threats via our Security Operations Centre (SOC), which provides 24/7/365 monitoring of our Information Technology (IT) and Operational Technology (OT) environments, and our preventative and detective controls through ongoing initiatives such as network modernisation, user awareness and education, identity and access management as well as external assurance. Execution of the Vector cyber security strategy and roadmap has resulted in advances such as the continuous development of security orchestration, while automation has resulted in reduction of manual effort and time required to remediate security incidents as well as streamlined identification, assessment, and remediation of vulnerabilities. The network modernisation initiative has progressed and will move Vector towards a zero-trust architecture with strong foundations in privileged access and service management with identity lifecycle automation for security risk mitigation, operational efficiency and visibility.

The Vector cyber security team continues to work with key global tier-1 security providers to apply a global perspective to cyber security assurance and technology, as part of an integrated Cyber Security Operating Model. We're also continuing our engagement and contribution to key New Zealand industry security forums, across public and private sectors.

The management of risk associated with cyber security is an industry wide concern. The Vector cyber security team continues to uplift cyber security capability across the industry, by bringing together key organisations to better protect themselves and promote security awareness. A cyber security risk can come from anywhere in the world, so collaboration between partners and industry participants provides a greater understanding of threats through intelligence and access to technologies, resources, and processes.

SECTION 07

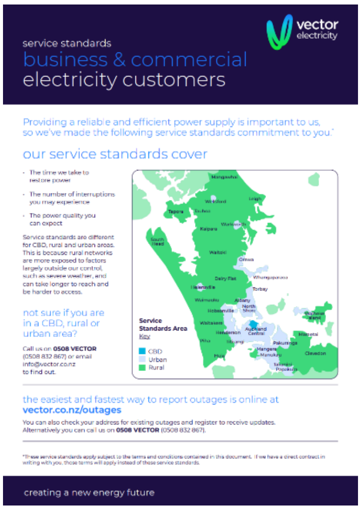
Our service levels

7 – Our service levels

This section sets out the specific service levels we measure our performance by to ensure we are delivering for our customers and stakeholders. Our service levels include regulatory targets such as SAIDI and SAIFI, as well as those we set ourselves.

7.1 Published service standards

Vector publishes on its website its service standards regarding the levels of network performance that a customer can expect on its website www.vector.co.nz. There are different standards for residential and commercial customers as well as for urban, CBD and rural. These differences reflect the different needs of customers as well as the realities of the network and surrounding geography.



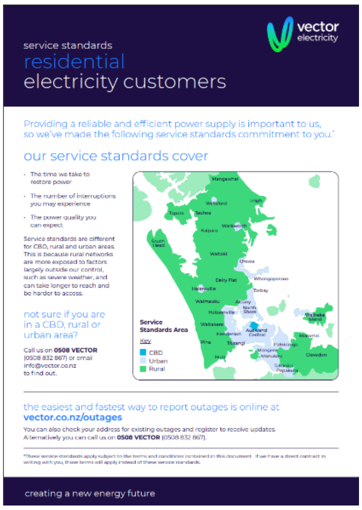


FIGURE 7-1: VECTOR SERVICE STANDARDS AS PUBLISHED ON COMPANY WEBSITE

7.2 Customer experience and customer satisfaction

7.2.1 ADVANCE NOTIFICATION OF PLANNED OUTAGES

DEFINITION

To provide customers with timely, accurate and reliable notification of planned outages.

MEASUREMENT

To provide a consistent measure of the Planned Outage notification service level, Vector has aligned calculations with the requirements under the DPP3 regulatory framework relating to the notification of customers of planned outages. Vector has made several significant system and operational changes to precisely track and record exact times that customers were notified of planned outages. These notices are published on the Vector website and are sent to customers via email or paper letter based on the contact details they have provided to retailers.

These changes were implemented and measured from the start of the RY21 year.

OUR HISTORICAL PERFORMANCE

DESCRIPTION	RY21	RY22	RY23
Notified Planned Interruption Accuracy	76%	81%	76%
Late Notice Limit	9.35%	7.14%	13.03%

TABLE 7-2: ADVANCE NOTIFICATION OF PLANNED OUTAGES

The two measures are designed to measure both the accuracy of notification to customers according to the defined service levels, as well as measuring the degree of accuracy when executing on planned outages.

Notified Planned Interruption Accuracy measures the percentage of planned outages which were notified according to the target service levels and carried out to plan.

Late Notice Accuracy measures the % of planned SAIDI incurred from late notification to customers.

OUR TARGET

Under the DPP3 regulatory framework, Vector is required to give residential and commercial customers a minimum of 4 working days' notice of a planned outage, and direct billed customers a minimum of 10 working days' notice. Vector incurs additional SAIDI penalties for planned outages that are notified to customers in breach of these timeframes and which do not meet the DPP3 requirements of a "Notified Interruption". To better meet residential and commercial customer's expectations, and to allow for postage and handling delays which could impact achievement of the regulated 4 working day notice period (where applicable), Vector has chosen to adopt a target of 7 working days' notice for these customers

To best serve our customers we have adopted an overall target of:

- Notified Planned Interruption accuracy target - 80%
- Late Notified target limit – No greater than 10% of planned SAIDI to be incurred from late notification of planned outages to customers.

7.2.2 CALL CENTRE GRADE OF SERVICE (GOS)

DEFINITION

To answer all customer calls concerning faults on the network within an acceptable agreed timeframe. Our customers want to be satisfied in their dealings with us when they call.

MEASUREMENT

We use the Grade of Service (GOS) call centre measure to judge how well we are doing. The GOS measures the number of calls made to the contact centre that are answered within 20 seconds.

OUR HISTORICAL PERFORMANCE

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
Average Grade of Service (GOS)	75%	79%	80%	84%	76%	73.9%*

* RY23 Grade of service includes the extreme weather events in January and February 2023 of the Auckland Floods and Cyclone Gabrielle. The Grade of Service outside of these events is 79.4%

TABLE 7-3: CALL CENTRE GRADE OF SERVICE

The contact centre Key Performance Metrics (KPMs) include a target for Grade of Service (GOS): 80% of calls must be answered within 20 seconds. The contact centre is incentivised to meet this, as performance against this target can impact its performance score, and subsequently its remuneration.

Vector is continuously working with our contact centre provider to improve GOS results, including increasing contact centre resource and driving efficiencies to enhance the contact centre's ability to handle high volume. We also continue to investigate self-service online capability which is at the customers' control.

Note: Some data may be excluded from GOS under a contractual Force Majeure with Telnet, covering exceptional events.

OUR TARGET

Our grade of service target is to have 80% of calls answered within 20 seconds.

7.2.3 SPEED OF QUOTES FOR NEW CONNECTIONS (SMALL CONNECTION CUSTOMERS)

DEFINITION

This service level applies to customers dealing with fewer than five lots and applies to the average time taken to quote on new connection applications. The speed of quotes for new connections is important to our customers, so we want to provide them with the information as quickly as possible.

MEASUREMENT

Measurement starts when a connection is requested and runs to the time the quote is provided.

OUR HISTORICAL PERFORMANCE

At present, 98 per cent of standard quotes are sent out within two days, and 88 per cent of quotes for non-standard connections are sent out within seven days. These measures were implemented in RY18 when standard charges were introduced for residential, 60-amp, single phase customer connections.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
Speed of quotes for new connections – Standard	84%	95%	93%	96%	95%	98%
Speed of quotes for new connections – Non-standard	68%	85%	75%	60%	70%	88%

TABLE 7-4: SPEED OF QUOTES FOR NEW CONNECTIONS

OUR TARGET

We aim to have 95 per cent of standard quotes sent out within two days, and 75 per cent of non-standard quotes sent out within seven days. These are reassessed every two years and we will continue this practice over the AMP period.

7.3 Power quality

Vector publishes all service standards on its website https://www.vector.co.nz/personal/electricity/about-our-network/our-service-standards , which include regulated voltage service standards, and instructions to customers on how to contact Vector to report voltage issues.

Vector delivers supply voltages as required under the Electricity (Safety) Regulations 2010. Maintaining the network within the permissible range is getting more complex and geographically diverse. Distributed generation (e.g. solar PV) is pushing the network voltage towards the upper threshold in summer, new electric loads, such as EV charging are testing the lower threshold. In time, rapid and synchronised response of large numbers of devices to external signals, such as energy spot prices, system frequency, or time-based retailer offerings, could also cause volatility in local voltage.

We are currently developing our capability to harness power quality from smart meter data through active trials with metering equipment providers. Additionally, we are rolling out a dedicated distribution transformer monitoring pilot in areas of the network that helps to complement smart meter data.

We are continuing to take the two following approaches to managing power quality, to work around a lack of access to customer smart metering data. Firstly, we have an active programme to install power quality meters (PQMs) at several of our zone substations and GXP sites to monitor the network. Secondly, we take a reactive approach to investigate any incidents identified by customers.

Vector has installed PQMs to primarily baseline and trend harmonic[12] levels on the network. This is especially helpful to us in monitoring and understanding the impact of power electronics operating at the residential level, particularly the increasing numbers of inverters associated with solar PV, electric vehicle, and battery charging. This also enables us to proactively address any power quality issues we identify.

When we are notified of instances of the network operating outside the regulated voltage range, we investigate and then remedy the problem. The data from PQMs is analysed to determine the cause of any network disturbances, and changes made to improve our performance to meet regulatory requirements.

The power quality requirements are summarised as:

- Electricity Safety Regulations requires that Low Voltage must remain within 6% of the nominal voltage (230V for single phase)
- Electricity Industry Participation Code Part 8 requires that High Voltage must remain within 6% of the nominal voltage
- AS/NZSS 61000 and its Parts sets out the requirements for voltage and current waveform distortions
- Voltage and frequency requirement for distributed generation (customer connections) are set out Vector's website

7.3.1 IMPROVING PRACTICES FOR MONITORING LV NETWORK VOLTAGE QUALITY

Vector's current practice regarding voltage services levels is to respond reactively to all customer reports of voltage issues. These are promptly investigated and where they relate to the quality of voltage at the customer's point of supply, are resolved by reconfiguring or upgrading the distribution network.

Vector has two key initiatives to improve visibility of the LV network, and specifically provide greater visibility of LV voltage. These two initiatives will allow Vector to proactively monitor customer LV network voltage quality, which is a step change from currently reacting to customer reports.

1) Distribution transformer LV monitoring
Vector is piloting a programme of work to install power quality instrumentation on a sample of its distribution transformer fleet. This will provide highly precise measurement of LV Feeder and LV Phase voltage performance. This data will be available in near-real-time and can be used to proactively identify and respond to voltage performance issues.

2) Smart meter power quality data
Vector is actively engaged with the two primary Metering Equipment Providers (MEPs) on the network to obtain comprehensive power quality data from smart meters installed on the network. Vector now has access to 30% of ICP's operational smart meter data which includes voltage recorded at 5-minute intervals, and is anticipating full network coverage will be achieved by the end of RY2025. Access to this data will provide a substantial improvement of Vector's ability to monitor the performance of the LV network as recorded at the customer's meter. This data will enable Vector to identify individual ICPs, as well as LV circuits and

[12] Harmonics occur on the network when current and voltage are distorted and deviate from sinusoidal waveforms. Harmonic currents are caused by non-linear loads connected to the distribution system

individual LV Phases experiencing voltage issues and will enable Vector to proactively respond and resolve issues. Additionally, this data will enable Vector to identify the potential root cause of voltage issues, such as unregistered or non-compliance DER installations, or increased EV density.

ADDRESSING KNOWN NON-COMPLIANCE

If any voltage non-compliance issues are identified from customer complaints and confirmed by data, then a technical investigation will ensure that the issue is not created by poorly configured customer-side equipment (e.g. induction motors or inverters) and will then identify the most suitable solution to address the issue. Typical solutions to address power quality constraints include altering the tap setting on the distribution transformer, reconfiguring the network, reconductoring the line or upgrading the transformer.

RESPONDING AND REPORTING

Vector responds reactively to all reported voltage issues. All reported issues are recorded as a voltage investigation service requests in our CRM system Siebel. These may be identified by our customers or by our field service providers.

The customer resolutions team manage the resolution of all investigation requests. Initially an investigation will be conducted into the nature of the issue. Typically, this will result in an on-site investigation, and a power quality logger will be installed and run for a minimum of 1 week to log the power quality at the point of supply. If the investigation request relates to a customer's specific appliance, then Vector may install a separate logger on the appliance to determine whether the issue relates to the Vector supply, or the customer's installation.

COMMUNICATING TO CUSTOMERS

All voltage investigations are dealt with by the customer resolutions team. A representative will contact customers directly, to inform them of all work being undertaken on the network to address voltage issues.

7.4 Safety

Each year Vector undertakes a large number of work activities without harm. Our ongoing commitment to achieve the safe outcome of these work activities is through continuous improvement and innovation. We foster collaboration across all stakeholders, we embrace technological advancements and maintain adaptability to build a resilient and safe network. We continue our focus on critical risks and build our assurances around the effectiveness of controls we rely on to manage these risks. We continue to place significant emphasis on the management of our outsourced field service providers, and the assurance of the quality of their health and safety systems and practices.

7.4.1 TOTAL RECORDABLE INJURY FREQUENCY RATE

DEFINITION

The total recordable injury frequency rate (TRIFR) encompasses all network incidents resulting in medical treatment, restricted work injury, lost time injury or fatality, which impacts Vector people including all contractors and FSPs.

MEASUREMENT

The incident count is divided by the number of hours worked for the same measurement timeframe, Vector reports TRIFR as a rolling 12-month average which is then normalised to report TRIFR in per million hours worked.

HISTORICAL PERFORMANCE

Table 7-4 shows the Networks TRIFR performance under the definition of this service level metric.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
Total recordable injury frequency rate (TRIFR)	14.07	5.01	5.82	7.45	6.25	2.25

TABLE 7-5: TRIFR

7.4.2 ASSET SAFETY INCIDENT MEASURE

DEFINITION

The asset safety incident measure is a count of incidents that resulted in harm to personnel, members of the public or to property, resulting from a deficiency or failure in any equipment on Vector's electricity distribution network.

MEASUREMENT

The asset safety incident measure is calculated by identifying the number of asset safety incidents in Vector's Risk and Incident Management System (ARM) which have caused harm or damage to people or property.

HISTORICAL PERFORMANCE

Table 7-5 shows the asset safety incident performance following the definition of this service level metric.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
Asset safety incident	7	5	4	0	1	1

TABLE 7-6: ASSET SAFETY INCIDENTS

The number of asset safety incidents has been the same as the previous year with one event in RY23.

7.5 Reliability

This considers the ability of the network to deliver electricity consistently when demanded under normal design conditions. We are committed to achieving compliance with the Regulatory quality metrics.

7.5.1 PROVIDING NOTICE AND COMMUNICATION OF PLANNED AND UNPLANNED INTERRUPTIONS TO CUSTOMERS

PLANNED OUTAGES

Ahead of all planned outages Vector conducts an extensive assessment of the customers to be affected. In particular, careful consideration is given to the operating hours of affected businesses and organisations such as churches and schools, and wherever possible Vector will adjust the schedule of planned outages to reduce the effect on customers. If necessary, Vector will contact customers directly to discuss scheduling.

Vector directly notifies customers of scheduled planned outages via Letter and/or Email, depending on the availability of email contact information provided from the retailers. Vector also sends SMS reminders for notified planned outages to customers that have valid mobile numbers. Vector has a target service level for sending direct notice to customers a minimum of 10 working days in advance of the notified planned outage. It is worth noting that the quality and availability of data for communicating to customers directly via electronic mechanisms (email and SMS) is dependent on data supplied to Vector by the customer's retailer. Where this has not been supplied to Vector, a physical letter is mailed to the customer's postal address and the physical address of the property affected (should they be different).

For planned outages that impact 20 customers or fewer (excluding direct-billed customers), Vector's field service provider has the option to Card Drop the outage notice directly to the customers mailbox at least 4 working days in advance of the outage.

Notice for postponement of a notified planned outage must be given to customers at the earliest convenience and is only allowed if the customer was notified of alternate dates and times on the original outage notice. Vector's target is to have customers informed of postponements prior to the proposed original start time.

Notice for cancellation of a notified planned outage must be given to customers at the earliest convenience. Vector's target is to have customers informed of cancellations at least 24 hours prior to the proposed notified start time.

All scheduled planned outage information is also published on Vector's website via the Outage Centre *https://help.vector.co.nz/planned* . This service allows customers to search an address to see upcoming planned outages. Customers can also view a map of Auckland to see planned outages currently being executed.

Improvements recently made to planned outage communications is the ability to send planned outage overrun notices directly to customers who have email/ SMS contact information, at times where outages unexpectantly take longer than originally notified. This will help to manage customer expectations when outages do not go to plan.

UNPLANNED OUTAGES

Vector has several channels for communicating to customers about unplanned outages. These are outlined below:

1. Website – Outage Centre

All known unplanned outages are shown on Vector's website https://help.vector.co.nz/address. Customers can either check their address or view a map of the Vector network to identify and track the status of known unplanned outages. Customers can also use the Outage Centre to report an outage if it is not currently displayed.

The Outage Centre is Vector's primary channel for providing interactive updates to customers on the progress of unplanned outage restoration. Customers can subscribe to receive SMS or email updates on the restoration progress of an unplanned outage. Wherever possible an estimated time of when the power will be restored is posted along with the reason of why the outage happened.

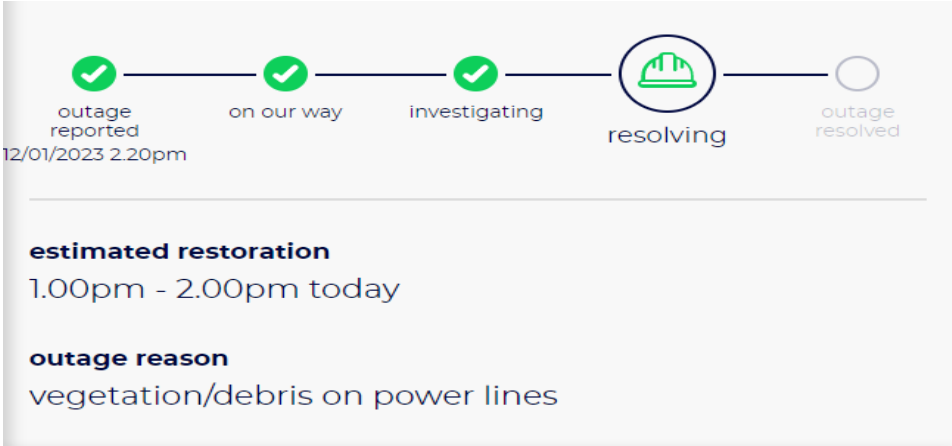


FIGURE 7-2: VECTOR'S WEBSITE OUTAGE CENTRE NOTIFICATION

2. SMS / TXT messaging

Should an unplanned outage occur which affects one or more high voltage feeder circuits, all affected customers, who have provided their electricity retailer with a valid mobile telephone number, are sent an SMS message detailing the nature of the fault and expected restoration time.

3. Call Centre & IVR

Vector operates a 24 x 7 call centre using the telephone number 0508 VECTOR or 0508 832 867. The call centre provides the ability for customers to report unplanned outages, as well as get updates on the status of current unplanned outages via a call centre operator. In addition, an Interactive Voice Response (IVR) tool is integrated with the call centre, which provides automated verbal updates on known unplanned outages to customers and redirects customers to the Outage Centre. The IVR minimises customer call waiting times during time of high call numbers.

4. Social Media

Before and during large scale events (such as a storm) with multiple unplanned outages, Vector will communicate to customers using social media.

5. Bespoke communications

Where a specific group of customers requires targeted communication due to the nature or duration of a specific unplanned outage, Vector will deliver targeted bespoke communications. These are in the form of an email or SMS.

We are committed to keeping our customers informed when unplanned outages occur, and we constantly drive improvements in making this happen.

Improvements have recently been made to provide more detailed and specific communications to customers during large-scale events, such as tropical cyclones. Twenty three regional customer zones have been developed and can be used for communication relating to the event and restoration plans for a specific part of the network. In addition improved automated communication methods have been implemented for providing customers information relating to their faults reported to the outage centre. Other planned initiatives are to enable guest reporting via the outage centre, improve the user interface, and enable hot water fault reporting by customers.

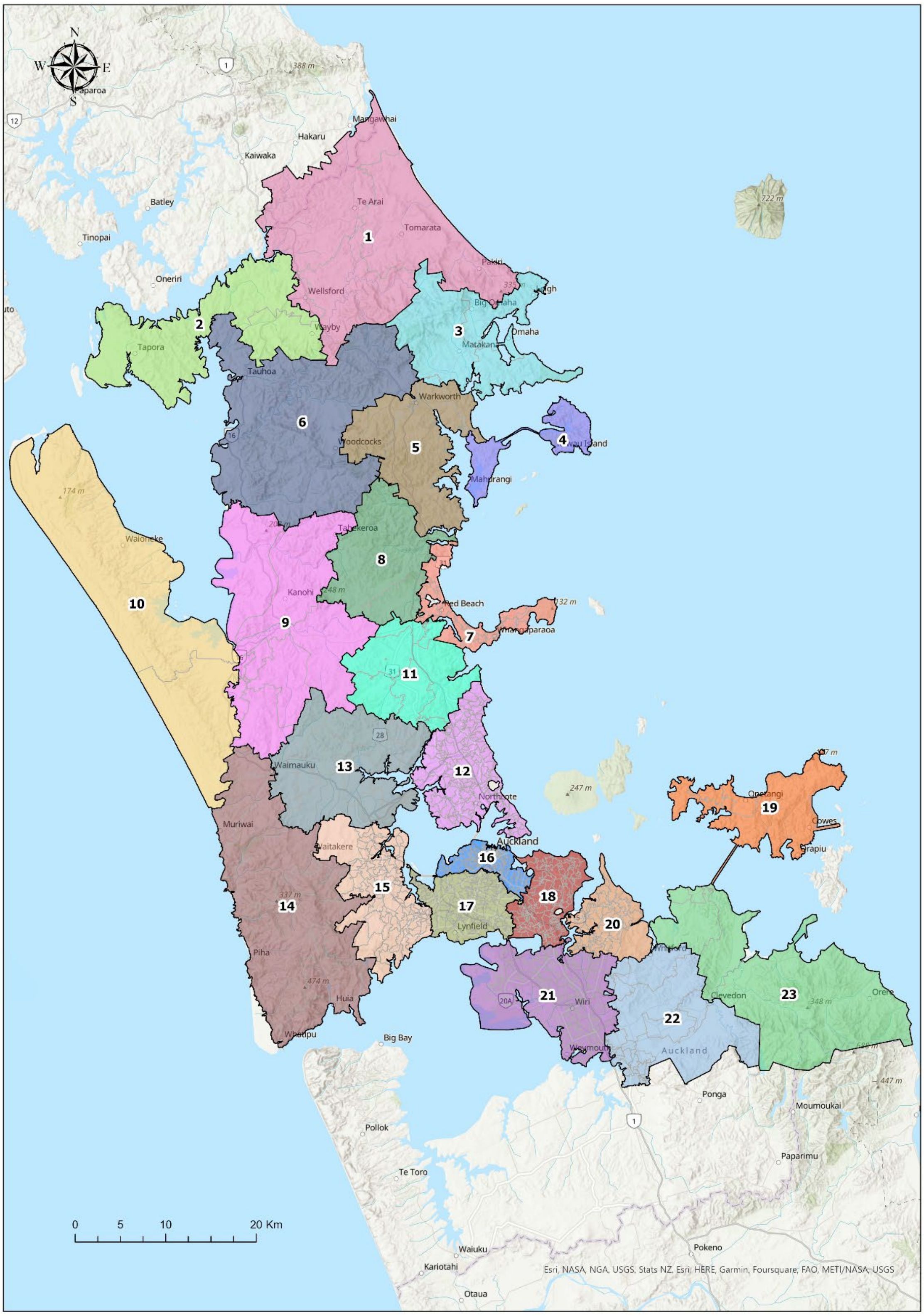


FIGURE 7.3: VECTOR CUSTOMER ZONES FOR OUTAGE COMMUNICATION

SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

DEFINITION

SAIFI measures the average number of outages per customer per RY, the value expressed in the number of interruptions. This is one of the key metrics used to assess the reliability of the network. It is calculated as the total number of customer interruptions divided by the total number of customers served, where interruptions are for 1 minute or longer.

In order to align with information disclosure requirements set out under the electricity distribution service default price-quality path determination (DPP3), from RY21 Vector has moved to measuring planned and unplanned SAIFI as two separate measures, with respective targets.

It is noted that Vector does not record SAIFI according to the 'successive interruption method' as defined in the 2022 Targeted Information Disclosure Review.

MEASUREMENT

SAIFI= (total number of interruptions) / (average number of customers)

SAIFI only measures outages caused by an event on the HV network and does not include the LV network. Unplanned SAIFI is limited where a major event has occurred (e.g. storms), to prevent these extreme events from distorting the overall SAIFI data. The following formula is used for the planned SAIFI calculation:

$$SAIFI\ planned, assessed\ = SAIFI_B$$

Where:

$SAIFI_B$ is the sum of the SAIFI values:

(a) for Class B interruptions commencing within the assessment period.

The following formula is used for the unplanned SAIFI calculation:

$$SAIFI\ unplanned, assessed\ = SAIFI_C$$

Where:

$SAIFI_C$ is the sum of the SAIFI values:

(a) for Class C interruptions commencing within the assessment period, where the SAIFI value for each 30 minute period that starts on the hour or half past the hour within a SAIFI major event that exceeds 1/48th of the SAIFI unplanned boundary value for that assessment period is replaced with 1/48th of the SAIFI unplanned boundary value for that assessment period.

The SAIFI Unplanned Boundary Value is calculated as per the Commerce Commission process. This limit is set to 0.037 for the current regulatory period (1 April 2020 to 31 March 2025).

Class B interruptions - means planned interruptions by a non-exempt EDB

Class C interruptions - means unplanned interruptions originating within the system fixed assets of a non-exempt EDB

All of Vector's interruption data is held in our HV Spec database which is used to calculate and report on SAIFI performance. SAIFI is continually monitored including reporting to the Strategic Reliability Management (SRM) fortnightly meeting and reported on a monthly and annual basis to inform asset management practices. For regulation purposes, SAIFI is reported to the Commerce Commission on an annual basis. SAIFI reporting to the Commerce Commission is subject to an external audit.

The SAIFI target is set by the Commerce Commission's regulatory determination every 5 years. It is largely based on the average SAIFI performance over a 10-year historical Reference Period. The process for setting this target is specified in the DPP Determination.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
SAIFI – Combined	2.14	1.76	1.58			
SAIFI – Planned				0.342	0.269	0.256
SAIFI – Unplanned				1.070	1.048	1.194

TABLE 7-7: SAIFI

For the 2023 assessment period, Vector did not exceed its reliability limits and was compliant with the DPP3.

Vector considers the matter of quality compliance of utmost importance. To improve our network reliability, we have invested significantly in network improvements and operational processes to improve network reliability.

TARGET

For the Regulatory Period, (1 April 2020 to 31 March 2025) Vector's annual SAIFI target has been set based on the limits defined within the DPP3. It is worth noting that from 1 April 2020 these targets have been split according to Planned and Unplanned events.

Unplanned SAIFI Limit = 1.337

Planned SAIFI Limit = 0.576 (Average annual)

(refer to the DPP3).

7.5.2 SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

DEFINITION

The SAIDI index measures the average duration of outages per customer per RY, the value is expressed in minutes. This is one of the key metrics used to assess the reliability of the network. It is calculated as the sum of the duration of all customer duration interruptions divided by the total number of customers served, where interruptions are for 1 minute or longer.

In order to align with information disclosure requirements set out under the DPP3, from RY2021 Vector has moved to measuring planned and unplanned SAIDI as two separate measures, with respective targets.

MEASUREMENT

SAIDI = (total interruption minutes) / (average number of customers)

SAIDI only measures outages caused by an event on the High Voltage (HV) network and does not include the LV network. The SAIDI dataset is normalised using a process defined by the Commerce Commission in the DPP. This process reduces notified planned interruptions by 50% as it is considered that customers are less impacted by interruptions that are planned. It also limits unplanned SAIDI on days where a major event has occurred (e.g. storms) to prevent these extreme events from distorting the overall SAIDI data. The following formula is used for the planned SAIDI calculation:

$$SAIDI\ planned, assessed\ = SAIDI_B + \frac{SAIDI_N}{2}$$

Where:

$SAIDI_B$ is the sum of the SAIDI values:

(a) for any Class B interruptions commencing within the assessment period that are not Class B notified interruptions; and

(b) in respect of any Class B notified interruptions commencing within the assessment period that have occurred partially or wholly outside of their specified notified interruption window or alternate day, the SAIDI value attributable to the period of minutes that falls outside of that specified notified interruption window or alternate day.

$SAIDI_N$ is the sum of:

(a) the SAIDI values attributable to any minutes that fall within the specified notified interruption window or alternate day of any Class B notified interruptions commencing within the assessment period, where the SAIDI value is the greater of that calculated based on:

(i) the duration of minutes accumulated for each ICP that the Class B notified interruption occurred for; and

(ii) the period of the notified interruption window minus two hours;

(b) the 'intended SAIDI values' of any intended interruption cancelled without notice in the assessment period, where the 'intended SAIDI value' for each of those intended interruptions cancelled without notice is the greater of that calculated based on:

(i) the duration of minutes accumulated for each ICP that the intended interruption occurred for, which will be nil; and

(ii) the period of the notified interruption window minus two hours; and

(c) the 'intended SAIDI values' of any intended interruption cancelled with notice in the assessment the period, where the 'intended SAIDI value' for each of those intended interruptions cancelled with notice is nil.

The following formula is used for the unplanned SAIDI calculation:

$$SAIDI\ unplanned, assessed\ = SAIDI_C$$

Where:

$SAIDI_C$ is the sum of the SAIDI values:

(a) for Class C interruptions commencing within the assessment period, where the SAIDI value for each 30 minute period that starts on the hour or half past the hour within a SAIDI major event that exceeds 1/48th of the SAIDI unplanned boundary value for that assessment period is replaced with 1/48th of the SAIDI unplanned boundary value for that assessment period.

The SAIDI Unplanned Boundary Value is calculated as per the Commerce Commission process. This limit is set to 4.83 for the current regulatory period (1 April 2020 to 31 March 2025).

Class B interruptions - means planned interruptions by a non-exempt EDB

Class B notified interruption - means a Class B interruption that a non-exempt EDB has given additional notice for, and the Class B interruption is recorded as a 'Class B notified interruption' in the non-exempt EDB's internal systems

Class C interruptions - means unplanned interruptions originating within the system fixed assets of a non-exempt EDB

All of Vector's interruption data is held in our HV Spec database which is used to calculate and report on SAIDI performance. Supply interruptions are identified by the Supervisory Control and Data Acquisition (SCADA) system or through calls to the Customer Excellence team. Once faults have been resolved by the FSP, details of interruptions are logged in HV Spec. The customer interruptions are updated as supply is restored, with SAIDI calculated for each step in the restoration process. Where faults are identified through the Customer Excellence team, details are also captured in Siebel and linked back to HV Spec. SAIDI is continually monitored including reporting to the SRM fortnightly meeting and reported on a monthly and annual basis to inform asset management practices. For regulation purposes, SAIDI is reported to the Commerce Commission on an annual basis. SAIDI reporting to the Commerce Commission is subject to an external audit.

The SAIDI target is set by the Commerce Commission's regulatory determination every 5 years. It is largely based on the average SAIDI performance over a 10-year historical reference period. The process for setting this target is specified in the DPP.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
SAIDI – Combined	226.2	198.2	167.5			
SAIDI – Planned				46.54	40.48	43.87
SAIDI – Unplanned				86.3	92.42	118.74

TABLE 7-8: SAIDI

For the 2023 assessment period, Vector exceeded its reliability limits and was not compliant with the DPP Determination for unplanned SAIDI. As of 26 January 2023, Vector ' s unplanned SAIDI and SAIFI were on track to be compliant for the 2023 assessment period as measured against the prorated year-to-date limit at that date. However network performance was impacted by sustained adverse weather conditions, notably severe flooding in late January and cyclone Gabrielle in early February which left the network in an abnormal state. Even though the events were classified as Major Events the ongoing tail from cyclone Gabrielle adversely impacted unplanned SAIDI resulting in the limit being exceeded. However despite these events the unplanned SAIFI limit was not exceeded.

Vector considers the matter of quality compliance of utmost importance. To improve our network reliability, we have invested significantly in network improvements and operational processes to improve network reliability.

TARGET

For the Regulatory Period, (1 April 2020 to 31 March 2025) Vector's annual SAIDI target have been set based on the limits defined within the DPP3. It is worth noting that from 1 April 2020 these targets have been split according to Planned and Unplanned events.

Planned SAIDI Limit = 117.08

Unplanned SAIDI Limit = 104.83

(refer to the DPP3).

7.5.3 NUMBER OF CUSTOMER INTERRUPTIONS PERFORMANCE AGAINST AGREED SERVICE STANDARDS

DEFINITION

This service level measures the number of unplanned supply interruptions experienced by customers on Vector's distribution network. It differs from SAIFI as it is the actual number of interruptions that a customer experiences rather than the average across the network. As with SAIFI, the interruptions are those of 1-minute duration or greater. At this stage, this metric only includes outages on the HV network. We see this measure as a much more effective representation of the impact of outages on customers, than an average measure such as SAIDI, that enables us to effectively engage customers affected by outages on issues such as cost quality trade-offs, etc.

The Default Distributor Agreements between Vector and energy retailers and Vector's Service Standards for Residential and Business & Commercial Electricity Consumers define the standard for customer interruptions. The standard states the number of interruptions, longer than 1 minute, that a consumer experiences per year should not exceed:

- 4 interruptions per annum in the CBD and urban areas; and 10 interruptions per annum in rural areas.

MEASUREMENT

All of Vector's interruption data is held in the HV Spec system, which is used to calculate and report on the number of customer interruptions performance. This metric is measured on an annual basis.

DESCRIPTION	RY18	RY19	RY20	RY21	RY22	RY23
Customer interruptions performance	92.6%	97.1%	97.3%	98%	98.6%	98.2%

TABLE 7-9: CUSTOMER INTERRUPTIONS PERFORMANCE

The number of customer interruptions exceeding the agreed service. standards has decreased over the past year. The factors affecting these measures are similar to those affecting Vector's SAIDI and SAIFI service standards, however, these service standards do not include any events outside of Vector's direct control (such as storms or third-party damage to the network).

TARGET

Vector's target is to meet or exceed 99% compliance.

7.6 Security of supply

Security of supply of the electricity network is the ability of the network to meet customer demand without interruption. Security of supply needs to balance the cost of redundancy with customer expectations and the benefit of supply availability for customers and society. The benefit for customer and society is progressively changing and in general increasing due to the growth of the service economy, electrification of transport and heat, and increased remote working arrangements.

Security of supply specifies the network capability for restoring power after single or multiple asset failures (unplanned outages) and maintenance (planned outages). The general principle is that the higher the network level, the more demand is at risk from a single event, and the stricter the requirements to provide demand restoration before the fault(s) are repaired. The reliability metrics SAIDI and SAIFI are closely related to security of supply. These metrics measure asset performance and outage management across the network (for assets ≥11 kV), while the SoS defines network architecture and restoration requirements (including redundancy of assets).

Vector uses a probabilistic approach in the security of supply standard (ESP010). These are based on nine categories, classified according to sub-transmission, distribution and CBD or non-CBD, as shown in Table below. Very importantly, the SoS standard sets the criteria for network development about when and where reinforcement is needed.

CLAUSE	DEMAND	CATEGORY	STANDARD
1	Any	Single events incurring greater than 4 SAIDI minutes	>4 SAIDI minutes: investment evaluated using a risk-based approach
2	Any	CBD ZSS and sub-transmission	N-1: All demand (first contingency – no interruption) N-2: All demand (second contingency – restored in 2 hours)
3	Any	Non-CBD ZSS and sub-transmission	N-1: All demand restored in 2.5 hours (urban), 4.5 hours (rural). This requirement to be met for 95 percent of the year for primarily residential substations and 98 percent of the year for primarily commercial substations
4	Any	CBD distribution feeders (22 kV or 11 kV)	Demand restored to all but a single distribution substation in 2.0 hours. Remainder restored in repair time
5	Any	Non-CBD distribution feeders (22 kV or 11 kV)	Primarily underground: demand restored to all but 800 kVA within 2.5 hours (urban). Remainder restored in repair time Primarily overhead: Demand restored to all but 2.5 MVA within 2.5 hours (urban) and 4 hours rural. Remainder restored in repair time. This requirement to be met for 95 percent of the year for primarily residential feeders and 98 percent of the year for primarily commercial feeders
6	Any	Distribution substations (11/0.4kV)	Restored within repair time
7	Any	Distribution feeders (400V or 230V)	Restored within repair time
8	Any	All sub-transmission and zone substations	Maximum of one month on security reduced with respect to clause 2 and 3
9	Any	All sub-transmission and zone substations	Spatial separation of primary network assets sufficient to avoid common mode failure

TABLE 7-10: SUMMARY OF SOSS

7.7 Cyber Security

As our electricity network continues to evolve greater digital capability is built to deliver customer benefits. We are committed to investing in technology solutions, processes and capabilities to ensure that we appropriately protect and detect potential disruptive security events that could impact customer privacy or our network services. The threat of a successful attack is ever-present, and we cannot rely solely on detective and preventative controls to mitigate the risk. Robust recovery strategies are also required to be able to quickly respond and recover to limit the impact.

While our ability to meet any service targets is highly dependent on the nature and complexity of each attack, we have set ourselves clear performance targets for the detection, containment and recovery from a cyber security incident. Effective processes and procedures have been developed to ensure our service targets can be met (or where possible exceeded) and Vector is very committed to achieving these. A description of the service levels is included below however, we do not publish the actual service level targets due to commercial sensitivities and for security reasons.

The table below summarises how we prioritise security incidents for our environment:

PRIORITY	DESCRIPTION	NARRATIVE
1	Critical Incident	Under Attack or Threat. Vulnerabilities are being exploited with a high level of damage or disruption, or the potential for severe damage or disruption is high and will have a severe impact on business operations and/or damage, disruption of Critical Infrastructure Assets.
2	Priority Incident	The real potential exists for malicious cyber activities due to exploits that have been identified or known exploits that have been identified that may indicate an advanced persistent threat. Or intelligence has been gained that a significant event may occur.
3	Standard Incident	Some disruption to business systems or users or customers may be experienced due to a cyber event, but does not impact any major services, or known exploits have been identified but no significant impact has occurred.
4	Low-Impact Incidents/ Request for Service	An incident that allows the Infrastructure or Client system to be used with limited functions and has a low risk of significant business impact. This also covers requests for service – i.e. not logging an Infrastructure fault. This typically comprises a change request but may also include requests for information.

TABLE 7-11: INCIDENT PRIORITY DEFINITIONS FOR CYBER SECURITY

7.7.1 INCIDENT AND REQUEST SERVICE LEVELS

SERVICE LEVEL NAME	SERVICE LEVEL
Incident Management **Incident Response**	P1: 90% of P1 Incidents responded to within 2 hours P2: 90% of P2 Incidents responded to within 4 hours P3: 90% of P3 Incidents responded to within 8 hours P4: 90% of P4 Incidents responded to within 8 hours
Incident Management **Incident Response**	P1 incident reports for service impacting events issued as and when agreed for the specific event
Request Fulfilment	90% of Service Requests are actioned within 5 business days

TABLE 7-12: INCIDENT AND REQUEST SERVICE LEVELS

7.7.2 INCIDENT SUPPORT HOURS

SEVERITY	SUPPORTED HOURS
1 – Critical Incident	24x7
2 – Priority Incident	24x7
3 - Standard Incident	Business Hours
4 - Request for Service	Business Hours

TABLE 7-13: INCIDENT SUPPORT HOURS

7.8 Complaints Management

This information is in addition to that provided in section 7.3.1 (Addressing known LV non-compliance).

Vector manages complaints in an efficient and pragmatic manner balancing legitimate customer concerns with Vector's long-term interests. Areas of complaints include:

- Planned outages: Planned outages include programmed maintenance; project works and customer-initiated connections
- Network reliability: Trees on lines, general unplanned disruption
- Other combined: Includes location of assets, self-service, quality of work, timelines, response times, etc
- Communication and information
- Connection costs

Complaints are lodged through various channels including the contact centre (primarily), online social media, emails, surveys, and letters. Customers receive an automated acknowledgement email or physical letter confirming their complaint has been received and a copy of the "Vector Disputes Resolution Process" is provided. Our disputes resolution process aligns with the expectations set out in the Energy Complaints Scheme document (as administered by Utilities Disputes formerly the Electricity and Gas Complaints Commissioner or EGCC).

Some complex complaints require time for investigation. Customers are updated if a resolution timeframe requires extension.

Some complaints and technical inquiries can be complex and may require site visits or specialist investigation.

Further detail can be found on the Vector website. dispute resolution process

SECTION 08

Network maintenance

8 – Network maintenance

8.1 Section overview

This section describes the key elements of Vector's approach to the maintenance of our network assets. These activities are crucial to ensuring that the assets are well maintained and can continue to operate safely and effectively while delivering to our Asset Management Objectives.

Vector's maintenance portfolio covers a broad spectrum of activities and includes investment across both OPEX and CAPEX profiles. The key elements of the portfolio include Planned Maintenance, Corrective Maintenance, Reactive Maintenance and Vegetation Management.

We continue to focus and optimise our risk based approach to corrective maintenance and vegetation management as we further refine these to continue to drive efficiencies in the medium to longer term.

As maintenance is the primary source of ongoing asset condition information, the ongoing benefits from the improvements from our systems and standards changes will allow us to become more predictive and risk based in our overall approach. This will support our longer-term Condition Based Asset Risk Management (CBARM) modelling initiatives and associated asset lifecycle decision making.

8.2 Network maintenance activity overview

The key elements of our network maintenance program are as follows:

Planned Maintenance (PM) – this activity delivers our routine maintenance programme for inspections, condition assessments, testing and servicing of our assets in accordance with our maintenance standards.

Corrective Maintenance (CM) – this activity primarily addresses issues identified through our condition-based assessments and inspections. Functionality is restored, and assets are repaired or replaced as required to ensure that the network can continue to operate safely and effectively.

Reactive Maintenance (RM) – this activity primarily focuses on restoration of supply when a fault or other network incident occurs. Reactive maintenance incorporates our faults response and the remediation work needed to restore supply.

Vegetation Management – this activity focuses on the management of vegetation to ensure our assets can continue to operate safely and effectively.

8.3 Asset management objectives

The Asset Management Objectives that are addressed through our network maintenance activity and investments are set out in the table below:

FOCUS AREA	OBJECTIVES
Safety, Environment and Network Security	• Prevent harm to workers, contractors and the public through our work practices and assets. • Ensure health and 'safety always' is at the forefront of decision making for the business. • Comply with relevant safety and environmental legislation, regulation and planning requirements. • All staff are competent and trained in their applicable roles with the right equipment available to work safely and effectively. • Asset management activities align with environmentally responsible and sustainable behaviours, in line with industry best practice, enabling wider emissions reductions. • Minimise the impact on the environment with regards to our assets and work practices. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).
Customers and Stakeholders	• Provide a high-quality customer service experience across all interactions. • Listen to and learn from our customers to ensure our service offering aligns with customer expectations. • Consider the impact of our operational decisions on customers and minimise the disruption of planned outages and unplanned outage response times. • Ensure the long-term interest of our customers by providing an affordable and equitable network.
Network Performance & Operations	• Comply with regulatory quality standards set out in the DPP3 Determination.

FOCUS AREA	OBJECTIVES
	• Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations. • Continual improvement of our asset management system and alignment to ISO 55001. • Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact-based investment profiling. • Maintain compliance with security of supply standards through risk identification and mitigation. • Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings. • Manage performance of field service providers through effective commercial arrangements and regular review.
Future Energy Network	• Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network. • Improve our visibility of, and ability to control, the LV network including management of the information required.

TABLE 8-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

8.4 Planned maintenance

8.4.1 OVERVIEW

Planned Maintenance is carried out periodically on all of Vector's assets to ensure they can continue to operate safely and effectively, to ensure reliability and resilience of the network and to maximise the service life of our assets. Our program of planned maintenance also gathers important asset condition information which is a primary input into our predictive asset strategies and replacement plans and ensures compliance with regulatory requirements.

Vector has a suite of maintenance standards which are a key control in managing the risks associated with all our assets. These documents define the specific requirements and schedules for inspections and servicing for each type of asset in service.

The main type of activities conducted during Planned Maintenance are:

- **Functional Inspections** – regular inspections and patrols ensure the integrity of the network and focus on identifying issues that may have a more immediate impact on safety and reliability. Functional inspections are our most frequent asset inspections and primarily feed into Vector's corrective maintenance regime.
- **Servicing and Testing** – maintenance tasks that are performed on an asset in accordance with our maintenance standards to ensure that our assets can continue to operate safely and effectively.
- **Full Inspections** – inspections that primarily record detailed asset condition information that is used to support our predictive asset strategies and analysis.

8.4.2 PLANNED MAINTENANCE OBJECTIVES

We have identified the following objectives to guide our Planned Maintenance programme.

ASSET MANAGEMENT OBJECTIVE	PLANNED MAINTENANCE PORTFOLIO OBJECTIVE
Safety, Environment and Network Security	Ensure that our planned maintenance regime is an effective control for the risks associated with owning and operating a network and our commitments to the environment and public safety are not compromised.
Customers and Stakeholders	Minimise planned outages to our customers by grouping and prioritising works effectively, and where economically practical use alternative supply options to reduce planned interruptions.
Network Performance & Operations	Asset Reliability - Maximise asset life and improve reliability by ensuring that planned maintenance is completed in accordance with our maintenance strategies. Monitor asset performance and reliability and review our planned maintenance requirements to ensure they are up to date. Operational Efficiency - Ensure that our planned maintenance requirements and expectations are clearly defined, and our supporting systems are configured to reflect this. This ensures that our delivery resources can focus on delivery and improving efficiency. Asset Lifecycle Information - Ensure that asset lifecycle and condition assessment information is recorded through our planned maintenance activities. Ensure that our asset data sets are consistent, complete and are of a high quality to support our predictive and risk-based asset strategies.

TABLE 8-2: PLANNED MAINTENANCE OBJECTIVES

8.4.3 PLANNED MAINTENANCE IMPROVEMENT INITIATIVES

We seek to continuously improve our approach to asset management and maintenance. The initiatives presented below are targeted at improving our planned maintenance programme.

INITIATIVE	DESCRIPTION
New Maintenance Standards	New Maintenance Standards are being introduced to define the requirements for Ripple Injection Plant, Battery Energy Storage Systems, Mobile Substation Contingency Plant and Power Transformers in Storage to enable these requirements to be systemised into SAP, like all other network assets.
CBM - Switchgear	Implementation of a new condition-based maintenance (CBM) regime for primary and overhead switchgear to supplement some of the existing time-based planned maintenance actions.
Continuous Improvement	Network risks and asset strategies are reviewed periodically to ensure that are aligned with Vectors network performance expectations and proposed changes to planned maintenance requirements are collated into a register for implementation into the maintenance standards.
Existing Maintenance Standards	Review existing inspection schedule to update, as required, inspection scopes, deliverables, and methodology for delivery

TABLE 8-3: PLANNED MAINTENANCE IMPROVEMENT INITIATIVES

8.4.4 PLANNED MAINTENANCE OPEX FORECAST

Our Planned Maintenance expenditure forecast is presented in Figure 8.1. The forecast incorporates changes to our planned maintenance activities through the introduction of our new maintenance standards and the introduction of new initiatives that are aimed at increasing our condition assessment knowledge base. As a result of the system changes implemented previously and our improving maturity, PM forecasts are now produced using the actual schedules in SAP associated with each specific asset, improving the integrity of the forecast.

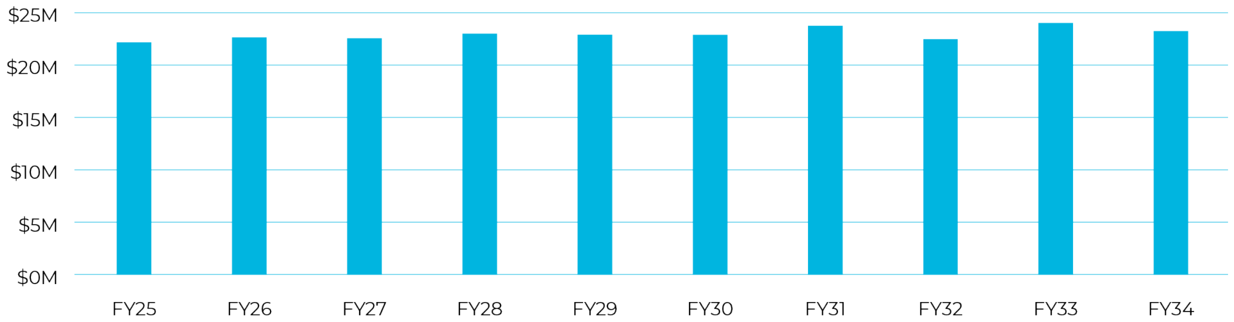


FIGURE 8.1: PLANNED MAINTENANCE OPEX EXPENDITURE FORECAST

8.5 Corrective maintenance

8.5.1 OVERVIEW

Corrective Maintenance is the action to restore and renew functionality of our assets before they fail by remediation of condition issues predominantly identified through our planned maintenance activities. These actions are crucial to ensure the assets can continue to perform their intended function safely and reliably. Corrective Maintenance activities assist with extending the service life of assets without compromising our performance expectations and are complementary to our pro-active CBARM driven asset replacement initiatives.

Vector's risk-based approach and other SAIDI related initiatives, including proactive CBARM asset replacement introduced in prior periods, continues to be a focus.

Our corrective investment can be broken down into the following key areas.

- **Corrective Maintenance Repairs** – These are minor corrective works undertaken to restore assets to a safe and functional state. These activities are classified as OPEX.
- **Corrective Asset replacements** – These are corrective asset replacements that are undertaken to ensure that the network can continue to operate safely and reliably without compromising performance. These activities are classified as CAPEX.

Vector has taken a holistic approach to corrective maintenance and has developed the necessary capability to plan and optimise this work using a full risk-based approach enabled by the system improvements introduced by SAP PM in RY21, which is described in more detail below. This means that work can be planned and executed at a TOTEX level. These systems and methodology have enabled capability that allows our field service providers (FSPs) to easily select and assemble packages of work that minimise outage disruptions for our customers while maximising the reduction in risk. Together, they enable dynamically optimised corrective work planning and delivery.

8.5.2 RISK BASED APPROACH (RBA)

A more comprehensive Risk Based Approach (RBA) to corrective work, introduced in RY21 as a part of our introduction of the SAP PM module, is a significant step forward in our asset management capability, introducing the ability to better prioritise the delivery of corrective work.

The RBA is complementary to our longer term pro-active CBARM driven initiatives and focuses on addressing risks that are more immediate. Under the RBA we now calculate a specific risk score for each notification which incorporates weightings for the potential financial, safety, environmental and customer impact (SAIDI consequence). These values are refreshed daily and designed to reflect each notification's relative risk at that time. This is a dynamic process which considers environmental changes, network reconfiguration, and changes to notification likelihood, as well as reflecting the current status of the notification pool to include any new notifications as well as those removed or changed.

The RBA methodology uses the calculated risk score value and network section identification information on each notification. Together, this enables the corrective planning teams to always focus on the notifications with the highest risk and develop and optimise work packs by incorporating other open high-risk notifications that can be completed during the same planned outage on the affected network sections. This reduces the number of outages our customers experience and improves the efficiency of delivery. The methodology provides Vector with a corrective risk-based platform that can evolve as required.

8.5.3 CORRECTIVE MAINTENANCE OBJECTIVES

We have identified the following objectives to guide our Corrective Maintenance programme:

ASSET MANAGEMENT OBJECTIVE	CORRECTIVE MAINTENANCE PORTFOLIO OBJECTIVE
Safety, Environment and Network Security	Ensuring that the network can continue to operate effectively without detriment to the environment or the safety of our people and customers. Our work is prioritised accordingly.
Customers and Stakeholders	Improve the overall experience for our customers and community by improving overall network performance and wherever possible, maximizing the utilisation of any planned customer outage to complete work that is required.
Network Performance & Operations	Asset Reliability – Maximizing asset life and reduce the incidence and impact of failures to our customers by prioritizing work accordingly and reducing overall risk. Operational Efficiency – Enable efficient planning, coordination, optimisation, and delivery of all corrective work activity.

TABLE 8-4: CORRECTIVE MAINTENANCE OBJECTIVES

8.5.4 CORRECTIVE MAINTENANCE INITIATIVES

With the implementation of the RBA as part of our SAP PM system implementation, we have a platform that will support our longer-term asset lifecycle information requirements as well as the ability to use this to support better decision making and maintenance optimisation.

INITIATIVE	DESCRIPTION
Line Clearance	This programme continues supported by dedicated OPEX and CAPEX budget
RBA Review Project (Risk Engine)	V2.0 of the RBA engine has been introduced. Further work including defect priority will be introduced through FY25 for completeness of the process
Continuous Improvement	Continuous improvement of our overall corrective RBA to improve effectiveness.

TABLE 8-5: CORRECTIVE MAINTENANCE INITIATIVES

8.5.5 CORRECTIVE MAINTENANCE OPEX AND CAPEX FORECAST

With the improvements introduced in RY21 through the new maintenance standards and supporting changes to our systems, our asset condition assessment knowledge base will expand. This condition information is usually recorded in the form of notifications associated with our assets. As a result, the notification pool will grow larger, but will have better integrity and definition. This improved quantum and quality of information will further support our corrective and pro-active asset management risk-based initiatives and improve the efficiency of our delivery.

In addition, we are also now forecasting an increase in corrective CAPEX and OPEX in RY24 and RY25 to allow focus on the remediation of higher risk line clearance intrusion notifications. Our corrective maintenance OPEX and CAPEX expenditure forecasts are presented in Figure 8-3 and Figure 8-4. respectively.

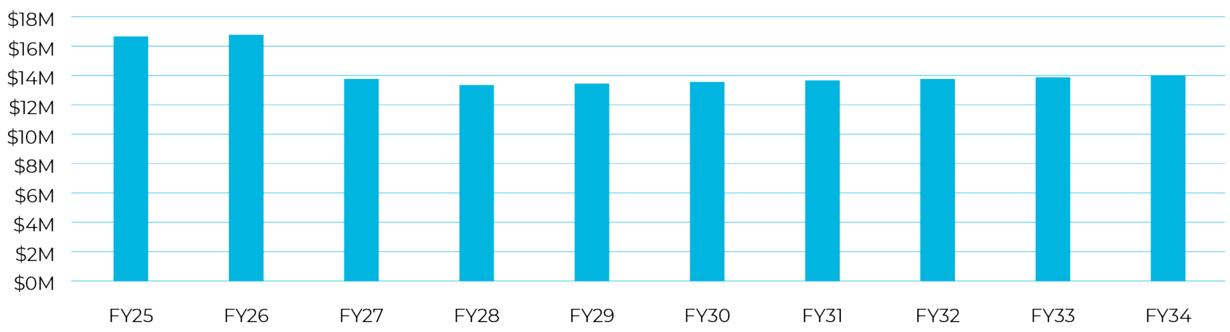


FIGURE 8.2: CORRECTIVE MAINTENANCE OPEX EXPENDITURE FORECAST

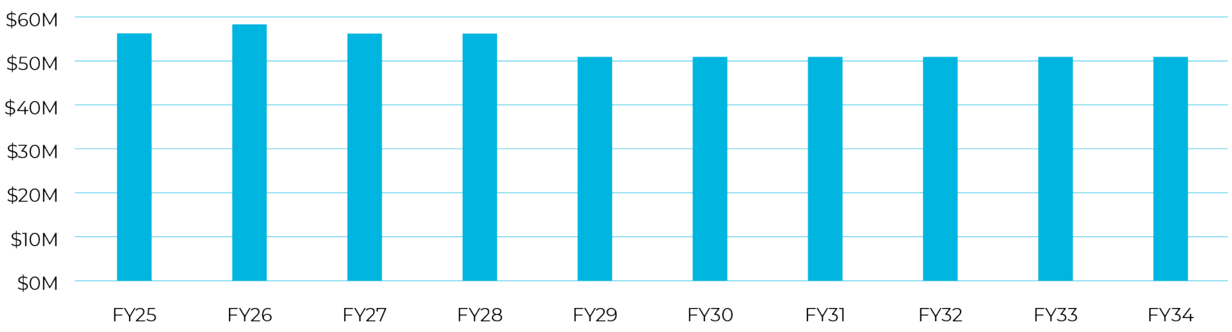


FIGURE 8.3: CORRECTIVE MAINTENANCE CAPEX EXPENDITURE FORECAST

8.6 Routine and corrective maintenance and inspections

Vector's forecast expenditure for Routine and Corrective Maintenance and Inspections is set out in Forecast Operational Expenditure (Schedule 11b) in Appendix 7 as part of the disclosure Report on Forecast Operational Expenditure. A typical breakdown of Vector's expenditure on Routine and Corrective Maintenance and Inspections across the primary asset categories is shown in Table 8-6, reflected as a percentage of the value forecast in Schedule 11b.

ROUTINE AND CORRECTIVE MAINTENANCE AND INSPECTIONS	FY23 – FY32
Sub transmission Switchgear	5%
Power Transformers	6%
Underground Cables	6%
Overhead Lines	19%
Distribution Equipment	27%
Auxiliary Systems	18%
Infrastructure & Facilities	14%
Protection and Control	5%

TABLE 8-6: ROUTINE AND CORRECTIVE MAINTENANCE AND INSPECTIONS – FORECAST EXPENDITURE BY ASSET CLASS

8.7 Reactive maintenance

8.7.1 OVERVIEW

Reactive maintenance relates to activities associated with our response to faults and other unplanned network events. These can be broken down into the following activities:

- **First Response** – This is our rapid faults response to unplanned network events. The primary functions here are to make the network safe, initiate and co-ordinate any switching to isolate the fault, restore supply where possible, and to confirm the nature of any remedial work required.

- **Fault Restoration and Repair** – This activity primarily focuses on the restoration of supply to all affected customers. These include the installation of generation, temporary repairs, and the restoration of the network to a fully operational state.

Reactive maintenance addresees all types of faults on the network including faults inherent to the degradation of the asset and faults due to environmental factors. Vector's pro-active and risk-based asset management practices are supporting an improving trend of reduced inherent faults. Faults due to environmental factors (vegetation, weather events, animals, third party damage etc.) continue to dominate unplanned outages. To mitigate the impact of these to our customers, a range of initiatives have been implemented through our Strategic Reliability Management Plan (SRMP) response. Those specifically associated with reactive activities include significant changes to the scheduling and resourcing of response crews, their locations as well their ability to access materials.

8.7.2 REACTIVE MAINTENANCE OBJECTIVES

ASSET MANAGEMENT OBJECTIVE	REACTIVE MAINTENANCE PORTFOLIO OBJECTIVE
Safety, Environment and Network Security	Ensuring that the network can continue to operate effectively without detriment to the environment or the safety of our people and customers. Our work is prioritised accordingly.
Customers and Stakeholders	Minimise impact to our customers and optimise restoration through faster response times, fault isolation and partial feeder restoration, and repairs.
Network Performance & Operations	Asset Reliability - Manage restorations without compromising asset reliability. Operational Efficiency - Continue to seek improvements to our response, isolation of faults to smaller localised areas and reduce impact to our customers.

TABLE 8-7: REACTIVE MAINTENANCE OBJECTIVES

8.7.3 REACTIVE MAINTENANCE INITIATIVES

Planned and corrective maintenance strategies are aimed at improving supply reliability, resulting in fewer faults on the network. When a fault does occur, the reactive maintenance initiatives target two key areas:

- Reducing the number of customers who lose supply when a fault occurs.
- Reducing the duration of the outage for customers who do experience a loss of supply.

INITIATIVE	DESCRIPTION
Optimisation of service provider's fault response model	Vector continues to review and improve on changes introduced to the reactive maintenance model to incorporate 24/7 manned fault response zones, and the approval of additional depot locations across the network. This is aimed at optimising travel times across Auckland to allow our field services teams to respond to faults as quickly as possible.

TABLE 8-8: REACTIVE MAINTENANCE INITIATIVES

8.7.4 REACTIVE MAINTENANCE OPEX AND CAPEX FORECAST

Our reactive maintenance OPEX and CAPEX expenditure forecasts are presented in Figure 8-5 and Figure 8-6 respectively. Our reactive spend increased in RY21 to support our network performance and reliability focus. Our reactive maintenance expenditure forecast maintains this level of focused investment.

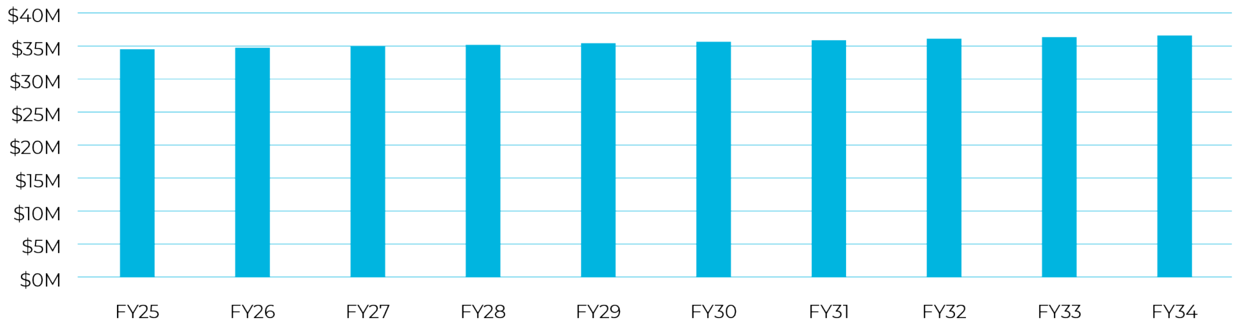


FIGURE 8.4: REACTIVE MAINTENANCE OPEX EXPENDITURE FORECAST

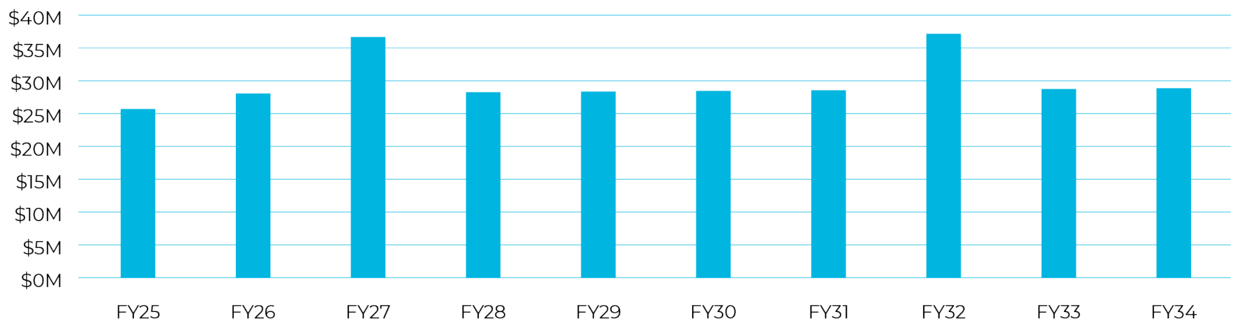


FIGURE 8.5: REACTIVE MAINTENANCE CAPEX EXPENDITURE FORECAST

8.8 Vegetation management

8.8.1 OVERVIEW

Control of vegetation in the vicinity of network assets is an essential activity for a distribution network to ensure we can continue to deliver a safe and reliable service. Management of vegetation is a complex issue, primarily due to the challenges associated with balancing ownership and accountability with amenity and utility value while also ensuring reliability of the network. The Electricity (Hazards from Trees) Regulations of 2003 is the regulatory framework currently in place. These regulations define the obligations of the network and tree owner when defined growth limits are breached. Unfortunately, these regulations have become ineffective and out of date for managing the risk that vegetation pose to the network. An estimated 80% of vegetation related outages are caused by failure modes which are outside the mitigations provided for by current regulation. In addition, the ability to recover costs from the party accountable in the regulations is often impractical.

The elements of Vector's vegetation management program are:

- **Regular inspections and assessment** – Routine inspections of the network are used to identify and record vegetation encroachment or risk of it as well as for updating our database cataloguing risk of these trees.
- **Administration and Prioritisation of work packs** – This activity consolidates vegetation work into logical work pack prioritised by risk as well as the administration of the necessary notifications specified in the regulations.
- **Delivery of vegetation works** – Activities focused on the delivery of the vegetation management works.

Vector has separated the accountabilities associated with these programs. The inspection and administration component is undertaken by a specialist contractor (Arborlab). The physical vegetation management is undertaken by vegetation service providers (Treescape and Asplundh).

Vector has a long term agreement with Auckland Council over an 'electricity network resilience' targeted rate, designed to enable more effective tree management by Council of Council owned vegetation encroaching on the electricity network.

8.8.2 VEGETATION MANAGEMENT PERFORMANCE

Our investment in vegetation aims to mitigate risk on the network. However, the overall effectiveness of vegetation investments is directly influenced by the Tree Regulations. As a result, Vector has taken a strong role within both the ENA and publicly to reform the Tree Regulations to ensure there is greater opportunity for compliance cutting to be designed to deliver both safety and reliability benefits.

Vector continues to advocate for the adoption of a Quantitative Tree Risk Assessment (QTRA) approach. This approach assesses the likelihood of failure of any tree irrespective of its proximity to powerlines, while assessing the consequence of failure using a risk-based criticality model. The risk-based approach seeks to provide a solution by way of a practical framework which determines the risk of vegetation coming into contact with electricity assets and proportionate mitigations - accounting for wider stakeholder and community interests, tree health, and options to respond to risk.

Vector's vegetation asset management strategy (VAMS) forms an integral part of its strategic reliability management plan (SRMP). The framework is designed to be adaptable to new arboriculture and operational data, as well as the different needs of communities and regions, whilst providing a robust and consistent process. By being targeted and preventive, it seeks to avoid both unnecessary vegetation management and outages – supporting affordability and resilience.

8.8.3 VEGETATION MANAGEMENT OBJECTIVES

Vector's vegetation management strategy reflects our strategic asset management objectives. Vector's overhead network exposure to vegetation comprises approximately 8,236 km of total route length. Vegetation in the proximity of these powerlines has a major influence on network performance, especially during storms and high winds.

ASSET MANAGEMENT OBJECTIVE	VEGETATION MANAGEMENT PORTFOL.IO OBJECTIVE
Safety, Environment and Network Security	Ensuring that the network can continue to operate effectively without detriment to the environment or the safety of our people and customers. Our work is prioritised accordingly. This includes the mitigation of fire risk associated with vegetation in the proximity of live electricity assets and takes into account resource consent conditions and restrictions associated with work in Significant Ecological Areas..

ASSET MANAGEMENT OBJECTIVE	VEGETATION MANAGEMENT PORTFOL.IO OBJECTIVE
Customers and Stakeholders	Improve the overall experience for our customers and community by improving overall network performance and wherever possible, maximizing the utilisation of any planned customer outage to complete work that is required.
Asset Reliability	Asset Reliability - Maximizing asset life and reduce the impact to our customers by prioritizing work accordingly and reducing overall risk. Operational Efficiency - Enable efficient planning, coordination, optimisation and delivery of all vegetation work activity.

TABLE 8-9: VEGETATION MANAGEMENT OBJECTIVES

8.8.4 VEGETATION MANAGEMENT INITIATIVES

The key initiatives being delivered under Vector's vegetation management strategy are:

INITIATIVE	DESCRIPTION
Continuous Improvement	Continuous improvement and refinement of our vegetation risk-based prioritization methodology. Investigate the use of temporary conductor covers to reduce tree contact in circumstances where negotiations with tree owners are ongoing. When creating new network assets consider deploying technology that provides improved risk mitigation (e.g. fully insulated conductors) based on whole-of-life cost assessment
New Technology	Assessing and developing Artificial Intelligence (AI) capability to predict vegetation growth rates, taking into account the species and climatic conditions at each specific location to be able to better forecast and risk assess potential vegetation intrusions. Utilising soil moisture monitoring devices to better predict when we will have vegetation at risk of uprooting in high winds to improve our levels of preparedness in adverse weather events.
Improved engagement with tree owners	Where the responsibility to clear vegetation does not lie with Vector, pro-actively notify the responsible parties/owners of their obligations to clear in accordance with relevant standards so as to alert them of a potential breach before it becomes an issue. This provides the third party with time in advance to act however where this approach does not address the issue, we continue to focus on developing alternative methods like collaborating with large private tree owners, e.g. Auckland Council and DOC to coordinate vegetation management efforts and balance resource consent restrictions and conditions with operational requirements.
Operational performance monitoring	Implement an external audit program to provide inspection and clearance works quality assurance and influence appropriate contractor behaviour/performance.

TABLE 8-10: VEGETATION MANAGEMENT INITIATIVES

8.8.5 VEGETATION MANAGEMENT OPEX FORECAST

Our Vegetation Management expenditure forecast is presented in Figure 8-7. The forecast incorporates changes to our vegetation management activities including the introduction of increased arborist capacity, independent scoping and auditing, resource consent conditions for work in Significant Ecological Areas and the targeted rate agreed with Auckland Council, to achieve better outcomes with council owned vegetation encroaching on the electricity network. There is an increased focus on network hardening and resilience in DPP4.

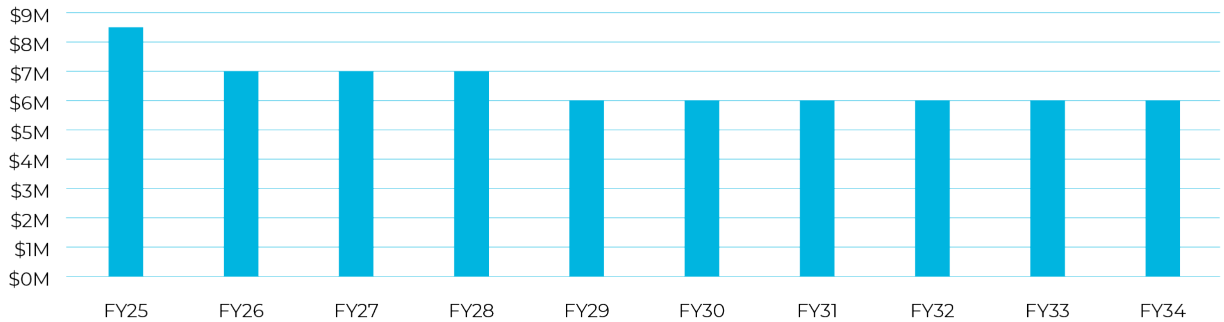


FIGURE 8.6: VEGETATION OPEX EXPENDITURE FORECAST

SECTION 09

Customer connections

9 – Customer connections

9.1 Section overview

This Section explains our approach to connecting new customers, changing customer connections, managing customer cost and communication, and how we forecast expenditure for these connections.

9.2 Customer connection growth

Reflecting Auckland's continued growth, electricity connections on our network surpassed 616,000 connections in 2023. These additional connections include a range of connections; from small connections such as for residential properties and special vehicle lane cameras to large connections for commercial buildings and industrial properties.

At Vector we utilise our pipeline data in conjunction with modelling (detailed in Section 10 Network Growth) to forecast connection growth. We also work closely with our customers to understand their planned development activities and intended timeframes for these.

9.2.1 EXTERNAL IMPACTS

Events last year such as the floods in Auckland and Cyclone Gabrielle impact on customer work in the first instance when resources are redirected to resolve event impacts but also impact developers whose sites are impacted by these events.

Inflationary pressures and stricter financing criteria have resulted in a reduction of small residential subdivision development but work on large complex residential subdivisions has increased and the number of EV connection projects has increased substantially over the past year.

9.3 Providing cost effective customer network connections

We connect new customers to the network as required through our customer connection process. To ensure an efficient and cost-effective service, small or simple connections are provided by our FSP for that part of the network at a unit rate. For larger or more complex connections, customers can elect for a price from both FSPs to ensure a competitive pricing process.

Vector provides full information on our website in relation to:

- our process for providing new connections or changing existing connections.
- our policy on customer capital contributions to new connections or changes to existing connections.
- our approach to planning and managing communication with consumers about new or altered connections; and
- the factors that may impact on the potential timeframes for different connection types.

9.3.1 DESIGN AND BUILD PROCESS

Customers can initiate a connection request through several different channels, including our web self-service portal, contact centre or by contacting our customer contracts team or their key account manager directly. Significant improvements to our self-service portal were completed last year to improve customer experience and ease of use. Improvements included the ability to order multiple ICPs at the same time within one order, more detailed tracking of progress online including explanations of what is currently happening and what is the next step as well as the ability to cancel an order online.

Depending on the complexity of the proposed connection(s) the connection request will be managed by either our Connections Team (small / simple connections), Customer Projects Team (large connections) or our Major Projects Team (large complex connections or infrastructure relocations). A simple connection is generally completed within 6 to 8 weeks after payment is received. We provide a high level, desk top based assessment of approximate scope and cost for complex connections within 10 working days after sufficient information has been received on the required scope. Each complex connection request needs to be assessed in relation to complexity and we endeavour to provide an indication of timeframes within a week after a design fee has been paid.

The Vector network is divided into two areas, each of which has a Field Service Provider (FSP) that are responsible for designing, building and maintaining the network in their area (zone). Small or simple connections are priced using agreed unit rates and the connection will always be built by the zone FSP. This is to enable a quicker turnaround from request to completion of the connection. For large and complex projects customers have the option for their connection to be priced by both FSPs, ensuring a competitive pricing process. Our Customer Contract Advisors work closely with customers to ensure that their requirements are understood, to provide further information such as possible consent requirements or impact of legislation related to building near existing electrical infrastructure as well as to ensure that an optimal design and quote is developed. The Customer Delivery Advisors work closely with our customers and the Service Provider project managers during the build phase of the connection assuring that the installation is as per the agreement. Delivery timeframes may be adversely impacted when there is a sudden increase in work volumes, adverse weather conditions impacting on civil works, third party requirements such as traffic management services, approval of consents to work near other utilities or trees, consideration of public impact by outages or road closures etc.

Vector's engineering teams have developed robust design standards to ensure that a safe and resilient network is built in accordance with legislative requirements, and which meets our Asset Management Objectives. All customer connections are designed to comply with these standards ensuring the integrity of our network and quality of supply to existing and new customers. Our Planning Engineers review all material changes to the network ensuring that the network is reinforced at the right times to cope with new connections being added.

9.3.2 COST OF CONNECTION AND DEVELOPMENT CONTRIBUTION

From 1 December 2023 Vector removed our standard prices for new electricity connections. The reason for this is that since electricity connection prices were last updated in December 2021, we, like most NZ businesses, have continued to see a rapid escalation in costs when providing our services. We're also seeing an increased demand from industry regulators for connection pricing to be cost reflective. This made it challenging for us to continue to offer standard prices for connections.

In some circumstances the connection applicant may undertake some of the work that would otherwise be covered by the capital contribution. Vector may allow consumers or the connection applicant to undertake the preparatory work using appropriately trained persons and with all work to be completed to Vector's standards and requirements prior to Vector installing the new electricity infrastructure. Preparatory work could include trenching and or civil work, reinstatement and laying of duct.

9.3.3 LARGE AND COMPLEX CONNECTIONS

Central and local government as well as large local and international commercial enterprise infrastructure investment decisions directly impact on our capital investment choices. We have recently seen strong growth in data centres being built in Auckland and significant investment in commercial EV chargers. Government driven examples include Kainga Ora's large-scale redevelopment of existing neighbourhoods; major motorway development projects; electrification of buses and ferries and continuing investment related to Watercare, Auckland Transport, Auckland Council, universities.

Our key account team manage the direct electricity conveyance contracts with several large customers on our network. These customers understand our network performance but also make individual decisions around network resilience and configuration to manage their unique requirements. They also provide dedicated account management for the large roading, rail and water infrastructure projects around Auckland. This ensures these large infrastructure projects have the greatest possible synergies and cause the least possible disruption for the public.

9.3.4 CONNECTION OF CUSTOMER DISTRIBUTED ENERGY RESOURCES (DER)

One of our Asset Management Objectives is to prepare the network for future changes that will include amongst others, the connection of customer DERs. When a customer wants to connect a DER to Vector's network the application is done via Vector's website. The website provides clear guidelines and standards that ensures that the network has sufficient capacity and capability to provide the required service levels and allow for the orderly and safe connection of distributed generation for a new application.

Vector needs to know where all distributed generation is connected and located to ensure that the equipment meets safety and operational standards as well as to ensure compliance with Part 6 of the Electricity Industry Participation Code (2010).

There are two options in Vector's website for distributed generation: less than 10kW or more than 10kW: the first step is for a customer to check whether there is congestion in the network (for DERs rated less than 10kW, congestion is usually not an issue but if it is Vector will inform the customer accordingly). Furthermore, customers need to ensure, as part of the application, that the inverter that they plan to use has been pre-approved for use in Vector's network; the Vector website provides a list of pre-approved inverters with full details.

The application form to install a DER and connect it to Vector's network is available on the website and Vector commits to acknowledge an application within five days and will review and approve (or decline if there is a reason), an application within thirty days. The last step in this process, after a DER installation has been approved, installed and tested, is for the customer to provide a signed certificate of compliance that outlines the scope of the installation and as well as confirm compliance with the AS/NZS standards for inverters and wiring installations.

The process for DERs greater than 10kW is very similar to those for less than 10kW but there is a chance in some parts of the network, that congestion could preclude the connection of a DER – especially where the proposed DER will contribute significantly to fault levels.

9.4 Customer connection forecast expenditure

Customer connection CAPEX is primarily driven by population growth (residential) and growth in commercial/industrial activity. Our forecast expenditure is based on trending historical connection activity using the FY23 forecast as a baseline and incorporating econometric parameters and customer growth insights. Step changes due to connection requests from major customers are included in our 10-year forecast.

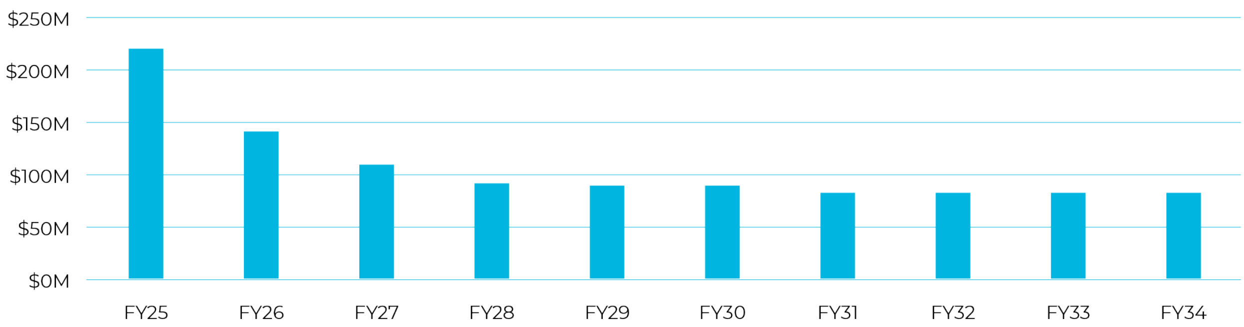
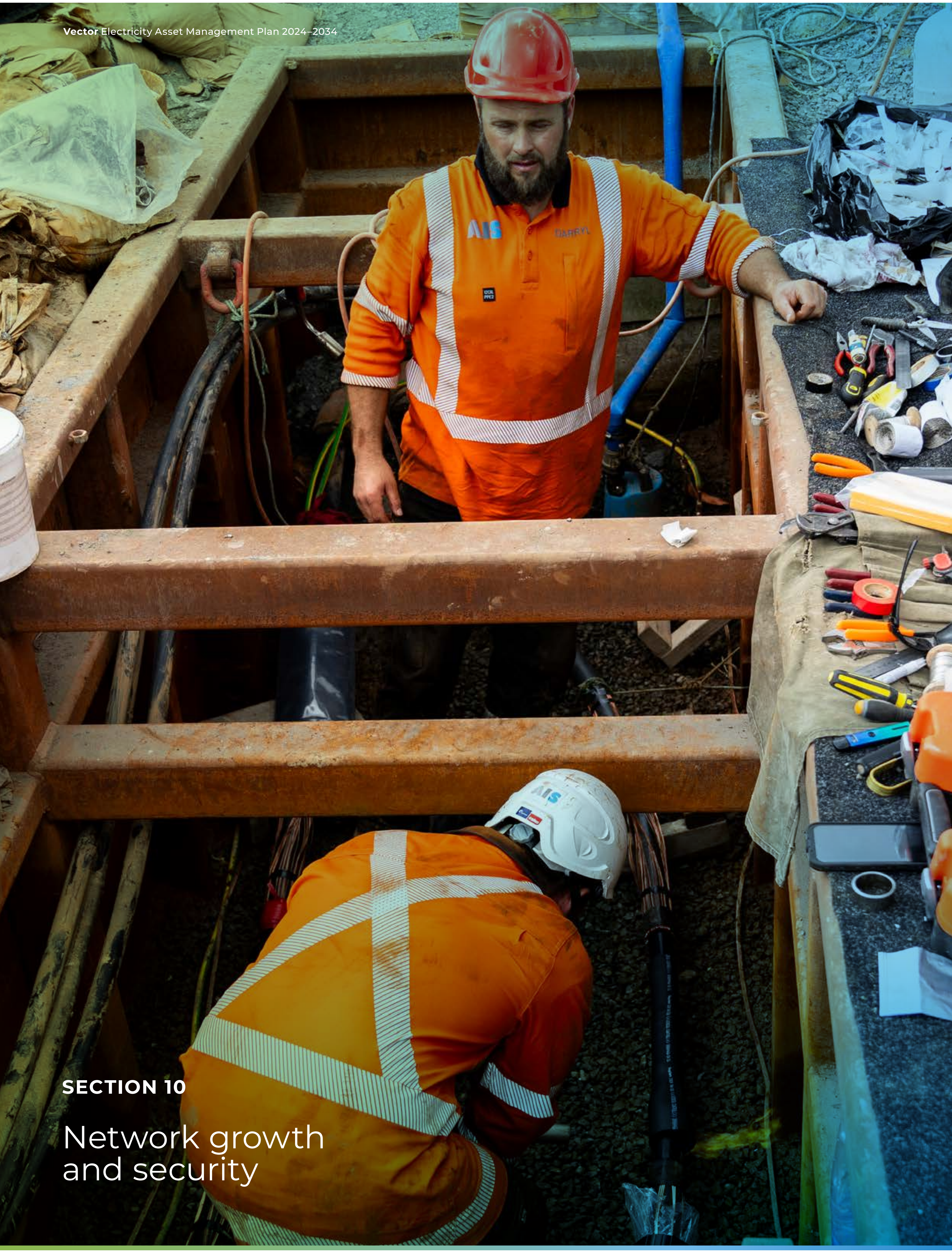


FIGURE 9.1: CUSTOMER CONNECTION EXPENDITURE FORECAST (GROSS)



SECTION 10

Network growth and security

10 –Network growth and security

10.1 Overview

This section describes the processes and systems Vector has implemented to identify where investment is required on the network to resolve network constraints, meet changes in electricity demand, manage changes in customer consumption behaviour, improve climate resilience and create the future energy network.

Network planning is about providing a reliable and resilient network in the long-term interest of our customers by developing a cost-effective electricity supply to meet new and future demands (e.g. organic growth, new development, urbanisation) and changing customer needs (e.g. energy efficiency, electrification of transport). This requires balancing supply side options with demand side solutions to ensure a network that is more flexible and responsive to changing customer behaviour and the increasing rates of renewable technology adoption.

Given electricity infrastructure typically has a life of more than 40 years, even planning for the near-term (next 5 years) must take into account the long-term need for infrastructure, managing uncertainty and avoiding stranded assets. Today, uncertainty is higher than ever due to rapid technology innovation and changing customer preferences which also challenge market and policy prospects. The majority of the factors driving uncertainty are out of Vector's control, which means that network planning needs to be scenario based and increasingly dynamic and flexible to pivot and adjust as the future evolves, while always ensuring timely investment and delivery of network projects.

We also recognise the changing technology landscape and how our customers will use the network may change as a result. In comparison to a few years ago when our largest market segment, the residential market, primarily used electricity for cooking and heating, we are seeing electricity being increasingly used for sewerage management (e.g. pumped schemes are substituting gravity flow systems), working from home and home-based education (e.g. step increase following the COVID-19 pandemic) and transport (e.g. the electrification of transport). This customer transition forms a significant input to our planning, to ensure we only build assets that are needed for the long term and reduce the risk of stranded assets.

To this end, our planning aims to transform our network to enable customers to interact and actively participate through distributed energy resources (i.e. solar PV and batteries) and load control. This will promote a lower-cost, smarter, and more decentralised electricity network which will also improve its resilience. This is in essence Vector's Symphony strategy from a network development perspective.

The following sections describe:

- overview of the asset management objectives and strategies applicable to network growth and security (Sections 10.2 and 10.3)
- our network planning approach and process, including (Section 10.4):
  - the critical steps in the planning process,
  - demand modelling and constraints identification.
  - how different solutions to address the constraint or meet the demand growth are assessed, including non-network options, and
- opportunities for non-wires alternatives (Section 10.5)
- finally, the major investment in security and growth projects to address identified constraints and demand growth are described (Section 10.6).

10.2 Growth and security objectives

10.2.1 ASSET MANAGEMENT OBJECTIVES

The asset management objectives that are addressed through the network growth and security programme of works and investments are set out in the table below.

FOCUS AREA	OBJECTIVES
Safety, Environment and Network Security	• Comply with relevant safety and environmental legislation, regulation, and planning requirements. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).
Customers and Stakeholders	• Enable customers' future energy and technology choices. • Ensure the long-term interest of our customers by providing an affordable and equitable network.
Network Performance & Operations	• Utilise clear business case processes, integrate risk management and complete post investment reviews to inform our decision making and analysis. • Maintain compliance with Security of Supply Standards through risk identification and mitigation. • Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. • Collaborate with teams throughout Vector to leverage different thinking, skillsets, and asset management capabilities. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings.
Future Energy Network	• Prepare the network for future changes that will be driven by: – technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc. – environment: climate disruption and network resilience – customer: decarbonisation of the economy, electrification of transport, etc. – operations: transition to distribution system operator model and whole-of-system planning. • Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third-party flexibility traders and retailers. • Facilitate customer adoption of new technology while ensuring a resilient and efficient network. • Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network. • Develop digital and data platforms to meet changing customer needs and enable the future network in partnership with new entrants to the energy market. • Improve our visibility of, and ability to control, the LV network including management of the information required. • Collaborate with the industry, partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions.

TABLE 10-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

Additionally, the following customer-related objectives specific to system growth apply:

- Manage the increasing load forecast uncertainty due to the unpredictability of the timing of large customer projects, changing customer behaviour (e.g. hybrid working arrangements) and the rate of our customers' adoption of new technologies.

10.3 Strategies to achieve the objectives

To meet these objectives, the following strategies are employed.

10.3.1 UNDERSTAND FUTURE TRENDS FOR LONG TERM PLANNING

Our planning process is anchored on granular bottom-up data analysis at customer level[13]. We use a Customer Scenario Model to forecast trends and their impact on our network and gain a clearer understanding or predictions of the future energy demand for the next 30 years. This modelling forecasts electricity growth based on expected volumes and locations of new customer connections, technology uptake and energy efficiency gains. It uses data from customer usage trends and changes to customer behaviour (from smart meter data), as well as results from industry trials (see case studies on EV Smart Charging Trial and Smart Hot Water Trial), regional and national forecasts, and consumer surveys. To ensure that we adapt and respond to changes, the model is continuously refined and updated. Further details of our scenario modelling areas are set out in section 10.4.

CASE STUDY: EV SMART CHARGING TRIAL

In 2022, Vector completed a multi-year EV smart charging trial with 200 real-world customers. The trial demonstrated that smart charging can seamlessly integrate EV charging demand into the existing network while maintaining customer satisfaction. More resources on the learning of the trial are available on our website.

https://www.vector.co.nz/articles/ev-smart-charging-trial

An immediate benefit of the trial has been that we can accurately estimate the impact of unmanaged EV adoption on the network. This is now used in our scenario model as well as for customer connection requests. After diversity maximum demand (ADMD) describes the peak contribution across a group by considering behavioural differences. It is a well-known and widely used metric for designing electric assets and has historically been established by measuring the aggregate demand across a group.

Granular time series data, such as EV charger data and smart meter data, can compute ADMD as a function of group size to determine an ADMD curve (Figure 10-1). With the increasing number of EV chargers, the ADMD curve exponentially drops. As the number of EVs on a network asset is increased, it becomes statistically less likely that the customer behaviour is aligned and that they charge at the same time. In other words, the behaviour is diverse. At a level of the network with 100 EVs or more (e.g. MV and HV), the curve has flattened out and load is diversified. A group of 100 EV chargers has an ADMD of 1kW per EV so would require 100kW of network capacity. When the number of EVs is low, for example an LV network with 10 EVs (which is common in a rural network), the ADMD is about 3kW per EV. To accommodate 10 EV chargers, an electricity network of 30kW capacity is required. In other words, by lowering the number of chargers to 10 in the last example, the network capacity required is only reduced by a factor of 3. Clearly, EV charging will affect the LV network and an emerging issue is that the LV network has traditionally built to 'fit and forget', with changes being driven by asset failure or customer complaints. To meet today's customer expectations, this is no longer an appropriate situation and the industry will require increased visibility at the LV level to monitor and deliver to the future needs of electricity customers.

Ongoing customer engagement and data is required to stay abreast of the ADMD development as EV adoption matures and deliver cost-efficient and reliable EV integration.

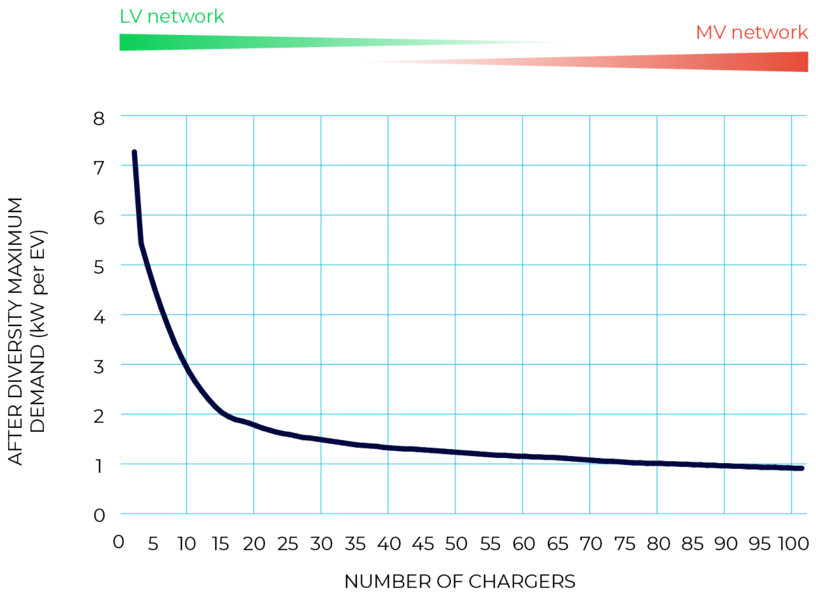


FIGURE 10.1: ADMD CURVE FOR EV CHARGING

[13] Heinen, S., Richards,, P., (2020), Towards customer-centric energy utilities - A granular data-driven bottom-up approach to understanding energy customer trends, The Electricity Journal, Volume 33, Issue 9, 2020.

10.3.2 ENGAGE WITH CUSTOMERS & STAKEHOLDERS

In an uncertain environment, customer and stakeholder engagement is pivotal. We have dedicated teams that engage with small and small to medium commercial customers, developers of large residential and commercial projects, large commercial customers, and Auckland infrastructure providers (e.g. road, rail, telcos, water). Those engagements identify synergies for system growth projects and customer projects, therefore minimising direct and indirect costs, such as disruption of traffic and local businesses. Those engagements also mean that our network developments plans are informed by latest developments of large-scale customers as well as new connections. (incl. distributed generation and storage). Our open data portal and the two new interactive maps (see case study below on interactive maps) also facilitate very early-stage engagement with customers and stakeholders but do no replace a formal connection process.

We develop large-scale connections and connections in close collaboration with the customer and their consultant, and continuously ensure alignment to the system growth projects. Customers submit details like their demand/injection levels, presence of special equipment (such as industrial motors or large inverters) and required redundancy, based on which Vector will develop connection options. At this stage, synergies with system growth projects are also considered. If the customer commits formally, and from that point the new or expanded customer connection will also be reflected in the load forecast and network constraint modelling (See Section 10. 4). To manage network risks for all connected customers, all customer projects need to comply with key standards and regulations (see next section). Preliminary connection requests are not reflected in the asset management plan process (e.g. load forecast and network constraint modelling). However, not all committed customer projects go ahead as initially planned, given that our customers operate in a dynamic market where conditions change. Continuous customer engagement means latest customer information (demand/injection, connection date) is received, and, given that the physical delivery timeframe (engineering design, construction, and commissioning) of our system growth projects is typically less than 2-3 years, there is opportunity to refine the plans.

The recent boom of data centre connection applications has demonstrated that our process is robust and flexible to adapt to unexpected requests. Over the last two years, several large tech and data centre providers have announced to build data centres in Auckland due to the exponential rise in cloud-based services, demand to store data in New Zealand for governance reasons and excellent connectivity of Auckland to global fibre backbone. Early and continuous customer engagement means that Auckland now already has 40 MW of data centres connected and a much larger connection pipeline.

CASE STUDY: INTERACTIVE MAPS FOR NETWORK HEADROOM AND SYSTEM GROWTH PROJECTS

To support customer and stakeholder engagement, Vector publishes key network information on its open data portal (https://data.vector.co.nz/) where users can not only visualise detailed geospatial information of the network but also conveniently download the raw information for use in their own systems or more detailed analysis in expert tools. The information available includes location of assets (ZSS and distribution feeders), the boundary of our coverage area and ongoing and future works for network projects (within next 2 years)

Based on customer and stakeholder feedback, the open data portal now also hosts two new interactive maps for network headroom and all system growth projects covered by this 10-year AMP. The network headroom map indicates the headroom in the distribution network for winter and summer peak conditions. The expectation is that this map supports early-stage customer engagement. For system growth projects, the AMP always provides a comprehensive view of expected expenditure, timing and options considered (Section 10.6 and Section 10a). The new interactive map will complement this information by providing a spatial visualisation, which ensures the stakeholders and customers can easily identify the projects planned in their area of interest.

10.3.3 COMPLY WITH SECURITY OF SUPPLY, POWER QUALITY AND OTHER REGULATIONS

Vector will comply with the relevant regulatory obligations and industry standards. The most relevant to growth and security are compliance with Vector's Security of Supply Standard (SoSS) (ESP010) which contribute to achieving the DPP3 Quality Standards and Power Quality requirements.

Our SoSS (summarised in Section 7) sets the probabilistic planning criteria for network development. This defines the number of coincident outages that can occur without loss of supply to customers and the time allowed to restore supply after an asset failure. If our network can by design not deliver this requirement, then a system growth project is triggered. The SoSS will provide customers with an acceptable reliability of supply at an acceptable cost. This involves understanding where there may be short- or long-term network constraints and planning for them.

We use our load forecast model, which combines organic growth from the scenario model with point loads (e.g. residential developments, data centres), to identify load requirements across the different network voltage levels (e.g. GXP, sub-transmission, zone substation (ZSS) and feeder) over the next 30 years. These load requirements combined with asset rating information and the SoSS, is then used to identify network constraints and capacity shortfalls using network modelling tools (e.g. load flow modelling). Reinforcement options and eventually network and non-wires projects are then designed to mitigate the SoSS breach. The capacity of new assets required to be installed are determined based on the size of constraints identified, the forecast demand growth and specifications of standard assets used by Vector.

Power quality is achieved through ensuring appropriate voltage levels and harmonics are maintained within prescribed limits. Where power quality issues are identified, Vector investigates the cause and follows the planning process to develop the most appropriate solution (See Section 7).

10.3.4 CONSIDER DIVERSE TOOLBOX OF SOLUTIONS FOR NETWORK PLANNING

To invest efficiently we use new technologies and understand future trends and customer behaviour, so we invest in a much smarter way. Our aim is to run the existing network smarter, and only invest in new infrastructure when we absolutely have to. The traditional approach to meet increased network demands and our SoSS has been to increase the capacity of existing assets or add new assets such as zone substations and distribution feeder circuits. With the change in customers' behaviours and needs, the current and future advancement of technologies and the attention to carbon emissions, our toolbox of solutions for network planning has become much more diverse. Our new approach promotes a lower cost, smarter, more decentralised but more connected network, rather than potentially overcapitalizing in projects that could result in stranded assets. (see case studies on EV Smart Charging Trial and Smart Hot Water Trial)

When planning for network development, we consider:

- The long-term (life cycle) costs of investments in the long-term interest of consumers;
- The use of probability-based incremental planning methods;
- Risk-based scenario models
- Continuous engagement with large-scale customers to ensure demand and timing-of connections is kept updated
- The agility and flexibility of solutions to be able to adapt to emerging technologies and urban development trends;
- The use of non-network solutions such as digital platforms to enable distributed energy resource integration;
- Use of data analytics and advanced operational practices;
- Non-network solutions such as demand side management strategies (including engagement with customers and third-party service providers) to reduce peak, and
- Network reconfiguration to improve the utilisation of existing assets and reduce losses.

These considerations are made via our capital expenditure justification process that is described in Section 10.5 and Section 10.6.

10.3.5 GROW DEMAND MANAGEMENT VIA OUR DISTRIBUTED ENERGY RESOURCE MANAGEMENT SYSTEM (DERMS)

We are actively enabling the transition to a clean, reliable, and affordable energy system through our use of our distributed energy resources management system (DERMS). DERMS is a platform that controls and manages the ever-growing number of third-party owned Distributed Energy Resources (DERs[14]) connected to the network. DERMS provides visibility and active demand management so that DERs can maximise their consumer and system value within the available network limits (considering actual operational conditions) (Figure 10-2). This reduces the need for traditional network reinforcement and accelerates the adoption of DERs. We are building capability to on-board customers (typically large commercial energy users – see case study on powering Auckland's E-Bus Fleet) onto Vector's Distributed Energy Resource Management Systems (DERMS) platform. While communication protocols are rapidly evolving, we have published our preferred interoperability mechanisms in the DERMS connection standard (ESS900). Engagement with technology providers, customers and third-party service providers have concluded that the key protocols for DER integration today are IEEE 2030.5, OpenADR and OSCP. While the protocols will continue to evolve, based on today's perspective, we can provide a clear direction to customers and third-party service providers on how we can communicate real-time network information to them. Together, our demand management systems and DERMS enable reduction of peak demand that needs to be supplied through our network, therefore allowing us to defer investment, maintain reliability and minimise costs to our customers.

Section 2 provides further details on the targets of orchestration in our future network roadmap and how we have revised our network connection standard and published a new metering guideline to ensure a consistent system architecture and interoperability across network, DERs and third-party service providers.

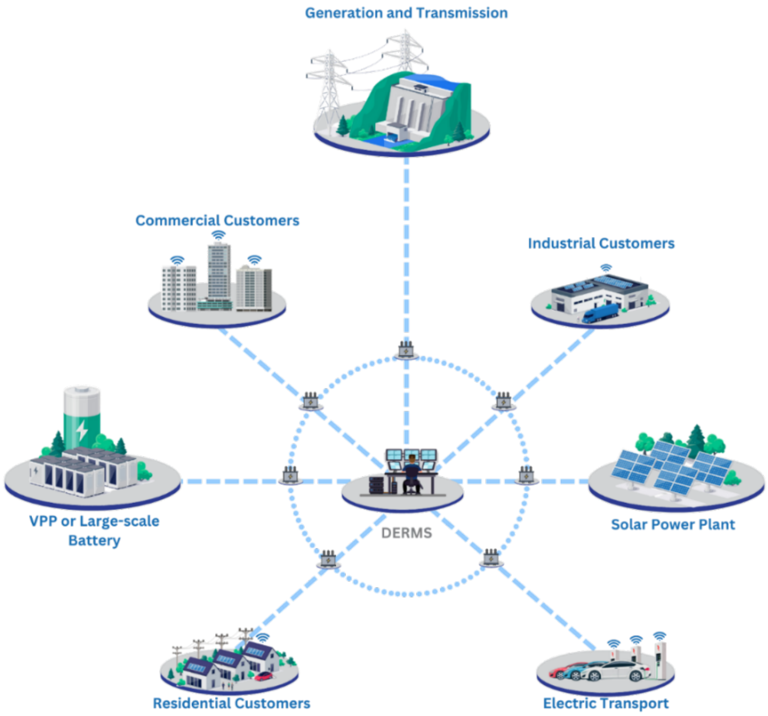


FIGURE 10.2: CUSTOMER AND NETWORK INTEGRATION VIA DERMS FOR COST-EFFICIENT AND RELIABLE DECARBONISATION

[14] Distributed energy resources is an umbrella term which includes connected devices such as distributed solar panels, batteries, heat pumps, pool pumps, electric vehicles as well as more aggregated load types such as smart buildings, large-scale batteries, data centres or e-Transport fleet depots.

CASE STUDY: VECTOR AND AUCKLAND TRANSPORT POWERING UP AUCKLAND'S E-BUS FLEET

We've joined forces with Auckland Transport (AT) to help electrify Auckland's bus fleet. That's no mean feat with 1,400 buses to be converted to zero emissions vehicles by 2030. The work began in 2020 when Vector and AT signed a Memorandum of Understanding to look for opportunities to reduce the costs of bus charging infrastructure, so that the transition can be more affordable. Last year we completed a detailed study into what it would take to electrify the whole fleet with high-capacity charging infrastructure at each of AT's 21 bus depots across the city, which is now reflected in this AMP.

Three bus depots were partly electrified in 2023 (and there are a further three planned to be electrified in 2024). The head of metro services at AT said this project would help reduce carbon emissions and improve air quality in the city. The newly electrified bus depots will have capacity to charge 20 to 30 buses each. This will mostly happen overnight, and the charging will be 'fleet managed' to achieve as smooth a load profile as possible.

Both these factors will reduce the impact on the electricity network, leading to cost efficiencies for Vector and Auckland Transport, which then benefit both organisations' customers. The fleet managed charging is coordinated through Vector's Distributed Energy Resource Management System (DERMS), which provides the transparency and simplicity required to make this work. The first DERMS-connected depot went live in January 2023. This collaborative project is a stellar example of Vector's Symphony strategy, finding innovative ways to deliver positive benefits for the customer, the business, and the environment.

10.4 Network planning process

Vector has developed an integrated Symphony planning approach to meet our SoSS, QoS, and PQ requirements. Symphony planning starts with developing a model that describes the demands placed on the network from a customer-level and builds our understanding of future network requirements from the bottom-up. The advantage of this approach is that locational differences are reflected and can inform options analysis. Also, new customer behaviour and technology adoption can be observed and considered in its early stages, allowing for more foresight and preparedness in the planning process, as well as more active customer engagement. Finally, our options analysis considers not only traditional solutions (e.g. cables, lines, transformers) which continue to serve us well, but also innovative non-wires solutions (e.g. smart hot water control, batteries, smart EV charging that is often owned by customers or third-party providers), in line with our strategy to only build new infrastructure when there are not more affordable solutions available. In the context of heightened uncertainty over future planning scenarios, non-wires solutions offer additional benefits: they are less intrusive in road corridors and heavy engineering works are reduced (i.e. a smaller community impact and more agile to deploy); and they are also more modular (i.e. can start at a small scale and grow incrementally) reducing the risk of stranded assets by dynamically matching needs as they evolve over time.

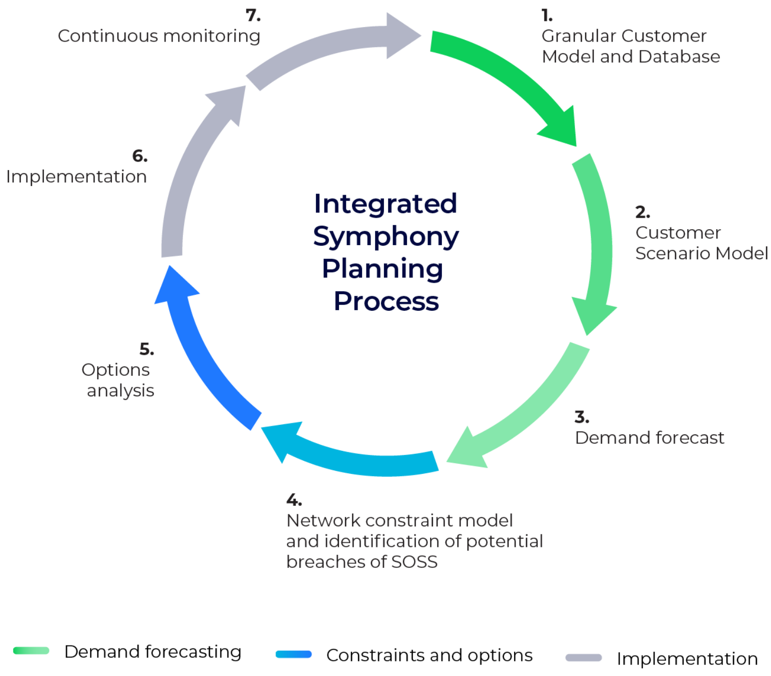


FIGURE 10.3: STEPS IN INTEGRATED SYMPHONY PLANNING PROCESS

The planning process is initiated by an annual assessment of the customer peak loading on all distribution feeders and zone substations. This reassesses the summer and winter peak loading and security levels. The distribution network loading and security assessment includes thermal limits and voltage modelling.

The capital expenditure justification process, described in section 10.5, ensures appropriate governance and rigor is applied to network development and investment decisions made through this network planning process.

10.4.1 DEMAND FORECASTING

The first three steps of the network planning (Figure 10-3) process are related to demand forecasting based on a detailed bottom-up build that takes into account historical demand, customer demographics and emerging trends.

The **Granular Customer Model and Database (Step 1)** is the basis of the bottom-up modelling process and brings together all information of Vector's customer today. The granular customer model and database combines all of Vector customer and energy information and links it to a wider set of information such as building characteristics and socioeconomics. The resulting model operates at ICP level and provides a granular view on changing energy consumption patterns, customer profiling and new technology adoption[15].

The **Customer Scenario Model (Step 2)** draws from the detailed Customer Model and additional demographic data to model future changes in incremental electricity demand and consumption. The model considers future changes due to population growth, employment growth, energy efficiency, as well as electrification- and decarbonisation-driven trends like distributed solar PV and battery energy storage systems, electric vehicles, water heating load and gas-to-electricity conversion. Learnings and data from various Vector trials (see case studies on EV Smart Charging Trial[16] and Smart Hot Water Trial) are fed into the model. Non-wires solutions that can be owned by customers or third-party providers and are managed via DERMS to avoid network reinforcement are also modelled. While the AMP covers a 10-year period, we run all our scenarios over a 30-year horizon to portray longer term impacts and derive short-term actions that prepare us for the future. Figure 10.4 provides an overview of the model.

The Customer Scenario Model represents our Auckland service territory in 548 geographical areas. Each zone, called Macro Strategic Model zones (MSM), cover roughly 1000 homes and is the size of a small suburb. The definitions of these zones and the socioeconomic inputs are unified across various government departments and service organisations via the Upper North Island Forecasting Network (UNIFN, previously Auckland Forecasting Network)[17].

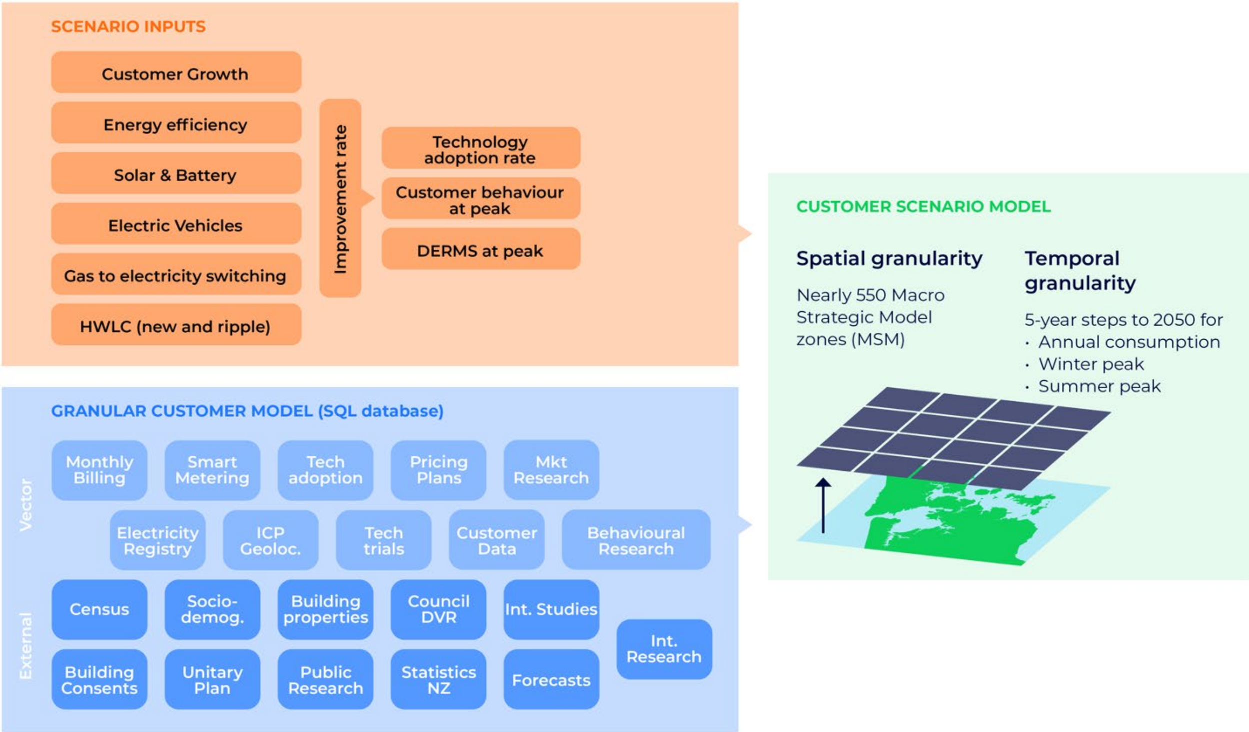


FIGURE 10.4: OVERVIEW OF CUSTOMER SCENARIO MODEL

[15] A detailed paper on this is publicly available at https://www.sciencedirect.com/science/article/abs/pii/S1040619020301287

[16] More information on the EV Smart Charging Trial is available here https://www.vector.co.nz/articles/ev-smart-charging-trial

[17] Upper North Island Forecasting Network (UNIFN) - Previously known as Auckland Forecasting Network, the purpose of the UNIFN is to support the delivery of timely, tailored and effective public infrastructure, social and community services through consistent, integrated, responsive and best practice demand forecasting. The 30+ UNIFN members include organisations that either: (i) Deliver the key public infrastructure, social, employment, visitor and community services in and/or for Auckland, or (ii) Agencies responsible for population, employment, visitor and land use forecasting scenarios and projections

CASE STUDY: SMART HOT WATER TRIAL

Smart hot water is the capability of granularly controlling hot water cylinder demand at the individual cylinder level in order to manage peak demand and distribution network capacity requirements across different topology levels. The capability can also bring benefits upstream to national energy and ancillary service markets. We used our Smart Hot Water pilot system in Te Atatu on about 100 ICPs combined with smart meter consumption data to confirm the load response of about 0.6kW/ICP, which further cemented the viability of smart hot water as a non-network solution. The results also re-confirmed the importance and challenge of bringing 'load back' after using them to avoid peak constraints. After utilising hot water for a peak shaving event, a new secondary demand peak occurred at around 20:00 that exceeded the uncontrolled demand peak, because the natural diversity from hot water cylinders was removed and all the controlled hot water cylinders began heating synchronously. This highlights the importance that electricity distributors place on orchestrating load restoration so that actual network conditions can be considered. In some circumstances, the secondary peak is not an issue, however, if the peak on the network assets needs to be mitigated, this secondary peak must be managed by restoring load more gradually. If a third-party provider or retailer were to manage hot water load for consumers then the coordination with the network via a DERMS or Load Management Protocol, accounting for real-time conditions and constraints, becomes even more critical.

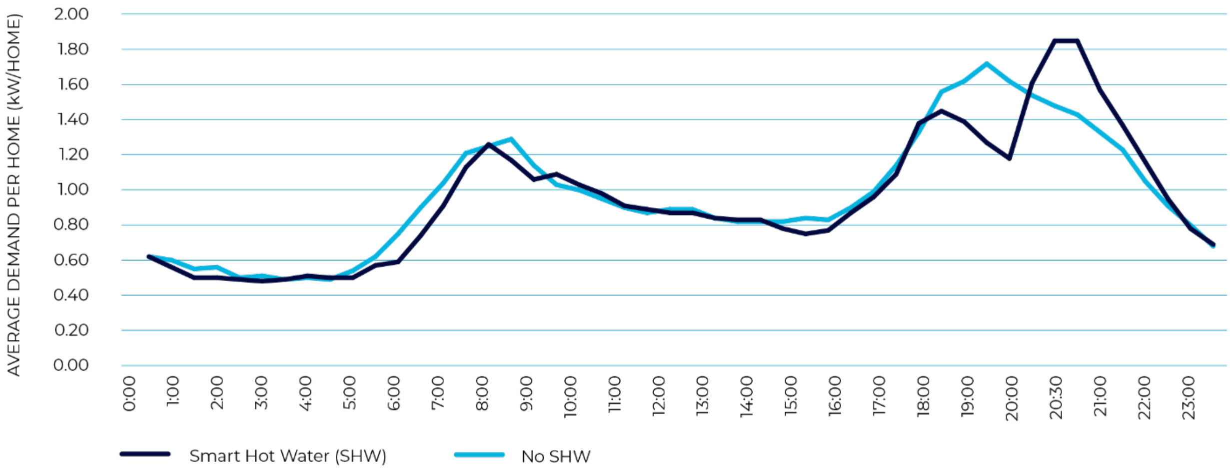


FIGURE 10.5: LOAD CONTROL RESPONSE DURING 10 HIGHEST PEAK DAYS IN WINTER 2022

Demand forecast (including network allocation) (Step 3) brings together the organic growth from the customer scenario model with non-standard or large customer projects such as known large housing developments, new commercial developments, or factories, and, increasingly, data centres. The present asset peak loading is established based on preceding years and normalization for abnormal network configurations. The incremental growth from the Customer Scenario model, which runs at neighbourhood level, is then allocated to electricity network assets based on network topology. Combined with non-standard and large customer projects, the demand 11 kV forecast for the next 30 years is then derived across different network levels (GXP< zone substation, 11 kV/22 kV feeder) by taking demand diversity into account. Customer-level smart meter data is then used to link the Customer Scenario results to network assets.

CASE STUDY: UNLOCKING SMART METER CONSUMPTION DATA

Creating a dynamic time-series view of the 'whole of network consumption' has been the vision at Vector for more than 5 years. This information is a key input into many aspects of Vector's symphony strategy, and supports the optimisation of planning, operations, customer service and pricing. Gaining access to smart meter data was identified early on as the most efficient method to achieve this goal as an industry. The value of smart meter consumption data can be harnessed without requiring the installation of (and investment in) additional devices at additional cost a cost which could ultimately be borne by our customers.

Over the past years, Vector has contracted with retailers on our network for the supply of half hour consumption data (kWh). This critical milestone took many years to achieve. Our journey to receiving consumption data began with the New Part 10 of the Code, which went live in 2013, including the new retailer-appointed MEP model. Under this model, retailers were initially either reluctant or unable to provide data to EDBs. Some retailer-MEP agreements had restrictive data access terms. In the latter half of the 2010s, there were extensive concerns by retailers around privacy and permitted uses of data if they were to share consumption data with any party, including EDBs.

Code changes in 2016 to open up data flows did not work as intended. We were however able to receive some consumption data for a portion of our customers for a single year. This was instrumental in developing our internal capability and processes. In particular this data supported the development of the scenario model for the network planning process.

In 2020 the publication of the default distributor agreement (DDA) started to open the door but there were still limitations:

1. Rules prohibited data being combined with other datasets, reducing the usefulness of the data for network planning purposes
2. Default delivery frequency was six-monthly
3. The DDA solution did not consider practicalities of MEPs liaising with EDBs for data provision

Today, we have DDA based data agreements in place for 99% of our ICPs under contract, and we are currently receiving consumption data for 95% of ICPs on a monthly basis. We have received historic data back to 2017, giving us a five-year 'whole of network' dataset.

Some of this data is provided direct from the retailer, some via the MEP (requiring reimbursement for reasonable costs). Our preference is to receive data in EIEP3 format, but this is not always the case. Reformatting and cleaning the data, pre- and post-ingestion, creates a significant amount of work, and in some cases, we still need to make adjustments for retailer switching and daylight savings differences.

Key learnings from our experience have been:

- Executive support is essential to ensure data acquisition and use is prioritised by the organisation.
- Commercial, legal, and regulatory expertise is required along with technical expertise.
- EDBs need to budget for the data. It will not come for free from all parties. Some will require the reimbursement of reasonable costs.
- Curating the data and analysing it also requires investment. Realistically value is best unlocked using analytical and data science methods, and through engaged engineers with analytical skills.
- Strict data governance is critical. This gives confidence that the data will only be used as intended, and appropriate safeguards will be put in place

10.4.2 CONSTRAINTS AND OPTIONS

Steps four and five of the planning process (Figure 10.3) identify network constraints throughout the 10-year AMP window based on demand forecast and then develop options for remediation. The constraints and options are identified through a sub-process as shown in the diagram below.

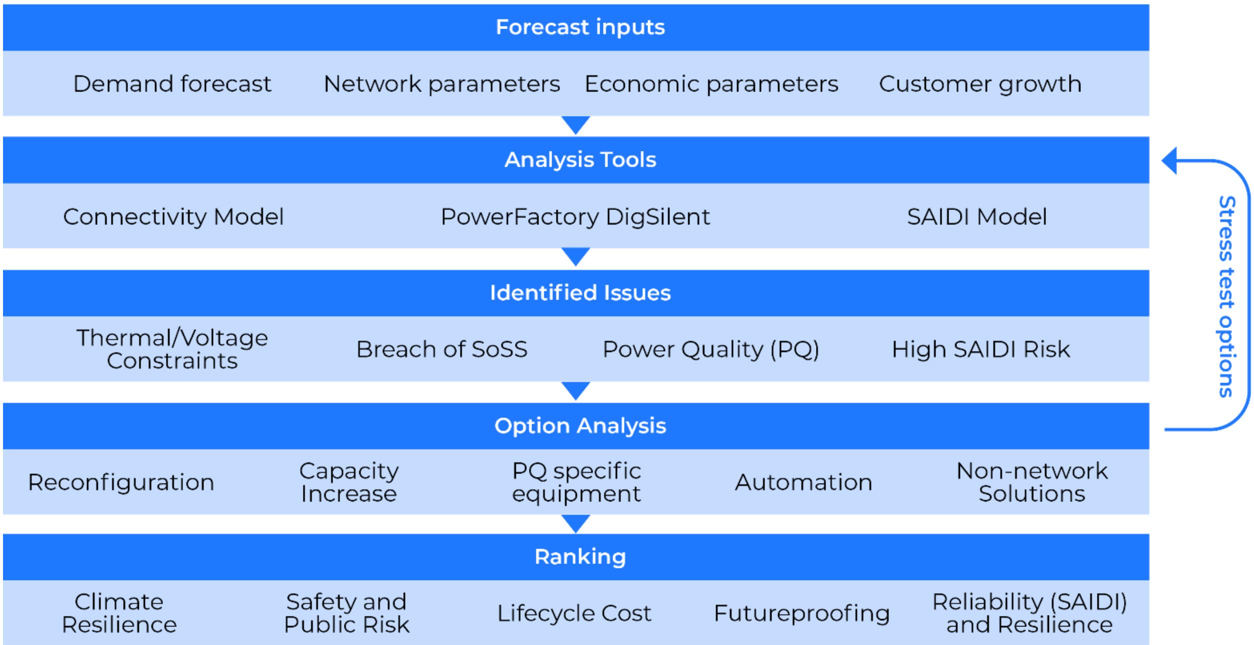


FIGURE 10.6: CONSTRAINTS AND OPTIONS PLANNING PROCESS

The **Network constraint model (Step 4)** uses the demand forecast to identify where and when capacity shortfalls resulting in a breach of our security of supply standard (Section 7) are expected over the next 10-year period for feeders and zone substations. This model also helps to identify options for alleviating shortfalls by re-routing the network from a location with excess capacity and therefore optimise existing capacity availability. The model captures connectivity of the network and backstopping can be modelled to understand if sufficient capacity is available to avoid a shortfall under contingency conditions (subject to SoSS). We have substantially improved this capability in the last two years by developing automation scripts that run power flow simulations (using Digsilent PowerFactory) for the full 10-year AMP horizon for system health and system backstopping. The outputs identify thermal and voltage constraints on network assets, and for cables and lines specific sub-sections, that cause the constraints, which expedites the options analysis. In parallel, we will continue to operate our legacy connectivity model to ensure consistency and robustness of process.

Once the type, location and timing of a constraint is identified, **Options Analysis (Step 5)** is undertaken to identify and evaluate the best solution. We use several analytical tools and visualizations to assist with identifying the demand, network constraints and benefits of different options. If more detailed analysis on network constraint or technical assessment of the options is required, we will run specific power flow simulations as required.

A full suite of options is developed. These include:

- Reconfiguration to improve utilization of existing capacity and assets
- Augmentation to add new capacity
- Augmentation to expand the network
- Non-wires alternatives

As required, we will also engage with customers and stakeholders (e.g. community organisations, other infrastructure providers, technology vendors) in this phase to assess additional risks for implementation of options and also identify synergy opportunities.

Non-wires solutions are our preference when feasible within customer, regulatory and economic constraints as they can help customer affordability by deferring or preventing the need for major investment, provide flexibility not available from traditional network solutions, and improve asset utilisation. These alternatives are not limited to options Vector could self-supply but could also be provided 'as a service' by a third-party provider under contract, if that would come at a lower cost to our customers. Non-wires alternatives can include:

- Real time monitoring and control of DERs through our ADMS and DERMS platforms
- Battery Energy Storage Solutions (BESS) to shave peak demand and/or control voltage
- Microgrids
- Demand side management through customer DER solutions (including third-party service providers), such as smart hot water and smart EV charging
- Increased network automation
- Improvements to visibility and control of the LV network

To identify the best solutions and optimise and prioritise the network investment, Vector takes a whole of life cycle approach to their evaluation. All the options identified are assessed and ranked based on benefits to network safety, life cycle cost and its impact on customer affordability (initial investment plus ongoing operational costs), reduction to network risk, ability to meet performance requirements and climate resilience (e.g. risk exposure).

Implementation (Step 6) involves, for both network and non-wires solutions, finalizing the detailed design, obtaining necessary approvals or permits required, construction and commissioning of the project.

Finally, Vector undertakes **Continuous Monitoring (Step 7)** of its network, investments and asset performance to ensure alignment with asset management objectives. The review process ensures the investments are achieving the planned outcome and that Vector continually learns and improves. The requirement for continual monitoring is a feature of Vector's Asset Management System and include:

- Asset Management Control, Review, Audit and Assurance
- Asset Performance and Health Monitoring
- Post Investment Reviews
- Stakeholder Engagement for implementation
- Sustainability impact

Findings from the reviews are fed back into the planning process.

10.5 Signposting opportunities for non-wires alternatives

Vector Networks has successfully deployed six large-scale battery energy storage systems to defer investments in traditional wires solutions. Additionally, we have trialled various NWAs to understand the technology and customer behaviour. Examples include the rollout of 250 SunGenie residential solar-battery programme (2014), the smart hot water trial (part 1: 2018; part 2: 2022), the peak-time rebate trial (2018) and the EV Smart Charging Trial (2019). At the back of these trials, Vector has developed a deep knowledge base around the technical potential of NWAs and has subsequently included the use of NWA to defer network reinforcement into the network planning process. In 2022, we also launched a public registration of interest to find NWAs that could help alleviate a security constraint in the wider Warkworth area.

As part of the options analysis of the network planning process (Step 5), different solutions are evaluated based on cost. However, wires and non-wires alternatives are not directly comparable based on their upfront cost alone, as they have different characteristics (see Table 10-2) and do not provide the same network reinforcement 'service'. In particular:

- Wires (or network) solutions involve reinforcement of the network due to load growth. They eliminate a network constraint for generally 15+ years and have a lifetime of more than 40+ years. The investment in these solutions is typically lumpy 'no-return' or irreversible, which means that, once it is deployed, the solution can't be economically re-sized and means spare capacity is created.
- Non-wires alternatives have very different characteristics – a) the decentralised nature of the solution means that it is adaptable/modular/scalable so that it can be adapted as load changes over time ; b) the technology has shorter lifetime (certainly less than 20 years, but often even less than 10);c) they introduce new performance risks due to customer behaviour and technology (e.g. communication) and ; d) if load growth is high or an unexpected new large customer connects, the need for the wires/network alternative is only deferred, not eliminated, and the deferment period could be much shorter than predicted or contracted (and paid) for.

	WIRES	NON-WIRES
Size of solution/investment	Lumpy	Modular and scalable
Lifetime	40+ years	10-20 years
Deferment of constraint (typical)	>15 years	about 5 years (more possible)
Performance risk	Typical electricity asset risks	Typical asset risks and new customer behaviour, contractual and technology (e.g. communication) risks

TABLE 10-2: COMPARISON OF WIRES AND NON-WIRES CHARACTERISTICS

Hence, a different framework is needed to understand the value of NWAs compared to wires/network solution and assess if an NWA makes sense from an economic perspective. Essentially, an NWA can be considered economic from a societal/customer perspective if the NWA deployment cost is lower than the deferral value of the wires/network investment.

10.5.1 ASSESSMENT FRAMEWORK

To increase our collaboration opportunities with customers and third-party providers, who consider DER projects, this year's AMP signposts the reinforcement projects, where we expect the NWA would be most competitive with network solutions. While our system growth projects have always been reflected in the AMP, this section is our effort to have a simpler, more transparent engagement with customers, communities and potential providers of non-network solutions:

1. Only system growth projects that deliver capacity are suitable (e.g. remove other system growth projects like recloser installations, land purchase, SAIDI project)
2. Focus only on wires projects with capital value larger than $2M over 10 years, reflecting the feasibility of the current NWA market to deliver cost-effective solutions.
3. Generally limited to flat and slow load growth regions as NWAs could significantly defer traditional investment here and deliver higher value

4. Finally, the deferment value is calculated based on load reduction delivered from NWA and the projects with a deferment value greater than $500k are flagged. This deferment value does not include the cost of the NWA nor the risk assessment, but it is a gauge to understand the economic potential. Note that the deferment value calculation captures uncertainty around future so that the specific characteristics described in this subsection are captured. NWAs have different characteristics from an investment perspective. NWAs can scale and adapt to load growth as well as providing the option to 'buy time'/'wait and see how' when dealing with uncertain load growth. Clearly this provides value, and our probabilistic framework captures sensitivities around the following i) future cost uncertainty ii) commissioning year (due to load growth uncertainty) and iii) deferment period (due to technology risk and customer behaviour around non-wires alternatives).

Figure 10-7 illustrates the assessment process and highlights the number of projects in each step of the process.

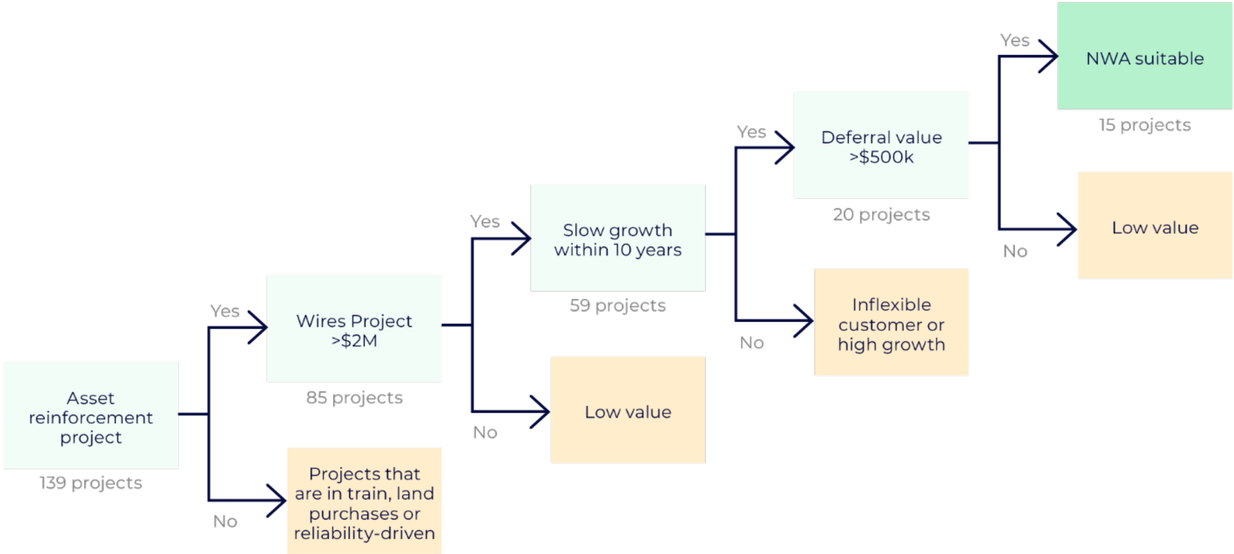


FIGURE 10.7: PROCESS TO IDENTIFY SIGNPOSTED NON-WIRES ALTERNATIVES

10.5.1.1 LIST OF REINFORCEMENT PROJECTS MOST SUITABLE FOR NWA

Our assessment framework has identified 13 projects with suitable characteristics for NWAs (Table 10-3:). This is based on value of deferment. The implementation of an NWA as final solution will depend on NWA cost, customer behaviour and regulatory environment. Key information on all projects are provided in the network planning area section (Section 10.6). For major projects (i.e., more than $1M investment) within next 5 years, more detailed information (including a description of the options considered) are available in Section 10A - Appendix: Growth and Security Projects.

PROJECT NAME
Hans Middlemore Cres 11kV feeder
Mangere Central Idlewild Ave 11kV feeder
Mangere East Puhinui Rd 11kV feeder
Otara Springs Road 11kV feeder
Flat Bush Murphy's Rd 11kF feeder
Westfield 3rd Tx
Westfield Abattoir Lane new 11kV feeders for security in WEST K08
Kingsland substation 110/22kV reinforcement
Sandringham 3rd Tx
Manurewa Alfriston Rd 11kV feeder
Waiheke T1 & T2 upgrade
Balmain 2nd 33/11kV TX & 33kV switchroom
Warkworth South Zone Substation New

TABLE 10-3: MOST SUITABLE PROJECTS FOR NWAS

Beyond this list there may be opportunities to defer other reinforcement projects if developers or customers are planning on installing a large DER (e.g. battery, generation plant) or a high number of DERs in a highly concentrated area. All our reinforcement projects are listed in this section and a new interactive online map also visually represents them on a map (see case study above on interactive maps).

We invite interested parties to contact us via the details provided on our website in the 'contact us' section (i.e. info@vector.co.nz).

10.6 Network planning areas, reinforcement and replacement

This section sets out Vector's network growth projects for the next 10-year period. The projects are related to the expansion and interconnection of the electricity network to account for Auckland's growth, the densification of suburban areas, the urbanisation of rural areas, and the improved resilience for more isolated rural communities.

The forecast peak winter demand within the AMP period is expected to increase by roughly 1000MW from 1800MW today. This highlights the importance of the next decade of having the right plans, processes and people to succeed. In terms of transport electrification, this AMP demand forecast includes the adoption of light-duty EVs in line with government targets and the electrification of buses (see case study above on powering Auckland's E-Bus Fleet) and Ferry fleet in line with Auckland Transport (AT) plans. Section 2 includes the forecasted peak winter demand to 2053.

To effectively manage investment planning, the network has been divided into geographical planning areas, which correspond to existing individual GXPs or group of GXPs. From the top down each subtransmission and ZSS supplied from the respective GXP is covered under the corresponding planning area. Where a new GXP is forecast to be needed in the future, then this is included in the planning area based on today's view. The figure below shows the network planning areas.

Each Network Planning Area summary describes the physical bounds of the area, the GXP, the ZSSs supplied from the GXP, demand forecast, and network development projects. In developing the projects, Vector takes into account any asset replacements or other investment that is planned for other drivers (such as condition) to ensure a coordinated and efficient approach to expenditure. The options that were considered when assessing each of the material projects are described in the Security and Growth Appendix.

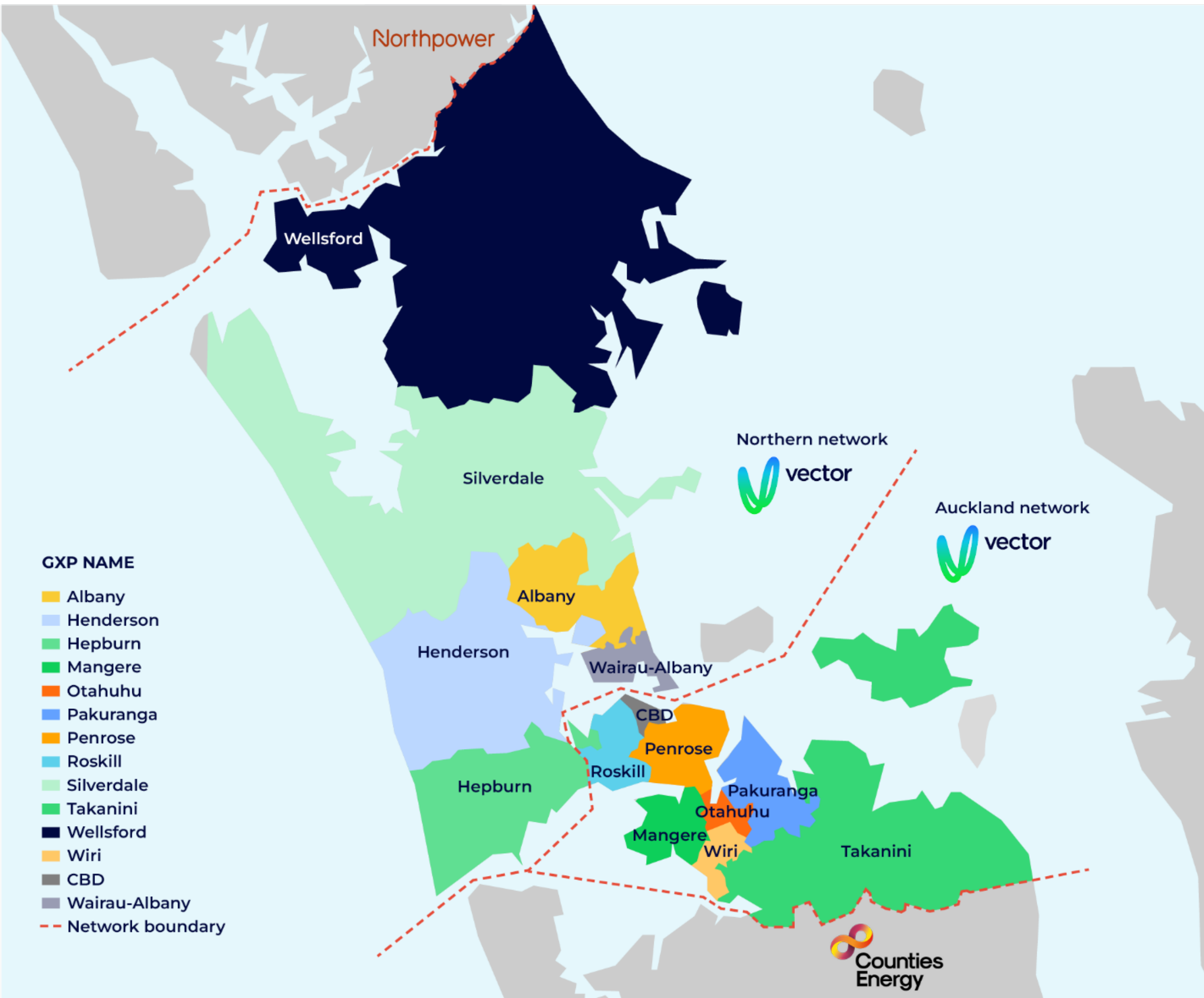


FIGURE 10.8: NETWORK PLANNING AREAS

Auckland's growth is based on the Future Urban Land Strategy laid out in the Auckland Unitary Plan. The Plan covers the areas of Auckland supplied by Vector's Northern and Auckland network regions. Under this plan, the network will need to expand into new undeveloped areas (e.g. Takanini and Wainui) and densify in sparsely developed regions (e.g. Whenuapai). These areas are currently supplied by low-capacity rural feeders and intensification to urban residential levels requires investment in both new ZSSs and distribution reticulation. The spatial distribution of future homes is aligned with the UNIFN for load forecasting (See Section 10.4.1). This includes two main intensification policies: a) The National Policy Statement for Urban Development 2020 (NPS-UD) allows for greater housing density (i.e. buildings of six storeys or more) within walkable distances of the city centre, ten metropolitan centres, and rapid transit stops (train stations and rapid busway stops) and b) the Resource Management Amendment Act 2021 (specifically, the Medium Density Residential Standards) enables three homes of up to three storeys to be built on most residential sites without a resource consent.

Within each planning area, Vector works with Transpower to ensure that demand at each GXP is managed efficiently to avoid over-expenditure on the transmission network when the constraint can be addressed at the distribution network level. This AMP discusses these projects under the subtransmission subheadings below. Any expenditure within the GXP that is not related to Vector owned assets is excluded.

To ensure efficient expenditure, the need for augmentation of any zone substation is assessed with consideration of the support that can be provided from adjacent zone substations. In many cases, multiple zone substations supply an area, so the ability to transfer load between substations to avoid significant expenditure is considered.

The following section describes each of the planning areas and material projects planned for the 10-year period of RY25 through to RY34. For land purchase projects, the expenditure forecast per project is not disclosed, as this would compromise Vector's commercial position during the land purchase process. The total land purchase forecast across 10 years and nine sites is $25M.

10.6.1 WELLSFORD PLANNING AREA

10.6.1.1 OVERVIEW

The Wellsford Planning Area is the most northern in Vector's network; it stretches from Puhoi north to Mangawhai, and Tapora east to Kawau Island. It includes the townships of Wellsford, Warkworth, Matakana, Sandspit, Omaha, Leigh and Snells Beach.

The Wellsford planning area is supplied by Transpower's GXP located at Wellsford. Vector owns four existing zone substations at Wellsford, Warkworth, Big Omaha and Snells Beach, with a fifth zone substation at Sandspit Road to be commissioned in 2025. The subtransmission network operates at 33 kV and distribution at 11 kV. The 33 kV overhead subtransmission lines are primarily on private land, with some on rough or heavily vegetated terrain.

The Auckland Unitary plan forecasts significant growth in the Warkworth area. Access to the area will be significantly improved due to the recently completed Puhoi to Warkworth motorway and Te Honohono ki Tai Matakana Link Rd, and the proposed Warkworth to Te Hana motorway.

The changes to the urban boundary open up significant new land for development, particularly for commercial and industrial development. As a result, the number of ICPs is forecast to grow from 17,000 at present to 44over the next 30 years.

The existing demand is typical for residential customers with a peaky daily load profile and high winter to summer seasonal variation.

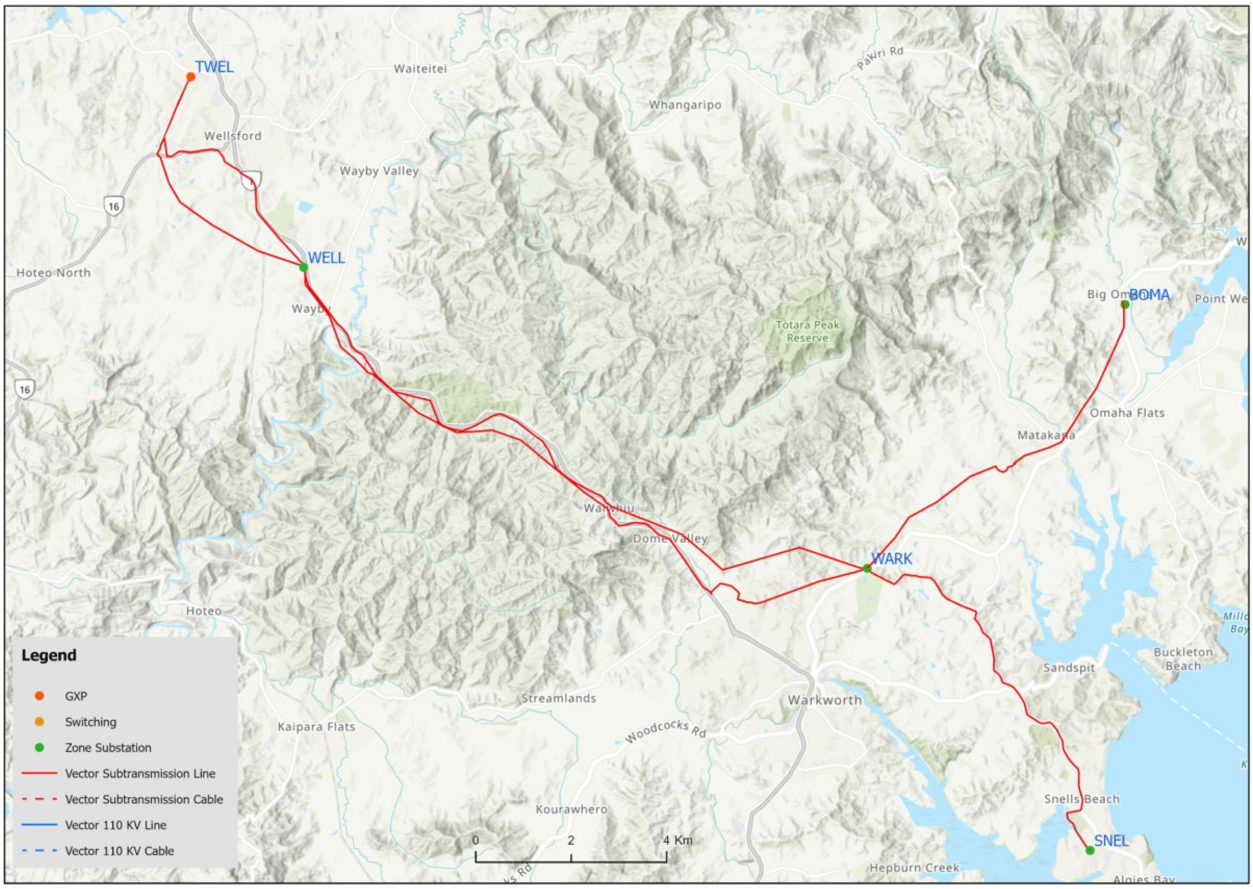


FIGURE 10.9: WELLSFORD SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Big Omaha	RES	7.5	7.7	7.9	8.2	8.4	8.7	9.0	9.3	9.6	9.8	10.3
Winter	Snells Beach	RES	7.1	8.7	8.8	9.0	9.1	9.4	9.6	9.9	10.1	10.4	10.9
Winter	Warkworth	RES	15.8	16.8	17.8	18.8	20.0	21.3	22.5	23.8	25.1	26.4	28.9
Winter	Wellsford	RES	9.3	9.8	10.2	10.7	11.1	11.7	12.3	12.9	13.4	14.0	14.9

TABLE 10-4: WELLSFORD LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.1.2 SUBTRANSMISSION

Recent Transmission Planning Reports from Transpower have identified the Wellsford GXP is at its N-1 security limit. Vector has formally engaged with Transpower to investigate options to increase supply capacity.

As shown in Figure 10.11, three 33 kV overhead circuits from Wellsford GXP supply a 33 kV busbar at Wellsford ZSS. From Wellsford ZSS two 33 kV overhead circuits supply Warkworth ZSS from where single 33 kV overhead circuits supply single transformers at Snells Beach and Big Omaha ZSS.

The 33 kV overhead lines from Wellsford GXP to Wellsford ZSS and Warkworth ZSS were constructed in 1964, are approximately 22 km long (route length) and access to the circuits is difficult as the lines traverse complex terrain and multiple privately owned properties.

Due to demand growth, the Wellsford to Warkworth circuits are expected to reach the firm capacity at peak winter evening demand in the near term. To address this constraint, Vector have completed the installation of cable ducts as part of a large-scale project to upgrade State Highway One (SH1) Twin Coast Discovery Highway between Wellsford and Warkworth. To meet the medium-term demand, a new 33 kV cable is being installed in the ducts and switchgear to connect it to the network.

Due to high load growth expectation in the area, the medium-term area plan is to establish a new zone substation (Warkworth South) in western Warkworth and in the longer term another (Mahurangi)to the northwest of Warkworth. The Mahurangi site will initially be supplied at 33 kV but with the ultimate objective of being supplied at 110 kV. Hence, the SH1 cable ducts are designed for 110 kV cables.

In accordance with Vector’s Symphony strategy, steps have been taken to use non-wires solutions to reduce the peak demand on the existing subtransmission circuits and ZSS transformers, thereby delaying the need for reinforcement. These strategies included the installation of Battery Energy Storage Systems (BESS) at Snells Beach (2.5 MW / 6 MWh) and Warkworth South (2.0 MW / 4.8 MWh) to flatten the demand profile. Permanent connection points have been installed at Wellsford and Warkworth ZSS to allow for generators to be connected over the winter months if required.

10.6.1.3 ZONE SUBSTATIONS

Wellsford GXP supplies four ZSSs: Wellsford (2 transformers), Warkworth (3 transformers), and Snells Beach and Big Omaha (both single transformer). A fourth ZSS Sandspit (single transformer initially) is being commissioned in 2025 which will be centrally located between the Warkworth and Snells Beach ZSS.

Warkworth ZSS, Snells Beach ZSS and Big Omaha ZSS will operate as a combined group providing inter zone substation security.

Battery Energy Storage Systems (BESS) with a total capacity of 4.5 MW have been installed in 2019 at Snells Beach and Warkworth South to reduce the network peak demand.

Snells Beach and Warkworth are expected to exceed transformer capacity in 2025 and 2029, respectively. The Warkworth scenario occurs under a Big Omaha or Snells Beach sub transmission contingency. Snells Beach and Warkworth peak demand can be managed by the BESS in the short term. The constraints will be resolved by constructing a new ZSS at Sandspit Rd in 2025 and at Warkworth South in 2029 and redistribution of the load between the group of five substations.

10.6.1.4 DISTRIBUTION NETWORK

The distribution network in this planning area covers a very large rural area that contains the longest 11 kV rural overhead distribution circuits within Vector’s network. The long feeders are susceptible to outages, resulting in poor reliability, and poor power quality.

To address the reliability and power quality issues Vector has identified a number of initiatives using both network and non-wires solutions (see 11.4.3 Distribution Spur Feeder Reinforcement). The recently commissioned Big Omaha ZSS (refer to the zone substation section above) has increased distribution feeder capacity to serve the greater Matakana, Whangateau, Omaha and Leigh areas and, by shortening the feeder lengths, will improve the quality of supply and reliability performance to these areas.

A recently installed new voltage regulator in Te Arai will improve power quality and resolve backstopping constraints.

A new section of overhead line will be installed to connect two long 11kV spurs on separate feeders in Puhoi, to improve backstopping and reduce the number of customers remaining off after a fault.

10.6.1.5 CONSTRAINTS AND NETWORK REINFORCEMENT

The following network reinforcement projects are planned for this area.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Puhoi reliability	Puhoi 11kV feeder link	FY26	0.8

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Wellsford – Warkworth subtransmission breaches SOSS	Wellsford ZSS to Warkworth 33 kV subtransmission cable new – Wellsford end	FY24	7.6[18]
	Wellsford 33 kV switchgear replacement. Related to the new Wellsford-Warkworth subtransmission cable		0.9[6]
Future constraints on the 33 kV and 11 kV networks	Land procurement for a future 33/11 kV Mahurangi ZSS and 110/33 kV bulk supply substation	FY25	Not discl.
Transformer capacity at Warkworth ZSS and Snells Beach ZS	New Zone Substation - Sandspit	FY25	6.5[6]
Warkworth area transformer capacity breaches SoSS	New Zone Substation - Warkworth South	FY29	15.7
Sub-transmission circuits to Warkworth breaching SoSS under N-1 conditions	Wellsford ZSS to Warkworth 2nd 33 kV SUBTRANSMISSION cable new	FY35	7.5[19]

TABLE 10-5: WELLSFORD CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.2 SILVERDALE PLANNING AREA

10.6.2.1 OVERVIEW

The Silverdale planning area extends from Albany north to Waiwera, and Whangaparaoa west to Helensville and the west coast. The highest population density is to the east of State Highway 1 (SH1) and comprises the Whangaparaoa, Gulf Harbour, Orewa, Millwater, Red Beach, and Silverdale areas. A MW-scale generation facility from landfill is operating in the area. New medium density developments are forecast to expand westwards from Millwater towards Wainui and Dairy Flat.

The Auckland Unitary plan forecasts significant population growth within the Orewa urban area, primarily due to the increased urban boundary. As a result the forecast is for 2,500 new residential ICPs plus industrial and commercial growth, which will increase demand by 14 MW (excluding potential major customers) over the next 10 years.

Significant new land area is zoned for commercial and industrial development in the Dairy Flat area with one large new customer identified.

FIGURE 10.10: SILVERDALE SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Gulf Harbour	RES	9.3	9.5	9.7	9.8	12.2	12.4	12.6	12.9	13.1	13.3	13.7
Winter	Helensville	RES	11.8	12.0	12.2	12.5	12.7	13.0	13.3	13.7	14.0	14.3	14.9
Winter	Kaukapakapa	RES	6.2	6.3	6.5	6.6	6.8	7.0	7.2	7.4	7.7	7.9	8.3
Winter	Manly	RES	19.5	19.7	20.0	20.2	20.5	21.0	21.5	22.1	22.6	23.1	24.1
Winter	Orewa	RES	22.7	23.6	24.5	25.3	26.2	27.3	28.5	29.6	30.7	31.8	33.9
Winter	Red Beach	RES	23.1	24.9	26.6	27.8	28.3	29.0	29.6	30.3	31.0	31.6	32.7

[18] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

[19] Only the cost falling within this AMP period is shown, the project will commence past this period.

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Spur Road	RES	15.0	19.9	20.8	21.8	23.5	24.9	26.3	27.7	29.0	30.3	32.3

TABLE 10-6: SILVERDALE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.2.2 SUBTRANSMISSION

The area is supplied from the Silverdale GXP. The subtransmission network operates at 33 kV and consists of predominately overhead lines. The 33 kV network is a primarily meshed with only the Gulf Harbour ZSS supplied by a radial line. The network includes two long overhead lines from Silverdale to Helensville.

Vector has identified that the new residential and commercial developments set out by the Auckland Unitary plan will create constraints on the subtransmission network that will breach the SoSS. The constraints will occur where one of the Silverdale – Orewa or Silverdale – Manly circuits is out of service (N-1) in 2024 . To resolve these constraints, Vector has scheduled projects to replace sections of older low-capacity cable.

Forecast constraints on the subtransmission circuits from Silverdale GXP to Orewa, Manly and Spur Rd ZSS will be addressed by cable replacement projects.

10.6.2.3 ZONE SUBSTATIONS

Silverdale GXP supplies five two-transformer ZSSs at Helensville, Manly, Red Beach, Orewa and Spur Road. Gulf Harbour and Kaukapakapa are single transformer substations.

A new zone substation at Millwater (single transformer initially) is planned to resolve the capacity constrained expected as a result of the new residential development on the western side of SH1 towards Wainui. Vector has a suitable site and has installed subtransmission ducts.

The outdoor 33kV switchgear at Horseshoe Bush is being replaced by a new indoor switchboard, as the first stage in a future ZSS.

A major customer facility was commissioned on the Red Beach 11kV network in FY22 with future expansion on dedicated 33kV cables in planning. An e-ferry charging station is in planning at Gulf Harbour.

The 33/11kV transformers at Manly ZSS are approaching when a sub transmission contingency occurs at Gulf Harbour and will be replaced by FY27.

10.6.2.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and underground in the urban areas. The rural distribution network covers a very large rural area that contains long overhead distribution circuits. The long feeders are susceptible to outages, resulting in poor reliability, and poor power quality. An emergency backup generator has been installed in the remote South Head peninsula network to improve service to our customers in the area, and a project is planned to make this a permanent installation.

Distribution network constraints mean the new Millwater ZSS and associated distribution network reinforcement will be required to provide capacity and maintain distribution feeder security to the growing greenfields urban development areas west of Orewa, in Wainui, Milldale and Dairy Flat.

The construction of the Highgate Bridge across SH1 at Milldale will enable Vector to install a feeder cable for the future Millwater ZSS.

The Waka Kotahi PenLink highway project in Whangaparaoa will provide an opportunity to install a new 11 kV cable on a new bridge across the Weiti River and improve security of supply to the Whangaparaoa peninsula.

Future forecast feeder constraints will be addressed by a cable project near Orewa ZSS.

10.6.2.5 CONSTRAINTS AND NETWORK REINFORCEMENT

The following network reinforcement projects are planned for this area.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Capacity for new point load	Dairy Flat land purchase for ZSS	FY25	Not discl.
Forecast breach of SoSS on the subtransmission network under N-1 scenarios	Silverdale GXP, Orewa and Manly Subtransmission Cable Upgrade	FY25	5.4
Future Milldale 11kV constraints	Highgate Bridge Elec 11kV cable	FY25	0.4
Reliability	South Head Permanent Standby Generation	FY26	1.4
Asset age/condition plus future capacity constraint	Horseshoe bush 33kV SWBD New	FY25	3.3[20]

[20] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Capacity constraint at Silverdale GXP	Silverdale GXP expansion Vector 33kV cable works	FY27	2.5
Capacity and security of supply constraints on the Millwater distribution network	New Zone Substation - Millwater T1	FY28	6.5[8]
Transformer capacity due to Gulf Harbour contingency	Manly 33 / 11 kV transformer capacity upgrade	FY27	14.4
Insufficient security of supply on the Whangaparaoa Peninsula (project timing determined by external roading project)	PenLink 11 kV reinforcement	FY28	0.6
Load forecast breaches SoSS in West Hoe Heights, Orewa	Orewa 11 kV West Hoe Heights reinforcement	FY34	2.2

TABLE 10-7: SILVERDALE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.3 HENDERSON PLANNING AREA

10.6.3.1 OVERVIEW

The Henderson area extends from Riverhead, Whenuapai, Hobsonville and Te Atatu westwards through Ranui, Swanson, Henderson Valley, and the Waitakeres to the west coast from Muriwai down to Te Henga.

The urban part of the region is one of the major growth areas in the Auckland region, with large population growth over the next 10 years projected in the Auckland Unitary plan. The growth is driven by major residential brownfield developments at Hobsonville Point extending northward towards Whenuapai, Riverhead, and Kumeu, and to Westgate and Redhills in the west. This growth equates to approximately 11,000 net additional dwellings and an approximate additional load of 30 MW over the next 10 years.

A number of large-scale data centres have been recently commissioned or are in construction or planning. This may result in over 120 MVA in installed capacity in a concentrated area around Westgate/Hobsonville.

E-ferry charging stations are in planning at West Harbour and Hobsonville.

Significant new land is available for commercial and industrial development plus four major customer sites identified or committed. Other important load centres include the New Zealand Air Force Whenuapai base and Waitakere Hospital.

A new zone substation at Hobsonville Point was commissioned in 2019 with a co-located 1 MW / 2 MWh BESS to provide peak demand support.

Vector is engaging with Transpower to increase the supply capacity at Henderson GXP and is in consultation over a possible future GXP in Huapai.

Load will be transferred to Albany GXP from Henderson GXP in order to manage demand on Henderson.

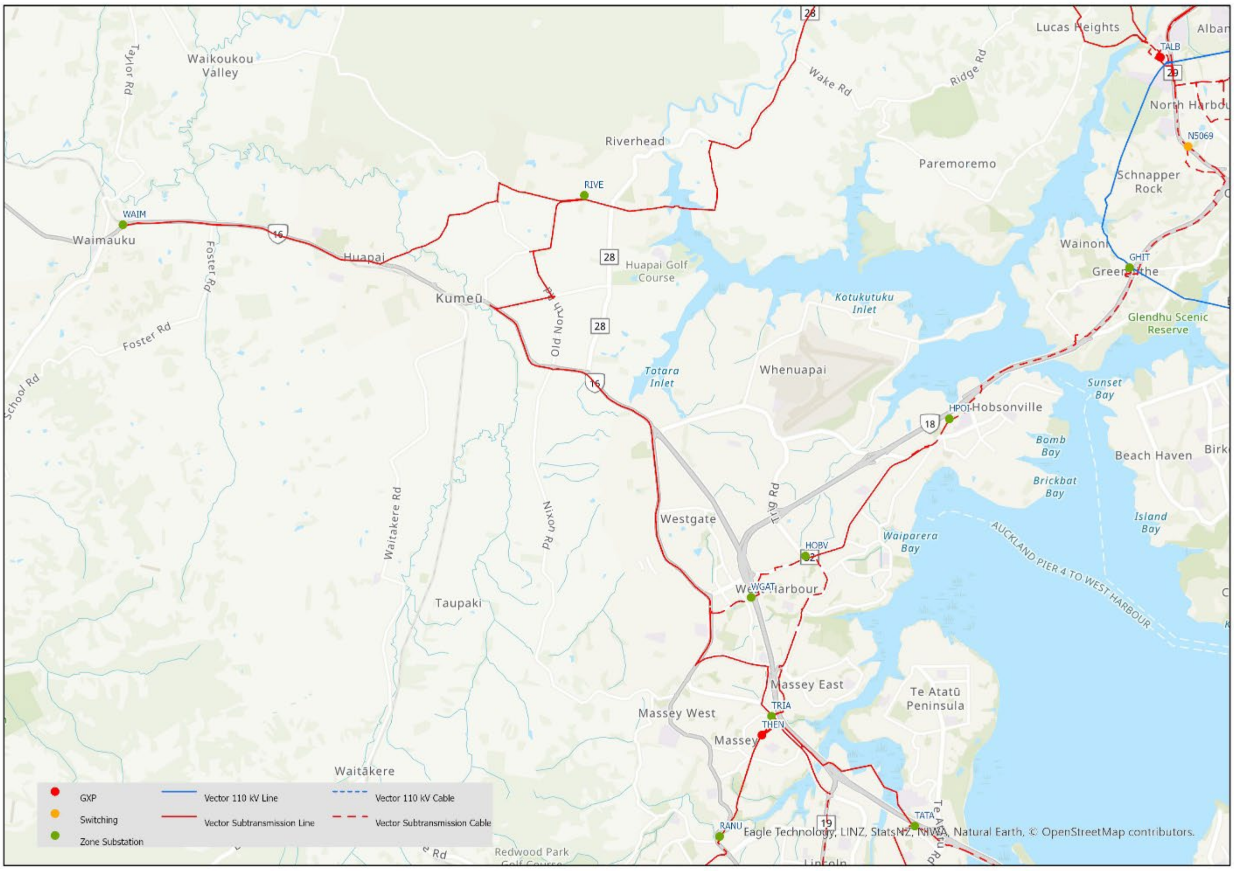


FIGURE 10.11: HENDERSON SUBTRANSMISSION NETWORK

SEASON	ZONE SUBSTATION	SOSS CATEGORY	LOAD FORECAST (MVA) 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Hobsonville	RES	13.9	15.6	17.0	18.2	19.0	20.0	20.9	21.9	22.9	23.8	25.0
Winter	Hobsonville Point	RES	11.6	16.9	20.6	23.7	26.6	27.5	28.6	29.5	30.5	33.2	34.3
Winter	Ranui	RES	9.3	9.8	10.3	10.7	11.2	11.6	12.1	12.5	12.9	13.3	13.8
Winter	Riverhead	RES	13.8	15.5	17.3	17.7	18.1	19.0	19.8	20.7	21.5	22.4	24.7
Winter	Simpson Road	RES	5.4	5.5	5.5	5.6	5.6	5.8	5.9	6.0	6.1	6.2	6.4
Winter	Swanson	RES	11.5	11.7	11.9	12.7	13.0	13.4	13.8	14.1	14.5	14.8	15.3
Winter	Te Atatu	RES	22.6	23.0	23.5	23.9	24.3	25.1	25.8	26.6	27.4	28.1	29.2
Winter	Triangle Road	RES	17.7	16.4	16.7	16.9	17.2	17.6	18.1	18.6	19.0	19.5	20.2
Winter	Waimauku	RES	12.8	13.2	14.1	14.5	14.8	15.5	16.1	16.7	17.4	18.0	19.3
Winter	Westgate	COM	19.1	22.0	23.9	24.7	25.4	26.3	27.2	27.9	28.6	29.4	30.4
Winter	Woodford	COM	8.9	10.2	10.5	10.9	11.2	11.6	12.0	12.4	12.8	13.2	13.7

TABLE 10-8: HENDERSON LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.3.2 SUBTRANSMISSION

The area is supplied from the Henderson GXP. The subtransmission network operates at 33 kV and consists of predominately overhead lines.

Vector has identified that the new residential and commercial developments set out by the Auckland Unitary plan will create constraints on the subtransmission network that will breach the SoSS. The constraints will occur under normal operating conditions (N) in 2028 on the Henderson to Hobsonville line and in 2030 on the Hobsonville to Hobsonville Point line. In the case where a subtransmission line is out of service (N-1), the constraints will occur in 2024 and 2027 if one of the two circuits on either the Henderson to Hobsonville line is out of service or the Henderson to Westgate line is out of service, respectively.

The Albany-Greenhithe subtransmission upgrade and Albany to Greenhithe 110kV to 33kV SUBT OH conversion projects (discussed in section 10.9.5 below) will add 33 kV capacity and security of supply into the Henderson Planning Area from the north and alleviate the Hobsonville constraints.

The 33 kV subtransmission to Waimauku zone substation is a single overhead line and even though it has two transformers, the substation is on N security. This is not a major risk as the overhead line is accessible and repairs can be carried out quickly to fully restore supplies and maintain compliance with the SoSS. A SafeRoads project for State Highway 16 (SH16) is in progress and Vector is taking the opportunity to lay ducts for a future second 33 kV circuit to Waimauku ZSS, subtransmission circuits between Kumeu and Westgate, and a new 11 kV cable to increase security of supply to Kumeu, Huapai and Waimauku.

As the demand growth of recent developments (including data centres) materialises, the implications for Grid Exit Point capacity will emerge. Options to increase capacity from the national grid are being actively investigated with Transpower.

10.6.3.3 ZONE SUBSTATIONS

Henderson GXP supplies 10 zone substations of which four are single-transformer ZSSs, namely Simpson Road, Swanson, Ranui, and Woodford and six are two-transformer ZSSs, namely Triangle Road, Te Atatu, Westgate, Hobsonville, Hobsonville Point, and Riverhead.

The demand forecast shows that there are expected to be breaches of the SoSS at Ranui ZSS (2026) and Swanson ZSS (2026). As these zone substations are adjacent to each other, Vector has identified the preferred solution to be the installation of a second transformer at Swanson ZSS and network reconfiguration to balance load. This project is in delivery.

A transformer capacity constraint is forecast at Riverhead ZSS and a transformer replacement project is in progress.

A transformer capacity constraint is forecast at Hobsonville Point ZSS which will be addressed by a transformer uprating project (installation of cooling fans).

Transformer capacity constraints are forecast at Te Atatu, Woodford Rd and Simpson Rd ZSS which will be addressed by transformer replacement projects.

Demand growth and a new major customer connection are driving an emerging constraint in Whenuapai and Redhills. The preferred solution is to construct new zone substations at Whenuapai and Redhills to provide the required capacity and avoid capacity upgrades at Westgate, Hobsonville and Hobsonville Point ZSS.

An 11 kV regulator project in construction will improve backstopping to Waimauku ZSS and improve SAIDI for the Muriwai area.

10.6.3.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and a combination of overhead and underground in the urban areas. The rural distribution network covers a very large rural area that contains long overhead distribution circuits.

The forecast growth will cause constraints on the 11 kV network will be addressed by the new zone substations at Whenuapai and Redhills. Vector's analysis showed that a new substation provided better value and feasibility than augmenting existing feeders or installing new feeders.

Continuing commercial development at the Westgate shopping centre is resulting in capacity constraints which will be addressed by the Fred Taylor Drive 11 kV reinforcement project (in delivery), and later by the Redhills ZSS.

Development at Waitakere Hospital will result in a feeder capacity shortfall and a cable replacement project is in progress.

10.6.3.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Capacity constraint on the distribution network	Fred Taylor Drive 11 kV reinforcement	FY25	1.4[21]
Project coordinated with Waka Kotahi roadworks	SH16 Kumeu to Brigham Creek future proofing ducts	FY28	9.9
Project coordinated with Auckland Transport roadworks	SH16 Huapai to Waimauku reinforcement	FY26	3.2[9]
Constraints on the 11 kV distribution network in the Redhills area; Redhills major customer	Henderson GXP Redhills subtransmission future-proofing ducts	FY25	2.9[9]
Constraints on the 11 kV distribution network in the Redhills area; Ranui ZSS capacity constraint	Redhills Zone Substation land purchase	FY25	Not discl.
	New Redhills Zone Substation	FY28	16.0
Forecast breach of SoSS on the subtransmission network under N and N-1 scenarios as well as constraints on the distribution network	Riverhead 33/11 kV transformer capacity upgrade and 11 kV switchgear	FY27	12.2[9]
Whenuapai 11 kV feeder capacity; Whenuapai major customer	Whenuapai Zone Substation land purchase	FY25	Not discl.
	New Whenuapai ZSS	FY27	25.6[9]
Simpson ZSS, Ranui ZSS and Swanson ZSS zone substation breaches SoSS	Swanson second 33/11 kV transformer	FY27	5.4[9]
Transformer capacity	Hobsonville Point T1+T2 transformer uprating	FY26	0.2

[21] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Transformer capacity	Simpson 33/11kV TX upgrade T1	FY35	0.9[22]
Transformer capacity	Woodford ZS 33/11kV TX upgrade T1	FY31	4.0
Forecast breach of SoSS on the subtransmission network under N and N-1 scenarios as well as constraints on the distribution network	Te Atatu 33/11 kV (T1 and T2) transformer capacity upgrade	FY27	6.6
Forecast breach of SoSS on the Ranui subtransmission network under N and N-1 scenarios as well as constraints on the transformer capacity and distribution network	New Redhills Zone Substation	FY30	7.6

TABLE 10-9: HENDERSON CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.4 HEPBURN PLANNING AREA

10.6.4.1 OVERVIEW

The Hepburn area includes Avondale, Te Atatu South, New Lynn, Green Bay, Titirangi and Laingholm, extending west to Piha and south to Parau, Cornwallis and Huia. Relatively low growth is forecast except for a major KiwiRail traction supply connection to the GXP, and pockets of re-development around the old Brickworks site in New Lynn and the Sabulite areas.

[22] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

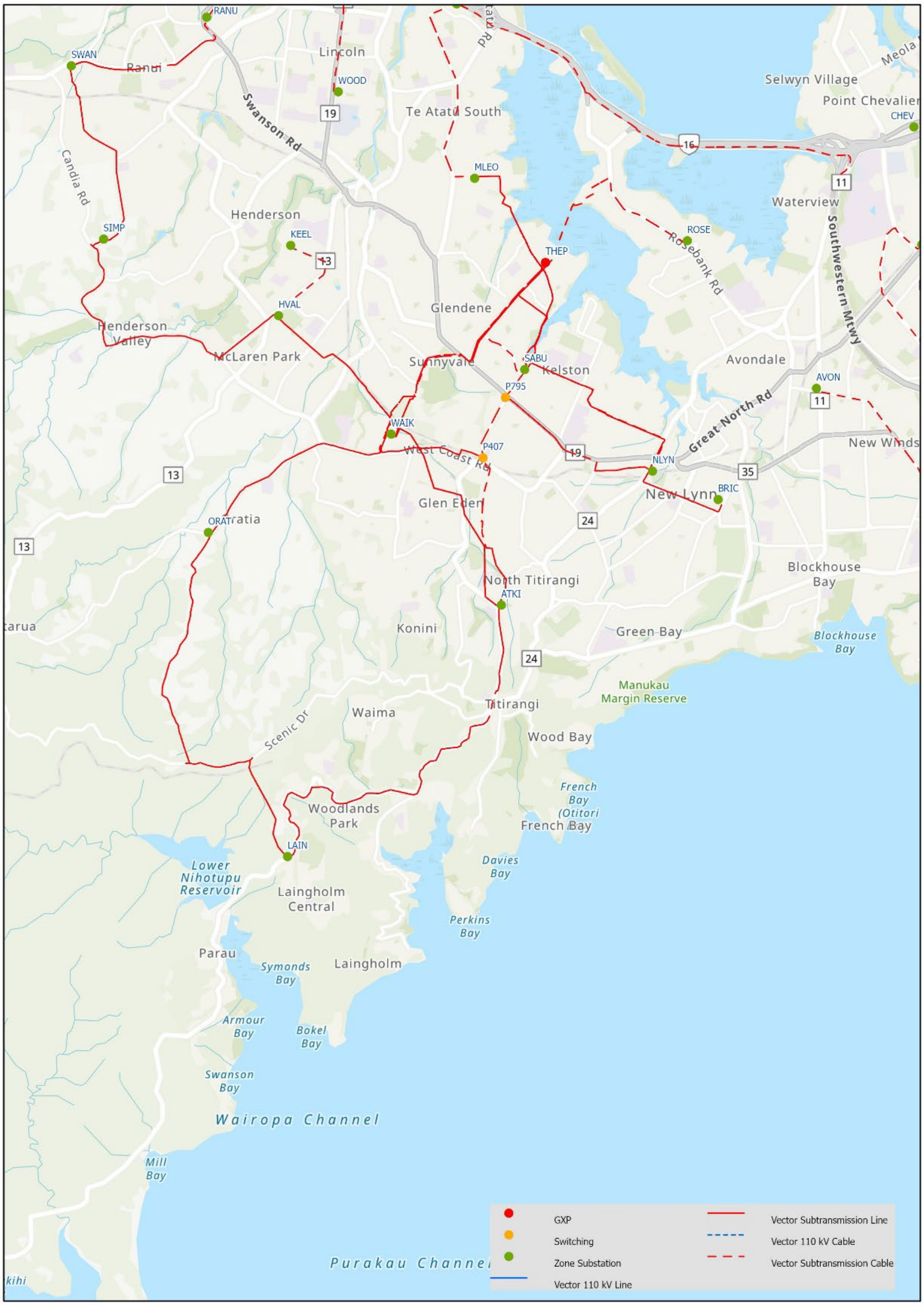


FIGURE 10.12: HEPBURN SUBTRANSMISSION NETWORK

SEASON	ZONE SUBSTATION	SOSS CATEGORY	LOAD FORECAST (MVA)										
			2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Atkinson Road	RES	20.5	20.7	20.9	21.1	21.3	21.8	22.2	22.6	23.0	23.4	24.1
Winter	Brickworks	COM	10.3	11.2	11.6	12.0	12.4	12.9	13.8	14.4	14.9	15.3	16.0
Winter	Henderson Valley	COM	15.5	16.0	16.6	17.1	17.7	18.5	19.3	20.2	21.0	21.8	23.0

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Keeling Road	RES	14.6	15.0	15.4	15.8	16.2	16.7	18.0	18.5	19.1	19.6	20.4
Winter	Laingholm	RES	8.8	8.9	8.9	9.0	9.0	9.2	9.3	9.5	9.6	9.8	10.1
Winter	McLeod Road	COM	9.8	10.0	10.2	10.4	10.5	10.8	11.1	11.4	11.7	12.0	12.4
Winter	New Lynn	RES	13.7	14.2	14.7	15.1	15.6	16.2	16.8	17.5	18.1	18.7	19.5
Winter	Oratia	RES	22.3	25.6	26.2	26.8	27.4	28.2	29.0	29.8	30.6	31.4	32.6
Winter	Rosebank	COM	5.3	5.3	5.3	5.3	5.3	5.4	5.5	5.6	5.7	5.8	6.0
Winter	Sabulite Road	COM	21.3	21.7	22.2	22.7	23.2	23.8	24.5	25.2	25.8	26.5	27.4
Winter	Waikaukau	COM	8.5	8.5	8.6	8.6	8.6	8.7	8.8	8.9	9.0	9.1	9.3

TABLE 10-10: HEPBURN LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.4.2 SUBTRANSMISSION

The area is supplied from the Hepburn GXP. The subtransmission network operates at 33 kV and consists of predominately overhead lines. The area mostly consists of low-density urban terrain, except for the subtransmission rings to Atkinson Road, Oratia and Laingholm subtransmission loop which traverses hilly and heavily vegetated terrain resulting in higher impact to reliability.

While there is low growth forecast, Vector has identified that there are expected to be constraints that occur under N-1 conditions when specific subtransmission lines are out of service. The constraints are all forecast for the end of the AMP period in 2030 and will occur if one of the four Hepburn GXP to Waikaukau ZSS circuits or the Waikaukau ZSS to Atkinson Rd ZSS line is out of service. Each of these constraints will cause a back-up circuit to exceed its rated capacity. The Hepburn to Waikaukau constraints will be resolved by cable replacements planned under asset replacement programmes. The Hepburn to Atkinson Rd constraint will be resolved by a subtransmission cable re-arrangement.

10.6.4.3 ZONE SUBSTATIONS

Hepburn GXP supplies 10 zone substations of which four are single-transformer ZSSs, namely Oratia, Brickworks, Waikaukau, and McLeod Road and six are two-transformer ZSSs, namely Keeling Road, Henderson Valley, Atkinson Road, Laingholm, Sabulite Road, and New Lynn.

Capacity constraints are forecast at Sabulite, Waikaukau, Brickworks, McLeod Rd, Henderson Valley and New Lynn ZSS, which will be addressed by transformer installation projects.

10.6.4.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and a combination of overhead and underground in the urban areas. The distribution network covers a very large rural area that contains long overhead line which present reliability challenges.

Reliability and resilience issues have been identified on the single radial 11 kV overhead feeder supplying the greater Piha area. To address this issue, temporary standby generation has been installed and at Piha, a cable project linking 11 kV feeders along Scenic Drive has been completed, extra remote-controlled switches are being installed in FY24, and a long-term generation solution is in planning.

10.6.4.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Reliability	Piha Permanent Standby Generation	FY27	1.8
Transformer capacity	Brickworks 33/11 kV 2nd transformer, 11 kV switchgear replacement, and new 33 kV cable	FY27	7.9
Transformer capacity	McLeod Rd 33/11kV TX upgrade T1	FY27	4.0
Subtransmission breaches SoSS under N-1 conditions	Atkinson Rd subtransmission cable reinforcement	FY28	0.3
Transformer capacity	Waikaukau 33/11kV TX Capacity Upgrade T1	FY26	4.5
Transformer capacity	Sabulite 33/11 kV transformer capacity upgrade	FY27	9.6
Transformer capacity	Henderson Valley 33/11kV TX upgrade T1+T2	FY31	6.7
Transformer capacity	New Lynn 33/11kV TX upgrade T1+T2	FY32	13.8

TABLE 10-11: HEPBURN CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.5 ALBANY PLANNING AREA

10.6.5.1 OVERVIEW

The Albany Planning Area extends from Totara Vale and Forrest Hill north to Fairview Heights, and the East Coast Bays from Castor Bay to Torbay, also including Paremoremo, Coatesville, and Dairy Flat. Important load centres include Watercare Rosedale treatment facility and the Massey University campus.

The major residential growth areas are Long Bay and Glenvar and steady densification of commercial areas (taller buildings and higher density construction) is driving an increase in demand in existing areas in Albany (i.e. McKinnon ZSS) and Rosedale. The overall growth in these areas 2033 is forecast to be 30+ MVA. Additionally, a few large commercial facilities will be connected in the area. Load will also be transferred to Albany GXP from Henderson GXP in order to manage demand on Henderson.

A major customer facility is in planning, with a direct connection to the GXP. This will bring forward a forecast capacity constraint at the GXP. Vector is in discussion with Transpower over solutions for the Albany GXP capacity, including a possible new GXP in the Rosedale area.

FIGURE 10.13: ALBANY SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Browns Bay	RES	17.3	17.7	18.1	18.6	19.0	19.5	20.1	20.7	21.3	21.8	22.6
Summer	Bush Road	COM	20.9	22.2	22.6	23.1	23.6	24.2	24.9	25.5	26.2	26.8	27.7
Winter	Coatesville	RES	11.7	11.9	12.2	12.5	12.7	13.1	13.4	13.8	14.1	14.5	15.0
Winter	East Coast Road	RES	15.6	16.1	16.6	17.1	17.7	18.3	19.0	19.7	20.3	21.0	21.9
Winter	Forrest Hill	RES	16.5	16.9	17.2	17.6	17.9	18.4	18.8	19.3	19.8	20.2	20.9
Winter	Greenhithe	RES	10.7	10.9	11.1	11.4	11.6	12.0	12.3	12.7	13.0	13.4	13.9
Winter	McKinnon	RES	17.9	18.6	21.1	21.8	22.6	23.4	24.3	25.2	26.1	27.0	28.2
Winter	Rosedale	COM	14.4	15.5	15.9	16.3	18.7	19.4	20.1	23.2	23.7	24.2	24.9
Winter	Sunset Road	COM	13.6	14.2	14.9	15.6	16.3	17.1	18.0	18.9	19.7	20.6	21.8
Winter	Torbay	RES	9.6	9.8	10.0	10.2	10.4	10.7	11.0	11.3	11.5	11.8	12.3
Winter	Waiake	RES	8.2	8.4	8.6	8.8	9.1	9.4	9.7	10.0	10.3	10.6	11.0

TABLE 10-12: ALBANY LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.5.2 SUBTRANSMISSION

The area is supplied from the Albany GXP. The subtransmission network operates at 110 kV and 33 kV and consists of predominately overhead lines in the rural areas and underground in the urban areas. The area mostly consists of low-density urban subdivisions, with a number of commercial centres.

Waimauku ZSS is supplied from Albany, however, it is included in the Henderson planning area as it is closer to Henderson GXP and supplies customers considered to be within the Henderson planning area. The long-term plan is to supply Waimauku ZSS from Henderson GXP or from a new GXP at Huapai.

A constraint on the Albany GXP to Greenhithe ZSS circuit is forecast and a cable installation project is scheduled by FY25, followed by a project to convert one of the Albany-Wairau 110 kV lines to 33 kV for a second Albany-Greenhithe circuit.

The wider Rosedale area is supplied by an interconnected subtransmission network which connects 9 ZSS. Constraints on the Albany GXP to Bush Rd ZSS circuits and Bush Rd ZSS to Sunset Rd ZSS are forecast. The preferred solution is to reinforce the existing Albany GXP to Rosedale ZSS circuit and install a second circuit, partially re-using two of the Albany-Wairau 110 kV lines at 33 kV.

Future forecast constraints on the Albany-Coatesville subtransmission circuits will be addressed by cable replacement projects.

10.6.5.3 ZONE SUBSTATION

Albany GXP supplies 12 zone substations of which four are single-transformer ZSSs, namely Greenhithe, Waiake, Torbay and East Coast Road and eight are two-transformer ZSSs, namely Coatesville, Waimauku, McKinnon, Browns Bay, Rosedale, Bush Road, Sunset Road, and Forrest Hill.

Capacity constraints are forecast at Torbay, Waiake, Forrest Hill and Sunset Rd ZSS, which will be addressed by transformer installation projects.

10.6.5.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and underground in the urban areas.

A forecast security of supply shortfall on a Rosedale ZSS feeder will be addressed by a project in delivery to create a new feeder (Triton Drive).

10.6.5.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Transformer Capacity	Torbay 33/11kV TX upgrade T1	FY26	8.2
Albany subtransmission breaches SoSS (project coordinated with Waka Kotahi roadworks)	Albany GXP Rosedale Subtrans Cable Reinforcement	FY25	6.1[23]
Albany subtransmission breaches SoSS	Albany GXP Greenhithe new Subtransmission cable	FY25	6.0[11]
Albany to Greenhithe subtransmission circuits breach SoSS	Albany to Greenhithe 110 kV to 33 kV subtransmission OH conversion	FY26	9.1
Transformer Capacity	Waiake 33/11kV TX upgrade T1	FY27	8.2
Albany subtransmission breaches SoSS	Albany GXP Coatesville Subtransmission Cable Replacement	FY32	3.0
Albany GXP capacity constraint	Rosedale GXP subtransmission cables	FY29	8.3
Transformer Capacity	Forrest Hill 33/11kV TX upgrade T1+T2	FY32	9.6
Transformer Capacity	Sunset Road 33/11kV TX upgrade T1+T2	FY34	9.6

TABLE 10-13: ALBANY CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.6 WAIRAU PLANNING AREA

10.6.6.1 OVERVIEW

The Wairau Planning Area comprises the urban North Shore from Bayview and Milford, south to the Devonport peninsula and the Waitemata Harbour.

Important load centres include Takapuna (the North Shore CBD), the New Zealand Navy base in Devonport, the North Shore Hospital, and Auckland University of Technology Akaranga campus.

Some zone substations in the Wairau Valley area have been targeted to supply the planned electrification of ferries.

A forecast capacity constraint at the Wairau Valley bulk supply substation is being addressed by a Transpower project for a second 220/33kV transformer at Wairau GXP. Vector is in discussion with Transpower over options to address future capacity limits at Wairau.

[23] Only the cost falling within this AMP period is shown, the project will proceed past this period.

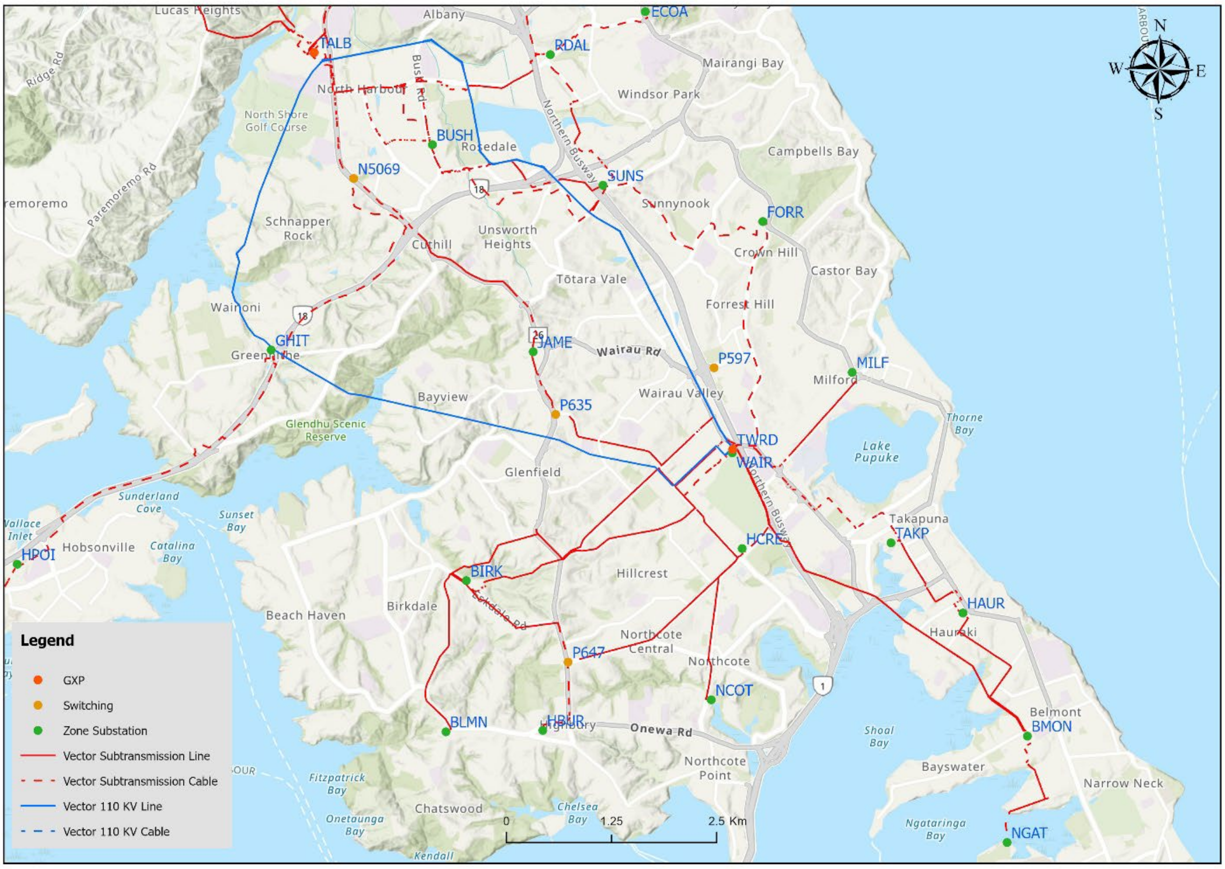


FIGURE 10.14: WAIRAU SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Balmain	RES	9.5	9.7	10.5	10.7	10.8	11.1	11.4	11.7	11.9	12.2	12.6
Winter	Belmont	RES	13.9	14.2	16.7	17.1	17.4	17.9	18.4	18.9	19.4	19.9	20.7
Winter	Birkdale	RES	22.4	22.6	22.7	22.9	23.0	23.5	24.0	24.5	25.0	25.5	26.4
Winter	Hauraki	RES	7.6	8.0	8.5	9.0	9.5	10.1	10.7	11.3	11.9	12.5	13.3
Winter	Highbury	COM	12.7	13.3	16.0	16.6	17.2	17.9	18.6	19.3	20.0	20.7	21.7
Winter	Hillcrest	RES	22.1	23.2	24.2	25.3	26.3	27.6	28.9	30.2	31.4	32.7	34.3
Winter	James Street	RES	20.4	20.8	21.2	21.6	22.0	22.7	23.3	24.0	24.7	25.4	26.5
Winter	Milford	RES	8.3	8.6	8.9	9.2	9.5	9.9	10.3	10.7	11.0	11.4	11.9
Winter	Ngataringa Bay	RES	8.2	11.1	11.3	11.5	11.7	11.9	12.1	12.4	12.6	12.8	13.2
Winter	Northcote	RES	6.4	6.6	7.0	7.2	7.5	7.8	8.1	9.1	9.4	9.7	10.1
Winter	Takapuna	COM	8.3	8.7	9.0	9.4	9.7	10.2	10.7	11.1	11.6	12.1	12.7
Winter	Wairau Road	COM	18.2	21.1	22.2	22.9	23.6	24.4	25.2	26.5	27.3	28.1	29.1

TABLE 10-14: WAIRAU LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.6.2 SUBTRANSMISSION

The area is supplied from the Wairau GXP. The subtransmission network operates at 110 kV and 33 kV and consists of predominately overhead lines.

A constraint on the subtransmission network appears just on the Wairau – Takapuna 33 kV circuit in FY34.

10.6.6.3 ZONE SUBSTATION

Wairau GXP supplies 12 zone substations of which seven are single-transformer ZSSs, namely Highbury, Balmain, James St, Northcote, Milford, Hauraki, Ngataringa Bay and Takapuna and four are two-transformer ZSSs, namely Wairau Valley, Birkdale, Hillcrest, and Belmont.

Capacity constraints at Wairau Rd, James St, Milford, and Balmain ZSS will be addressed by transformer installation projects.

As a result of E-Ferry and organic growth, Highbury zone substation is reaching capacity in 2026. This is also the cause of backstop shortfalls at other zone substations. A project for a second transformer and accompanying sub-transmission circuit is in delivery.

Four issues have been identified at the Ngataringa Bay ZSS:

- The 33 kV oil-filled submarine cable to Ngataringa Bay ZSS is approaching the end of its serviceable life which presents a network security risk and also an environmental risk from oil leaks
- Ngataringa Bay ZZS has insufficient 11 kV backstop capacity for an outage at peak demand
- The proposed electric ferry charging terminal at Devonport will exceed the capacity of the existing network
- Ngataringa Bay ZSS is low-lying and close to the coast, making it vulnerable to flooding. The flooding risk is expected to increase under forecast climate change scenarios
- Ngataringa Bay ZSS is low-lying and close to the coast, making it vulnerable to flooding. The flooding risk is expected to increase under forecast climate change scenarios

The first two issues are addressed by the Ngataringa Bay 11 kV cable replacement project starting in FY24. The permanent solution is planned for FY26 and will involve installation of a third transformer at Belmont ZSS to supply the area via new cables and thereafter decommissioning and removal of Ngataringa Bay ZSS.

10.6.6.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV with a combination of overhead and underground circuits. In the urban and commercial areas, steady densification (taller buildings and higher density construction) is driving an increase in demand on some 11 kV feeders. A feeder upgrade is planned for Highbury ZSS.

10.6.6.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Belmont ZSS capacity	Belmont 33/11 kV T3	FY26	9.2[24]
Highbury subtransmission capacity	Highbury 33/11 kV 2nd transformer and 2nd 33 kV cable	FY25	6.1[12]
Ngataringa Bay flood risk; Ngataringa Bay security of supply	Ngataringa Bay Direct Supply Belmont ZSS	FY25	3.7[12]
Project co-ordinated with Transpower	Wairau 220/33 kV 2nd transformer T9 enabling works	FY25	0.6[12]
Feeder supply and backstop shortfall	Highbury 11 kV New Feeder	FY30	1.0
Transformer capacity	James St 33/11kV TX upgrade T1+T2	FY28	13.8
Transformer capacity	Milford 33/11kV TX upgrade T1	FY28	4.0
Transformer capacity	Wairau 33/11kV TX upgrade T1+T2	FY26	6.7
Transformer capacity	Balmain 2nd 33/11kV TX & 33kV switchroom	FY33	9.9
Transformer capacity	Northcote 33/11kV TX upgrade T1	FY34	2.6
Subtransmission load forecast breaches SoSS	Wairau-Takapuna 33 kV cable upgrade	FY33	4.2

TABLE 10-15: WAIRAU CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.7 AUCKLAND CBD PLANNING AREA

10.6.7.1 OVERVIEW

The Auckland CBD covers the area bounded by the Northern Motorway (State Highway 1, SH1) towards the Harbour Bridge, the extension of (State Highway 16, SH16) down Grafton Gully and the Waterfront. The CBD network supplies over 37,700 customers (ICPs) with a total demand of 170 MVA.

There was an impact on the CBD demand due to the COVID-19 lockdowns. The demand declined significantly during each of the lockdown periods, and bounced back after lockdown ended, however, is still below the peak pre COVID level. While this trend could allude to some long-term changes that we will continue to monitor, it is also important to recognise the large-scale City Rail Link (CRL) project will improve transport access and could increase attractiveness of the CBD as a business, entertainment and residential area. This is supported by continuous connection and works requests in the CBD area throughout the COVID

[24] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

years. We will continue to closely monitor the demand forecast for the CBD to assess the COVID recovery as well as longer-term trends such as hybrid working.

The CBD is undergoing a transformation driven largely by the redevelopment of existing commercial sites, the City Rail Link (CRL) project and the Electric Ferry project at Downtown Ferry Terminal (DTFT), and a data centre.

Streetscape improvement projects (e.g. Quay St and associated wider Britomart area) provide the opportunity to future proof the network such as through installation of cables and ducts at a lower cost. These opportunities are assessed on a case-by-case basis.

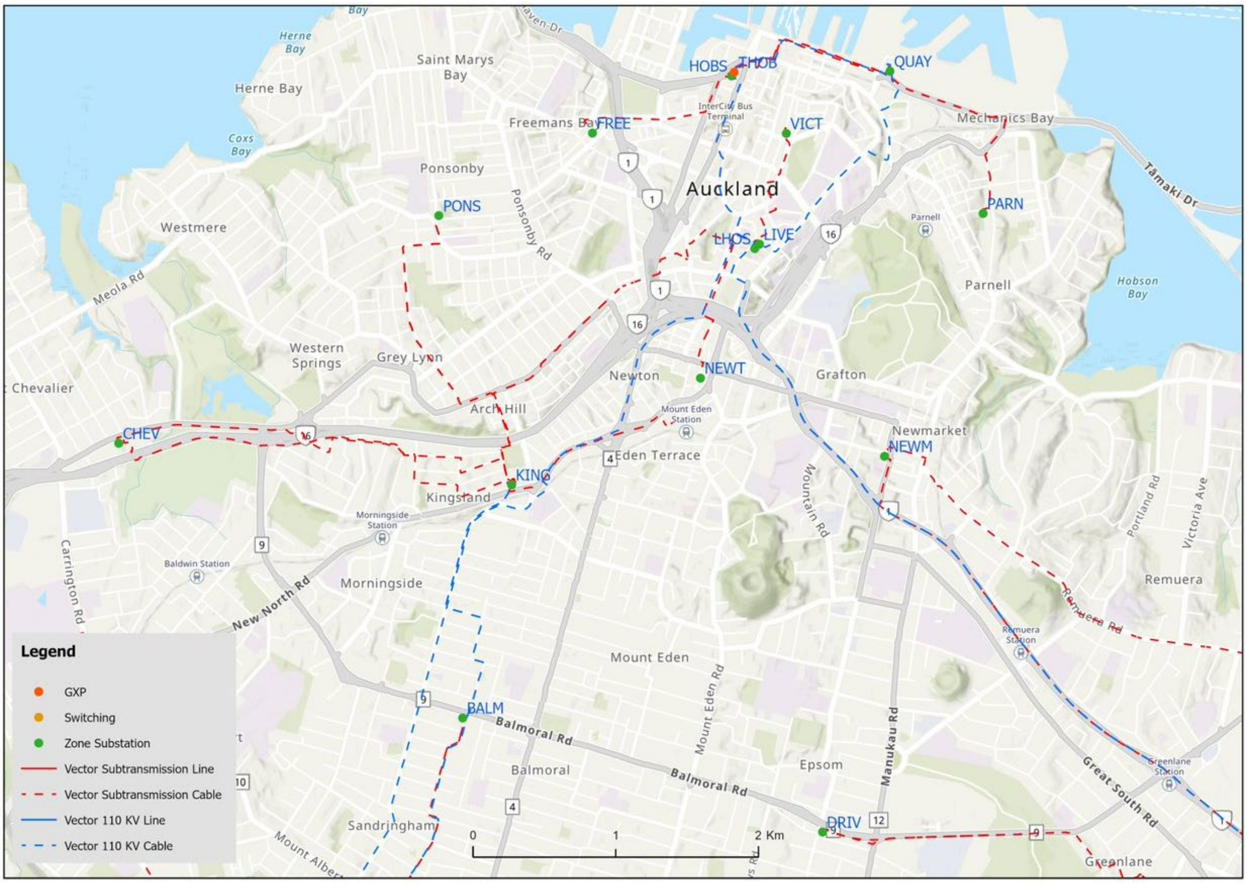


FIGURE 10.15: AUCKLAND CBD SUBTRANSMISSION NETWORK

			LOAD FORECAST (MW)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Freemans Bay	COM	18.3	18.9	19.6	20.2	20.8	21.5	22.2	22.9	23.6	24.3	25.5
Summer	Hobson 110/11 kV	CBD	8.5	8.9	9.2	9.5	9.8	10.2	10.7	11.1	11.5	11.9	12.5
Winter	Hobson 22/11 kV	CBD	11.3	11.6	11.8	12.1[1]	12.3	12.7	13.0	13.4	13.7	14.1	14.5
Winter	Hobson 22 kV	CBD	52.6	56.9	66.6	70.6	78.4	82.8	90.0	88.7	90.3	91.8	98.6
Winter	Liverpool 22 kV	CBD	93.3	97.1	99.7	102.8	107.4	111.3	118.8	141.6	145.5	149.4	155.0
Winter	Liverpool	CBD	35.4	36.5	37.7	38.8	40.0	41.3[25]	42.7	44.1	45.5	46.8	48.6
Winter	Newton	COM	18.7	19.8	20.9	21.9	23.0	24.3	25.7	27.0	28.3	29.7	32.0
Winter	Parnell	COM	14.5	15.1	15.7	16.3	16.9	17.6	18.4	19.1	19.9	20.6	21.9
Winter	Quay 22 kV	CBD	42.4	51.3	60.5	65.9	69.3	73.2	75.1	77.0	78.8	80.7	83.7
Winter	Quay	CBD	17.6	18.3	18.9	19.6	20.2[1]	23.2	24.0	24.8	25.7	26.5	27.8

[25] Load is expected to be lower, and the breaches deferred due to load transfer from 11kV to 22kV by RMU replacement projects.

			LOAD FORECAST (MW)									
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Summer	Victoria	CBD	17.3	17.8	18.3	18.8	19.3	20.0	20.6[1]	21.3	22.0	22.7	23.6

TABLE 10-16: CBD LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.7.2 SUBTRANSMISSION

The CBD area is supplied by subtransmission circuits at 110 kV and 22 kV. All subtransmission circuits are underground cables to improve resilience of the network.

The 110 kV network is supplied by two independent 110 kV grid sources, with two feeders from Penrose GXP and one feeder from Hobson GXP. This provides network security at N-1 without an outage and N-2 with a short outage. An independent backup supply is available from Roskill GXP.

The 22 kV subtransmission network is installed between the three primary substations, namely Hobson ZSS, Liverpool ZSS and Quay ZSS to provide additional backup to the 110 kV supply. The 22 kV subtransmission network is then used to supply four other zone substations, namely Freemans Bay ZSS, Newton ZSS, Parnell ZSS and Victoria ZSS.

No constraints are identified to occur in the subtransmission network, during the AMP planning period.

10.6.7.3 ZONE SUBSTATION

The CBD area is served by three primary zone substations, namely Liverpool, Hobson and Quay. The substations are connected to the 110 kV network via a total of eight 110/22 kV transformers and the 22 kV buses are interconnected via 22 kV subtransmission circuits. Each of these three primary zone substations also has multiple 22/11 kV transformers to step the voltage down to distribution level and ensure security of supply.

The 22 kV subtransmission network supplies an additional four 22/11 kV zone substations, namely Freemans Bay ZSS, Newton ZSS, Parnell ZSS and Victoria ZSS.

Security breach is forecast at Quay ZSS 22kV due to the proposed load from Downtown electric ferry terminal and commercial building development in Quay St area. It is proposed to install 3rd 110/22kV transformer, a 110kV switchboard, and a new 22kV switchboard extending from the existing 22kV switchboard at Quay ZSS to bring the security at the ZSS up to Vector standard.

Security breaches are also forecast at Hobson ZSS 22kV and Liverpool ZSS 22kV, due to the major new load from Downtown electric ferry terminal, a commercial building, and a data centre, to be added between 2026 and 2031. The reinforcement options and long-term plan are currently being explored. Options include upgrading the three-winding transformers at Hobson ZSS and establishing a new zone substation, namely Hobson West, at a Vector owned site in Hobson St. The long-term plan will be communicated once the option analysis is completed.

The load forecast shows the security of supply standard is expected to be breached at Newton zone substation from 2031, resulting from the proposed developments in the Mt Eden precinct after completion of CRL works. Vector currently plans to establish a new zone substation at Mt Eden to resolve the constraint (refer to Roskill Planning Area for project details).

Security breaches are also forecast at Quay 11 kV and Victoria 11 kV around 2034 and 2039, respectively, due to the load growth in the existing 11 kV network. Vector's plan is to convert selected 11 kV distribution substations to 22 kV and transfer the load to the 22 kV distribution network. New load will be connected to the 22 kV network wherever feasible. This approach will avoid the costly upgrade at the two zone substations and is in line with the long-term plan to upgrade the CBD distribution network from 11 kV to 22 kV.

10.6.7.4 DISTRIBUTION NETWORK

The distribution network in the CBD comprises both 11 kV and 22 kV feeders from the zone substations. The feeders are generally radial and interconnected via open points to meet Vector's security of supply standard.

The long-term plan for CBD distribution network is to progressively expand the 22 kV network coverage that will, over the long term, replace the aging 11 kV network, and increase capacity in the CBD. A key long-term plan is to provide 22 kV network coverage to ensure large new customer connections (typically for large new building developments) will be supplied from the new 22 kV distribution network. Conversion of existing 11 kV distribution load will also be carried out when existing 11 kV assets require replacement and when future constraints on the 11 kV network are forecast.

Auckland Transport is carrying out the streetscape project in the Britomart area bounded by Quay St, Queen St, Customs St and Britomart Place, and additional new potential loads have been identified. As the roads are being renewed (dug up and reinstated) and existing cables relocated, there are synergies and opportunities to expand the 22 kV network coverage to future proof the network by installing 22 kV cables and ducts. If Vector does not take this opportunity, then it may be difficult to get access to excavate these roads within the time period required to meet the growing demand of the CBD.

10.6.7.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $
Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth	CBD Albert Wellesley St 22 kV extension	FY25	1.2[26]
	CBD Hobson St Bradnor11 kV Lane 22 kV extension	FY26	2.4
Risk of capacity and security breach resulted from aged 11 kV PILC cables	CBD 11 kV to 22 kV Conversion Hobson St	FY25	0.3[14]
Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth	CBD Tyler St 22 kV extension	FY26	1.0
Synergy opportunity to future proof for area in co-ordination with City Rail Link (CRL) project	K Rd CRL OSD future-proofing ducts and cables	FY25	1.8[14]
Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth	CBD Wellesley St 22 kV extension bus improvement	FY25	0.3[14]
Quay ZSS 11 kV breaches SoSS	CBD Quay 11 kV to 22 kV conversion for security	FY33	4.5
Hobson feeders J02 & J09 breaches SoSS	Hobson Waterfront 22 kV feeders new	FY34	5.2
Hobson feeders HBOS J38, LIVE J05 and LIVE J17 breach capacity and SoSS	Hobson new 22 kV feeder re-termination	FY25	0.6
CBD 11 kV network breaches SoSS	CBD 22 kV Network Rollout	FY34	26.9
Quay ZSS 22kV breaches SoSS due to major commercial developments	Quay St ZSS 110kV SGEAR and 3rd TX	FY29	12.3
Hobson ZSS 22kV breaches SoSS due to major commercial developments	Hobson ZSS 2nd 75MVA 110-22 TX	FY29	6.6
Liverpool ZSS 11kV breaches SoSS	CBD Liverpool 11kV to 22kV conversion for security	FY34	4.0
Risk of capacity and security breach resulted from aged 11 kV PILC cables	CBD distribution sub 11kV to 22kV conversion	FY35	20.0

TABLE 10-17: CBD CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.8 ROSKILL PLANNING AREA

10.6.8.1 OVERVIEW

The Roskill planning area is located to the west of Auckland CBD and extends from Mt Eden west to Avondale and north to St Marys Bay. In total, the GXP supplies about 70,400 customers (ICPs) with a total load of about 175 MVA.

Commercial multi-level buildings and multi-level high density residential load growth is expected around Mt Eden station. Significant housing intensification by Kainga Ora in wider Roskill area is underway and forecast to add 17,000 dwellings over the next 20 years.

[26] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

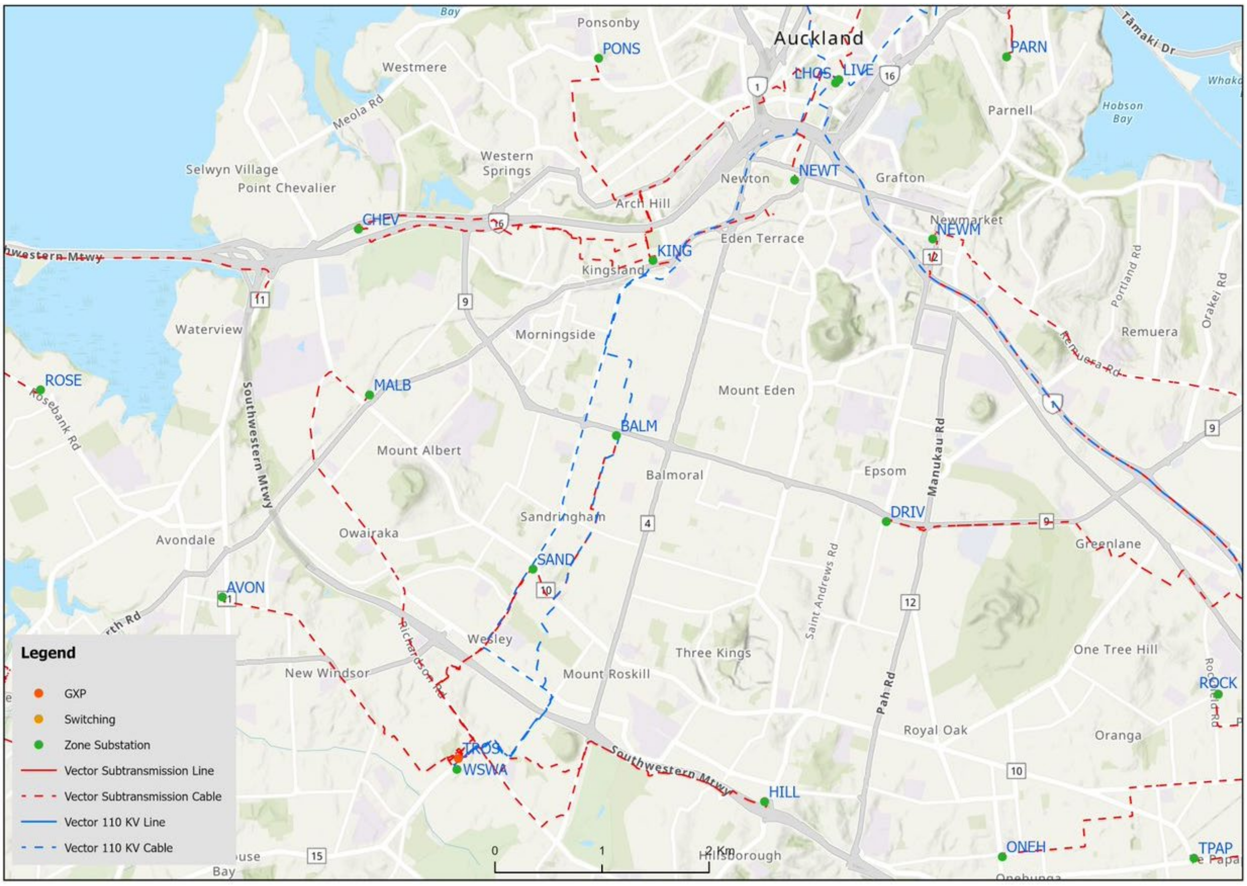


FIGURE 10.16: ROSKILL SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Avondale	RES	29.8	29.9	32.0	32.9	32.0	33.1	34.2	35.4	36.5	37.6	39.1
Winter	Balmoral	RES	14.1	15.0	15.8	16.6	17.4	18.4	19.3	20.2	21.1	22.1	23.4
Winter	Chevalier	RES	21.0	22.3	23.6	25.2	26.9	28.5	30.2	31.8	33.4	35.1	37.0
Winter	Hillsborough	RES	21.6	22.4	24.7	25.6	23.8	24.8	25.9	26.8	27.7	28.7	29.8
Winter	Kingsland 22 kV	RES	60.1	63.7	67.3	71.3	75.2	79.3	83.3	87.4	91.4	95.5	101.1
Winter	Kingsland	RES	24.8	26.4	28.0	29.6	31.2	32.9	34.5	36.2	37.9	39.6	42.3
Winter	Mt Albert	RES	8.7	9.4	10.1	11.6	13.1	14.1	15.1	16.1	17.1	18.1	19.3
Winter	Ponsonby	RES	13.8	14.5	15.2	15.9	16.6	17.3	18.0	18.7	19.4	20.2	21.2
Winter	Sandringham 22 kV	RES	31.4	33.1	34.9	36.6	39.6	43.5	47.5	51.5	55.0	59.4	81.6
Winter	Sandringham	RES	20.7	21.9	23.0	24.1	26.6	30.0	33.5	37.0	40.0	43.9	48.0
Winter	White Swan	IND	28.5	29.7	30.7	31.9	35.5	36.6	37.6	38.7	39.9	41.2	42.7

TABLE 10-18: ROSKILL LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.8.2 SUBTRANSMISSION

Roskill GXP provides a 110 kV supply to Vector's Kingsland 110/22 kV substation and a separate 22 kV supply to six Vector substations. Kingsland 22 kV buses provide supply to three zone substations. Roskill GXP also provides backup to the CBD network via a single 110 kV circuit to Liverpool substation. Two 110 kV circuits are connected between Roskill 110 kV GXP and Kingsland 110/22 kV transformers.

A 22 kV circuit connecting between Kingsland 22 kV bus and Liverpool 22 kV bus is used for backup purposes.

The subtransmission circuits at Sandringham are expected to breach SoSS from 2034. Mt Albert and White Swan are expected to breach both capacity and security from 2032 and 2033, respectively.

At Kingsland 110/22 kV substation, the existing two 110 kV circuits and the backup 22 kV circuit from Liverpool are all fluid filled cables over 50 years old. It makes the substation vulnerable upon any fluid filled cable failure. Also, the substation is forecast to breach SoSS from 2035. A project is proposed to connect the substation to the 110 kV circuit between Roskill and Liverpool utilising the capacity available. Feasibility will be investigated, and decision made in due course.

10.6.8.3 ZONE SUBSTATION

There are nine zone substations supplied from Roskill GXP, three via Kingsland zone substation using 22 kV subtransmission, two via Sandringham 22 kV buses, and the remaining four directly from Roskill 22 kV buses.

Mt Albert substation is currently supplied from Roskill 22 kV GXP via a single subtransmission circuit and single transformer. Due to the age and condition, the transformer has been replaced in 2023, and the subtransmission circuit planned in 2032, both under asset replacement projects. The replacement projects will improve the capacity and security at Mt Albert substation until 2032 when it is expected to breach the SoSS. Vector has identified the preferred solution to resolve the constraint is to install a second subtransmission circuit and second transformer. The supply will be transferred to Sandringham 22 kV buses, instead of Roskill 22 kV GXP, to take advantage of shorter cabling distance and existing spare circuit breakers, thus lower cost. This replacement project will be implemented based on the ultimate substation configuration. The augmentation project is planned for completion by 2029.

The proposed commercial and housing development at Mt Eden precinct by City Rail Link is expected to add significant load in the area. Capacity and security constraints are identified at Newton substation (included in CBD Planning Area), Kingsland substation, and various 11 kV feeders from 2033. It is proposed to establish a new zone substation at Mt Eden area to resolve the constraints. Land needs to be purchased in FY26, during design stage of the development, to secure an optimal location.

10.6.8.4 DISTRIBUTION NETWORK

The distribution network in the area comprises 11 kV feeders from the zone substations. The feeders are mainly radial and interconnected with open points in between to meet Vector's N-1 security of supply standard.

Three 11 kV feeders from Sandringham ZSS are expected to breach security in , between 2030 and 2032. It is proposed to install four new 11 kV feeders from Sandringham substation connecting to the existing network and rearrange the feeders in the area to remove the constraint.

10.6.8.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $
Newton substation, Kingsland substation, and various 11 kV feeders in the area breach capacity and security standard from 2031.	Mt Eden land purchase for ZSS	FY26	Not discl.
Synergy opportunity to future proof for Mt Eden precinct development in coordination with City Rail Link project	Mt Eden Precinct futureproof ducts and cables	FY26	2.7[27]
Synergy opportunity to future proof for Wairaka precinct development in coordination with Auckland Transport's road improvement project	Carrington Rd future-proofing ducts	FY27	5.2
Sandringham feeder K18 and Avondale K06 breaches SoSS	Sandringham Stoddard Rd 11 kV feeders new (KO driven)	FY29	4.5
Kingsland ZSS 22 kV supply at risk upon outage in both 110 kV fluid filled cables	Kingsland substation 110/22 kV reinforcement	FY34	9.4[28]
Newton substation, Kingsland substation, and various 11 kV feeders in the area breach capacity and security standard from 2031	Mt Eden Zone Substation New	FY31	25.0
Mt Albert substation and Sandringham substation breach capacity and security standard from 2032 and 2035, respectively	Mt Albert Zone Substation capacity upgrade	FY32	25.0
Synergy opportunity to future proof for Mt Roskill housing development in coordinated with multiple third parties' projects	Mt Roskill Precinct futureproof ducts and cables	FY32	3.8
Mt Albert feeder K16 breaches SoSS	Mt Albert new 11 kV feeders for capacity and security in MALB K16 (Wairaka housing)	FY30	4.2
Sandringham ZSS capacity and security shortfall	Sandringham third transformer	FY33	2.9
Avondale ZSS breaches SoSS	Avondale transformer capacity upgrade	FY33	5.0

TABLE 10-19: ROSKILL CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.9 PENROSE PLANNING AREA

10.6.9.1 OVERVIEW

This is Vector's largest planning area from Mt Eden east to the Tamaki River. The area has over 87,200customers (ICPs) with a total demand of 301 MVA. The area is supplied by Transpower's Penrose GXP at 33 kV and 22 kV.

[27] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

[28] Only the cost falling within this AMP period is shown, the project will proceed past this period.

The planning area is well developed with limited greenfield development areas. The growth is mainly driven by redevelopment and densification of existing areas. The major housing redevelopment is Kainga Ora's Tāmaki regeneration project in Glen Innes, Panmure and Point England. The housing growth based on the latest medium forecast is an additional 13,000 dwellings (hence ICPs) by 2036, and 18,600 dwellings (hence ICPs) by 2046.

Ongoing commercial redevelopment is expected to continue in Newmarket and Sylvia Park precincts.

The load forecast at Penrose 33 kV is expected to breach security limits in the 2040s. It is the largest GXP in our network and supply diversification would increase security of supply by reducing common mode failure. A new GXP is proposed to be established at Southdown. Then, existing ZSS in the area (including Onehunga, Westfield, Te Papapa and Carbine) will be supplied from the new GXP when the subtransmission cables at the ZSS are due for replacement.

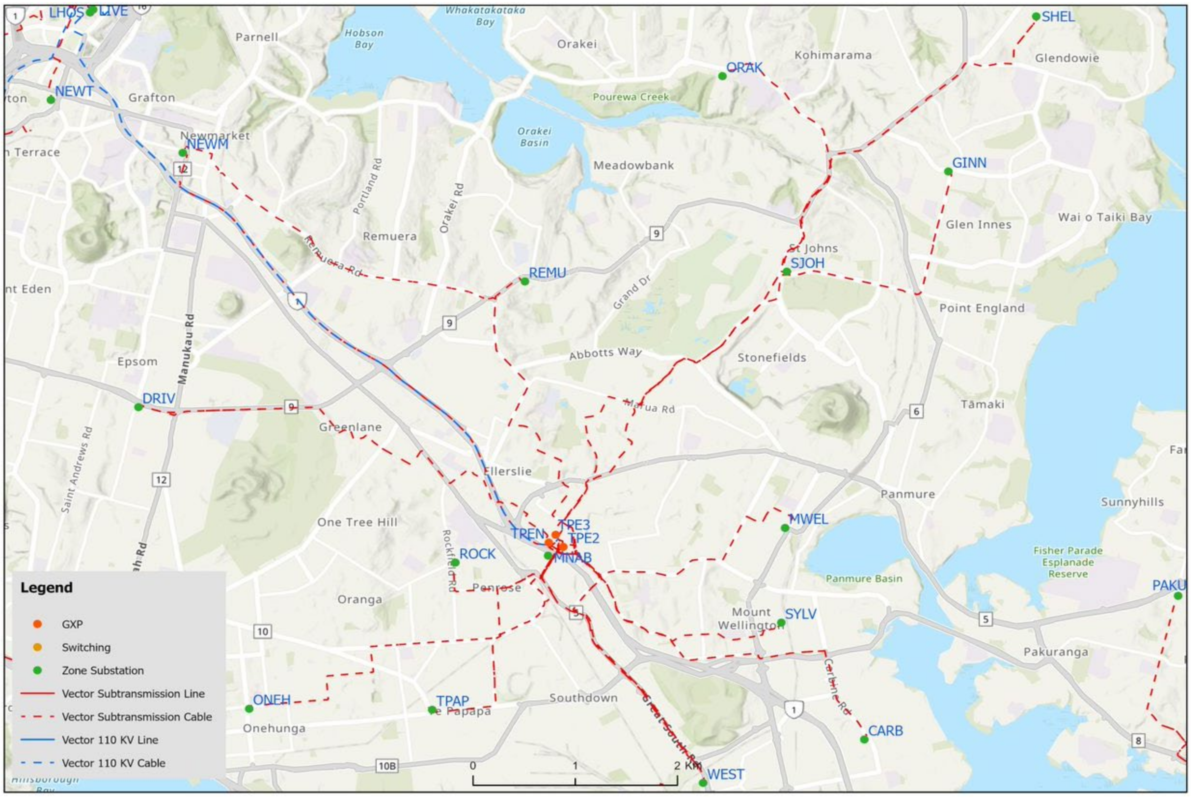


FIGURE 10.17: PENROSE SUBTRANSMISSION NETWORK

SEASON	ZONE SUBSTATION	SOSS CATEGORY	LOAD FORECAST (MVA) 2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Summer	Carbine	IND	12.6	12.7	12.9	13.0	13.2	13.3	13.5	13.7	13.9	14.0	14.2
Winter	Drive	RES	28.7	30.4	31.6	32.9	35.0	36.3	37.7	39.0	40.4	41.7	43.6
Winter	Glen Innes	RES	10.9	11.8	14.6	16.0	17.3	18.8	20.2	21.5	22.6	23.7	25.1
Winter	McNab	IND	50.7	52.7	54.8	56.8	58.9	60.8	62.7	64.6	66.6	70.3	72.7
Winter	Mt Wellington	IND	16.0	17.3	16.9	15.7	17.1	18.7	20.2	21.7	23.1	24.6	26.3
Summer	Newmarket	COM	35.7	28.6	29.3	30.0	30.8	31.9	33.0	34.1	35.2	36.3	38.2
Winter	Onehunga	IND	15.7	16.9	17.7	18.6	19.4	20.5	22.2	23.3	24.4	25.5	27.1
Winter	Orakei	RES	23.9	24.6	25.4	26.1	26.8	27.7	28.7	29.6	30.5	31.4	32.6
Winter	Remuera	COM	26.8	27.9	29.0	30.1	31.2	32.4	33.6	34.8	36.0	35.5	37.3
Winter	Rockfield	RES	21.7	22.8	23.8	24.8	25.9	27.0	28.1	29.2	30.4	31.5	33.0
Winter	St Johns 33 kV	RES	64.3	66.6	69.0	74.4	76.8	80.1	83.5	86.6	89.6	92.8	96.8
Winter	St Johns	RES	19.3	20.3	21.4	25.5	26.5	28.1	29.7	31.0	32.3	33.9	35.6
Summer	Sylvia Park	COM	17.1	17.2	17.2	17.3	17.4	17.5	17.7	17.8	18.0	18.1	18.3
Winter	St Heliers	RES	21.9	22.5	23.2	23.9	24.6	25.4	26.3	27.1	28.0	28.8	30.0
Winter	Te Papapa	IND	21.7	22.6	23.4	24.3	25.1	25.9	26.8	27.6	28.5	29.3	30.4
Winter	Westfield	IND	28.4	29.3	30.3	31.2	32.1	33.2	34.2	35.2	36.3	37.3	38.6

TABLE 10-20: PENROSE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS) DISTRIBUTION

10.6.9.2 SUBTRANSMISSION

The subtransmission network in the area is comprised of 33 kV and 22 kV circuits connected between Penrose GXP and Vector's zone substations.

Based on modelling result, St Johns 33 kV circuits are expected to breach SoSS from 2033

10.6.9.3 ZONE SUBSTATION

There are 15 zone substations supplied from Penrose GXP. 10 are supplied directly from Penrose GXP at 33 kV, 3 are supplied via the switching station at St Johns substation, and 2 are supplied directly from Penrose at 22 kV. The Glenn Innes zone substation also includes a 1 MW / 2.3 MWh BESS installed in 2017.

The Newmarket ZSS is forecast to breach the capacity from 2035 subject to commercial agreement with major customer. Vector's preferred solution is to establish a new zone substation on the same site utilising the spare space available.

St Johns ZSS (11 kV) is expected to breach the SoSS at some stage in the long term due to the significant housing development by Kainga Ora's Tamaki Regeneration project. The long-term strategy is to establish a new substation to supply the area. Although the substation is not required to be constructed within this planning period, Vector will purchase land to secure an optimal site at design stage of the Kainga Ora development.

10.6.9.4 DISTRIBUTION NETWORK

The distribution network in the area comprises 11 kV feeders from the zone substations. The feeders are mainly radial and interconnected with open points in between to meet Vector's N-1 security of supply standard.

A number of 11 kV feeders from Glen Innes, Mt Wellington, and St Johns ZSS's are expected to breach security between 2030 and 2035 as a result of load growth from Kainga Ora's housing development in the area. It is proposed to install new 11 kV feeders from Glen Innes and St Johns ZSS's connecting to the existing network and rearrange the feeders in the area to remove the constraint.

A number of 11 kV feeders from McNab, Onehunga, Rockfield, Te Papapa, and Westfield ZSS's are expected to breach security between 2030 and 2035 as a result of industrial / commercial load growth in the area. It is proposed to install new feeders from the ZSS's connecting to the existing network and rearrange the feeders in the area to remove the constraint.

In the longer term, a new Vector zone substation will be established at Southdown to off-load the large number of existing 11 kV feeders that are expected to breach SoSS, as well the ZSS in the area. It is proposed to purchase a land at Southdown for the new ZSS in FY24, however, the construction of the new substation is beyond the 10-year window covered by the AMP.

10.6.9.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
McNab ZSS breaches SoSS	Ellerslie substation new	FY31	25.0
Required for Tamaki new substation connection	Glen Innes 33 kV SWBD New	FY35	2.3[29]
Newmarket ZSS breaches SoSS	Newmarket substation capacity upgrade	FY35	11.3[17]
Constraints on the 11 kV distribution network in the Southdown area	Southdown land purchase for ZSS	FY25	Not discl.
Glen Innes K06 and K09 breaches SoSS	St Johns Apirana Ave 11 kV feeders new (KO driven)	FY30	5.2
St Johns feeder K02 and Mt Wellingtons K03 and K12, breach SoSS	St Johns Pilkington Rd 11 kV feeders new (KO driven)	FY30	7.3
Project coordinated with third parties' roadworks	Tamaki future-proofing ducts and cables	FY32	3.8
St Johns subtransmission and ZSS breaches SoSS	Tamaki Zone Substation New	FY35	12.6[17]
Synergy opportunity to future proof for Kainga Ora's housing development in coordination with third parties' projects	Tamaki FP Merton Rd and Apirana Av	FY25	0.1
St Johns substation (11 kV) breaches capacity and security in long term. It is proposed to establish a new zone substation to remove the constraints. Land needs to be purchased to secure an optimal site at design stage of the development.	Land purchase and designation for Tamaki new substation	FY25	Not discl.
Rockfield feeder K10 capacity shortfall	Te Papapa new 11 kV feeders to off load ROCK K10	FY30	4.2
Westfield ZSS 11 kV breaches SoSS	Westfield 3rd transformer	FY34	2.1
Remuera ZSS breaches SoSS	Remuera transformer capacity upgrade	FY34	5.0

[29] Only the cost falling within this AMP period is shown, the project will proceed past this period.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Synergy opportunity to future proof for cable installation in the proposed Southdown GXP and ZSS	Southdown on-site future-proofing ducts	FY26	8.0
Westfield feeder K08 breaches SoSS	Westfield Abattoir Lane new 11kV feeders for security in WEST K08	FY32	3.0

TABLE 10-21: PENROSE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.10 PAKURANGA PLANNING AREA

10.6.10.1 OVERVIEW

The Pakuranga planning area covers most of the eastern Auckland suburbs, including East Tamaki, Flatbush, Pakuranga, Botany, Howick and all the way out to Bucklands Beach. The areas to the south of Flat Bush are designated greenfield growth areas and an additional 10 MVA increase in demand is expected by 2034.

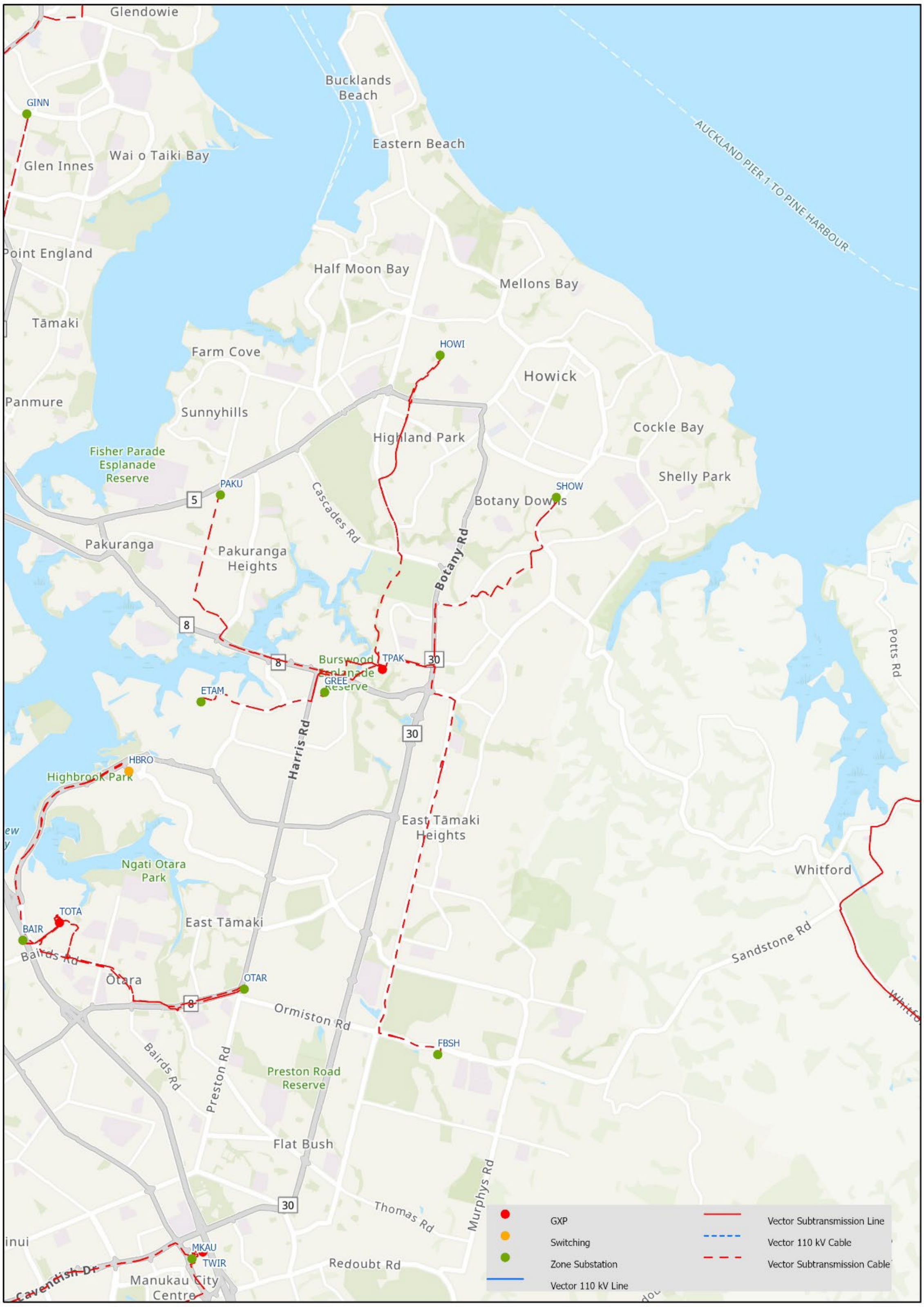


FIGURE 10.18: PAKURANGA SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	East Tamaki	COM	22.1	22.4	22.7	23.0	24.5	24.9	25.3	25.7	26.1	26.4	26.8
Winter	Flatbush	RES	26.7	27.5	28.3	29.1	29.9	31.0	32.0	33.0	34.1	35.1	36.4
Winter	Greenmount	COM	41.0	43.1	44.3	45.5	46.8	48.4	50.7	52.3	53.9	55.5	57.6
Winter	Howick	RES	40.8	43.3	43.9	44.4	45.0	45.7	46.5	47.3	48.1	48.8	50.0
Winter	Pakuranga	RES	22.4	22.8	23.2	23.5	23.9	24.5	25.1	25.6	26.2	26.8	27.8
Winter	South Howick	RES	26.3	26.7	27.2	27.6	28.0	28.7	29.5	30.2	30.9	31.7	32.8

TABLE 10-22: PAKURANGA LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.10.2 SUBTRANSMISSION

The area is supplied from the Pakuranga GXP. The subtransmission network operates at 33 kV and consists of underground cables that are installed along road reserves and supply six zone substations radially.

There are no subtransmission security constraints identified to occur during the AMP period.

10.6.10.3 ZONE SUBSTATION

Pakuranga GXP supplies six ZSS, all of which are comprised of multiple 33/11 kV transformers providing N-1 security of supply. Flatbush ZSS, East Tamaki ZSS, South Howick ZSS and Pakuranga ZSS each have two transformers while Howick ZSS and Greenmount ZSS both have three transformers.

The security constraint at Flatbush ZSS will be resolved by Otara Chapel Heights 11kV new feeder (Otahuhu GXP).

10.6.10.4 DISTRIBUTION NETWORK

The existing 11 kV feeder distribution is meshed and has sufficient backstopping capacity to feed adjacent ZSS.

A new Murphy's Rd feeder is planned to relieve a forecast capacity constraint.

Vector will install futureproof ducts in cooperation with Auckland Transport's AMETI Busway project, to reduce civil costs and public disruption.

10.6.10.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Third party roadworks	AMETI futureproof ducts EB2 EB3R and Bridge	FY28	0.8

TABLE 10-23: PAKURANGA CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.11 MANGERE PLANNING AREA

10.6.11.1 OVERVIEW

The Mangere Planning Area covers the Mangere township and surrounding residential, commercial and industrial areas, extending south to the areas identified for future greenfield development surrounding the Auckland airport.

There is significant demand growth forecast due to an additional 10,000 dwellings that are planned by Kainga Ora over the next 15 years. These will be located between the Mangere Central area northwards towards Mangere Bridge and eastwards towards Middlemore. The growth will be driven by housing redevelopment and densification of existing areas.

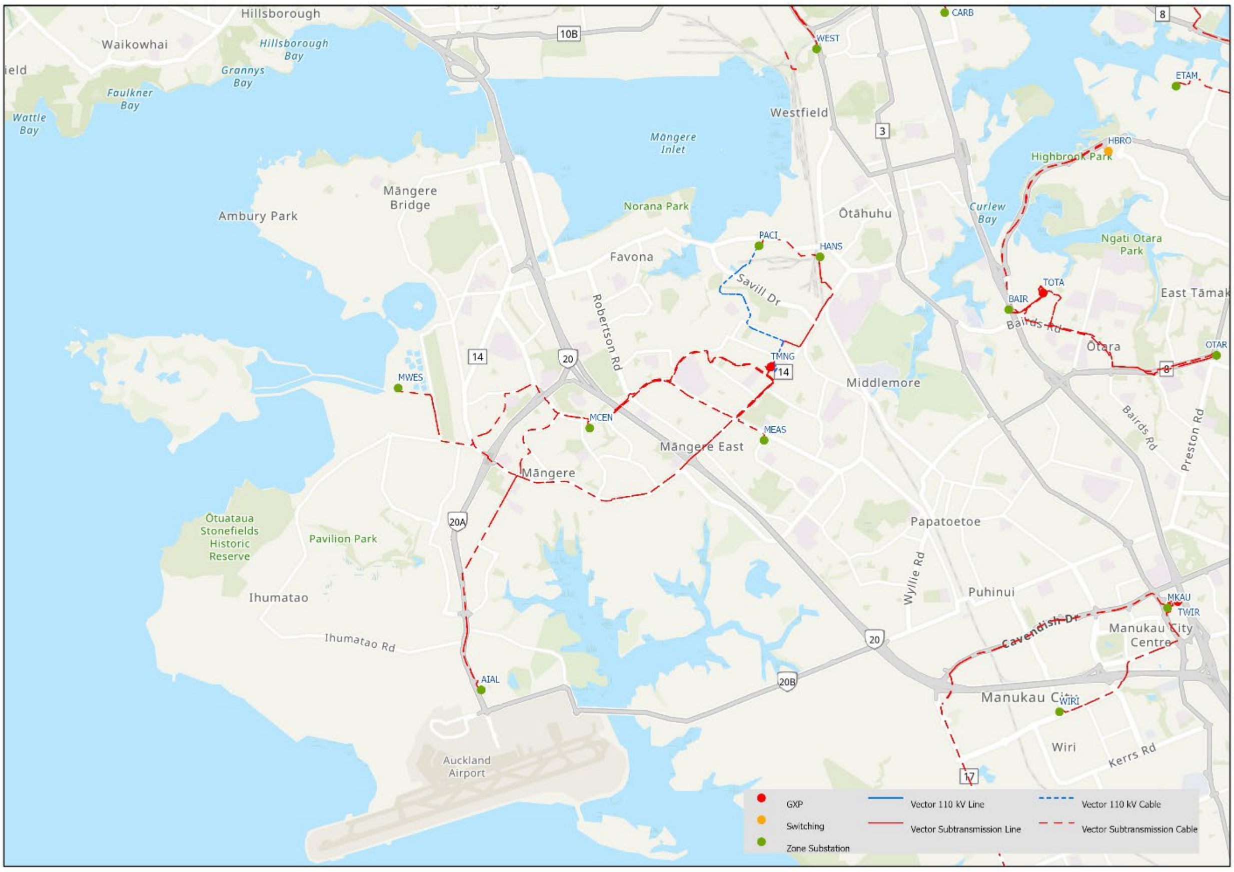


FIGURE 10.19: MANGERE SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Hans	COM	23.3	24.5	25.1	25.7	26.4	27.4	28.5	29.5	30.7	31.8	32.9
Summer	Mangere Central	RES	36.3	37.7	39.2	40.3	41.6	43.5	45.3	48.0	51.3	54.5	57.2
Winter	Mangere East	RES	32.5	34.4	35.8	37.5	38.4	40.3	41.9	43.7	45.1	46.7	48.0
Winter	Mangere West	COM	22.6	24.2	24.5	27.5	27.8	28.2	28.6	28.9	29.2	29.5	29.9

TABLE 10-24: MANGERE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.11.2 SUBTRANSMISSION

The area is supplied from the Mangere GXP. The subtransmission network operates at 110 kV and 33 kV and consists of predominately radial underground cables. The two 110 kV feeders supply 110/33 kV transformers at Pacific Steel and eleven 33 kV feeders supply five 33/11 kV zone substations.

There are no subtransmission security constraints identified to occur during the AMP period. However the 33kV network will be extended to connect a third transformer at Mangere East ZSS and the proposed Mangere South ZSS and a new transformer at the Airport substation.

10.6.11.3 ZONE SUBSTATION

Mangere GXP supplies six zone substations, all with multiple transformers which provide security of supply.

There is a demand constraint identified at Mangere East during the AMP period, due to the significant residential and commercial growth in the area. A third transformer and subtransmission cable will be installed to address this.

A transformer capacity constraint is forecast at Hans ZSS which will be addressed by a transformer uprating project (installation of cooling fans).

Vector will purchase a site (Mangere South)for a switchroom and future ZSS to ensure we are able to secure land in an optimal location.

10.6.11.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and underground in the urban areas. The forecast load growth in the Mangere area is expected to cause a number of constraints which will be addressed through a number of new feeders from Mangere Central (Robertson Rd, Massey Rd, and Idlewild Ave), Hans (Middlemore) and Mangere East (Puhinui Rd) ZSS.

10.6.11.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Mangere Central ZSS - SoSS breach distribution feeder capacity constraints to supply Airport Park industrial development area beyond 2030	Mangere South secure site for new zone substation	FY25	1.2
Airport 3rd transformer requirement	Mangere South new 33kV switchroom	FY26	7.2
Mangere Central ZSS breaches SoSS	Mangere South 11kV switchgear and 33/11kV transformer	FY32	12.3
Mangere East feeder K16 backstop and capacity shortfall	Mangere Central Robertson Rd 11 kV feeder new	FY25	3.1
Mangere Central feeder K17 backstop and capacity shortfall	Mangere Central Idlewild Ave 11 kV feeder new	FY27	4.4
Mangere East feeder K11 backstop and capacity shortfall	Mangere Central Massey Rd 11 kV feeder new	FY30	2.2
Mangere East ZSS breaches SoSS	Mangere East Third Transformer and 33kV cable	FY26	9.4
Mangere Central feeder K19 capacity shortfall	Mangere East Puhinui Rd 11kV feeder new	FY26	2.2
Hans feeder K20 backstop shortfall	Hans Middlemore Cres 11 kV feeder new	FY33	3.4
Hans ZSS breaches SoSS	Hans T1 & T2 fan upgrade	FY32	0.2

TABLE 10-25: MANGERE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.12 TAKANINI PLANNING AREA

10.6.12.1 OVERVIEW

The Takanini Planning Area covers the urban areas of Manurewa, Takanini and Papakura townships, extending east to the more remote areas of Clevedon, Maraetai, Beachlands and Waiheke Island. A MW-scale generation facility from landfill is operating in the area.

Waiheke Island is supplied by two 33 kV subtransmission cables from Maraetai. The feeders start off as underground cables and then switch to submarine cabling to cross the Tamaki Strait, and then convert to underground cabling upon reaching the island. There is a steady demand growth forecast over the next 10 years, with a total demand increase of 6.6 MVA.

The Takanini planning area, excluding Waiheke Island, is driven predominantly by residential growth along with large commercial customers, E-Bus and E-Ferry.

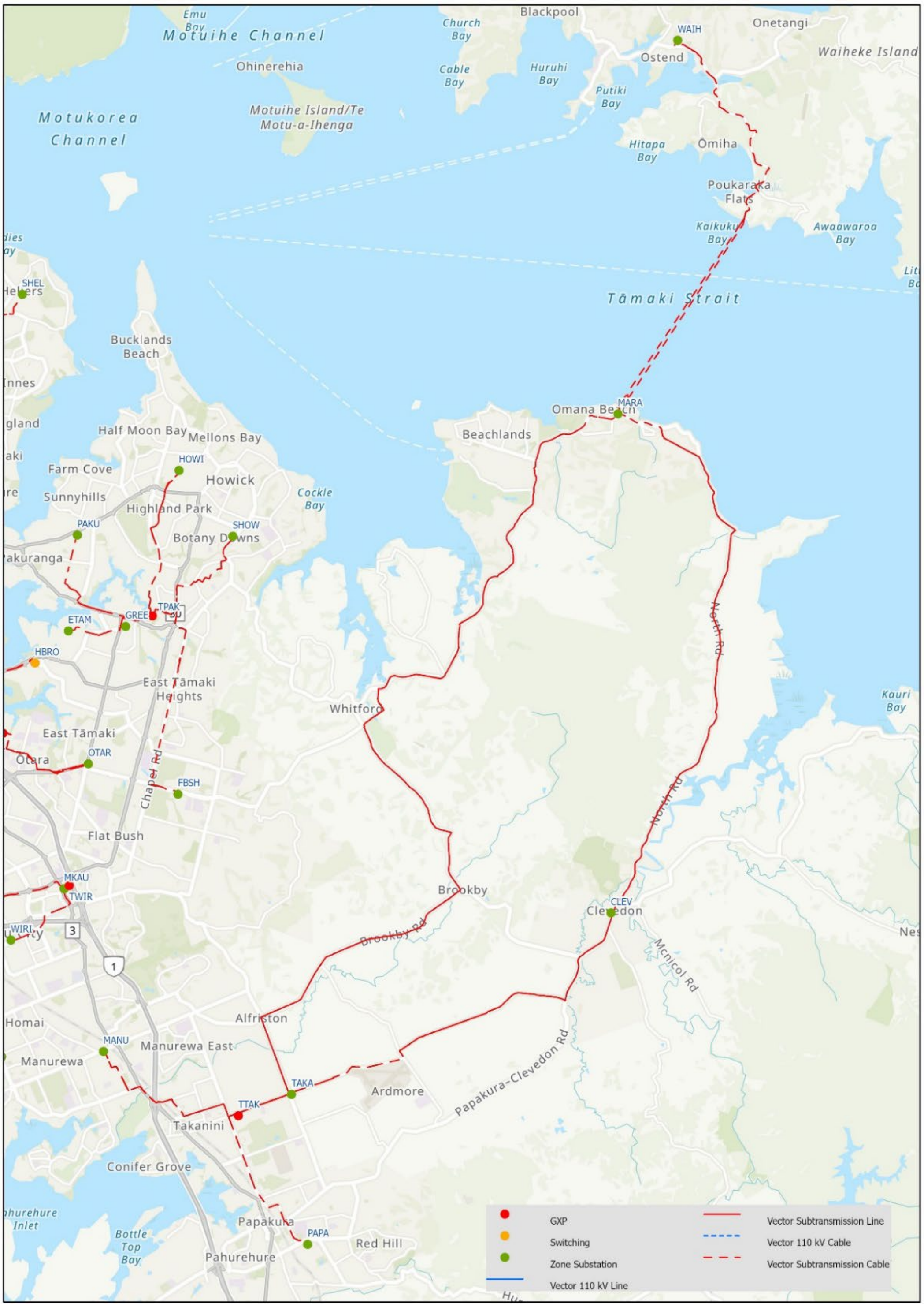


FIGURE 10.20: TAKANINI SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Clevedon	RES	3.2	3.3	3.4	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.2
Winter	Manurewa	RES	55.8	56.8	57.7	58.6	59.6	61.1	62.6	64.1	65.6	67.1	69.4
Winter	Maraetai	RES	10.8	11.8	12.9	16.0	17.1	18.3	19.5	20.7	21.9	22.6	23.6
Winter	Papakura	RES	30.0	30.8	31.6	32.4	33.1	34.4	35.6	36.8	38.0	39.2	40.9
Winter	Takanini	COM	31.5	33.3	34.1	34.8	35.6	36.6	37.6	38.5	39.4	40.3	41.5
Winter	Waiheke	COM	12.7	13.2	13.7	14.2	14.7	15.4	16.1	16.9	17.6	18.3	19.3

TABLE 10-26: TAKANINI LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.12.2 SUBTRANSMISSION

The area is supplied from the Takanini GXP. The subtransmission network operates at 33 kV and consists of predominately long radial overhead lines and two cables with submarine sections supplying Waiheke Island. The network also consists of underground 33 kV cables to supply Manurewa, Takanini and Papakura.

The subtransmission cables to Waiheke Island provide N-1 security, but any damage to the undersea portion of these circuits takes considerable time to repair, leaving the supply to the island dependent on a single circuit and without any backup at distribution level or any significant embedded generation. These cables are located adjacent to each other and do not have mechanical protection. Recent anchor strikes have identified that the risk of outages is higher than thought and needs to be mitigated. To address the risk and ensure compliance with the SoSS, Vector will install a third subtransmission cable. The new cable will be spatially separated from the existing cables and include mechanical protection to improve resilience to anchor strikes.

As a result of rapid organic growth, large commercial developments, and an E-ferry terminal, additional sub-transmission capacity is required in both the Takanini and Maraetai ZSS to maintain compliance with the SoSS.

10.6.12.3 ZONE SUBSTATION

Takanini GXP supplies six zone substations of which five have multiple 33/11 kV transformers and one, namely Clevedon ZSS, consists of a single 5 MVA 33/11 kV transformer. Waiheke Island ZSS consists of two transformers, each sized to be able to supply the entire island load, hence providing N-1 redundancy.

The Manurewa constraint will be addressed by load transfer to Clendon ZSS and a Clendon Weymouth Rd 11kV new feeder will provide additional capacity for further load transfer in FY28.

The Papakura constraint will be resolved by load transfer to Takanini ZSS in FY33.

Takanini ZSS breaches the SoSS as 2027 approaches. A third transformer and accompanying sub-transmission cable in FY26 will add capacity to the zone substation and allow for future commercial and residential developments in the area.

As a result of organic growth in addition to high commercial interest, a new Takanini South ZSS is expected to be required in the long term (beyond the AMP period). A project to acquire land is planned for FY29.

A capacity constraint at Waiheke ZSS will be addressed by a transformer replacement project.

10.6.12.4 DISTRIBUTION NETWORK

The distribution network in this planning area covers a very large rural area from Clevedon south to Kawakawa Bay and the eastern side of Waiheke Island. It operates at 11 kV and consists of predominately overhead lines. In Kawakawa Bay, a 1 MW / 1.7 MWh BESS to provide additional resilience for the network and local wastewater treatment facility was installed in 2020.

Vector forecasts that the Clevedon ZSS feeder will have a combined shortfall of less than 800 kVA by the end of the AMP period, which is still compliant with the SoSS (Clause 5). Vector will continue to monitor the load growth and shortfall and will take appropriate actions when required.

Significant growth caused by a mix of residential and commercial development has triggered the need for a new feeder and feeder reinforcements in Manurewa, Takanini and Maraetai.

10.6.12.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Maraetai subtransmission breaches SoSS	Maraetai Subtransmission Reinforcement	FY26	12.0
Maraetai feeder K01 breaches SoSS	Maraetai K01 feeder reinforcement	FY25	1.6
TAKA ZSS breaches SoSS	Takanini zone substation capacity upgrade	FY26	10.9[30]
Constraints on the 11 kV distribution network in the Takanini area	Takanini South land purchase for ZSS	FY29	Not discl.

[30] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Waiheke island subtransmission supply resilience	Waiheke third subtransmission submarine cable	FY26	7.8
Waiheke ZSS breaches SoSS	Waiheke 33/11kV T1+T2 TX capacity upgrade	FY28	14.7
Manurewa feeder K14 breaches SoSS	Manurewa K14 feeder reinforcement	FY25	1.8
Manurewa feeder K12 & K07 capacity shortfall	Manurewa Alfriston Rd 11 kV feeder new	FY27	3.2

TABLE 10-27: TAKANINI CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.13 OTAHUHU PLANNING AREA

10.6.13.1 OVERVIEW

The Otahuhu planning area is one the smallest non-CBD planning areas. It consists of Highbrook, Bairds and Otara. The area growth is due to intensification of industrial development around Otahuhu GXP and deployment of EV Bus chargers.

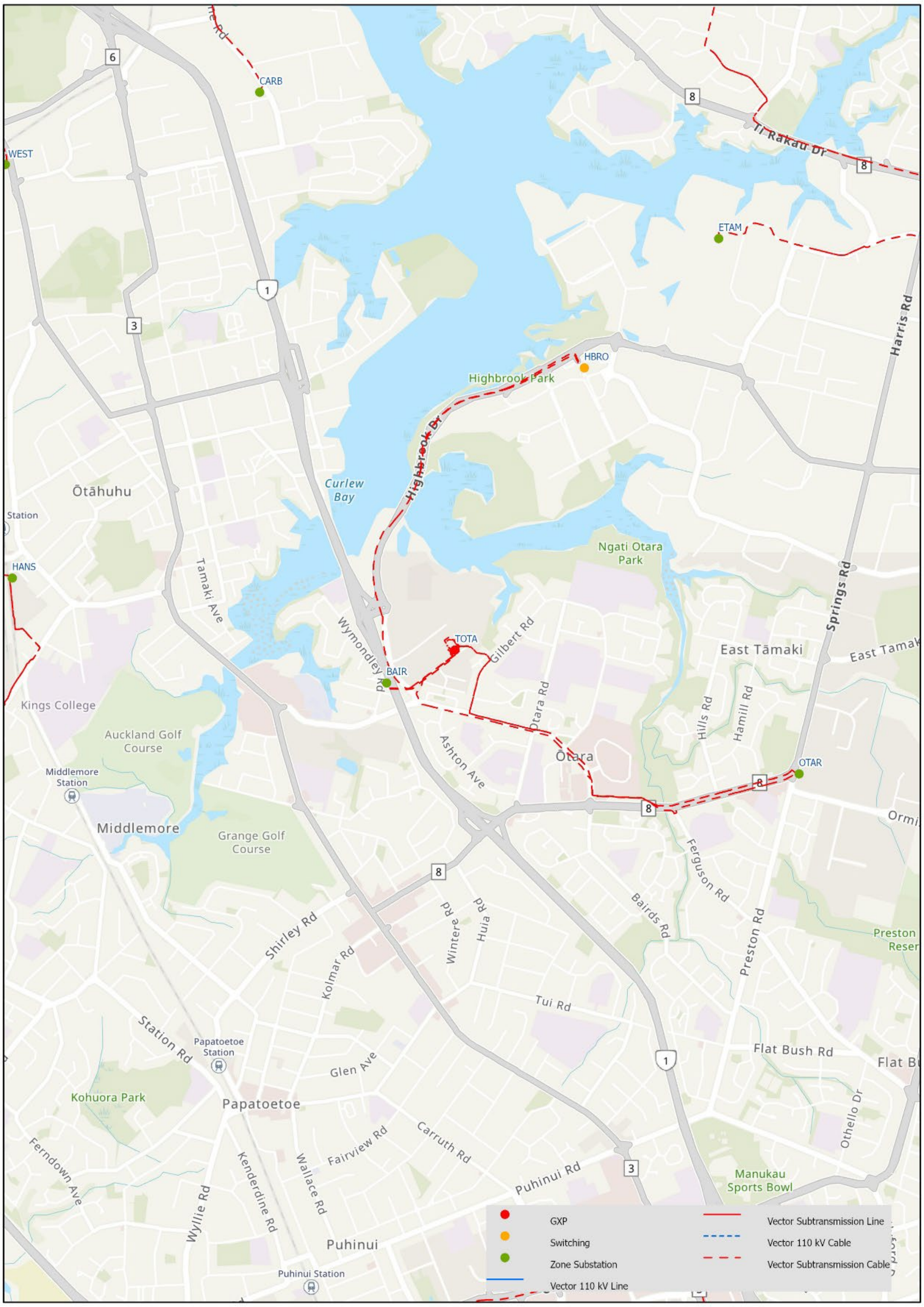


FIGURE 10.21: OTAHUHU SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	ZONE SUBSTATION	SOSS CATEGORY	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Winter	Bairds	RES	28.6	29.5	30.4	31.3	32.1	33.1	34.1	35.1	36.1	37.2	38.5
Winter	Highbrook	COM	9.8	10.0	10.3	10.5	10.7	11.0	11.2	11.5	11.8	12.0	12.3
Winter	Otara	COM	29.2	30.5	32.4	34.2	35.5	37.2	38.8	40.4	41.9	43.5	45.4

TABLE 10-28: OTAHUHU LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.13.2 SUBTRANSMISSION

The area is supplied from the Otahuhu GXP. The subtransmission network operates at 22 kV and consists of underground cables that supply three zone substations. Bairds ZSS and Otara ZSS are supplied radially and Highbrook is supplied by a closed subtransmission loop.

There are no subtransmission security constraints identified to occur during the AMP period.

10.6.13.3 ZONE SUBSTATION

Bairds ZSS and Otara ZSS have 22/11 kV transformers and the distribution network from these substations operates at 11 kV. Highbrook is a switching station, i.e. it does not have transformers and supplies the distribution network which operates at 22 kV. Hence, the two 22 kV cable supplies from Otahuhu GXP that supply Highbrook are considered to be subtransmission due to their function, while the 22 kV feeders used for distribution are considered distribution feeders (similar to Auckland CBD).

There are no security constraints identified to occur at zone substations during the AMP period.

10.6.13.4 DISTRIBUTION NETWORK

As noted above, the distribution network from Bairds ZSS and Otara ZSS operates at 11 kV and can be supported by adjacent substations, however the distribution network from Highbrook operates at 22 kV and is an isolated network with no distribution feeder ties to other zone substations. While there is negligeable industrial growth in the Highbrook region, there is sufficient capacity to supply future growth without breaching the SoSS.

Vector has identified 11 kV feeders from Otara ZSS that will breach the SoSS from FY26. To resolve this issue, the preferred solution is to install an RMU to provide connection to an adjacent feeder and rebalance load across the feeders. Two new feeders will be built in FY26 and FY32 for additional capacity and to maintain SoSS.

10.6.13.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Otara K15 11 kV feeder breaches SoSS	Otara - K15 11 kV feeder capacity optimisation - RMU installation	FY26	0.4
Otara K15 11kV feeder capacity shortfall	Otara Springs Road 11kV feeder new	FY32	2.6
Otara K01 and K07 breaches SoSS	Otara Chapel Heights 11 kV feeder new	FY26	2.4

TABLE 10-29: OTAHUHU PLANNING AREA CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.14 WIRI PLANNING AREA

10.6.14.1 OVERVIEW

Wiri planning area supplies Manukau CBD and Wiri Industrial area. Development of the greenfields area towards Auckland Airport into an industrial subdivision is expected. Redevelopment of the old quarry site and nearby areas introduce large industrial loads that are expected to require connection within the next few years. With the load increase in the next 10 years Vector plans to partially supply it from the new West Wiri ZSS, which is under construction and is expected to be commissioned in FY24.

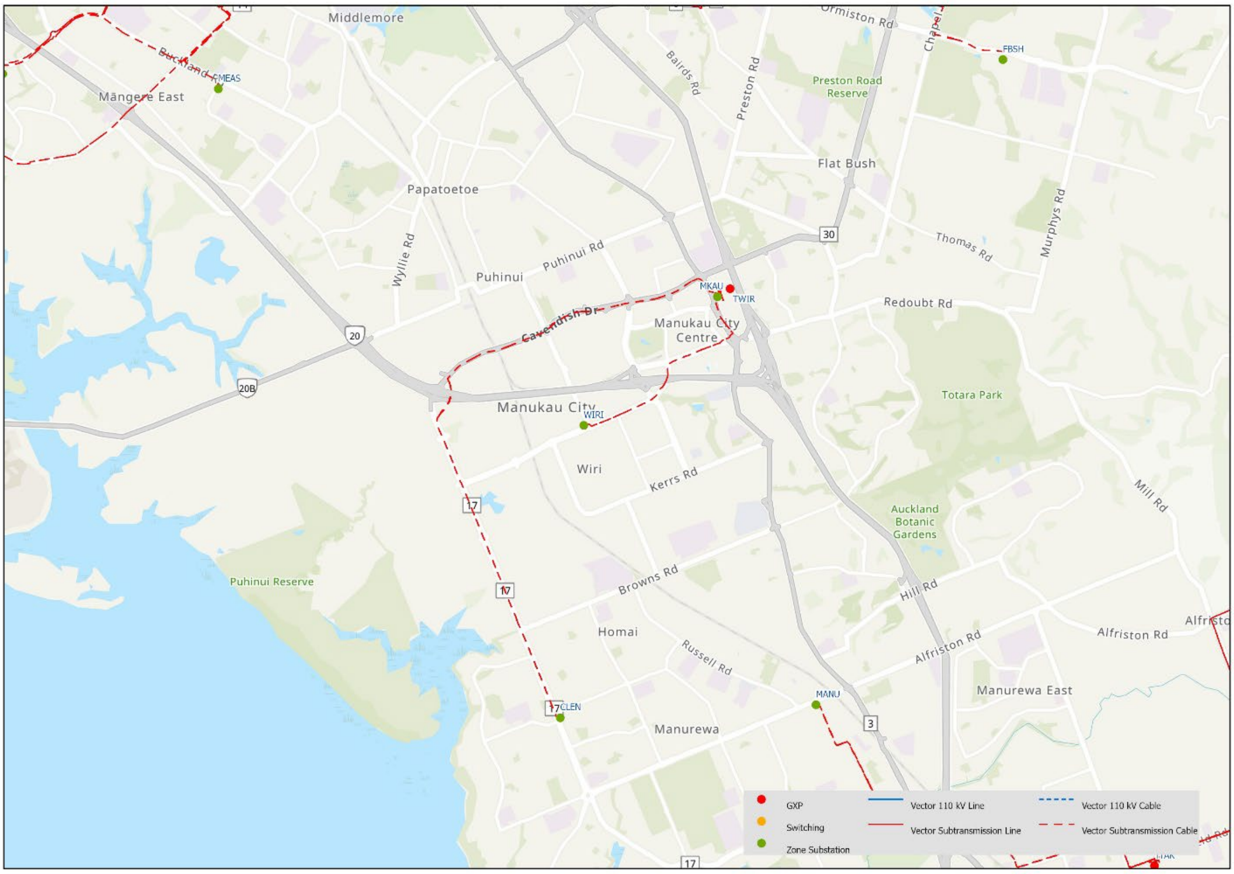


FIGURE 10.22: WIRI SUBTRANSMISSION NETWORK

			LOAD FORECAST (MVA)										
SEASON	**ZONE SUBSTATION**	**SOSS CATEGORY**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Winter	Clendon	RES	20.6	20.7	20.8	20.8	20.9	21.1	21.4	21.6	21.9	22.1	22.6
Winter	Manukau	COM	32.7	34.1	35.5	36.9	38.3	40.0	41.7	43.4	45.1	46.9	48.9
Summer	Wiri	COM	38.4	39.2	43.5	44.3	45.0	46.1	47.2	48.3	49.4	50.5	51.9
Summer	West Wiri	COM	26.8	30.3	33.8	37.3	39.8	42.3	42.3	42.3	42.3	42.3	42.3

TABLE 10-30: WIRI LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

10.6.14.2 SUBTRANSMISSION

The area is supplied from the Wiri GXP. The subtransmission network operates at 33 kV and consists of underground cables that radially supply three zone substations: Clendon ZSS, Manukau ZSS and Wiri ZSS.

There are no subtransmission security constraints identified to occur during the AMP period.

10.6.14.3 ZONE SUBSTATION

There are three zone substations currently supplying the Wiri area.

Expanding industrial development west of McLaughlin's Road and along Puhunui Road towards the airport is driving significant growth. This area will be supplied by a fourth zone substation (West Wiri) which is undergoing construction with an expected commissioning date of FY25.

10.6.14.4 DISTRIBUTION

The distribution feeders from Wiri westward towards the airport are close to full capacity and are forecast to breach the SoSS in FY25. This will be resolved by reconfiguring loads across Wiri ZSS and the future West Wiri ZSS once it is commissioned in FY25.

10.6.14.5 CONSTRAINTS AND SOLUTIONS

CONSTRAINT	SOLUTION / PROJECT NAME	COMMISSIONING FY	ESTIMATED INVESTMENT $M
Significant increase in demand due to large industrial load growth causing a breach of the SoSS	New zone substation - West Wiri	FY25	0.8[31]
Wiri feeder K06 breaches SoSS	West Wiri K13 11kV feeder reinforcement	FY25	0.3
Manurewa ZSS (from Takanini GXP) breaches SoSS	Clendon Weymouth Rd 11kV feeder new	FY28	2.3

TABLE 10-31: WIRI CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

10.6.15 EV UPTAKE

The last two years have seen an acceleration in EV uptake in Auckland.

Significant uncertainty whether this uptake will continue, given recent changes in government policy, e.g. incentives and road user charges. It has therefore become extremely difficult to forecast future EV uptake and associated demand with levels of confidence appropriate for including identified network reinforcement capital costs. As a result, Vector has identified but elected not to include it within our forecast capex expenditures, potential capital expenditure triggered by the current trend EV uptake forecasts. (I.e. omitting investment of $43 million CAPEX in RY26-30.)

Why we're not committing to this investment:

EV uptake and demand numbers could materially adjust based on the areas identified above and there is little ability to model this short of observing any changes to demand in 2024.

What needs to change for us to commit to this investment:

If the observed uptake of electric vehicles aligns with forecast, we would consider applying for an unforeseen project reopener.

Note - Policy development around smart home EV charging (as already adopted in the UK) could provide greater confidence in the potential for smart and scheduled management of EV load to reduce the impact of EV charging during network peak (i.e. orchestration) and optimise network reinforcement investment.

10.6.16 NETWORK-WIDE ALLOCATIONS AND FUTURE CAPABILITY PROGRAMMES

10.6.16.1 HV REINFORCEMENT AND MONITORING

Our system growth process identifies the major constraints, projects and related budgets, as presented above. While great care is taken in this process to capture all the projects, smaller reactive reinforcement needs or unforeseeable changes may occur that require additional projects. An annual provisional allocation is included in our AMP to cater for HV reinforcements that may arise during the year and need to be carried out with urgency. A similar allocation for the opportunistic installation of future-proofing cable ducts for future reinforcement projects is also included. Civil works are the most expensive component of cable projects so by installing future-proofing ducts during roading alterations, overall costs are reduced.

Dedicated power-quality monitoring (PQM) capability is deployed across approximately half of our zone substations and all GXPs. By trending PQ changes over time, PQ deterioration can be observed, causes can be identified (in particular by relating customer plant outage times to network voltage sags/swells) and remedial steps can be taken if necessary. Also, monitoring of power quality is increasingly important as more inverter-based resources connect to the network. Our PQM programme is progressively extending the PQ capability across zone substations that are identified as potential problem areas.

10.6.16.2 LV REINFORCEMENT AND MONITORING

In the absence of any LV network visibility, legacy practice is to address LV capacity and voltage constraints on a reactive basis. Informed by historic expenditure, an allocation for LV network reinforcement is included. Additionally, new DER connections will increase the need for reinforcement and the increase in LV visibility capabilities will surface constraints not captured reactively. An additional allocation is made to cover those LV reinforcements.

10.6.16.3 DEMAND-SIDE MANAGEMENT

The forecast increase in peak demand over this AMP period is driven by large-scale customers driving increased reinforcement investment, such as data centres, public transport electrification (buses and ferries), as well as organic load growth from continued residential development, fuel switching from gas to electricity, and electric vehicle charging.

Electric vehicle charging, one of the largest drivers of system growth, comes with significant opportunity to reduce peak contribution through orchestration, where peak demand is flattened at all levels of the network, by coordinating the individual demand from customers. Vector is taking opportunities to implement this strategy where possible. Examples include contracting with public transport operators to deploy flexible network connections for bus charging depots, where Vector provides a 24-hour

[31] Only the cost falling within this AMP period is shown, the project commenced prior to this period.

forecast of available network capacity over fifteen minute increments, which is then used to optimise bus charging to occur buses, in exchange for a lower connection cost to the customer because we are able to defer network reinforcement which would otherwise have been required.

In other cases which also offer similar potential to lower the customer costs of system growth requirements, such as residential electric vehicle charging, we are not able to implement such a scheme without regulatory support for smart charging, industry standards to enable communications with chargers, and the compulsory connection of smart chargers to the distributor's distributed energy resource management system, either directly, or indirectly via a third party's system (which itself is connected to Vector's system).

Despite the importance of certainty to support infrastructure planning, industry and regulatory arrangements are still some years from finalisation. In the absence of this clarity, Vector has set connection standards to enable the connection required. However, our ability to monitor and enforce compliance is limited; this means our confidence to defer investment is low and the customer cost of EV adoption is set to be higher than it needs to be.

Demand-side management and the use of NWAs underpin our Symphony strategy. A DERMS platform is essential to orchestrate the network and demand-side resources to mitigate constraints and will be used in conjunction with smart meter data to unlock any opportunities which present themselves.

10.6.16.4 CONSTRAINTS AND SOLUTIONS

CONSTRAINTS	ALLOCATION / PROGRAMME NAME	INVESTMENT OVER 10 YEARS $M/YEAR
Un-foreseen HV network constraint	HV network reinforcement	2.64
Opportunistic installation of cable ducts	Futureproofing duct opportunities	1.45
Monitor power quality of the HV network	PQM rollout programme	0.13
Relieve LV network constraints	LV network reinforcement	2.72
Reinforce the network to relieve voltage and capacity constraints due to DER increase	DER (solar/EV) LV network reinforcement	0.9

TABLE 10-32: NETWORK-WIDE ALLOCATIONS AND FUTURE CAPABILITY PROGRAMMES

SECTION 10A

Appendix: Growth and security projects

10a –Growth and security projects

10a.1 Appendix overview

This Appendix provides additional details of the constraints, options analysis, and preferred solution for major projects required within the next 5 years as outlined in Section 10 - Growth and Security.

Major growth and security projects are those exceeding $1M. Only major projects planned to commence within the next 5 years are listed. The rationale for only discussing the major 5-year projects in detail is due to the uncertainty of the load growth forecasts and the impact of new technologies on project timing beyond 5 years. The options analysis for projects that are already in formal delivery phase are not covered and were presented in previous AMPs.

Available options and preferred solutions on the listed major projects in this Appendix may change over time and cost estimates firmed up as projects move towards full funding approval and commencement. These projects are also all subject to detailed technical and financial scrutiny as part of Vector's governance approval process.

10a.2 Wellsford planning area

10a.2.1 WARKWORTH SOUTH ZONE SUBSTATION NEW

WARKWORTH SOUTH ZONE SUBSTATION NEW

CONSTRAINT

The load on Warkworth substation is approaching its firm capacity and 11 kV network capacity in Warkworth township will become constrained. Sandspit ZSS (project in delivery) will defer this constraint.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS in the Warkworth network. This option is not acceptable.
2. **Construct Mahurangi ZSS:** This site is not ideally located for the near-term load growth and is a longer term solution.
3. **Upgrade Warkworth ZSS transformers and reinforce 11 kV network:** This option proposes installing larger transformers at Warkworth to increase the firm capacity of the substation. Warkworth substation is located 4 km away from the township and load centre, resulting in considerable and unnecessary expenditure on 11 kV feeders to deliver the distant capacity to the township. When compared to Option 2 this solution is not only costlier but does not provide the security that two substations can offer (Option 2 and Option 4).
4. **Construct Warkworth South ZSS:** This option proposes a new 33/11 kV zone substation in Glenmore Drive, Warkworth on a site owned by Vector. In 2012 a new 33 kV feeder was constructed to Woodcocks Road (currently operating at 11 kV) in anticipation of supplying a future Warkworth South substation. Construction of Warkworth South substation will move the supply centre from Warkworth substation (4 km out of town) to the centre of the "future urban" zone.

PREFERRED SOLUTION

Option 4 is preferred. Building a new Warkworth South zone substation will relieve the emerging feeder capacity and SoSS constraints at Warkworth.

10a.2.2 MAHURANGI LAND PURCHASE FOR ZSS

MAHURANGI LAND PURCHASE FOR ZSS

CONSTRAINT

A bulk supply 110/33kV + 33/11kV substation northwest of Warkworth is part of the long-term strategy for the Wellsford GXP planning area. A suitable site has been identified in a proposed land redevelopment and will be secured.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS at Spur Road and Coatesville substations from 2025. This option is not acceptable.
2. **Early acquisition of a zone substation land at Mahurangi site:** Identify and purchase a site for a future substation at Mahurangi site at an early design stage of the development. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.
3. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.

MAHURANGI LAND PURCHASE FOR ZSS
PREFERRED SOLUTION
The preferred option is Option 2 to secure a future zone substation site. As a prudent network manager, Vector needs to identify and secure suitable future zone substation sites to ensure Vector can supply future developments cost effectively and reliably.

10a.3 Silverdale planning area

10a.3.1 DAIRY FLAT LAND PURCHASE FOR ZSS

DAIRY FLAT LAND PURCHASE FOR ZSS

CONSTRAINT

A new zone substation at Dairy Flat was part of the long-term strategy in the 2030s for the Redvale/Dairy Flat/Okura area. A new major point load in the area has brought forward the need for a switchroom in the area and a site for this will be secured.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS at Spur Road and Coatesville substations from 2025. This option is not acceptable.
2. **Early acquisition of a zone substation land at Dairy Flat site:** Identify and purchase a site for a future substation at Dairy Flat site at an early design stage of the development. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.
3. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.

PREFERRED SOLUTION

The preferred option is Option 2 to secure a future zone substation site. As a prudent network manager, Vector needs to identify and secure suitable future zone substation sites to ensure Vector can supply future developments cost effectively and reliably.

10a.3.2 SILVERDALE GXP OREWA & MANLY SUBTRANS CABLE UPGRADE

SILVERDALE GXP OREWA & MANLY SUBTRANS CABLE UPGRADE

CONSTRAINT

Orewa and Manly sub-transmission breaches security of supply standard.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS at Orewa and Manly substations from 2025. This option is not acceptable.
2. **Install a new Transpower Silverdale to Orewa ZSS subtransmission circuit:** Adding a third circuit would increase the security of supply into Orewa-Red Beach. While futureproof ducts have been installed on about half the Orewa route length, this is still much more expensive than Option 3.
3. **Replace the sections of cable which are limiting the circuit ratings:** This would cost less than Option 2 but does not provide the same increase in security of supply.

PREFERRED SOLUTION

Option 3 is the most cost-effective option in the short term to prevent cable overloading. To further increase capacity to the area when needed and provide improved network resilience and reliability of supply. Option 2 will be considered outside of this AMP period.

10a.3.3 MILLWATER ZONE SUBSTATION NEW

MILLWATER ZONE SUBSTATION NEW

CONSTRAINT

New residential developments are expanding westwards from Millwater towards Wainui and Dairy Flat. Distribution feeders supplying Millwater and Milldale greenfields residential developments are forecast to breach capacity and SoSS by 2028.

MILLWATER ZONE SUBSTATION NEW

OPTIONS

1. **Do Nothing:** Existing Milldale feeder cables will become overloaded.

MILLWATER ZONE SUBSTATION NEW

OPTIONS

2. **Provide feeders from Spur Road ZSS**: Supplying the Millwater area from Spur Road ZSS would require very costly 11 kV cabling and an expansion of the newly installed switchboard. The spare capacity at the Orewa, Red Beach and Spur Rd ZSS would be exhausted in the medium term, requiring the bringing forward of the proposed Dairy Flat ZSS.
3. **Build a new zone substation at Millwater:** Building Millwater ZSS will provide the required capacity to improve the security of supply to Millwater and the new Milldale greenfield development area.
4. **Install feeder cables from Orewa ZSS, Red Beach ZSS and/or Spur Road ZSS**: This would require very costly 11 kV cabling and switchgear extensions at both substations to supply Milldale. The spare capacity at the Orewa, Red Beach and Spur Rd ZSS would be exhausted in the medium term, requiring the bringing forward of the proposed Dairy Flat ZSS.
5. **Supply Milldale from Dairy Flat zone substation:** Dairy Flat ZSS will be required in any case, but it is more efficient to install the capacity near the load centre. A large investment in 11 kV network would be needed to bring capacity to Millwater from Dairy Flat.
6. **Implementation of non-wires alternative**: The growth is high and includes a large commercial point load. This option will not address the capacity and security shortfalls.

PREFERRED SOLUTION

Option 3 is preferred as it provides the most efficient solution for improved network security and resilience. The Millwater ZSS site is close to the major load centres and is better located than more distant alternative substations.

10.6.17 MANLY 33/ 11 KV TRANSFORMER CAPACITY UPGRADE

MANLY 33/ 11 KV TRANSFORMER CAPACITY UPGRADE

CONSTRAINT

Backstop for the single-transformer Gulf Harbour ZSS comes entirely from the Manly ZSS. In the event of a Gulf Harbour outage the Manly transformers will be overladed at peak demand by 2028.

OPTIONS

1. **Do Nothing:** The SoSS will be breached and supply will not be maintained following an outage at peak demand.
2. **Replace the transformers at Manly ZS with larger units**: This will address the security of supply constraint.
3. **Install a second transformer and subtransmission cable to Gulf Harbour ZS**: This would address the security of supply constraint, at a much higher cost than option 2.

PREFERRED SOLUTION

Option 2 is preferred as it provides the most cost-effective solution.

10a.3.4 SILVERDALE GXP EXPANSION VECTOR 33KV CABLE WORKS

SILVERDALE GXP EXPANSION VECTOR 33KV CABLE WORKS

CONSTRAINT

Demand on Transpower's Silverdale GXP is approaching firm capacity, due to strong ongoing residential growth and large point loads. Capacity upgrades will be delivered at Silverdale by Transpower, and Vector will need to re-arrange cable connections and terminations.

10a.4 Henderson planning area

10a.4.1 WHENUAPAI ZONE SUBSTATION NEW

WHENUAPAI ZONE SUBSTATION NEW

CONSTRAINT

Forecast residential development plus a major point load in Whenuapai means the 11 kV network will become capacity constrained and the security of supply standard will not be met.

OPTIONS

1. **Do nothing:** This option will result in breach of capacity and SoSS for feeders from Hobsonville and Hobsonville Point ZSS. This option is not acceptable.
2. **Install new 11 kV feeders:** New feeders from Hobsonville and Hobsonville Point ZSS would provide capacity in the short term, but transformer capacity limitations would mean option 2 would still be required shortly afterwards, resulting in over-investment in the cable network.

WHENUAPAI ZONE SUBSTATION NEW

3. **Install new Whenuapai ZSS:** This option will supply the point load and provide capacity and security of supply for Whenuapai into the long term.
4. **Implementation of non-wires alternative**: The need to supply the point load means this option will not address the capacity and security shortfalls.

PREFERRED SOLUTION

Option 3 is preferred because it is an efficient solution to solve the capacity and security breach constraint.

10a.4.2 HENDERSON GXP REDHILLS SUBTRANSMISSION FUTURE-PROOFING DUCTS

HENDERSON GXP REDHILLS SUBTRANSMISSION FUTURE-PROOFING DUCTS

CONSTRAINT

The existing Special Housing Area at Redhills is at the design and early construction stage and will comprise 5000 new dwellings. The wider area is forecast to double this. The existing network does not have sufficient capacity to meet these long-term load requirements. Redhills ZSS is scheduled to be constructed by 2028 and will require a new subtransmission circuit from Henderson GXP. A third-party cable installation in 2024-2025 is on the same route and this project will install future-proofing ducts for the Redhills cable.

OPTIONS

1. **Do Nothing**: Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies and increasing unreliability. This option is not acceptable.
2. **Install future-proofing duct**: A third party is carrying out project works on the cable route. Ducts will be installed in combination with the works to reduce the cost and public disruption of the standalone civil project later.
3. **Undertake civil works with cable installation**: The civil works will be carried out as part of the cable installation. This will involve re-entering public roads and creating distribution after the third-party works (mentioned in Option 2) have been completed.

PREFERRED SOLUTION

Option 2 is the preferred solution because it is cost efficient taking the synergy opportunity. It will also avoid the disruption to public when new cables are required to be installed at later stage.

10a.4.3 REDHILLS LAND PURCHASE FOR ZSS

REDHILLS LAND PURCHASE FOR ZSS

CONSTRAINT

The existing Special Housing Area at Redhills is at the design stage and will comprise 5,000 new dwellings. The wider area is forecast to double this. The existing network does not have sufficient capacity to meet these long-term load requirements. A new zone substation will be required, and this project is to secure a substation site in anticipation of this expansion.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS, this option is not acceptable.
2. **Early land acquisition of a zone substation land at Redhills site:** This ensures a suitable site is acquired in advance of the design process.
3. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition, and risk not being able to secure a suitable.

PREFERRED SOLUTION

The preferred option is Option 2 to secure a future zone substation site. As a prudent network manager, Vector needs to identify and secure suitable future zone substation sites to ensure Vector can supply future developments cost effectively and reliably

10a.4.4 REDHILLS ZONE SUBSTATION NEW

REDHILLS ZONE SUBSTATION NEW

CONSTRAINT

The existing network within the Redhills area is not capable of supplying the forecasted load, particularly on Ranui, Westgate and Riverhead feeders (also note comments for project about Redhills land purchase for ZSS)

OPTIONS

1. **Do Nothing:** Existing Ranui, Westgate and Riverhead feeders will become overloaded. Customers supplied from these feeders will increasingly suffer from supply reliability issues and possible equipment failure. This is not acceptable.
2. **Install new 11 kV cables into Redhills from Whenuapai ZSS and Westgate ZSS feeders:** This would be an expensive solution, and while it would defer the ZSS project for a few years, would result in stranded investment in 11 kV network after the ZSS is commissioned.
3. **Construct a new ZSS in Redhills:** This option represents a lower total cost than Option 2 and alleviates the constraint.
4. **Implementation of non-wires alternative**: The growth is high with large housing infill. This option will not adequately address the capacity and security shortfalls.

PREFERRED SOLUTION

Option 3 is preferred. Building a new Redhills zone substation will relieve the emerging feeder capacity and SoSS constraints Redhills.

10a.4.5 TE ATATU 33/11 KV (T1 AND T2) TRANSFORMER CAPACITY UPGRADE

TE ATATU 33/11 KV (T1 AND T2) TRANSFORMER CAPACITY UPGRADE

CONSTRAINT

Load growth in Te Atatu will result in a shortfall in transformer capacity at Te Atatu ZSS

OPTIONS

1. **Do nothing:** The existing transformers will become overloaded after an outage at peak demand. This is not acceptable.
2. **Replace Te Atatu transformers with larger units:** This meets the long-term requirements of load growth and increases security of supply into the Te Atatu and surrounding areas.
3. **Implementation of non-wires alternative**: This option does not adequately alleviate the transformer capacity shortfall for Te Atatu and does not provide the same security of supply to the wider area

PREFERRED SOLUTION

Option 2 is preferred.

10a.5 Hepburn planning area

10a.5.1 WAIKAUKAU 33/11KV TX CAPACITY UPGRADE T1

WAIKAUKAU 33/11KV TX CAPACITY UPGRADE T1

CONSTRAINT

Load growth in Glen Eden will result in a shortfall in transformer capacity at Simpson Rd ZSS

OPTIONS

1. **Do nothing:** The existing transformer will become overloaded at peak demand. This is not acceptable.
2. **Replace the Waikaukau transformer with a larger unit:** This addresses the capacity constraint at a lower cost than option 2. Due to asset age/condition, and flood risk at the site, the substation will be re-built with new switchroom and switchgear in parallel with the transformer replacement.
3. **Install a second transformer at Waikaukau ZS:** This would meet the long-term requirements of load growth and would increase security of supply into Glen Eden, Waikumite and surrounding areas. It would come at a greater cost than option 2, and may be undertaken at a later date
4. **Implementation of non-wires alternative**: The load is primarily commercial. This option will not address the capacity and security shortfalls.

WAIKAUKAU 33/11KV TX CAPACITY UPGRADE T1

PREFERRED SOLUTION

Option 2 is preferred as the more cost-effective solution.

10a.5.2 BRICKWORKS 33/11 KV SECOND TRANSFORMER, 11 KV SWITCHGEAR REPLACEMENT & NEW 33 KV CABLE

BRICKWORKS 33/11 KV SECOND TRANSFORMER, 11 KV SWITCHGEAR REPLACEMENT & NEW 33 KV CABLE

CONSTRAINT

Transformer loading at Brickworks breaches security of supply FY28, with neighbouring New Lynn ZSS transformer breaching security of supply in 2032.

OPTIONS

1. **Do Nothing:** The existing transformers will become overloaded. Customers supplied from these transformers will increasingly suffer from supply reliability issues and possible equipment failure. This is not acceptable.
2. **Install a second transformer T2 and a subtransmission cable at Brickworks:** The additional capacity will defer investment at New Lynn ZSS and address capacity constraints in the medium term.
3. **Upgrade New Lynn ZSS transformers and install new 11 kV feeders from New Lynn to the Brickworks network:** The New Lynn transformers will need to be upgraded in the future to meet local load growth, but it is more economic to add the capacity where it is required (Brickworks first), avoiding the need for 11 kV reinforcement to transfer load between the sites.
4. **Implementation of non-wires alternative:** The growth is primarily commercial. This option will not address the capacity and security shortfalls.

PREFERRED SOLUTION

Option 2 followed by option 3 is preferred as the most cost-effective approach.

10a.5.3 SABULITE 33/11 KV TRANSFORMER CAPACITY UPGRADE T1+T2

SABULITE 33/11 KV TRANSFORMER CAPACITY UPGRADE T1+T2

CONSTRAINT

Transformer loading at Sabulite Rd ZSS breaches security of supply FY32.

OPTIONS

1. **Do Nothing:** The existing transformers will become overloaded. Customers supplied from these transformers will increasingly suffer from supply reliability issues and possible equipment failure. This is not acceptable.
2. **Replace Sabulite transformers with larger units:** This meets the long-term requirements of load growth and increases security of supply into Kelston and surrounding areas.
3. **Implementation of non-wires alternative:** A significant component of the demand is commercial/industrial, making hot water load control a less effective option. Other NWA options will be considered closer to the constraint.

PREFERRED SOLUTION

Option 2 is preferred.

10a.5.4 MCLEOD RD 33/11KV TX UPGRADE T1

MCLEOD RD 33/11KV TX UPGRADE T1

CONSTRAINT

Load growth in Ranui will result in a shortfall in transformer capacity at McLeod Rd ZSS

OPTIONS

1. **Do nothing:** The existing transformer will become overloaded at peak demand. This is not acceptable.
2. **Install a second transformer at McLeod Rd ZS:** This would meet the long-term requirements of load growth and would increase security of supply into Ranui and surrounding areas. It would require new 33kV and 11kV switchgear and a new switchroom building.
3. **Replace the McLeod Rd transformer with a larger unit:** This addresses the capacity constraint at a much lower cost than option 2.
4. **Implementation of non-wires alternative**: This option will be investigated closer to the forecast constraint.

PREFERRED SOLUTION

Option 3 is preferred as the more cost-effective solution.

10a.6 Albany planning area

10a.6.1 TORBAY 33/11KV TX UPGRADE T1

TORBAY 33/11KV TX UPGRADE T1

CONSTRAINT

Load growth in Torbay has resulted in a shortfall in transformer capacity at Torbay ZSS, especially following an outage at Waiake ZSS

OPTIONS

1. **Do nothing:** The existing transformer will become overloaded at peak demand. This is not acceptable.
2. **Install a second transformer at Torbay ZS:** This would meet the long-term requirements of load growth and would increase security of supply into Torbay and surrounding areas. It would require new 33kV switchgear.
3. **Replace the Torbay transformer with a larger unit:** This addresses the capacity constraint at a lower cost than option 2.

PREFERRED SOLUTION

Option 2 is preferred as the more cost-effective solution.

10a.6.2 WAIAKE 33/11KV TX UPGRADE T1

WAIAKE 33/11KV TX UPGRADE T1

CONSTRAINT

Load growth in Waiake will result in a shortfall in transformer capacity at Waiake ZSS, especially following an outage at Torbay ZSS

OPTIONS

1. **Do nothing:** The existing transformer will become overloaded at peak demand. This is not acceptable.
2. **Install a second transformer at Waiake ZS:** This would meet the long-term requirements of load growth and would increase security of supply into Waiake and surrounding areas. It would require new 33kV switchgear.
3. **Replace the Torbay transformer with a larger unit:** This addresses the capacity constraint at a much lower cost than option 2.

PREFERRED SOLUTION

Option 2 is preferred as the more cost-effective solution.

10a.6.3 ALBANY GXP GREENHITHE NEW SUBTRANSMISSION CABLE

ALBANY GXP GREENHITHE NEW SUBTRANSMISSION CABLE
ALBANY TO GREENHITHE 110 KV TO 33 KV SUBTRANSMISSION OVERHEAD CONVERSION

CONSTRAINT

The Albany GXP to Greenhithe ZSS subtransmission cable is forecast to overload following an outage of the Greenhithe to Hobsonville Point ZSS circuit.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies and increasing unreliability. This option is not acceptable.
2. **Install a new cable to bypass the constrained cable:** This will resolve the constraint for several years, and there is an opportunity to share civil costs with other projects on the same route.
3. **Convert Albany-Greenhithe-Wairau 110 kV circuit to 33 kV to create a new subtransmission connection to Greenhithe:** This requires the prior installation of Transpower's 220/33 kV T9 transformer at Wairau ZSS, which will not be completed in time to resolve this constraint. For this reason, and due to the opportunity to share civil costs, Option 2 is chosen for delivery first (2024). The 110-33 kV conversion project is scheduled for FY25-26.
4. **Implementation of non-wires alternative**: The growth is high and includes large commercial point loads. This option will not address the capacity and security shortfalls.

PREFERRED SOLUTION

Option 2 is the most cost-efficient option and resolves the constraint in the short term. Option 3 is scheduled to follow in 2026.

10a.6.4 ALBANY GXP ROSEDALE SUBTRANSMISSION CABLE REINFORCEMENT

ALBANY GXP ROSEDALE SUBTRANSMISSION CABLE REINFORCEMENT

CONSTRAINT

Rosedale subtransmission becomes constrained in FY25.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies and increasing unreliability. This option is not acceptable.
2. **Upgrade the existing Albany-Rosedale subtransmission circuit and install a second circuit:** This option will re-purpose sections of two Albany-Wairau 110 kV lines after they are de-commissioned to save cable installation costs.
3. **Upgrade two Albany-Bush Road subtransmission circuits:** Due to the cable route length this is a more expensive solution than option 2. **Upgrade the Albany-Sunset Road subtransmission circuit.** Due to the cable route length this is an expensive solution which adds less capacity into the Rosedale-Sunnynook area than options 2 or 3.

PREFERRED SOLUTION

Option 2 is the preferred solution at present.

10a.6.5 ROSEDALE GXP SUBTRANSMISSION CABLES

ROSEDALE GXP SUBTRANSMISSION CABLES

CONSTRAINT

Demand on Transpower's Albany GXP is approaching firm capacity, due to ongoing residential growth and large point loads. Capacity upgrades will be delivered by Transpower, and Vector will need to install new subtransmission connections and terminations.

10a.7 Wairau planning area

10a.7.1 BELMONT 33/11 KV TRANSFORMER T3

BELMONT 33/11 KV TRANSFORMER T3

CONSTRAINT

Ngataringa Bay ZSS in Stanley Point is prone to the risk of flooding in the event of a king tide, an event that has already occurred, and one that is estimated to be a 1-in-10-year or more frequent event in future. Flooding of the ZSS could result in loss of supply to all customers presently supplied from this ZSS.

The ZSS is supplied by an ageing 33 kV oil-filled submarine cable crossing the bay, which poses an environmental risk of oil pollution if it fails or is mechanically damaged and the oil containment elements of its design are compromised.

Besides, Ngataringa Bay ZSS has insufficient 11 kV backstop capacity for an outage at peak demand, hence breaching the SoSS.

OPTIONS

1. **Do Nothing**: The environmental and security of supply risks posed by the single ageing oil-filled submarine cable and by the flooding of Ngataringa Bay zone substation remain. Ngataringa Bay backstop shortfall remains.
2. **Install 3rd transformer at Belmont:** To eliminate the risk to the network that would occur if Ngataringa Bay ZSS is inundated, customers presently supplied by 11 kV feeders from Ngataringa Bay ZSS would in future be supplied by new 11 kV feeders from Belmont ZSS. A 3rd 33/11 kV transformer would be installed at the Belmont zone substation to accommodate the additional 11 kV demand. The 11 kV switchboard at Belmont ZSS would be extended to accommodate the additional 11 kV transformer feeder and the additional 11 kV feeders to Stanley Point.
3. **Relocate Ngataringa Bay ZSS**: Acquire land and build a new zone substation in a suitable flood risk-free location in Stanley Point; remove (or drain and seal) the existing 33 kV oil-filled submarine cable and replace it with a modern XLPE equivalent; reroute existing 11 kV feeders to suit the new location of the ZSS. The key environmental and security of supply risks would be avoided.
4. **Rebuild Ngataringa Bay ZSS**: Rebuild the zone substation in its existing location, but on elevated foundations to eliminate the security of supply risk posed by the existing low-lying installation; remove (or drain and seal) the existing 33 kV oil-filled submarine cable and replace with a modern XLPE equivalent.

PREFERRED SOLUTION

Option 2 is preferred at a significantly lower cost than options 3 or 4. It also provides several outcomes for the area: alleviation of flood risk, alleviation of environmental pollution risk; and integration of the future Belmont ZSS transformer replacement.

10a.7.2 HIGHBURY 33/11 KV SECOND TRANSFORMER AND SECOND 33 KV CABLE

HIGHBURY 33/11 KV SECOND TRANSFORMER AND SECOND 33 KV CABLE

CONSTRAINT

As a result of E-Ferry and organic growth, Highbury zone substation is reaching capacity in 2026. The peak demand is forecast to increase by 8MVA over the next ten-year period. There is insufficient spare capacity at peak demand to provide backstop to neighbouring zone substations.

OPTIONS

1. **Do nothing:** accept Highbury substation is at capacity and supply to customers will become increasingly unreliable.
2. **Install a second transformer and sub-transmission cable:** the second transformer and sub-transmission cable will add capacity to the substation and allow for future commercial and residential developments in the area. There is space for a second transformer on site.
3. **Implement non-wires solutions:** The growth on this substation is dominated by a large point load from the E-Ferry. This option is expected to have little benefit from economic and network improvement due to the large point load.

PREFERRED SOLUTION

Option 2 is preferred due to the growth and capacity constraint in the area.

10a.7.3 JAMES ST 33/11 KV TRANSFORMER UPGRADE T1 AND T2

JAMES ST 33/11 KV TRANSFORMER UPGRADE T1 AND T2

CONSTRAINT

Transformer loading at James St ZSS breaches security of supply.

OPTIONS

1. **Do nothing:** accept James St ZSS is at capacity and supply to customers will become increasingly unreliable.
2. **Replace the James St transformers T1 and T2 with larger units:** This option meets the long term requirements of load growth and increases security of supply into James St and surrounding areas.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is preferred due to the growth and capacity constraint in the area.

10a.7.4 MILFORD 33/11 KV TRANSFORMER UPGRADE T1

MILFORD 33/11 KV TRANSFORMER UPGRADE T1

CONSTRAINT

Transformer loading at Milford ZSS breaches security of supply.

OPTIONS

1. **Do nothing:** accept Milford substation is at capacity and supply to customers will become increasingly unreliable.
2. **Replace the Milford transformer with a larger unit:** this option meets the long term requirements of load growth and increases security of supply into Milford and the surrounding areas.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is preferred due to the growth and capacity constraint in the area.

10a.7.5 NGATARINGA BAY DIRECT SUPPLY FROM BELMONT ZSS

NGATARINGA BAY DIRECT SUPPLY FROM BELMONT ZSS

CONSTRAINT

Ngataringa Bay ZSS has insufficient 11kV backstop capacity for an outage at peak demand and breaches security of supply. Ngataringa Bay ZSS has a 33kV oil-filled submarine cable which is approaching the end of its serviceable life and presents a

NGATARINGA BAY DIRECT SUPPLY FROM BELMONT ZSS

network security risk and environment risk from oil leaks. Additionally, this substation is low lying near the coast making it vulnerable to flooding.

OPTIONS

1. **Do nothing:** accept Ngataringa Bay substation is at capacity and supply to customers will become increasingly unreliable.
2. **Replace underrated 11kV cables with higher capacity cables:** This option allows load to be transferred to Belmont ZSS with extended higher rated 11kV cables. This addresses the SoSS, environmental risk of 33kV cable and flooding risk at Ngataringa ZSS. Ngataringa Bay ZSS can be decommissioned once all load is transferred onto Belmont ZSS.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is preferred due to the growth and capacity constraint in the area.

10a.7.6 WAIRAU 33/11 KV TRANSFORMER UPGRADE T5 AND T6

WAIRAU 33/11 KV TRANSFORMER UPGRADE T5 AND T6

CONSTRAINT

Load growth in Wairau will result in shortfall in transformer capacity at Wairau ZSS.

OPTIONS

1. **Do nothing:** accept Wairau substation is at capacity and supply to customers will become increasingly unreliable.
2. **Replace the Wairau transformers T5 and T6 with larger units:** This option meets the long term requirements of load growth and increases security of supply into Wairau and surrounding areas.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is preferred due to the growth and capacity constraint in the area.

10a.8 Auckland CBD planning area

10a.8.1 CBD HOBSON ST BRADNOR LANE 22 KV EXTENSION

CBD HOBSON ST BRADNOR LANE 22 KV EXTENSION

CONSTRAINT

Long-term growth forecasts indicate a general need to extend the 22 kV distribution network across the CBD, to future-proof the 22 kV distribution network against the impacts of long-term growth. It is strategically important to secure the route for the installation of new 22 kV feeders from Hobson substation to the CBD area.

OPTIONS

1. **Do Nothing**: Long-term growth forecasts make an extension of the 22 kV network into this area inevitable; doing nothing at this stage will defer the extension until such a time that increased cost and disruption will have a higher long-term financial and reputational impact on Vector and will risk Vector being completely locked out from access to the already congested sub-grade services available to all utilities.
2. **Extend 22 kV distribution network**: Install sub-grade services and future-proof the 22 kV distribution network to enable further expansion of the network in the heart of Auckland CBD.
3. **Install future-proofing ducts only:** This option will require excavations for pulling pits and joint bays when 22 kV cables are required to be installed in the future, which will result in disruption to the public traffic and higher cost comparing to Option 2.

PREFERRED SOLUTION

The preferred option is Option 2. The current significant development works within the CBD provide the opportunity to install services and facilities to future-proof the 22 kV network for further expansion. Failing to take advantage of this opportunity will risk significantly higher long-term financial and reputational impacts to Vector in the future.

10a.8.2 CBD TYLER ST 22 KV EXTENSION

CBD TYLER ST EAST 22 KV EXTENSION

CONSTRAINT

Long-term growth forecasts indicate a general need to extend the 22 kV distribution network across the CBD. Construction of the City Rail Link facilities in the Britomart/Lower Queen St areas has presented a synergistic opportunity to extend the 22 kV network along Tyler Street during the construction work and to future-proof the 22 kV distribution network against the impacts of long-term growth.

OPTIONS

1. **Do Nothing**: Long-term growth forecasts make the extension of the 22 kV network in this area essential. Doing nothing at this stage will defer the extension until such a time that increased cost and disruption in this highly visible and patronised area of the CBD will have a higher long-term financial and reputational impact on Vector.
2. **Extend 22 kV distribution network**: Take advantage of the CRL construction work to future-proof the 22 kV distribution network to enable further expansion of the network in this extremely busy area of Auckland CBD.

PREFERRED SOLUTION

Option 2 is the preferred option. The current significant development works within the CBD provide the opportunity to install services and facilities to future-proof the 22 kV network for further expansion. Failing to take advantage of this opportunity will risk significantly higher long-term financial and reputational impacts to Vector in the future.

10a.8.3 10A.8.3 HOBSON ZSS 2ND 75MVA 110/22KV TRANSFORMER

HOBSON ZSS 2ND 75MVA 110/22KV TRANSFORMER

CONSTRAINT

The proposed new loads from Auckland Transport's Downtown electric ferry terminal, high rise development, and data centre, are expected to result in breach of SoSS at Hobson ZSS 22kV.

OPTIONS

1. **Do Nothing**: Under this option the remaining transformers at Hobson 22kV will be overloaded under N-1 contingency condition. This option is not acceptable.
2. **Install 2nd 75MVA 110/22kV transformer:** Install a 75MVA transformer to replace the existing three winding transformer (40MVA rated at 22kV) at the ZSS therefore increase the capacity under N-1 contingency condition and remove the security constraint.

PREFERRED SOLUTION

Option 2 is the preferred option. The upgrade of the under rated transformer will increase the capacity at the ZSS to meet the load growth.

10a.8.4 QUAY ZSS SEISMIC WORKS

QUAY ZSS SEISMIC WORKS

CONSTRAINT

The proposed new load from Auckland Transport's Downtown electric ferry terminal is expected to result in breach of SoSS at Quay ZSS 22kV. It is proposed to install 3rd 110/22kV transformer to solve the security breach problem. A 110kV switchboard needs to be installed for the connection of the new transformer and the existing two transformers to the existing two 110kV circuits. The new 110kV switchboard will be installed in the existing switch building. The building was constructed in 1940s. Seismic assessment and strengthening works are required to make sure the building is adequate for the installation of the 110kV switchboard.

OPTIONS

1. **Do Nothing**: Under this option the existing building may not be adequate seismically for the installation of the new 110kV switchboard. The new switchboard could be damaged under seismic impact. This option is not acceptable.
2. **Carry out seismic works**: Carry out seismic assessment and strengthening works to make sure the building is adequate for the installation of the new 110kV switchboard.

PREFERRED SOLUTION

Option 2 is the preferred option. The works will enable proper installation and operation of the 110kV switchboard in the building.

10a.8.5 QUAY ZSS 110KV SWITCHBOARD

QUAY ZSS 110KV SWITCHBOARD

CONSTRAINT

The proposed new load from Auckland Transport's Downtown electric ferry terminal is expected to result in breach of SoSS at Quay ZSS 22kV. It is proposed to install 3rd 110/22kV transformer to solve the security breach problem. A 110kV switchboard needs to be installed for the connection of the new transformer and the existing two transformers to the existing two 110kV circuits.

OPTIONS

1. **Do Nothing**: Under this option it is unable to connect the 3rd 110/22kV transformer to the 110kV network and the capacity in the new transformer cannot be utilised to solve the security breach problem. This option is not acceptable.
2. **Install a new 110kV switchboard**: Install a new 110kV switchboard to connect the three transformers and two 110kV circuits at Quay ZSS.
3. **Install 3rd 110kV circuit**: this option is to install 3rd 110kV circuit in the existing spare ducts in Quay St for the connection of the 3rd transformer. This option requires excavation to access the cable joint bays in Quay St. Digging Quay St shortly after Auckland Transport completed the Quay St improvement project would not only cause disruption to the public traffic in the artery road but also have adverse impact to Vector's reputation.

PREFERRED SOLUTION

Option 2 is the preferred option. This option will be able to connect the 3rd transformer to the network with little adverse impact to the public traffic or Vector's reputation.

10a.8.6 QUAY ZSS 3RD 110/22KV TRANSFORMER

QUAY NEW 110KV SWITCHBOARD

CONSTRAINT

The proposed new load from Auckland Transport's Downtown electric ferry terminal is expected to result in breach of SoSS at Quay ZSS 22kV.

OPTIONS

1. **Do Nothing**: Under this option the remaining transformers at Quay 22kV will be overloaded under N-1 contingency condition. This option is not acceptable.
2. **Install 3rd 110/22kV transformer:** Install a 75MVA transformer at the ZSS therefore increase the capacity under N-1 contingency condition and remove the security constraint.

PREFERRED SOLUTION

Option 2 is the preferred option. The additional transformer will increase the capacity at the ZSS to meet the load growth.

10a.9 Roskill planning area

10a.9.1 MT EDEN LAND PURCHASE FOR ZSS

MT EDEN LAND PURCHASE FOR ZSS

CONSTRAINT

Significant residential development is being planned in the Mt Eden precinct, the area between Newton and Kingsland and centred around Mt Eden railway station, which is being redeveloped as part of the City Rail Link project. At present, the area is mainly supplied by 11 kV feeders from Newton and Kingsland zone substations. Load forecasts show that both substations are expected to breach capacity and security constraints from FY33.

OPTIONS

1. **Do Nothing:** If a zone substation in the Mt Eden area does not proceed, increasing demand in the precinct will result in deteriorating capacity and breaches of the SoSS at Newton and Kingsland ZSSs from FY33. Also, network loss would be greater owing to the Mt Eden load having to be supplied over a greater distance than if there were a ZSS in closer proximity to the Mt Eden precinct load centre.

2. **Early identification and acquisition of a zone substation location within the Mt Eden precinct:** Identify and purchase a site for the location of a future substation in the Mt Eden area at an early design stage of the development in about FY25 or FY26. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly developing area.

3. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs of a new ZSS. The rapid pace of development will reduce the number of suitable available sites on which a new zone substation could be constructed. Failing to secure a site in good time may also result in having to add new load to Newton and Kingsland zone substations, resulting in a breach of Zone substation capacity and security at the substations from FY30.

MT EDEN LAND PURCHASE FOR ZSS
PREFERRED SOLUTION
Option 2 is preferred. Securing an optimal site at an early stage of development will avoid a higher cost in a less optimal location for the new substation required from FY31.

10a.9.2 SANDRINGHAM STODDARD RD 11 KV FEEDERS NEW (KAINGA ORA DRIVEN)

SANDRINGHAM STODDARD RD 11 KV FEEDERS NEW (KAINGA ORA DRIVEN)

CONSTRAINT

As a result of Kainga Ora housing development in Mt Roskill area, a capacity and security shortfall will occur in Sandringham K18 and Avondale K06, which requires to install new feeders. Compared to AMP 2022, the RNF contribution was raised from 10% to 100% as the investment will be recovered through the growth charge.

OPTIONS

1. **Do nothing:** This option will result in breach of capacity and SoSS in feeder Sandringham K18. This option is not acceptable.
2. **Install new 11 kV feeders from Sandringham substation to Stoddard Rd.** This option will resolve the SoSS breaches in the two feeders within the Sandringham area, whilst providing a cost-efficient supply to Kainga Ora.
3. **Implement demand side management and non-wires alternative:** Due to the high growth from Kainga Ora housing development, this the load management does not provide sufficient benefit from an economic point of view (e.g. limit deferral).

PREFERRED SOLUTION

Option 2 is preferred because it is a cost-efficient solution to solve the problem of capacity and security shortfall in the existing network and provide sufficient capacity to meet the housing growth in the area for long term.

10a.9.3 CARRINGTON RD FUTURE-PROOFING DUCTS

CARRINGTON RD FUTURE-PROOFING DUCTS

CONSTRAINT

As a result of housing development on the ex-Unitec campus, the existing 11 kV feeders in the area will breach security in the long term. New feeders will be required to solve the problem. Also, new subtransmission cables will need to be installed for Mt Albert substation capacity upgrade.

OPTIONS

1. **Do nothing:** This option will result in higher cost and significant additional disruption to the public when, at later stage, new cables are required to be installed along this major road. It will also have adverse impact to Vector's reputation.
2. **Install future proofing ducts in coordination with Auckland Transports project:** This is cost efficient taking the synergy opportunity. It will also avoid the disruption to public when new cables are required to be installed at later stage.

PREFERRED SOLUTION

Option 2 is the preferred solution because it is cost efficient taking the synergy opportunity. It will also avoid the disruption to public when new cables are required to be installed at later stage.

10a.9.4 MT ALBERT ZONE SUBSTATION CAPACITY UPGRADE

MT ALBERT ZONE SUBSTATION CAPACITY UUPGRADE

CONSTRAINT

Capacity and security breaches are forecast at the ZSS from 2030. This is a single transformer ZSS. The capacity is restricted by the existing 22kV subtransmission circuit.

OPTIONS

1. **Do nothing:** This option will result in overloading in the existing subtransmission circuit and customers losing supply upon contingency conditions. This option is not acceptable.
2. **Upgrade ZSS capacity:** This option is to install 2nd transformer and subtransmission circuit therefore increase the capacity at the ZSS.

PREFERRED SOLUTION

Option 2 is the preferred solution to increase the capacity and remove the constraint at the ZSS.

10a.9.5 MT EDEN ZONE SUBSTATION NEW

MT EDEN ZONE SUBSTATION NEW

CONSTRAINT

Significant residential development is being planned in the Mt Eden precinct, the area between Newton and Kingsland and centred around Mt Eden railway station, which is being redeveloped as part of the City Rail Link project. At present, the area is mainly supplied by 11 kV feeders from Newton and Kingsland zone substations. Load forecasts show that both substations are expected to breach capacity and security constraints from FY33.

OPTIONS

1. **Do nothing:** This option will result in overloading at Newton ZSS and Kingsland ZSS, and customers losing supply upon contingency conditions. This option is not acceptable.
2. **Establish Mt Eden new ZSS**: This option is to construct a new ZSS by the installation of new transformers, switchgear, subtransmission circuits, and 11kV feeders. Land will be purchased earlier for the new ZSS.
3. **Upgrade Newton ZSS capacity:** This option is to install 3rd transformer and subtransmission circuit therefore increase the capacity at the ZSS. This option is difficult in feasibility due to the space constraint at Newton ZSS and the subtransmission cable installation required in CBD and across motorway bridge.
4. **Upgrade Kingsland ZSS capacity**: This option is to install 3rd 22/11kV transformer therefore increase the capacity at the ZSS. This option is difficult in feasibility due to the space constraint at Kingsland ZSS and the large number of distribution cable installation in major road to reach load centre.

PREFERRED SOLUTION

Option 2 is preferred because it is a cost efficient solution to supply the new developments at Mt Eden Precinct for long term. This option will also off load the existing Newton ZSS and Kingsland ZSS.

10a.9.6 MT ALBERT NEW 11KV FEEDERS FOR CAPACITY AND SECURITY IN MALB K16 (WAIRAKA HOUSING)

MT ALBERT NEW 11KV FEEDERS FOR CAPACITY AND SECURITY IN MALB K16 (WAIRAKA HOUSING)

CONSTRAINT

As a result of housing development on the ex-Unitec campus, the existing 11 kV feeder MALB K16 will breach security from FY31.

OPTIONS

1. **Do nothing:** This option will result in customers losing supply upon contingency conditions. This option is not acceptable.
2. **Install new feeders**: This option is to install new 11kV feeder connecting to the existing 11kV network therefore off load the existing feeder MALB K16.
3. **Implement demand side management and non-wires alternative:** This option is expected to have little benefit from an economic and network improvement point of view, due to the high growth rate from the housing development

PREFERRED SOLUTION

Option 2 is preferred because it is a cost efficient solution to solve the security breach problem in the existing feeder MALB K16.

10a.10 Penrose planning area

10a.10.1 SOUTHDOWN LAND PURCHASE FOR ZSS

LAND PURCHASE AND DESIGNATION FOR SOUTHDOWN NEW SUBSTATION

CONSTRAINT

As a result of industrial load growth in south of Penrose area, the existing substations Te Papapa and Westfield are forecast to breach SoSS from 2035.

OPTIONS

1. **Do Nothing:** Doing nothing will result in breach of SoSS at Te Papapa and Westfield substations from 2035. This option is not acceptable.
2. **Add new transformers at Te Papapa and Westfield substation:** This option is expected to be more expensive than a new substation at Southdown as the cable routes would be longer.
3. **Early acquisition of a zone substation land at Southdown site:** Identify and purchase a site for a future substation at Southdown site at an early design stage of the development in about FY24. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.

LAND PURCHASE AND DESIGNATION FOR SOUTHDOWN NEW SUBSTATION

4. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.

PREFERRED SOLUTION

The preferred option is Option 3 to secure a future zone substation site. As a prudent network manager, Vector needs to identify and secure suitable future zone substation sites to ensure Vector can supply future developments cost effectively and reliably

10a.10.2 TAMAKI LAND PURCHASE FOR ZSS

TAMAKI LAND PURCHASE FOR ZSS

CONSTRAINT

Tāmaki Regeneration is a 30-year housing intensification project being undertaken by Kāinga Ora in Tāmaki area. The area is mainly supplied by 11 kV feeders from St Johns, Mt Wellington, Glen Innes, St Heliers and Orakei zone substations. St Johns, St Heliers and Orakei substations are supplied from a 33 kV switching station served as bulk supply point (BSP) within St Johns substation site. The BSP is supplied by three 33 kV circuits from Penrose GXP. Long-term load forecasts show that planned development in Tāmaki will cause demand on St Johns 33 kV BSP to breach SoSS from FY32.

OPTIONS

1. **Do Nothing:** Doing nothing will result in a new 11 kV load in Tāmaki being connected to the existing St Johns ZSS distribution network. This will result in breaches of SoSS requirement at St Johns zone substation on the 33 kV assets from FY32. Failure to secure an optimal site at the design stage of the development will result in a higher cost to establish the new substation in future.
2. **Add new 11 kV feeders to Glen Innes zone substation:** Adding new feeders to Glen Innes ZSS will reduce the short-term impact on St Johns ZSS, but it is expected to be more expensive than from St Johns ZSS due to the longer cable route lengths involved.
3. **Early identification and acquisition of a zone substation location within the Tāmaki Regeneration area:** Identify and purchase a site for the location of a future substation in the Tāmaki Regeneration area at an early design stage of the development in about FY24. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.
4. **Defer acquisition of zone substation location:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.

PREFERRED SOLUTION

The preferred option is Option 3. Identification and acquisition of land for a new substation in Tāmaki area around FY24. Securing an optimal site at the design stage of the development will avoid a higher cost to establish the new substation forecast to be required from FY32.

10a.10.3 ST JOHNS APIRANA AV 11KV FEEDERS NEW (KO DRIVEN)

ST JOHNS APIRANA AV 11KV FEEDERS NEW (KO DRIVEN)

CONSTRAINT

As a result of Kainga Ora housing development, the existing 11kV feeders GINN K06 and GINN K09 are forecast to breach SoSS from 2031.

OPTIONS

1. **Do Nothing:** This option will result in customers losing supply upon contingency conditions. This option is not acceptable.
2. **Install two new 11 kV feeders from St Johns substation to Apirana Av:** connect the new feeders to the existing 11 kV network and rearrange the feeders in the area. This option will off load the heavily loaded feeders and solve the problem of security breach.
3. **Install new 11kV feeders from Glen Innes ZSS**: this option requires to install lengthy cables to reach load centre.
4. **Implement demand side management and non-wires alternative:** This option is expected to have little benefit from an economic and network improvement point of view, due to the high growth rate from Kainga Ora's housing development.

PREFERRED SOLUTION

Option 2 is preferred because it is a cost efficient solution to solve the problem of security breach in feeders GINNK06 and GINN K09.

10a.10.4 TE PAPAPA NEW 11KV FEEDERS TO OFF LOAD ROCK K10

TE PAPAPA NEW 11KV FEEDERS TO OFF LOAD ROCK K10

CONSTRAINT

As a result of load growth in the industrial / commercial area, feeder ROCK K10 is forecast to breach security from 2030.

OPTIONS

1. **Do Nothing:** This option will result in customers losing supply upon contingency conditions. This option is not acceptable.
2. **Install new 11 kV feeders from Te Papapa ZSS:** connect the new feeders to the existing 11 kV network and rearrange the feeders in the area. This option will off load the ROCK K10 and solve the problem of security breach.
3. **Install new 11kV feeders from Rockfield ZSS**: this option requires to install lengthy cables to reach load centre.
4. **Implement demand side management and non-wires alternative:** This option is expected to have little benefit from an economic and network improvement point of view, due to the industrial / commercial load profile.

PREFERRED SOLUTION

Option 2 is preferred because it is a cost efficient solution to solve the problem of security breach in the feeder ROCK K10.

10a.10.5 SOUTHDOWN ON SITE FUTURE PROOFING DUCTS

SOUTHDOWN ON SITE FUTURE PROOFING DUCTS

CONSTRAINT

Vector has 15 zone substations taking supply from Penrose 33kV GXP. It has been identified to be a risk of common mode failure due to the concentration of large number of ZSSs and magnitude of load. It is proposed to establish a new GXP at Southdown (by Transpower) and divert the load from Penrose GXP to Southdown GXP when the subtransmission cables at Vector's ZSSs in the area are due for replacement. Vector is also to purchase a land to build a new ZSS to off load the existing ZSSs in the area in longer term. Subtransmission and distribution cables will be required to be installed from the GXP site.

OPTIONS

1. **Do Nothing:** Doing nothing will lose the synergy opportunity to install future proofing ducts. It will be costly and disruptive to excavate and install the cables at later stage.
2. **Install future proofing ducts:** This option is to install future proofing ducts at the new GXP site taking advantage of the synergies from the site works.

PREFERRED SOLUTION

Option 2 is preferred because it is a cost efficient solution to install cables when required at later stage.

10a.11 Pakuranga planning area

There are no forecast growth or security related projects identified for the Pakuranga planning area that exceed $1m starting within the next five year period or are not already in formal delivery.

10a.12 Mangere planning area

10a.12.1 MANGERE SOUTH LAND PURCHASE FOR ZSS

MANGERE SOUTH LAND PURCHASE FOR ZSS

CONSTRAINT

Expansion of the Watercare wastewater treatment plant at Mangere, along with commercial and residential developments around the airport and Mangere area will result in Mangere Central substation breaching SoSS in 2032.

OPTIONS

1. **Do Nothing:** Failure to secure a site for Mangere South ZSS in good time will jeopardise Vector' s ability to secure a suitable site at a reasonable price and may delay the construction of the ZSS beyond FY29. Consequently, customers supplied from Mangere Central ZSS will increasingly suffer from supply reliability issues and possible equipment failure from FY32.
2. **Defer acquisition of land and build of zone substation:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.
3. **Early identification and acquisition of a zone substation location within the southern Mangere area:** Identify and acquire a suitable site for the location of a future Mangere South zone substation in reasonable proximity to forecast load growth centres.

MANGERE SOUTH LAND PURCHASE FOR ZSS

Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.

PREFERRED SOLUTION

The preferred option is Option 3. It is prudent to identify and acquire a suitable ZSS site close to future load centres before suitable sites become unavailable to Vector.

10a.12.2 MANGERE SOUTH ZONE SUBSTATION NEW

MANGERE SOUTH ZONE SUBSTATION NEW

CONSTRAINT

Expansion of the Watercare wastewater treatment plant at Mangere, along with commercial and residential developments around the airport and Mangere area will result in Mangere Central substation breaching SoSS in 2032.

OPTIONS

1. **Do Nothing:** Existing feeders from Mangere Central and Mangere West substations will become overloaded. Customers supplied from Mangere Central ZSS will increasingly suffer from supply reliability issues and possible equipment failure from FY32.
2. **Build a new zone substation:** Build a new zone substation on the acquired land. This will provide the required capacity and alleviate constraint at Mangere Central.
3. **Install new 11 kV feeders from alternative ZSS:** There will not be any spare circuit breakers available at the neighbouring ZSS (Mangere West, Mangere Central) by 2032. Additionally, this option would be expensive owing to the long cable route lengths to the development area. Planning reviews have also identified this option would be a temporary short-term solution due to the scale of the growth.

PREFERRED SOLUTION

Option 2 is preferred. Building a new Mangere South zone substation will relieve the emerging feeder capacity and SoSS constraints at Mangere Central.

10a.12.3 MANGERE CENTRAL ROBERTSON RD 11 KV FEEDER NEW

MANGERE CENTRAL ROBERTSON RD 11 KV FEEDER NEW

CONSTRAINT

Increasing residential development by Kainga Ora in Favona area will lead to a feeder, Mangere Ease K16 exceeding capacity in 2026.

OPTIONS

1. **Do nothing:** Accept one feeder at full capacity in 2026 and insufficient capacity for new developments in the area.
2. **Install new feeder:** This option will relieve load on Mangere East K16 and will add capacity to the area for Kainga Ora development.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option. This option addresses the feeder constraint and provides additional capacity to the high growth area.

10a.12.4 MANGERE CENTRAL IDLEWILD AVE 11 KV FEEDER NEW

MANGERE CENTRAL IDELWILD AVE 11 KV FEEDER NEW

CONSTRAINT

Increasing residential development by Kainga Ora in Mangere Bridge area will lead to a feeder Mangere Central K05 exceeding capacity in 2028 and another feeder Mangere Central K11 having a backstop shortfall in 2027.

OPTIONS

1. **Do nothing:** Accept one feeder at full capacity and breaching backstopping in 2027 and insufficient capacity for new developments in the area.
2. **Install new feeder:** This option will add capacity to the area for Kainga Ora development. It will relieve load on Mangere Central K05 and provide backstopping capacity to Mangere Central K11.

3. **Implement demand side management and non-wires alternative:** This area has a large residential component and implementation of non-wires alternative will be considered and subject to technology development, customer adoption and regulatory settings.

PREFERRED SOLUTION

Option 2 is the preferred option. This option addresses the feeder constraint and provides additional capacity to the high growth area.

10a.12.5 MANGERE EAST PUHINUI ROAD 11 KV FEEDER NEW

MANGERE EAST PUHINUI ROAD 11KV FEEDER NEW

CONSTRAINT

Increasing residential and commercial development by in the Mangere East and Wiri area will lead to two feeders, Mangere East K11 and K19 exceeding capacity in 2027 and 2032.

OPTIONS

1. **Do nothing:** Accept both feeders at full capacity and breaching backstopping in 2027 and insufficient capacity for new developments in the area.
2. **Install new feeder:** This option will add capacity to the area and relieve load on Mangere East K11 and K19.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option. This option addresses the feeder constraints and provides additional capacity to the high growth area.

10a.12.6 MANGERE EAST THIRD TRANSFORMER AND 33KV CABLE

MANGERE EAST THIRD TRANSFORMER AND 33KV CABLE

CONSTRAINT

Load growth in the Mangere area will result in a shortfall in transformer capacity at Mangere East ZSS, especially following an outage at Hans ZSS.

OPTIONS

1. **Do nothing:** The existing transformers will become overloaded. Customers supplied from these transformers will increasingly suffer from reliability issues and possible equipment failure. This is not acceptable.
2. **Install a third transformer and 33kV cable at Mangere East ZSS:** This meets the long-term requirement of load growth and increases security of supply into Mangere East and surrounding areas.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option due to growth and capacity constraints in the area.

10a.13 Takanini planning area

10a.13.1 MANUREWA ALFRISTON RD 11 KV FEEDER NEW

MANUREWA ALFRISTON RD 11 KV FEEDER NEW

CONSTRAINT

As a result of organic growth, two feeders in the area will be constrained. The Manurewa K12 feeder will reach capacity in 2028 and have a backstop shortfall in 2030. The Manurewa K07 feeder will reach capacity in 2027 and have a backstop shortfall in 2035.

OPTIONS

1. **Do nothing:** Accept the feeder reaching full capacity and breaching backstopping in 2027. Supply to customers will become increasingly unreliable.

MANUREWA ALFRISTON RD 11 KV FEEDER NEW

2. **Install a new 11 kV feeder:** Install a new feeder to relieve the load on Manurewa K07 and K12 feeders and provide additional capacity from the new feeder during contingency situations.
3. **Implement demand side management and non-wires alternative:** This area has a large residential component and implementation of non-wires alternative will be considered and subject to technology development, customer adoption and regulatory settings.

PREFERRED SOLUTION

Option 2 is the preferred option. This option will increase capacity and security to the area and is the most cost-efficient solution to meet the load growth in the area.

10a.13.2 MANUREWA K14 FEEDER REINFORCEMENT

MANUREWA K14 FEEDER REINFORCEMENT

CONSTRAINT

Manurewa K14 will breach security of supply in 2025.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and thereby risking the loss of customer supplies increasing unreliability. This will result in non-compliance with the SoSS.
2. **Reinforce the 11kV network:** Install 11kV cable to eliminate an underground spur and add backstopping to Manurewa K14.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option as it provides improved network resilience and customer reliability of supply.

10a.13.3 MARAETAI K01 FEEDER REINFORCEMENT

MARAETAI K01 FEEDER REINFORCEMENT

CONSTRAINT

As a result of organic growth, Maraetai K01 and K04 will breach security in 2025.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and thereby risking the loss of customer supplies increasing unreliability. This will result in non-compliance with the SoSS.
2. **Reinforce the 11kV network:** Install 11kV cable to increase backstopping on both feeders.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option as it will resolve the backstop shortfall on both feeders and provides improved network resilience and customer reliability of supply.

10a.13.4 MARAETAI SUBTRANSMISSION REINFORCEMENT

MARAETAI SUBTRANSMISSION REINFORCEMENT

CONSTRAINT

Maraetai subtransmission circuits supply three zone substations (Maraetai, Waiheke and Clevedon). Load growth at these substations is expected to double in the next 10 years. This includes organic growth at Maraetai and Waiheke, addition of E-Ferry, a large point load customer and a large greenfield development in the Beachlands. The increasing demand is forecasted to result in SoSS breach in 2026/27.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies increasing unreliability. This will result in non-compliance with the SoSS.
2. **Reinforce the sub-transmission network:** Replace sections of the two 33 kV sub-transmission circuits which are underrated with higher capacity cables.

MARAETAI SUBTRANSMISSION REINFORCEMENT

3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option as increase capacity to the area and provides improved network resilience and customer reliability of supply.

10a.13.5 TAKANINI ZONE SUBSTATION CAPACITY UPGRADE

TAKANINI ZONE SUBSTATION CAPACITY UPGRADE

CONSTRAINT

Expansion of large commercial customers along with new commercial and residential development around Takanini area will result in Takanini zone substation exceeding capacity in 2026.

OPTIONS

1. **Do nothing:** accept Papakura zone substation at full capacity and supply to customers will become increasingly unreliable.
2. **Install a third transformer and sub-transmission cable:** a third transformer will add capacity to the zone substation and allow for future commercial and residential developments in the area. There is space to install a third transformer on site.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is preferred due to the rapid growth and capacity constraint in the area.

10a.13.6 TAKANINI SOUTH LAND PURCHASE FOR ZSS

TAKANINI SOUTH LAND PURCHASE FOR ZSS

CONSTRAINT

Expansion of large commercial customers along with residential development will result in Papakura substation breaching SoSS in 2035.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies increasing unreliability. This will result in non-compliance with the SoSS.
2. **Defer acquisition of land and build of zone substation:** Defer site acquisition until shortly before the location must be locked in to allow final detailed designs for the new ZSS. The rapid pace of redevelopment will reduce the number of suitable available sites on which a new zone substation could be constructed and therefore increase the cost of acquisition.
3. **Early identification and acquisition of a zone substation location within the southern Takanini/Papakura area:** Identify and acquire a suitable site for the location of a future Takanini South zone substation in reasonable proximity to forecast load growth centres. Early action will avoid having to resort to a less optimal location later and will avoid having to compete and possibly pay a premium for space within an area already rapidly growing development.

PREFERRED SOLUTION

The preferred option is Option 3. It is prudent to identify and acquire a suitable ZSS site close to future load centres before suitable sites become unavailable to Vector.

10a.13.7 WAIHEKE T1 AND T2 UPGRADE

WAIHEKE T1 AND T2 UPGRADE

CONSTRAINT

Load growth in Waiheke island will result in a breach in security of supply at Waiheke ZSS in 2028.

OPTIONS

1. **Do Nothing:** Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies increasing unreliability. This will result in non-compliance with the SoSS.
2. **Replace the Waiheke ZSS transformers with larger units:** This addresses the security of supply at a lower cost than option 2.

WAIHEKE T1 AND T2 UPGRADE

3. **Implement demand side management and non-wires alternative:** This area has a large residential component and implementation of a non-wires alternative will be considered and subject to technology development, customer adoption and regulatory settings.

PREFERRED SOLUTION

Option 2 is the preferred option as the more cost-effective solution.

10a.13.8 WAIHEKE 33KV 3RD SUBTRANSMISSION CABLE NEW

WAIHEKE 33KV 3RD SUBTRANSMISSION CABLE NEW

CONSTRAINT

Waiheke island is supplied by two 33kV submarine sub transmission cables originating from Maraetai ZSS on the mainland. Under normal circumstances, the two cables provide the required N-1 security of supply; but in the event of the failure of one of the cables, the supply to the island is reliant on the remaining circuit while the fault is repaired. The cables are also laid near each other, so they are at risk of common mode failure due to, for example local seismic activity or mechanical damage by dragging ship's anchor.

Being submarine cables, the time taken to identify the location of a fault, lift the faulted section onto a ship, repair the fault and recommission the cable can be quite long and is dependent on several factors that are exclusive to submarine cables. The supply to the island will be reliant on a single cable for the time it takes to repair the failed cable.

OPTIONS

1. **Do Nothing:** Accept that supply to the island is at risk of two cable failures occurring in quick succession. Accept that multiple risks exist due to common mode failures, age related failure risk, and long require times due to nature of repairing submarine cables.
2. **Install of diesel generators on Waiheke Island:** High capital and operation cost would be disproportionate to the contingent back-up nature of the application. Transport and storage of enough fuel is costly and creates an unacceptable environmental risk.
3. **Install a third 33kV submarine cable to Waiheke Island:** A third fully raked 33kV sub transmission cable would provide N-2 security of supply so that up to two of the tree cables could fail without compromising customer supplies. This new cable would be spatially separated from the existing two cables and installed with mechanical protection.

PREFERRED SOLUTION

Option 3 is the preferred option. It would increase the security of the supply to Waiheke Island and improve its resilience to common-mode failures and coincident faults.

10a.14 Otahuhu planning area

10a.14.1 OTARA CHAPEL HEIGHTS 11KV FEEDER NEW

OTARA CHAPEL HEIGHTS 11KV FEEDER NEW

CONSTRAINT

As a result of organic growth, Otara K01 will reach capacity in 2026 and have a backstop shortfall in 2031.

OPTIONS

1. **Do Nothing:** Accept the feeder reaching full capacity and breaching backstopping in 2026. Supply to customers will become increasingly unreliable.
2. **Install a new 11kV feeder:** Install a new 11kV feeder to relieve the load on Otara K01 and provide additional capacity from the new feeder during contingency situations.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option as it will increase capacity and security to the area.

10a.15 Wiri planning area

10a.15.1 CLENDON WEYMOUTH RD 11KV FEEDER NEW

CLENDON WEYMOUTH RD 11KV FEEDER NEW

CONSTRAINT

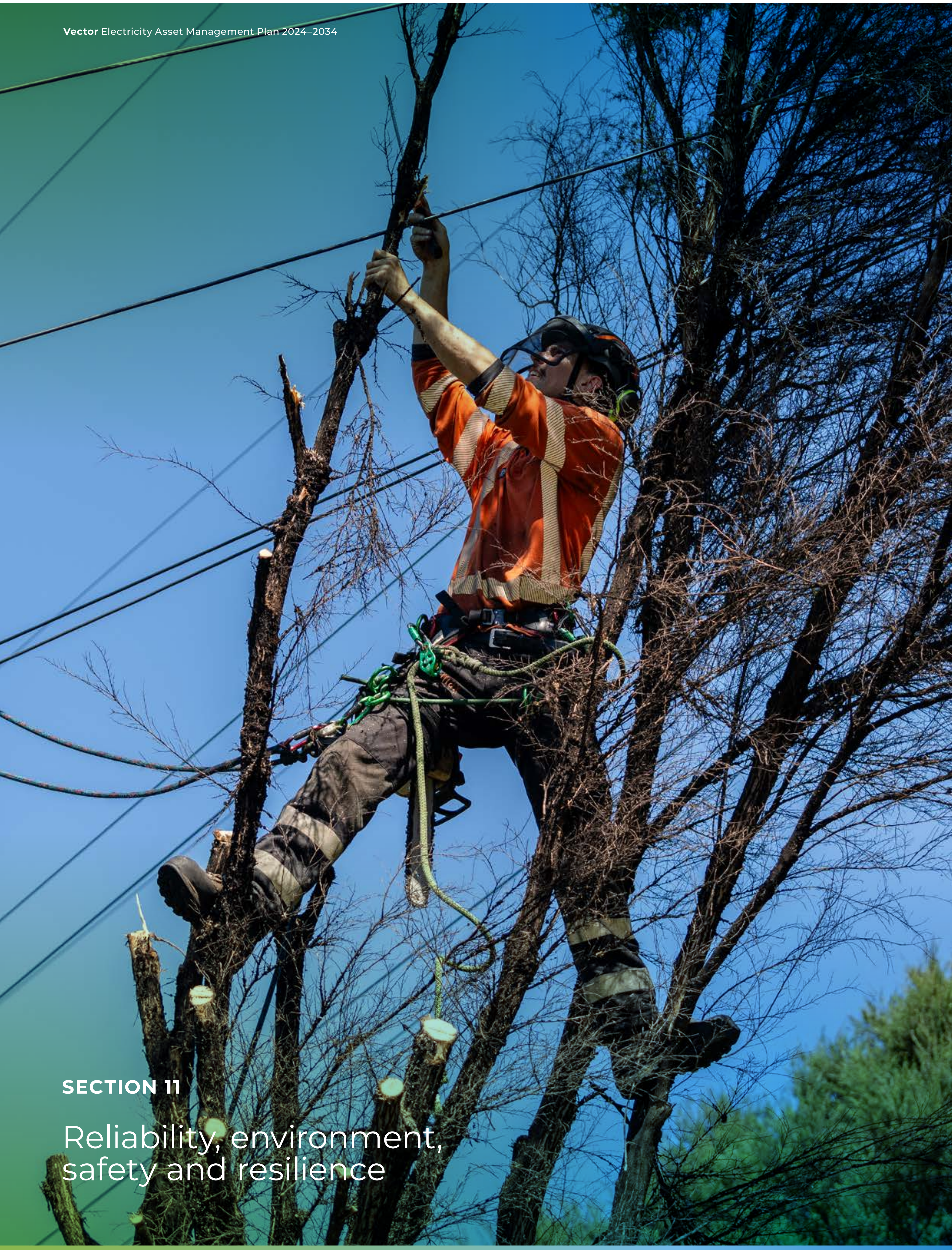
As a result of organic growth, Manurewa ZSS exceeds transformer capacity in 2028.

OPTIONS

1. **Do Nothing:** Accept Manurewa ZSS reaching full capacity in 2028. Supply to customers will become increasingly unreliable.
2. **Install a new 11kV feeder from Clendon ZSS:** Install a new 11kV feeder from Clendon ZSS to relieve the load on Manurewa ZSS and provide additional capacity to this area during contingency situations.
3. **Implement demand side management and non-wires alternatives:** This area has a large residential component and implementation of non-network option such as smart hot water has been considered. The reduction in demand from controllable loads will not deliver a sufficient deferred project cost.

PREFERRED SOLUTION

Option 2 is the preferred option as it will increase capacity to the area and offload Manurewa ZSS.



SECTION 11

Reliability, environment, safety and resilience

11 – Reliability, Environment, Safety and Resilience

11.1 Overview

Our customers are relying more and more on access to affordable and reliably energy to live their day-to-day lives. Network reliability and resilience are becoming increasingly important as customers increase their reliance on electricity for their day-to-day needs (communication, connectivity, working from home, electrification of transport etc). Network security is managed through several investment portfolios. This Section sets out the investment in both asset replacement and asset reinforcement categories with a specific focus on projects for the improvement and bolstering of network reliability and resilience, including managing the impacts of climate change as well as reducing our asset management carbon footprint.

11.2 Asset management objectives

The asset management objectives that are addressed through our network reliability and resilience investments are set out in the table below:

FOCUS AREA	OBJECTIVES
Safety, Environment and Network Security	• Comply with relevant safety and environmental legislation, regulation and planning requirements. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).
Customers and Stakeholders	• Enable customers' future energy and technology choices. • Ensure the long-term interest of our customers by providing an affordable and equitable network.
Network Performance & Operations	• Utilise clear business case processes, integrate risk management and complete post investment reviews to inform our decision making and analysis. • Maintain compliance with Security of Supply Standards through risk identification and mitigation. • Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. • Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings.
Future Energy Network	• Prepare the network for future changes that will be driven by: – technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc. – environment: climate disruption and network resilience. – customer: decarbonisation of the economy, electrification of transport, etc. – operations: transition to distribution system operator model and whole-of-system planning. • Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third party flex traders and retailers. • Facilitate customer adoption of new technology while ensuring a resilient and efficient network. • Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network. • Develop digital and data platforms to meet changing customer needs and enable the future network in partnership with new entrants to the energy market. • Improve our visibility of, and ability to control, the LV network including management of the information required. • Collaborate with the industry, partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions.

TABLE 11.1: ALIGNMENT WITH ASSET MANAGEMENT OBJECTIVES

11.3 Network reliability

11.3.1 STRATEGIC RELIABILITY MANAGEMENT PLAN (SRMP)

Over recent years we have accelerated specific programmes of work that reflect our commitment to quality compliance and the outcomes customers experience through the regulatory quality compliance framework. The Strategic Reliability Management Plan (SRMP) specifies how we will ensure compliance with quality standards and sustain this performance in future years, while not compromising health and safety outcomes, to meet the expectations of our customers and other stakeholders.

The reliability objectives and reliability strategies within the SRMP are a subset of Vector's broader set of asset management objectives and are governed by the Strategic Reliability Management (SRM) group. The SRMP builds upon the actions taken as part of our response to our reliability performance from RY2016-22, with a heightened focus on initiatives aimed at reducing the length of outages, which has been identified as Vector's key reliability challenge, as well as reducing the number of customers impacted by events. There is an annual review process for the SRMP at the end of regulatory years which assesses all components of unplanned SAIFI and SAIDI performance including contribution by cause and the effectiveness of the initiatives during that year. Following that review process the SRMP is revised and some of the initiatives are embedded into business-as-usual practice while other new initiatives aligned to the reliability strategies are developed for the upcoming year and provided for in the expenditure profile.

We returned to quality compliance in both RY21 and RY22 however the extreme weather events of January and February 2023 resulted in SAIDI breach in RY23. As of end of January 2024, unplanned SAIDI and SAIFI is on track to once again be compliant for RY24 pending any periods of sustained adverse weather conditions. The SRMP and associated reliability management targets a margin below the regulatory limit to allow for the variability in network operating conditions from year to year.

In this section, we describe the ongoing strategies, investment and initiatives underpinning our Strategic Reliability Management Plan.

11.3.2 SRMP GOVERNANCE AND MONITORING OF RELIABILITY PERFORMANCE.

The SRM meeting is held fortnightly and comprises the following actions and objectives;

- Discuss outage events of note for the preceding two weeks to determine operational learnings and any emerging trends affecting reliability performance and customer experience
- Monitor status of most significant HV constraints, subtransmission security of supply risks and Transpower planned outages with potential to impact customers to ensure contingency plans are in place, so any identified risks can be mitigated
- Tracking of reliability performance for year-to-date, including by cause, to monitor progress against year-end internal targets and need to accelerate actions if required
- Monitoring of the SRMP and associated initiatives to ensure actions are completed on time and within allocated budget

11.4 Specific SRMP Initiatives

11.4.1 RISK BASED VEGETATION MANAGEMENT

Vegetation strikes and damage, transient or sustained, are one of the most common causes of outages on Vector's network and with the change in climate this is becoming more prevalent. To manage the impact of vegetation, Vector utilises a risk-based approach to plan and then carry out remediation work. This involves an independent company to scope, plan and package the work using the risk-based approach and also carry out audits of work undertaken, in conjunction with Vector's in house expertise, to ensure work has been undertaken correctly. To deliver this work Vector engages two vegetation management businesses, along with others when required, to ensure that this targeted approach and the volumes of work can be achieved each year.

In 2021 a targeted rate for vegetation was implemented by the Auckland Council on Vector and to fund enhanced maintenance of Auckland Council-owned trees that present a risk to Vector's electricity network. Now that this programme has been in place for over three years, there is a review being undertaken into Vector's vegetation strategy and business rules to increase efficiencies with the Council programme while maintaining the risk-based approach.

Vector continues to advocate for changes to Tree Regulations which have a direct influence on the efficacy of our vegetation management practices and therefore vegetation related outages. This is discussed further in sections 8 and 11 of this AMP.

Under the Resource Management Act, the new National Policy Statement on Indigenous Biodiversity means we have a limited timeframe of just six months to cut back any trees to ensure we preserve and protect the habitats of native and protected animals. The focus for FY24 will be to find the right approach, so that we can meet this requirement while ensuring our vegetation management programme is effective in deliver better outcomes for customers, given the challenges of planning around suitable weather conditions, the availability of specialist crews and other maintenance activities.

11.4.2 DEPLOYMENT OF NETWORK AUTOMATION

Vector's SRMP strategy includes a programme to continue the deployment of automation and sectionalisation on the network. This programme provides for the automation for remote control of existing 11 kV switches and the rollout of new automated switches for remote control on 11 kV feeders over ten years. The programme was accelerated with the first six years of the deployment completed in 2021. The programme of automation is continuing. Further details on the nature of this initiative are provided further below.

Also included in this initiative is the development of a network automation integration strategy roadmap which will determine the use and further deployment of equipment such as Fault Passage Indicators (FPI) and Distance to Fault Technology (DTF) on the network to assist fault restoration. We are also implementing the use of smart meter technology to automatically detect and report on network outages.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
FPI Installation	0.00	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	3.22
Auckland Network Isolation and Automation	0.52	1.73	1.81	1.64	1.64	1.47	1.47	1.47	1.47	1.47	14.67
Northern Network Isolation and Automation	0.86	2.46	2.37	2.55	2.55	2.72	2.72	2.72	2.72	2.72	24.38
Total	**1.38**	**4.55**	**4.54**	**4.55**	**4.55**	**4.55**	**4.55**	**4.55**	**4.55**	**4.55**	**42.27**

TABLE 11.2: FORECAST EXPENDITURE FPI INSTALLATION

11.4.3 DISTRIBUTION SPUR FEEDER REINFORCEMENT

Vector has identified a number of spur feeders in our distribution network. These feeders do not have the ability to back-feed past the faulted position on the line. This can result in the longer than usual outage times and a degraded customer experience to those affected. Vector Is progressively addressing these issues by connecting them with other parts of the network. Some examples of feeders that are in delivery or planned within this AMP period are provided below:

- Piha to Henderson Valley feeder
- Puhoi (connecting Kaipara Flats and Waiwera feeders)
- Ti Point (connecting Whangateau and Tawharanui feeders)
- Cowan Bay (connecting two spurs on the Satellite feeder)
- Bethells to Swanson feeder network

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Distribution Spur Links	5.1	3.0	3.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	44.9

TABLE 11.3: FORECAST EXPENDITURE DISTRIBUTION SPUR LINKS

11.4.4 CUSTOMER EXPERIENCE IMPROVEMENTS

Through the SRMP, Vector has identified a number of projects that will enhance customer experience within communities at the edge of our network by improving power quality or reducing post fault network restoration times. Examples of these projects planned or in delivery within this AMP period are list below:

- Muriwai to Waimakau feeder upgrade: The installation of two new voltage regulators on these feeders will improve voltage issues
- Laingholm K038 feeder: Installation of additional remote switch to improve restoration times
- Kawau Island: Installation of additional FPIs to improve restoration times

11.4.5 WAIHEKE ISLAND SUBTRANSMISSION SUPPLY RELIABILITY

The sub-transmission cables to Waiheke Island provide N-1 security, but any damage to the undersea portion of these circuits takes considerable time to repair, leaving the supply to the island dependent on a single circuit and without any backup at distribution level or any significant embedded generation. The two existing submarine cable circuits are located adjacent to each other and do not have mechanical protection. Recent anchor strikes have identified that the risk of outages is higher than thought and needs to be mitigated. To improve resilience and reliability, and to ensure compliance with security of supply standards (SoSS), Vector proposes to install a third sub-transmission cable. The new cable will be spatially separated from the existing cables and include mechanical protection to improve resilience to anchor strikes.

This project was provided for in AMP23 under the System Growth capital expenditure category. A review of expenditure under this category concluded that this project was more closely aligned to the Reliability, Safety and Environmental investment and has subsequently been re-categorised in this AMP.

11.4.6 FSP ENABLEMENT TO REDUCE THE DURATION TIME OF OUTAGES

Analysis undertaken as part of the SRMP identified that one of the primary issues faced by Vector was the response and restoration time for addressing network faults. Initiatives that were kicked off in RY20 to address this, are continuing and includes:

- An incentive scheme has been established for our FSPs concerning the average outage duration (CAIDI) performance for unplanned outages;
- A new sub-depot has been established at Warkworth in close proximity to the vast Northern overhead network to reduce the distances and times to reach fault locations;
- Additional fault passage indicators have been deployed in the network to enable quicker identification of the location of faults;
- Dispersed deployment of field service crews around the network (rather than located in main depots) to speed up response to faults; and
- Providing additional training and tools to field service crews to enable them to respond immediately to a greater variety of faults without requiring a second crew to arrive for assistance.
- The benefits of these initiatives continue to be observed and are reviewed annually as part of the SRMP.

11.4.7 CORRECTIVE MAINTENANCE STRATEGY AND IMPROVED INSPECTION TECHNIQUES

To accelerate the delivery of corrective work to reduce high priority condition notifications, with prioritization on SAIDI critical sections which reduces the overall SAIDI risk profile of the network, resources to specifically focus on this strategy were increased since RY21. This strategy includes improved inspections techniques in the field, improved recording of network faults via software on tablets by crews in the field and, an improvement in data quality through SAP PM. This strategy also includes a program of works using LiDAR inspection techniques that focuses on the identification and correction of clearances between overhead lines to ground, structures, buildings, waterways, etc. to ensure compliance with statutory requirements, more specifically NZECP34 [32] and reduce the risk of harm to the public.

Furthermore, thermographic, acoustic surveys and aerial surveys (UAV) are highly effective technologies to identify certain asset failure modes and are an on-going part of Vector's routine inspections and monitoring strategies for the overhead network and other asset classes going forward. These programmes are crucial to identify latent and inherent faults early and the associated corrective work enables Vector to proactively correct such latent and inherent faults in the network. Thermographic and acoustic inspections are embedded as business-as-usual corrective practices.

11.4.8 MICROGRIDS – GENERATORS AND ENERGY STORAGE

Microgrids are small, self-sustaining local power systems that provide valuable benefits to the communities they serve. Traditionally, outages have been managed by enhancing interconnectivity and backstopping but this is not economical or practicable in certain remote areas on the edge of the distribution network. Microgrids are small self-sustaining local energy grids that serve a relatively small geographic footprint with their own interconnected resources such as generators or energy storage devices and have the capability to island from the broader distribution network. They can include the use of mobile generation to mitigate the impact of increased planned work on the customer experience, fixed generation as a contingency plan to manage SAIDI on long rural feeders where other options to improve network resilience are not economically viable or, can be large scale batteries colloquially known as BESS systems (battery energy storage systems). Microgrids, where economically feasible, are a helpful solution for assisting remote communities against the impact of climate change.

11.5 Ongoing reliability investments

11.5.1 APPLY SAFETY IN DESIGN

Vector has made Safety in Design (SiD) a mandatory requirement for Vector design and capital projects and SiD is embedded in the review process for the design of capital projects. For this purpose, Vector has developed a formal SiD standard, USH002 Networks Safety in Design, which sets out the minimum requirements to establish safety in design as early as possible in the design and throughout the life cycle of the asset.

This requires all parties to consult, co-operate and co-ordinate to eliminate or otherwise minimise risks in the design to prevent harm throughout the life of the asset being designed, as far as reasonably practicable. Safety in Design is a practice that integrates risk-management techniques into the design process early, to identify, assess and treat health and safety risks to people over the life of the asset being built. The transmission and distribution of high and low voltage electricity involve managing significant electrical hazards, and the Health and Safety at Work Act (HSWA) 2015 now places greater accountability on designers to achieve safe outcomes for the works they design.

Safety in Design means that the integration of control measures early in the design process eliminates, or, if this is not reasonably practicable, minimises the risks to health and safety throughout the life of the structure being designed. Safety in design applies to any plant, substance or structure that is constructed, whether fixed or movable. SiD will evolve to consider the impact of climate change to a much larger degree than in the past.

11.5.2 OVERHEAD REFURBISHMENT

Over recent years we have accelerated specific programmes of work that reflect our commitment to quality compliance and the outcomes that customers experience through the regulatory quality compliance framework.

Vector has over 3,707 km (route length) of distribution overhead conductor circuits, representing 45% of its total network line length. The expected asset life differs for each type of conductor deployed on the network and each type also has a different failure mode which are accounted for in the asset management strategies and plans. The actual life of each conductor type is also affected by environmental factors (corrosive elements and exposure to wind), mechanical loads, electrical loads and number and magnitude of downstream electrical faults. The geographical location of overhead conductor circuits thus plays a major part in its condition and rate of deterioration.

Vector's proactive replacement and refurbishment programmes of work are informed by our CBARM models, incorporating condition assessments and criticality.

This AMP provides for increased baseline resilience investment in our overhead network refurbishment, incorporating conductor replacement and pole top hardware replacement (crossarms, insulators etc.). This uplift is driven largely by the increased use of covered conductor (CCT) and composite crossarms across the CBARM identified refurbishment projects as well as a marginal increase in length of circuits replaced on an annual basis. The adjustment to specifications will assist with improving overhead network resilience to high winds, vegetation and climate challenges.

Additionally, LiDAR inspection (surveying of lines clearance as an ECP34 regulatory requirement) has been brought into this capital investment category. The LiDAR programme, which in addition to lines clearance measurement, includes components of high-resolution aerial photography of asset condition and vegetation risk assessment will offset maintenance related operating expenditure.

[32] Code of Practice for Electrical Safety Clearances, NZECP 34

11.5.3 OVERHEAD CONDUCTOR RENEWALS

The renewal of overhead conductors is an important reliability and climate change hardening program of works and focuses on the 11 kV network. This program has evolved to prioritise the areas for conductor renewal, using Vector's CBARM model, as well as SAIFI and SAIDI performance. Conductor renewal will by default include the replacement of crossarms with composite crossarms, replacement of class B insulators with class A post type insulators, lightning arrestors and if required, the replacement of pole structures to ensure the mechanical integrity of overhead line support structures. This holistic replacement approach will harden the overhead networks against the impact of increasing winds and storms in general as well as against lightning, all of which are the result of climate change. The replacement of conductors focuses on overhead line portions with small and conductors most at risk of failure, notably 16mm² copper conductors and 21mm² ACSR conductors. The Vector network has a sizeable population of these types of conductors.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Overhead Conductor Renewal	18.83	14.52	11.6	10.6	12.85	13.25	14.23	14.21	12.94	13.44	136.47

TABLE 11.4: FORECAST EXPENDITURE FOR OVERHEAD CONDUCTOR RENEWALS

11.5.4 THE USE OF COMPOSITE CROSSARMS

The crossarms across Vector's network are almost entirely hardwood and the vast majority is seasoned Australian hardwood. In the 2000's a noticeable deterioration in the performance of the Australian hardwood crossarms was noticed and a decision was made to switch to South American Purpleheart. However, the crossarm fleet continues to be a major contributor to SAIDI. After a number of successful trial installations using composite crossarms a decision was made to rollout composite crossarms in the 11 kV network as standard. This will provide hardening because they provide improved basic impulse levels against lightning induced impulse voltages, have a higher resistance to fire than timber crossarms and negates the need to use hardwood timber from hardwood timber forests. They are also less prone to leeching and moss build-up. Furthermore, composite crossarms do not break easily and tend to bend rather than break. This has the advantage that when a tree falls onto an overhead line the composite crossarm may bend but still hold the conductors.

It has become clear that not all poor performing 11 kV overhead network portions require capital intensive full conductor replacement works but a proactive planned program that focuses on crossarm-replacement, will be sufficient to improve the performance of certain network portions. Such a program will improve SAIDI and the customer experience.

This reliability program will focus on the 11 kV network and replacements will be targeted in accordance with a prioritised list of 11 kV network portions and all crossarms in the identified area will be replaced in one go in each area to make a larger immediate impact on SAIFI (and SAIDI) and also reduce the requirements for traffic management and multiple outages.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Crossarm Renewal			0.24		0.35	0.45		0.23	0.11	0.65	2.05
Northern Crossarm Renewal	4.38	5.79	4.61	4.81	5.25	5.34	5.60	5.70	5.50	4.77	51.77
Total	**4.38**	**5.79**	**4.85**	**4.81**	**5.60**	**5.79**	**5.60**	**5.93**	**5.61**	**5.42**	**53.82**

TABLE 11.5: FORECAST EXPENDITURE FOR CROSSARM REPLACEMENT

11.5.5 11 KV DISTRIBUTION CABLE REPLACEMENT

This reliability focused replacement program of works focuses on the proactive replacement of underground 11 kV cables. Vector's CBARM model for the underground 11 kV cable fleet is fully developed and this model is used to inform the program for proactive cable replacement. The focus of the program is on the PILC cable fleets that were installed between the 1950s and 1980s. Distribution 11 kV cables have an average fault rate of 0.047 faults/km with most of these faults attributable to PILC cables. Most faults are found to originate from cable joints but the results of some of the pre-commissioning tests upon repair suggest a deterioration of the cable insulation. Auckland CBD is undergoing major and rapid development and the line-item titled Auckland opportunistic cable replacement in the financial table below, makes provision for the proactive replacement of cable assets, where the risk of failure is sufficiently high enough, under major civil works upgrade in the Auckland CBD including the new underground central rail link and underground stations under a dig once, replace once approach to prevent continuous disruption to business owners and the public.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland 11 kV cable replacement	0.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	33.00
Northern 11 kV cable replacement	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	5.00
Auckland opportunistic cable replacement	4.27	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	31.27
Total	**10.56**	**5.27**	**7.00**	**7.00**	**7.00**	**7.00**	**7.00**	**7.00**	**7.00**	**7.00**	**71.83**

TABLE 11.6: FORECAST EXPENDITURE 11 KV CABLE REPLACEMENT

11.5.6 REPLACEMENT OF 11 KV RING MAIN UNITS (RMU)

This reliability focused program of works focuses on ageing 11 kV oil filled RMUs such as the Long and Crawford population, and the combined population of series 1 Andelect/Astec/ABB SD RMU switchgears. The CBARM model for this asset type is fully developed and is used to inform the replacement program. From RY19 to RY21 this program was delayed, to make way for the SRMP automation initiative but this program is now back up to speed and is planned to continue throughout the AMP period. The new RMUs will be automated as and where required and those that are not automated will be able to be retrofitted with automation if such a requirement should arise. This program will not only improve the reliability and resilience of the network but also remove the risk of oil spills and failure effects of the oil filled RMUs. The oil filled RMUs held risk to operators and its replacement will also improve operator safety (and by default, public safety). Even though this programme is more focused on reliability, the focus will also include climate change, especially flooding, to ensure RMUs are installed in elevated positions or in a different location less prone to flooding.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland RMU Replacement	6.30	10.42	10.42	10.42	10.42	10.42	10.42	10.42	10.42	10.42	100.08
Northern RMU Replacement	0.90	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	10.26
Total	**7.20**	**11.46**	**11.46**	**11.46**	**11.46**	**11.46**	**11.46**	**11.46**	**11.46**	**11.46**	**110.34**

TABLE 11.7: FORECAST EXPENDITURE RMU REPLACEMENT

11.5.7 REPLACEMENT OF DISTRIBUTION TRANSFORMERS

The Vector network utilises a large number of distribution transformers, either pole mounted and ground mounted as best suited to the application. A mature CBARM model is utilised for each of the pole mounted and ground mounted transformer asset classes to determine the asset risk profile and inform the replacement program. To ensure the integrity of this simple but important asset population, distribution transformers, both pole mount and ground mount, will be proactively replaced on a risk based priority, transformers smaller than 100 kVA will be run to failure.

The intention is the asset once installed should last its entire nominal life even with the forecast load growth. Hence all current single-phase transformers undergoing replacement shall be upgraded to a standardised 50kVA size and most 100kVA & 200kVA transformers being replaced will be upgraded to 300kVA. Pole mounted distribution transformers will be installed with improved and more robust kingpins that hardens the installation. Pole mounted transformers will include lightning arrestors to harden the network against the impact of lightning over voltages as increased lightning activity has been observed in parts of the network.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland distribution transformers replacement	2.32	2.32	2.32	2.32	2.32	2.32	2.92	2.92	2.92	2.92	25.60
Northern distribution transformers replacement	2.53	2.53	2.53	2.53	2.53	2.53	3.13	3.13	3.13	3.13	27.70
Total	**4.85**	**4.85**	**4.85**	**4.85**	**4.85**	**4.85**	**6.05**	**6.05**	**6.05**	**6.05**	**53.30**

TABLE 11.8: FORECAST EXPENDITURE DISTRIBUTION TRANSFORMER REPLACEMENT

11.5.8 REPLACEMENT OF OVERHEAD 11 KV SWITCHES

Vector's 11 kV overhead network includes a large number of air-break switches, disconnectors, fuses, isolating links, sectionalisers and reclosers. Vector does not have a CBARM model for its overhead 11 kV switch population, as most of the asset population are drop out fuses which are managed under a condition-based strategy. There is good record of failure modes as well as good maintenance records and records of defects that allow a risk level to be determined and to inform our proactive replacement program. The focus of the proactive replacement program is on the air break switch (ABS) population due to age and obsolescence. This program will replace like for like but where automation is needed, will replace a manual operated device with an automated device.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland overhead 11 kV switch renewal	1.20	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.27	12.63
Northern overhead 11 kV switch renewal	0.47	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	6.77
Total	**1.67**	**1.97**	**1.97**	**1.97**	**1.97**	**1.97**	**1.97**	**1.97**	**1.97**	**1.97**	**19.40**

TABLE 11.9: FORECAST EXPENDITURE OVERHEAD 11 KV SWITCH RENEWAL

11.5.9 MICROGRID ROLLOUT

Ensuring reliability in remote areas using traditional network enhancement or backstopping solutions is often costly relative to the number of customers served and, in some instances, simply not practicable. We are always looking at smarter and cost-effective ways to meet the requirements of our customers in areas on the edges of our network with modest growth but with inadequate quality of supply performance. This is where employing self-sufficient microgrids can be a viable economic alternative. Most microgrids are network-connected, but they can 'island' themselves during an outage. This means those connected to them can access back-up power, and this cost-effectively improves remote communities' resilience.

Temporary generation was deployed in the rural enclaves of Piha and South Head in 2019 and this generation has proved to be well worth the investment and hugely successful in alleviating SAIDI and improving the customer experience. Customers have been vocal in stating their satisfaction and support for the generation installations. In this AMP period, permanent generation sites will be established at these two remote communities that are reliant on single and lengthy 11 kV supplies. Piha is supplied by a 62 km long 11 kV feeder that services 1,744 customers and South Head is supplied by a 116 km 11 kV feeder from Helensville ZSS that services 1,133 customers. Both these feeders are in the SAIDI top ten worst performing feeders, backstopping is not available, and a traditional network backstop solution is not economic. The higher capital cost of BESS systems compared to diesel generation has discounted the installation of BESS systems in these enclaves. Apart from the higher installation cost, BESS systems are not suitable as a backup supply for long outages typically associated with for example a car-versus-pole incident which, can typically take up to 8 hours to replace at which time a BESS would have run out of capacity. Permanent diesel generator installations will be deployed in these enclaves.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
South Head permanent standby generation		1.42									1.42
Piha permanent standby generation	0.10		1.70								1.80
Total	**0.10**	**1.42**	**1.70**								**3.22**

TABLE 11.10: FORECAST EXPENDITURE FOR PERMANENT STANDBY GENERATION

11.5.10 DISTRIBUTED ENERGY RESOURCES

Vector has consolidated and further optimised its planned investment in the integration of Distributed Energy Resources (DER) to closer align to our view on the inherent uncertainty in demand profiles, impact of regulatory settings, and the roles and responsibilities of third-party agents in enabling the demand-side management of DER.

This project was provided for in AMP23 under the System Growth capital expenditure category. A review of expenditure under this category concluded that this project was more closely aligned to the Reliability, Safety and Environmental investment and has subsequently been re-categorised and reduced in this AMP.

11.5.11 THE INCREASED USE OF LIGHTNING ARRESTORS

Climate change has seen increased lighting activity around the network but more specifically in the North-western network. 11 kV lightning arrestors will become part of our standard for overhead installations. And where appropriate in areas of high lightning activity. In areas of high lightning activity, lightning arrestors will be retrofitted to the network. This will reduce the risk of overvoltage related damage to plant.

11.5.12 EXPULSION DROP OUT FUSE REPLACEMENT

With climate change there is a risk that hot and dry conditions can occur and perhaps increase which in turn leads to a higher risk of wildfires. The electricity network can contribute to the start of a wildfire if an expulsion drop-out fuse emits/ejects hot particles during operation to clear a fault. To reduce this risk Vector will install current limiting drop out fuses in a number of 11 kV overhead feeders in the Auckland and Northern networks. The performance of these feeders and current limiting fuses will then be closely monitored and if the performance of these new devices is to expectations, they will be rolled out network wide in the AMP period. These devices will provide reliability, safety and environmental improvements and hardening against climate change.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland expulsion drop out fuses replacement	0.09	0.27	0.27		0.27		0.27		0.27		1.44
Northern expulsion drop out fuses replacement	0.11	0.27	0.27		0.27		0.27		0.27		1.46
Total	**0.20**	**0.54**	**0.54**		**0.54**		**0.54**		**0.54**		**2.90**

TABLE 11.11: FORECAST EXPENDITURE FOR EXPULSION DROP OUT FUSE REPLACEMENT

11.6 Climate resilience

The need for increasing levels of investment in Auckland's electricity system in response to the higher frequency and intensity of climate change has never been greater. The importance of Vector's role as a lifeline utility is also increasing given the growing criticality of electricity for Auckland's energy, transport, and digital economy needs. Customer expectations have also changed, where utilities are now expected to maintain and restore a reliable supply during and after extreme weather events. We expect this trend to continue going forward into the future.

We have undertaken a full review of future resilience expenditure for our network, following the recent extreme weather events affecting Auckland such as the April 2018 storm, Auckland Anniversary flooding of January 2023, and Cyclone Gabrielle of February 2023.

We are continuing to refine our climate resilience threat and hazard modelling and have developed a network resilience index which models the risk level reduction, efficiency and efficacy of investments targeted at climate resilience and hence demonstrates prudent and efficient expenditure to our stakeholders.

The level of investment needed to fully address climate change resilience is not recoverable through the current DPP3 allowances. Vector's view continues to be that future DPP cycles must do more to account for the need for EDBs to invest in network hardening for climate change resilience.

This section discusses the above and describes Vector's view of network resilience now how this interacts with other workstreams.

11.6.1 NETWORK SECURITY

Vector considers that climate resilience is one component of overall network security. This concept is presented using the Venn diagram below.

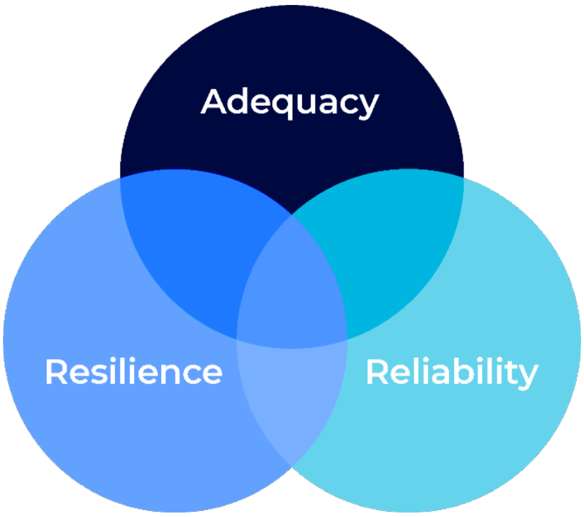


FIGURE 11-1: COMPONENTS OF NETWORK SECURITY

Network '**adequacy**' refers to workstreams and systems Vector has place to ensure that our network maintains appropriate levels service to our customers and is developed in way that accommodates future scenarios. This is discussed in Sections 7 and 10 and includes our probabilistic security of supply standards, power quality, system stability, upstream network risks (Transpower and generation), DER orchestration and wider future network initiatives.

Network '**reliability**' refers to the projects and programmes of work currently in motion and planned to maintain network performance to our customers and meet our regulatory obligations. This is discussed in throughout this AMP but primarily in Sections 7 and 12. This covers asset replacements, SAIDI/SAIFI/CAIDI initiatives, grid edge solutions and the evolution of our system architecture (feeder sectionalisation and mesh network)

Network '**resilience**' is a subset of overall network resilience that addresses specifically climate change related risks that give rise to extreme events (e.g. a 1/250-year flooding event). This work is discussed in the proceeding sections. As Figure 1.1 demonstrates, there are overlapping areas between 'resilience', 'adequacy' and 'reliability' where there are common project drivers and benefits.

11.6.2 CLIMATE CHANGE RESILIENCE PROJECTS

Vector has planned for several projects and programmes of work that provide a clear link to resilience against the impacts of climate change but also have benefits towards network 'adequacy' and 'reliability'. Examples of this include some of the projects in the preceding sections such as:

- Deployment of network automation
- Distribution spur feeder reinforcement
- Overhead conductor renewals
- Replacement of overhead switches
- Use of composite crossarms
- Microgrid rollout
- Expulsion drop out fuse replacement
- Waiheke island subtransmission supply reliability
- Ngataringa Bay ZSS decommissioning/Belmount ZSS 3rd transformer

Within this AMP, Vector has also identified and allowed for projects that exclusively address climate change risks. These projects include:

- Provision of network recovery for extreme weather events
- Mobile substation
- Flood mitigation work at ZSS specific sites

We've also identified several areas where further investment is available to secure additional customer benefits by addressing climate change risk, beyond what we've included in our expenditure forecasts at this stage. For each, we've identified why these investments have not been included, and what would need to change for them to be introduced into our expenditure forecasts. Should these be included in future, we intend to apply to the Commission under a reopener process.

Omitted investment and unrealised customer benefit	Why we're not committing to this investment	What needs to change for us to commit to this investment
Tree management (Without tree regulation reform) $196 million CAPEX in RY26-30	This investment is significant for customers, and so we are bound to ensure it represents value for money. Reformed tree regulations would provide the opportunity to achieve similar outcome for $59 million. This would be an OPEX cost. A typical example of this type of project is an overhead line to undergrounding or refurbish (e.g. using covered conductor). These projects have a non-network solution involving unrestricted tree regulation which can reduce much of the network risk at a fraction of the cost of a capital solution however are dependent on meaningful Tree Regulation reform.	1. If new modelling demonstrates that the capex investment is required, we would consider applying for an unforeseen project reopener. 2. If the Tree Regulations were to change to enable an Opex solution, we would consider applying for a change event reopener.
Network meshing (In addition to existing strategy) $106 million CAPEX in RY26-30	Uncertainty surrounding the Government's infrastructure resilience strategy and funding options.	Clarification of the Government's infrastructure resilience strategy and funding strategy is required. Based on the outcome we would consider applying for a change event reopener.

11.7 Managing carbon footprint

Vector has set a science aligned target to reduce Scope 1, and 2 emissions (excluding electricity distribution losses) by 53.5% by 2030 based on a 2020 baseline. The target has been set to meet the External Reporting Board's Climate Related Disclosure standards which Vector is obliged to comply with as a listed entity. Vector is also investigating Scope 3 reductions to meet Climate Leaders Coalition obligations, and is already working with supply chain partners, like our Field Service Providers, on reducing indirect emissions.

The table below outlines our emissions profile over the past three years, for Vector's electricity network. Emissions related to our science aligned target have been increasing due to an increase in SF_6 related emissions because of switchgear failure. Vector's stationary combustion has partially decreased since FY20 due to work in diesel generation optimisation, and the utilisation of mobile transformers for planned maintenance projects, however, there have been corresponding increases due to the increase in planned maintenance works. Our largest source of emissions increase has been in Vector's Electricity Distribution Losses. We expect this emission to increase as our network grows to cater for the wider decarbonisation transition, and therefore exclude it from our science aligned targets.

ELECTRICITY DISTRIBUTION NETWORK

Emission Categories for BU	tCO2e - FY20	tCO2e - FY21	tCO2e - FY22	tCO2e - FY23
Scope 1 - Stationary combustion	3,339	2,750	3,096	2,835
Scope 1 - SF_6	425	591	1,858	2,180
Scope 1 - Vehicle Fleet	34*	36*	27*	35
Scope 1 - Refrigerant leakage	0.94*	0.73*	0.34*	33**
Scope 1 – Total	**3,799**	**3,378**	**4,981**	**5,083**
Scope 2 - Electricity consumption	502	497	571	814
Scope 2 - Electricity Distribution Losses	32,504	33,622	39,078	42,590
Scope 2 – Total	**33,006**	**34,119**	**39,649**	**43,404**
Scope 3 - Fuel used by FSPs	6,474*	6,821*	6,450*	6,648
Scope 3 - Fuel- and Energy-related emissions	896*	754*	894*	872
Scope 3 - Business Travel	31*	5*	5*	5

ELECTRICITY DISTRIBUTION NETWORK				
Scope 3 – Total	**7,401**	**7,580**	**7,349**	**7,525**
Total	**44,206**	**45,077**	**51,979**	**56,012**
Biogenic emissions	162	133	150	138
Science-aligned target emissions	**4,463**	**4,008**	**5,702**	**6,035**

* A small percentage of these emissions arise from activities shared with Vector's Gas distribution and Fibre businesses. This has been separated from FY23 onwards.

** From FY23, we began measuring refrigerant leakages from Zone-substations which has increased the emissions in this area. Because the increase didn't make the materiality threshold, previous years have not been rebased.

TABLE 11.12: SCOPE 1,2,3 EMISSIONS FOR VECTOR'S ELECTRICAL NETWORK

11.7.1 DIESEL GENERATION REDUCTION (STATIONARY COMBUSTION)

The largest lever for distribution decarbonisation lays in the reduction of temporary diesel generation during planned construction works or planned maintenance works. Temporary generation is required to maintain supply when the plant to be worked on needs to be de-energized. The present strategy focuses on better management of diesel generators, and the use of mobile transformers as an alternative to diesel generation. Such initiatives not only reduce emissions but also noise, street pollution, urgency of the shutdown window, and overall cost. For more information refer to our Greenhouse Gas Emissions Inventory Report [33]. Note that the Diesel Generators used as standby generators for outages, such as those in Piha and Southhead represent only 0.5% of overall diesel emissions and can therefore be considered negligible.

11.7.2 SF_6

SF_6 emissions have increased in 2023 due to leaks in major SF_6 switchgear as a result of seal failures. As SF_6 comes under the emission trading scheme (ETS), Vector is obliged to purchase New Zealand Units (NZUs). SF_6 reduction can be achieved through improvements in monitoring and management. Nevertheless, failures will always occur, and the only solution to eliminate SF_6 emissions is through the installation of SF_6 free equipment.

11.7.3 NET ZERO OPERATIONS BY 2030 – REGULATORY ALLOWANCE FOR CARBON CREDITS

Vector is a member of the Climate Leaders Coalition, a CEO-led community of over 100 organisations representing 60% of New Zealand's gross emissions. As part of our 2017 obligation to the Climate Leaders Coalition, Vector has set a net-zero emission target of Scope 1 and 2 emissions (excluding electricity distribution losses) by 2030. Net-zero emissions is achieved through the purchase of carbon offsets on an international market. Assuming the science-based emission target is achieved, and the price of carbon is $140/tCO2e, Vector's electricity business would have an additional operating expenditure of $285k to meet this need. This allowance will be required from 2030 onwards.

11.7.4 CONSIDER ENVIRONMENTAL IMPACTS

The environmental effects of installing, operating, maintaining and upgrading Vector's network are regulated by a range of legislation and statutory controls - particularly the Resource Management Act 1991, as given effect to by the Auckland Unitary Plan.

Vector follows the processes and procedures and complies with the relevant regulations and standards, set by this framework. In some instances, this framework provides for Vector's assets and network activities as 'permitted activities'. The design and installation of upgrades in the network is undertaken in a way that ensures that permitted activity thresholds are applied. Where this is not possible, Vector obtains the requisite resource consents for its assets and related activities, which ensures the environmental effects of these are appropriately avoided, remedied, mitigated or minimized as far as is practicable.

11.8 Financial summary of reliability programmes of work

The investment forecast below provides a financial summary of the programmes of work that are already in progress to address network resilience, reliability, safety, and the environment but also includes our high-level forecast for programmes of work in the DPP4 period that will specifically focus on hardening the network to improve resilience for weather related events.

[33] https://www.vector.co.nz/investors/reports

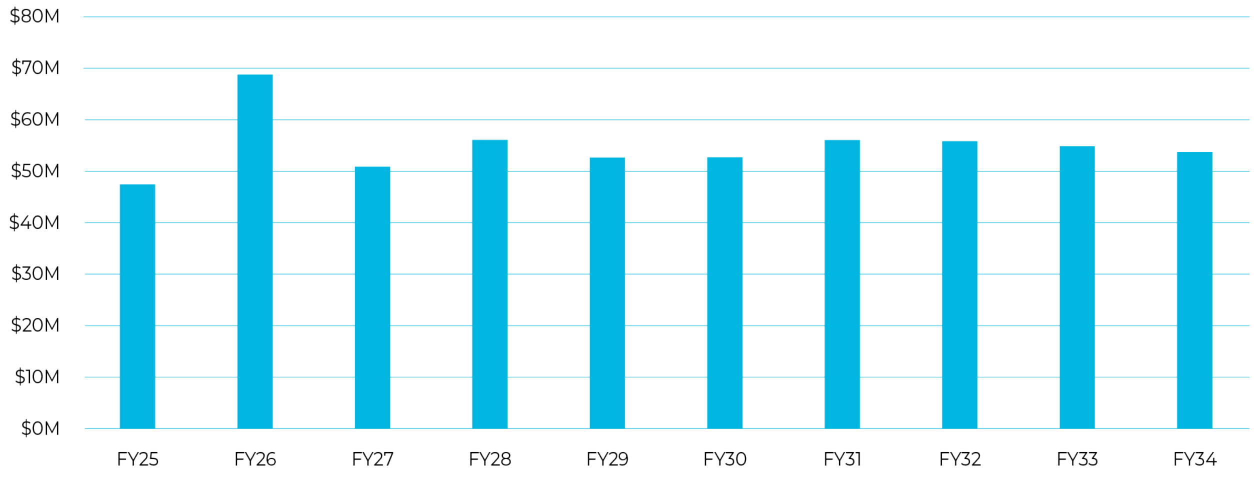


FIGURE 11-2: FORECAST RELIABILITY IMPROVEMENT AND CLIMATE CHANGE NETWORK HARDENING

SECTION 12

Our assets

12 –Our assets

Asset replacement and renewal is aimed at ensuring that the assets installed on the network are in serviceable condition and are replaced pro-actively (prior to failure) or reactively (after failure) according to their condition and criticality. Vector takes a whole of life cycle approach to assessing the need for asset replacement to minimize the cost to customers.

The following sections describe:

- an overview of the asset management objectives applicable to replacement and renewal, and strategies to achieve those objectives
- how we manage our asset fleets
- the factors that influence our asset management strategy
- our approach to forecasting and drivers for asset replacements
- a summary of the major investments identified to maintain network performance between 2024 and 2034

12.1 Renewals objectives and strategy

12.1.1 ASSET MANAGEMENT OBJECTIVES

The asset management objectives that are addressed through the replacement and renewal programme of works and investments are set out in the table below.

FOCUS AREA	OBJECTIVES
Safety, Environment and Network Security	• Comply with relevant safety and environmental legislation, regulation and planning requirements. • Asset management activities align with environmentally responsible and sustainable behaviours, in line with industry best practice, enabling wider emissions reductions. • Minimise the impact on the environment with regards to our assets and work practices. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).
Customers and Stakeholders	• Enable customers' future energy and technology choices. • Ensure the long-term interest of our customers by providing an affordable and equitable network. • Consider the impact of our operational decisions on customers and minimise the disruption of planned outages and unplanned outage response times while providing a high-quality customer experience across all interactions.
Network Performance & Operations	• Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact-based investment profiling. • Utilise clear business case processes, integrate risk management and complete post investment reviews to inform our decision making and analysis. • Maintain compliance with security of supply standards through risk identification and mitigation. • Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings.
Future Energy Network	• Prepare the network for future changes that will be driven by: – technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc. – environment: climate disruption and network resilience – customer: decarbonisation of the economy, electrification of transport, etc – operations: transition to distribution system operator model and whole of system planning • Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third party flex traders and retailers. • Improve our visibility of, and ability to control, the LV network including management of the information required.

TABLE 12-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

12.1.2 STRATEGIES TO ACHIEVE THE OBJECTIVES

To meet the asset management objectives, the following strategies are employed by Vector. As electricity networks are complex interconnected systems, each strategy addresses multiple objectives.

12.1.2.1 COMPLY WITH RELEVANT REGULATIONS

Vector will comply with the relevant regulatory obligations, legislative requirements such as the Electricity Safety Regulations and industry standards. The most relevant to network integrity, growth and security are compliance with the Security of Supply Standards, achieving and maintaining compliance with the DPP3 Quality Standards and complying with the Power Quality requirements.

By modelling the condition of our assets, we identify where assets are likely to fail and plan our remedial actions to prioritise the assets with highest criticality through to lowest criticality, hence managing network risk, and ensuring resilience and compliance with regulations.

12.1.2.2 ASSET INFORMATION AND INSIGHTS STRATEGY

Vector has established the Information and Insights Strategy, which is tightly coupled with the Digital Strategy, to focus on improving asset data and condition information required to enable advanced analytics, support Network Operations, and optimise Asset Management decisions. Initiatives under this strategy have included investing in new systems to improve the quality and accuracy of asset data, improve network visibility through smart meter acquisition, analytical solutions, and modernising data platforms to improve data management.

12.1.2.3 RISK BASED ASSET CONDITION FORECASTING METHODS

Vector applies a risk-based approach to forecasting asset condition, and therefore the expected asset volumes and expenditure required for asset replacement. The value and criticality of the asset type determines the complexity of the modelling implemented so that the effort is appropriate for the risk posed to the network. Asset obsolescence, vendor support and/or availability of spare parts are included in the condition assessment of asset types. For example, high value assets such as switchboards are forecasted using condition-based risk models, whereas low value and low criticality assets such as LV distribution equipment, are forecast using historical trend models and condition assessments.

12.1.2.4 MAINTAINING NETWORK SAFETY

Safety of the public and workers is of the highest importance to Vector. Where an asset is identified to pose a risk to safety, we will prioritise remedial actions to remove the risk. Such risks are documented in Vector's risk management system and reviewed on a regular frequency as appropriate by a steering group until the risk is closed out. Vector is required to operate its network in compliance with NZS7901 which details safety management systems for public safety.

12.1.2.5 MANAGING ASSETS TO ENSURE LEAST COST ACROSS THE LIFE CYCLE

At each point in an asset's life cycle, Vector will take the appropriate action to ensure the least cost of owning the asset across its life cycle. Actions may include replacement/retirement if the asset is no longer needed, refurbishment/life extension, or maintenance.

Our approach is to identify possible options to address the need, undertake a cost and benefit analysis for asset replacements of each solution, and to select the solution which has the best benefit-cost ratio. The options analysis considers capital and operational costs, safety, environmental impacts, risks and opportunities from the whole of asset life perspective. For some low value asset classes, a run to failure approach with reactive replacement is applied where deemed more efficient.

12.2 Forecasting methods

The purpose of forecasting assets renewals is to ensure that an appropriate level of capital and resources are available for Vector to manage network risk at a fleet level and align with our wider Asset Management Objectives. Vector uses a number of different methods to forecast asset renewals needed on its network. The type of forecasting method used is dependent on the asset value, asset criticality, population size, renewal drivers and robustness of available information associated with the asset class.

For high value assets such as power transformers, where inspection and testing provide robust condition information, predictive modelling is undertaken to understand when individual assets are at the end of their serviceable life. For low value high volume assets that are less critical to network operations, such as air-break-switches, the forecasting is done at a portfolio level to identify the expenditure required for the asset fleet while actual replacements are identified based on field inspections. The forecasting methods applied by Vector are described below.

12.2.1 RISK BASED MANAGEMENT

Vector has adopted the use of Condition-Based Asset Risk Management (CBARM) to model the condition of selected asset classes from a fleet perspective. This approach is based on the methodology published by the UK regulator Ofgem[34] (Office of Gas and Electricity Markets) and considers asset criticality, asset health data, deterioration rates, and probability of equipment failure. The outcome of this modelling provides a fleet-wide overview of the asset health risk of a particular asset class. It also allows various intervention strategies to be tested by providing a forecast of the asset risk profile in the future. By comparing different intervention strategies Vector is able to assess the scale of replacement required to efficiently manage network risk.

[34] DNO Common Network Asset Indices Methodology

The asset data used as inputs to the models are directly retrieved from SAP PM thereby enabling each model to be updated with the latest information from the field. Vector's focus on improving its asset health information is complementary to the continued improvement in the accuracy of its CBARM models."

In the context of this AMP the output of our CBARM models have been defined using the following risk categories:

- **R1: Minimal risk** – Assets are generally in good condition. Continue to review and monitor using current asset maintenance standards.
- **R2: Moderate risk** – Assets are showing signs of deterioration. Where issues have been identified, these can be addressed through corrective maintenance to ensure the assets remain serviceable.
- **R3: High risk** – Assets have defects that have the potential to cause failure. Remedial planning and specific actions need to be identified and executed.
- **R4: Maximum risk** – Assets are in a poor condition with a heightened risk of failure. Requires immediate remedial actions.

12.2.2 CONDITION BASED ASSESSMENT

In instances where asset criticality information is not available, the asset fleet condition is based on various health indicators such as age, type, known defects and results of routine testing. This differs from CBARM as it produces a condition score rather than risk score, that is the criticality of the asset is not assessed. An example of this the power transformer asset class where the condition score is based on the results of tests on the oil and insulation in addition to age and type, to arrive at a combined condition score. The asset fleet health indicators are described using the criteria below:

- **H1: Negligible risk of failure** – Assets are generally in good condition. Continue to review and monitor using current asset maintenance standards.
- **H2: Moderate risk of failure** – Assets are showing signs of deterioration. Where issues have been identified, these can be addressed through corrective maintenance to ensure the assets remain serviceable.
- **H3: Increasing risk of failure** – Assets have defects that have the potential to cause failure. Remedial planning and specific actions need to be identified and executed.
- **H4: Material risk of failure** – Assets are in a poor condition with a heighted risk of failure. Requires immediate remedial actions.

This assessment approach is compared against historical records to validate any anomalies in modelling outputs.

12.2.3 AGE AND TYPE

For some asset classes it is appropriate to use deterministic factors such as age and type information to predict asset replacement needs. In particular, where it is not efficient or possible to gather sufficient condition information to assess the health of individual assets or develop a CBARM model.

An example is digital devices, such as modern protection relays, which are generally managed to a specific age as it is not possible to assess the condition of the integrated circuits and/or software and firmware upgrades are not available anymore.

12.2.4 HISTORICAL TRENDS

In asset classes where there is insufficient asset information available to support the use of the methods above, the number of assets replaced on an annual basis can be predicted by referring to historical trends. The historical trend rates can also be extrapolated or adjusted to account for changes in age across the fleet. This is typically applied to high volume, low value and low criticality asset types.

A high-level summary of renewal forecasting methods and renewal drives by asset class is provided below in Table 12-2:

FLEET	RENEWAL DRIVER	PRIMARY FORECASTING METHODS
Primary switchgear	Obsolescence, condition, age, safety, reliability	CBARM and Condition based assessment
Power transformers	Obsolescence, condition, age, safety, reliability	CBARM and Condition based assessment
Underground cables	Condition, age, safety, reliability, environmental	CBARM, Historical for LV
Overhead lines	Condition, age, safety, reliability, environmental	CBARM and Condition based assessment
Support structures	Condition, age, safety	Condition based assessment
MV Distribution equipment	Condition, age, safety, reliability	CBARM
Distribution transformer	Condition, age, safety, reliability, environmental	CBARM
LV Distribution equipment	Obsolescence, condition, age, safety, reliability	Historical and Condition based assessment for some assets
Protection and controls	Obsolescence, age, availability of spares, functionality	Type and age
Auxiliary systems	Obsolescence, age, reliability	Type and age, Historical
Generation and energy systems	Condition, age	Historical
Infrastructure and facilities	Condition, safety	Historical

TABLE 12-2: RENEWAL DRIVERS AND FORECASTING METHODS

12.3 Primary switchgear

The purpose of primary switchgear is to provide protection of the network and primary assets such as underground cables, overhead lines and power transformers, as well as a point of control and isolation of primary circuits.

Primary switchgear is used to provide a means to safely disconnect a faulted section of the network and to provide a point of control or isolation needed for network control or planned maintenance activities.

This Section describes our primary switchgear fleet and provides a summary of our associated asset management practices. The primary switchgear fleet consists of the following three subcategories:

- Indoor and outdoor 110 kV switchgear
- Indoor 33 kV, 22 kV and 11 kV switchgear
- Outdoor 33 kV switchgear

12.3.1 110 KV SUBTRANSMISSION SWITCHGEAR

12.3.1.1 FLEET OVERVIEW

Three sites on Vector's network house 110 kV switchgear. Liverpool and Hobson Zone Substations both have indoor GIS switchboards and Lichfield GXP has two outdoor circuit breakers. All of Vector's 110 kV switchgear are SF_6 insulated and use SF_6 gas puffer circuit breaking technology.

12.3.1.2 POPULATION AND AGE

The two outdoor 110 kV GIS circuit breakers at Lichfield GXP are 28 years old. The 110 kV GIS switchboards at Liverpool and Hobson zone substations are 26 and 12 years old, respectively. The Liverpool switchboard was extended in 2021 with the installation of three new circuit breaker bays

12.3.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Vector's indoor GIS assets have been performing well with no notable failures since commissioning. Although not an issue at this time as more than half of the fleet is under 12 years old, assets of this type are vulnerable to obsolescence as more modern designs become available and the original equipment manufacturer (OEM) no longer provides support or can make readily available parts. To mitigate this risk, Vector has secured strategic spares and vendor support for these assets.

The circuit breaker hydraulic drives on the GIS switchboard at Liverpool substation due to age and reliability concerns were considered for mid-life refurbishment and upgrade. To mitigate the increasing risk of drive-mechanism failure presented by the existing hydraulic system, Vector engaged in a program of complete hydraulic systems renewal with extended monitoring and control functionality. This major 20-year mid-life refit program was completed in FY23.

There are known issues associated with the SF_6 gas seals on the outdoor circuit breakers installed at Lichfield GXP (a spare pole is held on site) as well as the ability to maintain a supply of serviceable spares. Due to obsolescence and the availability of spare parts, these circuit breakers are scheduled for replacement in 2028 (refer to Appendix 12 for details).

12.3.1.4 CONDITION AND HEALTH

Provided there are no major failures, indoor GIS switchboards technically have no end of life if proper maintenance is undertaken and there is a supply of spare part. The Merlin Gerin type D-TH7 switchboard installed at Liverpool zone substation is no longer in production but is still supported by the OEM factory in Grenoble France (MasterGrid) for parts and service. Some of its components are vulnerable due to age related deterioration such as gaskets, "O" rings and polycarbonate materials which have been historically difficult to acquire. Vector has recently repaired known SF_6 leaks with new seals and component renewals and has further procured a contingent of spare parts to minimise any future repair time. A project to install gas loss trending equipment to monitor the leak rate of any compartment has also been completed which will act as an early warning system to investigate any future leaks faster.

As the Lichfield 110 kV circuit breakers are located outdoors, they are prone to the typical issues associated with outdoor switchgear such as corrosion, pollution, or animal interference. These circuit breakers have performed in line with expectations, but their age and risk of obsolescence mean that they are approaching end of life.

12.3.1.5 MANAGEMENT STRATEGY

Subtransmission GIS switchgear is procured to align with site specific functional and performance requirements.

The maintenance for the 110 kV indoor GIS is detailed in Vector's maintenance standard ESM102 and the outdoor breakers at Lichfield zone substation are covered under Vector's maintenance standard ESM103. Planned maintenance activities consist of inspection and testing with specialist work contracted to the OEM. Routine inspections are undertaken by Vector's FSPs every two months. Specific OEM service works are conducted at a frequency of between one and eight years depending on the level of service, make and model of the switchgear as determined by the OEM. The replacement of this asset class is driven primarily by obsolescence, lack of vendor support or availability of spare parts and is conducted on a proactive basis.

The outdoor circuit breakers installed at Lichfield zone substation are planned to be replaced due to obsolescence, reliability, and risk of supply.

12.3.2 INDOOR PRIMARY SWITCHGEAR

12.3.2.1 FLEET OVERVIEW

Indoor primary switchgear on Vector's network operates at 11 kV, 22 kV or 33 kV depending on the topology of the network. The 33 kV and 22 kV switchgear are used for subtransmission, and 22 kV is used for distribution in certain areas of higher density load such as the CBD and Highbrook Industrial Park. Indoor switchgear comprises modular panels containing integrated devices such as circuit breakers, disconnectors, earth switches, instrument transformers and protection relays. A series of modular panels connected together makes up a switchboard which is housed in a purpose-built building with temperature and humidity control. This switchgear is generally more reliable than its outdoor equivalents because it does not incur as many issues associated with corrosion, pollution and other environmental factors.

The indoor switchgear on Vector's network includes both conventional and fixed pattern types. The conventional switchgear fleet uses oil, vacuum or SF_6 for its interrupter mediums whilst modern fixed pattern switchgear uses vacuum interrupter technology only. The composition of this fleet according to build type, interrupter type and voltage level is provided in Table 12-3 below.

TYPE	110KV FIXED PATTERN	110KV CONVENTIONAL	33 KV FIXED PATTERN	33 KV CONVENTIONAL	22 KV FIXED PATTERN	22 KV CONVENTIONAL	11 KV FIXED PATTERN	11 KV CONVENTIONAL
Oil				2				303
Vacuum			177	2	93		596	359
SF_6	22		17	16		29	18	123

TABLE 12-3: INDOOR SWITCHGEAR

12.3.2.2 POPULATION AND AGE

The population and age profile for both the conventional and fixed pattern indoor switchgear types is shown below in Figure 12-1 for each voltage level.

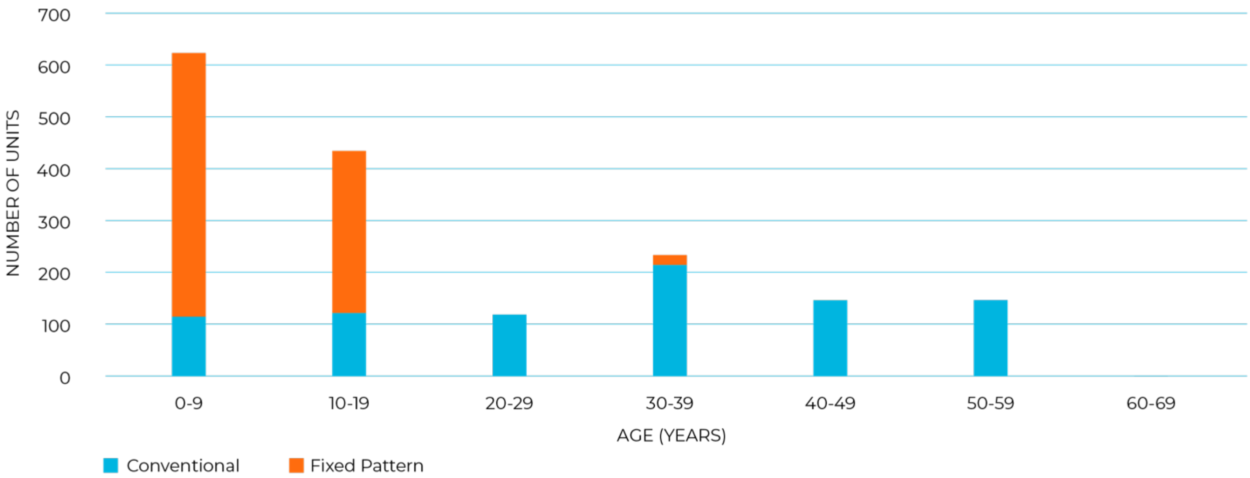


FIGURE 12-1: INDOOR SWITCHGEAR FLEET AGE PROFILE

12.3.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Indoor switchgear of conventional design has several known failure modes including mechanical failures, insulation breakdown and secondary circuit malfunctions. The issues identified for indoor switchgear of fixed pattern design are relatively minor in comparison to conventional design. Fixed pattern switchgear has generally proven to be reliable and performed well with no major incidents recorded. Minor incidents involving these assets are usually attributed to improper cable installation or termination rather than defective equipment.

12.3.2.4 CONDITION AND HEALTH

Vector has recently developed a CBARM model to assist to inform the replacement programme for indoor switchboards. This model is based on age, condition and criticality. The present (RY23) risk level for the indoor switchboard fleet is shown below in in Figure 12-2.

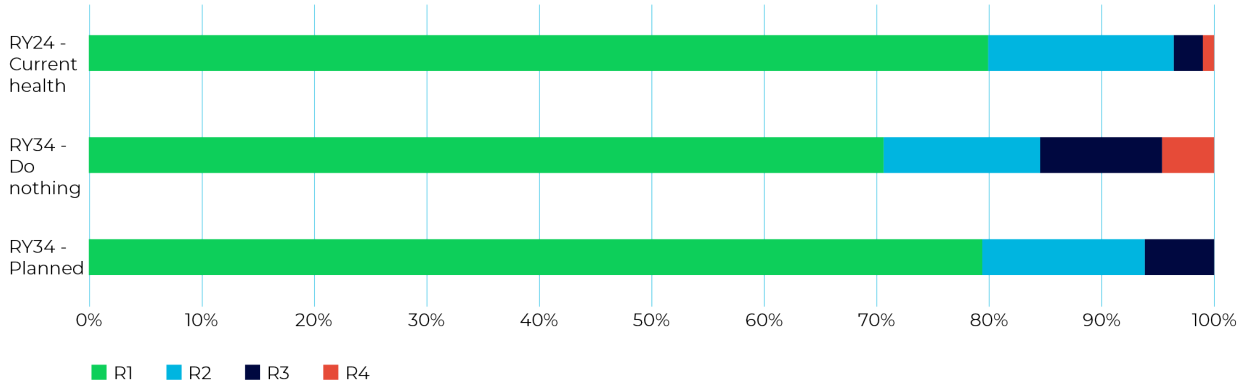


FIGURE 12-2: INDOOR SWITCHBOARD FLEET RISK PROFILE

This indicates that the indoor switchboard fleet is in good condition and Vector's investment programme will maintain the risk profile at approximately present levels. Full details of this programme are provided in Section 12 Appendix.

12.3.2.5 MANAGEMENT STRATEGY

The management strategy for indoor switchboards is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.3.2.6 DESIGN AND CONSTRUCT

Vector has adopted fixed pattern switchgear as a standard given its safety, reliability, and performance benefits as well as reduced maintenance needs over conventional switchgear. As such, conventional switchgear is procured by exception and where it is an economic and safe solution. Examples of this include extensions to existing switchgear and oil to vacuum breaker conversions. Generally, fixed pattern switchgear is used for all new installations and is procured using Vector's specification ENS-0005. Conventional switchgear is procured based on specific site performance and functional requirements.

12.3.2.7 OPERATE AND MAINTAIN

Vector's maintenance standard ESM103 for conventional switchgear apparatus is a culmination of best practice as per AS/NZ 2467 standard and manufacturer specific maintenance regimes. In addition, Vector has recently purchased a magnetron atmospheric condition tester to better determine the condition and serviceability for vacuum circuit breakers (where it is physically possible to be used). Vector has a separate maintenance standard ESM101 specifically for fixed pattern switchgear.

Typical planned maintenance activities are shown below in Table 12-4.

ACTIVITY DETAIL	Visual inspections	Thermovision inspections	Partial discharge testing	Kelman (timing) testing
FREQUENCY	2 Months	1 Year	2 Years	2 Years

TABLE 12-4: PLANNED MAINTENANCE ACTIVITIES FOR INDOOR AND OUTDOOR SWITCHGEAR

In addition, specific OEM service works are conducted at a frequency of between two and sixteen years depending on the level of service, make and model of the switchgear as recommended by the vendor. Investigations, programs of repair, inspection and modifications have been initiated where systemic issues are identified. For example, the cable terminations on Schneider switchgear incomer CBs were changed from socket type outer cone terminations to inner cone terminations to reduce the risk of torsional forces on 33 kV bushings leading to premature failure.

12.3.3 OUTDOOR PRIMARY SWITCHGEAR

12.3.3.1 FLEET OVERVIEW

Conventional outdoor switchgear is a general classification for 33 kV outdoor circuit breakers [35], associated bus works, support structures, disconnectors, and instrumentation. Their deployment is limited to the Northern region and this class of switchgear is used exclusively for subtransmission in the Vector network.

Vector's outdoor 33 kV switchgear fleet includes both conventional and GIS types as shown in Table 12-5.

[35] Note that 'outdoor circuit breakers' excludes the 110 kV circuit breakers at Lichfield GXP

TYPE	33 KV GIS – OUTDOOR	33 KV CONVENTIONAL – OUTDOOR
Oil		58
Vacuum	18	10
SF_6		3

TABLE 12-5: OUTDOOR SWITCHGEAR

12.3.3.2 POPULATION AND AGE

Vector has 89 outdoor circuit breakers in service across its network. The population and age profile for these outdoor circuit breakers is presented below in Figure 12-3.

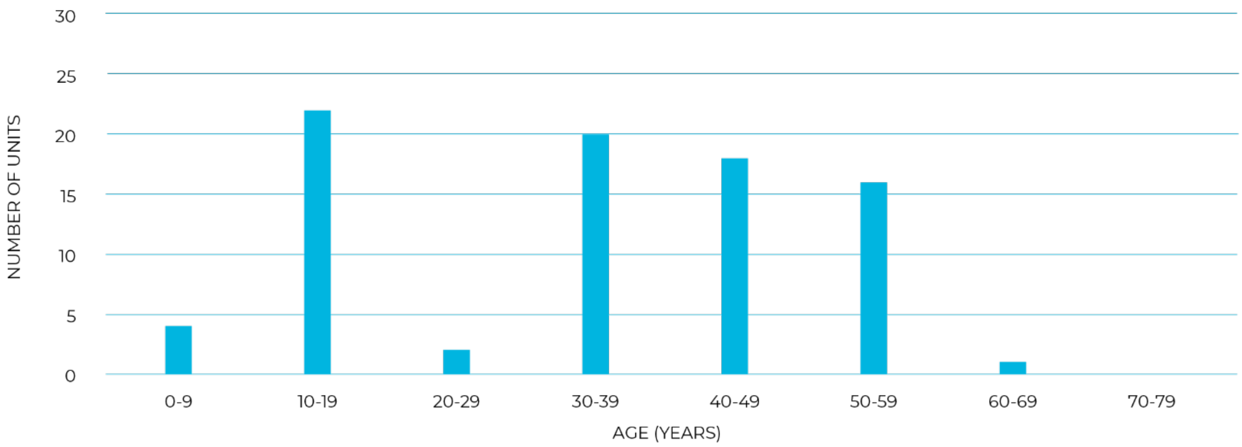


FIGURE 12-3: OUTDOOR 33 KV SWITCHGEAR FLEET AGE PROFILE

12.3.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

In 2013, a Vector owned 33 kV oil-filled circuit breaker failed at Transpower's Hepburn Road GXP resulting in collateral equipment damage in the switchyard and a prolonged outage. This is an inherent risk of all outdoor switchyards containing oil-filled circuit breakers with porcelain bushings, which have the potential to fail catastrophically resulting in damage to surrounding equipment. The risk of failure for these type of circuits breakers increases as they get older.

12.3.3.4 CONDITION AND HEALTH

This asset class is aging with the average age being 31 years. The reliable working age for this asset type is 40 years and therefore approximately 53% of the fleet requires remediation or replacement within the next ten years. There have been two failures of this asset type, namely at Milford zone substation in 2007 and as stated above, at Hepburn GXP in 2013. In both cases, complete replacements were undertaken.

12.3.3.5 MANAGEMENT STRATEGY

Typical planned maintenance activities are shown in Table 12-4. Vector is managing the risk of failure of outdoor circuit breakers by progressively replacing those circuit breakers that have been identified to pose a risk on the network with indoor fixed pattern type in larger ODID conversions and piecemeal replacement where warranted. However, there are instances where a complete conversion to indoor fixed pattern switchgear is not economical in which case new outdoor circuit breakers will be deployed. Vector's specification ENS0106 covers the requirements for new outdoor circuit breakers should they be required as one-off replacements or extension projects should strategic stock be unavailable.

There is no planned like-for-like asset replacement programme for individual outdoor circuit breakers with the intention being to replace them with modern indoor fixed pattern switchgear where possible. This equipment has improved safety, spatial, maintenance and economic benefits and eliminates the risk of catastrophic failures associated with bulk oil circuit breakers with porcelain bushings.

In addition to Vector's internal replacement program of this type, Vector has also worked with Transpower to replace similar 33 kV outdoor circuit breakers at GXPs under a so-called outdoor to indoor conversion programme colloquially known as the 'ODID' programme. This programme has made good progress with only two GXPs remaining.

12.3.4 REPLACE, RENEW AND DISPOSE

Renewal and refurbishment of primary switchgear assets is undertaken to ensure continued reliable and safe operation of the assets well into the future. Our switchgear assets need to be considered against the cost of continued maintenance, obsolescence, vendor support and the availability of spares. The afore mentioned as well as the asset health and criticality drives our switchgear replacement programme.

In addition to the above, environmental factors and climate change such as a risk of flooding as an example, will also drive the need and timing for replacement of primary switchgear out of harm's way. The programme of works for primary switchgear replacement consists of either a complete replacement of switchgear, or partial replacement or retrofit of oil circuit breakers with vacuum circuit breakers as the case may require.

When primary switchgear is replaced, components are carefully selected and retained to serve as strategic spares for similar equipment that remain in service. Carcasses are then scrapped as per Vector's contractual agreements with scrap metal companies.

12.3.5 FORECAST SPEND

The forecast capex graph shown in Figure 12-4 provides a summary of the overall capital investment for this asset header class for the 10-year AMP forecast period. The replacement and refurbishment programme for primary switchgear is described in detail in Section 12 Appendix and includes the proposed investment for each individual project.

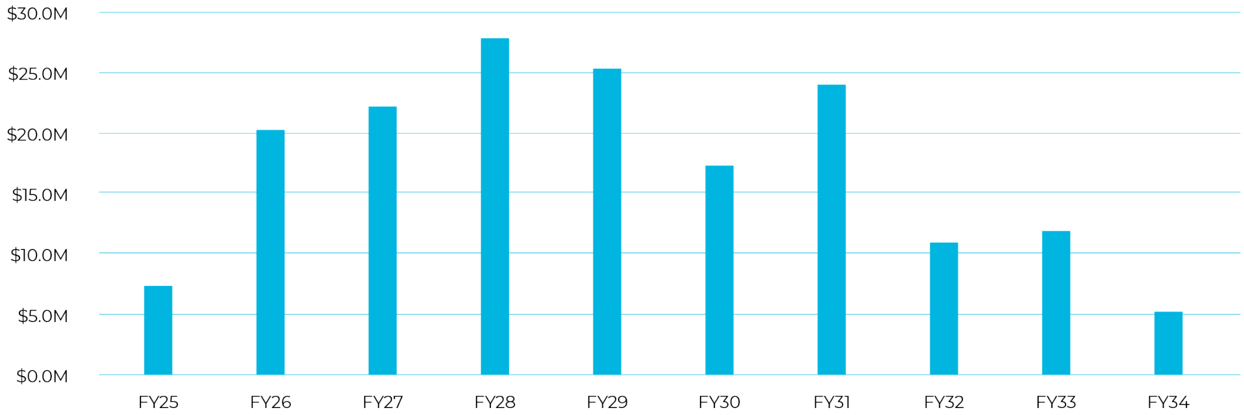


FIGURE 12-4: FORECAST CAPEX – PRIMARY SWITCHGEAR

12.4 Power transformers

This Section describes our Power Transformer fleet and provides a summary of our associated asset management practices within the following three subcategories:

Power Transformers

Power Transformer Tap Changers

Power Transformer Ancillaries

12.4.1 POWER TRANSFORMERS

Power transformers are static devices that are used to transform electrical energy from a higher voltage to a lower voltage. They are critical and capital-intensive assets for utilities. Power transformers come in various sizes, phase arrangements and voltages. Performance of the power transformer is critical to maintaining supply to customers.

Power transformers are robust with very good reliability, requiring relatively low maintenance. However, the on-load tap changers are prone to wear and tear which can lead to premature failure if not monitored and not regularly maintained. The internal health of a transformer is not easily observed and therefore it is highly important for transformers to be regularly monitored and tested to ensure the overall health of the asset is within acceptable parameters and limits. Failures of power transformers are rare but if they do occur they are often sudden and can have a severe impact including considerable collateral damage to other equipment, lost revenue, extended network outages, and in rare instances injury or death to persons.

12.4.1.1 POPULATION AND AGE

Vector currently has 218 (VIA DATA) power transformers in service ranging from 5 MVA to 80 MVA. They take supply from the Transpower network at 110 kV, 33 kV and 22 kV to step the voltage down to 22 kV or 11 kV for network distribution. The transformer fleet is composed of 20 different manufacturers encompassing 21 different models. Since the year 2000, Vector has standardised on a small number of manufacturers and power transformer models which has reduced the type and number of spare parts required. The average age of our power transformers is 34.9 years. 56 power transformers are 50 years and older with the oldest being 66 years of age.

Table 12-6 provides a summary of the population of our power transformers by voltage category. Most of our power transformers (approximately 70%) are rated 33/11 kV.

CATEGORY	110/11 KV TRANSFORMER	110/22/11 KV TRANSFORMER	110/33 KV TRANSFORMER	110/22 KV TRANSFORMER	33/22 KV TRANSFORMER	33/11 KV TRANSFORMER	22/11 KV TRANSFORMER
Population	2	2	5	8	1	163	43

TABLE 12-6: POWER TRANSFORMER POPULATION

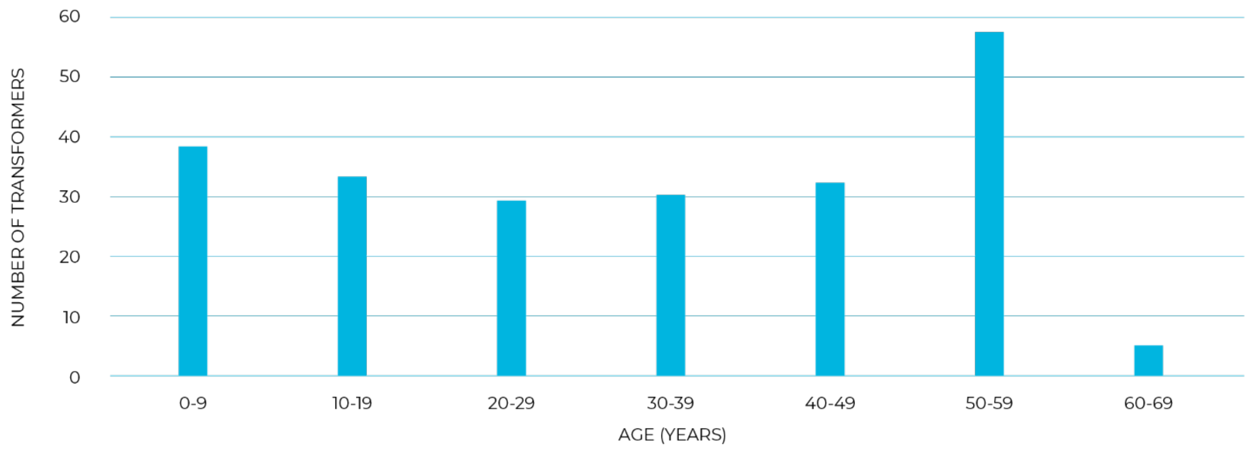


FIGURE 12-5: POWER TRANSFORMER FLEET AGE PROFILE

12.4.1.2 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector relies on Dissolved Gas Analysis (DGA) of the insulating oil in the form of Transformer Condition Assessment (TCA) of the main tank and Tap Changer Activity Signature Analysis (TASA) for its tap changers. This type of oil testing identifies the presence of different gases and by-products of internal insulation degradation and trending over time, allowing Vector to trend and determine the health of the internal condition of the power transformer fleet.

In addition to the TCA, power transformers are monitored using Reg-DA voltage regulating relays and protection relays. These protection relays monitor inputs from current transformers, instrument transformers, temperature sensors, oil level sensors and Buchholz devices (which detect internal faults resulting in rapid gas accumulation and surges inside transformers). Incipient faults trigger alarms via SCADA which then elicits a response by field crews to undertake detailed investigations.

Over the last 20 years, there have been very few power transformer faults resulting in complete loss or long-term outages. These faults were mainly due to close in through faults or tap changer failure. in most cases the power transformers were able to be repaired. However, in rare cases, the power transformer had to be replaced: details of power transformer failures can be found in Vector's asset strategy for this header class. Overall, the performance of Vector's transformer fleet has been very good.

12.4.1.3 CONDITION AND HEALTH

Vector is actively monitoring the health and condition of the power transformer fleet to ensure we get the optimum life from this fleet. We carefully manage our power transformers so that they are not subject to excessive or prolonged high electrical loading, and we ensure they undergo regular testing in accordance with our maintenance regime.

Vector utilises a VIA analytics model to provide a fleet-wide overview of the condition of its power transformers. Using the available asset health data as input, the model is able to estimate the current health of the transformer fleet, as well as forecast the future health levels in response to different modelling scenarios. The output of this model is used to inform which unit(s) should be refurbished or replaced. Vector's strategy is to progressively replace the population of power transformers that have the worst asset health and are the most likely to suffer major failures.

The present (RY23) condition level for the power transformer fleet is shown in Figure 12-6.

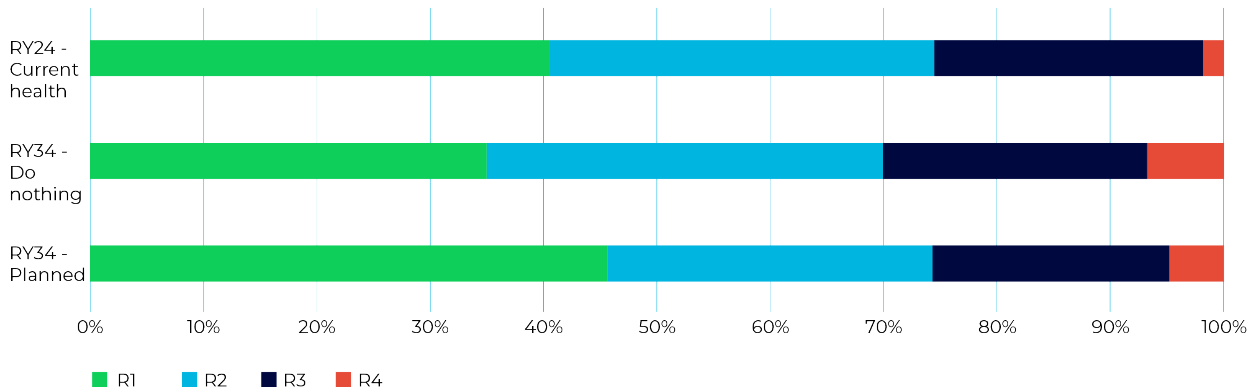


FIGURE 12-6: POWER TRANSFORMER FLEET CONDITION PROFILE

This indicates that Vector's power transformer fleet is in good condition and approximately 10% of the fleet will approach end of life within the next 10 years. Vector's investment programme will ensure that the risk profile of this asset fleet is appropriately managed.

12.4.1.4 MANAGEMENT STRATEGY

The optimal life cycle investment considers the balance between asset renewal requiring capital expenditure and the combination of reactive, preventive, and corrective operational expenditure. The strategies for each of the stages of a transformer lifecycle have been established to address the fleet condition and performance.

Vector has agreed with Transpower to add an additional 220/33 kV interconnecting grid transformer to supplement the existing T7 interconnecting grid transformer at Transpower's Wairau GXP adjacent to Vector's Wairau bulk supply substation. The Vector owned 110/33 kV transformers at Wairau zone substation will be retired in a staged decommissioning program after the second 220/33 kV grid transformer is commissioned into service.

The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.4.1.5 DESIGN AND CONSTRUCT

Vector has two specification standards for new power transformers:

ESS-0120 - Specification for two winding power transformers (33 kV/11 kV); and

ENS-0124 – Specification for 110 kV/22 kV two-winding power transformers

These two Vector standards refer to IEC standards and form the basis under which all new power transformers are purchased. Since the year 2000, Vector has standardised its fleet to 15 MVA and 20 MVA transformers to allow efficient strategic spares management and optimise maintenance tasks. Recently Vector has introduced 28 MVA rated transformers as an option to accommodate customer connections requiring more capacity.

12.4.1.6 OPERATE AND MAINTAIN

Power transformers have very long in service life expectations and can operate at full load continuously. However, continuous use at full rating will result in the insulation life of the paper being exhausted and failure will become imminent at around 25 years. However, Vector, like most utilities worldwide, designs its network with N-1 contingency and as a result the loading on our power transformers is rarely greater than 50% of its nameplate rating for most of its operating life. At this level of loading, we can expect service life to exceed 50 years.

The insulation of power transformers comprises mineral oil, paper and pressboard that has a finite life even under ideal operating conditions. Aging of the paper insulation depends primarily on the operating temperature of the oil and the time in operation at high oil temperatures. Moisture and the presence of oxygen are other factors that will accelerate the ageing of the insulation. Another factor in the life expectancy of a power transformer is the number of downstream faults to which a transformer has been subjected. High magnitude through faults may cause winding and core deformation that will lead to unintentional short-circuits across the insulation, of which a high percentage are irreparable. Depending on the condition of power transformer, mid-life refurbishment is an option to extend the life of a transformer.

Oil tests are conducted on an annual basis, supplemented with TCA and Furan analysis every third year. This program of testing was implemented approximately twenty years ago as a means of lowering operating cost and reducing faults caused by incorrect maintenance on tap changers using time and operations-based intervals.

Vector's maintenance standard ESM201 details the planned, corrective, and reactive maintenance requirements for its power transformer fleet. The planned maintenance regime for our power transformer assets is summarised below in Table 12-7.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Inspection	Inspection of power transformer	2 Months
Thermovision Inspection	Thermovision Inspection of power transformer	1 Year
Partial Discharge Inspection	Partial Discharge Inspection of power transformer	2 Years
Service	Service on tap changer	5 years
Testing	Testing of oil in the power transformer tap changer	1 Year
Testing	Testing of oil in the power transformer tap changer (Vacu-tap)	1 Year
Testing	Testing of oil in the power transformer tank	1 Year
Testing	Testing of oil in the power transformer tank – Furan	3 Years
Testing	Testing of Power transformer protection	4 Years
Testing	Benchmark electrical tests	5 Years

TABLE 12-7: PLANNED MAINTENANCE ACTIVITIES FOR POWER TRANSFORMERS

Until recently, maintenance activities on power transformers were solely triggered from the results of oil analytics. However, an increase in unexpected power transformer failures and faults prompted Vector to introduce a time-based electrical benchmark testing regime to supplement oil testing analytics. Recent electrical baseline tests have identified issues that would not have otherwise been picked up with oil testing alone.

Corrective maintenance is a task carried out to further diagnose or restore a network asset to its serviceable condition and involves further testing, repairing or replacement of parts to ensure that the unit is functioning effectively. Vector's maintenance standard ESM201, Section 4 details the requirements of specific corrective maintenance activities for power transformers.

Reactive maintenance work for power transformers involves returning a power transformer to service, usually after an unplanned outage due to an unforeseen event such as close-in through faults. For every unplanned outage, we undertake post event root cause analysis to ensure that any valuable information as a result of the fault is captured and data is available to identify any trends.

A Failure Mode Effect Analysis (FMEA) register has been created for all power transformers to consider the design, procurement, construction, testing and commissioning, operations and maintenance, and decommissioning. Outputs from the FMEA will be used to further develop the Transformer Risk Ranking tool to provide greater population risk analysis, improved maintenance and inspection regimes and better prioritised asset replacement programs of work.

12.4.2 POWER TRANSFORMER TAP CHANGERS

The purpose of a tap changer is to regulate the output voltage of a transformer so that it can be maintained within the required voltage range. Tap changers have preconfigured 'steps' with typical changes to the output voltage of 1.25% per step to +5% and down to -15%. Tap changers can be fitted to either the primary (HV) or secondary (LV) winding but the majority are fitted to taps on the HV winding due to the lower current and easy access to the outer HV winding.

12.4.2.1 POPULATION AND AGE

Power transformers for Vector's network are procured complete with a tap changer. Tap changers are intended to match the entire life of a power transformer subject to good maintenance practices. It is rare that a tap changer is replaced in its entirety and can generally be considered as fit for life. As such, asset health modelling is focused on the power transformer as described in the previous section instead of considering tap changers separately.

There are two types of tap changers in use: on and off load. Most of Vector's power transformers are equipped with oil type on-load type tap changers because they can be operated while the transformer is energised. Since 2009, Vector has procured power transformers with vacuum interrupter type on-load tap changers. The off-load types require the transformer to be de-energised and isolated so are only used where automatic voltage regulation is not required. Only two of Vector's power transformers are fitted with off-load tap changers.

Currently, Vector has tap changers in service from eight different manufacturers with Ferranti, Fuller and Reinhausen being the most prevalent. Since 2000, Vector has standardised its fleet to use only Reinhausen tap changers.

12.4.2.2 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Due to age and uncommon types of tap changers used on some of the transformers, there is a risk of obsolescence and unavailability of spare parts. Vector has partnered with local manufacturers to custom manufacture parts as needed.

Secondary system components such as tap-changer drive/control mechanisms are complex and prone to faults as the equipment ages. This type of failure does not often result in a permanent loss but can contribute to power quality issues.

12.4.2.3 CONDITION AND HEALTH

Vector uses the results of TASA (Tap Change Activity Signature Analysis) oil tests results to trigger maintenance activities. TASA oil tests assume a certain number of operations over the entire range of the tap changer positions, rather than the actual range. Because of Vectors excellent voltage stability, tap changers seldom transition more than three taps either side of the nominal position. With a similar number of tap change operations, oil test results from the tap changer cycling through all 17 tap positions vs. a tap changer cycling through only six positions would show similar results, but the contacts of the latter would show significantly less deterioration.

While TASA oil tests have proven to reduce costs as compared to traditional time-based methods, they are not perfect. Vector has recently experienced issues with tap changers not picked up by this test method. To overcome this issue, a new time and operations-based inspection and maintenance activity has been introduced to the maintenance programme on an initial five-year basis. This new activity will coincide with the new time-based electrical benchmark testing activity being introduced for power transformers.

12.4.3 POWER TRANSFORMER ANCILLARIES

In addition to the main tank and tap changer, there are small but important components fitted to a power transformer. These ancillary components include:

- Bushings - Every power transformer is fitted with LV and HV bushings. Nearly all Vector power transformers are fitted with solid porcelain bushings. Older outdoor power transformers are fitted with solid porcelain oil filled type bushings. These are reliable having no systemic issues other than periodic leaks of a gasket, which are usually minor in nature and repairable.
- Protection Equipment - Protection, control and monitoring of power transformer comprises either legacy analogue, solid state or fully digital systems. The preferred digital platform is the REG-DA (A-Eberle) system for voltage control and transformer monitoring.
- Neutral Earthing - Neutral earthing resistors act to reduce the fault current during phase to earth faults. They are effective to reduce damage to network equipment and require little to no maintenance and are co-located with the power transformer.
- Cooling Systems - There are two systems used on Vector's transformers: bulk oil cooling and heat exchanger systems. The oil radiator system is by far the most common in use and is also an uncomplicated system. The heat exchanger system relies on the continuous operation of pumps and is rarely used due to its complexity.
- Oil Preservation - All of Vector's power transformers are either of a free breathing or atmoseal (bladder) type preservation systems. The free breathing type are not sealed from the atmosphere. As the unit heats and cools through normal operation, the changes in the oil volume are taken up in the headspace of the conservator tank.

12.4.3.1 CONDITION AND HEALTH

Transformer ancillaries are almost always acquired at the same time as the power transformer and are covered by the same specifications. Transformer ancillaries are expected to last the life of the power transformer. Vector maintains a stock of spare parts and ensures contractor capabilities to carryout timely repairs.

12.4.3.2 MANAGEMENT STRATEGY

Maintenance of ancillary components is carried out during periodic inspections or by test regimes as indicated by Vector's maintenance standards.

If required, some component parts are replaced or repaired as necessary under corrective works. However, the ancillary components are generally replaced when the power transformer is replaced.

12.4.4 REPLACE, RENEW AND DISPOSE

The key drivers for replacement are asset health and criticality to ensure the continued reliability of zone substations. Operationally, most of Vector's fleet of power transformers have been loaded well below their design rating thus ensuring oil and winding temperatures have been kept low through most of their operating life thus prolonging the life of the paper (cellulose) insulation. This often enables 30–40-year-old units to have what is commonly called a 'midlife refurbishment' in which the transformer is taken off-site and is completely stripped down, dried out and all badly worn parts replaced before being re-assembled and taken back to site.

The refurbishment is undertaken in accordance with Vector's standard ENS-0164 with the objective to extend the life of the transformer by 25 years. Candidates for refurbishing are reviewed on a case-by-case basis, triggered by condition, criticality, and future value to the network. The economics of the option to refurbish vs replacement are also considered.

The availability of spare parts, especially for tap changers, will impact our decision on whether to refurbish or to replace a power transformer. Notwithstanding our maintenance and testing regime, the asset health of our oldest power transformers has now reached a stage where 'midlife refurbishment' is unlikely to be an economic option.

Power transformers that require replacement are scrapped but parts will be salvaged and placed in strategic stock to be utilised as a source of spares for similar transformers in the fleet that remain in service.

Some of our older power transformers have off-tank radiators; this layout has triggered a new initiative to procure a variety of power transformers of sufficient capacity, impedance, and off-tank radiator design to enable existing building enclosures to be used. With the initiative to add off-tank radiator power transformers to the fleet procurement strategy, it is anticipated to significantly reduce power transformer bay demolition and civil rebuild costs that would otherwise be unavoidable with Vector's present standard on-tank radiator rectangular footprint design.

Tap changers are integrated components of transformers so are typically replaced when the associated transformer reaches end of life. However, if and where required, a tap changer will be replaced as a separate entity if a transformer is still in good asset health. Vector has only replaced a few tap changers during refurbishment.

As described in the previous section, the availability of spare parts for tap changers guides our decision on whether to refurbish or to replace a power transformer. Replacement parts for certain older generation tap changers are almost impossible to source and decommissioned tap changers are used for spare parts where possible.

12.4.5 FORECAST SPEND

Figure 12-7 below shows our forecast capital spend for the complete replacement programme of power transformers as well as provision for refurbishment in the AMP period. Full details of the individual transformer replacements are given in Section 12 Appendix.

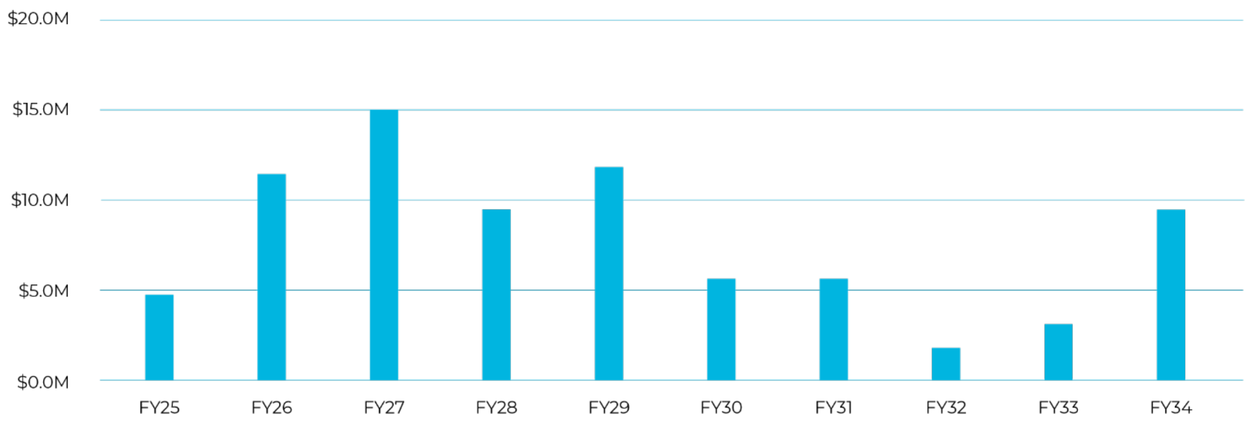


FIGURE 12-7: FORECAST CAPEX – POWER TRANSFORMERS

12.5 Underground cables

This section describes our cable fleet and provides a summary of our associated asset management practices. The cable fleet comprises of:

- Subtransmission (includes submarine cables)
- Distribution
- Low Voltage (LV)
- Joints and terminations

12.5.1 SUBTRANSMISSION

The subtransmission cable network transports electricity from Transpower GXPs to Vector's bulk supply substations and zone substations. Vector's subtransmission cable network operates at 110 kV, 33 kV and 22 kV.

The 110 kV subtransmission network originates from Transpower 110 kV GXPs and connects to Vector's bulk supply substations in the Auckland CBD, Kingsland and Wairau Valley on the North Shore. The 110 kV subtransmission network includes the cables installed within the Penrose to CBD tunnel as well as cables buried underground directly or in ducts. The 33 kV and 22 kV subtransmission circuits run from Vector's bulk supply substations and Transpower GXPs to Vector's zone substations and are installed in underground buried directly or in ducts and in some instances in Vector's tunnels.

12.5.1.1 FLEET OVERVIEW

Key statistics of the 110, 33 and 22 kV subtransmission cable assets are shown in Table 12-8.

CATEGORY	NUMBER OF 110 KV UNDERGROUND SUBTRANSMISSION CIRCUITS	110 KV UNDERGROUND SUBTRANSMISSION CIRCUITS ROUTE LENGTH	110 KV UNDERGROUND SUBTRANSMISSION CIRCUITS IN TUNNELS ROUTE LENGTH	NUMBER OF 33 KV AND 22 KV UNDERGROUND SUBTRANSMISSION CIRCUITS	33 KV AND 22 KV UNDERGROUND SUBTRANSMISSION CIRCUITS ROUTE LENGTH	33 KV AND 22 KV SUBMARINE SUBTRANSMISSION CIRCUITS ROUTE LENGTH
Population	12	28 km	21 km	240	548 km	12 km

TABLE 12-8: SUBTRANSMISSION CABLES FLEET OVERVIEW

The total number of circuits for 110,33 and 22kV circuits has decreased since last year due to consolidated data. This data excludes internal cables circuits between zone substation transformers and switchgear (internal cabling).

12.5.1.2 POPULATION AND AGE

The expected life for subtransmission cables is indicated below in Table 12-9:

CATEGORY	22 KV, 33 KV OIL CABLES	22 KV, 33 KV PILC	22 KV, 33 KV PRIOR TO MID 1980'S XLPE	22 KV, 33 KV PRESENT GENERATION XLPE	22 KV, 33 KV SUBMARINE CABLE - XLPE	22 KV, 33 KV SUBMARINE CABLE - PILC	22 KV, 33 KV SUBMARINE CABLE – OIL CABLES	110 KV XLPE
Onset of unreliability	70 years	60 years	30 years	60 years	60 years	60 years	70 years	70 years
Maximum practical life	100 years	90 years	45 years	80 years	60 years	60 years	70 years	90 years

TABLE 12-9: EXPECTED LIFE OF SUBTRANSMISSION CABLES

The figures above are based on EEA Asset Health Indicator (Guide) 2019 and ODV. However, some projections of the lifespans have been amended based on Vector's experience.

Figure 12-8 below summarises the population and age of our 110 kV, 33 kV and 22 kV subtransmission cable fleets.

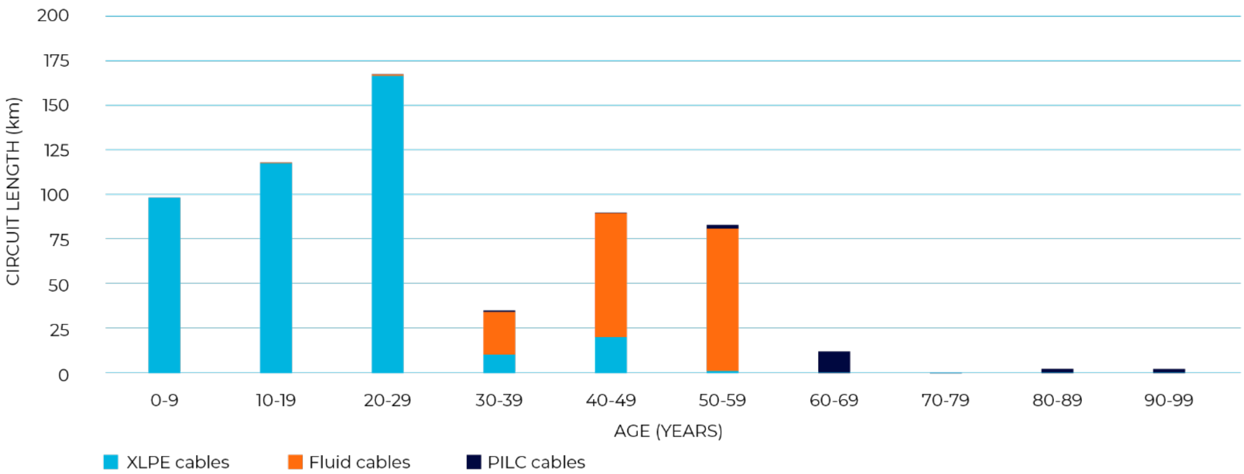


FIGURE 12-8: SUBTRANSMISSION CABLE FLEET AGE PROFILE

12.5.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

General:

Figure 12-9 shows the SAIFI interruptions contributed by subtransmission cables system assets and the number of unplanned events between regulatory years 2014-2023.

Just under half of the total number of unplanned events have the cause recorded as cable, however most of these are likely attributed to joint or termination failures due to records not being updated once the root cause is discovered.

Because the subtransmission network normally operate at an N-1 security level, unplanned events often result in no loss of supply and no SAIDI or SAIFI. For example, in 2017 there were six unplanned events caused by subtransmission cable assets but zero SAIDI and SAIFI was contributed. However, when there is a loss of a circuit, it leads to reduced security of supply and can impact a much greater SAIFI.

110 kV cables: The oldest 110 kV cables in Vector's fleet are the two cables from Mt Roskill GXP to Kingsland zone substation which have been in service since 1965 (57 years old). The 110 kV cables to Pacific Steel were installed in 1982 and the remainder of the fleet after that. The maximum practical life of 110 kV cables and their accessories is projected to be approximately 90 years and we do not expect any material deterioration of these assets over the next 10 years.

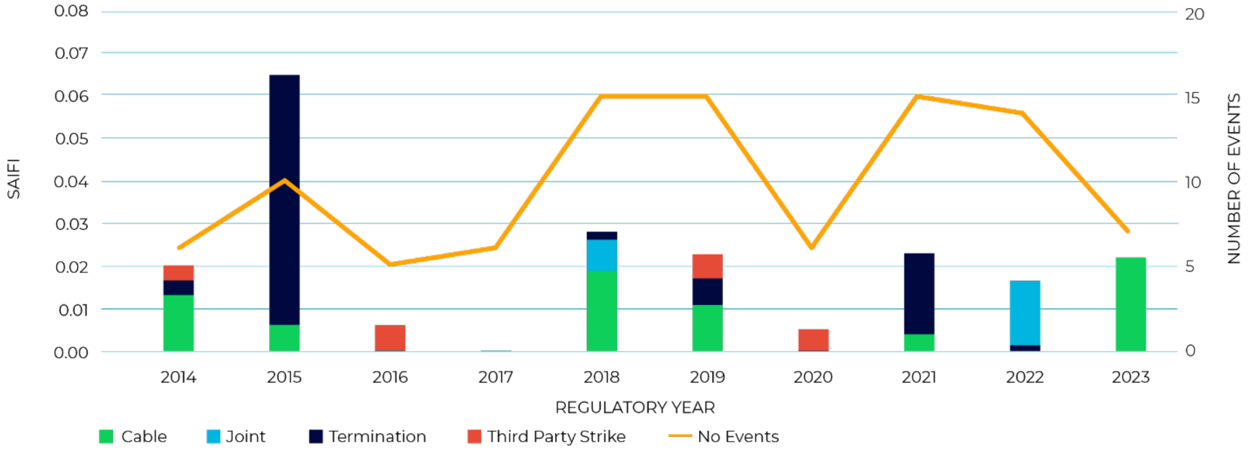


FIGURE 12-9: SUBTRANSMISSION CABLE SYSTEM ASSET PERFORMANCE

22 kV/33 kV PILC cables: We have identified that for some 33 kV and 22 kV PILC cables in our fleet, there is an increasing contribution to SAIDI, but others are performing well. This specific population is viewed as the type at highest risk and is therefore being closely monitored.

22 kV/33 kV fluid filled cables: An average of four outages per year over the last ten years are attributable to oil filled cables, with leaking cable joints being the main cause. While the trend of oil loss over the entirety of the fleet of oil filled cables has been rising, an increased focus over the last two years has seen this trend decrease due to improved management practices. There is an industry wide risk that the resource pool required to repair and maintain oil filled cables is reducing at a time when there will be an increased need to manage this type of cable fleet. Accordingly, Vector is working with its FSPs to ensure the appropriate skills and resources are available to manage this risk going forward.

22 kV/33 kV XLPE cables: While the current versions of this cable are very robust, the early generations of XLPE (between 1970-1990) had manufacturing defects which could result in premature failures of the cable. Vector has experienced several repeat failures on the early generations of XLPE, resulting in the establishment of a proactive replacement programme for the population.

12.5.1.4 CONDITION AND HEALTH

Vector has recently developed a CBARM model to assist to inform the replacement programme for subtransmission cables. This model is based on age, condition and criticality. The present (RY24) risk level for the subtransmission cables fleet is shown below in Figure 12-10.

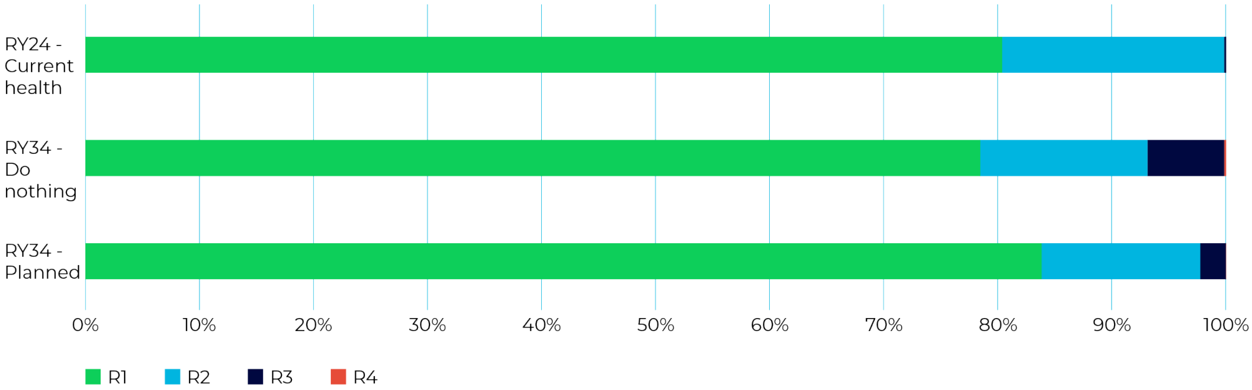


FIGURE 12-10: SUBTRANSMISSION CABLE FLEET RISK LEVEL

The above indicates that the subtransmission fleet is in good condition. However, without intervention from Vector's investment programme, we expect that a small portion of the assets will be reaching an extremely high-risk category (R4 category) and a larger portion reaching a high-risk category (R3 category) within the next 10 years. Vector's investment programme will ensure that the risk profile is maintained at current levels. The risk profile for FY24 has changed since the last iteration due to improvement in the input data and recalibration of criticality factors within the CBARM model.

12.5.1.5 MANAGEMENT STRATEGY

The management strategy for subtransmission cables is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers and close scrutiny by the Vector Asset Management team. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.5.1.6 DESIGN AND CONSTRUCT

New cable circuits generally comprise three-core or single core cables with XLPE insulation, copper wire screen, PE or PVC outer sheaths with a water blocking layer. Cables sizes and types are standardised across the network to reduce the required types of spares and accessories and simplify the procurement and maintenance activities.

New major cable circuits are generally installed in ducts utilising directional drilling techniques. Cables sizes and types are standardised across the network to reduce the required types of the spares and accessories and simplify the procurement and maintenance activities.

Vector standards, ENS-0191 and EN-0032 detail the technical requirements for the procurement of subtransmission underground cables. Vector balances the benefits in economies of using a single cable manufacturer against the risks of not having supply chain redundancy and reduced standardization and potential costs.

Vector utilises CYMCAP cable thermal rating software to model the installation details and ensure optimum ratings for a cable circuit(s). This model considers the physical cable installation environment, prospective future load profiles and other external factors such as heat sources from other cables. The CYMCAP software is also used to determine the ampacity of subtransmission circuits and the impact of adjacent cable circuits.

Vector has design standards (refer to Appendix 2 in Section 17) in place that ensures that cables are installed in a consistent, cost-effective manner and in accordance with best practice to ensure that asset life is maximised.

12.5.1.7 OPERATE AND MAINTAIN

Subtransmission cables are operated within rating limits established by CYMCAP cable rating modelling for summer, winter, and contingency situations. These limits undergo a partial review every two years and a full review every five years.

Vector manages the seasonal ratings of subtransmission cables via Scada, informed by soil moisture content data gathered from NIWA weather stations.

Planned maintenance activities for subtransmission cables revolve around preventing third party damage via proactive patrolling and inspection of construction and subdivision sites as it is difficult to physically inspect cables once they are installed underground. Where possible (such as zone substations or overhead connections), subtransmission cable assets are visually inspected. Joints and terminations which are visible are monitored for signs for distress. The oil filled cable fleet is well maintained by trained oil mechanics and condition assessed by our engineering specialists. The oil pressure in oil filled cables is monitored and alarmed to the EOC via the SCADA system. This enables us to respond quickly to loss of pressure and repair a defect before it turns into a cable fault.

Vector's maintenance standard ESM301 details the planned, corrective and reactive maintenance requirements for its subtransmission cables. The planned maintenance programme for our subtransmission cable assets is summarised below in Table 12-10.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Inspection	Inspection on subtransmission patrol	1 Week
Inspection	Inspection on oil and gas cables and drums in strategic stock	6 Months
Inspection	Inspection on oil truck & trailer inspection	6 Months
Inspection	Inspection on tunnel cables and their support structures in tunnels	1 Year
Inspection	Inspection on maintenance of waterway crossings - land based inspections	5 Years
Inspection	Inspection on maintenance of waterway crossings. Water based inspection	5 Years
Thermovision Inspection	Thermal inspection on externally visible cable systems (cables, terminations, joints)	1 Year
Servicing	Servicing on cable equipment kiosk/pit maintenance	6 Months
Servicing	Servicing on cross link bonding boxes	2 Years
Testing	Testing on all alarm settings and operating function on gauges and transducers	6 Months
Testing	Test, check and calibrate all cable oil pressure alarm gauges and transducers	2 Years
Testing	Testing on subtransmission cables servicing testing	2 Years
Testing	Testing on cable cover protection unit (SVLs) (Oil and solid cable)	5 Years

TABLE 12-10: PLANNED MAINTENANCE ACTIVITIES FOR SUBTRANSMISSION CABLES

Corrective maintenance activities for subtransmission cables are carried out to further diagnose or restore a network asset to its serviceable condition.

Reactive maintenance for subtransmission cables involves work needed to return a cable to service, usually after an unplanned outage due to an unforeseen event such as a fault due to third party interference. For every unplanned outage, we undertake post event root cause analysis and record data pertaining to faults to check any developing trend, root cause or issues with a specific type of material or cable.

In addition, partial discharge, tan delta diagnostic testing is used as required to provide information on XLPE circuits which have a suspected issue. The testing is currently done on selective circuits and based on circumstances and condition of the cable as testing could lead to premature failures on old assets with known condition issues.

12.5.2 DISTRIBUTION

Distribution cables connect zone substations to distribution switchgear or transformers and connect between distribution transformers and switchgear. Vector's distribution cables are predominantly XLPE and PILC 11 kV cables. However, we also have population of 22 kV distribution cables in the Highbrook, Roskill, Kingsland and CBD supply areas of the network to cater for high density energy needs.

12.5.2.1 FLEET OVERVIEW

Key statistics of Vector's distribution cables assets are shown in Table 12-11.

NUMBER OF 11 KV AND 22 KV UNDERGROUND DISTRIBUTION CIRCUITS	922
LENGTH OF 11 KV AND 22 KV UNDERGROUND DISTRIBUTION CIRCUITS (KM)	3,924

TABLE 12-11: DISTRIBUTION CABLES FLEET OVERVIEW

12.5.2.2 POPULATION AND AGE

The expected life for distribution cables is indicated below in Table 12-12:

CATEGORY	ONSET OF UNRELIABILITY	MAXIMUM PRACTICAL LIFE
11 kV PILC	60 years	80 years
Pre 1985 XLPE	20 years	40 years
11 kV, 22 kV present generation XLPE	60 years	80 years

TABLE 12-12: EXPECTED ASSET LIFE FOR DISTRIBUTION CABLES

The figures above are based on the EEA Asset Health Indicator (Guide) 2019 and ODV. However, some projections of the lifespans have been amended based on Vector's experience.

Figure 12-11 summarises the population and age of our 11 kV and 22 kV distribution cables.

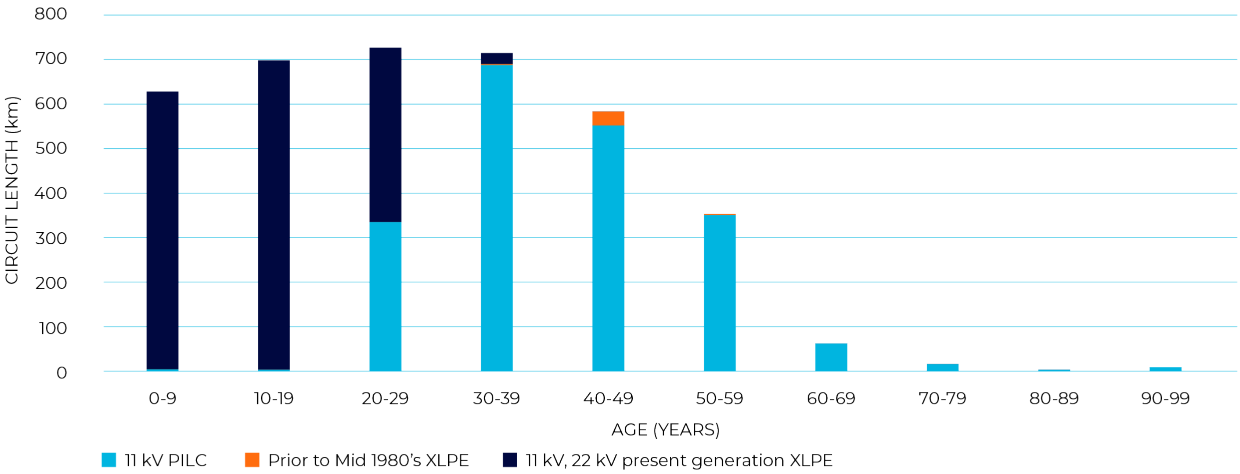


FIGURE 12-11: DISTRIBUTION CABLES FLEET AGE PROFILE

12.5.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector's distribution XLPE cables are performing well with most cables being less than 20 years old and therefore in the early part of their operational life span. The exception to this is our polyloom cables and XLPE cables manufactured and installed prior to 1990. These have exhibited poor reliability due to the integrity issues on the outer sheath. However, our population of polyloom cable is relatively small and the impact on network performance has been minor. Vector has a significant portion of distribution installed between 1950 and 1980 and are approaching the end of their reliable working life. A proactive programme of replacement has been on-going and is continuing to replace 11 kV and 22 kV cables most at risk or in areas of high criticality.

Distribution cables have an average fault rating of 0.047 faults/km with most of these faults attributable to PILC cables. Most faults are found to originate from cable joints or terminations. However, the results of some of the pre-commissioning tests upon repair suggest a deterioration of the cable insulation.

Vector has identified that the trend of increasing frequency of sustained high temperatures over the summer months presents a risk of accelerated degradation to all underground cables when it coincides with low soil moisture content and increased cyclic loading. Vector mitigates this risk by modelling cable circuits approaching ampacity limits.

Figure 12-12 shows the SAIFI contribution from distribution cable system assets and the total number of unplanned events between regulatory years 2014-2023. Most events attributed to cables are likely caused by joints and terminations in both subtransmission and distribution cable systems. Third party is a major contributor to cable faults however, we expect to see a reduction of this with more modern cables being installed in ducts at greater depths.

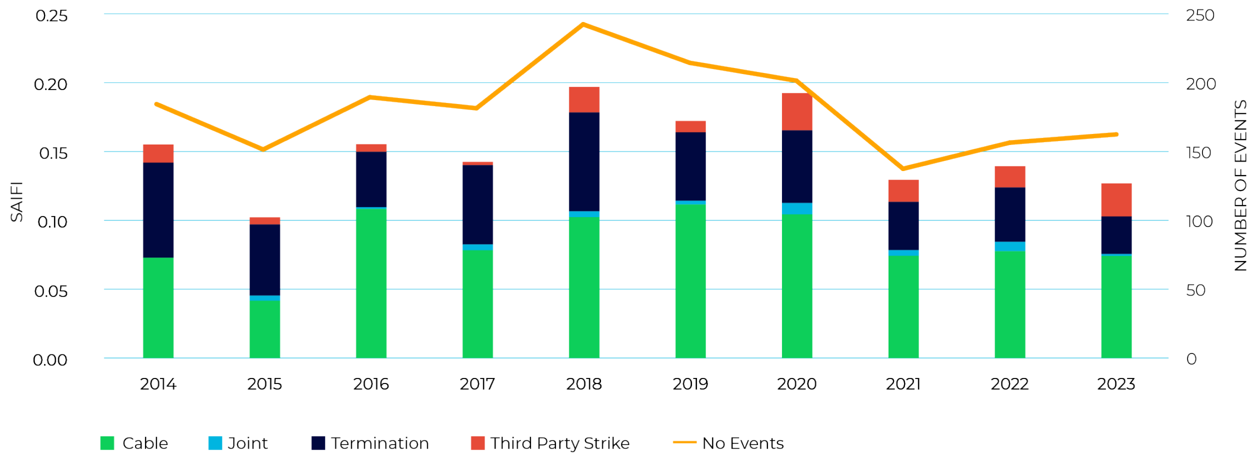


FIGURE 53-12: DISTRIBUTION CABLE SYSTEM ASSET PERFORMANCE

12.5.2.4 CONDITION AND HEALTH

Our CBARM model for distribution cables is based on age, condition and criticality. The present (RY23) risk level for the distribution cables fleet is shown in Figure 12-13.

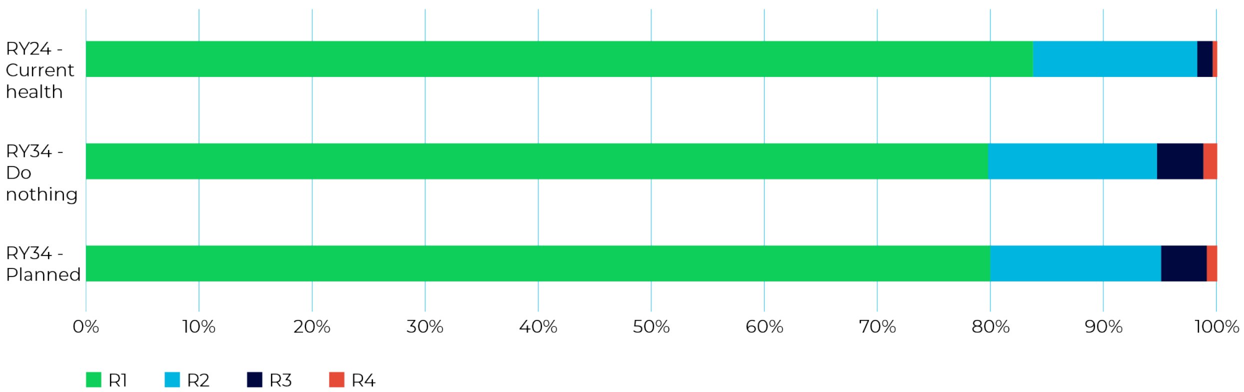


FIGURE 12-13: DISTRIBUTION CABLES RISK PROFILE

The risk profile indicates that the distribution cable fleet is aging. This is predominately due to the PILC cable fleet which has an average age of 40 years. Our analysis shows that approximately 1% of the fleet will approach end of life within the next 10 years. Due to this, it is possible that number of cable faults occurring on the 11kV network may increase from present levels. In the past 3 years, we have conducted tan delta and PD testing on approximately 200 main sections of the feeders to capture further condition insights. While we have found PD can be inconclusive especially with PILC cables, it is a tool to provide a condition score for the cables and not a sole reason for replacement. Vector's investment programme will ensure that the risk profile of this asset fleet will be maintained at approximately present levels.

The risk profile for FY24 has changed since the last iteration due to improvement in the input data and recalibration of criticality factors within the CBARM model.

12.5.2.5 MANAGEMENT STRATEGY

The management strategy for distribution cables is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.5.2.6 DESIGN AND CONSTRUCT

Vector has standardised the type of cables used in its distribution network to reduce the stockholding of many types (and accessories, simplify procurement and maintenance activities and reduce stockholding costs. Generally, new cables are specified to be three-core or single core cables with XLPE insulation, copper wire screen, PE or PVC outer sheaths with a water blocking layer.

Vector's procurement standard ENS-0127 details the requirements for distribution underground cables. The distribution network uses predominantly 11 kV cables, but 22 kV XLPE cables are used in high-density load areas.

Vector maintains a strategic stockpile of the standard range of cable types and sizes used by Vector to ensure that critical spares are available for contingencies.

Vector has design and installation standards ESE301, ESE302 and ESE303 in place which ensures that cables are installed in a consistent and cost-effective manner and in accordance with best practice to ensure that asset life is maximized (see Appendix 2, Section 17 for the list of design standards). Construction of new cables for the distribution network is like that for subtransmission network and are exclusively XLPE.

12.5.2.7 OPERATE AND MAINTAIN

Vector's maintenance standard ESM301 details the planned, corrective and reactive maintenance requirements for its distribution cable fleet. The planned maintenance regime for distribution cable involves a visual condition assessment inspection on externally visible cable systems (cables, terminations, joints) every five years.

Corrective maintenance activities for distribution cables are carried out to further diagnose or restore a network asset to its serviceable condition. This typically involves sheath integrity testing for distribution cables identified with a high risk of failure.

Reactive maintenance for distribution cables involves work needed to return a cable to service, usually after an unplanned outage due to an unforeseen event such as a fault due to third party interference. For every major unplanned outage, we undertake post event root cause analysis to ensure that any valuable information relating to the fault is recorded and data is available to identify any trends.

12.5.3 LOW VOLTAGE

Low voltage cables are used for distribution and connection from ground or pole mounted transformers to the customer.

12.5.3.1 FLEET OVERVIEW

Key statistics for the low voltage cable assets are shown in Table 12-13.

CIRCUIT LENGTH OF LV UNDERGROUND CABLE DISTRIBUTION FEEDERS (KM) – AUCKLAND NETWORK	3,645
CIRCUIT LENGTH OF LV UNDERGROUND CABLE DISTRIBUTION FEEDERS (KM) – NORTHERN NETWORK	2,554

TABLE 12-13: LOW VOLTAGE CABLES FLEET OVERVIEW

12.5.3.2 POPULATION AND AGE

Approximately 65% of the LV network in the Auckland region is undergrounded. In some areas, the underground network has been in service for over 60 years. Pockets of underground LV networks exist in the Northern region, but the underground network in the Northern region are generally of lower age. Due to population growth in the Northern region, the underground LV network is expanding.

12.5.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

We are not experiencing any systemic network failure modes in our LV underground network but are seeing a slight increase in faults in older parts of the LV underground network. The biggest threat and cause of faults in the LV underground cable network is damage by third party excavations and vehicle strikes on above ground pillar boxes.

12.5.3.4 CONDITION AND HEALTH

For legacy reasons, data deficiencies exist for much of the existing LV underground network and hence Vector does not presently have robust data with regards to condition and health for this asset class. Vector is improving its data accuracy for LV cables by recording asset information for all new installations and replacement work.

12.5.3.5 MANAGEMENT STRATEGY

The low voltage cable fleet is not replaced as part of a proactive programme of works but is dealt with on a reactive replacement basis given its relatively localised impact on the network due to the low numbers of customers impacted by these failures. These circuits are however replaced as part of larger scale works when required.

Vector considers the improvement of existing data records as a top priority for this asset class as it is a critical pre-requisite before the establishment of a proactive asset management strategy. The ESM505 maintenance standard defines the procedure for data capture and system updates carried out by Vector's field service providers. It also prescribes preventive maintenance requirements, frequency of inspections, and how to treat defects identified either through corrective maintenance or asset replacement processes.

12.5.4 CABLE JOINTS AND TERMINATIONS

Cable terminations and joints are used to join cable sections together or transitioning the cable to busbars or overhead lines. They are a critical component of the cable system for subtransmission, distribution and low voltage cable systems but are often the points of failure.

12.5.4.1 FLEET OVERVIEW

Key statistics of the cable ancillary assets are shown in Table 12-14. The transformer cable termination component of the statistics (as well as the population chart in Figure 12-12) is inferred from the population of our distribution and power transformers due to data unavailability.

TYPE	UNITS
110 kV subtransmission cable joints & terminations	138
33 kV subtransmission cable joints & terminations	2,392
22 kV subtransmission cable joints & terminations	732
22 kV distribution cable joints & terminations	1,461
11 kV distribution cable joints & terminations	71,381

TABLE 12-14: DISTRIBUTION CABLE JOINT & TERMINATION FLEET OVERVIEW

12.5.4.2 POPULATION AND AGE

The expected life for cables joints and terminations are indicated below in Table 12-15.

CATEGORY	ONSET OF UNRELIABILITY	MAXIMUM PRACTICAL LIFE
Subtransmission cable oil filled cable joints and terminations	40 years	60 years
Subtransmission solid cable joints and terminations	40 years	65 years
Distribution joints and terminations	40 years	65 years

TABLE 12-15: EXPECTED LIFE OF CABLE ACCESSORIES

The figures above are based on the EEA Asset Health Indicator (Guide) 2019 and ODV. However, some projections of the lifespans have been amended based on Vector's experience. The graphs below summarises the population and age of our cable joints and terminations.

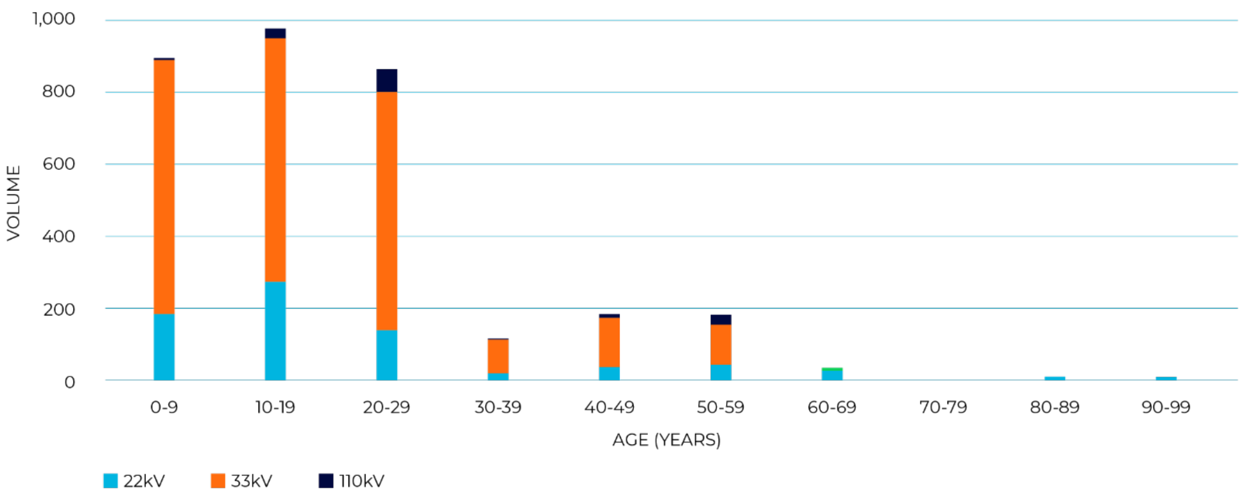


FIGURE 12-14: SUBTRANSMISSION CABLE JOINT AND TERMINATION FLEET AGE PROFILE

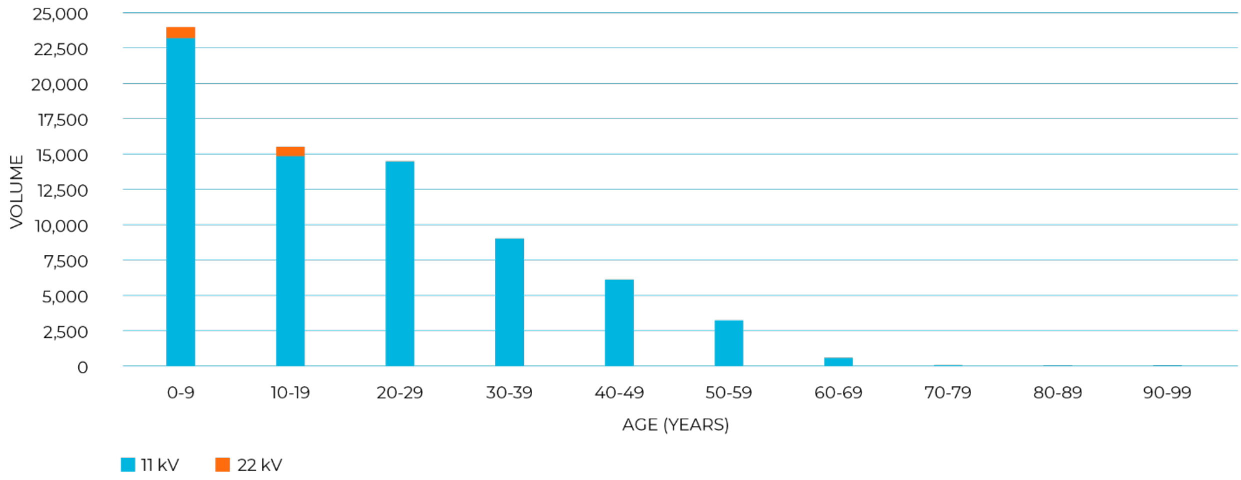


FIGURE 12-15: DISTRIBUTION CABLE JOINT AND TERMINATION FLEET AGE PROFILE

12.5.4.3 CONDITION AND HEALTH

The routine condition assessment of cable joints can be impractical as they are predominately installed underground and require the cable to be offline to undertake testing. As such, the monitoring of joints is reserved for critical circuits and instead, the age of the joint is used as a proxy for its condition. As such, aside from specific known issues or established trends, the condition of cable joints and terminations mirrors that of its associated cable.

12.5.4.4 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector has identified several trends associated with specific types of joints and terminations. There are some known issues associated with the twelve Pirelli (Prysmian) outdoor terminations installed in 1998. The issues concern the internal oil sealing mechanism which can be unreliable. Vector actively monitors these terminations to identify any issues that may lead to premature failure and takes remediation action where necessary.

Vector has approximately 11,100 compression joints on the 11 kV distribution network and close to 1,000 joints in the subtransmission network. These joints were installed between 1980 and 2005 and are now between 11 and 35 years old. Vector has identified a quality issue associated with the jointing techniques used during this period which, in some cases resulted in the premature degradation and eventual failure.

Cast metal pothead cable terminators on the 33 and 11 kV overhead network have degraded over time. The degradation of this type of termination can allow moisture ingress which has the potential to lead to failure.

Inadequate installation practices on a type of '3M' terminations used on three-core cables has resulted in moisture ingress. In some cases, this has led to discharge and eventual flashover.

Vector has experienced termination failures inside ABB SafeLink ring main units, often after a switchgear replacement job where the existing PILC cable termination is reused. Partial discharge caused by re-orientated cables crossing over, or a misalignment between the termination and bushing are thought to be predominate causes of these failures. Apart from exceptional circumstances, Vector standards no longer allow existing PILC cable terminations to be reused in switchgear replacements.

Some cable termination failures in Safelink units have indicated signs of the termination cover boots slipping down and allowing partial discharge to develop. Inline connector termination kits specifically developed for Safelink switchgear are now used to mitigate this. The moulded cover of this kit is shaped to fit the profile of the Safelink bushings which prevents air gaps and increases mechanical support.

12.5.4.5 MANAGEMENT STRATEGY

The management strategy for subtransmission and distribution cable joints and terminations is based on asset health, network criticality and safety. It is informed by asset health data where it is available and is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.5.4.6 DESIGN AND CONSTRUCT

For the procurement of new cable joints and terminations, Vector uses its standards ENS-0191 and ENS-0032. Vector uses the relevant AS/NZS or IEC standard for testing and quality assurance of the cable accessories used on its network. New products go through a well-defined and rigid trial and evaluation process prior to asset introduction.

Joint and termination kits for solid cables are readily available therefore not stocked as strategic stock. However, for oil filled, 110 kV XLPE and submarine cables, straight, stop and transition joints have a lead time for up to six months and therefore Vector maintains strategic spares for these assets.

12.5.4.7 OPERATE AND MAINTAIN

Vector's standard ESM301 details the maintenance requirements for cable joints and terminations. Aside from instances where specific issues and requirements are identified (such as with 110 kV terminations), Vector's typical routine maintenance practices involve the following:

- Externally visible joints and cable terminations in a zone substation are inspected for any signs of deterioration on an annual basis.
- Overhead cable equipment visual inspection including thermographic and acoustic imaging are undertaken every five years.
- On-line partial discharge tests are undertaken in accordance with a scheduled programme.

12.5.5 REPLACE, RENEW AND DISPOSE

Vector uses its CBARM tool as a risk-based approach to assist to forecast the need for cable replacements. The CBARM model considers asset health, probability of failure and criticality to forecast the need to replace or retire specific subtransmission or distribution cables. Before committing to a decision to replace a cable, Vector validates the output of the CBARM model against test results taken in the field and historical records to ensure the model is providing accurate guidance. Using the outcomes of this analysis Vector has identified the programme of subtransmission cable replacements listed in the Section 12 Appendix to be undertaken within the next 10-year period.

For distribution cables Vector also uses a targeted risk-based approach for replacement. This focuses on replacing the cable sections with a higher-than-average rate of cable faults and the cable sections where the cable is approaching or has reached the end of its reliable service life. The decision for the replacement of a cable circuit is checked against field test results and historical records.

As LV cables have a low impact on network performance the strategy for the replacement of this asset class is to renew the asset on a reactive basis, at end of functional life or when they pose a public health and safety risk.

Vector will replace its cable joints and terminations on an 'as needed' basis. This usually means that the replacement of cable joints and terminations will coincide with cable circuit replacement or repair. The exceptions to this are when targeted programmes of work designed to address specific risks, are undertaken. For example, the programme of work to replace metal pothead terminations which commenced in 2004 with the last remaining potheads expected to be completed in the next two to three years.

12.5.6 FORECAST SPEND

The forecast capex graph shown in Figure 12-16 provides a summary of the overall capital investment for this asset header class for the 10-year AMP forecast period. The replacement and refurbishment programme for underground cables is described in detail in Section 12 Appendix and includes the proposed investment for each individual project.

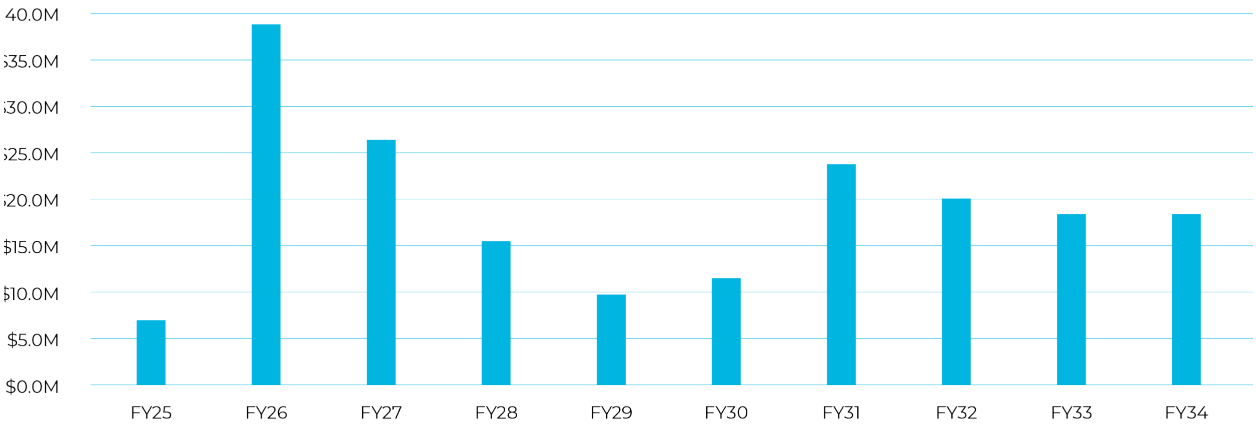


FIGURE 12-16: FORECAST CAPEX – UNDERGROUND CABLES

12.6 Overhead lines

12.6.1 SUBTRANSMISSION

12.6.1.1 FLEET OVERVIEW

Vector's overhead subtransmission circuits transfer electricity from GXPs to bulk supply substations and zone substations and typically operate at 33 kV or above. Vector owns and operates three 110 kV rated subtransmission overhead circuits and 86 circuits operating at 33 kV.

In many instances, multiple subtransmission, distribution and/or low voltage circuits are installed on the same support structures.

12.6.1.2 POPULATION AND AGE

The overhead 110 kV subtransmission network comprises three circuits that run between Transpower's Albany GXP and Vector's Wairau zone substation. All three circuits were constructed in the 1970's with upgrades in 2011 and 2012. The circuits are of the

AAC conductor type. The overhead 33 kV subtransmission overhead line network is spread across Vector's network and comprises a mix of copper, ACSR and AAC conductors mostly installed on concrete poles. Most of this network was built between 1970 and 1995.

Table 12-16 summarises the expected lives of the different conductor types. The actual life is affected by environmental factors (corrosive elements and exposure to wind), mechanical loads, electrical loads and the number/magnitude of downstream electrical faults.

Vector utilizes a variety of different conductor types depending on the amount of energy to be transferred and voltage regulation requirements. Each type of conductor has different expected ages and failure modes that are accounted for in the asset management strategies and plans.

TYPE	EXPECTED LIFE (YEARS)	LENGTH (KM)	
		110 KV	33 KV
All Aluminium Alloy Conductor (AAAC)	60	0	4
Aluminium Alloy Conductor (AAC)	60	27	323
Aluminium Conductor Steel Reinforced (ACSR) >100mm2	55	0	28
Copper (Cu) > 60mm^2	70	0	6
Total		**27**	**361**

TABLE 12-16: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet in Figure 12-17 shows that nearly 10% of the asset fleet is up to 60 years old. Approximately 10% of this asset fleet has exceeded it's expected serviceable life and the end of this AMP period it will increase to 35%.

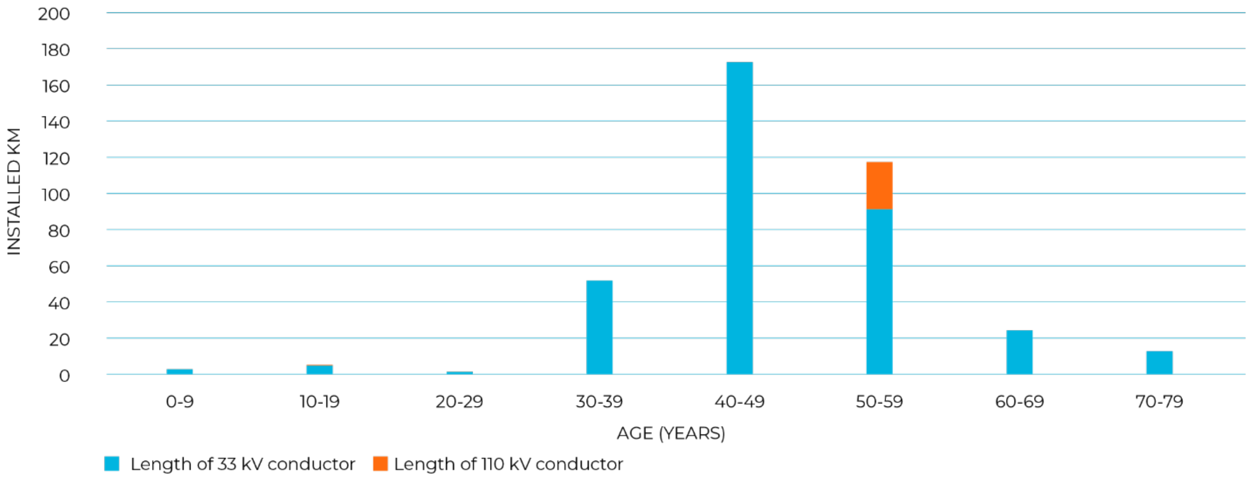


FIGURE 12-17: SUBTRANSMISSION CONDUCTOR FLEET AGE PROFILE

12.6.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

The expected life of each conductor is related to the type of conductor, operating conditions and environmental factors. Conductor diameter is also a factor on life expectancy because smaller conductors are inherently weaker and are less able to withstand shock impacts from external forces such as vegetation and vehicle impacts. Once they have broken, they are repaired with additional joints. Joints are known to be a likely point of failure, especially under fault conditions where secondary failures can occur. As conductors deteriorate and have increasing numbers of joints installed due to repairs, their reliability is expected to decrease.

Figure 12-18 shows the performance of the subtransmission lines as fault rate per 100km. Subtransmission lines are maintained to have a high level of reliability and have redundancy. A fault on a subtransmission line does not necessarily result in a power outage to customers.

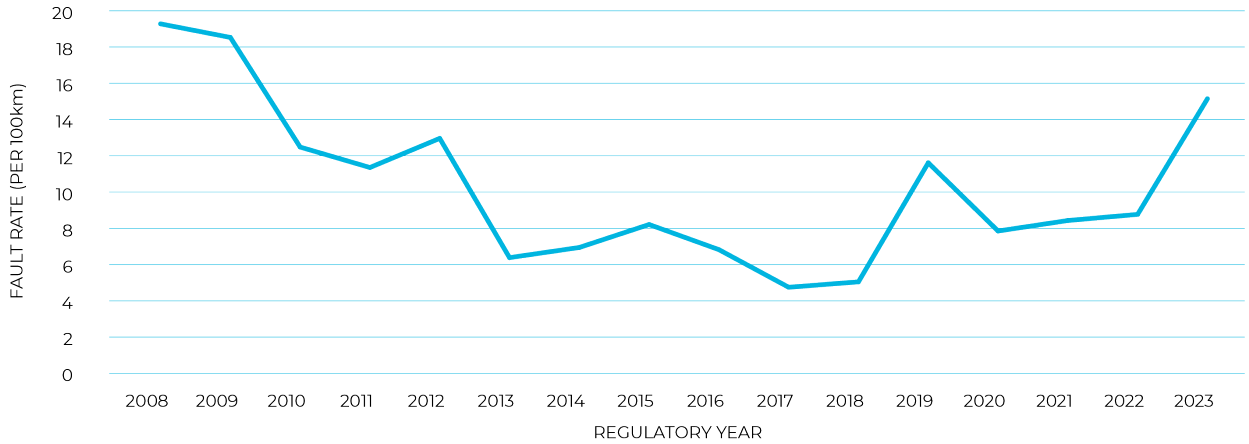


FIGURE 12-18: SUBTRANSMISSION OVERHEAD LINE PERFORMANCE (FAULT RATE)

Other causes of faults and emerging risks identified for this asset fleet that are contributing to its performance are:

- The failure of components of overhead lines, in particular joints
- Vegetation in the proximity of overhead power lines causing transient faults or damage through physical contact. These types of outages are more likely during storms and high winds. This can cause power outages and damage to the conductors that can result in immediate or delayed failure.

Vector has established management strategies to address these issues and ensure the subtransmission network reliability is maintained to comply with the Quality Standards.

12.6.1.4 CONDITION AND HEALTH

The condition of the subtransmission overhead fleet is modelled using CBARM. This model is reasonably well developed and is used to point out network areas that are at risk. Figure 12-19 shows that there is a strong trend of increasing risk if no action is taken. This aligns with the expected increase in the age of the asset fleet and the percentage of the fleet that will be exceeding its expected life by the end of the 10-year forecast.

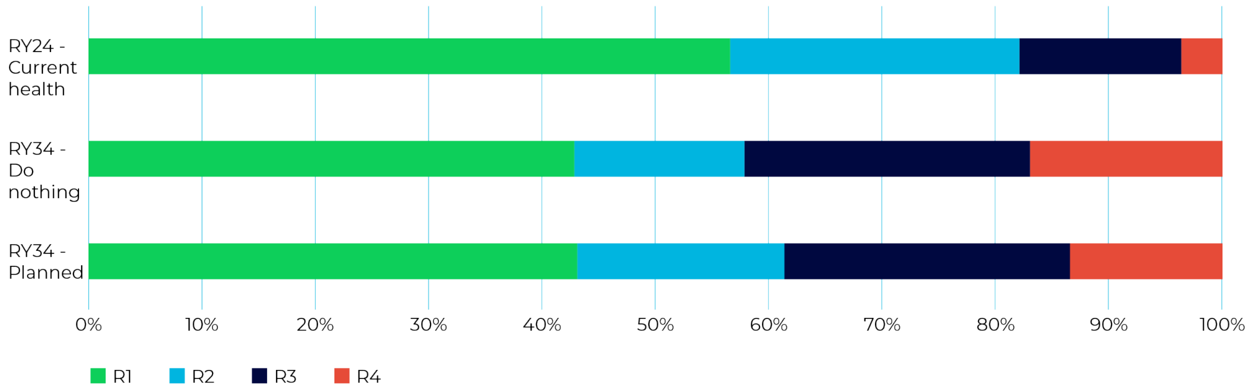


FIGURE 12-19: SUBTRANSMISSION OVERHEAD FLEET RISK PROFILE

12.6.1.5 MANAGEMENT STRATEGY

The optimal lifecycle investment considers the balance between asset renewal requiring capital expenditure and the combination of preventive, corrective and reactive operational maintenance expenditure.

Vector proactive replacement and refurbishment programmes of work are informed by our CBARM models, condition assessments and criticality. Projects or programmes are initiated to address gaps in service level targets that are either already apparent or are forecast in the next 5-10 years. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.6.1.6 DESIGN AND CONSTRUCT

The design of the replacement of overhead subtransmission lines are undertaken by Vector with assistance from specialist engineering consultancies and input from the FSPs. The design and performance characteristics are prescribed in Vector's Standard ENS-0153: Specification for overhead conductors. The completed designs are issued to the FSPs for construction and commissioning according to Vector's standards. The design for replacement or refurbishment will also be cognizant of the impact of climate change, significantly storm events, and how to improve the design to harden against the impact of these events. Routes will also be carefully selected to not build in flood prone areas or along routes where there is a risk of ground slips.

12.6.1.7 OPERATE AND MAINTAIN

Vector implements a wide range of routine and operational tasks covering asset inspections, condition-based testing and maintenance. The tasks and timeframes are set out in our standard ESM401. The preventive tasks are designed to uncover non-compliant or serviceability defects which are then treated as corrective maintenance actions or an asset renewal action depending on the extent and level of risk to performance and safety.

Most defects are identified through visual inspection. Under the current inspection cycle, conductors are inspected every two years and any defects are recorded against the nearest pole as it has a point location and unique identifier in GIS. Key tasks carried out during inspections include:

- Inspection of ground clearances.
- Conductor separation and proximity to structures are assessed for adequate clearance.
- Assessment of clearance from vegetation.
- Spans checked for balanced sags.
- Conductors free from broken strands, corrosion and (vegetation or conductor) clash burn marks.
- CCT high voltage conductors are free from insulation damage.
- Joints in conductors are visually secure and not showing signs of overheating.
- Inspection of support structures e.g. crossarms, insulators, foundations, straps etc.
- Acoustic inspection of infrastructure

Vector has also implemented the use of LiDAR technology as a tool to carry out height measurements and assessing clearances from vegetation as well as clearances from the ground. The intrusions identified are processed into SAP and are being addressed on a risk prioritised basis. LiDAR surveys will be conducted across the network ensuring that this risk is managed, and compliance breaches are identified

Vector is currently reviewing the capture methodology for all compliance and inspection data. Vector is looking at how the use of aerial technology can be optimised to deliver additional value add inspection services.

12.6.2 DISTRIBUTION

12.6.2.1 FLEET OVERVIEW

A distribution overhead circuit is defined as an electrical line that transfers electrical energy from a zone substation to a distribution transformer where it is converted to low voltage. The distribution voltages used by Vector are 22 kV and 11 kV. In many instances, multiple subtransmission, distribution and/or low voltage circuits are installed on the same support structures.

Unlike overhead subtransmission lines, not all distribution feeders have redundancy, and a fault will result in an outage to consumers that can only be rectified with corrective repairs.

12.6.2.2 POPULATION AND AGE

Vector has over 3,707 km (route length) of distribution overhead conductor circuits, representing 45% of its total network line length. Table 12-17 summarises the typical expected lives of the different conductor types along with the length at each voltage level. There is a short length of 11 kV aerial bundled conductor on Vector's distribution network in the Clendon area.

The expected asset life differ for each type of conductor and each type also has a different failure mode which are accounted for in the asset management strategies and plans. The actual life of each conductor type is also affected by environmental factors (corrosive elements and exposure to wind), mechanical loads, electrical loads and number and magnitude of downstream electrical faults. The geographical location of overhead conductor circuits thus plays a major part in its condition and rate of deterioration.

TYPE	EXPECTED LIFE (YEARS)	LENGTH (KM)	
		22 KV	11 KV
All Aluminium Alloy Conductor (AAAC)	60	2	92
Aluminium Alloy Conductor (AAC)	60	0	984
Aluminium Conductor Steel Reinforced (ACSR) >100mm2	55	0	119
Aluminium Conductor Steel Reinforced (ACSR) <100mm2	50	0	1,517
Copper (Cu) > 60mm2	70	0	222
Copper (Cu) < 60mm2	55	0	764
Unknown type	55	0	6
Total		**2**	**3,704**

TABLE 12-17: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet in Figure 12-20 shows that 60% of the asset fleet is between 30 and 50 years old. Approximately 17% of this fleet has exceeded its expected serviceable life

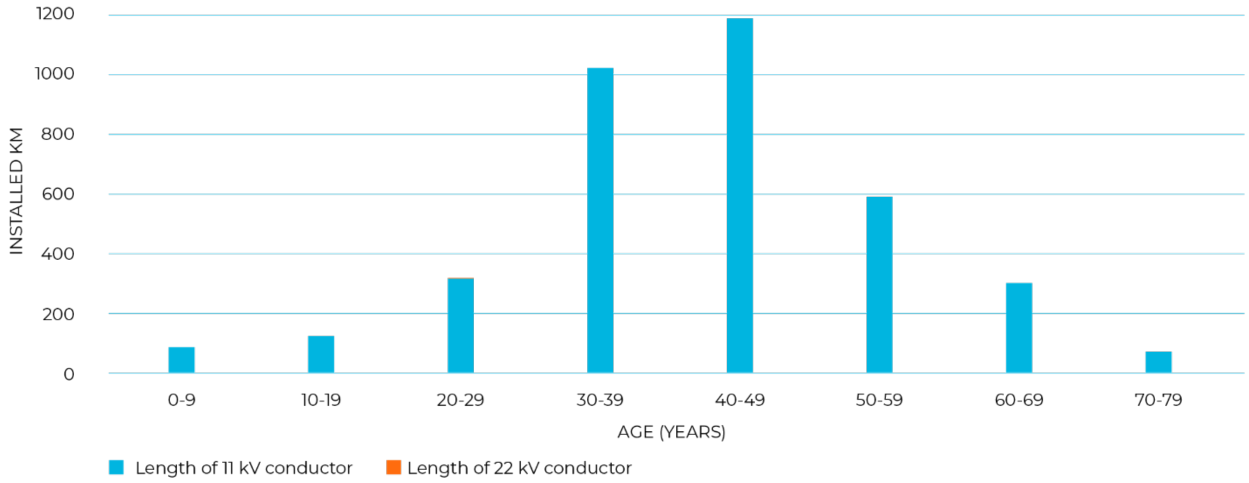


FIGURE 12-20: DISTRIBUTION CONDUCTOR AGE PROFILE

12.6.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Over the last decade, approximately 20% more conductors have been removed (185km) from the network than has been installed (84km). As a result, the length of overhead line is reducing, with an average annual decrease of approximately 6km per year. This reduction is the result of overhead to underground conversions that are driven by Vector, customers and new development in areas where Auckland Council require undergrounding of existing overhead reticulation. This trend is expected to continue for the planning horizon of this AMP.

Conductor diameter affects life expectancy as smaller conductors are inherently weaker and are less able to withstand shock impacts from external forces such as vegetation and vehicle impacts.

As shown in Figure 12-21, there has been a long-term trend of increasing faults on the overhead distribution network. Analysis of the data showed that vegetation impacts and the proximity to marine environments are significant contributors to the fault rate. The following are some of the failure modes:

- Vegetation in the proximity of our overhead power lines is a major factor in network outages especially during storms and high winds. In most instances the impacting vegetation is within the growth limit zone but falling trees from outside the zone can also have a significant impact. The power outages and damage to the conductors can either result in an immediate or delayed failure.
- Overhead conductors harden over time (anneal) due to wind induced vibration, movement and thermal cycling, resulting in becoming brittle and a reduction of its tensile strength, eventually leading to failure.
- The marine environment is more corrosive due to salt in the air and is generally a windier environment and this contributes to the deterioration rate of conductors. All of Vector's network is less than 15 km from the nearest shoreline, and approximately 50% is within 3 km of the shoreline. Hence, these factors are an important driver of asset condition.
- The failure of components of overhead lines (other than the conductor itself) contribute significantly to interruptions on distribution feeders.
- We are starting to see the impact of climate change. This became especially poignant during the Jan-Feb 2023 cyclone where ground slips put portions of the overhead distribution network at risk.

By then end of this planning period, 38% of the distribution overhead conductor population is expected to exceed its serviceable life and in the past four years Vector has embarked on an accelerated proactive refurbishment programme for this fleet to ensure high impact areas are addressed.

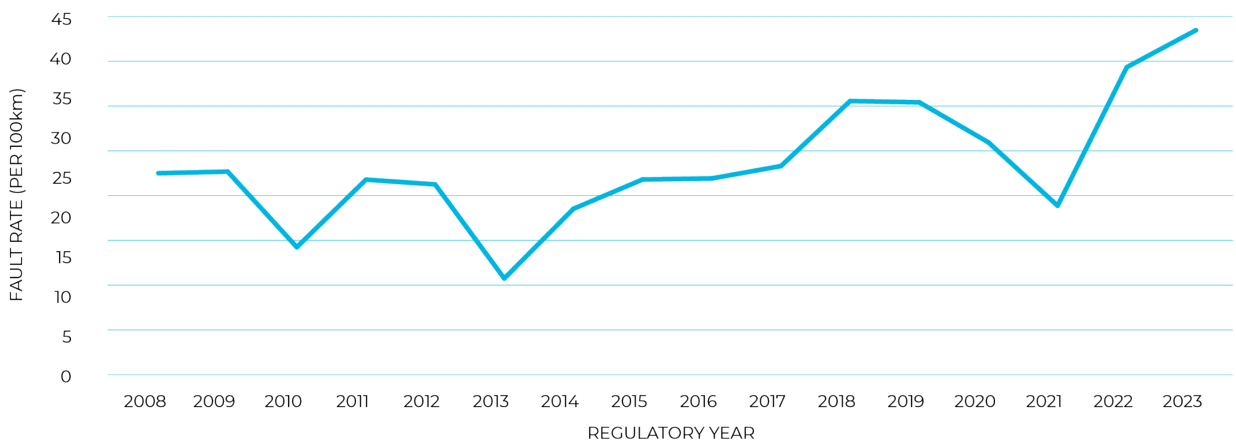


FIGURE 12-21: DISTRIBUTION OVERHEAD CONDUCTOR FAILURE RATE PER 100KM

12.6.2.4 CONDITION AND HEALTH

The condition of the distribution conductor fleet is modelled using CBARM, output shown in Figure 12-22 below This model is well developed and is used to point out network areas that are at risk. The forecast risk of the network is used to develop an intervention strategy and inform the programme of works that will manage the risk to within acceptable compliance limits.

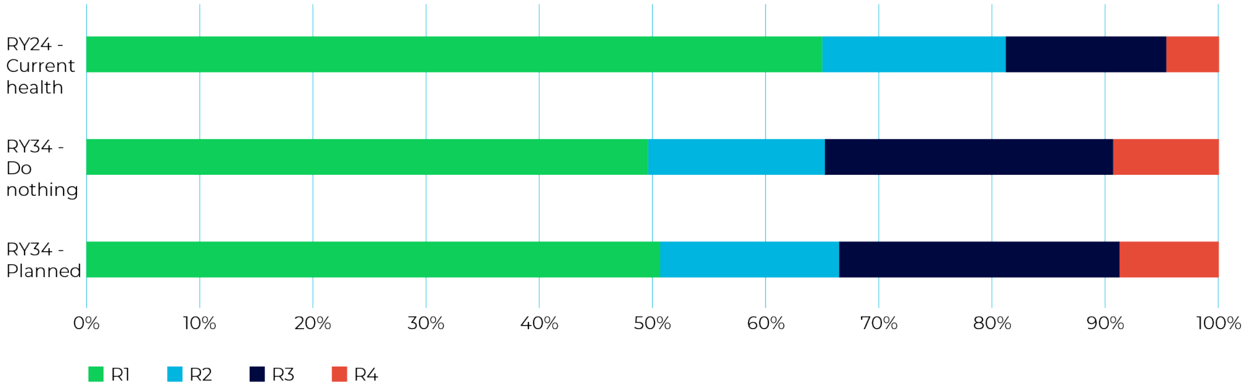


FIGURE 12-22: DISTRIBUTION OVERHEAD CONDUCTOR FLEET RISK PROFILE

12.6.2.5 MANAGEMENT STRATEGY

The optimal lifecycle investment considers the balance between asset renewal requiring capital expenditure and the combination of preventive, corrective and reactive operational maintenance expenditure.

The life of the conductor is determined by its ability to maintain operating tensions developed by static (gravity) and dynamic (wind) forces. These in turn are influenced by conductor type, size, span length, sag and environmental factors (corrosive elements and exposure to wind).

Vector proactive replacement and refurbishment programmes of work are informed by our CBARM models, condition assessments and criticality. Programmes of work are initiated to address gaps in service level targets that are either already apparent or are forecast in the AMP period. The completion of our replacement and refurbishment programmes during this AMP period is expected to improve the overall resilience and reliability of our overhead network, and accordingly reduce our overhead conductor failure rate.

The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.6.2.6 DESIGN AND CONSTRUCT

Vector uses specialist overhead network design consultancies together with practical input from our FSPs to design the refurbishment of overhead lines. The design and performance characteristics of overhead conductors are prescribed in Vector Standard ENS-0153: Specification for overhead conductors. Design requirements are stated in ESE401, overhead line design requirements and ESE402, overhead design standard design applications. The completed designs are issued to the FSPs for construction and commissioning according to Vector's standards. The full suite of standards will be reviewed through the first quarter of 2024 with recommendations implemented in the second quarter. This review aims to ensure the application of aerial inspection technology and processes are integrated across the overhead network.

The impact of climate change will also be considered in the design of routes for rebuilds and refurbishment and methods to harden construction against the impact of climate change will be added to our standards.

Increased use of lightning arrestors will be implemented on our overhead networks to harden the network against the impact of lightning surges.

12.6.2.7 OPERATE AND MAINTAIN

Vector implements a wide range of routine and operational tasks covering asset inspections, condition-based testing and maintenance. The tasks and timeframes are set out in our standard ESM401. The preventive tasks are designed to uncover non-compliant or serviceability defects which are then treated as corrective maintenance actions or an asset renewal action depending on the extent and risk to performance and safety.

Most defects are identified through visual inspection. Under the current inspection cycle, conductors are inspected every two years and any defects are recorded against the nearest pole as it has a point location and unique identifier in GIS. The key tasks carried out during inspections are similar to those detailed in Section 12.6.1.

Vector has also implemented the use of LiDAR technology as a tool to carry out height measurements and assessing clearance from vegetation and from the ground. The intrusions identified through the latest LiDAR survey are now processed into SAP and a corrective program of work has been initiated to remediate them on a risk prioritised basis.

12.6.3 LOW VOLTAGE

12.6.3.1 FLEET OVERVIEW

A low voltage overhead circuit is defined as an electrical line that transports electricity from a distribution transformer from which connections are then taken to customer's premises. The low voltage network operates at 400 V and excludes conductors associated with load control and streetlight systems. The low voltage network is generally a three-phase network i.e. comprises four wires: three phases and a neutral. In many instances, subtransmission, distribution and low voltage circuits are installed on the same support structures.

12.6.3.2 POPULATION AND AGE

Vector has over 4,120km (route length) of low voltage overhead conductor circuits, which is 50% of its total overhead network fleet length. Table 12-18 shows a summary of the types of LV conductor in the fleet with typical expected asset lives along with the installed route length for each type. Each of these types of conductors have different expected asset lives and failure modes, however the actual life of each conductor type is also affected by environmental factors (corrosive elements and exposure to wind), mechanical loads, electrical loads and number and magnitude of downstream electrical faults.

TYPE	EXPECTED LIFE (YEARS)	LENGTH (KM)
All Aluminium Alloy Conductor (AAAC)	60	6
Aluminium Alloy Conductor (AAC)	60	1,239
Aluminium Conductor Steel Reinforced (ACSR) <100mm2	50	452
Copper (Cu) > 60mm2	70	211
Copper (Cu) < 60mm2	55	1,549
Aerial Bundled Cable (ABC)	30	210
Unknown type	55	454
Total		**4,121**

TABLE 12-18: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet is shown in Figure 12-23. It shows that 77% of the assets are between 30 and 60 years old and that approximately 13.5% of assets have exceeded their standard asset life. During the planning period of this AMP, an additional 19% of LV conductor is expected to exceed its standard expected asset life. As the condition of a conductor is determined by factors other than age, the asset management strategy for conductors is to utilise an inspection-based maintenance regime to determine risk and prioritise replacement. Due to historical data deficiencies for this fleet, an analytical approach was undertaken to allocate an age to each conductor based on its material type, size, age of the development in which overhead LV lines are located, age of associated assets and information gathered from the field. Values are in kilometres with a data error rate of approximately 1%.

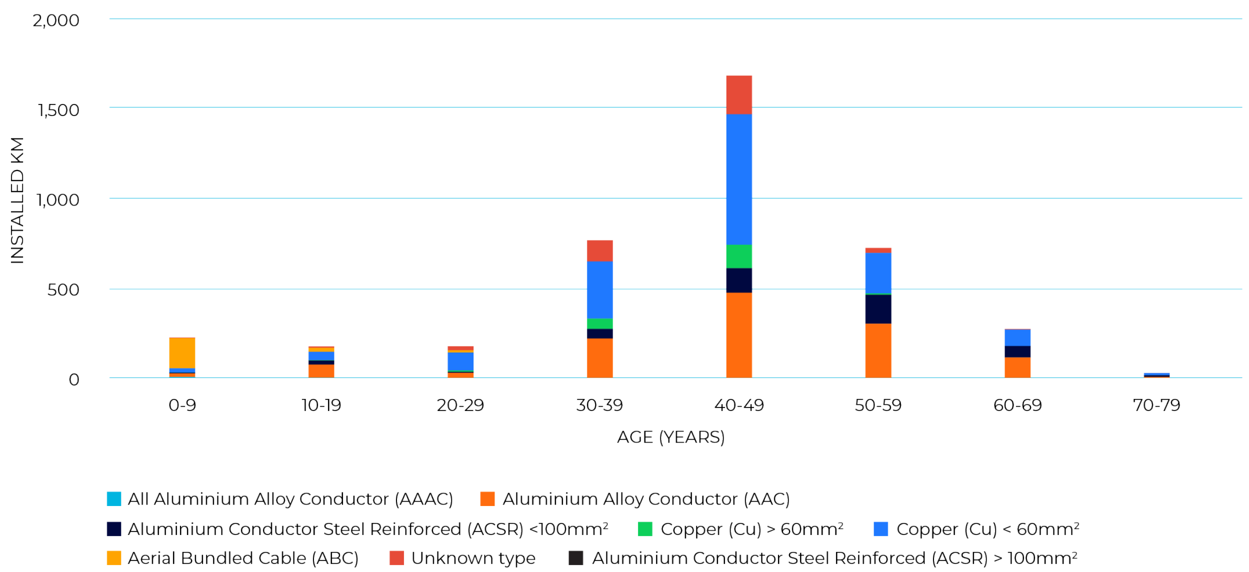


FIGURE 12-23: LOW VOLTAGE OVERHEAD CONDUCTOR FLEET AGE PROFILE

12.6.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Similar to conductors operating at higher voltages, the life of each conductor varies significantly and is related to conductor type, operating conditions and environmental factors. As most of the observed failure modes for conductors are not driven by age, the expected life based on age is an indication only. Conductor diameter is also a factor on life expectancy as smaller conductors are inherently weaker and are less able to withstand shock impacts from external forces such as vegetation and vehicle impacts. If a conductor fails, it is repaired with additional joints being introduced into the network. Joints are known to be likely points of failure, especially under fault conditions where secondary failures can occur. As conductors deteriorate and an increasing number of joints are installed under repairs, the reliability of such a circuit is likely to decrease.

Analysis of outage data showed that vegetation is a significant cause of faults. Proximity to marine environments also impacts conductor life considerably, observed failure modes are detailed below:

- Vegetation has proved to be major contributor to faults, especially during storms and high winds and thus a major contributor to a reduction in the reliability indices and customer service levels. Our increasing use of fully covered ABC conductor is assisting to mitigate this risk.
- Overhead conductors harden over time due to wind induced vibration, movement (strain hardening) and thermal cycling, resulting in becoming brittle and a reduction of its tensile strength, eventually leading to failure.
- Proximity to the ocean creates a more corrosive environment due to salt in the air and is generally a windier environment increasing the deterioration rate of conductors. All of Vector's network is less than 15 km from the nearest shoreline, and approximately 50% is within 3 km of the shoreline. Hence, these factors are an important driver of asset condition.
- The failure of components of overhead lines (other than the conductor itself) contribute significantly to interruptions on distribution feeders.
- Reporting of low lines by the public result in disconnection of the supply by Vector to take a no-risk approach to public safety until the situation has been made safe or repaired.
- The impact of climate change was very evident during the Jan-Feb 2023 cyclone when a significant number of outages occurred because of airborne debris and trees undermined by slips falling on conductors.

12.6.3.4 CONDITION AND HEALTH

We are not experiencing any systemic network failure modes in our LV network apart from the impact of vegetation during storms, which impact other parts of the overhead network as well. However, the LV network is experiencing the failure of aging hardware components such as neutral conductor clamps and crossarms and this has impacted customer service levels. The increasing frequency and severity of climate change events emphasis the need to design and construct a more reliable and resilient overhead LV network. A comprehensive review of the LV network strategy is being carried out in 2024 to determine how greater automation and data gathering capabilities can be utilised to better understand the LV network, as well as identify and manage risk.

12.6.3.5 MANAGEMENT STRATEGY

The optimal lifecycle investment considers the balance between asset renewal requiring capital expenditure and the combination of preventive, corrective and reactive operational maintenance expenditure.

In order to deliver network opportunities aligned with our Symphony modelling, our focus on the visibility of our LV network and dynamic management of the LV network will increase. We will continue to maintain, refurbish and upgrade the LV network in line with our Asset Management Objectives.

This includes enhancing our capability to model and analyse the behaviour of our LV network, and the customer energy demands placed on it particularly where DER and transport electrification is becoming pronounced. We have defined the use cases to improve visibility of the LV network using modern and cost-effective monitoring devices to measure energy flows in the LV network and trial sites are being evaluated. Data from smart meters and advanced metering infrastructure are key enablers of our LV network visibility strategy.

Vector proactive replacement and refurbishment programmes of work are informed by our condition assessments and criticality projects or programmes are initiated to address gaps in service level targets that are either already apparent or are forecast in the next 5-10 years. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.6.3.6 DESIGN AND CONSTRUCT

The design of new or replacement distribution lines is undertaken by Vector with input from the FSPs and pole engineering specialists as required. The design and performance requirements are defined in Vector Standard ENS0153: Specification for overhead Conductors. The completed designs are issued to the FSPs for construction and commissioning.

12.6.3.7 OPERATE AND MAINTAIN

Vector undertakes a wide range of routine and operational tasks covering asset inspections, condition-based testing and maintenance as detailed in our standard ESM401. The preventive tasks are designed to uncover non-compliant or serviceability defects which are then treated as corrective maintenance actions or an asset renewal action depending on the extent and risk to performance and safety.

Most defects are identified through visual inspection. Under the current inspection cycle, conductors are inspected every two years and any defects are recorded against the nearest pole as it has a point location and unique identifier in GIS. The key tasks carried out during inspections are similar to those detailed in Section 12.6.1.

Any identified defects that render a potentially unsafe situation to the public or property are repaired, replaced or isolated immediately. Remediation timeframes are based on likelihood of failure creating an unsafe situation and interruption to consumers. Vector is also currently using LiDAR technology as a tool to carry out height measurements and assessing clearance from vegetation, ground and buildings.

12.6.4 SUPPORT STRUCTURES

12.6.4.1 FLEET OVERVIEW

Overhead support structures include towers, poles, crossarms and associated pole and conductor hardware. These are designed to carry overhead conductors of all voltages under a wide variety of configurations. The support structures must be able to withstand design loads that are generated by the equipment fixed to the pole for the expected lifetime of the asset. Vector has a variety of concrete (reinforced and pre-stressed), wood (hardwood and softwood) and composite (fiberglass) poles, as well as steel monopoles and lattice towers.

12.6.4.2 POPULATION AND AGE

Overhead supports are described by the highest voltage conductor that is attached to the structure, that is - HV (110 kV), MV (33 kV, 22 kV or 11 kV) and LV (400 V or 230 V). It is common for supports to have conductors of two or more voltages installed on them.

As shown in Table 12-19, approximately 92% of Vector's fleet of 125,487 poles are concrete poles. Approximately 4% are wood and the remaining 4% are either steel (predominantly on the subtransmission network), composite materials or unknown material.

MATERIAL	LIFE EXPECTANCY (YEARS)	VOLUME NORTHERN			VOLUME AUCKLAND			TOTAL
		HV	MV	LV	HV	MV	LV	
Wood – Softwood	40		478	1,234		83	1,925	3,720
Wood – Australian Hardwood	60	64	186	56		654	457	1,417
Steel – Lattice Tower	100	45	57					102
Steel – Monopole	100	16	7	1			4	28
Composite	80		261	792		64	396	1,513
Concrete – Prestressed	80	25	10,572	6,820		22,391	25,090	64,898
Concrete – Reinforced	80	34	36,234	10,737		1,826	1,560	50,391
Unclassified			2,430	676		62	180	3,348

TABLE 12-19: POLE FLEET COMPOSITION BY NETWORK REGION

Figure 12-24 below shows that approximately 13% of poles currently exceed their expected life and during the next 10-year planning period, this will increase by an additional 3%. However, these assets are assessed annually for condition and replaced if required. Vector notes that due to incomplete pole age data, this data is considered to be circa 87% accurate.

Prior to 1990, reinforced concrete poles were the preferred type. These were often produced locally and consist of reinforcing bar with concrete poured onto it in a cast. Modern concrete poles comprise a prestressed steel core and spun concrete that results in less concrete being used (lighter) but retains the structural strength as required.

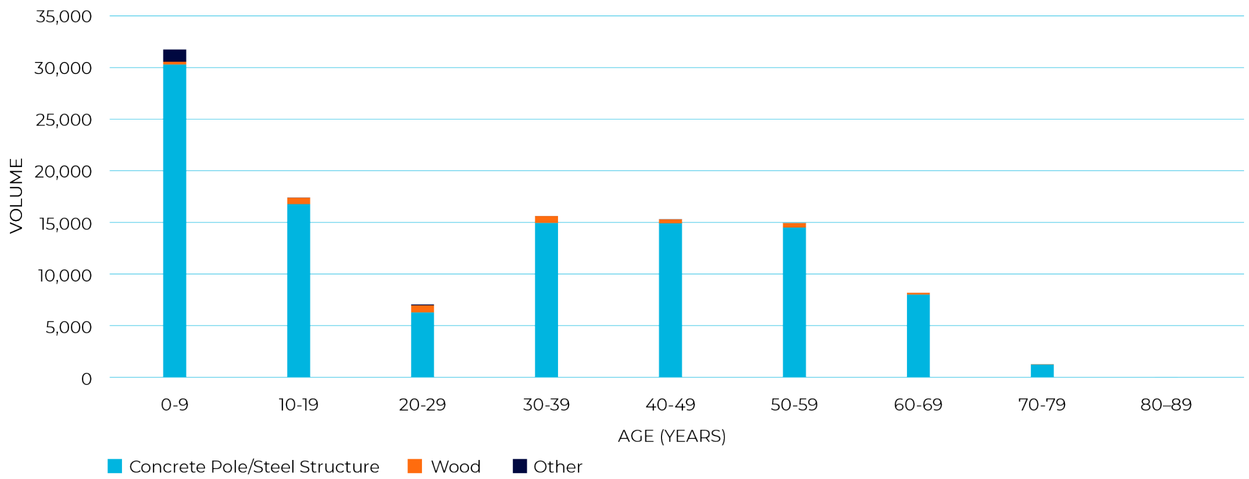


FIGURE 12-24: POLES FLEET AGE PROFILE BY MATERIAL TYPE

12.6.4.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Although the events shown in Figure 12-25 below have been recorded in our outage recording system as being a 'Pole' failure, investigations have found that an external factor is often the cause of the outage. For example, if a car hit a pole, it is recorded as 'Pole' in the system. Vector has recently improved the way it categorises pole failures which is reflected in the low number of events recorded since 2020.

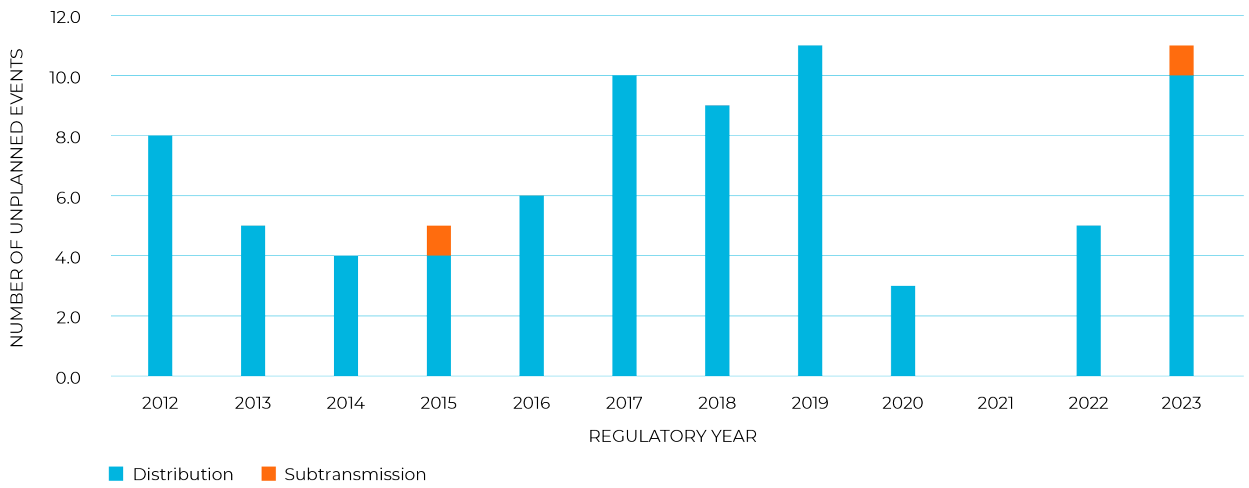


FIGURE 12-25: POLE FAILURES RECORDED ON THE NETWORK

The failure modes and expected life of poles are determined by their material type and environmental factors. As poles age and deteriorate, they lose their mechanical strength and will eventually fail due to the load of the assets installed on them. High winds increase the load on poles. Environmental factors such as moisture and proximity to the ocean accelerate deterioration.

Concrete poles can fail due to 'concrete cancer' where moisture penetrates and causes the reinforcing steel to corrode and crack the concrete. Many of Vector's concrete poles are the 'Vierendeel' poles which are the prestressed type cast into a mould, which are susceptible to the concrete cancer failure mode. This poses a risk to field crews. Prior to any Vierendeel No. 1 concrete pole being climbed, it is inspected and if showing signs of stress, is not climbed unsupported.

KNOWN ISSUE	HOW IT WAS DISCOVERED	HOW IT IS BEING ADDRESSED
Weak Firth Vierendeel poles (especially No. 1 type poles)	Historic design	Work practice (do not climb unsupported, replace when changing the load)
Poles with unknown ownership	GIS legacy data	GIS updated as and when these situations are found
Wooden Poles failing within inspection frequency	Pole Failure	External testing of root cause and recommendations being implemented into the revised inspection and maintenance regime
Pole with customer ownership not being adequately maintained	Observed failure trend	Proactive right of way survey and pole replacement
Poles owned by other utilities with different asset management capabilities	Observed failure modes	Work practices – do not climb

TABLE 12-20: KNOWN ISSUES AND RESOLUTION FOR POLES

12.6.4.4 CONDITION AND HEALTH

In the absence of a developed CBARM model, Vector uses an aged-based assessment to describe the condition of its pole fleet. Figure 12-26 shows that there is a trend of deteriorating condition if no action is taken. This aligns with the expected increase in the age of the asset fleet and the percentage of the fleet that will be exceeding its expected life at the end of the 10-year forecast.

Vector has developed an intervention strategy to replace at risk overhead supports during the current AMP period. These supports will be replaced with increasingly more reliable infrastructure that has a longer life and is more robust

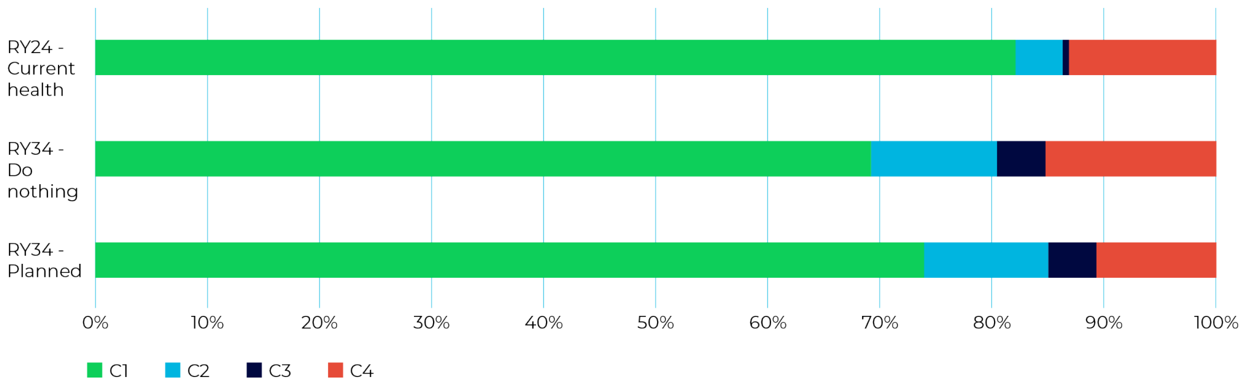


FIGURE 12-26: POLE FLEET CONDITION PROFILE

12.6.4.5 MANAGEMENT STRATEGY

Vector uses a condition-based approach that considers asset health and safety to identify the need to replace or retire specific poles. The remaining life of a pole is difficult to predict accurately because it is dependent upon several factors. These include the pole material and construction, natural environment, public exposure, access and the load that is being supported. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.6.4.6 DESIGN AND CONSTRUCT

Vector has several approved pole designs covering concrete, steel or composite materials. Vector has largely stopped the installation of new wooden poles in the network because unlike the other pole types, timber requires regular specialist inspections to assess the integrity of the timber through a wood pole's life cycle. In the rare occasion where Vector does install a new wooden pole, these are procured on a "made-to-order" basis.

Poles on the 110 kV line and some 33 kV tower routes require bespoke solutions, e.g., specifically sized monopoles, and replacements may take several months to procure.

Where overhead supports are replaced, it is Vector's preference that prestressed concrete poles be used. For specialist applications (height or strength requirements), steel monopoles are used. As composite poles are light weight, they can be used in remote locations without vehicle access because they are easier and safer to transport.

When designs are being undertaken, the locations of poles and selecting the use of structures the impact of climate change will become an important consideration. For example, areas that are prone to ground slips must be avoided as far as practicable and routes in areas that are flood prone must also receive special consideration.

12.6.4.7 OPERATE AND MAINTAIN

Most defects are identified through visual inspection. Under the current inspection cycle, each pole and its associated pole top hardware are inspected every two years and wood poles are subject to additional testing every five years at just below ground level where decay occurs. All equipment defects are recorded in SAP PM. A tagging system is used during visual indications to tag poles that require replacement. Different colour tags define the timeframe in which remedial action is required.

The routine inspection, maintenance and testing requirements for Vector's overhead structures are currently prescribed in Vector Standard ESM401.

12.6.5 REPLACE, RENEW AND DISPOSE

12.6.5.1 CONDUCTORS

Vector decides on replacement of its overhead subtransmission, and distribution lines based on condition observed during field inspections and from the output of the conductor CBARM model. When the condition of part or all of an assembly meets the replacement criteria, the entire assembly is assessed to test for the cost efficiency of replacing just the component or the entire assembly.

A conductor testing regime has also been introduced to improve the assessment of the condition of conductors where visual observation shows suspect conductors. Furthermore, whenever a conductor fails a sample is retrieved and tested for tensile strength and ductility. These properties provide better indication of the condition of a conductor and its need for replacement.

For the overhead distribution network fleet, a targeted program has been established to replace over 127km of overhead conductors for which there is a trend of increasing failure rates. A significant portion of the small conductor fleet is also expected to reach its standard asset life. The key types targeted for replacement are 16mm² Copper conductors and older 21mm² ACSR conductors. Due to these conductors also being in areas with higher population densities, they pose an increased safety hazard to the public as well as a reliability risk. In line with the requirements of the Auckland Unitary Plan, replacement of LV conductor will either be with aerial bundled conductor or with underground cable.

12.6.5.2 SUPPORT STRUCTURES

Vector applies a condition-based approach in managing the pole populations. Each pole structure is inspected on a periodic basis, or if a potential issue is reported, against assessment criteria established in the maintenance standards. The decision to repair or replace is based on the outcome of the inspection and condition assessment. In addition, poles may also be replaced when new assets attached to the pole are added or removed. This is contingent on an engineering assessment being carried out on the existing pole and in accordance with the design standard.

Pole replacements identified for replacement under the tagged inspection regime are forecast as part of the corrective maintenance programme. However, where a proactive overhead line refurbishment project is undertaken each pole in the route will be assessed for replacement and if required, its replacement will be undertaken as part of the overhead refurbishment scope of works. Pole replacement includes the replacement of the hardware.

12.6.6 FORECAST SPEND

Because of its focus on reliability the forecast capex spend for the 10-year AMP period for this asset fleet is shown in Section 11 - Network Resilience and Reliability Management.

12.7 Distribution equipment

This section describes our distribution equipment fleet and provides a summary of our associated asset management practices. The distribution equipment fleet consists of the following six subcategories:

- 11-22 kV overhead switchgear
- Pole mounted distribution transformers
- 11-22 kV Ground mounted switchgear
- Ground mounted distribution transformers
- Voltage Regulators
- LV Distribution system (non-overhead)

12.7.1 11-22 KV OVERHEAD SWITCHGEAR

In the distribution network, overhead switchgear comprising of circuit breakers, load break switches and isolating links are used to control, protect and isolate the network. The function of the switchgear is to provide protection, by interrupting short circuit and overload fault currents, or isolation, by providing a clear open point, while maintaining service to unaffected circuits.

The circuit breakers in the overhead distribution network are typically epoxy insulated reclosers with vacuum interrupters capable of manual operation and remote operation where required. Older designs consist of SF_6 gas insulation, installation of which ceased in 2000.

Load break switches in our network use either epoxy resin, SF_6 gas or air as an insulation medium. These switches are capable of breaking loads and use various methods of extinguishing the resultant arc. We have recently introduced the epoxy resin insulated load break switch (LBS) as a trial to compare performance against the extensively used SF_6 insulated LBS.

Isolating links refer to drop out fuses, knife links and sectionalisers. Drop out fuses and knife links require manual operation to achieve isolation whereas sectionalisers use logic to determine when to operate, based on defined settings. Sectionalisers are used to isolate larger network portions during a fault. Drop out fuses are used to protect transformers, short sections of overhead line and underground cable sections to transformers. Load break switches are used to provide safety isolation to personnel and to reduce the number of customers affected by a planned or unplanned outage.

12.7.1.1 FLEET OVERVIEW

Key statistics of the overhead switchgear assets are shown in Table 12-21.

EQUIPMENT TYPE	POPULATION
ABS/ABI (air break switch/air break isolator)	849
Drop out fuses	9,518
SF_6 gas switch	603
Solid and sectionalising links	514
Reclosers with vacuum interrupters	200
Automated switch with vacuum interrupters	47

TABLE 12-21: KEY STATISTICS

12.7.1.2 POPULATION AND AGE

The expected life for the overhead switchgear fleet is indicated in Table 12-22

CATEGORY	DESIGN LIFE SPAN
ABS/ABI	30 years
SF_6 gas switch	30 years
Circuit breaker (reclosers and automated switches with vacuum interrupter technology)	30 years
Drop out fuse holder	20 years
Drop out fuse	Single use
Solid and sectionalising links	20 years

TABLE 12-22: EXPECTED RELIABLE OPERATING LIFE FOR OVERHEAD SWITCHGEAR

The table above shows the design life of the overhead switchgear assets. However, this is often not the driving factor for replacing the asset. The longevity of each piece of equipment is influenced by other factors including the operating environment, the number of operations completed, and maintenance completed throughout the life of the equipment. This results in the retention of equipment within our network beyond their design life if the asset is serviceable and can be operated safely.

Figure 12-27 summarises the population and age of our overhead switchgear (Vector notes the level of data error is approximately 10% and the population data consistency is being continually refined).

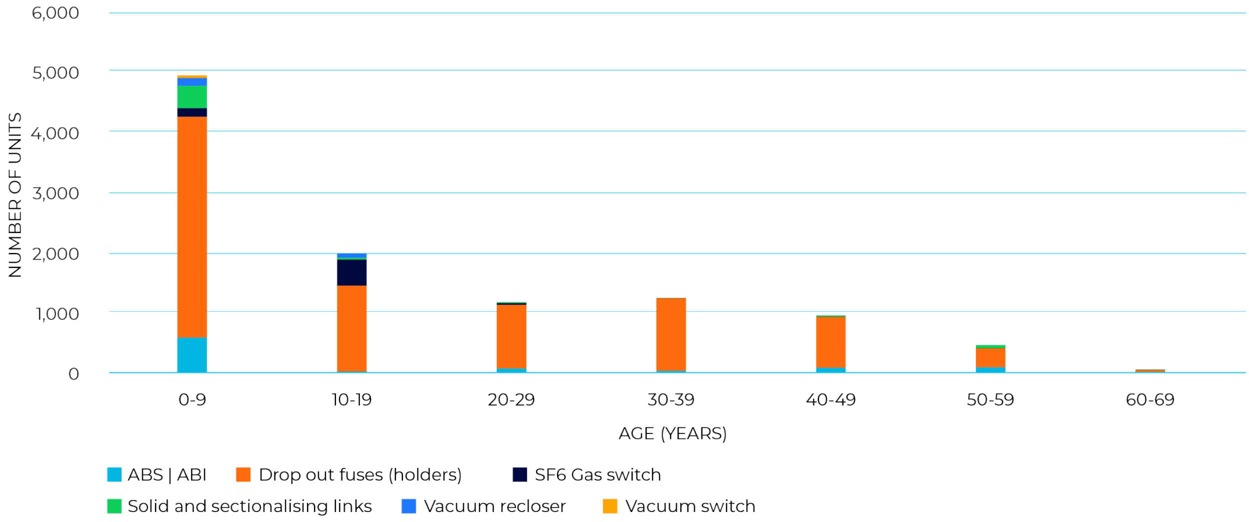


FIGURE 12-27: DISTRIBUTION SWITCHGEARS FLEET AGE PROFILE

12.7.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

With proper maintenance on the exterior of a switch to ensure its integrity as well as maintenance on external connections, the gas and vacuum switch fleet can continue to provide trouble-free operation beyond the stated design life. Vector started using gas and vacuum switchgear technologies in the early 2000s which means that the oldest units in the network are only halfway through their stated design life.

Vector has experienced gas leakages from the tanks of gas insulated switchgear. This has led to the re-introduction of air-break switches with arc limiting chutes, to replace earlier than expected failed gas switches. Since this is not a whole of population problem, we will continue to maintain the existing gas insulated switchgear and monitor for additional failures through routine maintenance activities for as long as practicable.

There are approximately 160 ABS/ABI units of pre-1980s vintage. Although these switches are over 30 years old, their operational counts are low and therefore they are still able to adequately perform their functions. Accordingly, Vector plans to continue to undertake periodic inspection and maintenance on these switches. However, for certain types, Vector has embarked on a proactive programme of replacement.

There has been a considerable growth in the number of transformers in the network over the past ten years due to the growth of Auckland's population. This in turn resulted in an increase of the drop out fuse fleet because fuses remain the preferred method of protection for distribution transformers and spur lines due to their simplistic design, effective operation mode and their economic cost.

Prior to the 2000's there was limited deployment of SF_6 gas switches in the overhead distribution network and use was limited to specific network applications only. From 2003 Vector adopted the use of pole mounted gas switches with the intent for it to be a standard type of overhead equipment to replace air-break switches. Together with the uptake of gas switchgear additional reclosers were installed in critical locations of the overhead network driven by an initiative to improve the network SAIDI performance. Due to regular occurrences of gas leakage in the gas switch fleet there has been an increase in the usage of ABS's since 2015. Vector has recently introduced a vacuum operated gas switch that will be utilised in locations where remote-controlled switching is required.

Due to the age and condition of Vectors ABI overhead switch fleet, live operations using these devices are only permitted if the load on the network at the time of operation is 20 amps or less.

The Vector maintenance standard defines periodic maintenance activities to identify defects or signs of deterioration in the overhead switchgear fleet. The maintenance standard also prescribes corresponding remedial actions to address any identified defects to ensure the risk of equipment failure is managed appropriately.

12.7.1.4 CONDITION AND HEALTH

Vector uses age as a proxy to indicate the condition of its overhead switchgear fleet. The majority of the overhead switchgear population are drop out fuses that are managed by replacement on condition. As such the risk profile is significantly skewed positively by this subset of the population as it is a simple asset that presents low risk through life. To better present the risk profile that is driving the asset replacement program for overhead switchgear, the risk from the 849 ABS/ABI switches are presented in Figure 12-28. This shows that there is a trend of deteriorating condition if no action is taken. This aligns with the expected increase in the age of the asset fleet and the percentage of the fleet that will be exceeding it expected life by the end of the 10-year forecast.

Vector has developed an intervention strategy to ensure the condition of the fleet is maintained at current health levels.

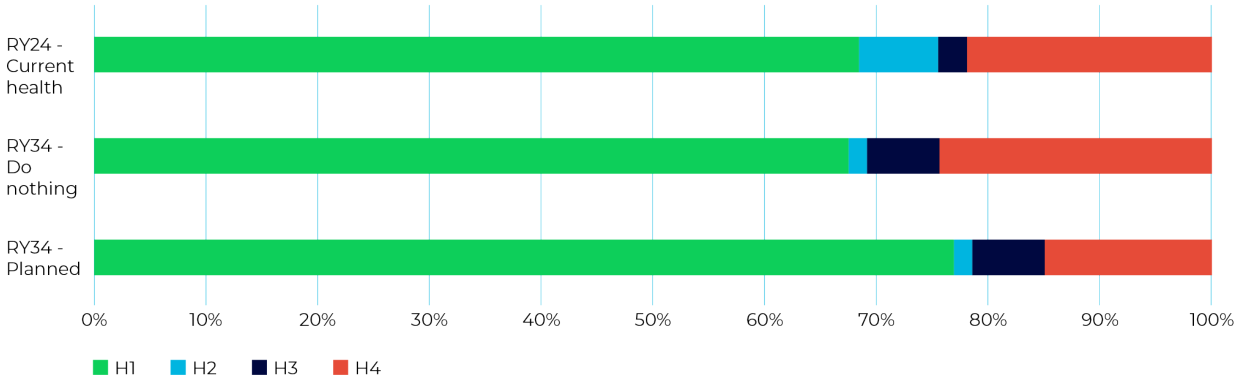


FIGURE 12-28: OVERHEAD SWITCHGEAR (ABS/ABI) FLEET CONDITION PROFILE

12.7.1.5 MANAGEMENT STRATEGY

Vector uses a condition-based approach that considers asset health, and safety to identify the need to replace or retire specific distribution overhead switchgear.

If major off-site maintenance is required to be carried out on a legacy ABS, Vector's present practice is to replace the switch with a new modern equivalent. The old switch will be scrapped because of outdated designs or obsolescence and because they generally require a higher level of maintenance compared with modern equivalents.

12.7.1.6 DESIGN AND CONSTRUCT

Drop-out fuse links and solid links are procured by the FSPs in accordance with Vector standards. All other types of overhead switchgear are directly purchased by Vector and released to Vector's FSPs on request as free-issue equipment or as part of proactive works projects.

Vector is currently reliant on a single supplier for several overhead switchgear types and a priority for Vector is in the process of tendering alternative suppliers in order to establish a minimum of two suppliers for each equipment type to alleviate supply chain and commercial risk. Current procurement challenges include the recent supply discontinuation of a protection relay commonly used across multiple device types, as well as a supply discontinuation of a standard issue overhead switch.

Vector has developed a comprehensive suite of in-house design standards and drawings that define the installation requirements for different overhead switchgear types. All installations must conform to these standards but Vector can give permission for deviations through a change control process.

12.7.1.7 OPERATE AND MAINTAIN

The Vector maintenance standard prescribes preventive maintenance requirements, frequency of inspections, and method of treatment of defects identified either through corrective maintenance or asset replacement processes. The standard also defines the procedure for data capture and system updates carried out by Vector's field service providers.

Modern ABSs are equipped with graphite-coated contacts and this coating adds strength to the contacts enabling them to withstand the wear-and-tear over their life. In a SF_6 gas switch or a vacuum switch all contacts and switching assemblies are housed inside a permanently sealed tank, which render these parts completely inaccessible throughout the switch's life. These concealed parts are designed to provide durable mechanical and electrical operations throughout a switch's life without maintenance.

The equipment only requires a periodic functional test, in which a closing and opening operation is carried out to exercise all moving parts and mechanical chain links to ensure the operational integrity of the switch.

If major off-site maintenance is required to be carried out on a legacy ABS, Vector's current practice is to replace the switch with a new modern equivalent. As such, there is currently no asset refurbishment needed for overhead switchgear other than performing a few simple onsite maintenance activities on the legacy ABSs and ABIs, such as greasing the moving parts or replacing arc horns to maintain their operational efficiency.

Vector's maintenance standard ESM501 details the requirements for the distribution overhead switchgear fleet. Table 12-23 summarises the planned maintenance regime for this asset subclass.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Functional inspection	Functional inspection on all overhead distribution sites including ABS, ABI, gas break switches, reclosers, sectionalisers and HV knife links	1 year
Full Inspection	Full inspection of distribution gas switches	5 years
Full Inspection	Full inspection of distribution automated switches	5 years
Inspection	Inspection on zone substation and point of supply ABS	2 months
Inspection	Inspection on all overhead switchgear including Omnirupter switches but excluding ABS and ABI	5 Years
Thermovision Inspection	Thermovision inspection on ABS in zone substations and point of supply	1 year

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Thermovision Inspection	Thermovision inspection on all overhead distribution switches including ABS, ABI, gas break switches, reclosers, sectionalisers and HV knife links	1 Year
Servicing	Full inspection and servicing on ABS and ABI, excluding Omnirupter switches	3 years
Servicing	Servicing on ABS in zone substations and point of supplies	4 years
Servicing	Servicing on sectionalisers and automated gas switches	10 years
Servicing	Servicing on reclosers	10 years

TABLE 12-23: PLANNED MAINTENANCE ACTIVITIES FOR OVERHEAD SWITCHGEAR

Vector does not carry out any electrical testing on its overhead switchgear unless there is a specific issue that needs to be investigated and resolved. Thermal imaging and testing for partial discharge (PD) can be included as part of the testing regime once a decision to test is made.

Vector incorporates risk elements in the overall maintenance approach, such that the treatment of an identified defect is also heavily influenced by consequence and hazard likelihood. For example, assets that have low impact on network performance, such as fuses supplying individual dwellings, are allowed to run to failure because it is more cost effective to replace the failed units rather than inspecting them on a regular basis.

12.7.2 POLE MOUNTED DISTRIBUTION TRANSFORMERS

Pole mounted distribution transformers are essential components in the distribution network that transform the higher voltages down to consumer usable voltages. These are similar to the larger power transformers but are limited to 300 kVA due to their installation at height. Pole mount transformer installations in overhead networks are an economical way to locate the equipment close to the point of supply.

12.7.2.1 FLEET OVERVIEW

Vector has approximately 7,550 pole mounted distribution transformers ranging from 1 kVA to 300 kVA. Vector uses a combination of 11 kV/400 V 3 phase, 11 kV/230 V single phase transformers to step the voltage down to 400 V or 230 V for customer use. Transformers up to 100 kVA are 'hung' on poles and larger transformers are mounted on an elevated platform.

12.7.2.2 POPULATION AND AGE

Table 12-24 provides a summary of the population of our pole mounted distribution transformers by size.

CATEGORY (SIZE)	POPULATION
1 kVA	1
5 kVA	5
7.5 kVA	11
10 kVA	57
15 kVA	1,253
20 kVA	56
25 kVA	102
30 kVA	3,062
50 kVA	1,822
75 kVA	1
100 kVA	209
150 kVA	27
200 kVA	252
250 kVA	1
300 kVA	695

TABLE 12-24: POLE MOUNTED DISTRIBUTION TRANSFORMER POPULATION

Figure 12-29 illustrates the age profile of our pole top distribution transformers. The average age of pole top transformers is 22.5 years. Our pole top transformer fleet is considered young compared to the typical 30 to 40-year design life.

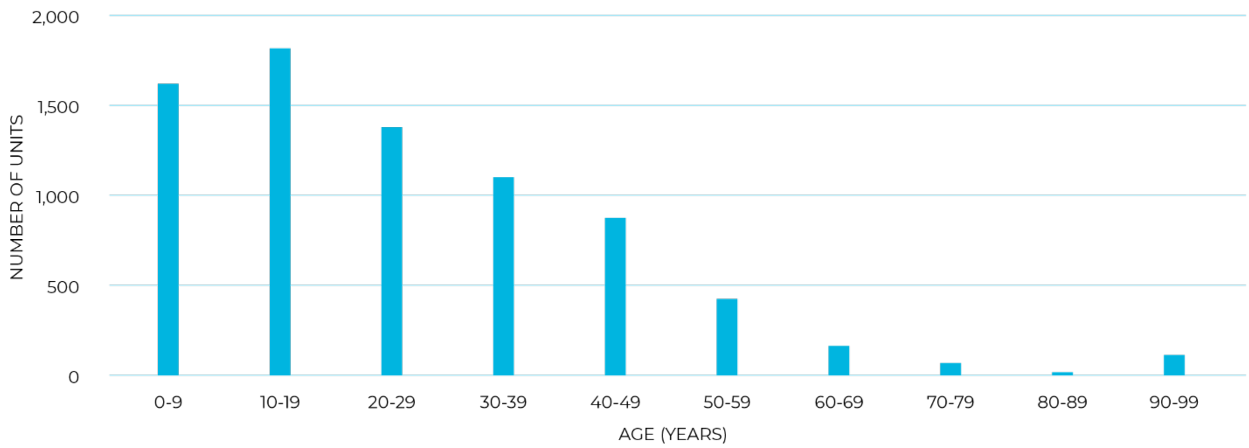


FIGURE 12-29: POLE TOP DISTRIBUTION TRANSFORMER FLEET AGE PROFILE

12.7.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector relies on visual inspections to determine the condition of the transformer fleet but is also informed by the CBARM model. The transformer life depends on loading and operating conditions. If loaded beyond rated capacity for prolonged periods, the expected lifespan is shortened. Typically, these transformers are not operated above nameplate and therefore are not unduly stressed, leading to a low count of replacements due to fatigue.

12.7.2.4 CONDITION AND HEALTH

Our CBARM model for pole top transformers is based on age, condition and criticality. The present (RY24) risk level for the pole top transformer fleet is shown below in Figure 12-30.

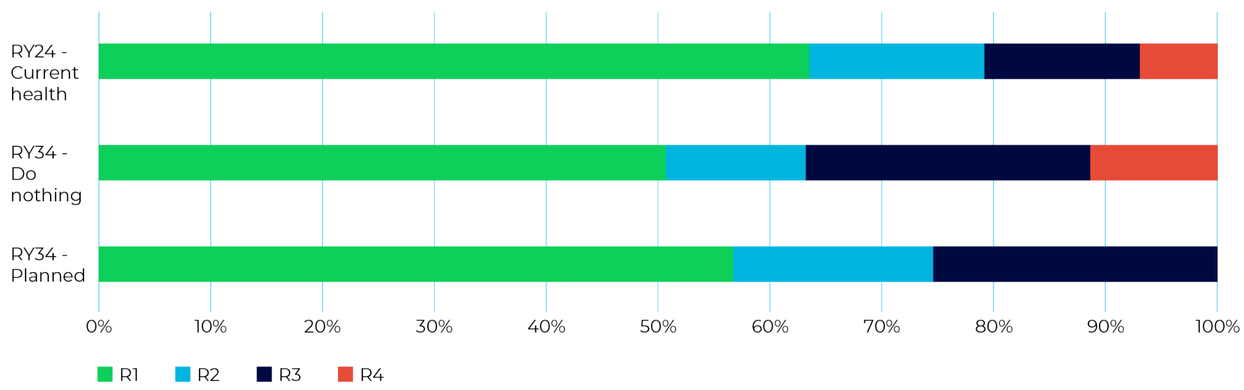


FIGURE 12-30: POLE TOP TRANSFORMER FLEET RISK PROFILE

The risk profile indicates that the pole top transformer fleet is in good condition with less than 11% of the fleet approaching end of life within the next 10 years. Vector's investment programme will significantly reduce the number of pole top transformers within the highest risk category in the upcoming AMP period.

12.7.2.5 MANAGEMENT STRATEGY

The management strategy for pole mounted transformers is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.7.2.6 DESIGN AND CONSTRUCT

All new pole mounted distribution transformers are manufactured to Vector's equipment specification ENS-0093. Vector has developed a suite of design standards and drawings that define the installation requirements for pole mounted distribution transformers.

To ensure diversity of supply Vector currently has three approved suppliers for this asset class.

12.7.2.7 OPERATE AND MAINTAIN

Vector's maintenance standard ESM502 details the planned and corrective maintenance requirements for its pole top distribution transformer fleet. The planned maintenance regime for our distribution transformer assets is summarised below in Table 12-25.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Functional inspection	Inspections that focus on addressing public safety and SAIDI risk as well as record some basic condition information	1 year
Full inspection	Inspections that focus on addressing public safety and SAIDI risk as well as a detailed condition assessment of the asset.	5 years

TABLE 12-25: PLANNED MAINTENANCE ACTIVITIES FOR DISTRIBUTION TRANSFORMERS

Visual inspections are used to check external components because the internal components are sealed and inaccessible for on-site inspections.

Vector runs a refurbishment programme for pole mounted distribution transformers. Every transformer removed from the network is sent to the service depot at ETEL Transformers. The condition of the old transformer is assessed and refurbished if the refurbishment assessment criteria are met, otherwise the transformer is scrapped. It is expected that a transformer' service life will be extended by 25 to 30 years following refurbishment.

12.7.3 11-22 KV GROUND MOUNTED SWITCHGEAR

In the Vector distribution network, ground mounted distribution switchgear is commonly known as Ring Main Units (RMUs) whose function is to connect underground cables to form a meshed network feeder. RMUs are found inside buildings, on private properties or installed in enclosures on the road reserves.

RMUs provide multiple functions – load break switch, circuit breaker and fuse switching. Circuit breaker and load break switching is incorporated in the main connection of the network and the fuse switch is typically used to feed a downstream distribution transformer directly.

12.7.3.1 FLEET OVERVIEW

The fleet of RMUs is made up of oil filled, SF_6 gas filled and epoxy resin insulated equipment of varying ages and manufacturers. The arc-quenching medium used is natural mineral oil, SF_6 gas and air, respectively. The majority of the older RMUs are oil filled due to the industry widely using this method of insulation up until late 2011. Since 2012 SF_6 gas insulated equipment has been the new standard. A small number of epoxy resin insulated RMUs were installed in the 1980s, however this ceased due to safety concerns.

Most of the RMUs in the network are rated at 12 kV and installed in the 11 kV network. There are a small number of 24 kV rated units in the 22 kV network which are all SF_6 gas insulated. The number of installed RMUs is shown in Table 12-26.

EQUIPMENT TYPE	POPULATION
Resin	86
SF_6 gas	3,521
Oil	5,922

TABLE 12-26: NUMBER OF RMUS INSTALLED

12.7.3.2 POPULATION AND AGE

The expected/design life of the differing insulation categories for RMUs is shown in Table 12-27.

CATEGORY	DESIGN LIFE SPAN
Resin	40 years
SF_6 gas	30 years
Oil	40 years

TABLE 12-27: DESIGN LIFESPAN OF RMUS

Figure 12-31 illustrates the age profile of our RMUs. The average age of the RMUs installed in the Auckland region is 28 years, while the average age of the RMUs installed in the Northern region is 17 years. The older equipment in the fleet is predominantly oil insulated, and as discussed above, this is progressively being replaced with SF_6 insulated equipment.

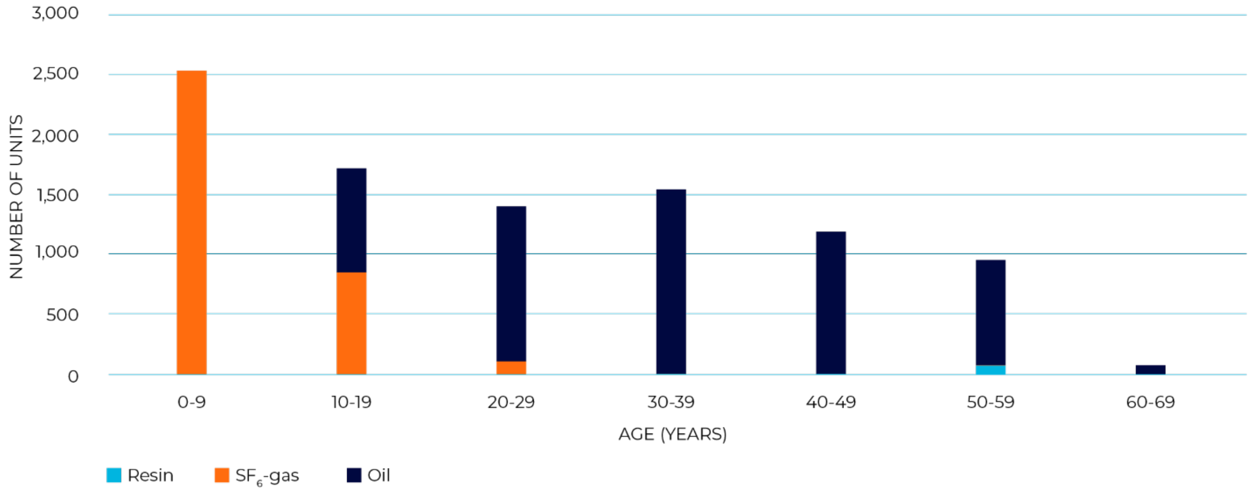


FIGURE 12-31: RMU FLEET AGE PROFILE

12.7.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

RMU service life is a function of the number of duty cycles that the switches experience, the volume and magnitude of through faults, and the RMU's installation environment. Aggressive environmental conditions such as heavy pollution or corrosive atmospheric conditions can have a detrimental effect on the service life of a switch. These operating conditions affect the steel and the protective coatings that protect the switch. A key factor is the effect on the corrosion of steel, which directly affects the integrity of the sealed gas tank and thus its ability to maintain the required pressure of the SF_6 insulating gas for safe switching operations.

For oil-filled switchgear, deterioration in the tank condition could result in a loss of the insulating oil and/ or exposing the switching assembly housed inside the tank to external interferences, such as moisture or other contaminants. These defects can lead to internal failure in the tank and shortening the life of the equipment.

Accessibility can also affect the longevity of ground mounted switchgear. Vector typically installs distribution RMUs in public spaces, such as footpaths and road reserves where they are more exposed to external damage such as vandalism or vehicle impact.

In 2017, an oil filled Long & Crawford RMU failed catastrophically which has resulted in Vector targeting this make of switchgear for further investigations to ensure the continued safe operation of this type. Vector, in line with other utility operators, is performing ongoing assessment of the arc flash risk at the distribution sites across the network. New installations contain arc quenching capability; so, will comply with safety standards. However, all oil and resin, as well as any SF_6 gas RMUs installed prior to the 2000s, will need to be monitored and maintained to ensure appropriate measures are in place to limit the risk to workers and the public.

12.7.3.4 CONDITION AND HEALTH

Our CBARM model for RMU's is based on age, condition and criticality. The present (RY24) risk level for the RMUs is shown in Figure 12-32.

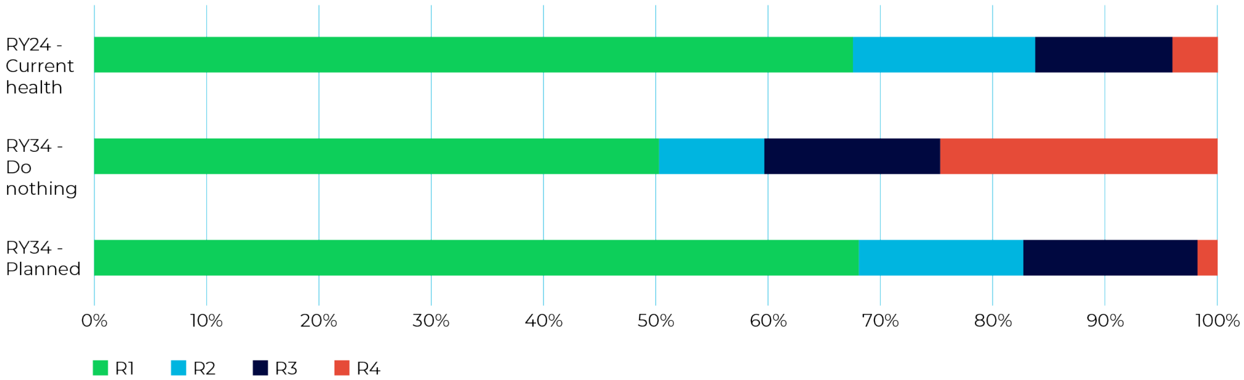


FIGURE 12-32: RMU FLEET RISK PROFILE

The risk profile indicates that the RMU fleet is currently in good condition, but without intervention from Vector's investment programme, an increasing percentage of the asset fleet will be approaching end of life within the next 10 years. Vector's investment programme will ensure that all R4 risks are removed and the remaining risk profile of this asset fleet will be maintained at approximately present levels.

12.7.3.5 MANAGEMENT STRATEGY

The management strategy for RMU's is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The replacement of RMUs is an important part of our program to improve network reliability as described in Section 11.

12.7.3.6 DESIGN AND CONSTRUCT

There are a wide range of switchgear models and makes operating in the Vector network. New RMU's are supplied in compliance with Vector's equipment specification standard ENS-0103. In 2017, to standardise the network design and minimise the required capital investment and operating costs Vector rationalised to two switchgear models from ABB and Siemens to be used for the foreseeable future.

The ABB SafeLink 2 is rated at 12 kV and is used for 11 kV applications. The Siemens 8DJH is rated at 24 kV and is used for both 11 kV and 22 kV applications.

12.7.3.7 OPERATE AND MAINTAIN

Vector's maintenance standard ESM503 details the maintenance requirements for its RMU fleet. The planned maintenance regime for our RMU assets is summarised below in Table 12-28.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Functional inspection	All 11 kV and 22 kV ground mounted distribution switchgear in distribution substations, excluding HV customer with HV Metering	1 year
Full Inspection		5 years
Thermovision Inspection		5 years
Partial discharge inspection		5 years
Full Inspection	Functional inspection on all 11 kV and 22 kV ground mounted distribution switchgear in distribution substations where there are HV customers with HV Metering	2 years
Thermovision Inspection		2 years
Partial discharge inspection		2 years
Servicing	Servicing on all 11 kV and 22 kV oil filled ground mounted distribution switchgear	10 years
Servicing	Servicing on all 11 kV and 22 kV cast resin ground mounted distribution switchgear	10 years

TABLE 12-28: PLANNED MAINTENANCE ACTIVITIES FOR RMU'S

Due to the decision to move away from oil and resin insulated switchgear, these items will continue to be operated until maintenance requirements require removal from the network, at which point they will be scrapped. Given the relatively young age of the gas-filled switchgear population, any unit removed from the network is returned to the supplier's depot for assessment and servicing. The refurbished unit will then be re-issued back into Vector's distribution equipment stock pool for further use.

12.7.4 GROUND MOUNTED DISTRIBUTION TRANSFORMERS

Like the pole mounted distribution transformer fleet, ground mounted distribution transformers are essential components of the distribution network that transform the higher voltages down to consumer usable voltages. Vector uses transformer ratings from 100 kVA to 1500 kVA, with smaller exceptions in remote areas and larger exceptions related to higher load requirements.

Vector maintains a combination of 11 kV/400 V and 22 kV/400 V 3 phase transformers installed with one of three designs – cabinet, cubicle and package.

12.7.4.1 FLEET OVERVIEW

Vector maintains approximately 15,000 ground mounted distribution transformers, predominantly at 11 kV/400 V. The 22 kV/400V population makes up less than 2% of the entire population.

Vector records show 23 different transformer ratings ranging from 10 kVA to 1.5 MVA. Table 12-29 shows a breakdown of the populations by kVA rating.

TRANSFORMER SIZE	POPULATION
<100	827
100	4,237
150	560
200	2,575
250	102
300	3,265
325 to 450	17
500	1,963

TRANSFORMER SIZE	POPULATION
750	818
1000	665
1250 to 1500	101

TABLE 12-29: GROUND MOUNTED DISTRIBUTION TRANSFORMER POPULATIONS BY TRANSFORMER RATING

12.7.4.2 POPULATION AND AGE

The average age of the ground mounted distribution transformer fleet is 27 years as presented in Figure 12-33.

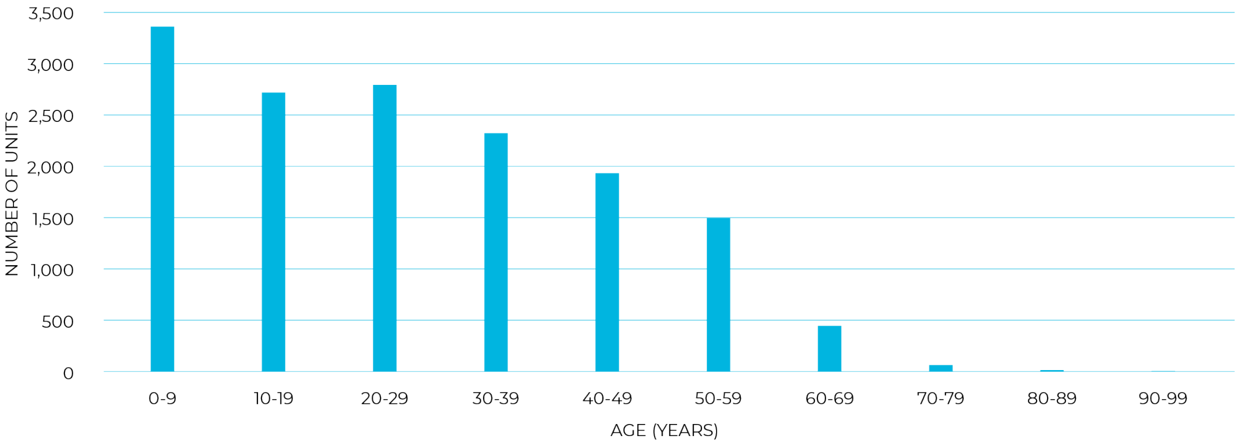


FIGURE 12-33: GROUND MOUNTED DISTRIBUTION TRANSFORMER AGE PROFILE

12.7.4.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

The contribution of ground mounted transformers to the overall SAIDI target is considered small mainly due to a small number of transformers being involved with an outage in any one year.

As shown in Table 12-29, there are a large range of transformer kVA sizes currently installed. Vector has rationalised the range of kVA sizes to 8 simplify inventory management and optimise the number of spares to be held.

A considerable number of ground mounted transformers are currently connected as a daisy-chain through the practice known as “group fusing”, in which a single set of protection fuses is used to provide protection for a chain of distribution transformers. This network design has the advantage of reducing the development cost as the network continues to grow. However, it has a disadvantage of not being able to detect individual transformer faults, especially in detecting faults on the LV terminal bushings - thus driving up fault response time and we also lose the ability to isolate individual transformers if needed. Group fusing is now only permitted in rural subdivisions with two transformers of matching capacity that are both 100kVA and under in rating. Due to the size of the fuse required to maintain load condition stability, low level faults may remain undetected until the fault develops into a fault significant enough to operate the fuse. Vector has recognised that this poses a high threat to people and property in close proximity and has significantly restricted the criteria for new group fused installations and developed an extensive mitigation strategy for existing group fuse installations, this is outlined in ESE806 - Protection distribution substations.

Occasionally, a customer with a large load demand may require two or more transformers in parallel. A fault on the HV winding side will trigger the HV protection and isolate the faulted transformer on the HV side. A risk of undetected earth fault exists in the HV delta winding if the faulted transformer is back fed via the LV side from the unfaulted transformer in parallel. Vector’s Multiple Transformer Configuration Guide (EGP501) stipulate controls for various installation configurations requiring multiple transformers.

Fire-related events involving distribution transformers are often caused by a combination of high loads and loose connections in congested LV frames. To counteract this Vector has compiled a detailed design standard for ground mounted transformers that clearly describe the maximum number of LV cables and fuseways allowed to be installed. Visual inspections including thermal imaging helps identify this hazard before thermal runaway develops and eventuates as a transformer fire.

12.7.4.4 CONDITION AND HEALTH

Our CBARM model for ground mounted distribution transformers considers age, condition and criticality. The present (RY24) risk level for the ground mounted transformer fleet is shown below in Figure 12-34.

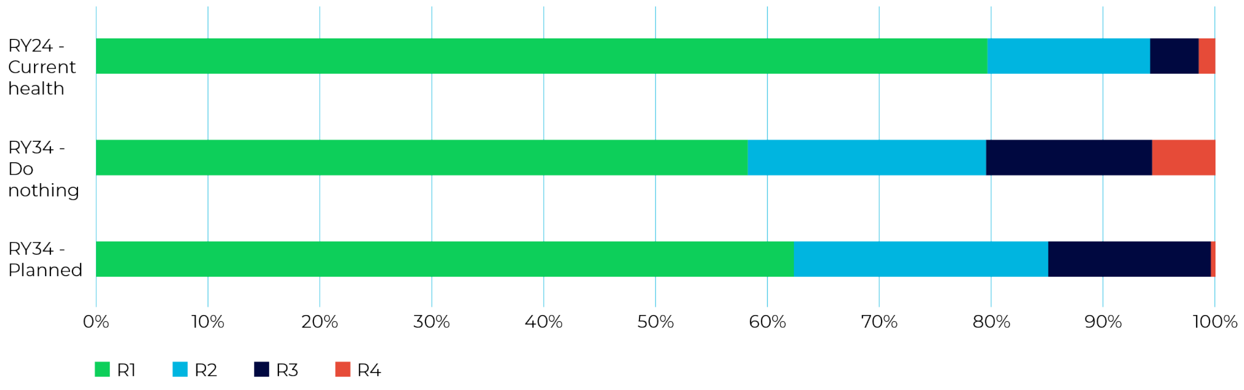


FIGURE 12-34: GROUND MOUNTED DISTRIBUTION TRANSFORMERS RISK PROFILE

The risk profile indicates that the ground mounted distribution transformer fleet is currently in good condition and approximately 10% of the fleet will approach end of life within the next 10 years. Vector's investment programme will ensure that the risk profile of this asset fleet will be maintained at approximately present levels.

12.7.4.5 MANAGEMENT STRATEGY

The management strategy for ground mounted transformers is based on asset health, network criticality and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.7.4.6 DESIGN AND CONSTRUCT

All new ground mounted distribution transformers are supplied in compliance with Vector's equipment specification standard ENS-0093: Specification for fluid filled distribution transformers. This standard applies to both 22 kV/400 V and 11 kV/400 V transformers.

To ensure diversity in the supply chain Vector currently has three approved suppliers for this asset class. One of these suppliers has also been contracted to provide a refurbishment service for the inspection and repair if practicable, of faulted distribution transformers. Refurbished transformers are released back into the general equipment stocks for re-use on the network.

Vector has developed a suite of design standards and drawings that define the installation requirements for ground mounted distribution transformers. The design documents pertaining to ground mounted distribution transformer are listed in Section 17, Appendix 2.

12.7.4.7 OPERATE AND MAINTAIN

Vector's maintenance standard details our maintenance requirements, including the frequency of inspections, and treatment of defects identified through either the corrective maintenance or asset replacement processes. The planned maintenance regime for our ground mounted transformer assets is summarised below in Table 12-30.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Functional inspection	All 11 kV and 22 kV ground mounted distribution transformers in distribution substations, excluding HV customer with HV metering	1 year
Full inspection		5 years
Thermovision inspection		5 years
Partial discharge inspection		5 years
Full Inspection	Functional inspection on all 11 kV and 22 kV ground mounted distribution substations in distribution substations where there are HV customers with HV metering	2 years
Thermovision inspection		2 years
Partial discharge inspection		2 years

TABLE 12-30: PLANNED MAINTENANCE ACTIVITIES FOR GROUND MOUNTED DISTRIBUTION TRANSFORMERS

Planned maintenance inspections as listed above ensures that faults are detected early and minor repairs such as oil top up, replacement of holding down bolts, repair of minor oil leaks, minor rust treatment and paint repairs are undertaken on site.

12.7.5 VOLTAGE REGULATOR

A voltage regulator is a device that automatically produces a regulated output voltage from a varying input voltage. The purpose is to hold the line voltage within predetermined limits and to ensure compliance with voltage regulatory requirements at customer points of supply. The regulators in Vector's network are step-voltage regulators, fitted with on-load tap changers to achieve the desired line voltage.

12.7.5.1 FLEET OVERVIEW

Voltage regulators have been deployed at three sites in the Auckland region and four sites in the Northern region to ensure voltage is within permitted limits. Vector uses two types of voltage regulators: the Siemens JFR single phase and the ABB three phase at Puhoi. The three-phase regulator at Puhoi is rated to 417 kVA; the remainder are the Siemens models rated at either 165 kVA or 220 kVA.

Single phase regulators are connected in either open delta or closed delta arrangements. A closed delta connection uses three separate single-phase voltage regulators whereas an open delta connection uses two separate single-phase voltage regulators. The difference in range of voltage regulation between the two configurations is the deciding factor in how they are implemented in the network.

12.7.5.2 POPULATION AND AGE

The average age of the regulator fleet is 10 years and considering the 25-year minimum lifespan of the asset, this is a young fleet. Figure 12-35 shows the age profile of the installed voltage regulators.

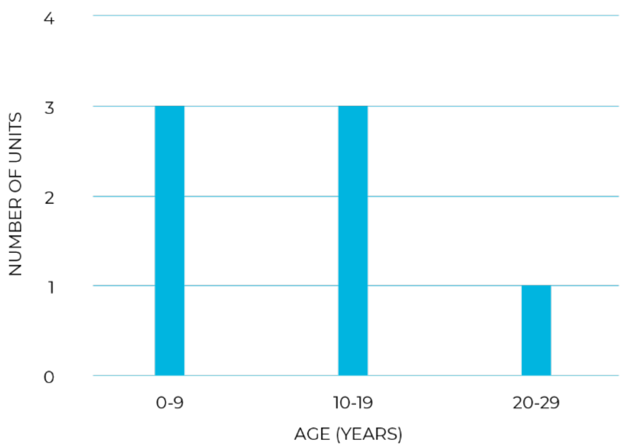


FIGURE 12-35: VOLTAGE REGULATOR FLEET AGE PROFILE

12.7.5.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

There are no recorded network events attributed to voltage regulators. The small population does not allow any meaningful trend analysis. Similarly, there are no risks recorded in Vector's risk management system, attributed to distribution voltage regulators.

12.7.5.4 CONDITION AND HEALTH

The environment in which the regulators in the Auckland region operate is relatively hostile because they are situated very close to the coast. This results in an elevated level of marine induced corrosion occurring on the regulator tanks and mild steel controller enclosures (the mild steel has a low resistance to corrosion). Electrically they are in good condition and provides reliable service, however the condition-based maintenance regime will identify and resolve defects to the enclosures and tanks as the units age. Only the Siemens JFR models will be used in the future.

12.7.5.5 MANAGEMENT STRATEGY

The management strategy for voltage regulators is based on asset health, reliability and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.7.5.6 DESIGN AND CONSTRUCT

The existing fleet of Siemens JFR regulators were procured on the basis that they offered the same performance ratings and characteristics as the legacy regulators installed in the network. Vector has identified a need to develop an equipment specification to document Vector's procurement and product requirements for its MV voltage regulators.

12.7.5.7 OPERATE AND MAINTAIN

ESM503 is Vector's maintenance standards for Ground Mounted Distribution Equipment and Voltage Regulators. It prescribes preventive maintenance requirements, frequency of inspections, and how to treat defects identified either through corrective maintenance or asset replacement processes. Vector's approach is to assess the condition of these assets during visual inspections, and to devise appropriate remedial action(s) based on the results of the condition assessment.

Table 12-31 lists the planned maintenance activities and the interval at which they are to be completed.

ACTIVITY TYPE	FREQUENCY
Functional inspection	1 year
Full inspection	5 years
Thermovision inspection	5 years
Partial discharge inspection	5 years
Servicing	10 years

TABLE 12-31: PLANNED MAINTENANCE FREQUENCY FOR VOLTAGE REGULATORS

12.7.6 LV DISTRIBUTION SYSTEM (NON-OVERHEAD)

Vector's low voltage distribution network is the part of the network that conveys electricity from a large network of inter-connected distribution substations to the end users at either 400 V (three phase) or 230 V (single phase).

The ground mounted LV distribution network consists of several key equipment types:

- LV underground cables (including streetlight cables)
- LV switchboard, commonly referred to as LV frame
- LV switchgear
- Pillars
- Pits

LV underground cables were of a paper insulated lead sheathed (PILC) construction until the emergence of polyvinyl chloride (PVC) and cross-linked polyethylene (XLPE) insulated cables in the late 1960s. Since then, PVC has become the predominant type of cable used in the LV network. XLPE is sometimes used in the LV network.

LV frames can be either free-standing or wall-mounted with 3-phase galvanised aluminium or copper busbar arrangement onto which cables and switchgear are terminated or mounted. Its primary function is to distribute power from the incoming main LV incomer to the outgoing distribution cables supplying individual customers or LV feeders.

LV switchgear is designed to perform two main network functions; firstly, to provide overcurrent protection against excess currents due to overloads, short circuit or ground faults and secondly to provide an isolation point. LV switchgear consists of fuses, circuit breakers and visible isolating disconnector units. These devices are mounted in LV frames, pillars, pits and network boxes as required.

Pillars are commonly referred to as an enclosure or a cabinet mounted above ground in which network connections are housed for distribution purposes. Pits serve the same purpose as the pillars, except that the connections are contained in a casing or container buried in the ground. Functionally, there are two types of pillars and pits: link pillars and link pits are used for connecting main LV distribution cables and to facilitate the extension of Vector's LV distribution network when required; service pillars and service pits are used for connecting individual customers onto the LV distribution network.

12.7.6.1 FLEET OVERVIEW

There is approximately 6,100 km of LV underground cable on our network, comprising aluminium and copper conductors with either XLPE, PVC or PILC insulation. Approximately 11% of the installed LV cable fleet lack identifying information relating to core-size or the insulation type. Of the cables with known core type, 54% are aluminium cables due to the lower cost of aluminium compared with copper.

The majority of the 3,500 LV frames on the Northern Network have been installed after 2000, and the total now is almost double the number on the Auckland Network. Due to historical data legacy issues the asset information on LV switchgear is poor and initiatives have been put in place to update data to assist with LV switchgear faults.

There are approximately 163,000 known pillars and pits across the Vector network with 68% installed on the Auckland network. This is made up substantially of service pillars and pits with only 9,300 link pillars and 170 link pits. There are a large number of assets with deficiencies in data recorded for their installation dates. These account for 6% of the known population of pillars and pits and is an area where Vector will need to improve data records.

12.7.6.2 POPULATION, AGE AND CONDITION

Figure 12-36 shows the current known populations of low voltage distribution cables with the recorded installation decade. Values are in kilometres with a data error rate of approximately 6%.

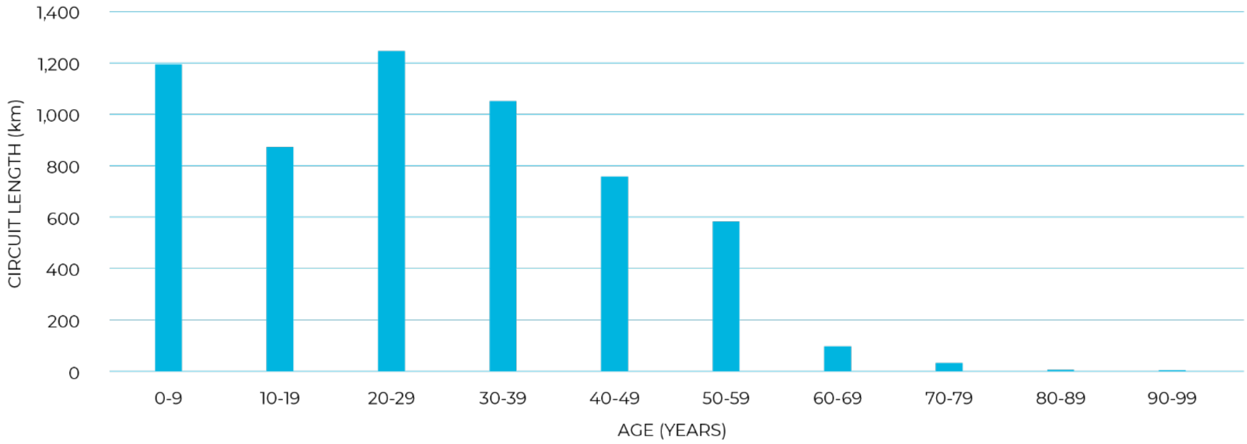


FIGURE 12-36: LV DISTRIBUTION CABLE AGE PROFILE

The average age of the LV cable fleet is 28 years. PILC cables have a design life of 70 to 80 years. Early implementation of XLPE and PVC cables were expected to last 40 to 50 years. With cable technology advancing, the design life of XLPE and PVC has increased up to 60 years. Temperature and the cable's installation environment have the largest impact on cable asset life.

Our fleet of LV frames has an average age of 22 years and an expected life of 30 years. Figure 12-37 below shows the age profile of the LV frame fleet. (Vector notes the level of data error is approximately 12%).

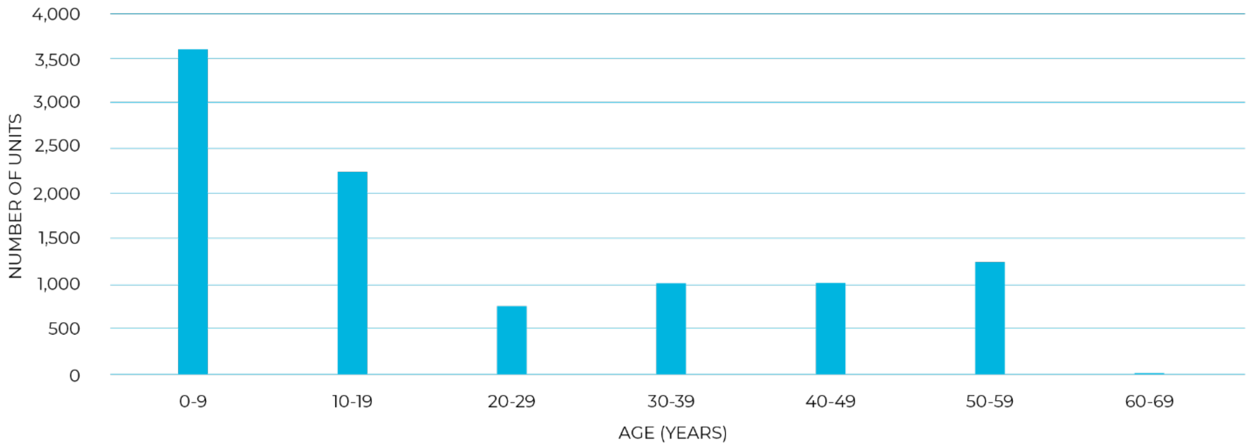


FIGURE 12-37: LV FRAME FLEET AGE PROFILE

Vector maintains approximately 163,000 LV pits and pillars with the majority installed in the Auckland region. Figure 12-38 shows the age profile of the combined pillar and pit populations as these two asset types are not recorded separately (Vector notes the level of data error is approximately 11%).

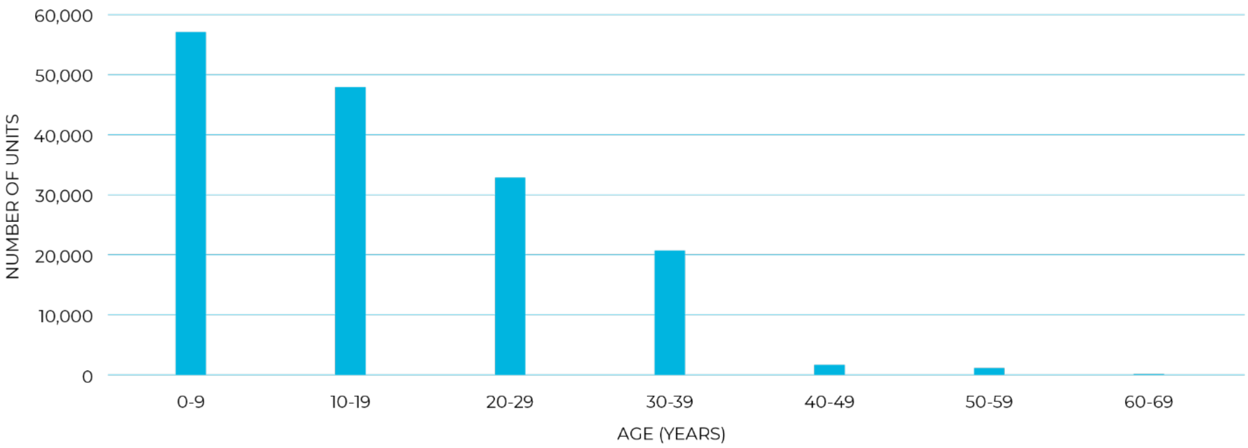


FIGURE 12-38: PILLAR AND PIT FLEET AGE PROFILE

Early generations of pillars were made of cast metal. While larger link pillars have continued to be constructed from aluminium, service pillars have been primarily constructed from plastic since the 1980s. Plastic pillars and pits are expected to last 30 years. Metal pillars are expected to last between 30 and 40 years.

12.7.6.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Since the 2000s we have preferred the installation of underground pits over above ground pillars because of the visual amenity with less equipment visible on kerbs. This is also public preference.

There are several issues which we are closely monitoring in this asset class and includes the following:

- Water ingress susceptibility in solid aluminium conductor LV cable
- Exposed busbars in LV frames
- Failing J Wedge fuse holders
- Failure of neutral connections at customer connections
- Inadequate earthing of metal low voltage service pillars
- Incorrect lugs, loose cable connections causing hot spots
- Building removals without LV isolation confirmed

12.7.6.4 MANAGEMENT STRATEGY

The condition and health of underground LV cables, service pillars and pits are presently monitored on a limited basis. The condition of LV frames is monitored as part of the maintenance programme for ground mounted transformers. The following sections describe how Vector is managing this asset class through the key lifecycle phases. The LV network strategy is currently being reviewed and updated to determine how greater automation and data gathering capabilities can be utilised to better understand the LV network, as well as identify and manage risk.

12.7.6.5 DESIGN AND CONSTRUCT

Vector controls the procurement of LV equipment through the following equipment specifications:

- ENS-0078 Specification for 400 V underground cable
- ENS-0154 Specification for LV service pits
- ENS-0155 Specification for IPPCs for LV distribution pits.

Vector has supply agreements in place with a pool of approved manufacturers and suppliers for each LV equipment category but does not procure directly from them. LV equipment is procured by the FSPs who have their own commercial arrangements with the approved suppliers.

12.7.6.6 OPERATE AND MAINTAIN

Our maintenance standard ESM505 details maintenance requirements, frequency of inspections, and how to treat defects identified either through corrective maintenance or asset replacement processes. It also defines the procedure for data capture and system updates carried out by Vector's field service providers.

The maintenance of the LV distribution system is achieved through periodic visual inspections of the accessible elements of the network (pits, pillars and LV switchgear). Neither invasive maintenance nor electrical testing is carried out unless there is a specific issue that needs to be investigated and resolved.

Thermal imaging is carried out on LV frames mounted inside ground mounted distribution transformers and distribution substations as part of the inspection requirements specified in Vector's standard ESM503.

Onsite maintenance for LV assets is minimal, and we generally operate these assets on a "run to failure" philosophy unless they pose a health and safety risk. The planned maintenance for this asset sub class is shown in Table 12-32 below.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Functional inspection	Functional inspection on service pits, service pillars, link pillars, fuse boxes, network boxes and underground link boxes	1 year
Full inspection	Full inspection on service pits, service pillars, link pillars and fuse boxes	5 years
Full inspection	Full inspection on network boxes and underground link boxes	3 years
Full inspection	Full inspection on LV frames in distribution substations [all Vector enclosures and third-party buildings and excluding HV customer substations]	5 years
Full inspection	Full inspection on LV frames in HV customer substations	2 years
Thermovision inspection	Thermovision inspection on LV frames in distribution substations [all Vector enclosures and third-party buildings and excluding HV customer substations]	5 years
Thermovision inspection	Thermovision inspection on LV frames in HV customer substations	2 years

TABLE 12-32: PLANNED MAINTENANCE ACTIVITIES

12.7.7 REPLACE, RENEW AND DISPOSE

Overhead Switchgear

Vector's approach to replacement of MV overhead switchgear is condition-based. The age of the asset may be reflected through the condition along with other factors, such as environment, loading, duty cycles, maintenance history etc., but it is not used as a primary determining factor in Vector's asset replacement consideration.

Generally, the replacement of an MV overhead switchgear is dependent on the condition assessment resulting from the inspections of the assets in accordance with Vector's maintenance standard. Defect(s) identified during these inspections are evaluated to determine if the identified condition had exceeded the threshold for replacement.

In the absence of a condition-based asset risk management (CBARM) model for this asset class, the remediation of defects is prioritised through the same risk-based prioritisation methodology described for the treatment of the maintenance defects.

Ground Mounted Switchgear

Given the disparity in condition and age among Vector's ground mounted distribution switchgear (ring main unit) population, we have chosen to approach the management of equipment renewal both on a condition based and age-related basis.

For relatively new equipment, condition-based replacement is the most appropriate measure used to maintain the serviceability of this portion of the RMU population. This includes all SF_6 gas insulated switchgear, some of the oil-filled switchgears (namely the ABB SD Series 2 and Lucy models) and all epoxy resin installed switchgear.

Aging equipment such as the older models among the Long & Crawford switchgear population, and the combined population of Andelect/Astec/ABB SD Series 1 switchgear are being renewed through a more proactive replacement approach with an aim to progressively remove this equipment from Vector's network.

Under the condition-based replacements, the most common cause for an RMU replacement is expected to be significant degradation in the physical condition due to corrosion or leaks. Other general causes are expected to be due to vehicle damage and network growth.

The proactive replacement program uses the assessments from field service providers in the CBARM framework to identify assets for replacement in a yearly rolling program. Figure 12-29: RMU FLEET RISK PROFILE shows a comparison between the RY33 risk level with and without a proactive replacement programme. Without a proactive replacement program, the health of this asset fleet will steadily decline.

Transformers

The most common cause for a transformer replacement is a significant degradation in its physical condition due to corrosion or leaks, with less common causes being due to vehicle damage and network growth. Historically, 100 kVA, 200 kVA and 300 kVA transformers are replaced most frequently which aligns with these being the predominant populations of transformers.

Since their introduction in the 2000s there have been two 22 kV/400 V transformer replacement based on reactive maintenance. This low rate is expected considering the low overall age of this equipment.

In 2018 Vector developed a condition-based asset risk management (CBARM) framework to inform its programme for the renewal of distribution transformers. Vector now has a proactive distribution transformer replacement programme in place, however pole mount transformers with a rating under 100kVA are replaced only on reactive basis.

Voltage Regulators

Vector's approach to replacement of voltage regulators is condition-based. Presently there is no planned replacement programme for the current fleet of voltage regulators, as they have a relatively young age. It is expected that the existing installations will continue to operate in the network for the foreseeable future. Replacement forecasting for this asset class is based on historical records.

LV Non-Overhead Assets

LV assets are typically replaced when they have reached the end of functional life or pose a public health and safety risk, this strategy presents a balanced approach to remove risk while allowing maintenance resources to be prioritised for the higher consequence assets in the distribution and HV parts of the network. The LV frame and associated switchgear are usually replaced in conjunction with the replacement of a distribution transformer.

Currently there is no proactive replacement programme for the LV distribution system. Programmes to remove specific asset types have occurred in the past, such as the replacement of mushroom pillars and letterbox pillars. We may adopt the same approach in the future for other types of assets as the need arises. Replacement forecasting for this asset class is undertaken on a historical basis.

12.7.8 FORECAST SPEND

The focus on improving the reliability of the network, means that the proposed capital investment in overhead switches, RMUs and distribution transformers are included in Section 11, Reliability. The forecast capex graph shown in Figure 12-39 below provides a summary of the overall capital investment for the LV distribution class for the 10-year AMP forecast period.

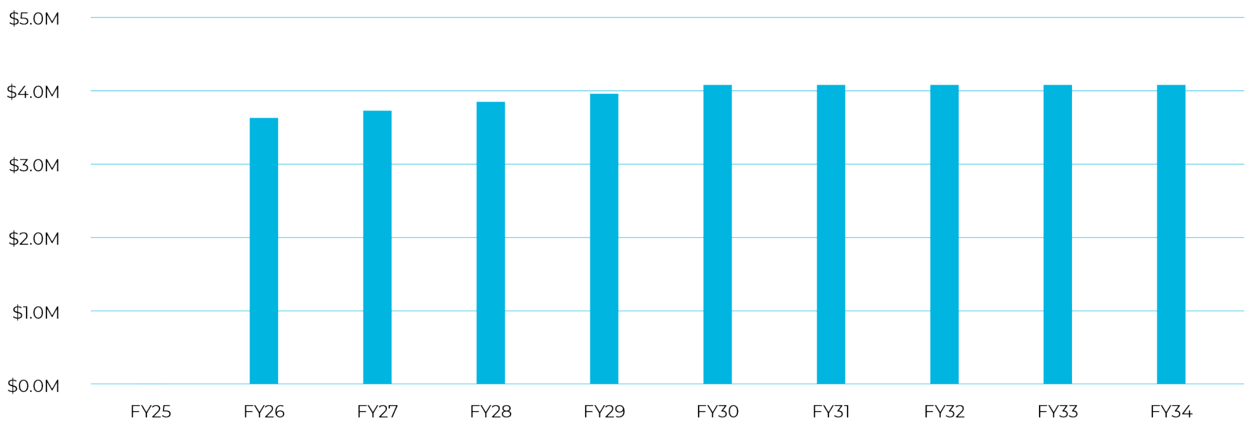


FIGURE 12-39: FORECAST CAPEX – DISTRIBUTION SYSTEMS

12.8 Protection and Control

This Section describes our protection and control fleet and provides a summary of our associated asset management practices. The protection and control fleet comprise the following five subcategories:

- Protection systems
- Transformer management systems
- Communications systems
- Automation systems
- Power quality metering

12.8.1 PROTECTION SYSTEMS

Protection relays are devices that form a major part of the protection system. These are crucial for the safe and reliable operation of the electrical network. The protection relays detect faults and isolate the faulted network parts from the electrical network whilst retaining the healthy part of the network in service. This allows Vector to minimise the number and extent of power outages to customers.

Vector uses a variety or protection relays as discussed in the sections that follow. Failures of protection relays are rare, but they have a shorter design life than the primary equipment they protect. Additionally, the legacy electro-mechanical relays within the network are at risk of obsolescence, with limited manufacturer support and spare parts availability. The failure of protection relays in detecting and clearing faults can potentially result in catastrophic plant damage, cascade network damage and in rare instances, injury or death to persons. As such, the effective monitoring of asset health and flexible designs to allow for asset replacement, is highly important for this asset class.

12.8.1.1 FLEET OVERVIEW

Vector has approximately 3,300 protection relays in service within the network. They are installed within GXPs, zone substations, and distribution assets to isolate and clear faults that could otherwise damage network assets or cause harm to the public. Vector uses three types of relays:

- Electromechanical
- Numerical
- Static

Table 12-33 provides a summary of the relay types in the fleet. This shows that the majority of protection relays in Vector's network are numerical relays.

ELECTROMECHANICAL	STATIC	NUMERICAL
694	76	2,652

TABLE 12-33: SUMMARY OF RELAY TYPE COMPOSITION

12.8.1.2 POPULATION AND AGE

The population and age profile for electro-mechanical, numerical and static relays are provided in Figure 12-40 below (Vector notes that the level of data accuracy is approximately 96%)

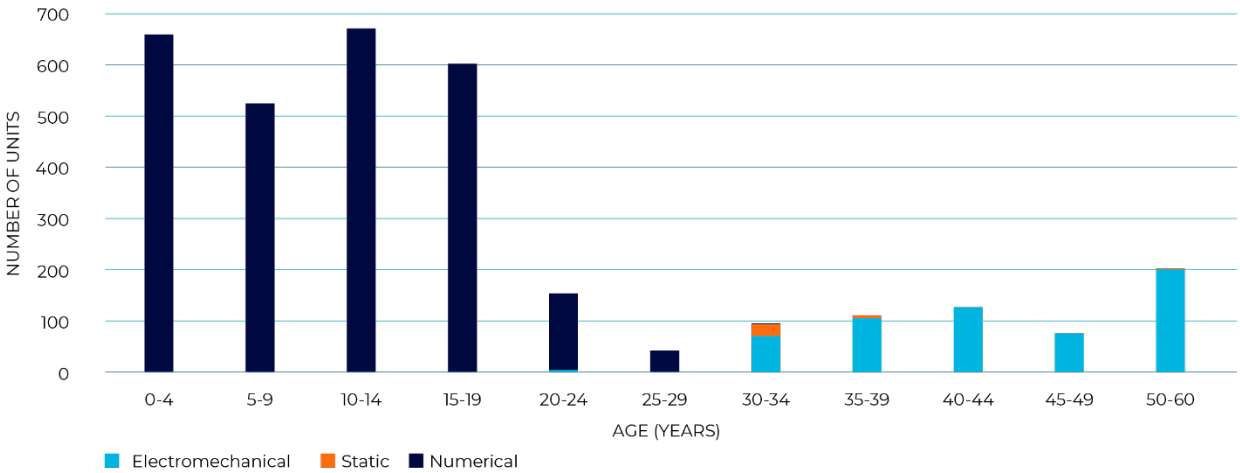


FIGURE 12-40: PROTECTION RELAY FLEET AGE PROFILE BY TYPE

12.8.1.3 CONDITION AND HEALTH

As protection relays reach their design life, their failure rate is expected to increase. Most relay failures on Vector's network since 2013 have been due to failure of an aging asset. Vector has programmes of work in place to replace existing electromechanical, static and first-generation numerical relays with modern numerical relays.

Electromechanical relays are reliable but is an aging legacy protection technology at risk of obsolescence and with only basic functional settings and data storage capability which prohibits fault and event analysis. They also have no relay supervision functionality. It is becoming increasingly costly to obtain spare parts and retain the skills required to maintain and operate this fleet. Approximately 20% of the relays are electromagnetic. The oldest are 50 to 60 years old.

Static relays are solid state devices with no moving parts, are easy to configure and more flexible compared with electro-mechanical relays. However, they are limited in their functionality when compared with numerical relays and lack event recording facilities. Static relays are also becoming obsolete, spare parts are becoming harder to source and more expensive; there are also reliability issues associated with this type of relay. The static type relays on Vector's network are 30 years old.

Numerical relays are extremely flexible as they are programmable and can be configured to perform a wide range of protection functions. They can store data and be used for post fault event analysis. They are also equipped with digital communication functionality and can be integrated directly with the SCADA system. The disadvantages of these relays include a relatively short 20-year design life as they use microprocessor-based technology and the need to manage firmware versions and compatibility requirements. To date, failures of numerical relays have been rare.

12.8.1.4 MANAGEMENT STRATEGY

64% of all relays will require replacement over the next 10 years. Vector's asset management strategy for protection relays is to phase out static, electromagnetic and first-generation numerical relays then replace numerical relays as they exceed the 20-year design life of the relay. The risk of relays will be reassessed annually, and the replacement activities are prioritised as required.

The superior monitoring and control capabilities provided by the modern numerical relays provide better visibility and control to the network. This will allow Vector's network to deliver higher reliability and resilience.

The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.8.1.5 DESIGN AND CONSTRUCT

All new relays on Vector's network will be the of numerical type and will take into consideration the relay being replaced at least once during its design life. This replacement must be seamless through flexibilities allowed during the design stage. Vector has rationalised to two relay manufacturers: Siemens and SEL (Schweitzer Engineering Laboratories). This standardised approach reduces the number of relay variants and the number of spares held and introduces familiarity with the programmable logic used in the relays, the firmware and setting software. The standardised relay approach combined with standardised wiring designs decreases the duration of network outages for installations.

12.8.1.6 OPERATE AND MAINTAIN

Vector's maintenance requirements for protection relays are detailed in ESM801. FSPs undertake the following general inspection and maintenance activities:

- Investigate and repair or replace any faulty devices and associated systems showing signs of imminent failure or damage.
- Fix any wiring or mounting of the device that is unsecured or damaged that poses electrical failure risks and safety hazards.
- Maintain general cleanliness of the devices due to build-up of dust or grime.
- Investigate and remediate a device that has powered down or indicates abnormal alarms.
- Arrange a replacement of a relay that has failed the self-test.

12.8.1.7 REPLACE, RENEW AND DISPOSE

Replacement prioritisation for Vectors investment programme include the following considerations:

- Imminent relay or protection system failure.
- Risk of large-scale failure of numerical relays when reaching end of life.
- Relay spares availability
- Reliability concerns (based on performance of particular models)
- Data storage and fault recording capability, grading limitations and type of connected load.
- Feeder automation program
- Live line works implementation (Health and Safety)

12.8.2 TRANSFORMER MANAGEMENT SYSTEMS

Vector employs Transformer Management Systems (TMS) to monitor zone substation power transformers, manage their performance and predict failure. TMS systems are used to monitor supply voltage quality to ensure compliance with regulatory standards. TMS within Vector's network range from legacy electromechanical relays, older generation programmable logic relays to modern numerical relays. A failure of TMS relay could potentially result in Vector's primary assets operational integrity being compromised, its performance to deteriorate, or creating undue risk to equipment.

12.8.2.1 FLEET OVERVIEW

Vector has 212 TMS relays in service. These devices can be grouped into four major types as listed below:

- Numerical TMS relays
- Static TMS relays
- Programmable Logic Controller (PLC) TMS
- Electromechanical TMS relays

Table 12-34 below provides a summary of TMS fleet. This shows approximately 78% of the TMS fleet are modern numerical types.

ELECTROMECHANICAL	STATIC	PLC	NUMERICAL	TOTAL
11	23	0	178	212

TABLE 12-34: TMS RELAY FLEET COMPOSITION

12.8.2.2 POPULATION AND AGE

The population and age profile for electro-mechanical, numerical, PLC and static TMS relays are provided in Figure 12-41 (Vector notes this data has an error rate of approximately 3%):

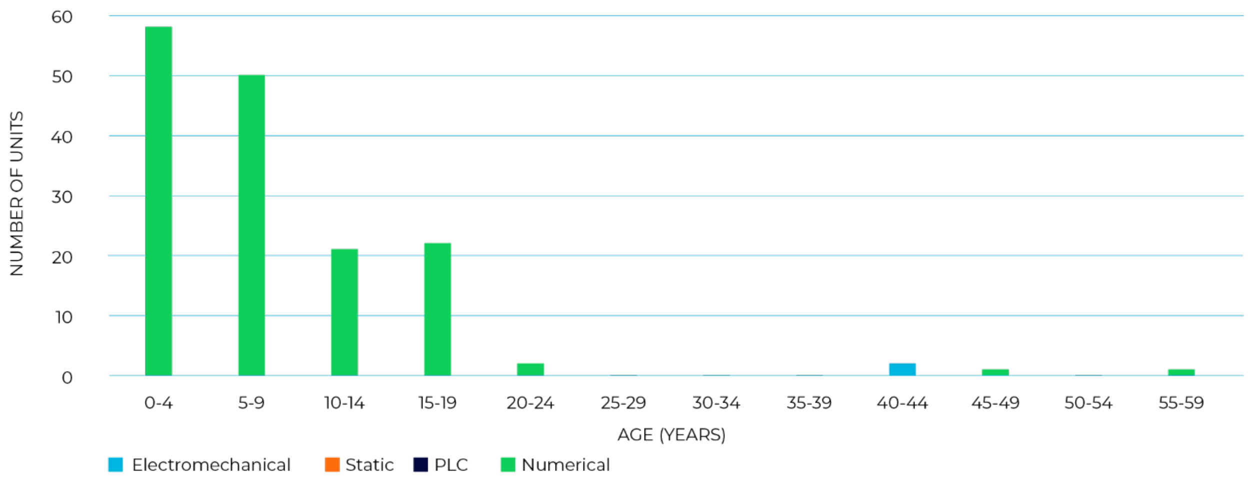


FIGURE 12-41: TMS RELAY FLEET AGE PROFILE BY TYPE

12.8.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

The majority of the modern numerical TMS relays on the network are within their design life of 20 years, hence failures are rare.

The age of the electromechanical TMS relays range between 28 and 51 years. While most are still functioning satisfactorily, they are at risk of obsolescence with limited spare parts and technical support available from manufacturers. They also require regular calibration that adds cost and consumes technician resources. All remaining PLC based and electro-mechanical TMS systems with high failure rate have been replaced with modern numerical systems. The remaining static and electro-mechanical TMS systems will be replaced as part of the power transformer or switchgear replacement.

CONDITION AND HEALTH

Over the past 5 years, the use of modern numerical TMS relays on Vector's network has increased from 63% to 77%. Modern numerical relays within Vector's network are well within their design life of 20 years hence are considered to be highly reliable and in good working condition.

12.8.2.4 MANAGEMENT STRATEGY

The management strategy for TMS is based on asset age, risk of obsolescence and reliability. It is informed by asset health data being collected from our SCADA and supplemented with information gathered by our field service providers and industry peers (such as other utilities). The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.8.2.5 DESIGN AND CONSTRUCT

The replacement of the TMS units will reuse existing control wiring as well as the enclosures (cabinets) where practicable. Vector has standardised on two types of TMS relays: REGSys and Schweitzer. New switchboards will incorporate REG-DA relays (from REGSys), while retrofit projects will have either REG-DA or SEL-2414 (Schweitzer) relays.

12.8.2.6 OPERATE AND MAINTAIN

Vector's maintenance requirements for protection relays are detailed in ESM801. The Field Service Providers undertake general inspections of the relays as follows:

- Investigate and repair or replace any faulty devices and associated systems that is mal-operating or has physical damage.
- Fix any wiring or mounting of the device that is unsecured or damaged that poses electrical failure risks and safety hazards.
- Maintain general cleanliness of the devices due to build-up of dust or grime.
- Investigate and remediate a device that has powered down or indicating abnormal alarms.
- Arrange a replacement of the TMS or relay that has failed the self-test.

12.8.3 COMMUNICATIONS SYSTEMS

Vector uses communication systems to enable real time control, monitoring, management and restoration of the power network. The communications systems consist of backhaul communications networks and onsite communications networks. The backhaul network known as the Operational Technology Wide Area Network (OT WAN) links the remote sites to centralised control and monitoring systems. The onsite communications typically substation local area networks (LANs) interface the intelligent electronic devices (IEDs) within the remote sites to each other and to the OT WAN.

12.8.3.1 FLEET OVERVIEW

The backhaul communication network consists of:

- The Vector Fibre network which is used for connectivity to 116 zone substations and GXP's which is over 80%.
- The Wireless Plus cellular network using dual SIM 3/4G routers to provide communications to 751 predominantly automated distribution sites.
- Fibre and ADSL networks provided by third parties that are used when the Vector Fibre network is unavailable.
- Radio networks including Digital Microwave Radio (DMR), Very High Frequency (VHF) and Ultra High Frequency (UHF) radio systems used where fibre connectivity is unavailable.
- Pilot cables which are a legacy communications medium for telecommunications between some substation sites

The on-site communication systems consists of:

- Substation Routers
- Ethernet Switches
- Media Converters

The key communications equipment are the substation routers, ethernet switches and cellular routers. Table 12-35 provides a summary of the fleet.

SUBSTATION ROUTERS	ETHERNET SWITCH	CELLULAR ROUTERS
169	424	751

TABLE 12-35: NUMBERS OF ROUTERS AND SWITCHES

12.8.3.2 POPULATION AND AGE

The population and age profile for substation routers are provided in Figure 12-42:

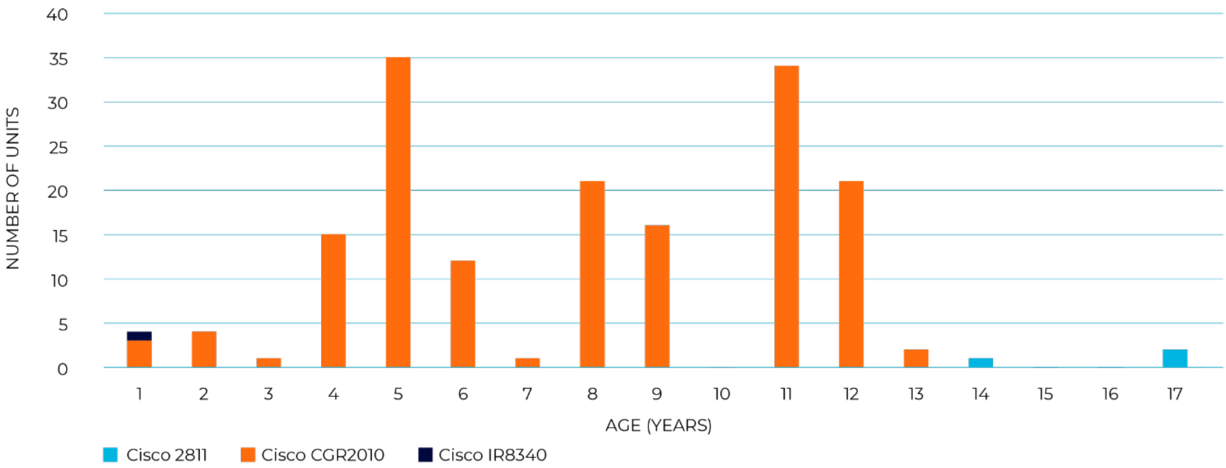


FIGURE 12-42: SUBSTATION ROUTER FLEET AGE PROFILE

The population and age profile for ethernet switches are provided in Figure 12-43.

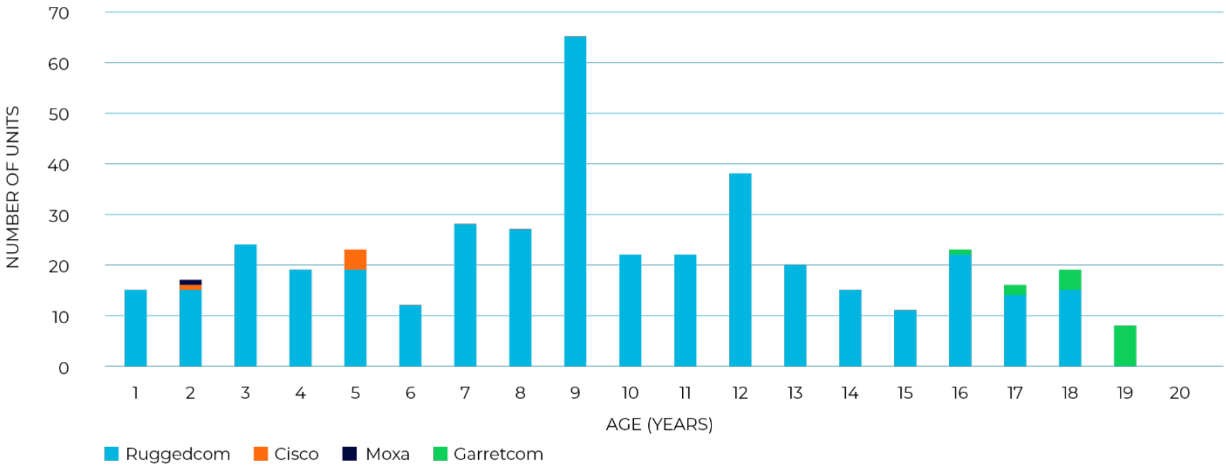


FIGURE 12-43: ETHERNET SWITCH FLEET AGE PROFILE

The population and age profile for cellular routers are provided in Figure 12-44 below.

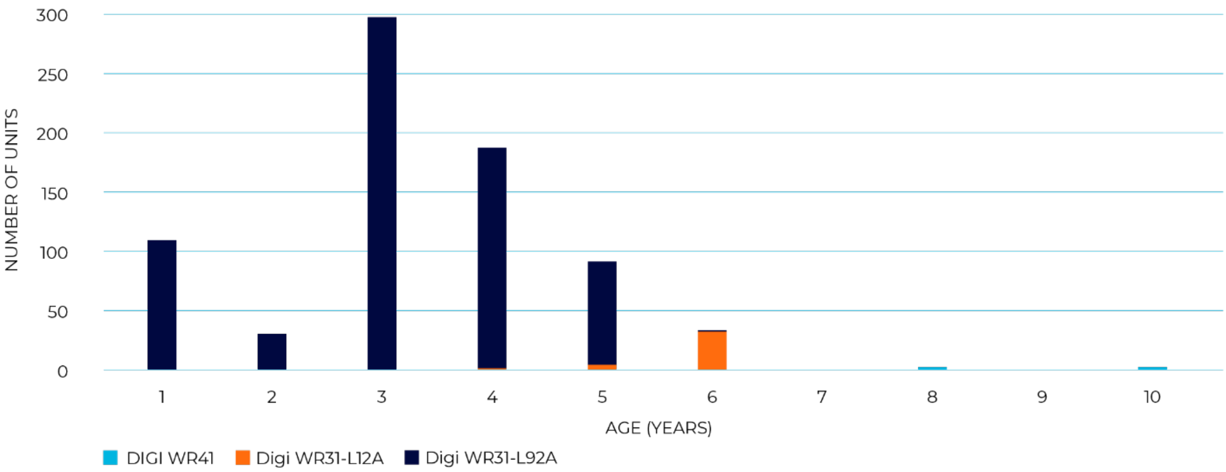


FIGURE 12-44: CELLULAR ROUTER AGE FLEET PROFILE

12.8.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

For fibre infrastructure the system availability figure for the last year has been above the 99.95% availability target. The fibre outages experienced are predominantly caused by third party strikes on the network. The fibre network is fit for purpose, has been extensively expanded over the last few years and will continue as required. The available bandwidth on the fibre network is sufficient for future expansion except between data centres once the new data centre comes online. A high-capacity Dense Wavelength Division Multiplexing (DWDM) fibre ring is being implemented to meet this demand.

The overall device availability for the cellular network for the last year has been above the 95% target. The risk of failure in the third-party infrastructure (e.g., cell tower) could cause loss of communications to multiple distribution automation devices and there is no guaranteed quality of service so if usage of a cell site is high, this impacts the signal strength to one or multiple sites resulting in loss of communications. Dual sim and dual antenna routers with connections to two cellular providers provides some mitigation of these risks.

The performance of the radio systems are not actively monitored. Real time remote monitoring functionality will be implemented in the future to provide performance information. The key risks associated with radio are environmental and third-party damage.

Availability of substation routers and ethernet switches is above the 99.95% target over the past year.

12.8.3.4 CONDITION AND HEALTH

The asset condition and health of the fibre infrastructure, cellular network,.3rd party fibre connections and DMR network for backhaul communications is good. Onsite communications asset health is also good. Aging systems being replaced include the VHF radio system, the copper pilot wire connections and 3rd party ADSL connections.

12.8.3.5 MANAGEMENT STRATEGY

When assessing communications options to sites fibre is the preferred backhaul communications interface for zone substations, GXP and critical distribution sites. In certain remote areas, especially the far northern regions of the network, the cost of fibre installations is prohibitive, and this is where 3rd party fibre and/or radio solutions are implemented.

Vector is progressively replacing copper pilot cables with fibre cables for the backhaul communications network to cater for the bandwidth and reliability required for the network.

The radio system provides a network that is highly available and has sufficient spare capacity for future expansion. This system is expected to be in operation for the foreseeable future.

The CGR2010 router is no longer available and will be out of support in 2028. New installations now utilise the Cisco IR8340 and the replacement program will replace the CGR2010 and remaining Cisco 2011 routers.

The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.8.3.6 DESIGN AND CONSTRUCT

For the backhaul communications network, the following must be considered when designing and constructing new infrastructure:

- Provide a secure, highly available communication link to remote sites like zone substations, GXP's etc.
- Ensure that a failure of a single communications node does not impact multiple sites.
- Provide the infrastructure for real time monitoring and control capabilities to manage Vector's electricity network.

On site network equipment is standardised as much as possible to reduce the number of spares required to be kept.

The Cisco Grid Series routers and Ruggedcom ethernet switches are Vector's standard devices across all substations and strategic spares are kept for zone substations.

12.8.3.7 OPERATE AND MAINTAIN

The fibre infrastructure for the Operational Technology network is managed by Vector Fibre and a support agreement is in place for the cellular routers, substation routers and ethernet switches.

The maintenance requirements for the radio systems are defined in Vector's standard ESM805. These include:

- Annual off-site inspection (remote monitoring) with corrective follow-up on remedial actions as required.
- Annual on-site inspection with corrective follow-up on remedial actions as required.
- Two yearly on-site testing with corrective follow-up on remedial actions as required.

Where maintenance of radio equipment is required, site specific maintenance standards are developed (ESM805 Maintenance of Radio Equipment, ESM709 Penrose – Hobson Tunnel Radio Systems and ESM712 Penrose – Hobson Tunnel Radio Systems.)

12.8.4 AUTOMATION SYSTEMS

Vector employs network automation systems, comprising substation remote terminal units (RTUs) and distribution controllers, to provide real-time remote presence at locations throughout the network and enable automation of key processes such as monitoring plant status and service restoration. Vector has adopted an internationally recognised open communications architecture standard that allows different devices located within the zone substations to integrate seamlessly and communicate with the ADMS system through the communications network.

12.8.4.1 FLEET OVERVIEW

Vector has 691 RTU devices from a variety of suppliers within its network. Table 12-36 below provides a summary of RTU types.

TYPE	NUMBERS
ABB	209
Abbey Systems	10
AdvanceTech	2
Foxboro	62
Fuji Electric	9
GTP Plessey	16
Leads & Northrup	1
Linak	2
Mitsubishi Electric	1
SEL	359
Siemens	14
Unknown	6

TABLE 12-36: RTU FLEET COMPOSITION

Table 12-37 below provides a summary of distribution automation devices type composition.

DEVICE TYPE	TOTAL NUMBER
Voltage Regulator Devices	4
Customer DC System Monitoring	3

TABLE 12-37: DISTRIBUTION AUTOMATION DEVICE COMPOSITION

12.8.4.2 POPULATION AND AGE

The majority of automation devices range in age from new to over 12 years, with the odd exceptions that were installed in 1988.

The population and age profile of Vector's fleet of automation devices are provided in Figure 12-45 below (Vector notes this data has an error rate of approximately 18%):

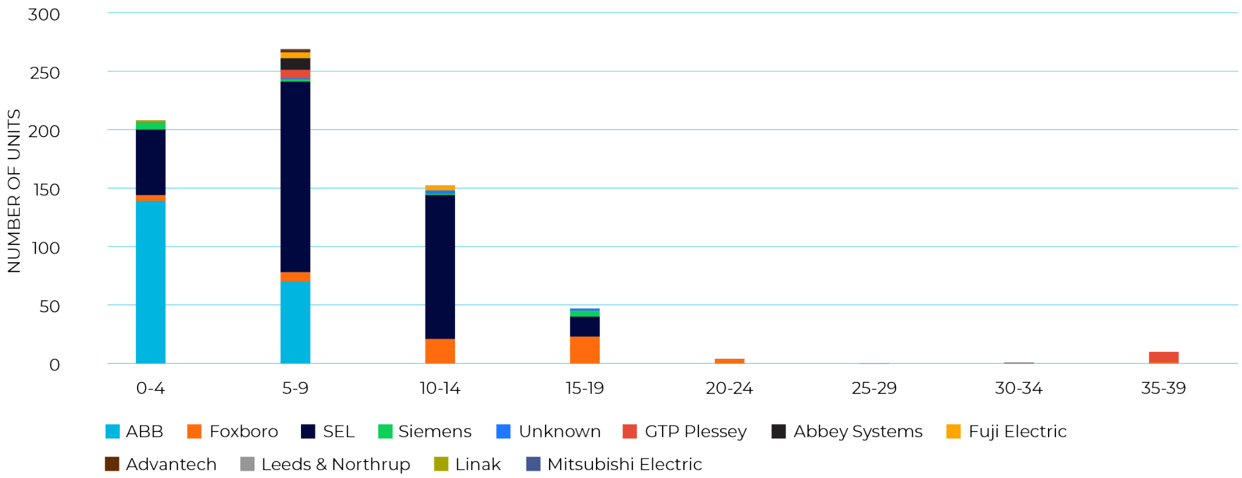


FIGURE 12-45: NETWORK AUTOMATION SYSTEM AGE PROFILE

12.8.4.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

The introduction of distribution automation infrastructure has clearly demonstrated the benefits of network visibility afforded by these systems. Reliable and accurate visibility of our network is critical when making real time operational decisions and responding to outages. In addition, the implementation of automation systems allows hands-off operation of the network and reducing the need for crews to travel, with its associated hazards and time to navigate congested roads, to remote destinations.

Whilst the loss of an RTU may not be an immediate issue under healthy network conditions, the loss of visibility under abnormal or fault conditions can result in overloaded networks, delayed fault restoration and, most importantly, lack of response to safety risk events.

Vector maintains its capability to operate and maintain RTU's and distribution automation devices across multiple generations of underlying hardware platforms. The current core capability of Vector's Distribution Automation system is sufficient to operate the network now, but it is evident that additional capability and performance will be required as the industry develops, and Vector has to adapt to the needs of our customers.

12.8.4.4 CONDITION AND HEALTH

Due to the age of Vector's legacy RTU equipment, some of the components within the RTU are no longer manufactured and/or supported by the OEM. Therefore, a portion of the RTUs within Vector's fleet, especially those installed in the 1980s and early 1990s, are obsolete. In addition, better technology is required to ensure the network can accommodate higher levels of volatile generation and unpredictable loads. The technology used by the old generation of RTUs cannot cope with new demands. Vector systematically replaces legacy devices as part of switchgear and protection replacement projects and as stand-alone RTU replacement projects.

In general, the modern RTU devices within Vector's network have been operating reliably and improves safety by providing network visibility and control that allows remote operation.

12.8.4.5 MANAGEMENT STRATEGY

Replacement of RTU devices in Vector's network is based on the level of functionality, the technology and the availability of spare components rather than any measurable condition points.

The existing infrastructure has been architected so it can expand to accommodate the anticipated service, traffic and interface growth. The following strategy is adopted by Vector for RTUs:

- Replace on failure – cut spending to a minimum and accept a progressive decline in performance and increasing risk
- "BAU" – no investment beyond maintaining current capability, migration to current standard on major site-works only and resolving any significant issues
- Invest in achieving a common base platform across the fleet, removing the obsolete plant that is still in service but presenting progressively higher risk

The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.8.4.6 DESIGN AND CONSTRUCT

The automation infrastructure provides operational services to the SCADA system. The infrastructure needs to be designed with the following in mind:

- Provide a secure environment in which the automation equipment can operate
- Provide infrastructure which allows efficient development of data acquisition and control services
- Utilise robust infrastructure installations to support high service performance
- Provide robust DC systems with adequate backup supply suitable for the prolonged loss of AC mains
- Provide adequate capacity for present and future needs

Vector has standardised RTU designs that use devices from approved manufacturers to reduce the number of spares required thereby minimising the total cost of ownership.

12.8.4.7 OPERATE AND MAINTAIN

Vector's maintenance requirements for RTUs are specified within ESM801.

FSPs will undertake the following general inspections of RTUs:

- Investigate and repair or replace any faulty devices and associated systems or damaged units.
- Fix any wiring or mounting of the device that is unsecured or damaged that poses electrical failure risks and safety hazards.
- Maintain general cleanliness of the devices due to build-up of dust or grime.
- Investigate and remediate a device that has powered down or indicating abnormal alarms.
- Arrange a replacement of the RTU or relay that has failed the self-test.

12.8.5 POWER QUALITY METERING

Vector's power quality meters (PQMs) are intelligent revenue class devices that provide power quality analysis coupled with revenue class accuracy, communications, and control capabilities. They are deployed at key distribution points such as GXPs and zone substations. These meters communicate to the metering central server over an IP communication network. Power quality information and energy consumption metrics are required to make informed decisions that best meet the business objectives as well as to meet legal and regulatory requirements. At the GXP level PQMs provide the function of "check meter" to compare electricity consumption against revenue metering measurements. PQMs are also used to initiate interruptible load via the ripple systems to reduce peak demand. Their event data storage functionality is also used for post fault analysis and power quality excursions.

12.8.5.1 FLEET OVERVIEW

Vector has 142 power quality meters commissioned on its sub-transmission and distribution networks. Vector uses two types of PQM spanning multiple generations:

- Advanced functionality PQM: ION 7700, ION 7600, ION 7650 v3XX, ION 7650 v400, ION 92040
- Intermediate: functionality PQM: ION 7330, PM 8000, ION 7400

Advanced PQM's are typically deployed at Transpower GXP's and zone substations, while intermediate PQM's are deployed on distribution feeders.

Table 12-38 summarises the PQM fleet.

TYPE	NUMBERS
ION7330	5
ION7400	13
ION92040	13
ION7600	1
ION7650 V3xx	55
ION7650 V4xx	62
ION7700	0
PM8000	3

TABLE 12-38: PQM TYPE COMPOSITION

12.8.5.2 POPULATION AND AGE

The population and age profile for PQMs are provided in Figure 12-46 below:

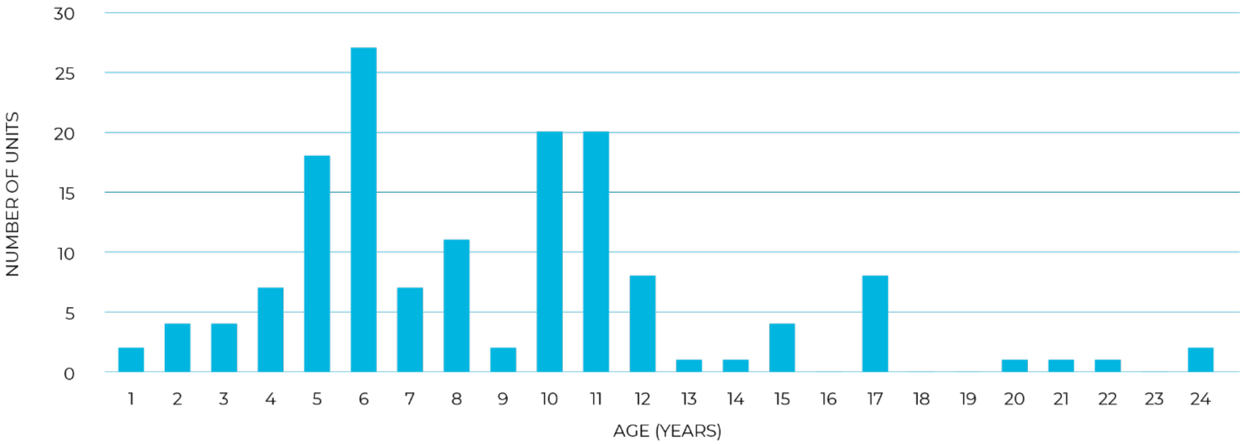


FIGURE 12-46: PQM FLEET AGE PROFILE

12.8.5.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

The PQM's currently in service are in good health, despite the age of some devices. All PQM's within the network are equipped with self-monitoring capabilities. However, older versions of devices are running on unsupported software and devices that are getting close to or exceed their design life of 15 years will be included in the replacement programme.

Key risks involving PQM devices are communications and hardware failure. The PQM field devices have a 30-day data storage capability that mitigates the risk of data loss. Further, the communications to all zone substations have dual redundancy which provides a high level of reliability.

12.8.5.4 CONDITION AND HEALTH

The power quality metering devices in service operate reliably even though some of these devices are reaching the end of their design lives. These devices have in built self-supervision functionality and provide remote monitoring and recording functionality for post event analysis. Replacement devices are obtainable from a selected New Zealand-based supplier.

12.8.5.5 MANAGEMENT STRATEGY

Vector is progressively replacing older (15 years or over) models of the PQM fleet to ensure a fleet is in place that will have technical support of the hardware as well as software support from the vendor. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.8.5.6 DESIGN AND CONSTRUCT

The PQM system must be designed with the following considerations:

- Utilise robust infrastructure installations to support high service performance
- Provide adequate capacity for present and future needs
- Provide infrastructure which allows efficient development of communications services

12.8.5.7 OPERATE AND MAINTAIN

The PQM hardware is digital and has no field serviceable parts and does not require physical maintenance. The PQM Software and hardware are monitored and supported by Vector's service representative as part of a support agreement.

12.8.6 REPLACE, RENEW AND DISPOSE

12.8.6.1 PROTECTIONS SYSTEMS

The electromechanical, static and first-generation numerical relays within Vector's network are coming to the end of their expected service lives. Many will remain in operation but are planned to be replaced with numerical relays within the next 10 years. The replacement of relays will be prioritised based on the following risks:

- Imminent relay or protection system failure
- Spares availability
- Reliability concerns, i.e., increasing failure of relays of a particular model
- Fault record capability, grading limitation and type of connected load

12.8.6.2 TRANSFORMER MANAGEMENT SYSTEMS

The main drivers for the replacement of transformer management systems are age, risk of obsolescence and reliability. Vector's approach is to replace the PLC based units and Static TMS relays followed by electromechanical TMS relays and other TMS devices that are more than 20 years old. The replacement projects are prioritised as follows:

- Replacement of all PLC based systems (over the next 2 years)
- Replacement of failing static devices (within 5 years)
- Replacement of all electromechanical devices (within 10 years)

12.8.6.3 COMMUNICATIONS SYSTEMS

The main drivers for the replacement of Vector's communications systems are age, risk of obsolescence and reliability. Vector is in the process of replacing its legacy network that remains in service but no longer has manufacturers' support and inhouse expertise.

12.8.6.4 AUTOMATION SYSTEMS

The main drivers for the replacement Vector's automation systems are age, risk of obsolescence and reliability. The specific criteria for RTU replacement are:

- Substation primary equipment, such as the switchboard, is being replaced with modern equipment. The RTU will be replaced with either an IED or modern RTU to enable improved facilities, such as Ethernet connection and remote engineering connection to equipment, and to reduce the small wiring required to install the switchboard and therefore reduce installation costs.
- Lack of strategic spares available for ongoing maintenance of the remaining RTUs.
- To support improved functionality such as for IEC61850.

12.8.6.5 POWER QUALITY METERING

The main drivers for the replacement of legacy PQMs are obsolescence and lack of ability to upgrade software on older models. The availability of spares will help prolong the asset life of existing PQMs although not indefinitely as both the PQMs and spares are already in an aged condition and is not compatible with software updates. Where practicable, PQMs are replaced as part of other capital projects such as switchgear replacement.

12.8.7 FORECAST SPEND

The forecast capex graph shown in Figure 12-47 provides a summary of the overall capital investment for this asset header class for the 10-year AMP forecast period. The replacement and refurbishment programme for protection system assets is described in detail in Section 12 Appendix and includes the proposed investment for each individual project.

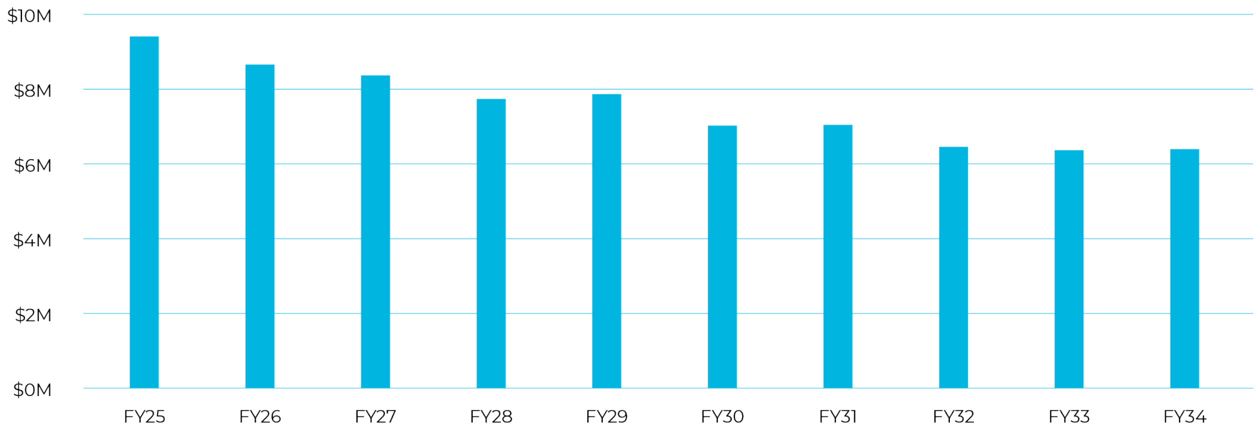


FIGURE 12-47: FORECAST CAPEX - PROTECTION CONTROL

12.9 Auxiliary systems

This section describes our auxiliary systems fleet and provides a summary of our associated asset management practices within the following subcategories:

- Power supply systems
- Load control systems
- Capacitor banks
- Security and access systems
- Fire protection systems
- Earthing systems

12.9.1 POWER SUPPLY SYSTEMS

Auxiliary power supply systems provide power to secondary systems in zone and distribution substations including protection, control, automation, metering, and communications equipment. Typically, this equipment operates at 110, 48, 24 or 30 V DC and is critical for the safe and reliable operation of a zone substation and its primary function of customer power supply. DC battery banks are charged by LV AC chargers and ensure that in the event of a LV AC system failure, the DC battery bank supplies these critical secondary systems for a period sufficient to re-establish LV AC supply. At zone substation critical sites, DC systems are fully redundant to provide resilience and minimise operational disruption when maintenance activities are undertaken.

12.9.1.1 FLEET OVERVIEW

Key statistics of the DC charger assets are shown in Table 12-39.

TYPE	NUMBERS
240V DC chargers	2
110 V DC chargers	340
48 V DC chargers	5
30 V DC chargers	41
24 V DC chargers	89
12 V DC chargers	1

TABLE 12-39: DC CHARGER FLEET OVERVIEW

The 110 V DC systems are used to provide power to protection relays and DC secondary systems within switchgear. The 48 V DC and 24 V DC systems are used to supply power to the communications and digital radio systems respectively. The 30 V DC systems exist in zone substations with legacy communications equipment and legacy circuit breakers with 30 V equipment. These legacy DC systems are being progressively replaced with 110 V DC and 48 V DC systems as part of a wider risk-based legacy switchboard replacement strategy.

12.9.1.2 POPULATION AND AGE

Based on Vector's experience, the expected age of reliable operation for a DC charger is around 15-20 years. The age distribution for each voltage type of DC charger is shown in the chart below. Due to incomplete installation date records, Vector notes this data has an error rate of approximately 30%.

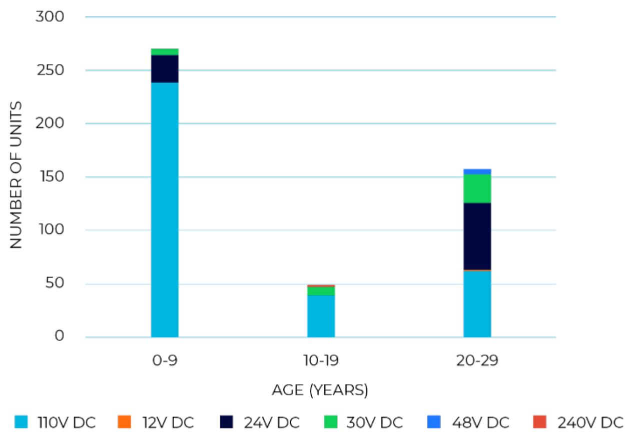


FIGURE 12-48: DC CHARGER FLEET AGE PROFILE

12.9.1.3 ASSET PERFORMANCE, EMERGING TRENDS, AND RISKS

A large, planned programme to replace legacy DC chargers over the last few years has ensured that Vector's DC systems are continuing to perform in line with expectations and there have been no recent failures leading to an unplanned loss of supply.

12.9.1.4 CONDITION AND AGE

Age can be used as a proxy for the condition of DC systems. The average asset age of our DC systems is 15-20 years. Vector manages the condition of its DC systems using its inspection and testing regimes. Our 110 V DC systems also employ a PowerShield Sentinel monitoring system which provides real-time monitoring on each discrete battery (monobloc): temperature, impedance and voltage. This approach has proven successful in replacing assets prior to systemic failure.

12.9.1.5 MANAGEMENT STRATEGY

The management strategy for auxiliary systems is based on asset health, risk of obsolescence, reliability, and safety. It is informed by asset health data which is being continuously improved with information gathered by our field service providers. The following sections describe how Vector is managing this asset class through the key lifecycle phases.

12.9.1.6 DESIGN AND CONSTRUCT

Vector has standardised its secondary systems on its switchgear to be powered using 110 V DC across all zone substation sites. Some sites still have legacy 24V DC and 30 V DC and are being progressively replaced due to condition or through planned site upgrades. Vector continues to monitor the benefits of new technologies such as the use of Lithium-Ion batteries.

For the procurement of new DC systems, Vector utilises its specifications ESE-601 and END-6001.

12.9.1.7 OPERATE AND MAINTAIN

For real time visibility and monitoring of our DC systems, Vector has installed a PowerShield Sentinel monitoring system at each of its zone substations. This provides real-time measurements and alarms to the engineering SCADA team to then generate any fault-correction response required by our FSP's.

Vector's maintenance standards for DC systems are outlined in the ESM601 maintenance standard. Planned maintenance activities are summarised below in Table 12-40.

ACTIVITY TYPE	ACTIVITY DETAIL	FREQUENCY
Inspection	Inspection on AC circuitry, fittings, main boards, network LV supply, auto changer over panel, meter panel, UPS	2 Months
Inspection	Thermovision inspection on all electrical equipment	1 Year
Functional Testing	Functional DC system testing on batteries, battery chargers, DC circuitry, UPS , fittings	4 Months
Inspection	Full DC system performance discharge testing on batteries, battery chargers, DC circuitry, UPS, fittings and convertors	2 Years

TABLE 12-40: PLANNED MAINTENANCE ACTIVITIES FOR DC SYSTEMS

Vector follows internationally recognised standards such as AS2676, IEC 60050 and IEEE 1188 for the testing of its DC systems to ensure that best practice are adhered to in the management of its DC systems. Inspection and test results are uploaded to the SAP planned maintenance module by the FSP.

Minor items are addressed as corrective maintenance. Defects unable to be addressed as corrective maintenance are recorded within Vector's Active Risk Management system (ARM), along with assigned controls and action plans for a project-based resolution.

12.9.2 LOAD MANAGEMENT SYSTEMS

12.9.2.1 FLEET OVERVIEW

Vector uses demand-side load management systems on its distribution network to offer non-instantaneous system capacity reserve to the wholesale electricity market, and to respond to national grid emergencies. The following sections relate to customer hot water heating load management.

Due to the separate legacy power board network philosophies at the time of installation, four types of signalling systems exist: ‘ripple injection’ over power lines in the Auckland network, and parts of the Northern network as ‘ripple injection’, ‘pilot wire’, ‘rotary’ or Cyclo’ systems. Customers in the Auckland network can sign up to a ‘controlled’ (lesser cost) time of use (TOU) tariff. This allows signalling of these customer’s hot water cylinders to switch on or off, shifting Vector’s network demand peaks for up to three hours continuously within a 24-hour period. This signalling equipment also switches streetlights on and off at dusk and dawn on behalf of Auckland Transport for the remaining small balance of their streetlights not yet converted to their new management systems will be decommissioned in RY25.

The number of ICPs per type of hot water load control system is provided in Table 12-41.

ASSET SUBCLASS	NUMBER OF ICPS	SYSTEM STATUS
Ripple	317,320	Active load management in Auckland region only
Pilot wire	135,040	No active load management
Rotary	36,744	No active load management
Cyclo	13,719	No active load management

TABLE 12-41: NUMBER OF CUSTOMERS PER HOT WATER CONTROL TYPE

12.9.2.2 POPULATION, AGE AND CONDITION

Vector’s fleet of 32 ripple plant units are installed across twelve zone substations. The replacement of two new plants in 2021 has brought down the average age from 34 years to 22 years. Apart from the 2021 replacements, Vector fleet of ripple plants are approaching end of life.

12.9.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

The two Otahuhu zone substation ripple plant controllers have repeatedly failed in recent years. An HV inductor failure at Liverpool zone substation and internal dielectric breakdowns of the capacitors used for the Mangere East and Manukau plants have also occurred. Although these plants have been successfully returned to service, these events are typical symptoms of an ageing ripple plant fleet. Bespoke repairs are increasingly required due to no OEM support or spares availability for this legacy equipment.

Although Vector’s ripple plants are suspectable to age related failure modes, they are still considered to be performing adequately. This is a benefit of ripple load management system architecture which can tolerate the loss of a ripple plant without the loss of customer hot water supply.

12.9.2.4 MANAGEMENT STRATEGY

The new Transpower Pricing Methodology (TPM) that takes into effect from 1 April 2023 replaces interconnection and HVDC charges with benefit-based charge and residual charges. This will effectively remove the economic incentive to manage regional coincident peak demand (RCPD) under the current TPM. In the past, hot water load control has played a pivotal role in managing the RCPD.

Vector has reviewed the viability of their hot water (ripple) load management system under the new TPS and have decided to progressively decommission it. Vector’s load control capability will reduce over time in a ‘stepped’ manner and in accordance with the scale of ripple plant being decommissioned.

12.9.3 CAPACITOR BANKS

12.9.3.1 FLEET OVERVIEW

Vector uses static capacitor banks to maintain voltage stability and power quality across the network. As an outcome of Vector’s annual network power system modelling the Auckland and Northern network zone substation capacitor banks were removed in 2023/24. Similarly, the Northern network pole-top capacitor banks will be progressively removed as their condition shows they are at risk of failure.

12.9.3.2 POPULATION, AGE AND CONDITION

The average age of Vector’s capacitor banks was 23 years, achieving their performance targets against an expected operating life of around 20 years. This was aided by capacitor banks installed in an indoor environment typically remaining in better condition than their outdoor equivalents as they are not prone to environmental issues such as corrosion and pollution.

12.9.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

There is an increasing number of failures relating to the remaining pole-top capacitor units as this asset class approaches end of life. The most common type of failure is internal bushing insulation breakdown, particularly for units installed outdoors.

Although failures have occurred, there have been no arc-flash incidents.

12.9.3.4 MANAGEMENT STRATEGY

Vector uses its DigSILENT network modelling software to determine the need for capacitor banks in the electricity network. Modelling results will show which capacitor banks can be removed from the network altogether or where new capacitor banks (and/or reactors) need to be installed. Current annual modelling shows no network requirement for these. Planned maintenance for capacitor installation is detailed in Vector's maintenance standard ESM603 and includes on-site assessments such as visual and thermographic inspection and condition testing. Minor items are corrected as corrective maintenance. Defects unable to be corrected as corrective maintenance are recorded within Vector's Active Risk Management system, along with assigned controls and action plans for a project-based resolution.

This asset class equipment is replaced when it reaches its end of functional life, or poses a non-performance or health and safety risk, as detected during routine planned maintenance activities.

12.9.4 SECURITY AND ACCESS SYSTEMS

12.9.4.1 FLEET OVERVIEW

Vector security and access systems at facilities consist of keyed and electromagnetic locks, door hardware, electric and perimeter fencing and access and monitoring systems. Proximity card readers are used for access and monitoring and are installed across all zone substation sites and other critical sites such as Transpower GXPs and the Vector Penrose-Hobson cable tunnel.

Vector EOC remotely monitors, via SCADA, the entrance and egress of facilities via the card reader. Motion detectors are fitted to detect intruders in switch room and enclosed transformer buildings. If an unauthorised entry event alarm occurs, the EOC contacts the FSP to investigate. If required, the Police are contacted.

12.9.4.2 POPULATION, AGE AND CONDITION

There are 149 installed sites across the network.

12.9.4.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

There have been no recorded failures in this asset class nor have there been any unauthorised building intrusions across Vector's zone substation sites. Proximity card access systems have proven to be robust and are performing in line with expectations with a product replacement pathway.

12.9.4.4 MANAGEMENT STRATEGY

Vector's acquisition strategy will be to continue to procure security and access systems from its current accredited supplier using procurement standard ESE603. Ordering is by the contractor directly with the NZ based vendor.

Asset maintenance is in accordance with Vector's maintenance standard ESM603 and is undertaken at regular planned intervals by Vector's field service providers and where required, asset-specific specialists. Planned maintenance activities include visual inspections and self-diagnostic tests which can be conducted remotely from site.

12.9.5 FIRE PROTECTION SYSTEMS

12.9.5.1 FLEET OVERVIEW

Vector's fire protection systems can be separated into two categories.

- Passive - preventative systems such as flame traps, hypoxic, smoke/heat detection, intumescent products
- Active - automated extinguishing systems such as sprinklers, Inergen gas flood, foam, fire ventilation shutters

Fire protection passive and active control is determined by risk assessment associated with the criticality of a substation's connected customers and asset value. Vector's risk evaluation procedures, guides and standards are used for risk assessment.

Vector requires zone substations either within the Auckland CBD, supplying critical customer load, or supplying downstream zone substations as a bulk point of supply, to have both passive preventative and active automated extinguishing fire protection systems. All other zone substation sites have passive preventative systems only unless otherwise determined as part of a risk-based assessment.

A local indoor fire panel installed at all zone substation sites provides collation and communication of system status and fire heat and/or smoke detection alarms to the local Security Panel for SCADA annunciation to EOC. This enables the EOC to contact FENZ to request a responder for the alarmed site in the appropriate circumstance.

CBD zone substations also signal in parallel to EOC a fire event to a FENZ approved aggregator to achieve a FENZ callout response.

12.9.5.2 POPULATION, CONDITION AND AGE

The age of individual fire protection systems is not currently recorded. It is reasonable to assume that the age of this asset class to be aligned with the age of the building it is installed in.

12.9.5.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

There has been a deliberate increased focus on fire protection of assets due to the safety, asset, and customer supply continuity risk that fire poses.

Fire protection evaluation and implementation uses AS2067, the NZ Fire Code, the NZ Building Act, Vector's standards, site specific fire engineer reports, and known appropriate industry practice. Fire protection is also guided by the lessons of the 5 October 2015 Penrose GXP fire within Vector's 33 kV cable trench and the 400 V a.c. local service supply fire within Takanini zone substation in 2016. At Takanini its standard 2-hour fire resistance rating (FRR) prevented damage to the substation itself.

Site specific hazard reviews have found the following risks along with resolving these:

- To avoid 11kV to 0.4 kV superposition hazard caused by car versus pole incidents, zone substation local service 0.4kV supplies are not connected to the overhead 0.4kV network.
- Legacy internal doors between adjacent transformer bay fire cells continue to be removed where this does not impact twin emergency egress. Auto-closers will be fitted to those that provide a second egress between the fire cells.
- The replacement programme for end of technical life legacy 1970's bespoke Guardall fire protection panels has been completed in FY24. This was to achieve H&S risk minimisation although there was no failure hazard or occurrence.
- With vendor's changed supply lines since Covid, fire door specifications have been revised in FY24.
- Fire doors and fire dampers are now installed within naturally ventilated power transformer buildings where appropriate to their distance to other buildings and neighbouring boundaries.
- The Penrose-Hobson Tunnel Penrose, Liverpool and Hobson vertical cable riser shafts will have their 25-year-old cable-wrap fire suppression system replaced, commencing in FY25. The 9.1 km tunnel sprinkler head replacement programme will be completed in 2024.
- For the eight minor cable tunnels, installation of heat/smoke detection and SCADA communication to EOC is being prioritised for FY25 by the three tunnels with cable joints. Joints have already been treated with intumescent protection for fire.
- Due to the criticality of radio huts for network operations and distance from FENZ responders, an investigation is required inclusive of FENZ input to determine the need and solution for automated active fire suppression. Conclusions from investigation are expected in FY24 with delivery in FY25.

  Investigation in FY19 including references with Transpower NZ and Australian electricity utilities showed that hypoxic air technology (active fire suppression by oxygen reduction) was unsuitable to introduce for reasons of interruption to maintenance and fault rapid responder access, that a fire can spontaneously ignite when oxygen is returned to its levels required for entry of personnel, use of arc flash protected switchgear suppressing failure induced fire generating high energy arcing with a rapid reduction of thermal energy, the phasing out of oil insulated indoor switchgear for non-flammable types with higher breakdown insulation levels (BIL), and the difficulty of providing guaranteed 24/7 airtight buildings.

The asset class population age began in the 1960's for fire protection systems in general, with replacement updates being made as existing technology has reached its end of technical or service performance life, in consultation with registered fire engineers and associated fire Standards and Codes.

12.9.5.4 MANAGEMENT STRATEGY

The fire protection asset classes have inspection and testing regimes in accordance with ESM603 which aligns with AS/NZS 4512 - fire detection and alarm systems in buildings. Fire engineer studies are commissioned and implemented for all new buildings and major renewals. Assets are replaced when they reach their end of functional life, or pose a non-performance or health and safety risk, as detected during routine planned maintenance activities. On-site assessment is by visual and thermographic inspection, and test condition, in accordance with the afore-mentioned maintenance standard.

12.9.6 EARTHING SYSTEMS

Earthing systems are required to protect people and equipment from the risk of harm of electricity due to abnormal network operation, inadvertent contact to live conductors, interaction with third party infrastructure and environmental effects such as lightning strikes. Earthing systems also ensure that protection systems operate as intended and are specifically designed to meet established performance criteria.

Every zone substation has an earth system, commonly a combination of buried earth conductors, earth rods and the building reinforcing. All asset installations with conductive equipment have their own independent earthing systems. In general, the earthing systems comprise a set or sets of pins (electrodes) driven into the earth connected using bare copper conductor. Copper is both an excellent electrical conductor and mechanically resistant to in-ground corrosion but has a risk of theft as described below.

The nature of the surrounding soil and surface covering play an integral part in the performance of the earthing system. The effects of local soil electrical resistance, localised site surface covering (e.g., metal chip and asphalt) and transferred voltage potentials from the site are included in the overall analysis of earth system step and touch voltage performance within regulatory limits.

12.9.6.1 CONDITION, EMERGING TRENDS AND RISKS

An earthing system is usually aligned with the age of the equipment or buildings it serves. As such it is difficult to establish an accurate age profile of the different components of an earthing system. The condition and health of earthing systems are essentially determined by visual inspection and testing.

Copper theft remains an ongoing issue. Both passive and active security measures are used as a preventative tool. Vector uses regular site security and asset inspections as part of planned maintenance regimes as a preventative measure. Raising awareness of the issue to FSPs also assists in ensuring that issues are identified and remediated as soon as practicality possible.

Construction works in existing zone substation sites run the risk of damage to earth grids and theft. This risk is reduced by undertaking potholing to locate earth grids and up-front ground penetrating radar to best confirm the layout of existing earth grids.

To minimise harm to personnel and the public in an operational electricity substation site, damage to earthing must be minimised and immediately repaired. Earthing consists of typically copper conductor which is susceptible to corrosion in contaminated soils, by galvanic action with dissimilar metals and hazardous substances. ESE704, ESE506 and ESM607 activities control this risk.

12.9.6.2 MANAGEMENT STRATEGY

Earthing systems for zone and distribution substations are installed in accordance with Vector engineering standards ESE704 and ESE506 respectively. Earthing design incorporates a risk-based approach for safety of nearby public and Vector's own personnel including control to safe touch and step voltage levels. Fault levels are controlled to 13.1 kA for distribution network equipment and 26.0 kA for zone substation equipment. Zone substations and distribution earthing systems are subject to a thorough testing regime that is performed every five years as detailed in Vector maintenance standard ESM607. Earthing studies are commissioned and implemented for all new sites and primary transformer equipment capacity upgrades and additions. The latter as customer electricity supply increases require two-transformer sites to become three-transformer sites.

Vector's earthing related standards reference the EEA (NZ) Guide to Power Systems Earthing Practice and the Safety Manual – Electricity Industry (SM-EI). Independent audits completed in accordance to NZS 7901 are undertaken annually to assess public safety adjacent to the zone substation property. These audits and Vector's planned maintenance regime ensures corrective actions are undertaken to maintain the design safety performance of its earthing systems.

Special care is required for cable power supply connections to traction rail systems such as KiwiRail and City Rail Link to avoid to avoid direct connection of cable screens and the hazard of traction earthing neutral (TEN) current return paths raising fault current levels on the Vector public multiple earth neutral system (thereby avoiding raised fault levels being superimposed on the MEN) system. Specialist design, installation and maintenance practices are undertaken to control these risks. Vector's asset strategy for earthing systems is described in strategy report EAA600 Auxiliary Systems.

12.9.6.3 REPLACE, RENEW AND DISPOSE

Programs of work are triggered by new standards or regulatory requirements, or systemic environmental changes, asset failures or end-of-life assets. The solution is determined by reference to customer and business needs, and in conjunction with asset vendors or other industry bodies with recognised technical knowledge.

Power Supply Systems

DC systems assets are replaced when they reach their end of functional life, or pose a non-performance or health and safety risk, as detected during routine planned maintenance activities. Generally, the replacement timeframe is based on risk, age, identification of any systematic issues or findings from routine maintenance activities.

New DC charger installations achieve an N-2 level of security to ensure that contingency remains in the system while a charger is out of service during testing, maintenance, or replacement.

Load Management Systems

Assisting the replacement strategy has been the transfer of Vector's management of streetlights to Auckland Transport as they migrated these to LED luminaries with a new radio/cellular switching control technology and transfer of full control to Auckland Transport (AT). Their programme began in 2014 and is now planned by AT for completion in 2024, later than planned due to deployment interruption caused by Covid-19 lockdowns and extreme weather events. The same systems we use to manage streetlights are used to manage customer hot water cylinders and must be retained for that purpose until a new technology replacement is rolled out.

Capacitor Banks

There are no capacitor bank investments planned in the upcoming AMP period.

Security, Access, and Fire Protection Systems

Security, access and fire system software and firmware updates will be required from FY25 onwards to ensure their continued functional performance. A similar programme of passive fire sensor replacements will begin, prioritised by their installed age. .

Earthing Systems

Assets are replaced when they reach their end of functional life, or pose a non-performance or health and safety risk, as detected during routine planned maintenance and its forecast expenditure is thus included under OPEX. New and replacement zone substation builds provide for new/upgraded earthing based on site-specific earth testing and design to Vector specified standards including the EEA (NZ) Power System Earthing Practice Guide and IEEE 80/81. A zone substation earth grid renewal programme is being initiated in FY25 for systems that from our five-yearly testing programme are found not to meet current standards.

12.9.7 FORECAST SPEND

The forecast capex graph shown in Figure 12-49 provides a summary of the overall capital investment for this asset header class for the 10-year AMP forecast period.

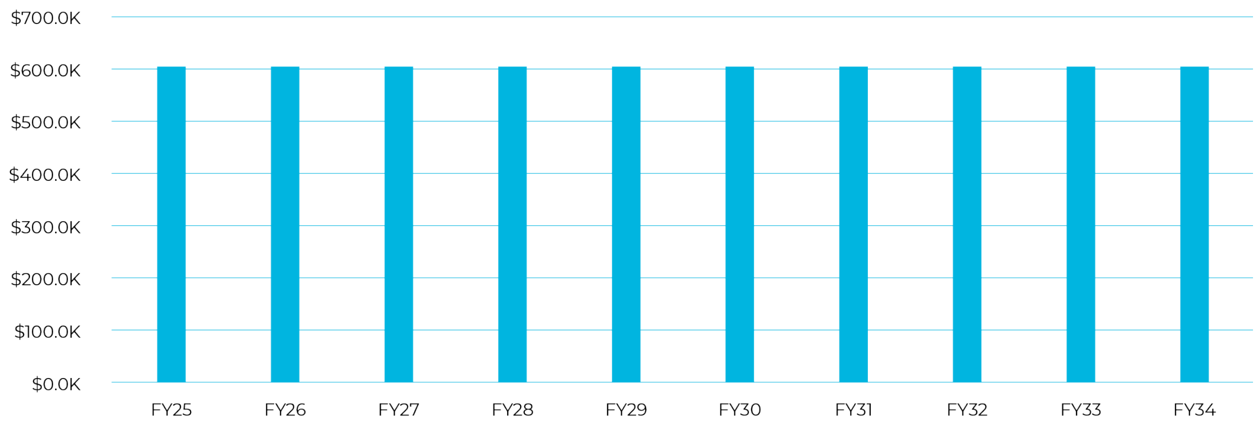


FIGURE 12-49: FORECAST CAPEX – AUXILIARY SYSTEMS

12.10 Generation and energy storage

12.10.1 UTILITY BATTERY ENERGY STORAGE SYSTEMS (BESS)

12.10.1.1 FLEET OVERVIEW

The Utility Battery Energy Storage Systems (BESS) installed in Vector's network are connected to the 22 kV and 11 kV networks. The BESS are designed to perform multiple functions applicable to the entire electricity system. The BESS installed at zone substations perform peak shaving and voltage control functions and assists with resolving the sub-transmission network security deficiencies. The BESS installed at remote ends of the 11 kV feeders improve the feeders' reliability and voltage quality. They are also able to supply electricity to customers during outages by forming microgrids.

Vector considers BESS within a suite of options when deciding on capital investment solutions to enhance the electricity network's resilience, quality of supply or network capacity expansion. BESS are installed where it is determined to be a more economical solution to address network capacity expansion in comparison to traditional primary systems investments or to defer investment in primary systems.

Most operational BESS are of the Tesla Powerpack type except for Tapora (which is a hybrid site made up of Hitachi and Samsung equipment). The Tesla Powerpacks are of modular and scalable construction that can be relocated within the network. They have also been tested and proven to comply with the safety requirements of current international standards. The BESS can be repurposed or relocated once the functions they perform at the installed location are no longer needed.

12.10.1.2 POPULATION AND AGE

We have a total of seven operational BESS, with our first 1 MW/2.3 MWh BESS at Glen Innes zone substation being in service since October 2016. Our second and third BESS were commissioned at Warkworth South and Snells Beach zone substations in 2018 and have successfully assisted in deferring network capacity expansion investment. The BESS at Kawakawa Bay and at Hobsonville Point were commissioned in February 2020 and November 2020 respectively. The BESS at Kawakawa Bay is installed at the end of a long rural feeder to improve voltage quality and feeder reliability. It also enables a segment of the feeder supplying Kawakawa Bay customers to operate as a microgrid.

The construction of the 1.14 MW / 1.254 MWh BESS at Tapora was completed in 2022. Unlike previously installed BESS on the Vector network which are Tesla Powerpack battery systems, the Tapora BESS consists of an ABB Power Conversion System and Samsung Battery System. The BESS is to improve reliability and voltage quality and support operation of a microgrid.

The BESS and a solar energy PV system installed as part of Vector Lights initiative provides renewable energy for Vector Lights on Auckland Harbour Bridge. The current BESS fleet uses Tesla Powerpack battery systems.

Key information of the BESS assets are shown in Table 12-42.

LOCATION	RATINGS	AGE
Zone Substation Glen Innes	1.0 MW / 2.3 MWh	7 years
Zone Substation Warkworth South	2.0 MW / 4.8 MWh	6 years
Zone Substation Snells Beach	2.5 MW / 6 MWh	6 years
22 kV Feeder - Vector Lights	0.25 MW/0.475 MWh	5 years
11 kV Feeder - Kawakawa Bay	1 MW / 1.7 MWh	3 years
Zone Substation Hobsonville Point	1 MW/2.0 MWh	3 years
11 kV Feeder - Tapora	1.14 MW / 1.254 MWh	2 years

TABLE 12-42: KEY INFORMATION FOR BATTERY ENERGY STORAGE SYSTEMS

12.10.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Four Tesla battery power pods failed at Warkworth South substation which was commissioned in November 2021. It took more than nine months to achieve replacement. As most of our Tesla Powerpack are first generation, the availability of spares and equipment obsolescence is a point of discussion with Tesla to increase parts availability and decrease time to supply spares.

There have been several instances of hardware and software issues affecting BESS remote control operations and indications at Tapora where localised system resets have been required to restore communications, and this issue is being investigated by Hitachi.

12.10.1.4 CONDITION AND HEALTH

The Tesla Powerpack systems come with a 10-year warranty. Each Tesla Powerpack system is connected to the Tesla Remote Management (RM) System that enables remote monitoring, diagnostics, configuration managing and upgrading. The expected operational life of the batteries depends on aggregated energy throughput and functionality implemented. Apart from some deterioration of outdoor battery enclosures, the BESS population is in good health and condition.

Tesla is holding spares for replacement during the warranty period. A requirement and quantity of the spares to be purchased after warranty expires is to be discussed with Tesla closer to 2026.

For the Hitachi Powerstore BESS Vector has purchased spare equipment and quantity as recommended by Hitachi. The spares are also to be used in conjunction with Hitachi SLA agreement.

12.10.1.5 MANAGEMENT STRATEGY

Preventative maintenance on BESS are carried out by FSP In line with the Vector maintenance standard which requires yearly, 5-yearly and 10-yearly inspections and servicing.

Corrective maintenance of Tesla Powerpack BESS is carried out with Tesla as part of its product warranty.

Any further investment in new BESS, improving the functionality of the existing BESS will be based on a cost-benefit analysis, considering functional requirements and network planning considerations.

12.10.1.6 DESIGN AND CONSTRUCT

At present, on a utility scale and for functionality required for the operation of distribution and the electricity system, lithium-ion battery-based energy storage systems are the technology of choice due to their energy density and lowest cost. We have deployed our lithium-ion BESS to understand the technology, defer investment in network capacity expansion, and improve supply quality.

As part of the installation of the first BESS at Glen Innes substation, detailed BESS requirements document including technical specifications were developed. Based on the system requirements and standardised system architecture, a design have been produced, which has been used to realise subsequent BESS installation.

IEC has been working on the standard set under IEC 62933 Electrical energy storage (EES) systems. The technical requirements as defined in IEC 62933 standard set, in addition to previously defined IEC/IEEE/ISO standards, will be used for future BESS acquisition.

12.10.2 DIESEL GENERATION

12.10.2.1 FLEET OVERVIEW

Two Vector owned Diesel generating sets (genset) are currently used in Piha and a service provider owned genset is deployed at South Head. Both gensets are at the end of lengthy 11 kV feeders to improve the network reliability to these two remote communities. The generators are only operated as required during planned or unplanned network outages. The gensets are connected to the 11 kV feeders supplying the area via interconnection equipment.

Presently the diesel gensets and interfacing equipment are fixed installations on leased land with land extension agreements in place on a year-by-year basis. Vector plans to attain land in South Head to establish a permanent generation station site by FY24. The intention is to use Vector owned generating sets and step-up transformer.

For small portable petrol generator sets, a process is in place to manage engagement with customers and the qualification of customers to supply electricity from the portable petrol gensets during outages. The field management of the portable generators is carried out by our field service providers.

12.10.2.2 POPULATION AND AGE

The Piha generators are owned by Vector whilst the interconnection equipment is leased. At the South Head location two 1.25 MVA diesel generators and interconnection equipment are presently leased. The Vector owned diesel gensets installed at Piha are around 3 years old and are infrequently used (i.e., used only during outages). This implies very low wear and tear and of course also low carbon emissions.

12.10.2.3 CONDITION AND HEALTH

The gensets are in good condition and are maintained as part of an agreement with a generator service provider.

12.10.2.4 EXPENDITURE FORECAST

Because of its focus on network reliability, the capex forecast for permanent generation sites at Piha and Southhead are shown in Section 11, Network Reliability.

12.10.3 RESIDENTIAL PHOTOVOLTAIC (PV) AND BATTERY ENERGY STORAGE SYSTEMS (BESS)

12.10.3.1 FLEET OVERVIEW

Initially, Sunverge and SunGenie BESS with rated energy capacity of 10.7 kWh were installed. 253 SunGenie BESS are in operation.

Subsequently, Tesla Powerwall BESS have been installed. Tesla Powerwall generation 1 has 2 kW rated power and 6.4 kWh rated energy capacity. The latest Tesla Powerwalls (generation 2) have a rated power of 5 kW and rated energy capacity 13.5 kWh,

12.10.3.2 POPULATION AND AGE

Table 12-43 below summarises our population of installed combined residential solar PV energy and battery energy storage systems, and stand-alone residential battery energy storage systems.

ASSET	QUANTITY
Solar Photovoltaic combined with Battery Energy Storage Systems	409
Residential Battery Energy Systems (no solar)	208

TABLE 12-43: KEY INFORMATION FOR SOLAR/BATTERY AND STAND-ALONE BATTERY SYSTEM INSTALLATIONS

Figure 12-50 and Figure 12-51 shows the age profiles for solar/battery installations and stand-alone battery installations, respectively.

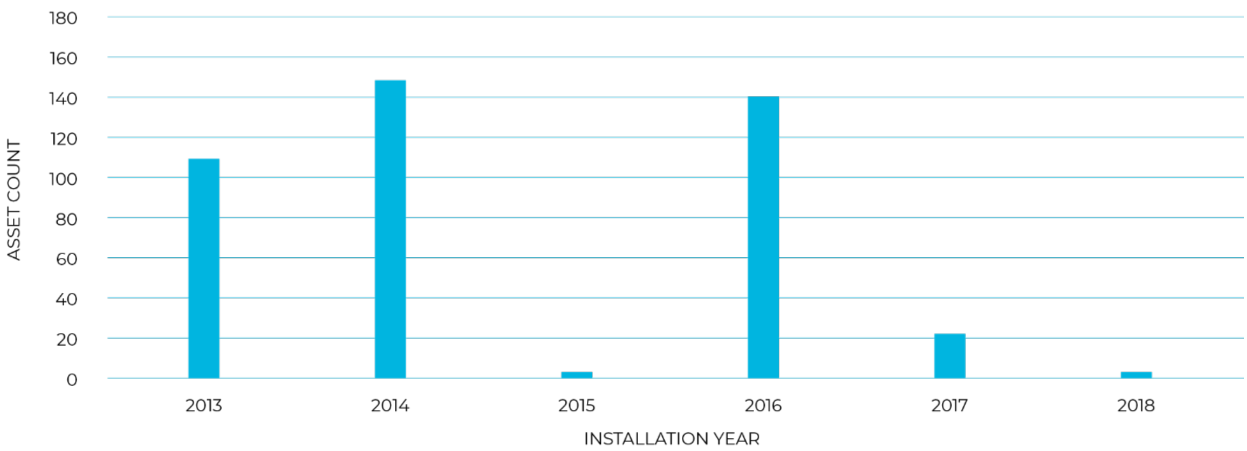


FIGURE 12-50: AGE PROFILE FOR SOLAR PV AND BATTERY ENERGY STORAGE SYSTEM INSTALLATIONS

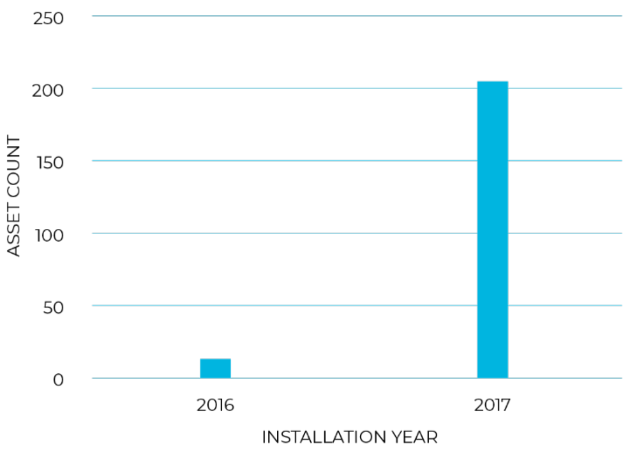


FIGURE 12-51: AGE PROFILE FOR BATTERY ENERGY STORAGE SYSTEM INSTALLATIONS

12.10.3.3 CONDITION AND HEALTH

Solar panels and battery installations form part of our maintenance regime for which provision is made in our OPEX budget. The solar panel and battery populations are relatively young, and apart from teething issues with operating software, we have not experienced systemic failures in our solar panel or battery fleets. However, we have experienced a deterioration of the steel enclosures where they exist in an outdoor environment.

12.10.4 DISTRIBUTION ELECTRICAL VEHICLE (EV) CHARGING STATIONS

12.10.4.1 FLEET OVERVIEW

With the electrification of transportation, the integration of public EV charging stations into the electricity network and the potential impact on infrastructure investment needs to be carefully considered to avoid overloading and mitigate an exponential increase in peak load.

In 2015 we commenced on a programme of works to install EV charging stations in strategic public locations over the wider Auckland region as a trial. The purpose of the trial was to understand the network impacts of public EV charging so that we could plan for a future where EVs are much more common on our roads. With EV ownership increasing, growing numbers of participants in the market, maturing technology, and our understanding of network impact greatly enhanced in both public and home charging, we have met our objectives.

After a rigorous selection process, Vector selected EV public charging provider ChargeNet to acquire and manage Vector's public charging assets including both DC and AC chargers. ChargeNet will assume Vector's assets into their own public charging fleet and service model. Vector selected ChargeNet, in part, due to their willingness to support Vector's symphony strategy and engage in an ongoing partnership supporting Vector's strategy of being able to respond to periods of high and low electricity demand. Public charging sites that have not been acquired by ChargeNet have been or are scheduled to be decommissioned.

We also have several EV charging stations in the basement of our main office building to charge our own fleet of EVs as well as charging stations in our office parking area for visiting customers with EVs.

Starting in 2019, Vector installed 200 controllable 7 kW EV charging stations in customer premises over the wider Auckland region. These were being trialled to understand the peak demands caused by EV chargers, the impact on peak demand by controlling chargers and the customer experience if chargers are controlled as well as gain information for EV charger customer habits and patterns in general. For clarification the residential customer trial chargers are not transferring to ChargeNet.

12.10.4.2 POPULATION AND AGE

The table below summarises our population of public EV charging stations. The first units were installed in 2016 with the latest installed in 2018.

ASSET TYPE	ASSET QUANTITY
A.C. EV Charging Stations	12
A.C Residential Smart EV Charging Stations	193
D.C. EV Fast Charging Stations	18
A.C. V2G EV Charging Stations in Vector's Office Building	0
A.C. EV Charging Stations in Vector's Office Building	20

TABLE 12-44: KEY STATISTICS FOR EV CHARGER STATIONS

12.10.4.3 CONDITION AND HEALTH

EV charging stations form part of our maintenance regime for which provision is made in our OPEX budget. The EV charging station fleet is young, and apart from some teething issues that are often experienced with a new asset class, most of the fleet is in good health. The passing on of the Vector public EV chargers will provide some anticipated reduction in budget involved with maintaining these assets.

12.10.5 FORECAST SPEND

Because of their focus on the improvement of reliability in the network, the forecast capex investment for the installation of permanent generating sites at Piha and South Head are included in Section 11, Network Reliability. Planned, corrective and any other maintenance costs related to the generation and energy storage assets are included in the OPEX forecasts in AMP 2023.

12.11 Infrastructure and facilities

Infrastructure and facilities reside across the Vector network. The purpose of these assets is to provide a means of siting and housing primary and secondary zone substation equipment, digital microwave radio systems and customer hot water load management infrastructure, for the following reasons:

1. Security and safety for the public
2. Security and safety for Vector personnel
3. Operational security plus environmental and performance safety for electricity network assets

This Section describes our Infrastructure and Facilities fleet and provides a summary of our associated asset management practices. The fleet consists of two subcategories:

1. Buildings and Grounds
2. Cable Tunnels

12.11.1 BUILDINGS AND GROUNDS

Vector's buildings and grounds portfolio includes zone substation buildings housing protection, communications, indoor and outdoor switchgear, transformers, and structures, and ripple injection plant. Site grounds are secured from entry by boundary fences, and contain access driveways, potable, storm and wastewater infrastructure, security systems, and gated access ways. The degree of security is risk-based determined by customer and network asset importance, location, and risk of unobserved intrusion. Vegetation, asset screening and property fencing management are key to site security and for personnel, public and asset safety. Property frontages use palisade security fences that allow street visibility into the site to deter trespass, and closed board shiplap fences to customer facing boundaries for their privacy.

12.11.1.1 FLEET OVERVIEW

Buildings are constructed of various materials including reinforced steel cast in-situ or masonry block, light timber frame, since 2008 precast tilt slab concrete, and since circa 2010 sandwich insulated panel (SIP). Unreinforced masonry brick infill panels between reinforced concrete pilasters and bond beams are typical of pre-1960's era construction, with this construction having the highest risk of seismic failure. Key statistics of the buildings and grounds assets are shown in Table 12-45.

TYPE	ASSET QUANTITY
Customer Substation Buildings	126
Substation Buildings and Grounds	115
Substation Buildings	193

TABLE 12-45: BUILDINGS AND GROUNDS FLEET OVERVIEW

12.11.1.2 POPULATION AND AGE

The expected life for the building fleet is 80 to 100 years with an onset of unreliability between 40 to 60 years. Figure 12-52 illustrates the age profile of Vector zone substation buildings. Their average age is 36 years.

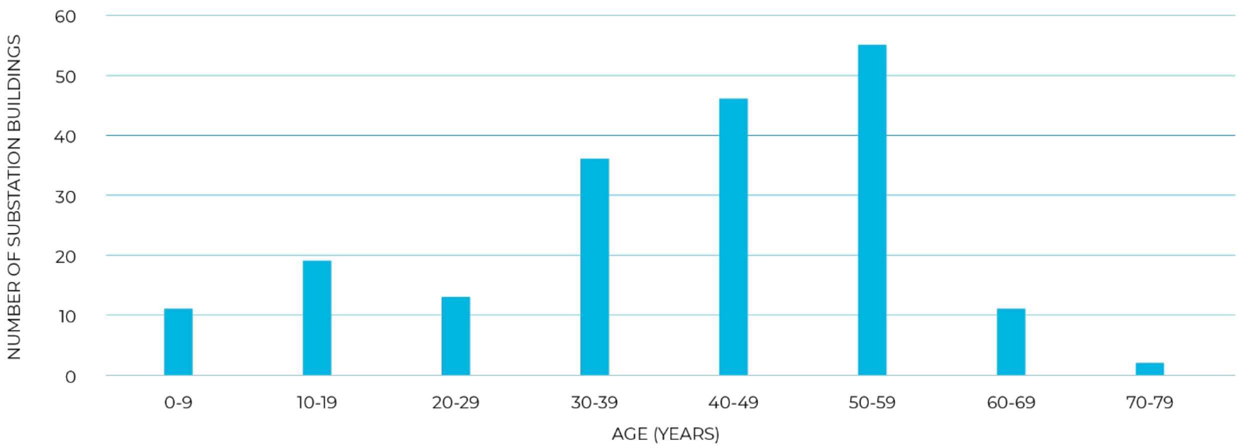


FIGURE 12-52: POPULATION AND AGE PROFIILE FOR SUBSTATION BUILDINGS

12.11.1.3 CONDITION AND HEALTH

Vector buildings and grounds fleet is ageing in accordance with expected industry trends, and we are actively monitoring their health and condition to ensure we achieve the optimum life from the fleet. We manage our buildings in perpetuity, except for where substation primary electricity asset renewal requires a rebuild for additional space than the existing building allows.

12.11.1.4 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Due to our regular planned maintenance programme with corrective and planned actions our building performance is in a good state. The current drivers for our programme of work are property perimeter fencing, roofing replacements due to age or asbestos control, extreme weather events and seismic performance. We have assessed the higher risk category of zone substation buildings against the New Zealand Society of Earthquake Engineering (NZSEE) grades using engineering specialists also experienced in setting the NZ IEECP and the Christchurch earthquake re-build.

Multi-storey buildings of circa 1990 to 2010 are of variable performance within the NZ building sector due to that era's building standards, for which Vector's planned maintenance inspections target evidence of issues, as for all other buildings. A recent example is Sandringham zone substation's partial rebuild that is now achieving 100% NBS performance for its 1990's building extension that had leaky building issues that appeared outside its 15-year Council code-compliance performance.

NZS7901 annual external assessor audits provide a risk-based independent assessment of zone substation property perimeter safety to the public, with their recommendations and observations corrected on site, and where required the updating of standards, and knowledge sharing with designer and planned maintenance practices. We also monitor sites with SMF with the intention that if deemed in the future to be a H&S hazard we have the necessary records to remedy that.

There are substation buildings in low lying ground that are prone to flooding, which was highlighted more than ever during the Jan-Feb 2022 and 2023 cyclones and, these form part of capital projects to either harden against the impact of climate change, rebuild on higher ground, or other distribution network solutions as described in Section 12 Appendix.

We have assessed flood hazards and their mitigation for zone substations since 2012 inclusive of reference to Auckland Council hydrology records. Third party specialists in climate change and extreme weather impact now also inform our planning for new zone substation builds and rebuilds of existing sites required by replacement of primary equipment and/or seismic condition. Sites most likely to be operationally affected by flooding also form our rebuild programme. Analysis includes industry norms of a 1:100 return event, and for 2024 onwards 1:500 events due to apparent increasing 24-hour rainfall intensity volumes and durations.

12.11.1.5 MANAGEMENT STRATEGY

The management strategy for the buildings and grounds fleet is based on safety and asset condition, including as important considerations the impact of climate change and how to harden facilities against such impacts. This is informed by condition data which is being continuously improved with information gathered by our field service providers during planned maintenance inspections to ESM701. This approach aligns with our asset management objective of safety and reliability underpinned by risk-based failure mode effect analysis (FMEA).

12.11.1.6 DESIGN AND CONSTRUCT

Vector as part of its conceptual development of new substation buildings and grounds, integrates the design within the surrounding environment and in conjunction with the Auckland unitary plan. In urban and rural areas, we make our sites as unobtrusive as practicable, with aesthetics incorporating architectural and open landscape treatment sensitive to the surrounding neighbourhood. When we renew existing substation buildings, we consider changing demographics and where practicable adapt the substation appearance to align with these trends. As stated above, the impact of climate change is considered and incorporated in our new builds and replacements.

Specification standards for the design and construction of new buildings and grounds are design standards ESE701, ESE702 and AS2067. Although electricity utility operator sites are not within the NZ Building Act: 2004 and our buildings are classed as unoccupied, for prudency our standards incorporate the requirements of the NZ Building Code, the Auckland unitary plan, and electrical industry Standards inclusive of AS2067.

12.11.1.7 OPERATE AND MAINTAIN

Vector routinely inspect its buildings and grounds fleet through the use of appropriately qualified personnel to ensure they remain fit for purpose. Remedial work is scheduled based on personnel and asset safety, and asset performance condition and functional importance. Vector's maintenance standard ESM701 comprehensively details the planned, corrective, and reactive maintenance requirements.

12.11.2 CABLE TUNNELS

Vector cable tunnels are installed where there is no other practical cost-effective means to install and maintain electricity cables. These satisfy the requirements of motorway crossings or mass cable runs within congested and difficult to access routes such as in the CBD.

The tunnel fleet houses extra high voltage power cables connected to Transpower grid exit point supply substations and between Vector zone substations.

All the tunnels are defined as confined spaces and are restricted to entry by personnel trained in those safety procedures.

This asset class includes the tunnel's structure and access security, ground water drainage pumps, active fire suppression where warranted and small power electrical circuits.

The 9.2km long Penrose-Hobson Tunnel at between 20 and 60 m underground as the land lies has added infrastructure of dual 375kW ventilation fans, five 37kW ground water pumps, an industrial lift for equipment and personnel, a light rail system for expedient access, tunnel fire sprinkler and cable shaft deluge active fire protection, permanent gas sensors for personnel protection, and a digital radio personnel communication system, all with remote systems status to the Vector electricity operations centre.

The Penrose-Hobson Tunnel safety systems are in addition to the confined space personal protective equipment (PPE) specified by Vector's HSEMS work type competency (WTC) requirements for all entrants to tunnels.

12.11.2.1 FLEET OVERVIEW

Vector has one major (9,200m) and six minor (total length 762m) cable tunnels.

12.11.2.2 POPULATION AND AGE

The expected life for cable tunnel structures is between 80 to 100 years with an onset of unreliability between 60 and 80 years. The electrical and mechanical, secondary and process systems within the tunnels have a typical replacement lifecycle of 15 to 20 years.

12.11.2.3 CONDITION AND HEALTH

The cable tunnel fleet is ageing against industry norm expectations. We are actively monitoring and maintaining their health and condition within our Planned Maintenance regime (ESM708 and ESM709) to ensure we achieve optimum fleet life.

12.11.2.4 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector completes five-yearly structural and seismic surveys using certified structural engineers of proven experience in tunnel design and construction for tunnels. The survey results continue to show good asset performance. A seismic event will result in a structural survey after the event has safely subsided to ensure asset integrity and that entry is safe for personnel.

HILP risk for all Vector cable tunnels is loss of hazard warning and personnel communication systems, impaired ventilation, atmospheric gas ingress, fire, or ground water flood. Vector uses a process safety approach to assess tunnel hazards and their controls, with the electricity operation and planned maintenance standards providing the method and frequency for their performance inspection and correction.

Emerging trends and risks are for tunnel ancillary and process systems as these approach 15 to 20 years of age within high moisture environments. Our maintenance and replacement program addresses this.

12.11.2.5 MANAGEMENT STRATEGY

The management strategy for the cable tunnel fleet is based on safety and asset condition. It is informed by condition data which is being continuously improved with information gathered by our field service providers.

12.11.2.6 DESIGN AND CONSTRUCT

Tunnels are designed, certified, and constructed as a professionally engineered specific design since cable tunnels do not fall within the NZ Building Code. Vector does not have specification standards for the design and construction of new cable tunnels, and international tunnel standards would apply at the time, plus IEC and AS/NZS standards including health and safety.

12.11.2.7 OPERATE AND MAINTAIN

Vector routinely inspects its cable tunnels to ensure they remain fit for purpose. Remedial work is scheduled based on personnel and asset safety, and asset performance condition and functional importance. Vector's maintenance standard ESM701, ESM708 and ESM709 comprehensively details these planned, corrective and reactive maintenance requirements for its tunnels and their associated above ground “portal” buildings fleet.

12.11.3 REPLACE, RENEW AND DISPOSE

12.11.3.1 BUILDINGS AND GROUNDS

Buildings and grounds renewals and disposal programmes are driven by seismic upgrades, mitigation from flood plain and overland flow path hazards, additional primary equipment (switchgear and/or power transformers), or network growth replacements and building performance to meet its intended function. Climate change and hardening against the impact of climate change extreme weather events is an important consideration. Buildings found to not meet the current standard for seismic compliance then become part of a seismic strengthening programme, or if it is uneconomical to do so they are replaced in conjunction with primary equipment replacement requirements.

Each building and grounds site that requires asset replacement is inspected to ascertain the scope of works and site constraints. Planned maintenance findings, predicted lifecycle costs and primary equipment updates are further inputs. This information is used to build a cost-benefit risk-based NPV estimate for forecast expenditure. As part of any building replacement or program, the new facility must meet current standards, codes of practice and legislative requirements.

12.11.3.2 CABLE TUNNELS

In an unlikely event a Vector tunnel is no longer required for cable routes, provided it is structurally sound, then it will be sealed from access and left in-situ. If not structurally sound, then pressure injected concrete infill is one method used to provide its required ongoing safety performance. Tunnel ancillary systems are renewed as required and the end-of-life equipment disposed of at environmentally certified facilities.

Tunnel ancillary's asset replacement ascertains the scope of work including site constraints, planned maintenance findings and predicted lifecycle costs. This information is used to build a cost-benefit risk-based NPV estimate for forecast expenditure. New equipment and systems must meet current standards, codes of practice and legislative requirements.

12.11.4 FORECAST SPEND

Detailed and individual programme forecasts for infrastructure and facilities as well as cable tunnel programmes of work are included in Section 12, Appendix. The forecast chart below is a summary of all the capex for infrastructure and facilities as well as cables. The only exception is the potential future replacement of the personnel egress ladder in the tunnel shaft at Newmarket substation. The replacement of this ladder is driven by safety, and while annual maintenance inspections show no degradation, a nominal allowance is prudently included in the forecast capex in Section 11, Network Reliability.

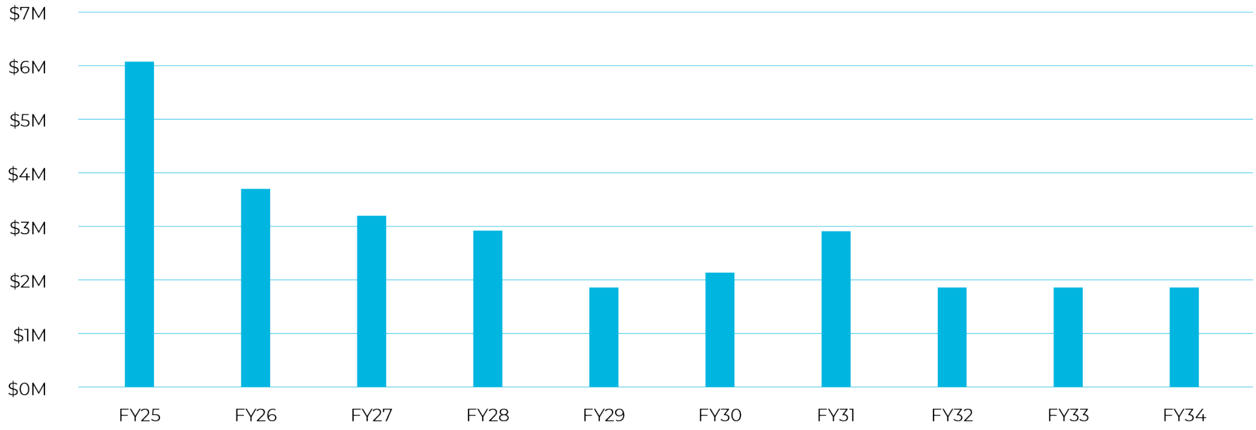


FIGURE 12-53: FORECAST CAPEX – INFRASTRUCTURE AND FACILITIES

SECTION 12A

Appendix: Asset replacement and renewal

12a – Asset replacement and renewal

12a.1 Overview

This Appendix provides details for significant asset replacement and renewal projects that have costs of $1m and over. All dollar values are nominal and include inflation. For easy reference, the programmes of work are also shown.

12a.2 Primary switchgear

12a.2.1 FREEMANS BAY 11KV SWITCHBOARD REPLACE

Freemans Bay supplies large residential areas in Ponsonby as well as a large portion of the commercial strip in Ponsonby Rd. It also supplies a large part of the Wynyard/tank farm and St Mary's Bay; areas that are fast developing and includes major office and hotel developments. Freemans Bay ZSS is presently fitted with Brush Electric (Hawker Siddeley) R4/2MK4 oil filled 11 kV switchgear fitted with GEC31 electro-mechanical relays.

The switchgear and relays were manufactured in 1967. There is sufficient space in the 11 kV switchroom to undertake an in-situ 11 kV replacement. The switchgear building and transformer enclosures have been assessed for seismic compliance and achieves 100% of NBS for IL3 buildings but some civil upgrades will be undertaken. The civil works will consist of the construction of a cable trench, installation of ducts and replacement of doors with Vector standard safety doors with crash bars. An HVAC system that includes a system for positive pressure will be installed and lighting will be upgraded to new Vector standard LED lighting.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Freemans Bay 11kV SWBD replacement	1.02										1.02

12a.2.2 PAPAKURANGA 11KV SWITCHBOARD REPLACE

The 11 kV switchgear in Pakuranga ZSS is a 1969 vintage Brush R4/2 MK4 oil filled switchgear with electro-mechanical protection relays. The switchgear and relays are not vendor supported and the switchgear is nearing the end of life. The asset health and criticality as per our CBARM model requires the switchgear to be replaced in the AMP planning period. There is enough room in the existing 11 kV switchroom to undertake an in-situ staged replacement and allow room for two additional panels if a switchboard extension is required.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Pakuranga 11kV SWBD replacement	3.15										3.15

12a.2.3 WIRI 11KV SWITCHBOARD REPLACE

Wiri ZSS is a three transformer ZSS: three 15/20 MVA (ONAN/ONAF) Tyree power transformers. The 11 kV switchgear in Wiri ZSS consists of seven Yorkshire SF_6 fixed pattern CBs with SEL numerical relays (installed 1998), two 2011 installed Reyrolle LMVP vacuum CBs and 14 Reyrolle England LMT2 CBs with electro-mechanical relays installed in 1983. The suite is configured as a three-bus section switch with two bus-couplers: transformers T2 and T3 supply the Reyrolle England switchgear portion.

This new Wiri 11 kV switchboard will contain vacuum interrupting CBs equipped with numerical protection relays. The existing cable terminations will not be re-used, instead the existing PILC cables entering the substation replaced with XLPE tails fitted with new terminations. The cable boxes will be fitted with arc detection sensors along with VAMP 125 arc detection relays. The transformer management systems will also be replaced under this project and a new Vector standard 110 V DC system will be installed.

The switchroom building achieves 80% (IL3) of NBS and civil works will be minor upgrades e.g. installation of doors with crash bars.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Wiri 11kV SWBD replacement	0.38										0.38

12a.2.4 HOBSONVILLE 11KV SWITCHBOARD REPLACE

The 11kV switchgear in Hobsonville ZSS is of the South Wales C4X oil filled type installed in 1975 and is fitted with electro-mechanical relays. A staged in-situ 11 kV switchgear replacement is not practical because of the limited space in the switchroom and a new switchroom will be installed. This switchroom will be designed and constructed with sufficient room for a future 33 kV replacement of the outdoor switchgear with indoor switchgear.

The new 11kV switchboard will make provision for future additional 11 kV feeders and include all ancillary works and balance of plant e.g. DC system, SCADA panel, control and instrumentation.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Hobsonville 11kV SWBD replacement	5.80										5.80

12a.2.5 ROSEBANK 11KV SWITCHBOARD REPLACE

Rosebank ZSS supplies the whole of the Rosebank peninsula and parts of Waterview that includes a large base of small and medium enterprises and industrial/commercial customers as well as 4,345 residential customers. The 11 kV switchgear consists of twelve Reyrolle UK LMT oil-filled CBs with electro-mechanical protection relays installed in 1970 and four Reyrolle LMVP vacuum CBs with Siemens numerical protection relays installed in 2007. The oil filled switchgear and the protection relays are not vendor supported and the substation has a history of faults on VTs and CTs. The output from the switchgear CBARM model categorises this switchboard as having a R4 rating (maximum risk).

Theoretically, this 1970s Reyrolle switchgear could be retrofitted with vacuum CB trucks but the general condition of the switchgear, cable termination boxes and secondary cabinets is such that the cost of retrofitting versus the benefit and asset life extension is not worthwhile. It will be more beneficial from a safety, operational and asset life point of view to replace the entire switchboard. The new switchgear will be fitted with Vector standard numerical protection relays and the 1970s vintage Reyrolle switchgear suite will be scrapped but selected parts will be retained as strategic spares for similar switches in service. The existing Long and Crawford 11 kV local supply substation RMU will be replaced.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Rosebank 11kV SWBD replacement		4.95									4.95

12a.2.6 SABULITE 33KV OUTDOOR TO INDOOR SWITCHBOARD CONVERSION

Sabulite ZSS is the distribution node for Kelston, Glendene South and North, Glen Eden East and New Lynn West in the Auckland Waitekere region and supplies 8,271 residential customers, 740 small and medium enterprises and 44 industrial customers. In 2012 the then existing South Wales 11 kV type C4/C8 X series of switchgear was replaced with a Schneider GHA fixed pattern switchboard in a Portacom style building that was designed with sufficient space for a 33 kV switchboard to be installed. The 33 kV outdoor CBs at Sabulite consist of five Nissin KOR type oil filled CBs installed in 1966 and one GEC VOX SF_6 outdoor live tank type CB installed in 2008. The protection relays for the 33kV CBs were upgraded in 2008 to Siemens numerical devices.

The Nissin KOR oil filled CBs have been identified as presenting a network risk because if and when they fail, they tend to do so spectacularly with a risk of collateral damage. The 33kV outdoor switchgear will be replaced with indoor fixed pattern switchgear in the AMP 2023 planning period. The works will include cutting, joining and turning new XLPE 33kV tails to the indoor switchgear and civil and structural works under the existing Portacom to make appropriate space for the 33kV cable tails. Replacement of the numerical relays will be required at the remote end 33kV zone substations connected to Sabulite.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Sabulite 33kV SWBD ODID		4.03									4.03

12a.2.7 ROCKFIELD 11KV SWITCHBOARD REPLACE

The 11 kV switchgear at Rockfield ZSS is a combination of 1978 vintage Reyrolle UK LMT oil-filled CBs with CDG electro-mechanical relays, and two RPS LMVP vacuum CBSs installed in 1998 and 2005 respectively. Although the Reyrolle oil-filled CB's can be retrofitted with modern vacuum CB's, pressure from expected demand growth on Rockfield ZSS along with the benefits of having the switchboard of the same vintage has prompted a complete switchboard replacement. The scope will include the installation of modern numerical protection relays, replacement of the transformer management system, and the existing VT supplied rectifier units will be replaced with a Vector standard 110 V DC system.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Rockfield 11kV SWBD replacement		0.44	2.70								3.14

12a.2.8 NEW LYNN 33KV ODID AND 11KV SWITCHBOARD REPLACE

33kV Outdoor to indoor conversion

The 33 kV outdoor switchgear in New Lynn ZSS consists of a variety of Siemens India oil filled CBs installed in the mid-eighties and a Vox SF_6 CB installed in 2007. The asset health and criticality of the 33 kV outdoor switchgear is such that it will be retained in service until after the 11 kV switchgear has been replaced. Accommodation for the 33 kV switchgear will be designed and constructed as part of the 11 kV switchgear project.

11kV Switchboard replace

The New Lynn 11 kV switchboard consists of a mixture of South Wales D4XD 1954 vintage switchgear, three C8X 1954 vintage CBs and three South Wales HG12 SF_6 CBs installed in 1987. All protection relays are electro-mechanical. Based on asset health and criticality the oil filled CBs need to be replaced but the complete suite including the three later model South Wales SF_6 CBs will also be replaced because a partial replacement will be physically challenging and costly to achieve. The three recovered SF_6 CBs will be retained as a source of spares.

The existing 11 kV switchroom does not have any space for a staged 11 kV switchboard replacement regardless that the building achieves 90% seismic compliance of NBS. There is sufficient space in Vector's designated substation land to construct a new switchgear building. It will be designed and constructed to house new indoor 33 kV switchgear that will be undertaken after the 11 kV replacement. The site is within a flood plain and the substation building design will consider this. The works will include the required balance of plant installation, e.g. 110 V Vector standard DC panel, SCADA panel and communications panel

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
New Lynn 33kV ODID & 11kV SWBD replace				5.0	9.5						14.5

12a.2.9 WAIKAUKAU 33KV ODID AND 11KV SWITCHBOARD REPLACE

33kV outdoor to indoor conversion

The 33 kV substation at Waikaukau ZSS consists of an extensive outdoor switchyard on a combination of concrete and timber support structures with 70s vintage porcelain insulators and rocking type disconnectors/air break switches. There are ten outdoor 33 kV CBs and eight bus disconnectors in the overhead bus structure but no remote-controlled bus coupler CB: any bus fault means a manual operation of bus disconnectors on site with prolonged outage time.

The 33 kV CBs are a mix of Nissin KOR-22 and Takaoka 3ORO oil filled types that have been identified as a risk to operating personnel because the failure of these type of CBs has resulted in explosions and collateral damage. A 1986 installed Inoue outdoor oil CB exists and an Areva VOX SF_6 outdoor CB replaced an oil filled CB in 2008. Protection relays are a mix of Siemens and SEL previous generation numerical relays in indoor protection panels in the relay building on site.

This ZSS is in a floodplain and at risk during heavy downpours. In March 2017 and again in January 2023 the substation was shut down due to flooding and had to be back-fed while a clean-up operation was undertaken.

FIGURE 12A-1: WAIKAUKAU ZSS DURING FLOOD JANUARY 202

The extensive size of the outdoor switchyard also makes it prone to outages by bird and vermin. A failure mode of cracking of insulators in the rocking disconnectors have been observed and resulted in a total outage of the 33 kV switchyard in January 2019. Apart from the inconvenience to customers this also resulted in undue SAIDI.

The 33 kV outdoor switchyard and CBs will be replaced with modern fixed pattern switchgear. For this purpose, a combined 33 kV/11 kV switchroom building will be constructed towards the front of the property that sits at a higher elevation (the 11 kV switchgear replacement will be undertaken separately in a subsequent year and is described further below). The switchroom will be designed with a floor height that takes into consideration the Unitary Plan flood plain modelling to prevent water from reaching the substation floor level.

Many 33 kV overhead lines enter the substation and as part of the works, this will be tidied up and replaced with underground cable portions into the new switchgear from cable risers. The transformers will also be relocated under the project to purpose built enclosures at a location on site with a higher elevation.

By the time this project will be delivered the existing numerical protection relays would have reached the end of life and the new fixed pattern switchgear will be delivered with generation 5 numerical relays and relays at the remote ZSS ends supplied from Waikaukau will also be replaced with generation 5 relays.

11kV Switchboard replace

The 11 kV switchboard in Waikaukau ZSS is a 1975 vintage South Wales suite that consists of five oil filled CBs: a mixture of D8 and C4X1 types fitted with CDG electro-mechanical protection relays. The South Wales oil filled switchgear is not supported by vendors and has been identified in Vector's asset strategy for replacement.

The 11 kV switchboard will be replaced with fixed pattern low maintenance switchgear and numerical protection relays in a switchgear room installed in a prior year as part of the 33 kV outdoor switchyard replacement.

The switchgear room height will consider the flood plain height as experienced in the Jan-Feb 2023 cyclone to mitigate the risk of flooding and harden this zone substation for the impact of climate change

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Waikaukau 33kV ODID & 11kV SWBD replace		5.0	9.5								14.5

12a.2.10 HENDERSON VALLEY 33KV ODID AND 11KV SWITCHBOARD REPLACE

33kV outdoor to indoor conversion

The 33 kV CBs at Henderson Valley ZSS are Takaoka type 30K0 oil filled outdoor CBs, some manufactured in 1967 and others in 1970. They exist in an outdoor switchyard with reinforced concrete bus structure supports with Canterbury type rocking disconnectors connecting to aluminium busbars. The cable support structures are steel. These outdoor oil circuit breakers are forecast to reach the end of life in this AMP period, does not have vendor support and have a known safety risk that when an internal fault occurs, it could result in the explosive expulsion of porcelain parts.

The 33 kV ODID project will follow after the construction of a new switchroom building for the 11 kV switchgear replacement project, described separately in this section. The existing 33 kV cables will be extended to new fixed pattern indoor 33 kV switchgear. The balance of plant equipment such as a DC system and SCADA panel will be replaced with modern Vector standard equipment. This 33 kV switchgear replacement is scheduled for planning and procurement to commence in FY29 and project delivery in FY30.

11kV Replace

The Henderson Valley 11 kV switchboard consists of 15 Reyrolle oil filled CBs: a mix of 1968 vintage LMT type 23T CBs and LMT X6 CBs. The existing protection relays are Reyrolle type TJV electro-mechanical overcurrent and earth fault relays with no relay supervision, no fault recording or fault location analysis capability and no capability for remote access to check and change protection settings or to access data in the relays. They also do not have the ability for definite time settings. Bay control on this old suite of CBs is via RTUs. The asset health and criticality of this switchgear is such that it is scheduled for replacement before the conversion of the 33 kV outdoor switchgear at Henderson Valley. The accommodation for the new fixed pattern 11 kV switchgear will be designed and constructed to make provision for the 33 kV outdoor to indoor conversion works described separately and that will follow the completion of this project. This zone substation is in a low-lying area and its design will consider flood levels taking cognizance of the Jan-Feb 2023 cyclone and its impacts.

The implementation of protection relays with definite time settings will allow much improved coordination with the large number of downstream reclosers and sectionalisers on the extensive Piha rural network

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Henderson Valley 33kV ODID & 11kV replace			5.0	9.5							14.5

12a.2.11 HILLCREST 11KV SWITCHBOARD REPLACE

Hillcrest ZSS has a 13-panel 11 kV switchboard supplied from two 12/24 MVA transformers. Two of the CBs are Reyrolle Pacific LMVP vacuum CBs installed in 2008. The remaining 11 CBs are Reyrolle Pacific LMT2 and ZMT2 oil filled CBs installed in 1990. The first-generation numerical protection relays (GEC MCGG Micom) which are known to have reliability issues will be replaced along with the transformer management system. Along with replacing unreliable and aging assets, the capacity rating of the new Hillcrest ZSS switchboard will also allow for demand growth in the Hillcrest suburb and outskirts of the Takapuna metropolitan area.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Hillcrest 11kV SWBD replacement				4.95							4.95

12a.2.12 TAKANINI 11KV SWITCHBOARD REPLACE

The Reyrolle 11 kV switchboard at Takanini ZSS is a combination of six LMT/LMT2 oil CB's, two LMV vacuum CB's and three LMVP vacuum CB's. The switchgear vintages span across five decades with the oldest and newest being 1976 and 2014 respectively. The protection relays installed also vary and include CDG31 electro-mechanical relays, SEL-751 numerical relays and a GEC MCGG

Micom first generation numerical relay. The new switchboard will contain modern numerical protection relays and vacuum interrupter CBs with capacity to complement the network reinforcement projects taking place during this AMP period.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Takanini 11kV SWBD replacement			4.95								4.95

12a.2.13 KINGSLAND 11KV SWITCHBOARD REPLACE

Kingsland ZSS is one of the larger distribution centres in Auckland’s network and it is supplied from Mt Roskill GXP onto two 110 kV/22 kV transformers that supply a 22 kV switchboard. A large (20 panel) 11 kV switchboard is supplied from the 22 kV switchboard via two 22 kV/11 kV transformers. The 11 kV switchboard is a Reyrolle Pacific switchboard installed in 1990. Although the feeder CBs all have vacuum interrupters, the three incomer CBs and two bus coupler CBs are oil filled Reyrolle Pacific LMT2 CBs. The scope of this project was originally to retrofit the oil CBs with vacuum interrupter CBs, however this was reconsidered in favour of a complete replacement in order to standardise and modernise every component of the switchboard. Circuit breaker replacement alone does not mitigate all risk with this type of switchgear; considering fluid filled cable box conversion, VT and CT replacement and related upgrades it is more cost effective and future proofing to replace the apparatus in its entirety.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Kingsland 11kV SWBD replacement				4.95							4.95

12a.2.14 LICHFIELD 110 KV OUTDOOR CB REPLACE

The two 110 kV CBs at Lichfield ZSS are AEG type S1-145 F1 outdoor single pole encapsulated live tank SF_6 CBs commissioned in the mid-1990s. These CBs have had systemic issues with leaking SF_6 but diligent maintenance and refurbishment have kept them running. ABB still provides some technical support and spare part inventory for this type, but these CBs need to be replaced in this AMP period.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Lichfield 110 kV OD CBs replacement				0.57							0.57

12a.2.15 ST HELIERS 11KV SWITCHBOARD REPLACE

St Heliers ZSS is equipped with thirteen Reyrolle England 1970s vintage CBs that is a mixture of LMT 36T and LMT X8 types; electro-mechanical protection relays are fitted. According to the CBARM model, the risk category of this switchboard is expected to regress into the R4 category towards the end of the AMP period.

Lighting will be replaced with Vector standard LED lights and emergency lighting, and to reduce solar heat gain the windows will have a covering applied. The 1974 vintage Long and Crawford oil filled RMU in the local supply substation will be replaced with a modern equivalent under the works. The fire protection system will also be upgraded.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
St Heliers 11kV SWBD replacement				2.22	6.68						8.9

12a.2.16 TE PAPAPA 11KV SWITCHBOARD REPLACE

Te Papapa ZSS is supplied from Penrose GXP to two 15 MVA transformers that feed a 13-panel Reyrolle England 11 kV switchboard with oil filled CBs installed in 1975. The line differential protection relays on the two 11 kV incomer CBs were modernized in 2020 to numerical protection relays that operate on a fibre optic signalling cable due to an ageing and failing copper pilot cable.

The oil filled switchgear and electro-mechanical relays are not vendor supported and will be replaced in line with Vector’s asset strategy for primary switchgear. The existing substation building has structural issues and although there is space in the 11 kV switchroom for a staged in situ replacement, a new building is the preferred option to house new fixed pattern low maintenance replacement switchgear. The two numerical relays in the existing incomers will be retained as strategic spares at the time of the works. The forecast cost below is based on a new switchgear room constructed on site.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Te Papapa 11kV SWBD replacement				0.59	5.90						6.49

12a.2.17 QUAY ST 11KV SWITCHBOARD REPLACE

Quay St ZSS is the bulk supply zone substation that supplies the lower eastern Auckland CBD including Ports of Auckland via a 22 kV and 11 kV network. It also supplies Parnell ZSS via two 22 kV subtransmission underground cables. The 22 kV ABB Calor Emag SF_6 1991 vintage installed double bus switchgear at Quay St recently (FY20/21) underwent a mid-life refurbishment which added ~20 to 30 years to its asset life. No capital works are required on this switchgear in the AMP planning period.

The 11 kV switchgear in Quay St ZSS is a double bus switchgear suite that consists of:

- 9 x Reyrolle 2LMT/MO oil filled CBs with CDG electro-mechanical protection relays installed in 1972. The switchgear has a short circuit rating of 350 MVA for 3 s;
- 17 x Yorkshire YS/L 13.8 kV rated SF_6 CBs with Siemens numerical protection relays installed in 1993. The switchgear has a short circuit rating of 476 MVA for 3 s.

The lack of vendor support, asset age, no fault analysing or data storage capability in the protection relays and high criticality of Quay St ZSS drives a replacement of the Reyrolle 2LMT oil filled CBs later in the AMP 2023 planning period. An in-situ replacement in place of the existing switchgear is simply not practical but the substation has real estate in which to install the new switchgear and undertake a staged transfer of 11 kV circuits. The Yorkshire SF_6 switchgear is still in good condition and although out of production, Vector has a repository of spares for this type to enable its retainment beyond the AMP 2023 planning period. However, the existing Siemens Siprotec 3 generation protection relays in the Yorkshire switchgear will need replacement later in the present planning period with Siprotec 5 generation numerical relays.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Quay St 11kV SWBD replacement					1.22	4.68					5.9

12a.2.18 SUNSET RD 11KV SWITCHBOARD REPLACE

Sunset Rd ZSS in the North Shore supplies the Sunnynook area, parts of Unsworth Heights, northern parts of Wairau Valley and the extensive Constellation Rd and Upper Harbour commercial areas. It includes the North Shore police headquarters in the supply area. The 11 kV switchgear consists of 11 GEC BVP17 oil filled CBs installed in 1972. The protection relays are GEC CDG36 electro-mechanical relays of the same vintage as the switchgear. An in-situ replacement in the existing 11 kV switchroom is unlikely due to limited space and a new switchroom will likely be utilized for fixed pattern low maintenance switchgear.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Sunset Rd 11kV SWBD replacement					1.39	4.63					6.02

12a.2.19 SUNSET RD 33KV OUTDOOR TO INDOOR CONVERSION

The 33kV switchgear at Sunset Rd ZSS consists of seven outdoor CBs: five Takaoka 3OKO oil filled CBs, one Inoue 3OTEO oil filled CB all installed between 1978 and 1980 and one Siemens India vacuum outdoor CB installed in 2005. The oil filled CBs are of a type that has been identified as a risk and will be replaced. Numerical relays were installed on the incoming 33 kV feeder CBs in 2019 and will be returned to stock as strategic spares at the time of the replacement because the new fixed pattern switchgear will come fitted with new protection relays. The existing 11 kV switchroom (see above) will most likely be repurposed for the new 33 kV switchgear.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Sunset Rd 33kV ODID					0.58	4.55					5.13

12a.2.20 SANDRINGHAM 11KV SWITCHBOARD REPLACE

Sandringham ZSS is fitted with a mixture of Brush Q16/2 and Brush R4/2 oil filled CBs installed in 1967; twelve CBs in total. The switchgear is fitted with electro-mechanical protection relays. Neither the switchgear nor protection relays are vendor supported and the switchgear is of the type that has been identified in Vector's asset strategy for primary switchgear, as a type to be replaced. Its ranking in the switchgear condition-based risk model calls it out for replacement in the current AMP planning period.

The existing switchroom building is a remnant of the leaky building period but extensive capital has been invested in recent years, including guttering, roofing and concrete paving to control soil erosion and seasonal swelling/shrinking around the building. The existing substation land is constrained and there is insufficient space to undertake an in-situ replacement inside the existing 11 kV switchroom and the existing building will most likely have to be extended to create space for a new 11 kV switchboard. This will require extensive geotech investigations to ensure the mass of any building additions does not impact the stability of existing buildings on site. Furthermore, the existing building foundations may require seismic upgrade and the building addition will likely have some separation so the buildings will have separate mass responses: details to be confirmed at the time of design.

The allowance in the AMP forecast estimate for this switchgear replacement is thus provisional and not firm until the afore-mentioned detailed investigations have been undertaken. This will happen closer to the time but ahead of works delivery. As part of this project, the existing PILC 11 kV incomer cables will be replaced. It is also planned to replace the existing Long and Crawford and LV distribution panel in the local supply substation at this ZSS. If necessary, Vector will deploy its mobile trailer (container) mounted 11 kV switchboard to facilitate the new switchgear installation.

The peak demand in Sandringham in the 2022 winter was 19.6 MVA and is forecasted to reach 37.0 MVA by the end of the AMP planning period. The new design and switchgear installation will make provision for easy extension of an additional 11 kV CB on either side of the bus in the future: a requirement for a new 11 kV feeder is a high likelihood.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Sandringham 11kV SWBD replacement						0.63	5.63				6.26

12a.2.21 WOODFORD 11KV SWITCHBOARD REPLACE

Woodford ZSS is a single transformer substation that supplies a mixture of residential and commercial load. The 11kV switchboard is presently fitted with mid-1970's Reyrolle UK oil filled 11kV switchgear along with English Electric CDG36 electro-mechanical relays of the same vintage. There is sufficient space in the 11kV switchroom to undertake an in-situ 11kV replacement and no remedial work on the switchroom building is required to make this building comply with the Seismic Provisions of the Building Act.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Woodford 11kV SWBD replacement						1.39	2.33				3.72

12a.2.22 MANLY 11KV SWITCHBOARD REPLACE

Manly ZSS supplies suburbs located on the Whangaparaoa peninsula including Whangaparaoa, Manly and Stanmore Bay. Vector's substation switchgear CBARM model has identified the Manly 11kV switchboard as becoming high risk towards the end of the current AMP period and requiring replacement. The 11kV switchgear consists of 11 GEC BVP17 oil filled CBs installed in 1972 with English Electric CDG36 electro-mechanical relays. The new switchboard will be fitted with modern numerical relays and auxiliary systems will be replaced to meet the current Vector standard.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Manly 11kV SWBD replacement						1.39	4.63				6.02

12a.2.23 MCLEOD 11KV SWITCHBOARD REPLACE

The 11kV switchgear in McLeod ZSS is of the South Wales C4X oil filled type installed in 1975 and is fitted with electro-mechanical relays. Neither the switchgear nor protection relays have any vendor support and the equipment is nearing the end of life. A review into integrity of the switchroom building will be required to determine if a replacement is required or if it is economical to maintain for the lifetime of the new switchboard. Fixed pattern switchgear will be installed in the existing switchroom if practicable, otherwise a new switchroom will be constructed.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
McLeod 11kV SWBD replacement							4.95				4.95

12a.2.24 EAST COAST RD 11KV SWITCHBOARD REPLACE

East Coast ZSS has a nine panel 11kV switchboard supplied from a single 12/24 MVA transformer. Three of the CBs are Reyrolle Pacific LMVP vacuum CBs installed in 2006. The remaining six CBs are Reyrolle Pacific LMT2 oil filled CBs installed in 1989. The oil CBs are fitted with first-generation numerical protection relays (GEC MCGG Micom) while the vacuum CB's are fitted with later generation Siemens numerical relay.

Vectors substation switchgear CBARM has identified the East Coast 11kV switchboard oil CB's as being highly critical assets with their health deteriorating towards the end of the AMP period. The switchboard will be replaced and modern numerical protection relays will be installed with the new switchboard.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
East Coast Rd 11kV SWBD replacement							4.95				4.95

12a.2.25 NEWTON 11KV SWITCHBOARD REPLACE

Newton ZSS supplies the large commercial area in Newton, Eden Terrace and a part of Mt Eden. The 11kV switchboard is a double bus GEC NZ type BTVP suite with oil filled CBs and GEC CDG electro-mechanical protection relays installed in 1980. The risk category of this switchboard according to the CBARM model is expected to regress into the high-risk category towards the end of the AMP period

There is no space in the switchroom for an in-situ staged replacement and insufficient space to build a new switchroom. To replace the switchboard will most likely require a major construction project to build a second level over and above the existing switchroom for new fixed pattern switchgear. This zone substation is close to a cliff in which small landslips occurred during the Jan-Feb 2023 cyclone and this will be considered in the design of this upgrade.

The investment forecast is provisional as this project requires extensive planning and investigations to select a viable option.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Newton 11kV SWBD replacement								2.22	6.68		8.9

12a.2.26 BRICKWORKS 11KV T2 INCOMER CB REPLACE

In 2021, the spare =K08 T2 incomer (a Schneider type GMA 1250A panel) at Brickworks ZSS was swapped with the failed =K07 T1 incomer panel at Riverhead ZSS. The Riverhead =K07 T1 incomer cable connection bushing had failed. This type of switchgear is constructed such that the primary bushings cannot be replaced prompting a primary component replacement. At the time, a strategic spare panel was not available. The primary parts were swapped between the Brickworks and Riverhead ZSS. The defective panel was reinstalled at Brickworks as a 'bus bar bridge' between neighbouring panels. This panel now requires replacement to enable the installation of a second transformer at this site.

This project will involve removing the defective primary panel and installing a new replacement panel of the same type in its place. All secondary components will be re used so as to minimise the commissioning time of the replacement primary panel components.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Brickworks 11kV Incomer replacement	0.95										0.95

12a.2.27 VT 110KV METERING ADAPTOR

Description: The 110 kV switchgear has revenue class voltage transformers (VTs) in each of its 110 kV incomer bays. The Electricity Industry Participation code (2010), Part 10, Metering arrangements, require that revenue metering be tested every eight years to confirm their accuracy is still within predetermined tolerances and hence are deemed 'certified' for revenue metering purposes. Vector does not have access to a 110kV VT test adaptor to undertake this testing.

After investigating a range of options, the procurement of a test adaptor was determined to be the most economic option. To provide redundancy, a spare 110kV revenue class metering VT will also be procured. This will be certified at the same time as the in-service VT (using the test adaptor). This VT can then be deployed at short notice should any of the in-service VTs unexpectedly fail.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
VT 110kV Metering Adaptor	1.0										1.0

12a.2.28 SWITCHBOARD REPLACEMENTS IN THE LATTER PART OF THE AMP PERIOD

The forecast below is for switchboard replacements in the latter part of the AMP period that have been assessed based on asset health and criticality. Depending on the performance of the equipment as well as load growth, the priorities for these replacements might change.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
James St 11kV SBWD replace							0.89	4.13			5.02
Hobsonville 33kV SWBD ODID							0.59	4.5			5.09
Howick 11kV Replace									5.19		5.19
Otara 11kV SWBD replace										5.19	5.19
Total							1.49	8.63	5.19	5.19	20.49

12a.3 Zone substation power transformers

12a.3.1 TRIANGLE RD ZSS REPLACE TRANSFORMERS T1 AND T2

Triangle Rd ZSS is a two transformer ZSS supplied from Henderson GXP via two trefoil (3 x 1-core) Aluminium 300mm² XLPE cables directly to two transformers. Transformer T1 is an ASEA 10 MVA continuous rating ON transformer manufactured in 1956 and installed in 1961 and transformer T2 is a Wilson Electric 10 MVA continuous rating ON transformer installed in 1961: both units are outdoor transformers installed in bunds complete with SEPA unit. The Triangle Rd ZSS peak demand in winter 2022 was 14.2 MVA and is forecasted reach 19.1 MVA by 2033.

These transformers were originally scheduled for replacement later in the AMP period but tests have shown that their asset health is degrading and their replacement was brought forward. Vector standard 15/20 MVA ONAN/ONAF power transformers will be installed in the same locations as the existing transformers.

A further driver for their replacement is the development of a large datacentre that will be supplied from this zone substation.

The civil works will include modification of the bunds to ensure they are suitable for the larger oil volume transformers; it will also include the construction of a firewall between the transformers and a firewall between the transformers and the existing switchgear building. The cable works will likely include new 11 kV incomer cables from the transformer terminals to new Vector standards: this will be determined under detail design.

Works on T2 replacement are underway with livening expected in April 2024. T1 replacement will begin in earnest in July with anticipated completion October 2024.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Triangle Rd 33/11 kV TX Replace T1 & T2	1.5										1.5

~~12a.3.2~~ HANS ZSS REPLACE TRANSFORMERS T1

1978 Bonar Long 15/20 MVA ONAN/ONAF transformers at Hans ZSS have DP values that require these two transformers to be replaced within the AMP period. T52 was commissioned into service in December 2023 under FY24programs of works and T1 replacement is currently being planned. The existing transformers are off-tank radiator transformers in transformer enclosures to suit the existing off-tank radiator designs. The winter 2022 peak demand is 23.1 MVA and is forecast to reach 34.3 MVA in 2033. Similar pattern, i.e. off tank radiator, replacement transformers rated 20 MVA (30 MVA 2-hour rating) will be procured and these will be delivered complete with Reg-DA transformer management systems as per Vector's standards.

Because similar footprint transformers, to suit the existing transformer rooms, will be procured, the civil works will include modification of the transformer and radiator pads to suit the new design as well as core drilling of duct routes to suit termination boxes. Because of previous overheating issues, larger louvres will likely be installed, or the roof raised to improve airflow in the transformer enclosure to optimise heat dissipation for the replacement transformers – this will be determined as part of the detail design. The DC system is compliant with Vector's latest standard. The 33 kV oil filled cables that presently terminate directly on to the existing transformers will be terminated to oil-to-XLPE trifurcating stop joints and XLPE tails installed to the new transformer 33 kV termination enclosure.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Hans 33/11 kV TX Replace T1	0.65	3.8									4.45

12a.3.3 MCNAB ZSS REPLACE TRANSFORMERS T2 AND T3

McNab ZSS is a highly loaded and critical zone substation that supplies a large commercial and industrial customer base (1,269) as well as 5,062 residential customers. The large Illinois Glass recycling plant counts amongst the industrial customers connected to this ZSS. The deteriorating degree of polymerization (DP) values of the 1966 vintage transformers mean that they need to be replaced to ensure the continued reliability of the supply.

The peak demand in 2022 was 37.8 MVA and forecast growth is expected to reach a peak demand of 60.6 MVA in 2033. In line with this forecast peak demand, the project is to replace the three existing 20 MVA transformers with similarly sized 20 MVA (30 MVA 2-hour emergency rating) transformers. However new large industrial customers might require larger transformers to be installed at the time.

The 11 kV switchgear at this ZSS is relatively young and meets Vector's load and short circuit requirements and will remain in service but the transformer impedance will be selected to keep fault levels at the appropriate level as stated in Vector standards. The 33 kV supply cables from Penrose GXP as well as the 11 kV 1-core 630 Al XLPE incomer cables will be retained. The transformers will be delivered with on-board Eberle Reg-DA transformer management systems as per Vector design standards. The transformers will be replaced in sequence so as not to compromise the security of supply at this important commercial and industrial hub. Transformer neutral CTs will be replaced, and protection settings revised for improved earth fault protection. Secondary cabling will be replaced as required and full details will be determined as part of the detailed design.

The transformer foundations will be modified to suit the footprint of the new transformers and new masonry reinforced concrete bunds will be installed to oil volume requirements. The transformer bays will be equalized: this will involve a new blast wall between transformers T1 and T2 and replacement of the existing blast wall between T2 and T3. The existing rain shields will most likely be replaced with Vector standard Osbourne rain/ventilation louvres. New primary cable supports will be installed. Existing NERs are fit for purpose and will remain. A second 110 V battery bank will be added to bring this ZSS to Vector standards for high importance zone substations.

The new T1 (designated T51) commissioning was delayed due priority Transpower works affecting the McNab replacement programs. The new T51 is now scheduled for completion first quarter of FY24.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
McNab 33/11 kV TX Replace T2		0.65	3.0								3.65
McNab 33/11 kV TX Replace T3					3.0						3.0

12a.3.4 MANUREWA REPLACE TRANSFORMER T3

Manurewa ZSS is a three transformer ZSS that feeds a 22-panel fixed pattern 11 kV switchboard installed in 2018. All three transformers are 16 MVA (ONAN) Bonar Long units. T1 and T2 were installed in 1968 and T3 was installed in 1976. Manurewa ZSS supplies 17,271 residential customers, 1,1159 small and medium enterprises and 96 industrial customers. The peak demand in 2022 was 50.6 MVA and is forecast to reach a peak of 68.6 MVA by 2033.

During sampling in July 2020, the oil showed a high-level of moisture and high acid content which shows that fluid oxidation is advancing and the interfacial tension in the oil has reduced. The cellulose in this transformer has degraded and its DP value is 346 and declining at a rate of -23. The insulating oil was streamlined (dry-out process) in December 2020 to improve its reliability for the time being going forward but has been scheduled in the AMP for replacement in FY26. The installed transformer capacity is 48 MVA and N-1 capacity is 32 MVA. However, with the 11 kV backstop that is in place the security limit is such that it has enough headroom for the ZSS to be operated with two transformers during an unplanned failure or while the replacement takes place.

The block and brick panels in the transformer radiator enclosures are unreinforced and will require a rebuild. The works will also include the civil works to construct a new foundation pad for the replacement transformer.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Manurewa 33/11 kV TX Replace T3	0.65	3.8									4.45

12a.3.5 NEWTON ZSS REPLACE TRANSFORMER T1 AND T2

Newton ZSS is supplied from the Liverpool ZSS 22 kV bus via two 3-core Aluminium PICAS PVC oil-filled cables that terminate directly onto two Turnbull and Jones 12/16 (ONAN/ONAF) MVA 22/11 kV transformers manufactured in 1978. Newton ZSS supplies the south-western corner of Auckland's CBD and has backstop 11 kV circuits to Kingsland and Newmarket ZSSs. This ZSS has a winter peak that reached 18.2 MVA in 2022 and is forecasted to reach 31.0 MVA by 2032.

The existing transformers are off-tank radiator transformers. The replacement transformers will be 20 MVA (30 MVA 2-hour) rated units and will be of a similar off-tank radiator design to suit the layout of the existing enclosures. The two oil-filled cables will be terminated into oil-to-XLPE trifurcating stop joints and XLPE tails terminated in the new transformer 33 kV cable termination enclosures. The 11 kV PILC incomer cables will be replaced with new XLPE tails as per Vector's standards.

The GEC BTV17 11 kV switchgear oil filled switchgear has a short circuit rating of 250 MVA for 3 sec. The switchgear has been ranked in the CBARM model for replacement towards the end of the 10-year planning period. At this point, the asset health of transformer T2 at Newton has not warranted a replacement in the 10-year plan.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Newton 22/11 kV TX Replace T1		0.65	3.8								4.45
Newton 22/11kV Tx Replace T2			0.65	3.8							4.45

12a.3.6 MT WELLINGTON ZSS REPLACE TRANSFORMERS T1 AND T2

Mt Wellington ZSS supplies the large commercial and industrial hub of Mt Wellington. This ZSS is equipped with two 15/20 MVA rated Wilson transformers installed in 1963. Both these transformers are showing a decline in the degree of polymerization. As an interim measure both these transformers underwent Fullers treatment in 2021 to help maintain their integrity and reliability until their replacement.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Mt Wellington 33/11 kV TX Replace T1		0.65	2.90								3.55
Mt Wellington 33/11 kV TX Replace T2			2.09								2.09

12a.3.7 OTARA ZSS REPLACE TRANSFORMERS T1 AND T2

Otara ZSS supplies the commercial and residential community in the southwest of East Tamaki. Otara is T3 Power Transformer configured substation. T1 and T2 are 22/11kV 15 MVA ONAN rated AEI manufactured transformers commissioned in 1964. T3 is a as new Pauwels 20MVA ONAN transformer commissioned in 2009.

Both T1 and T2 transformers are showing a decline in the estimated degree of polymerization. At last measure (2023) the E.DP of T1 and T2 was 462 and 440 respectively. Indicating more than 40% of the tensile strength in the paper has been depleted. As the E.DP is an averages measure the actual DP can vary greatly where vulnerable areas of the transformers insulation below DP 350 are likely.

In 2023, Waimauku T1 (a 1959 manufactured 7.5MVA Wilsons Transformer) was removed from service under a RNF program of work. The oil tests indicated a E.DP of 619 however papers samples taken from the windings pre scrapping revealed DP below 448. This has shown a large margin of error is due to no long term E.DP test history.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Otara 22/11 kV TX Replace T1			0.65	2.5							3.15
Otara 22/11 kV TX Replace T2				0.65	2.5						3.15

12a.3.8 THE DRIVE REPLACE TRANSFORMER T1 AND T2

The Drive ZSS supplies a largely residential and retail area of Mount Eden Epsom and One Tree Hill. The Drive is a twin transformer supply station. T1 and T2 are circa 1972 YET (Yorkshire Electric Transformer) 15/20MVA ONAN/ONAF 33/11kV units.

Both T1 and T2 transformers are showing a decline in the estimated degree of polymerization to critical levels. At last measure (2023) the E.DP of T1 and T2 was 510 and 336 respectively. T2 E.DP indicates more than 65% of the tensile strength in the paper has been depleted. As the E.DP is an averages measure the actual DP can vary greatly where vulnerable areas of the transformer insulation strength below DP 300 is likely. T1 and T2 are the same design and age in service. The large delta in E.DP between the two can only be attributed to T1 having had a large quantity of oil renewed or has it has been streamlined resulting in a higher health score that is realistically possible.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
The Drive 22/11 kV TX Replace T1				0.65	3.8						4.45
The Drive 22/11 kV TX Replace T2					0.65	3.8					4.45

12a.3.9 TRANSFORMER REPLACEMENTS IN THE LATTER PART OF THE AMP PERIOD

The forecast table below provides a summary of power transformers that have been identified for replacement in the latter part of this AMP period based on criticality and asset health. Maintenance and monitoring of these transformers will continue and any deterioration in the quality of paper insulation might require a bringing forward of replacement. Mid-life refurbishment more specifically Fuller's earth treatment and oil streamlining (see description further below) will not extend the life of a transformer but will decelerate oil related insulation depleting processes such as high acid, low breakdown voltage and moisture to ensure that a transformer at least achieves its standard asset life.

At the time of writing in late Dec 2023, Laingholm T1 was returned to service after a program of HV bushing renewal and extensive oil streamlining to remove moisture from the solid insulation. This unit will be carefully monitored but may need to be replaced within the AMP period.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Highbury 33/11 kV TX Replace T1									0.65	3.8	4.45
Te Papapa 33/11kV TX Replace T2							3.8				
Te Papapa 33/11 kV TX Replace T1									0.65	3.8	4.45
Total							3.8		1.3	7.6	8.9

12a.3.10 TRANSFORMER REPAIRS, REFURBISHMENTS AND OIL STREAMING

The lifeblood of a transformer is the insulating oil and during its service life, the oil will degrade. This exposure degrades the quality of the oil which if left unchecked will accelerate the ageing of paper insulation, form sludge which then affects cooling and it also reduces the dielectric withstand capability of the oil. These factors can lead to the premature failure of transformers. The forecasts below are bucket allowances to refurbish and repair older transformers and treat the oil to reduce the risk of accelerated degradation of paper insulation. This work will allow Vector to utilise the treated transformers up to their full expected asset lives or as far as possible. The works will be prioritised after scheduled maintenance testing of the older transformers in the fleet. This programme will include some of the transformers described above, ear-marked for replacement to help to maintain their integrity up to the time of replacement.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland ZSS TX Refurb and Repair	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	2.9
Northern ZSS TX Refurb and Repair	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	2.9
Auckland Transformer Oil Streaming	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	2.1
Northern Transformer Oil Streaming	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	2.3
Total	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	10.2

12a.3.11 NEUTRAL EARTHING RESISTORS

Neutral earthing resistors (NERs) are used to limit earth fault currents in power systems: their primary purpose is to decrease fault current when an earth fault occurs on the system. For certain customers, to provide uninterrupted supply from two 11 kV bus sections, the fault current has to be limited to maintain it within cable earth screen ratings. Installing NERs however has other consequences such as a rise in the phase to neutral voltages of the unfaulted phases during an earth fault on the third phase: this could cause failures on existing 11 kV surge arrestors. The financial provision in the table below will be used as and where required and will not be applied until or unless a study of the network in question has been undertaken to ascertain the benefits and risks to the chosen installation site.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland neutral earthing resistors	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	3.7
Northern neutral earthing resistors	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	3.7
Total	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.74	7.4

12a.4 Subtransmission cables

12a.4.1 WESTFIELD SUBTRANSMISSION CABLE REPLACEMENT

Westfield ZSS is supplied from the Penrose GXP 22 kV bus via three 22 kV rated subtransmission cables (circuits 1, 2 and 3). Circuits 2 and 3 are 3-core copper 240 mm^2 (0.37 inch^2) PICAS oil-filled cables both installed in 1967. Circuit 1 consists of two x 3-core copper PILC SWA cables: one is a 95 mm^2 (0.15 inch^2) cable installed in 1928 and the other is a 150 mm^2 (0.25 inch^2) cable installed in 1941. These two cables existed as separate cable circuits to Westfield in the past before the installation of the oil-filled cables in 1967 but were then, at the time, connected in parallel to become a single (third) subtransmission circuit.

Several faults have occurred on the paralleled cable circuit (#1) but there has not been an increase in the rate of failures over the last number of years. The peak demand at Westfield was 22.2 MVA in summer 2022 and is forecasted to reach 34.6 MVA in 2033. The two oil filled cables (circuits 2 and 3) each have long term cyclic ratings of 17.7 MVA.

Westfield ZSS also has about 10 MVA of 11 kV backstop capacity to adjacent ZSSs: so, with a contingency on circuit 1, the load at Westfield is not at risk and the existing subtransmission and backstop circuits will be able to supply the demand. Based on present asset health and performance, the capacity of the two oil-filled cables and backstop, this replacement project will take place in FY26.

As part of the civil works to replace circuit 1 the second set of trefoil ducts will be installed as future proofing for the replacement of one of the oil-filled cables in the long term. The replacement cable will be 33 kV rated to future proof the circuit for future conversion to the 33 kV bus at Penrose GXP.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Westfield SUBT cable replacement		12.40									12.40

12a.4.2 EAST TAMAKI SUBTRANSMISSION CABLE REPLACEMENT

The East Tamaki 33 kV subtransmission cables are relatively young XLPE cables. They supply East Tamaki ZSS from Pakuranga GXP. The cables run underwater through a creek and wetland and it appears that water has entered the extruded insulation. Thus far the circuits have been maintained and smaller sections of cable have been replaced but continued insertion of small sections of cable and an increasing number of joints is not good cable asset management practice and in the longer term the sections through the creek and wetland area will have to be replaced with proper water blocked cables.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
East Tamaki SUBT cable replacement		0.28	1.11								1.39

12a.4.3 ONEHUNGA SUBTRANSMISSION CABLE REPLACEMENT

The subtransmission supply to Onehunga ZSS is from Penrose GXP via two underground 3-core copper PILC SWA cables installed in 1963. Small and medium enterprises form a large part of this ZSS's customer base. Vector's asset strategy for PILC circuits over 1000m is to replace the entire circuit rather than undertake piecemeal replacements.

The medium-term plans for the subtransmission network in the area will see the expansion of the existing Transpower Southdown site (Hugo Johnston drive, Penrose) to include a new GXP connection to Vector. This new GXP connection will supply three zone substations (Westfield, Onehunga, and Carbine) currently taking supply from the Penrose GXP. Direct replacement of the aging subtransmission circuits from the Penrose GXP as a result is no longer a cost-effective long-term plan.

This project will include the installation of trefoil ducts and cable for two 33 kV circuits between Onehunga ZSS and the proposed Southdown GXP. A set of trefoil ducts will also be installed between Southdown GXP and the Te Papapa ZSS for a future 33 kV circuit along with smaller ducts for future DTS cables.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Onehunga SUBT cable replacement		10.00	5.39								15.39

12a.4.4 ZONE SUBSTATION CABLE SUPPORT UPGRADE

A recent review into the cause of several switchgear bushing failures determined that they were under significant mechanical stress prior to failing. The cable support systems at these sites did not meet Vector's current standards and were deemed to be a root cause of the bushing failures.

Inadequate cable support systems result in the switchgear bushings supporting the weight of the cable terminations and cable. Indirect alignment of the cable termination with the bushing also induces lateral force on the bushing. Preliminary investigations into the cable support structures at select zone substations has identified sites where the existing cable support system does not meet Vector's current standards, and more are expected to be identified as the investigations progress to all of Vectors zone substations. Cable support system upgrades will include the installation of additional support struts, resizing and replacement of cable clamps, and alignment of the cable termination with the bushing.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
ZSS cable support upgrade		1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	9.60

12a.4.5 LIVERPOOL-KINGSLAND SUBTRANSMISSION CABLE CROSSBONDING PIT RENEWAL

The Liverpool-Kingsland subtransmission circuit is over 3.3km km long and is comprised of three single core cables arranged in trefoil formation. Along the route there are three underground link boxes where the cable screens can be cross connected or "cross-bonded" between cables of different phases. This improvement will maximise the thermal rating of the cables by reducing circulating currents in cable screens. All 11 link box enclosures along the route will be replaced along with the covers.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Live-Kingsland SUBT Cable cross-bonding		0.21	0.62								0.83

12a.4.6 NORTHERN SUBTRANSMISSION CABLES REPLACEMENT

The first-generation XLPE cables had taped semiconductor screens which were an ineffective barrier to stop water trees from developing and non-tree retardant XLPE which led to the "water tree growth" in the extruded insulation. Substantial portions of subtransmission cables in the Northern network are of this type and if left unchecked the water trees will lead to failure of the insulation and outages. For the interim, smaller cable-portions are replaced as required but, in the longer term a programme of partial discharge and tan-delta tests will be undertaken and those portions with poor test results will be replaced as whole circuit portions.

The output from the CBARM model typically categorises these cables either as R3 or R4 which are the highest risk categories. The cables currently categorised as R3 often regress into the R4 risk category by the end of the AMP period as their condition deteriorates.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Highbury (52B) SUBT Cable replace	1.20										1.20
Hepburn (38,39,43,44A,49,50) SUBT Cable replace		7.00	7.00	6.08			,				20.08
Manly (55B) SUBT Cable replace			3.25								3.25
Sunset road (20) SUBT Cable replace				0.70							0.70
Triangle road (25&26) SUBT Cable replace					1.33						1.33
Wairau (52A) SUBT Cable replace							2.10				2.10
Silverdale (55A) SUBT Cable replace							1.00				1.00
Total	1.20	7.00	10.25	6.78	1.33	0	3.10	0	0		26.44

12a.5 Distribution equipment

12a.5.1 LV NETWORK REPLACEMENT

Vector's approach to replacement of assets in the LV distribution network is condition rather than age based. Vector has previously had programmes to replace specific population type assets in the LV network but has not had a proactive replacement programme for the LV distribution system in general. The LV network replacement programme will target assets identified during network inspections as being in a deteriorated and/or unsafe condition. LV asset replacements are normally done like for like but considerations will be made to enhance safety and demand growth from EV charging and distributed generation. Enhancements will also take consideration of the impact of climate change.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland LV network replacement		1.81	1.86	1.92	1.98	2.03	2.03	2.03	2.03	2.03	17.72
Northern LV network replacement		1.81	1.86	1.92	1.98	2.03	2.03	2.03	2.03	2.03	17.72
Total		3.62	3.72	3.84	3.96	4.06	4.06	4.06	4.06	4.06	35.44

12a.6 Auxiliary systems

12a.6.1 DC SYSTEMS

DC systems must be available 24/7 to ensure safe and secure zone substation asset operation for continuous power supply to customers. The failure of a DC charger and a subsequent loss of its DC system, therefore, has a zone substation outage SAIDI risk. Vector currently has a total of 335 110 V DC systems in service within zone substations, communications sites, and several distribution substations. Both Auckland and Northern networks have an on-stream system to provide an immediate 24/7 replacement response.

The 9 Northern and 19 Auckland network Benning 110 V charger end-of-life, non-vendor supported system replacements by Cordex systems will be completed in FY24. This has also standardised the DC systems fleet.

The fleet condition-based asset life replacement programme is shown by the annualised investment budget below. This ensures continued successful operation of zone substation control, protection, automation, interlocking and other essential equipment that is reliant on a correctly functioning DC system.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland DC replacement	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.70
Northern DC replacement	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.70
Total	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	1.40

12a.6.2 SECURITY, ACCESS, AND FIRE PROTECTION

Since 2016 NZS 7901 Public Safety annual audits by Telarc provide an independent safety assessment of randomly selected distribution asset and zone substation perimeter earthing, signage, safety, and security of access. A decreased trend of severity and occurrence for security risk was gained in 2019 following workshops held with the FSPs on how to improve planned maintenance inspections, such as looking outward as well as inward from the perimeter and Vector responding quicker to approve projects to address security concerns raised by the FSPs.

All buildings are monitored with intruder detection, with no unauthorised entry incidents. Although property entry incidents in previous years have been rare, in 2024 unauthorised access driven by copper theft has required increased hardening of property fencing and transformer bay security panelling. Although we monitor the benefit of grounds surveillance cameras, however preventing access, good lighting, and trespass investigations are more cost-effective solutions. Smart locks are being investigated for improved security management and can be implemented where they provide a cost-effective control.

Using this approach for site security to minimise the risk of unauthorised entry, copper theft or asset damage with potential harm to the intruder, our program of perimeter and transformer fencing, gate and padlock security upgrades continues from its inception in FY20 for critical customer sites and those typically in rural and industrial areas with their heightened potential risk of unobserved perimeter entry. Additionally, the Gallagher Cardax security system undergoes regular software security upgrades.

While fires in zone substations are rare the consequences can be very serious. The objectives of fire protection are clearly defined in Vector guideline "ENG-0028 Fire protection in zone substations" and asset strategy EAA600 [36]. All detection systems connected to the zone substation Fire Panel must comply with NZS4512 and maintenance standard ESM603 activities to ensure performance compliance is met during their installed life. Our program of replacing legacy fire panels to current standards was completed in FY22, while detection systems will continue their ongoing planned replacement into FY25.

Radio huts, which the northern network SCADA and EOC are dependent on, require new passive fire detection. Although the Swanson St minor tunnel cable joints are intumescent coated, the addition of fire protection is prudent.

The budget allows for progressing legacy site-by-site targeted improvements to meet new standards for zone substation security including perimeter fencing, and fire protection upgrades, for which Design Standard ESE703 applies.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Fire and Security upgrade	0.40	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.75
Northern Fire and Security upgrade	0.40	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.75
Total	0.80	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	3.50

12a.6.3 HEATING, VENTILATION AND AIR CONDITIONING

Increasing ambient temperatures and the duration of these over summer has in recent years increased the need to provide cool dry air via heat pumps as part of our climate hardening response. New systems are required at up to six zone substation sites p.a. in addition to the usual new installs for ARP and RNF switchgear or building replacement projects. Sites are prioritised by their temperature/humidity excursions outside the specified measurement requirements of Vector standard ESM603 Auxiliary Systems.

Heat pumps are the industry standard to cost effectively control the zone substation and other facility building internal atmosphere temperature and humidity to ensure IEDs and metal clad switchgear operate within manufacturer and their IEC standards recommended parameters. The positive air pressure systems draw filtered external air into the building to pressurise and provide continuous air changes as controls to minimise dust entry, stale air and to inhibit corrosion, rust, and deterioration.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland ZSS HVAC installations	0.22	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	3.82
Northern ZSS HVAC installations	0.22	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	3.82
Total	0.44	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	7.64

12a.7 Infrastructure and facilities

To safeguard personnel, the public, and supply performance for customers, Vector's zone substation and tunnels primary and secondary electrical equipment needs to be protected from natural hazards that can cause its maloperation, failure or loss.

Vector's infrastructure and facilities are part of providing that safety by design performance. Environmental natural hazard impact is evaluated during zone substation property acquisition for new sites, throughout the life of the substation, and for site rebuilds.

Site rebuilds are usually associated with the replacement of major primary and secondary equipment and those asset sections within the AMP will also include the expenditure required for environmental hazard response.

Acquiring new property for zone substations includes a planned hazard assessment of changing weather impact on flood plains and overland flow path hydrology, as well as other neighbouring and site-specific natural hazards of seismic, wind, fire, geotechnical, landfill, slope stability, archaeological remains, and hazardous materials and activities (HAIL). This is in addition to assessing our own impact on the local environment and neighbouring communities.

Similarly, rebuilds of existing zone substation (and other) infrastructure provides for these same natural environmental hazards, to cost-effectively provide infrastructure and facilities that safely endure environmental change for the life of their performance.

12a.7.1 PENROSE TUNNEL

The Penrose to Hobson Tunnel contains Vector's 110 kV subtransmission cables from Transpower Penrose GXP to Liverpool and 33 kV cables to Newmarket ZSSs as well as the TP 220 kV NAaN cable from Penrose GXP to Hobson GXP. The tunnel also contains 22 kV express feeder interconnectors between Liverpool ZSS and Hobson ZSS. Transpower has shared access rights for the tunnel. The tunnel was commissioned in 2001 and the auxiliary systems necessary for personnel safety and performance of the power cables now progressively require upgrade or replacement as they reach their end of life. To also ensure 24/7 access for maintenance and emergencies these systems cannot be run to failure. This includes the service train within the tunnel, which is subject to New Zealand Transport Authority regulations for rail safety. Furthermore, the tunnel is classed as a confined space that requires strict entry requirements and the auxiliary systems providing that safety for personnel must also be operational 24/7.

For an auxiliary system failure, there is a health and safety risk which could result in the Asset Safety Incident Rate being increased. To ensure the integrity and safe operation of personnel and plant within this strategic asset there is a need to replace and refurbish auxiliary systems inclusive of the rail and its anchor systems.

A major on-off planned expenditure is replacement in FY25/26 of the tunnel vertical lift that provides personnel and equipment access/egress at the tunnel mid-point. The lift has performed well since its installation for construction of the tunnel services prior to the tunnel becoming operational, with the timing of its replacement determined by prior annual condition-based certification surveys of its remaining safe life.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Tunnel - Ventilation Motor replace	-	-	0.36	-	-	-	-	-	-	-	0.36
Tunnel - Control Room addition	-	0.24	-	-	-	-	-	-	-	-	0.24
Tunnel - Train, Generator, Rolling Stock replace	-	-	-	-	-	-	0.54	-	-	-	0.54
Tunnel - Ventilation VSD replace	-	-	-	0.24	-	-	-	-	-	-	0.24
Tunnel - Sump pump replace	0.13	-	-	0.12	-	-	0.12	-	-	-	0.37
Tunnel - Newmarket Plant Room Exterior replace	-	-	-	0.58	-	-	0.11	-	-	-	0.69

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Tunnel - Newmarket Lift replace	1.80	1.20	-	-	-	-	-	-	-	-	3.00
Tunnel – Penrose portal cable support upgrade	0.20	-	-	-	-	-	-	-	-	-	0.20
Tunnel – sump pump control system upgrade				0.12							0.12
Tunnel - Atmospheric Sensors replace	-	-	-	-	-	0.28	-	-	-	-	0.28
Tunnel – Portals fire deluge control system replace											0.00
Tunnel - Rail Track and Anchor replace	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.55
Tunnel - Newmarket Egress Ladder Compliance replace	0.23	-	-	-	-	-	-	-	-	-	0.23
Tunnel - Fire Main Valve replace	0.16	-	-	-	-	-	-	-	-	-	0.16
Tunnel - PLC Firmware upgrade	0.40	-	-	-	-	-	0.29	-	-	-	0.69
Tunnel - Airlock Security replace	0.17	-	-	-	-	-	-	-	-	-	0.17
Total	3.145	1.495	0.415	1.115	0.055	0.335	1.115	0.055	0.055	0.055	7.840

12a.7.2 LIGHTING AND EMERGENCY LIGHTING UPGRADES

Vector's design standard ESE703 Zone substation building services follow the guidelines set out by the Department of Labour and NZS 1680.2, interior lighting – recommended illuminances. The investment forecast under this item is a prioritised risk-based programme for the upgrade of normal and emergency lighting in legacy zone substations that do not comply with Vector's design standard and there is thus a risk of workplace harm due to insufficient lighting or lack of emergency lighting.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland ZSSs Lighting Upgrades	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	1.74
Northern ZSSs Lighting Upgrades	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	1.74
Total	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	0.352	3.48

12a.7.3 ZONE SUBSTATIONS CIVIL AND STRUCTURAL UPGRADES

Several ageing zone substation buildings exist in our network and although these are maintained following a rigorous and structured maintenance regime there are instances where normal maintenance is not enough to remedy larger civil and structural defects. In such cases, a capital project must be undertaken to remedy issues. Examples of larger defects are seismic non-compliance and deterioration of a building due to soil movement where structural strengthening is then required. There are also instances where deficient construction methodologies, e.g. improperly installed monolithic construction, was used in the 2000's to construct some of our substations and these now require extensive repair work beyond normal maintenance.

Furthermore, switchroom and transformer bay roofing inspections and sporadic leakages are now driving the need for a full roof replacement programme to avoid the risk of metal clad primary plant failure in switch rooms and the need to add SEPA systems to transformer bunds. This is primarily for light timber frame galvanized steel roofing. Fire walls are also programmed for FY26/27 at existing Auckland network sites to meet AS2067 industry practice.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland ZSS civil structural upgrades	0.21	0.58	1.16	0.18	0.18	0.18	0.17	0.17	0.17	0.17	3.17
Northern ZSS civil structural upgrades	0.21	0.18	0.18	0.18	0.17	0.17	0.17	0.17	0.17	0.17	1.77
Total	0.42	0.40	0.72	1.28	0.33	0.33	0.33	0.33	0.33	0.33	4.94

12a.7.4 ZONE SUBSTATIONS EARTHING UPGRADES

Vector's zone substation earthing systems must limit the touch and step potential rise that occurs in the event of a fault on their network. This is to protect visitors and workers within the zone substation as well as the nearby public outside the property. Corroded joints above and below the ground will be repaired, transferred potentials corrected, and any bonds that arise between neighbouring metal fencing and the substation fence are corrected. Considerations will also be made for any fault level change that has occurred since the earthing system was initially designed and installed during the construction of the zone substation.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland ZSS Earthing upgrades	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.25	2.32
Northern ZSS Earthing upgrades	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.25	2.32
Total	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.50	4.64

12a.8 Protection and control

12a.8.1 SIEMENS SIPROTEC NUMERICAL RELAYS REPLACE

The Siemens Siprotec 3 and first generation Siprotec4 range of numerical protection relays is the first-generation Siprotec based numerical relays installed in Vector's network starting from 1998 onwards. The expected asset life of this generation of numerical relay is ~15 to 20 years. The Siprotec 3 and 4 numerical relays are a discontinued line and replacement parts are very expensive and some parts are simply not available for this generation of numerical relays. Replacement is more economical than repair and the devices will be replaced with modern numerical relays.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Siprotec 3 and first generation Siprotec4 relays replace	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	12.0

12a.8.2 AUCKLAND AND NORTHERN ELECTRO-MECHANICAL RELAYS REPLACEMENT

Vector's population of electro-mechanical relays is around 60 years old and there remains thirty three zone substations with this type of protection relays. The electro-mechanical relay population (together with static relays – described elsewhere) is about 23% of the total relay population in Vector's network. Electro-mechanical relays, although reliable, provide only basic overcurrent and earth fault protection and has no data storage or recording ability which makes analysis of faults onerous. Furthermore, these relays are not supervised which means that if they fail none will be aware of such failure of the relay until a network fault occurs and an upstream trip is required to clear the fault: such a scenario is not tenable as it could lead to a much larger outage and commensurate high SAIDI. This population of relays also do not have the ability for definite time protection settings to be implemented which is required for increased safety of our large rural overhead networks and cannot be remotely accessed for data interrogation or to load revised settings. The electro-mechanical protection relays will be replaced with modern numerical relays.

The program below applies to zone substations where a switchgear replacement is not planned within five years. Where a switchgear replacement is scheduled within five years, a protection relay replacement will be delayed to then be undertaken in concert with the switchgear replacement project.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland electro-mechanical relays replace	0.5	0.6	0.7	0.7	0.9	0.5	0.6	0.2	0.1	0.1	5.1
Northern electro-mechanical relays replace	0.5	0.4	0.5	0.4	0.5	0.3	0.3	0.2	0.2	0.2	3.5
Total	1.0	1.0	1.2	1.0	1.4	1.0	1.0	0.4	0.3	0.3	8.6

12a.8.3 NORTHERN STATIC 1ST GENERATION NUMERICAL RELAYS REPLACE

Static (1st generation numerical) relays form about 2% of Vector's relay population. These relays were the first-generation electronic relays installed in place of electro-mechanical relays in protection schemes in Vector's network (and the world over), about 25 to 30 years ago.

Although they have added setting functionality over and above electro-mechanical relays their reliability has not been to expectation. The static relay population consists of ABB relays used for underfrequency load shedding and Micom general protection relays all in the Northern network in five zone substations namely Bush Rd, Simpson Rd, Hillcrest, Henderson Valley and East Coast Rd. Several maloperations of this type of relay have occurred. The manufacturing of static relay has halted many years ago and there is no vendor support. The relays will be replaced with modern numerical relays and the program is planned to commence in FY24.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Northern Static 1stGen Numerical Relays Replace	0.5	0.6	0.4	0.5	0.3	0.3	0.1	0.1	0.1	0.1	3.4

12a.8.4 AUCKLAND AND NORTHERN POWER QUALITY METER REPLACEMENTS

Power Quality Meters (PQM) monitor in real time the condition of the power system and analyse the power quality by an enterprise software application. PQMs locally stores reports generated by the system and makes the information available when required and monitor frequency events affecting the Vector network. PQM meters are also used to initiate interruptible load via the ripple systems to reduce peak demand.

The expected asset life for a PQM meter is ~15 years and approximately 23 have exceeded that period and the latest operating software upgrades are not compatible with these previous generations PQM meters in the network. The exact priority list for the PQM replacement is being worked through in detail and the first sites in which replacements will be undertaken in this AMP period are Rosebank ZSS, Hepburn GXP, Lichfield ZSS, Hobson 110 kV ZSS and Wellsford GXP.

The forecast below makes provision for the afore-mentioned sites and the remaining 18 (of 23) sites at which replacement will take place in the 10- year forecast period.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland PQM replacements	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Northern PQM replacements	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Total	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.0

12a.8.5 POLE TOP DEVICES CONTROLLER REPLACEMENT

The early installation of the SEL351R pole top device controller is reaching the twenty years end of life. It will be replaced with SEL651RA controller. The pole top G&W switch has twice the lifetime of the controller, therefore it doesn't need to be replaced. The program will involve replacing ten controllers per year at multiple locations starting from the oldest.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Pole Top Device Controller Replacement	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	9.5

12a.8.6 SUB-TRANSMISSION NETWORK PROTECTION REPLACEMENT

The sub-transmission network is essential to the continuity of supply. The early numerical relay installations are reaching the 20 years end of design lifetime and needs to be replaced. leaving the relay in service after reaching the design lifetime increase the risk of large scale failure. This program of work allows for the replacement of one zone substation per year starting from the oldest.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Sub-transmission network relay replace	0.5	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	15.8

12a.8.7 AUCKLAND AND NORTHERN SUBSTATION LOCAL AREA NETWORK REPLACEMENT

Vector adopted the IEC standard and internationally recognised open communications architecture that would allow different devices located within a zone substation to integrate seamlessly and communicate with the ADMS control system. The substation local area network (LAN) is based on a redundant optical ethernet architecture compliant with IEC 61850 Standards. The LAN enables the co-ordination of protection, automation, monitoring, metering and control functions using network switches and routers to the wide area network and then to the ADMS master station.

The existing Vector standard Ruggedcom RSG2100 models are restricted to a maximum number of 20 ports. These Ethernet switches do not support the latest redundancy protocols and Ethernet switches with a higher port density, could reduce the total number of switches required at a substation. The existing Cisco CGR2010 router are end of life and require replacement to maintain support. An investigation into alternatives to the Ruggedcom RSG2100 switches is on-going with the first trials expected to commence in first half of FY25.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Substation LAN replacement	0.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	4.4
Northern Substation LAN replacement	0.3	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	4.4
Total	0.60	1.40	1.20	1.00	1.00	0.70	0.70	0.70	0.7	0.70	8.70

12a.8.8 AUCKLAND AND NORTHERN RTU REPLACEMENT

The RTUs located at our zone substations provide an essential part of the ADMS system to collect status information from the site and allow remote control of the auxiliary and facilities plant at the site. The maximum anticipated life of an RTU is 20 years. As an

RTU approaches the end of life, reliability suffers, requiring more frequent maintenance. Also, older RTUs are no longer supported by suppliers and spares are difficult to get hold of. When an RTU fails, situational awareness of what is happening at the site is lost: the EOC is then unable to receive updates of events from the site or remote control equipment. Hence, the EOC controller is unable to effectively respond to any emerging contingency.

This programme of work is for the replacement of substation RTUs and distribution controllers. The substation and distribution control RTU fleets consist of a mixture of ABB RTUs for 11k V distribution switches and, GPT Plessey, Foxboro, SEL 2440 and SEL 2411 RTUs in zone substations. The first-generation Foxboro and GPT Plessey range of RTUs are no longer technically supported and production has halted a few years ago. These RTUs will be replaced.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland RTUs replace	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.50
Northern RTUs replace	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.50
Total	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	3.00

12a.8.9 AUCKLAND AND NORTHERN COMMUNICATIONS UPGRADES

The copper pilot population is 50 plus years old and is simply not suitable for the high bandwidth requirements for the energy network of the future. The copper pilot cable also has serious reliability issues and requires lengthy periods for fault finding and repair. We have embarked on a programme of works to replace the copper pilot cable fleet with fibre optic communications channels to improve reliability and resilience. This programme of work that commenced in FY18 will continue to completion. Under this provision, the network will also be thoroughly assessed to identify sites with reduced redundancy or connection points that could cause bottlenecks in the future. Chorus copper ADSL/HSNS connections will be replaced with a fibre optic equivalent.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Communications Upgrade	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	1.00
Northern Communications Upgrade	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.10	0.10	0.10	1.30
Total	0.30	0.30	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	2.30

12a.8.10 AUCKLAND AND NORTHERN COMMUNICATIONS UPGRADE IN DISTRIBUTION ASSETS

Vector has ~750 distribution switches in the Auckland and Northern networks that use cellular communications infrastructure for SCADA and engineering communications to enable remote control of the distribution switches. The distribution switches are a combination of pole top devices (e.g. reclosers, sectionalisers, disconnectors etc.) and ground mounted switches, mostly ring main units. Many of the routers have reached the end of life and low reliability and low availability are causing undue SAIDI.

Under this programme of works Sarian and Digi WR41 routers will be replaced and optimized antennae combinations will be installed. This programme of works commenced in FY22, rolled through FY23 and will continue over the AMP 2025 10 year planning period. This programme includes provision for trials and proof of concept testing of 5G based router options.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Comms Upgrade Distribution Assets	0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.15	0.16	0.17	1.2
Northern Comms Upgrade Distribution Assets	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.15	0.16	0.17	1.8
Total	0.35	0.4	0.4	0.20	0.2	0.26	0.28	0.3	0.3	0.3	3.1

12a.8.11 ARC FLASH DETECTION RETROFIT IN EXISTING SWITCHGEAR

The installation of arc-flash sensors on the inside of a switchgear panel together with an arc-flash relay can substantially reduce the amount of incident energy should an arc-flash occur, making switch rooms safer for personal to work in and visit. Early detection of arc flash also reduces the scale of collateral damage of plant. At selected sites, arc detection sensors will be installed in the cable boxes with VAMP 125 arc detection relays. Switchboards identified in Vector's ZSS switchboard replacement programme will be excluded from this programme as arc flash protection will be included in the replacement switchgear delivery scope.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Auckland Arc Detection Retrofit	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3.6
Northern Arc Detection Retrofit	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.2
Total	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	7.2

12a.8.12 AUFLS 4-BLOCK SCHEME ENABLE

The automatic under-frequency load shedding (AUFLS) scheme plays a critical role in preventing cascading asset failures on the national grid following a significant loss of generation. The Electricity Authority has amended the Electricity Industry Participation Code to enable the transition of the AUFLS provision in the North Island from a 2-block scheme to a 4-block scheme. Project expenditure will be for engaging external service providers to upgrade protection settings, prepare testing documentation and commissioning changes on site.

DESCRIPTION	FY24 $M	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	TOTAL $M
Auckland AUFLS 4 Block Scheme enable	0.8										0.8
Northern AUFLS 4 Block Scheme enable	1.0										1.0
Total	1.8										1.8

12a.8.13 SMALLER UPGRADE PROJECTS TO IMPROVE PROTECTION AND COMMUNICATIONS

The following is a summary forecast table of smaller scale projects that will be undertaken during the AMP period to improve protection, reduce the risk of spurious tripping due to mutual coupling and improve communications.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Northern Protection signalling improvement mutual coupling	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1.70
Self-powered relay replacement	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.50
Northern Extended Reserves UF Relays Install	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	1.10
Subtransmission Network Relay Replacement	0.50										0.50
Northern DMR improvements	0.04	0.14	0.10	0.08	0.08	0.05	0.05	0.05	0.05	0.05	0.69
Auckland Clock Synchronisation improvements	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.50
Northern Clock Synchronisation improvements	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	1.50
Auckland BESS Controller Standardisation and Improvement	0.12	0.12	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.66
Northern BESS Controller Standardisation and Improvement	0.13	0.13	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.69
Total	1.42	1.02	0.88	0.81	0.81	0.78	0.78	0.78	0.78	0.78	8.84

SECTION 13

Asset relocations

13 –Asset relocations

13.1 Overview

The growth and improvement of other asset types such as water infrastructure, roads infrastructure, rail, sewerage, stormwater as examples result in the relocation of Vector's assets. This Section explains our approach to relocating assets on behalf of customers, other utilities or requiring authorities and describes typical relocation works, our process for managing these works, and how they are funded.

13.2 Asset relocation requests

One of Vector's objectives when planning projects and compiling the capital budget is to identify the need to relocate Vector assets when reasonably required by third parties. Vector is obliged to relocate its assets by Sections 32, 33 and 35 of the Electricity Act 1992, Section 54 of the Government Roading Powers Act 1989 and Sections 147A and 147B of the Telecommunications Act 2001 and by the specific terms of licences or easements under Sections 34 and 35 of the New Zealand Railways Corporation Act 1981.

Relocations generally occur when infrastructure projects are initiated by road or rail corridor managers, e.g. Auckland Council or Auckland Transport (AT), New Zealand Transport Agency (NZTA) and to a lesser extent KiwiRail. Other utility providers such as Transpower, Chorus and Watercare can also initiate asset relocation projects. The process and funding of such relocation works is governed by the relevant Acts as listed above.

The timing and scope of relocation projects are driven by third parties and as a result of this Vector often has less advance notice of relocation projects and / or detailed scope compared to projects initiated from within Vector. The forecasting and timing of capital spend for relocation works are thus at a high level and preliminary in many cases. Asset relocations can vary from large extensive multi-million dollar projects to small and minor relocations such as a pole replacement.

13.3 Asset relocation growth

Long term and consistent growth in the Auckland region have resulted in an increased demand for transport corridor owner requests for asset relocations. The central rail link is a case in point where Vector assets, to the tune of millions of dollars, had to be relocated to make way for the underground rail tunnels and continues to be relocated to make way for new underground stations. Extensive motorway upgrades and new motorway projects by NZTA are continuing; the construction of bus lanes, cycle lanes and minor road upgrades by Auckland Transport continue to be requested at a consistent or growing pace; and streetscape rejuvenation by Auckland Council. These types of works generally require the relocation of Vector assets within the project footprint.

More recently, works to support the reconstruction of damaged roads and streetscapes from the January 2023 Auckland floods have caused further relocation requests.

Vector continues to liaise closely with transport corridor owners and private sub-division developers to understand the scope and timing of their future works and to look to integrate Vector initiated works where appropriate to make allowance for future grid exit points, new zone substations and transmission corridors, in alignment with our Asset Management Objectives. It is vital for Vector to understand how the corridor works and/or new subdivisions will impact on the network to ensure that we can maintain an integrated network to the satisfaction of our customers and stakeholders, while delivering on our Asset Management Objectives.

The Unitary Plan rule change (plan change 78) for urban housing intensification permits multi-level buildings up to three stories high to be constructed on standard land sections that previously contained single level dwellings set back from the road front. The permitted multiple dwellings combined with shallow yard setbacks and their increased heights are now becoming a contributor to increasing breaches of minimum distances to existing overhead lines. This in turn triggers relocations of portions of overhead power lines at the cost of developers. Vector is continuing- to engage with a number of parties to raise awareness about close approach risks, particularly working and building near the network, and to find a solution to the problem of increasing numbers of permitted development occurring in breach of safe clearances detailed in ECP 34 - New Zealand Electrical Code of Practice for Electrical Safe Distances (NZECP 34:2001).

13.4 Managing relocation works

Vector's asset relocation works are generally smaller in scale, both in terms of scope and cost, when compared to transport corridor infrastructure works (usually less than 5% of the total project cost). Relocation projects are driven by the wider civil works programme of third parties, and this can impact the timing and duration of power outages our customers experience during the relocation works due to the requirements of traffic management, road closures etc. These parameters are outside of Vector's control and if not managed carefully and in detail can introduce inefficiencies and cost to the projects.

Vector's electricity network assets are generally installed in local authority owned and managed transport corridors in accordance with the Electricity Act 1992 and the Telecommunications Act 2001. Access to NZTA's motorways and state highways are subject to the provisions of the above legislation and the Government Roading Powers Act 1989. On Kiwirail corridors, Vector is required to sign a licence agreement (Kiwirail Deed of Grant) and contribute the full cost of the relocation works plus payment of an annual fee.

13.4.1 RELOCATIONS OF VECTOR ASSETS

Where the transport corridor owner requests Vector's assets to be relocated, the cost allocation of such relocations are governed by legislation (Electricity Act 1992, Government Roading Powers Act 1989 and the Utilities Access Act 2010). In all cases, Vector pays for any betterment works if and when Vector elects to improve its assets under relocation works.

13.4.2 INFRASTRUCTURE AGREEMENTS AND SUCCESSFUL RELOCATION PROJECT OUTCOMES

The details of the Vector assets that will be relocated are recorded in Vector's standard Infrastructure Agreement. The financial contribution by the third party and any betterment costs that Vector will carry are also defined in the Infrastructure Agreement. It furthermore includes:

- an initial estimate for the cost and cost allocation of the relocation works (final cost allocation is based on the actual total cost of the works)
- a methodology of how the works will be delivered; and
- the payment of the actual costs incurred (the contribution) is undertaken at agreed milestones

Vector does not enter into agreements with the third party or corridor owner's contractors but will liaise with the contractors during the delivery of a relocation project to coordinate the works to ensure effective delivery. To ensure successful relocation project outcomes, an experienced Vector project manager is involved from the early planning stage of relocation projects and then throughout the project delivery phase. This leads to the project manager taking a proactive role in ensuring the construction contractor(s), both for the third party and Vector, pays due consideration to the key outcomes relating to the Vector activities. This is achieved through clear communication of Vector's expectations and reinforcing them throughout the project. Creating and managing the right level of communication between the corridor owner and the civil contractor/construction contractor helps to deliver the works to the agreed standard. Variations are usually initiated by the entity requesting asset relocation and are governed by a proper scope change process that involves documentation, costing and agreement between Vector and the third party.

13.5 Current project summary

Table 13-1 presents a summary of projects where relocations will be required with a value of >$1M which are either in progress or anticipated to be undertaken in the near term over the AMP period.

THIRD PARTY	DESCRIPTION
Kainga Ora Urban Rejuvenation Projects	Relocation of Vector services in the Auckland network will be undertaken in urban redevelopments in Oranga, Mangere, Tamaki and Mt Roskill In the Northern network, relocations will be undertaken in the large urban rejuvenation in Northcote
Auckland Transport (AT) and/or NZTA Projects	AUCKLAND NETWORK: • Eastern Busway (Pakuranga to Botany) construction support • Cycle lane and cycleway improvements – for example Point Chevalier-Westmere Cycleway • Bellingham Rd, Flatbush – road improvements • Relocation works for the Central Rail Link in the Auckland CBD and Mount Eden region including underground station development NORTHERN NETWORK: • O Mahurangi - Penlink Motorway construction including the new Weiti Bridge • State Highway 16 Stage 1 and 2 road improvements • Highgate Bridge improvements • Rosedale Rd, Rosedale, North Shore – busway construction
Watercare	• Central Interceptor • Herne Bay Interceptor stormwater separation works
Auckland Council Healthy Waters	• Stormwater separation projects

TABLE 13-1: CURRENT RELOCATION PROJECT SUMMARY (>$1M)

13.6 Forecast expenditure - relocations

The timing and scope of relocation projects are driven by third parties and their project timing and schedule. The initial financial forecasts are always at a high level and as the project and its design and scheduling becomes more detailed, our CAPEX forecasts will become more accurate. The expenditure profile histogram below is based on our knowledge of FY24 asset relocations projects and incorporates our best indicator of CAPEX spend for the 10 year AMP period. The initial years will have the highest level of pricing confidence but for the latter years the pricing confidence will be at a lower level of accuracy.

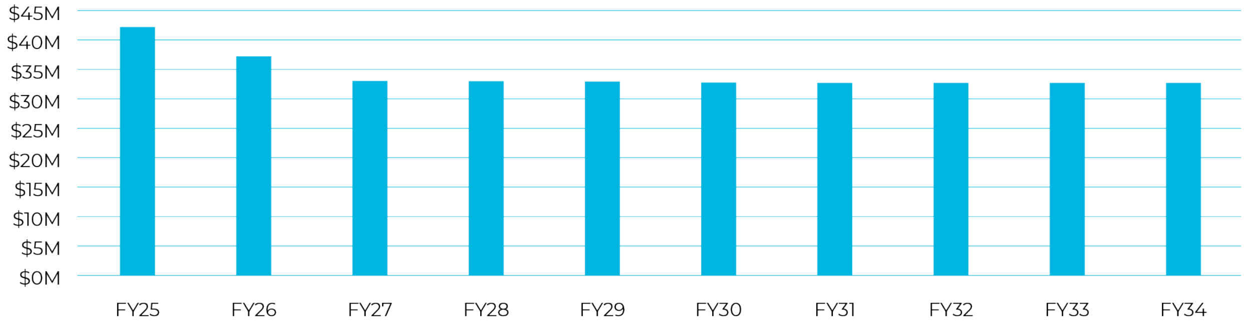


FIGURE 13.1: FORECAST EXPENDITURE - ASSET RELOCATION

SECTION 14

Non-network assets

14 –Non-network assets

14.1 Overview

As part of Vector's Symphony strategy, digital platforms and tools are critical enablers. Vector is investing in Digital capabilities to establish, operate and support these platforms given their importance to core network operations. To do this effectively, an operating model (based on standards) was established that divided the electricity distribution business into its core functions - these have been labelled Value Streams.

Value Streams have key outcomes they set out to achieve, twenty-four-month roadmaps that chart out forecasted investments, and cross functional teams that plan and execute work on a quarterly basis. The construct of these cross functional teams delivers effective solutions, as well as skilled and experienced people to operate and support the solutions once they are live. During FY24, Vector reviewed and updated the naming and structure around our electricity Value Streams, on the basis of continuous improvement around ways of working, delivery effectiveness, and ensuring we have the right capabilities in place to deliver to our Future Network Roadmap. These changes to the updated Value Streams are noted in Section 14.7.

In addition to the Value Streams and their respective roadmaps, planning has been significantly informed by the Future Network Roadmap, as outlined in Section 2. The Pathway and Planks that have been defined, have a significant basis in non-network development. As part of this, we have outlined the activities which have been identified as needing to be undertaken, on the basis of executing our Future Network Roadmap and achieving our Symphony Strategy.

In this section, we define the context for our increasing investment in Digital, our major programmes/projects, and definitions and focus areas for each of the Value Streams. As uncertainty increases the further we forecast, the Value Stream model allows us to use roadmaps to define the initial 24-36 months to some level of detail with following years indicating a level of forecasted investment by Value Stream. As roadmaps are updated, they provide increasing visibility to the latter years of the investment forecast.

14.1.1 UPDATE FROM AMP23

Our review for AMP24 sees a reflection of our continued maturation of our Cloud First strategy, responding to vendor movements towards providing Software as a Service, and refining many of our development strategies to be of a Managed Service nature rather than sole Vector asset creation.

This strategy is specifically reflected in our approach to investment associated with LV and DER Operations, and DERMS Modernisation. Previous years' AMP's had significant investment associated with these two domains, however development and assessment over recent years has yielded a revised strategy to procure and operationalise these capabilities as a Service, and hence are reflected in our Opex expenses (see Section 14.10)

Further, within Section 14.10, we note the growing sophistication around cyber activity and the corresponding growth in Cloud activity needing proportionate cyber defence coverage. Given utilities are seen as an opportune target for illegal cyber activity, Vector has provisioned to maintain the highest levels of cyber security vigilance to all forms of cyber threat.

Beyond these reflections, the core investment roadmaps for each of our Value Stream's remain valid and are largely unchanged from previous years.

14.2 Asset management objectives

The asset management objectives that are addressed through our non-network investments are set out in the table below:

FOCUS AREA	OBJECTIVES
Safety, Environment and Network Resilience	• Preventing harm to workers, contractors and the public through our work practices and assets. • Ensure health and 'safety always' is at the forefront of decision making for the business. • Comply with relevant safety and environmental legislation, regulation and planning requirements. • All staff are competent and trained in their applicable roles with the right equipment available to work safely and effectively. • Asset management activities align with environmentally responsible and sustainable behaviours, in line with industry best practice, enabling wider emissions reductions. • Minimise the impact on the environment with regards to our assets and work practices. • Proactively manage network security, which includes adequacy, reliability and resilience (including managing the growing impact of climate change).
Customers and Stakeholders	• Enable customers' future energy and technology choices. • Provide a high-quality customer service experience across all interactions. • Listen to and learn from our customers to ensure our service offering aligns with customer expectations. • Consider the impact of our operational decisions on customers and minimise the disruption of planned outages and unplanned outage response times.
Network Performance & Operations	• Comply with regulatory quality standards set out in the DPP3 Determination. • Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations. • Continual improvement of our asset management system and alignment to ISO 55001.

FOCUS AREA	OBJECTIVES
	• Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact based investment profiling. • Utilise clear business cases processes, integrate risk management and complete post investment reviews to inform our decision making and analysis. • Maintain compliance with Security of Supply Standards through risk identification and mitigation. • Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. • Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities. • Ensure continuous improvement by reviewing and investigating performance and embedding learnings. • Manage performance of field service providers through effective commercial arrangements and regular review.
Future Energy Network	• Prepare the network for future changes that will be driven by: – technology: increased active customer participation, distributed energy resource (DER) integration, DER orchestration etc. – environment: climate disruption and network resilience – customer: decarbonisation of the economy, electrification of transport, etc. – operations: transition to distribution system operator model and whole of system planning • Prioritise network flexibility to meet changing customer needs and facilitate an affordable transition to a decarbonised economy including DER orchestration through third party flex traders and retailers. • Facilitate customer adoption of new technology while ensuring a resilient and efficient network. • Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to customers and the network. • Develop digital and data platforms to meet changing customer needs and enable the future network in partnership with new entrants to the energy market. • Improve our visibility of, and ability to control, the LV network including management of the information required. • Collaborate with the industry, partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions.

TABLE 14-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

14.3 Non-network assets

14.3.1 INFORMATION SYSTEMS, PROCESSES AND DATA

Within Vector's suite of Information Systems (outlined in Section 6.6.), and the associated processes and data sources, there are a number of areas and opportunities we have identified where the use of digital technology can improve the way we plan for, monitor, control and manage our assets.

The proposed investment in the upcoming years in enabling non-network digital systems, processes and information management will ensure Vector has the capability and tools required to deliver to our Asset Management Objectives.

Section 2 outlined the Future Network Roadmap Framework, and a significant amount of effort has gone in to assessing the non-network activities required to support this strategy. Across the three Pathways identified (Network, Customer and Enabling) there are several Planks which require significant non-network investment in order to achieve the desired outcomes. The significance of and activities which are required within the relevant Planks are outlined below.

Network modernisation

- New planning tools
- DER integration headroom
- Complex operations
- Advanced asset management
- Network visibility
- Advanced analytics
- Digitalisation
- Distribution network automation

Customer DER orchestration

- Onboard organic DER capacity
- Customer-initiated DER capacity
- NWA capacity
- Commercial models
- DER orchestration capability
- DSO operating model
- Future focused pricing

Enabling policy and regulatory settings

- Secure regulatory funding
- Policy and regulatory mandates
- Defined sector roles and responsibilities
- Common DER standards and communication protocols

FIGURE 14-1: FUTURE NETWORK ROADMAP PATHWAYS

PATHWAY: NETWORK MODERNISATION

There are a number of factors which are driving a category of planning we have termed Network Modernisation. Traditional network growth, changing customer behaviours and requirements, alongside technology advances all mean Vector expects to see a significant increase in both traditional and non-traditional/new asset types forming part of the network. To effectively plan for this increasingly variable future state, dynamic planning tools must be developed and utilised, in order to help better optimise for capacity, cost, resilience and reliability. As new asset types (or devices that may connect to the network) are introduced, we need to be able to understand their impact quickly and efficiently, or to provide potential customers with toolsets in order guide their planning. We must leverage both existing and new datasets to gain new and better insights, in order to optimise asset lifecycles and ensure our capital investment is directed in the most effective way. Significant progress is underway in this area as a result of Vector's partnership with X (formerly Google X), where we are undertaking innovation and development activities relating to the development of a platform which facilitates the virtualisation and simulation across Vector's network, with a focus on expedient options analysis and ease of updating asset types and properties.

MANAGING COMPLEX OPERATIONS

As distribution technology advances, core traditional Operational Technology (OT) devices are becoming more and more digitally dependant in nature. This can be due to increased connectivity of assets and devices, increased data collection, increased security needs (or requirements), or device management at scale. These changes are causing significant convergence between OT and Digital spaces and devices.

Based on these advances, it is important that Vector more acutely accounts for this as scope and complexity of operating the network itself increases. Further non-network asset investment is required to ensure new processes and technologies are effectively and efficiently introduced and onboarded into Vector's operating systems. Non-network asset investment is required to:

- Secure and manage a greater volume and type of network devices,
- Efficiently operate the network with greater fidelity
- Incorporate increasing data into processes and tools from an increasing number of 3rd party sources
- Increasingly allow both Vector and 3rd party support entities to secure and seamless access to relevant systems and data
- Introduce and provision management of the LV network

NETWORK VISIBILITY

A key element of supporting the asset strategy is providing a complete and accurate view of the Network from as as-built and as-operated perspectives, in close to real-time. This will involve an uptake in data utilisation from pre-existing sources. Additionally, the growth in both network size and scope will require experimentation with new data sources from both the field and a significant number of external partners. This change will be particularly pronounced in the LV network as changing customer needs and the impact of DERs will require this visibility to be extended to the meter.

DER INTEGRATION

The increasing prevalence of DERs on the network mean specific focus is required in this area, notwithstanding the management and utilisation of DERs being integral to the non-network solution aspect of Vector's Symphony Strategy. The proliferation of DERs will drive changes in customer demands, increased commercial engagements, and the potential for new pricing and planning strategies. Vector systems will need to be updated and kept current to accommodate these changes prior to the real-world implementation, in order to appropriately enable smooth and effective DER integration into the Vector environment.

DIGITALISATION

Investment is required across Vector's corporate systems to accommodate the predicted changes in terms of scale. This can span the number of active devices, volume of data required to be processed and stored, number of employees or number of partners. Subsequent implications for training, onboarding, health and safety are additional examples where digitalisation is needed to keep pace with our projected rate of growth.

ADVANCED ANALYTICS

In order to keep pace with the increasing change on the horizon, a platform investment is needed in both the underlying data platform, governance and analytics capabilities. This platform will need to be able to handle the increased scale requirements resulting from both a bigger network but also the increased data from a smarter one.

APPROACH TO INVESTMENT HORIZONS

To this end, we have developed a plan with a higher degree of certainty for the first two to three years, and less specificity thereafter. In the latter years, we have less fidelity over exact projects but have proportionally projected investment levels in each of the Value Streams (key areas that define and manage the digital execution of components that make up our Electricity Distribution Business). Given the rate of change in technology, we continuously look for the optimal solution, whether this is through the use of new and emerging digital technologies or optimising existing solutions. This section is structured to reflect this, and comprised of two parts:

1. Strategic areas of focus resulting in significant projects and programme investments
2. Value Stream Need Statements outlining desired investment outcomes

For all the projects described below we looked for the optimal solution before deciding on the investment choice (and will continue to do so). Whether this is through the use of new and emerging digital technologies, or existing solutions, in all cases, we identify the solution that will deliver the best outcome for our customers.

14.4 Significant projects / programmes of work - Networks Digital

14.4.1 MANAGING COMPLEX OPERATIONS

14.4.1.1 ADVANCED DISTRIBUTION MANAGEMENT SYSTEM (ADMS): IMPLEMENTATION OF PHASE- II

Vector is focused on investing in platforms that support and improve core network operations. One of the key investments in this area is an Advanced Distribution Management System (ADMS). The core component of an ADMS, the SCADA platform, has been replaced and integrated as part of our ADMS Phase-I initiative, completed at the end of RY23. After the conclusion of Phase-I, Vector has undertaken discovery work for Phase-II prior to formally starting the Phase-II implementation, which is now scheduled for FY25.

Phase-II is focused on making sure that the data available to and generated in the field and control room can be provided in near real-time to corporate and customer systems. This will allow operators to operate the network without the need for manual processing, enabling the ability to keep customers and business stakeholders aware and informed as to the state of the network.

ADMS PHASE -II

Investment now focuses on Phase-II of this programme – establishing and integrating OMS and SOM:

- Outage Management System (OMS) – this functionality will predict the most likely fault location and provide relevant information to control room operators, to minimise response times.
- Switch Order Management (SOM) – this functionality will allow the reduction of reactive switching times through the use of what-if scenario tools and automatic safety checking. Longer term, this functionality will be used to fully autogenerate restoration switching sequences, freeing up operators to concentrate on other operational tasks.

There are several drivers and benefits to investing in an ADMS:

1. **Customer Experience**: Customers will receive reliable information regarding outages through better system integration, **automated** processes and improved data capture and validation.
2. **Safety**: Reduced risk of human error to prevent harm to people and assets through digitisation and automation of error prone manual processes
3. **Resilience**: Improved SAIDI performance through faster outage response and restoration times - including major event recovery, enabled by:

- Efficient utilisation of smart assets in the field using automated fault identification and restoration sequences.
- Supported decision making and better situational awareness in the EOC through integrated tools and automated processes.
- Increased focus on network operations by controllers through intelligent systems and system visibility drawing attention to critical issues.
- Improved prioritisation of fault restoration through real-time fault location information and crew visibility and utilisation.

4. **Reliability**: Improved SAIFI performance through use of smart field equipment via automation processes supported by enhanced asset management practices providing rich data capture.
5. **Cyber Security**: Reduced risk of cyber-attacks resulting from Operational Technology (OT) and Information Technology (IT) network convergence through utilising security by design principles enabled by a modern ADMS ecosystem.

An ADMS creates an ecosystem where DERMS combined with Outage Management and real time LV Visibility, will allow us to be able to provide better outage planning utilising DERs as well as managing peaks with DER support, thus ensuring optimal investment from traditional assets.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
ADMS Phase II	6.0	6.0									12.0

TABLE 14-2: ADMS PHASE II INVESMENT FORECAST

14.4.1.2 OPERATIONAL TECHNOLOGY (OT) CYBER SECUIRTY

The global Cyber Security landscape is changing and with it Vector's investment needs to continue to build cyber resilience, stay current and build new capability to stay ahead of the various threats acts globally. There are several macro trends that are driving Vector's need for significant investment in the OT cyber security zone including the increasing number of devices, more telemetered devices needing to be deployed on poles and a greater number of sites.

Operational information is increasingly needing to be combined with data from the field in order to enable optimal decision making in the control room. An ever-increasing scope and capability of devices coming from vendors provides opportunity to increase visibility and control however it may also increase our level of potential vulnerabilities. Supply chain vulnerabilities pose an increasing risk resulting from various geopolitical changes. And the potential for a greater capability and willingness to execute against TI infrastructure from advanced threat actors worldwide remains a pervasive risk.

These trends mean that the reliance on 'air gapping' and network level controls for security in an OT environment is no longer sufficient to keep pace. Investment needs to be made in the following technologies for anomaly detection, end point protection, device management and remote access to protect the OT Network and continuity of supply.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
OT Cyber Security	0.25	0.5	2.3	1.45	0.45	1.25	0.25	0.25	0.25	0.25	7.2

TABLE 14-3: OT CYBER SECURITY INVESTMENT FORECAST

14.4.2 NETWORK MODERNISATION

14.4.2.1 PLANNING TOOLS

In an increasingly complex and evolving environment, there is a need for a more sophisticated network planning toolset enabling a more dynamic approach. The toolset needs to deliver the capability to rapidly explore multiple investment options and optimise on key parameters to drive the desired outcomes with improved capital efficiency. An iterative and rapid exploration approach has the potential to transform the AMP process and further optimise vector's investment planning. The requirement for this is fast approaching, and Vector's planning system capability cannot continue to merely cater for the cadence of legacy demands.

As outlined in Section 10.4, Vector is in partnership with X (formerly Google X) to develop Grid Planning Tool as part of the Tapestry Platform - a platform that virtualises the network, allowing for complex simulations that can then be leveraged to rapidly test and evolve investment options to achieve the desired outcomes. The platform is a significant leap in that it brings together many disparate datasets and allows Network Planners to leverage more holistic data driven solutions.

Development of Grid Planning Tool will create a primary tool that Vector's Network Planners will use to identify constraints and explore and decide on the investments going into the AMP. The simulation capability will also be leveraged by the Network Operations team to explore options that allow maintenance work to occur with the least impact on customers and manage the load on the network.

The network of the future will be affected by trends in the market in an increasingly quicker manner. Whether due to the demand side increased customer uptake of technologies like EVs and edge generation, or improvements to distribution network technologies themselves, planning will need to become more dynamic and on a more frequent cadence. Vector has identified the need for investment in a system that will allow it quickly change assumptions in its models and base assumptions and see how they would flow and affect the network over the long term.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Dynamic Planning Tools	0.75	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.25

TABLE 14-4: PLANNING TOOL INVESTMENT FORECAST

14.4.3 NETWORK VISIBILITY

14.4.3.1 SMART METER DATA PROGRAMME

Vector has decided to develop the use of Smart Meter Data (SMD) in order to provide visibility of the LV network to enable a "single pane of glass" for Network Operations to manage the entire network. LV visibility is integral to Vector's Symphony Strategy to manage the future trends of decarbonisation, electrification of transport and climate change alongside the affordability, integrity, safety, and reliability of its electricity network. SMD is a key enabler of many of the initiatives on the Future Network Roadmap.

Following the first phase of the programme, the proposed approach is to deliver the programme in two further phases with their own strategic focus, deliverables, and associated business case. In summary the three phases are:

- Phase I (FY21-23) – Establish foundation, gain access to data, discovery & trial, minimise spend (complete)
- Phase II (FY23-25)- Scale data for whole of network view. Make the data outputs (consumption, device data, power quality) available to be operationalised in other Vector Electricity systems to drive more timely and effective decision making
- Phase III (FY26-34) – Establish near-real-time data availability across Vector system landscape as we move towards increased automation

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Smart Meter and Data Use Cases	0.35	0.35	0.35	0.35	0.35	0.35	0.35	035	0.35	0.35	3.5

TABLE 14-5: SMART METER & DATA USE CASES INVESTMENT FORECAST

14.4.3.2 GIS ELECTRIC AS-BUILTING

Currently, when changes to the network are done in the field, technicians are required to manually record changes and then records are digitally recorded in the office after the fact. This results in latency in updating information as well as increased costs and overheads. Vector will focus on capturing these changes digitally in the field as they happen. This will be the final piece of connecting or As-Designed to As-Built to As-Operated model. Keeping these models will allow Vector decision makers access to more timely and accurate information. Additionally, Vector will be able to provide customers more accurate outage information as they will be aware of changes in the Network on a daily rather than monthly cadence.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
GIS -Electronic As-Builting		1.0	1.0								2.0

TABLE 14-6: ELECRTRONIC AS-BUILT INVESTMENT FORECAST

14.5 Insights and data management

14.5.1 DATA WAREHOUSE & PLATFORM MODERNISATION

As Vector continues to ingest increased amounts of data from a greater number of sources, our underlying platform will need significant investment. This platform will need to be able to store and process an order of magnitude more data that previously required. Additionally, much data will come will limitations on who and for what purpose the data can be consumed. These constraints must follow the data as it progresses through to data analytics and systems of record. This will require a step change in our data warehousing capability. As part of our data warehousing capability, Vector has successfully trialled Snowflake as a platform which will meet these needs. This will allow Vector to maintain its governance requirements whilst simultaneously enabling the scale and performance need to maintain other initiatives. This requires an initial investment to support planning and build requirements of associated data systems, alongside the implementation of Snowflake. Subsequent investment later in the period is in order to be ready to meet the scale demands of the operational requirements.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Data Warehouse Modernisation	0.5	0.35			0.1	0.9	0.1	0.1	0.1		2.15

TABLE 14-7: DATA WAREHOUSE MODERNISATION INVESTEMENT FORECAST

14.6 Significant projects / programmes of work – Vector Group and Core Digital

The following areas have been identified as requiring capital investment over the course of the planning period, with relevant commentary around their development, maintenance and/or renewal detailed below. All investment is in line with Vector's asset replacement lifecycle processes. Other minor systems are expected to require replacement or upgrade during the planning period however their cost is not material in terms of the non-network investment forecast.

14.6.1 IT NETWORK MODERNISATION

The Vector group, like most modern organisations, relies heavily on reliable, consistent, and secure access to the internet to conduct its day-to-day operations. This is required across all devices and all office locations, with both wired and wireless connectivity a baseline expectation of employees, team members and stakeholders across the organisation. As more services continue to move to the cloud, there is an increasing need to modernise the IT network to reduce functional issues and manage security risks. This is a critical and ongoing work as the IT network is foundational to all system technologies.

The Vector Group IT Network Modernisation project includes both, the corporate IT and elements of the Electricity OT (Operational Technology) Ethernet computer networks. The functional role of these networks is to provide secure and reliable access to the internet, and effectively limit access to some areas of the network to provide redundancy and disaster recovery capability, alongside enabling the transfer of data from machine to machine both internally, and where appropriate, outside of the Vector network e.g. for Field Service Providers. Connectivity is a critical component of effectively managing and maintaining our core Network and Business operations, as losing connectivity, or having insecure access to the internet would directly impact our visibility of core network alarms and prevent us from effectively providing any services to our customers, stakeholders or businesses who rely on that connectivity.

Over the last two years significant improvements have been made in this space particularly in the replacement of all the OT Firewalls and modernisation of current network services. This area of investment continues with the next phases focusing on Network segmentation and the scaling our investment in anomaly detection and perimeter vulnerability management.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
IT Network Modernisation	1.6	0.6	0.6	0.43	0.2	3.0	0.6	0.6	0.6	0.6	8.8

TABLE 14-8: IT NETWORK MODERNISATION INVESTMENT FORECAST

14.6.2 ERP MODERNISATION – SAP UPGRADE

Vector uses SAP for several critical functions; from it being our financial system of record to being used for core asset management, material management, project systems, sales and distribution and HR. In recent years this system has become central to the electricity business in that it receives all the maintenance records from our field service providers. This has provided us with greater visibility over asset health and has enabled us to be more proactive in our asset management capabilities.

Vector's SAP implementation is running ECC. Although Vector has kept ECC patched and running up to date, the product is approaching end of life. An upgrade is a significant undertaking which will require multiple years for execution. Vector is likely to upgrade from EC to S4 / HANA by 2027.

This upgrade needs to be made in a manner to allow Vector to pursue a conditional based model for Asset Management across a significantly expanding number of assets. The demand in scale is driven not just by an expansion of network capacity but also by the number of new assets that will need to be tracked in order to meet the needs of network visibility. ERP (Enterprise Resource Planning) modernisation and transformation will enable automation and scalability of the Risk Based Approach described in Section 8.5.2.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
ERP Transformation	5.0	7.0	7.0								19.0

TABLE 14-9: SAP UPGRADE INVESTMENT FORECAST

14.6.3 CLOUD MIGRATION

With the rapid evolution of cloud services, and the inherent advantages of automated scaling, reduced operational cost and significantly improved resilience and recovery, there is an ongoing need to move towards cloud-based infrastructure.

Cloud technologies directly support the achievement of our Asset Management Objectives through improved capability (e.g. for data storage and backup), enable enhanced data analytics and simplify the digital technology infrastructure at a more efficient cost.

More importantly, the migration of applications and infrastructure to cloud first technologies also provides enhanced capabilities to capture and consume the increasing amount of data that is being generated and used across the network, and then better utilise this data in near real time to make accurate, relevant and timely decisions. Increasing penetration of DERs, investments in technology at the grid edge, increasing scale of microgrid deployments, distributed control of network assets all require significant connectivity with an associated demand on computing power – cloud first technologies provide this computing power at scale at a significantly lower cost per unit than on-premise and datacentre infrastructure.

Investment in cloud migration continues alongside the move of our Data Centre move and is core to its timely completion.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Cloud Migration	0.38	0.38	0.38								1.14

TABLE 14-10: CLOUD MIGRATION INVESTMENT FORECAST

14.6.4 DATA CENTRE TRANSFORMATION

Vector has vacated its office working space in CGR101 and moved to a new building, CGR110.. Leaving CGR101 means that we must relocate our primary datacentre (decoupled from the office move), which is provides critical services to Electricity, Fibre and Corporate operations. The need to relocate provides an opportunity to modernise what was a 30yr old datacentre, improve Disaster Recovery capability and the remediation of technical debt that exists in such an aged facility. Further to the CGR101 data centre relocation, Vector will also consolidate the rack space, compute capability, and storage hosted in the Orbit Drive Datacentre, in order to optimise on-going datacentre operational cost.

The key outcomes, based on future proofing the user experience through new technology, to be addressed by this programme are as follows:

- CGR101 DC evacuation and migration by Oct 2024 to a new facility that is highly resilient and managed
- Address and simplify the amalgamation of services by following good architecture practices and documenting the as-built state
- Address operational risk by building a disaster recovery capability with a documented failover plan for the services which require DR
- Repurpose existing hardware in warranty & acquire minimal new equipment to ensure a sustainable asset lifecycle exists for all services and longevity of rebuild investment
- Migrate services to the cloud as a 'cloud first' principle to reduce the burden of maintaining physical infrastructure & mitigate hardware out of warranty

This program will be supported by the cloud migration and infrastructure lifecycle management work also underway.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Datacentre Transformation	3.5	0.4	0.9								4.8

TABLE 14-11: DATACENTRE TRANSFORMATION INVESTMENT FORECAST

14.6.5 IT INFRASTRUCTURE LIFECYCLE MANAGEMENT

Vector operates significant and complex compute, network and storage infrastructure and architectures across both Information Technology (IT) and Operational Technology (OT) environments. These environments require significant ongoing investment to maintain infrastructure at vendor supported levels to meet best practice performance and security requirements.

Vector is continuously developing refreshed compute, network and storage operating model and capabilities which will support the Group, Business and Digital operations to achieve Vector's strategy and vision. All investment in this area is aligned with each asset's lifecycle. Effective lifecycle management of digital assets improves Vector's ability to its Asset Management Objectives.

Within the IT infrastructure lifecycle management program there is a focus on continuous improvement and not creating technical debt, these principles are enabled by clear business strategies and supported by 24 month rolling roadmaps that allow Vector Digital to make the right infrastructure investment decisions to support Vectors need to scale and automate as effectively as possible.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
IT Infrastructure Lifecycle Mgmt.	1.9	1.3	1.3	1.3	1.3	1.3	1.0	1.0	1.0	2.0	13.4

TABLE 14-12: IT INFRASTRUCURE LIFECYCLE MANAGEMENT INVESTMENT FORECAST

14.7 Value Stream needs statements – Networks Digital

Please note the Value Stream investment breakdowns below include the projects detailed above.

14.7.1 CUSTOMER OPERATIONS

The Customer Operations Value Stream sole focus is to ensure that customers have a great experience whenever they engage with Vector. The investment is focused on new capabilities to serve customers increased and changing needs, alongside continuous improvement based on customer feedback. All projects in this value stream include customer research and customer testing to ensure that the solutions we provide to customers are fit for purpose and deliver a great experience.

Vector continues to invest in designing experiences that allow for richer and more informative interactions during outages. Development of Vector's Outage Centre has allowed customers to directly and more easily interact with Vector to report outages and receive ongoing information on the progress of resolving outages. Additionally, customers are able to get information on planned outages so they can plan and minimise the impact to their lives.

Vector continues to invest in improving the Outage Centre experience while transitioning to a strong focus on self-service for customers. This shift is driven by the customers' desire for customers to have more channel choice and control as they take on and manage products and services from Vector. Self-service platforms also form the foundation for the scalability which will be required to cater for the increased types and volumes of interactions that we anticipate over time.

Specific projects included in this investment category include continuous improvements in Vector's Outage Centre based on customer feedback, self-service for customers with an initial focus on connections, disconnections, and alterations, alongside continued investment in new and existing customer channels for support, for example via webchat and pro-active SMS notifications. Further, the expected investment in foundational capability required over time is reflected in the outer years, where there is recognition that as customers' requirements to change, Vector's service mix must also evolve to meet them. Based on this. there are allowances for both back-office systems and front end development – including a review of our Customer Relationship Management system (CRM), with upgrade or replacement provisioned for in FY's 27 and 28 - aimed at catering for and responding to changing customer behaviour, as well as enabling Vector to undertake demand response type activity with direct customer engagement.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Customer Operations	2.4	3.4	4.7	4.7	2.0	1.4	2.0	1.4	1.4	1.6	24.7

TABLE 14-13: CUSTOMER OPERATIONS INVESTMENT FORECAST

14.7.2 NETWORK OPERATIONS

Network operations investment is targeted at ensuring we operate a consistent, reliable, and resilient supply across the network, and the digital capabilities required to support the achievement of this. The network operations domain includes multiple categories and functions which are required to support the execution and management of a distribution network in the future.

The focus of this investment category in the early years of the period is on development of fit for purpose capability to enable enhanced control room functions, with increasing capability in operational management of outage events across their lifecycle, including significant events. In parallel, there is capability growth associated with meeting the changing customer expectations for electricity, including increased EV and smart device penetration. Examples of specific initiatives categorised here include fault location detection, weather monitoring and the potential impact on the network, further ADMS enhancements such as mobile field switching, etc.

Scalability across all functions of Network Operations is once again key to ensuring our both our Asset Management Objectives (and in particular, the Future Energy Network aspect) are achieved. As the number of assets on the network grows, alongside customer connections, proliferation of DERs, the opportunity for more active management of the LV network, all the while meeting the expectations of customers, means managing complex operations becomes a core tenet of our investment roadmap.

As we move to the second phase of our ADMS implementation (with Phase 1 – replacement of SCADA - being completed in RY23), investment now focuses on implementation of OMS and SOM, and integrating these processes in order to achieve operational efficiency and enhanced customer experience.

Further to managing complex operations, inhouse capability to assist in delivering effective and efficient field services is critical to improving capability to meet customer needs. In line with this there is investment and initiatives covering aspects such as permit management, scheduling and notification of planned works, field crew loading analysis and work order scheduling.

The Network Operations digital investment category targets both specific projects and expected investment in required capabilities to enable enhanced network performance, and ensures that we deliver effective, resilient and reliable services.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Network Operations	12.0	20.5	11.9	6.4	8.4	7.0	4.7	6.7	12.2	4.7	94.4

TABLE 14-14: NETWORK OPERATIONS INVESTMENT FORECAST

14.7.3 NETWORK PROCURE & CONSTRUCT

Network Construction and Design investment is targeted at ensuring consistent and reliable ways of running network projects (e.g. growth and asset replacement). The digital capabilities required to support achievement of this are, a state-of-the-art portfolio management system, drawing management system and associated processes. Based on the required capital investment for network build, a particular focus of this Value Stream is optimising Inventory Management processes, in order to enhance and maximise efficiency when executing capital projects. The network construction and design domain includes multiple categories and functions which are required to support the execution and management of a growing and enhancing Vector's distribution network in the future.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Construction and Design	1.2	0.75	0.3	1.3	1.3	0.8	0.3	0.3	0.3	0.3	8.0

TABLE 14-15: NETWORK CONSTRUCTION AND DESIGN INVESTMENT FORECAST

14.7.4 NETWORK VISIBILITY

The Network Visibility Value Stream (previously Records and Information Management) ensures that decision makers across the business have easy access to well structured, integrated and high-quality data to optimise operational processes, ensure regulatory compliance and support more advanced analytics capabilities.

The focus of investment has been on ensuring primary network information systems and data sets are in place to support fundamental network processes, and a single version or systems of records. In addition, the focus is on improved tools and data sources for data exploration and use and laying foundations for the requisite administration and management of data required for both core business data systems and LV network data management. Example of this are Asset management systems integration, BI platform enhancements for SAIDI and SAIFI tracking and DDA data management.

Previous years' work has seen significant progress on the acquisition and processing of Smart Meter Data sets – a key enabling component across the Value Stream, but also outcomes embedded within other Value Streams (e.g. Network Operations, Customer Operations and Network Planning & Performance). Investment in the near term is focussed on operationalising these datasets and realising value from the initial use-cases, alongside the mid-term of enhancing planning and operations by helping facilitate LV Visibility.

We have developed in-house capabilities to support strong information management practices across the business, and these include a team for data quality management, development of data standards, and data governance.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Records and Information Management	5.5	4.5	3.31	2.2	3	2.8	2.8	3.8	2.7	2.0	32.6

TABLE 14-16: RECORDS AND INFORMATION MANAGEMENT INVESTMENT FORECAST

14.7.5 NETWORK PLANNING & PERFORMANCE

Network Planning and Performance covers the domains to two previous Value Streams – Network Planning, and Maintenance and Asset Management. Investment is targeted at ensuring we have the digital capabilities to support a consistent, reliable, and resilient supply across the network. The network planning and performance domain includes multiple categories and functions which are required to support the planning, execution and management of a distribution network in the future. The focus of this investment category in the early years of the period is on enhancing Vector's symphony modelling capability to better understand the impact of DERs on the network, alongside initial targeted DER Management applications. In parallel, there is capability growth associated with meeting the changing customer expectations for electricity, including increased EV and smart device penetration and how customers can play a more active role in the electricity value chain.

The ability to perform Dynamic Planning forms a key pillar of achieving our Asset Management Objectives, and Symphony goals. Vector continues in a partnership with X (Google X) to develop a platform which looks to facilitate virtualisation, simulation and orchestration across the network using both existing and new datasets, leveraging AI and ML capabilities to assist in performing expedient analysis based on changing inputs, provide a greater breadth of options analysis.

We are also working to improve our understanding of LV network performance (LV visibility). To achieve these outcomes, Vector will put a focus on:

- Increased network monitoring to enable real-time modelling. Successful implementation may lead to the use of dynamic ratings to increase network utilisation without breaching equipment ratings, alongside new simulation capability. This is ultimately both a planning and operations tool.
- Improvements and simplification of the method to calculate the spare capacity on the distribution network to enable more efficient use of the network distribution assets and ultimately capex investment.
- Implementing a platform for managing those field devices that need to be managed, for both energy injection (e.g. solar/PV, batteries) and energy offset devices (e.g. HWLC, smart charging and implementation of Dynamic Operating Envelopes for specific customers).
- Increased demand and voltage monitoring capability of the LV network. Current practices of installing short-term dataloggers is inadequate as it still requires an estimate of peak demand. 24/7 monitoring is required together with efficient data management.

In addition, key drivers in this stream are to get better visibility of maintenance activities and their results, to improve asset management capabilities around total cost of ownership (TCO) and Asset Risk Management. As outlined in Section 14.7.2 SAP-PM has become central to the electricity business in that it receives all the maintenance records from our field service providers, providing significantly greater visibility over asset health, and has enabled us to be more proactive in our asset management capabilities

The investment strategy for these key systems will be anchored in further developing the plant maintenance module of SAP (SAP-PM) alongside the upgrade of this platform. The benefits of this include providing operational history, allowing planned and corrective maintenance activities to be monitored and updated, incorporating a record of financial costs and equipping FSPs with access to a fully mobile information system at each work site. With the foundational improvements made to standardise asset information completed, Vector continues to leverage new technologies making it more efficient to collect asset information, plan maintenance work and further optimise the execution of maintenance work to reduce outages.

The Network Planning & Performance digital investment category targets both specific projects and expected investment in required capabilities to enable enhanced network performance and ensures that we deliver effective and resilient services.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Network Planning & Performance	2.1	2.0	1.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	10.9

TABLE 14-17: NETWORK PLANNING & PERFORMANCE INVESTMENT FORECAST

14.8 Value Stream needs statements – Core Digital

14.8.1 CORPORATE

The Corporate Value Stream ensures that the appropriate systems and tools are in place for the corporate functions of Vector to function effectively. Investments are focused to establish and support tools for functions such as Finance, Regulatory, Marketing and Communications, Legal and Risk.

The most significant area of Investment in the upcoming years is the modernisation of Vector ERP system, as documented above. Other areas of focus continue to be payroll, document management and customer communication tools.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Corporate	6.3	10.5	11.4	4.4	4.1	3.1	3.1	4.2	1.7	1.7	50.5

TABLE 14-18: CORPORATE INVESTMENT FORECAST

14.8.2 EMPLOYEE EXPERIENCE / DIGITAL WORKPLACE SERVICES

The Employee Experience Value Stream focuses on two main areas, ensuring that Vector employees are equipped and mobilised to fully engage and perform their roles effectively and the lifecycle of an employee at Vector from Onboarding, to learning, leadership, performance management, employee engagement and offboarding This includes having the appropriate devices, connectivity, IT support that allows for independent and collaborative work, along with the supporting mechanisms that encourage an engaged workforce.

With the need for increased flexible working scenarios there continues to be investment in Digital tools to support collaboration and dispersed workforces with a focus on security and user experience We continue to operate in a tight labour market and need to attract and retain talent, this means we are focusing investment in the area of automation of the lifecycle of an employee and staff learning and engagement.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Employee Experience	1.4	1.7	1.6	1.5	1.6	1.6	1.6	1.7	1.6	1.7	16.0

TABLE 14-19: EMPLOYEE EXPERIENCE INVESTMENT FORECAST

14.8.3 DIGITAL SERVICES PROVIDER

The focus for this portfolio of Value Streams is to drive better efficiency and effectiveness by establishing consistent digital toolsets and core platform components that all digital solutions can leverage. The outputs are consumed by all Value Streams thus avoiding duplication and the standardisation leads to more efficiency in the operation and support of our Digital ecosystem.

There are three Value Streams within this portfolio:

Shared Tools and Services: Manage and operationalize standardized digital tools

Site Reliability: Provide Value Streams with the ability to build and operate scalable and highly reliable digital solutions

Networking and Security: Provide a secure and scalable IT network to protect against cyber security threats.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Digital Services	6.2	2.8	2.5	1.6	2.3	2.6	1.5	2	1.4	2.4	25.3

TABLE 14-20: DIGITAL SERVICES PROVIDER

14.9 Non-network property

Non-network Property and Leases CAPEX provides accommodation required to ensure the network business can operate as an effective, well-governed business. The networks business benefits from economies of scale with Vector providing shared accommodation across its group of regulated and non-regulated businesses. In addition to accommodation these values reflect warehousing arrangements and Right of Use (ROU) lease assets specific to the Networks business.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
Non-network Property and Leases	2.5	7.9	2.1	2.8	2.7	2.7	7.7	7.6	7.7	25.4	64.1

TABLE 14-21: NON-NETWORK PROPERTY INVESTMENT FORECAST

14.10 Non-network OPEX

Total non-network OPEX is projected to be $1,354 million over the 10-year AMP planning period.

- Expenditure on System Operations and Network support is forecasted to be $691 million for the period FY25-FY34. This expenditure line item captures direct system and network support costs that are required to deliver on the capex and maintenance plans.
- The above expenditure also includes a share of expenditure related to the resource shared between Vector's Electricity and Gas Distribution businesses.
- Business Support expenditure is forecasted to be $662 million over the AMP planning period. Business Support expenditure includes a share of health and safety, public policy & regulatory, legal & risk management, finance, human resources, digital and

marketing costs incurred at Vector Group level. The Electricity Distribution business benefits from economies of scale with Vector providing shared support across its group of businesses.

- Drivers for the change in expenditure for AMP24 are attributed to continued migration to Software as a Service and Cyber Security expenses. Our loud first strategy has ensured that our business is equipped to meet the vendor trend to SaaS. However, implementing our capability and moving to a SaaS acquisition model has shifted this burden of our enabling digital software into Opex at an accelerating rate.
- The increase in cyber costs is related to both the growing sophistication of cyber activity and the growth in Cloud based activity needing cyber defence coverage. Given utilities are seen as an opportune target for illegal cyber activity, the business needs to maintain the highest levels of cyber security vigilance to all forms of cyber threat.

DESCRIPTION	FY25 $M	FY26 $M	FY27 $M	FY28 $M	FY29 $M	FY30 $M	FY31 $M	FY32 $M	FY33 $M	FY34 $M	TOTAL $M
System operations and network support	57.6	61.3	63.2	65.4	67.3	70.2	72.5	75.1	77.6	80.9	691.0
Business Support	59.1	60.9	62.3	63.9	65.4	66.8	68.4	70..1	71.9	73.7	662.5

TABLE 14-22: NON-NETWORK OPEX (FINANCIAL YEAR, $'000 NOMINAL)

14.11 Expenditure forecast –Non-Network CAPEX

Figure 14-2 presents the total non-network CAPEX forecast expenditure for the 10-year planning period.

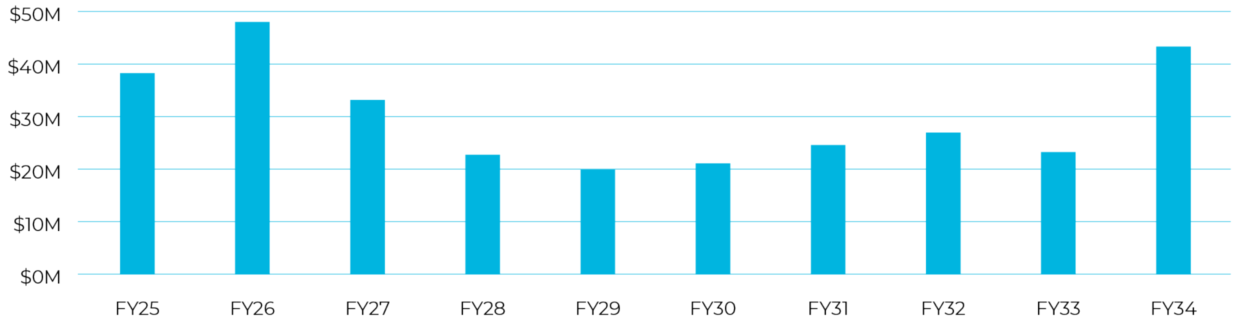


FIGURE 14-2: NON-NETWORK CAPEX

SECTION 15

Expenditure forecast

15 –Expenditure forecast

15.1 Overview

This section describes the CAPEX and OPEX forecasts for the electricity distribution network assets for the next 10-year planning period based on the investment proposals outlined in Sections 8 to 14. It includes context for key assumptions and provides a high-level comparison with the forecast included in the 2023 AMP (disclosed in May 2023).

The CAPEX and OPEX forecasts presented in this section align with Vector's planning process and financial year (FY) reporting period 1 July to 30 June. All figures presented are in 2024 dollars. The regulatory disclosure forecast, shown in Appendix 6 and Appendix 7, are presented in regulatory year (RY) 1 April to 31 March, in both constant and nominal dollars, as per the Information Disclosure requirements.

15.2 CAPEX forecast

The forecast CAPEX during the next 10-year planning period is presented below, based on our key asset management strategies, demand modelling and customer information available. These are grouped in the following categories:

- **Growth CAPEX** – detail discussed in Sections 9, 10 and 13, and includes Customer Connection, System Growth and Relocations.
- **Integrity CAPEX** – detail discussed in Sections 11 and 12, and includes Asset Replacement and Renewal, and Reliability, Safety and Environment.
- **Non-network CAPEX** – detail discussed in Section 14.

Note all CAPEX figures shown here are gross.

15.2.1 TOTAL CAPEX

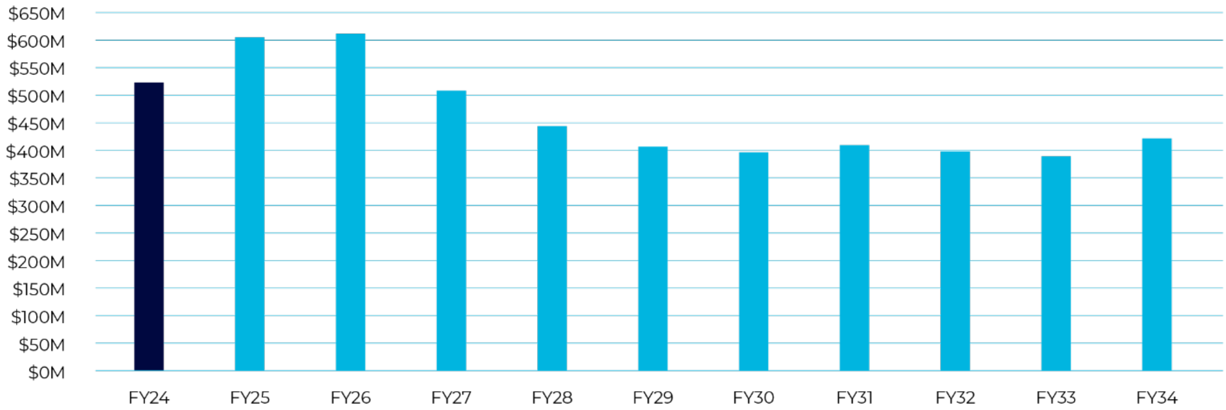


FIGURE 15.1: TOTAL CAPEX

Total CAPEX averages $458m p.a. with the expenditure profile reflecting the growth and integrity forecast (see detail in the following sections), which are punctuated by large significant projects for which there is more certainty in the short term. The higher gross expenditure in FY25 to FY26 is driven by increased customer connections expenditure and associated system reinforcement requirements, as well as a large number of primary asset replacement projects planned during this period. The expenditure profile also aligns with network technology initiatives including ADMS Phase II implementation, data centre transformation, cyber and platform lifecycle management initiatives including Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) reviews and/or upgrades.

15.2.2 GROWTH CAPEX

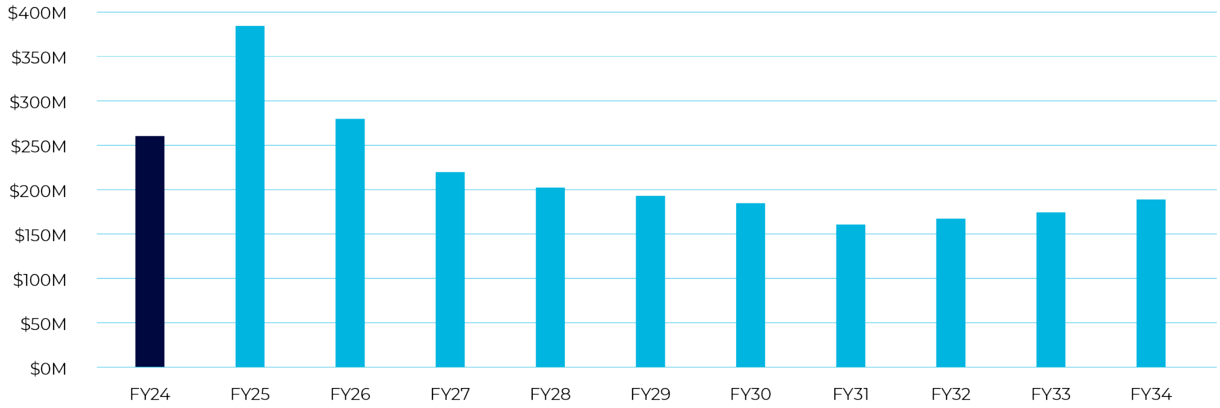


FIGURE 15.2: GROWTH CAPEX

The expenditure profile for Growth CAPEX is influenced by the timing of significant projects with large capital outlay. The higher spend in FY25 and FY26 is driven by several large customer connections and network capacity investments including nine data centres, ten transport electrification projects and three large developments in CBD. The key reinforcement projects include five new zone substations, one zone substation upgrade, 5 significant cable projects as well as provision for seven land purchases.

The expenditure level from FY27 onwards averages circa $185m, reducing from an average of $210m in the previous AMP, reflecting the reduced investment in EV capacity related projects due to uncertainty on the continuation of an accelerated growth path, and recategorization of projects (see section 15.3 for detail) from System growth to Asset Integrity capex to better align with the nature of the investment.

15.2.3 INTEGRITY CAPEX

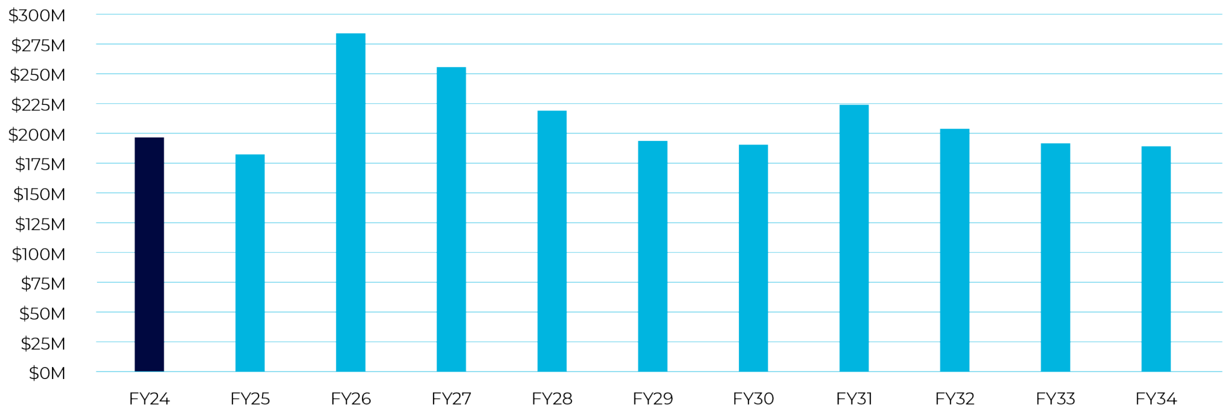


FIGURE 15.3: INTEGRITY CAPEX

The Asset Integrity expenditure is lower in FY24 and FY25 due to previously planned projects for this period being proactively brought forward to FY23 to mitigate the risk of project slippage resulting from supply chain delays and labour resourcing shortages that have increased since 2020. The expenditure in FY26 and FY27 is higher due to several significant primary asset replacements including 16 transformer replacements, 7 switchboard replacements and 5 sub-transmission cable replacement projects, as well as provision for storm related remediation cost and flooding mitigation initiatives.

Integrity expenditure from FY28 onwards averages circa $200m p.a. and is slightly higher than the previous AMP ($187m) with increased investment in primary assets that is partially offset by the removal of climate related network hardening initiatives forecast in last year's AMP.

15.2.4 NON-NETWORK DIGITAL CAPEX

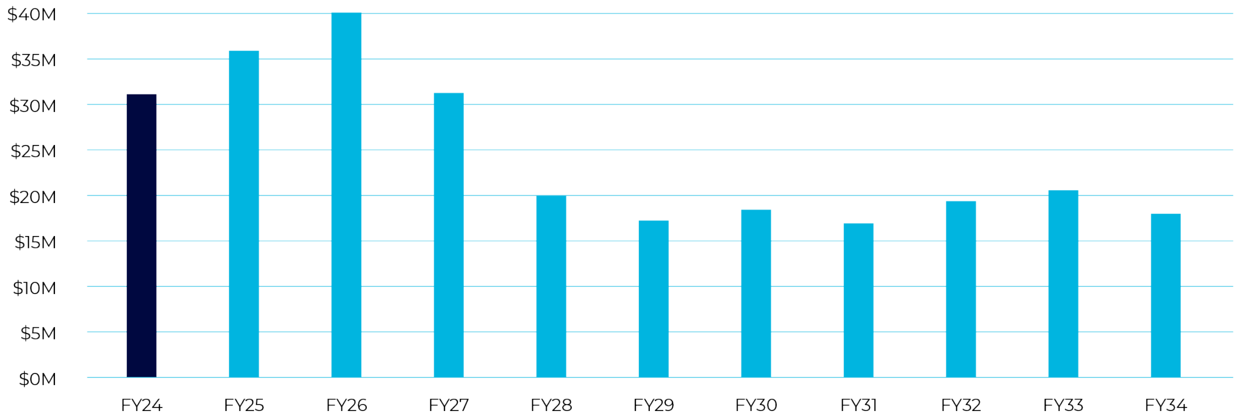


FIGURE 15.4: NON-NETWORK DIGITAL CAPEX

Digital investments support the technology required to execute our Symphony strategy. The proposed investment in the upcoming years in non-network digital systems, processes and information management will ensure Vector has the capability and tools required to deliver on our Asset Management Objectives. The focus in the near term (FY24-25) is building on the foundation delivered by the ADMS Phase I programme of work and beginning Vector's ERP transformation (FY24-27). The investment in ERP transformation and electricity growth enablement technologies will leverage modern automation and toolsets to support a scaled operation beyond 2030. Throughout the AMP period we continue to invest in a modernised network and lifecycle management that will both replace aged platforms and leverage new technology delivered by modernised systems.

15.2.5 NON-NETWORK PROPERTY AND LEASES

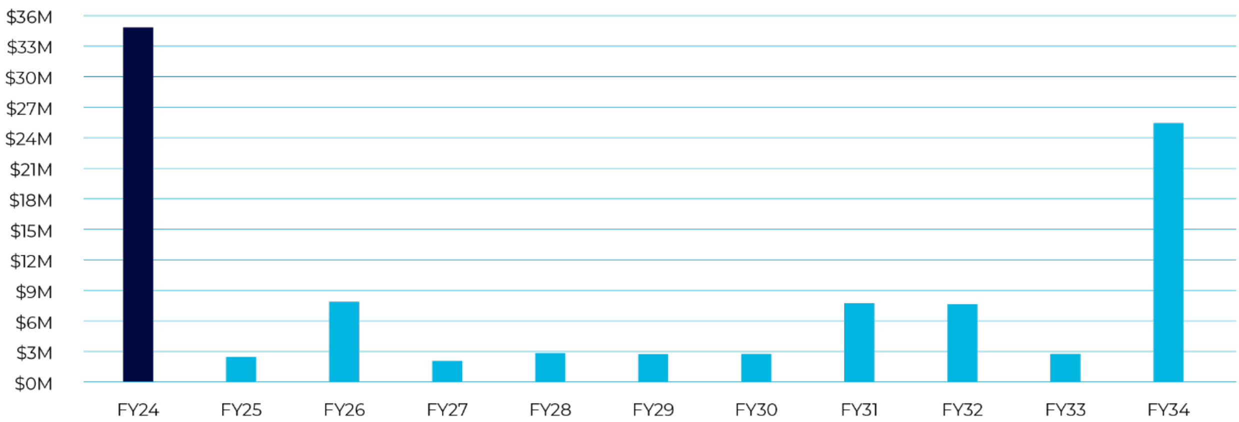


FIGURE 15.5: NON-NETWORK PROPERTY AND LEASES

Changes to the Head Office lease drive the increase in CAPEX in FY24 and the increased longer term warehousing arrangements to mitigate supply chain risk renew in FY34.

15.3 CAPEX forecast variance to previous AMP

The forecast CAPEX during the next 10-year planning period is broken down into the key asset categories defined in the Commerce Commission's Electricity Distribution Information Disclosure Amendments Determination 2012 (shown in Table 15-1).

Figure 15-6 shows the difference between the 2024- and 2023-AMP expenditure forecasts year on year, with Table 15-2 breaking down the variance by expenditure categories.

KEY CAPEX CATEGORIES	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	TOTAL (FY25-34)
Consumer connection	219,322	140,311	108,602	90,849	88,752	88,780	81,814	81,923	81,923	81,923	**1,064,201**
System growth	122,201	101,632	77,454	77,931	70,782	62,629	45,721	52,089	59,315	73,751	**743,506**
Asset relocations	42,212	37,244	33,052	32,974	32,932	32,776	32,726	32,726	32,726	32,726	**342,095**
Asset replacement and renewal	116,745	202,377	197,443	157,287	140,698	137,687	167,644	148,303	137,144	135,712	**1,541,039**
Reliability, safety and environment	65,160	80,852	57,464	61,149	52,818	52,275	55,819	55,004	53,970	52,862	**587,373**
Non-network assets	38,269	48,029	33,169	22,736	19,894	21,124	24,586	26,948	23,258	43,322	**301,335**
Total CAPEX	**603,910**	**610,444**	**507,183**	**442,927**	**405,876**	**395,271**	**408,310**	**396,995**	**388,337**	**420,297**	**4,579,549**

TABLE 15-1: AMP 2024 CAPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY24)

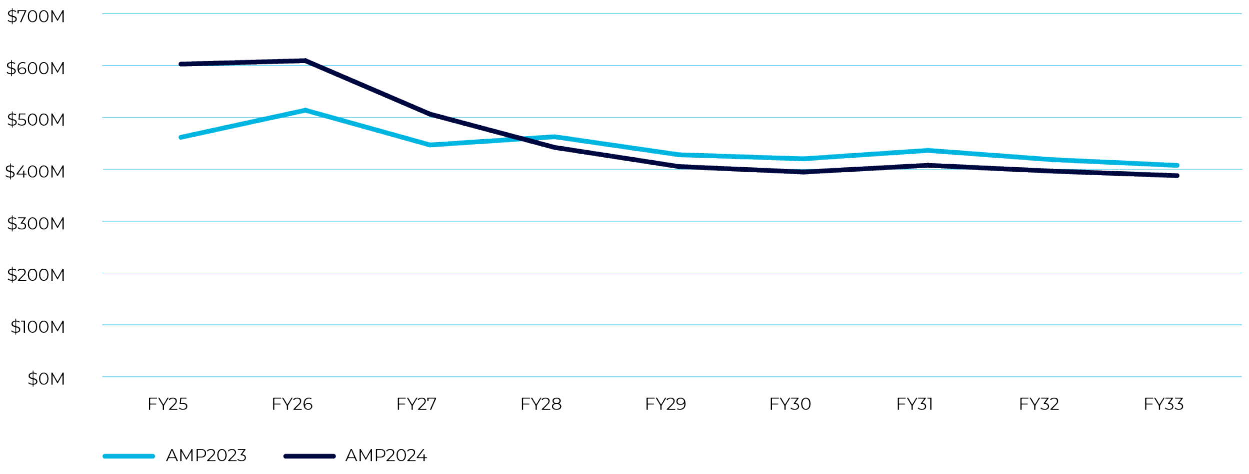


FIGURE 15.6: AMP 2024 VARIANCE TO AMP 2023 CAPEX FORECAST (FINANCIAL YEAR, $M CONSTANT FY24)

KEY CAPEX CATEGORIES	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	TOTAL (FY25-33)
Consumer connection	66,560	42,909	14,050	8,119	5,004	5,032	3,463	3,573	3,573	**152,283**
System growth	22,820	893	9,395	(35,333)	(23,113)	(30,690)	(62,530)	(48,835)	(22,811)	**(190,206)**
Asset relocation	3,524	2,055	(4,893)	(1,843)	(1,885)	(2,041)	(2,091)	(2,091)	(2,091)	**(11,355)**
Asset replacement and renewal	26,096	48,598	65,612	29,728	24,516	24,702	52,863	41,999	25,617	**339,731**
Reliability, safety and environment	17,706	(1,419)	(20,230)	(14,868)	(19,768)	(19,972)	(15,924)	(15,661)	(15,812)	**(105,948)**
Non-network assets	4,790	2,682	(4,363)	(6,386)	(7,564)	(2,641)	(4,555)	(1,152)	(8,324)	**(27,513)**
Total CAPEX	**141,496**	**95,718**	**59,571**	**(20,583)**	**(22,810)**	**(25,609)**	**(28,774)**	**(22,167)**	**(19,849)**	**156,992**

TABLE 15-2: AMP 2024 VARIANCE TO AMP2023 CAPEX FORECAST TABLE (FINANCIAL YEAR, $'000 CONSTANT FY24)

15.3.1 EXPLANATION OF MAJOR NETWORK CAPEX VARIANCES

Key changes in Network CAPEX over the 9 years for which the 2023 AMP and 2024 AMP overlap are as follows:

- A significant increase in customer connection gross expenditure driven by higher large customer dedicated network investments ($81m) primarily relating to data centres ($49m), e-transport infrastructure ($36m) and development in downtown Auckland ($13m), as well as higher forecast residential subdivision and connections ($50m)
- System growth forecast has reduced by $190m largely due to key drivers below:
  - A reduced investment associated with EV demand due to high uncertainty with the trend of an accelerated EV uptake ($60m).
  - Recategorisation of power transformer upgrade projects provisioned in AMP23 that are driven by improved asset health condition assessment information to asset replacement and renewal to better align with expenditure categories ($50m).
  - Vector has consolidated its planned investment in the integration of demand side load control capabilities to closer align to our view on the inherent uncertainty in demand profiles, impact of regulatory settings, and the roles and responsibilities of third-party agents in enabling the demand-side management ($20m).

- A review of expenditure of Distributed Energy Resources (DER) and load control integration under this category concluded that these projects are more closely aligned to the Reliability, Safety and Environmental investment and has subsequently been re-categorised and reduced in AMP24 ($29m).
- A third Waiheke cable is planned to improve resilience and reliability due to the two existing submarine cable circuits being located adjacent to each other without mechanical protection. The project is more closely aligned to the Reliability, Safety and Environmental investment and has subsequently been re-categorised from System Growth ($8m).
- A lower forecast for residential and small commercial LV transformers upgrades ($18m) and consolidation in demand load control capabilities ($20m).

- Asset replacement expenditure has increased by $340m compared to last year's AMP as a result of the following:
  - Increased primary asset replacement including zone substation transformers ($156m, including projects recategorized from system growth), switchgear ($13m) and sub-transmission cables ($42m) due to updated asset condition and criticality assessment (see section 12 for further details)
  - Increase in reactive expenditure forecast ($71m) driven by higher operating cost that are attributed to the increasing number of significant adverse weather events, amendments in regulations (traffic management and new national biodiversity policy) and the impact of cost pressures.
  - Corrective expenditure has increased ($18m) as part of the continuous improvement to address high priority asset notifications (see 8 for further details).
  - Additional provision for ring main unit replacement ($18m) reflecting RMU replacement within the Auckland CBD where site access constraints and business interruptions incur significant project complexity and cost.
  - A $12m increase in overhead expenditure to accelerate replacement of softwood poles that are deemed unsafe to climb - leading to extended outage periods due to complete pole replacement being required under reactive restoration works.
  - A new program has been introduced to replace end-of-life controllers for our recloser assets ($11m) that will no longer be supported by the manufacturer.
- The timing of asset relocation projects is dictated by third party projects. The expenditure forecast largely aligns with the previous AMP, with the updated long-term forecast based on historical expenditure that results in a small reduction in forecast over the 9-year period (-$11m).
- Forecast investment in Reliability, safety and environment has reduced by $106m due to the factors below:
  - Removal of resilience provision in last year's AMP to improve network adaption to climate change (-$188m) pending the regulatory settings around financeability and other policy decisions such as tree regulations.
  - An increase investment in distribution overheard conductor circuits ($57m) driven by an increased use of covered conductor and composite crossarms, as well as incorporating pole top hardware replacements to improve network reliability against high wind, vegetation and climate challenges.
  - Recategorisation of Waiheke Island 3rd sub-transmission cable ($8m), DER associated expenditure ($9m) and Southdown GXP and zone substation ($8m) from system growth to better align with the driver of the investment, as discussed earlier under the system growth category.

15.3.2 EXPLANATION OF MAJOR NON-NETWORK CAPEX VARIANCES

Key changes in Non-network CAPEX over the 9 years for which the 2023 AMP and 2024 AMP overlap are as follows:

- An increase in network digital expenditure of $21.3m, is largely attributed to:
  - Continued modernising IT/OT Network infrastructure: With the increasing number of threats and their severity, Vector is forecasting an increased expenditure of $12m to ensure investments in platforms in both the IT and OT networks are protected.
  - Data Centre move of Vector's main data centre out of Vector's Head Office to a more fit for purpose facility ($7m)
- ADMS Phase II investment has moved to a later period following on from the implementation of the foundation Phase I investment. ADMS Phase II enables the efficient operation and integration of Outage Management (OMS) and Switch Order Management (SOMs) as part of an Advances Distribution Management System ($13.m).
- Increased cost of the GIS upgrade following detailed design –($4m).
- Data use cases and data platform improvements required to support data driven decision making as well as laying the foundations for LV and DER visibility initiatives into the future ($3m)
- Investment in planning and operations tools needed to support these operations at scale ($1m)
- Continued and increased investment in the lifecycle of many digital platforms in 3-5 years as there is not only future uncertainty but also currently unknown technologies that will be available to deliver better outcomes. Using our Value Stream construct, we have increased the expenditure allocated to each value stream to replace and upgrade platforms based upon this lifecycle. The increase in forecasted investment is approximately $4m.
- Property and leasing costs have remained largely the same compared to the previous AMP.

15.4 OPEX forecast

The forecast OPEX during the next 10-year planning period are presented below, based on our key asset maintenance standard and operational structure. These are grouped in the following categories:

- **Network OPEX** – discussed in Section 8

- **Non-network OPEX** – discussed in Section 14

15.4.1 TOTAL OPEX

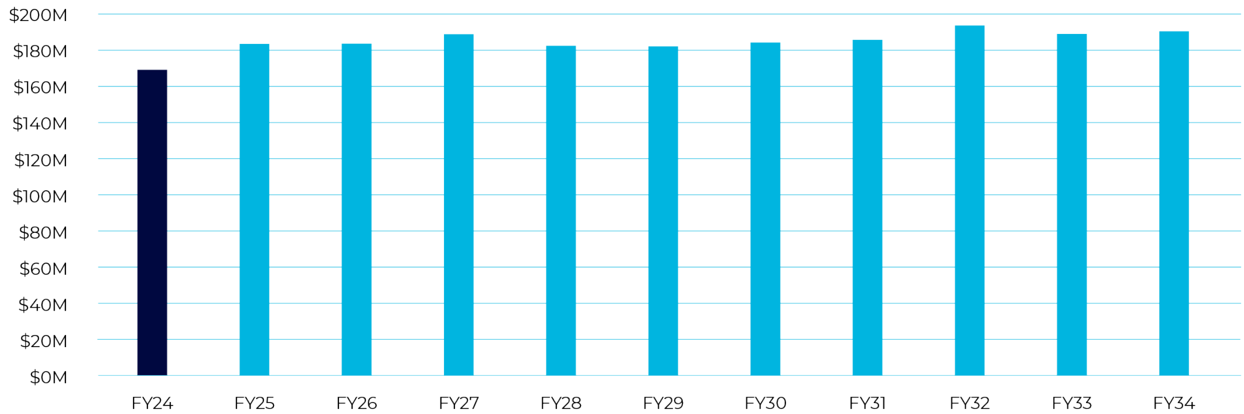


FIGURE 15.6: TOTAL OPEX (FINANCIAL YEAR, $'000 CONSTANT FY24)

The total OPEX expenditure profile is relatively consistent over the AMP horizon with an initial increase in FY25 due to increased expenditure in response to the increased number of weather events, higher back-office support costs and computer expenses due to digitalisation (SaaS and Cyber Security). FY27 and FY32 includes $7.5m each year for a major storm event as experienced twice over the past 10 years. There is also a small uplift each year from FY30 to FY34 due to increasing insurance costs, meter data processing costs and network data due to growth.

15.4.2 NETWORK OPEX

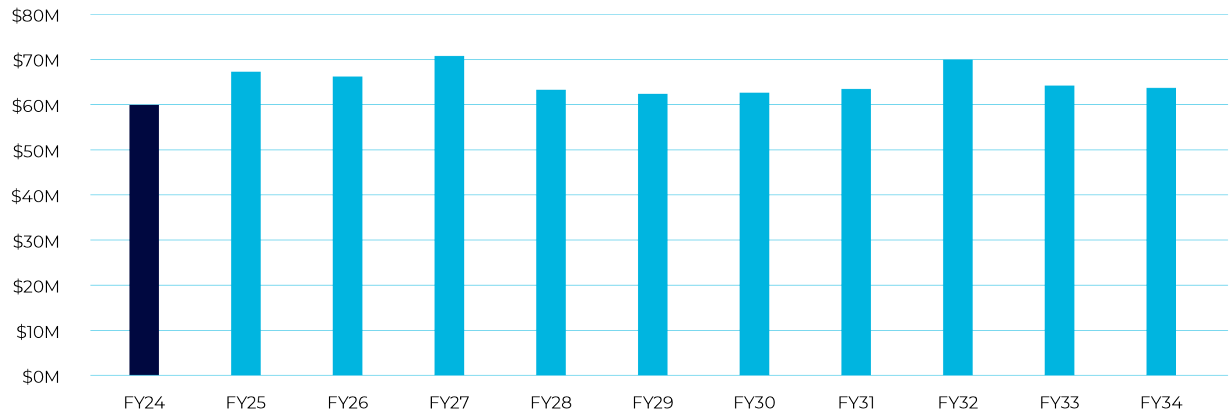


FIGURE 15.7: NETWORK OPEX (FINANCIAL YEAR, $'000 CONSTANT FY24)

The network OPEX forecast expenditure is underpinned by the latest asset maintenance standards. Over the 10-year planning period the expenditure profile varies based on the network requirements in particular timing of additional line clearance work, vegetation spend and asset cycles for corrective maintenance inspection work as a result of the Risk Based Approach (RBA) introduced as part of the SAP PM system. FY25 includes uplifts for reactive maintenance for the impact of increased number of weather events, vegetation brought forward to address risk, additional line clearance work and increased corrective maintenance inspection work. FY27 and FY32 includes $7.5m each year for a major storm event.

15.4.3 NON-NETWORK OPEX

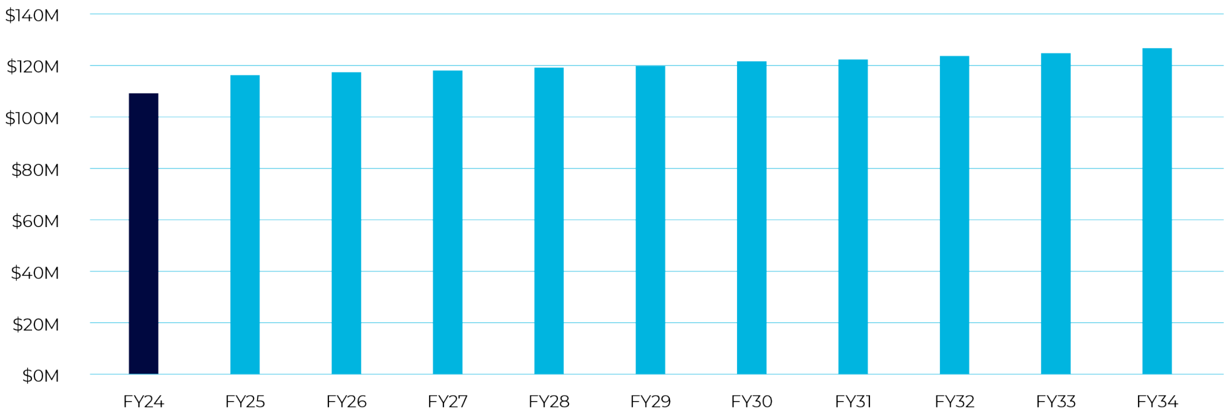


FIGURE 15.8: NON-NETWORK OPEX (FINANCIAL YEAR, $'000 CONSTANT FY24)

Non-network OPEX forecast expenditure is trending higher over the AMP period due to increasing levels of costs for insurance, network data, meter data and additional services to process meter data.

15.5 OPEX forecast variance to previous AMP

The forecast OPEX during the next 10-year planning period is broken down into the key asset categories defined in the Commerce Commission's Electricity Distribution Information Disclosure Amendments Determination 2012 and shown in Table 15-3.

Figure 15-10 shows the difference between the 2024- and 2023-AMP expenditure forecasts year on year, with Table 15-4 breaking down the variance by expenditure categories.

KEY OPEX CATEGORIES	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	TOTAL (FY25-34)
Service Interruptions and emergencies	16,985	17,112	24,740	17,370	17,500	17,632	17,766	25,400	18,036	18,173	**190,714**
Vegetation management	8,500	7,000	7,000	7,000	6,000	6,000	6,000	6,000	6,000	6,000	**65,500**
Routine and corrective maintenance and inspection	25,006	25,222	25,136	25,441	25,315	25,316	25,928	24,653	26,192	25,415	**253,624**
Asset Replacement and renewal	16,667	16,773	13,772	13,354	13,458	13,563	13,669	13,775	13,883	13,991	**142,925**
System operations and network support	57,835	58,852	59,344	60,214	60,651	62,335	62,811	63,885	64,675	66,273	**616,875**
Business Support	58,133	58,250	58,426	58,659	58,832	58,963	59,220	59,503	59,812	60,153	**589,951**
Total OPEX	**183,127**	**183,209**	**188,419**	**182,037**	**181,757**	**183,809**	**185,393**	**193,216**	**188,598**	**190,005**	**1,859,570**

TABLE 15-3: OPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY24)

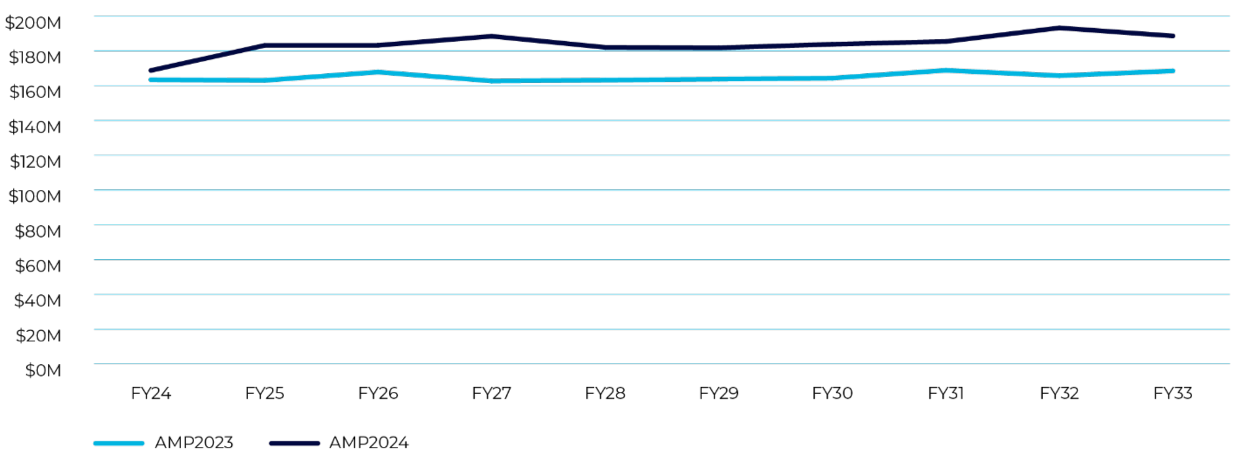


FIGURE 15.9: AMP 2024 VARIANCE TO AMP 2023 OPEX FORECAST CHART (FINANCIAL YEAR, $M CONSTANT FY24)

AMP24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	TOTAL
Service Interruptions and emergencies	(875)	(877)	(8,379)	(881)	(883)	(885)	(887)	(8,389)	(891)	**(22,946)**
Vegetation management	(2,826)	222	222	222	1,222	1,222	1,222	1,222	1,222	**3,950**
Routine and corrective maintenance and inspection	(2,251)	382	(1,647)	(1,785)	(1,892)	(1,968)	878	(1,794)	(1,711)	**(11,788)**
Asset Replacement and renewal	(210)	(840)	(1,564)	(1,465)	(1,473)	(2,077)	(2,090)	(2,104)	(2,117)	**(13,941)**
System operations and network support	(4,334)	(4,656)	(4,644)	(5,149)	(5,118)	(5,932)	(5,759)	(6,337)	(6,428)	**(48,356)**
Business Support	(9,604)	(9,625)	(9,693)	(9,805)	(9,849)	(9,839)	(9,945)	(10,064)	(10,198)	**(88,623)**
Total OPEX	**(20,100)**	**(15,394)**	**(25,704)**	**(18,862)**	**(17,992)**	**(19,479)**	**(16,581)**	**(27,467)**	**(20,124)**	**(181,704)**

TABLE 15-4: AMP 2024 VARIANCE TO AMP 2023 OPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY24)

15.5.1 EXPLANATION OF MAJOR NETWORK OPEX VARIANCES

Key changes in Network OPEX over the 9 years for which the 2023 AMP and 2024 AMP overlap are as follows:

- $23m increase in Service interruptions and Emergencies expenditure is largely attributable to $7.5m provided for in FY27 and FY32 for a major storm event with the remaining increase each year in reactive maintenance expenditure due to the increased number of sustained adverse weather events.
- $4m decrease in vegetation expenditure is due to spend brought forward in FY24-25 to address climate change risk and network hardening.
- An increase of $12m in Routine and Corrective Maintenance is largely due to additional costs for power transformer electrical testing, CBM overhead switchgear operational testing and frequency change in assessing wooden poles.
- An increase of $14m in Asset Replacement and Renewal due to the removal of the previous AMP23 forecast assumption of corrective maintenance reductions.

15.5.2 EXPLANATION OF MAJOR NON-NETWORK OPEX VARIANCES

Variances in non-network OPEX over the 9 years for which the current and prior year AMP overlap, reflect the following key changes:

- Systems operations and network support expenditure is forecasted to be $48m higher as a result of increased personnel costs, insurance premiums, call centre charges, network data costs, meter data and additional services to process meter data.
- A forecast increase in Business Support expenditure of $89m driven by increased investment in digitalisation as well as increased costs due to SaaS services now being recognised as OPEX. This includes Microsoft licenses which under previous standards were treated as Capex but going forward now get captured as Opex in our AMP forecast. In addition to this, allocated corporate costs have increased due to higher insurance premium and personnel costs.

15.6 Inputs and assumptions for information disclosed

This section outlines key inputs and assumptions used for the forecast expenditure in the AMP planning period. Estimates for projects and programmes for the first few years in the AMP period receive a higher level of scrutiny during the compilation of estimates and thus have a higher level of accuracy than projects in the latter years.

15.6.1 NETWORK CAPITAL EXPENDITURES

SPECIFIC PROJECTS

The requirement to invest capital for specific individual projects is either borne out of large customer connection requests, asset relocations triggered by third party infrastructure projects, asset condition and failure risks and network system reinforcement requirement to ensure security of supply.

Vector has extended the use of Condition Based Asset Risk Management (CBARM) modelling to primary assets including indoor primary switchgear and subtransmission cables. It is also used to support and prioritise programmes of work for distribution assets over the 10 year forecast horizon.

The CBARM models are based on the principles and calculation methodologies outlined in the OFGEM DNO Common Methodology and tailored to reflect Vector's operational environment. The models incorporate Vector's input data such as historical failure rates and asset health data to predict the volume of assets that will need to be replaced and thus the level of investment needed to manage each of the asset fleets. Historical actual costs are used as the basis for the unit cost applied in the forecast expenditure. Vector utilises other modelling techniques to forecast replacement capital expenditure for asset types where CBARM models are not suitable – refer to section 12.2.

The assumptions and processes that build up the reinforcement expenditure are detailed in section 10.4. It is initiated by an annual assessment of the customer peak loading on all distribution feeders and zone substations. Any capacity shortfalls and breaches of our security of supply standard are identified through network constraint modelling and solutions are assessed and proposed through investment option analysis.

Cost estimation for significant capital projects (greater than $1m) involves site inspections to determine site and other constraints and risks to deliver a solution. From this, a scope and constraints summary is compiled with a relatively detailed project estimate. The cost estimate is built with a bottom-up approach using a standardised cost estimating model, which draws the inputs from the moving cost from SAP inventory data for materials and plant, standard rates for internal staff time writing and standard agreed rates for external commissioning support and contracted project management.

PROGRAMMES OF WORK

Forecasting for volumetric programmes of work applies to most of Vector's customer connection expenditure and investment relating to Vector's distribution assets.

The forecast for customer connections volumes is supported by data from the Auckland Forecasting Group (AFG). The assumption for consents converting to gross connections has dropped in the medium term from the prior year but expected to rise back up in the long term. The cost estimates for customer connections are based on an average cost using historical data but a cost estimate is built bottom-up for each connection application.

For distribution assets, Vector has continued with the use of CBARM models for asset classes including distribution ring main units, distribution transformers, overhead conductors, and overhead 11 kV switchgear to inform the forecasted volume of assets to be replaced and/or remedied during the AMP cycle.

15.6.2 NETWORK DIGITAL ASSUMPTIONS

Given the fast-changing landscape, the uncertainty in investments increases with time. There is reasonable certainty for the investments in the initial 18-24 months with less certainty beyond that. The investment forecasts provided are based on projects being currently undertaken and market conditions. Vector has a standard quarterly planning process that reviews investments, reprioritises as required and follows a business case process to proceed with investments.

Our forecasts include provision for support of all existing platforms thus avoiding unexpected replacement. Specifically, the current SAP version support will continue through to 2027. In addition, cybersecurity threats are assumed to remain at a level where current investment forecasts are sufficient to protect Vector systems and respond to incidents within the IT domain. Investment forecasts do assume increased investment in OT Cybersecurity controls as the number of sensors and devices connecting to the OT network increases. The Electricity business will need to leverage modern automation technology and tools to scale its operations efficiently to meet growing consumption demand. Vector operations will also require investment to achieve the scale necessary to service increased connections and increased consumption over the next 10 years.

15.6.3 PROPERTY AND LEASES

There are no significant changes in the forecasts from the prior year. Larger warehousing to mitigate supply chain risks are now in place and the Head Office move is complete.

15.6.4 OPERATING EXPENDITURES

To a large extent, the network operating expenditure relates to a programme of planned maintenance work driven by a suite of maintenance standards and a risk-based approach to corrective asset maintenance. To this end, our planned maintenance network operating expenditure forecast has been constructed bottom-up, taking into consideration the various activity unit rates, frequencies and the quantum of activities.

We have constructed the non-network operating expenditure forecast primarily based on the existing operating structure with modifications for known changes and excludes one-off transitional type cost items. Further, in certain instances, we have relied on historical averages to form a baseline view, where we believe forecasting the expenditure items with a reasonable degree of accuracy is challenging.

SECTION 16

Programme delivery

16 –Programme delivery

16.1 Overview

This Section provides an overview of the processes used to manage the delivery of our capital works and maintenance works programmes. It provides an overview of our Programme Delivery process that enables us to consistently deliver our work safely, to quality, cost effectively and to schedule. We also provide an overview of our approach to prioritizing works and optimizing resources for delivering our works programme. Finally, we provide an overview of our use of standardised equipment types and standardised equipment ratings and sizes, approach that assists in minimising inventory costs and critical spares inventory.

16.2 Capital works delivery

Capital Delivery is the delivery of the annual capital programme including project engineering, project management, procurement of equipment, tendering of capital works, and financial control and governance.

CAPITAL PROJECT GOVERNANCE

Vector has well defined and embedded processes for identifying network upgrade needs and capital justification to achieve its business objectives and reduce network risk. Our network investment planning and project delivery follows a stage-gate governance approval process. The process, shown in Figure 16.1, covers all expenditure and consists of five approval 'gates' that are governed by the Delegated Authority Framework. Our SAP workflow mirrors this approval stage gate process for budget applications. The first three gates relate to the identification of the risk and need for a project or program, analysis of the options for the works and development of the preferred solution. A Capital Expenditure Justification (CEJ), essentially a business case to gain approval to undertake capital investment, together with a detailed cost estimate, are the artefacts that are developed to demonstrate prudence and efficiency of expenditure and that the governance process has been followed.

FIGURE 16-16.1: PROJECT LIFECYCLE

Project progress is recorded and monitored using an enterprise-wide project management tool[37] and undergoes a monthly review. Exception reporting is provided to the Executive and Board monthly, covering; HSE, performance against schedule, financial performance, issues, challenges and risks. HSE and risk are also reported through to the Board using our risk software application known as ARM (Active Risk Manager). Risks are escalated to the Board Risk Committee as required.

Monthly reviews of each project are carried out by the Programme Management Office (PMO), a team within the Capital Projects Delivery team, to ensure that projects are going to plan and identify issues, constraints and challenges. The performance of projects in delivery is also reviewed through a series of monthly contractor performance meetings attended by the Manager Capital Programme, respective project managers and representatives from the contractors. Contractual issues are dealt with directly by Project Managers and the Engineer to Contract and if necessary, escalated to the Team Leaders within the Capital Delivery Team.

An internal Governance Group (GG) that includes representatives of the Network Performance, Finance and Capital Projects Delivery teams, meet weekly to discuss new scopes of work, exceptions to scopes and manage scope changes via a formal change control process. The GG is chaired by the PMO lead. The General Manager, Capital Programme Delivery, chairs a monthly meeting that focuses on progress against financial year and regulatory year delivery and financial targets, DPP period spends vs budget, and corrective actions that might be required to achieve targets.

Approvals are required before any commitment is made. Approvals are governed and must follow Vector's Procurement Policy and Delegated Authority Framework.

The capital works delivery process includes five primary stages: Risk assessment and project identification, Scoping, Feasibility Assessment, Procurement, and Delivery (Construction, Commissioning and Closeout). Table 16-1 provides an overview of the processes undertaken under each of these phases.

[37] Project-on-line

PHASE	ACTIVITY OVERVIEW
Identification of network risk and the need for a project or program	• Network risk, network need requirement and options analysis • Project prioritisation • Establish base cost estimate • Needs statement • Recommendation for inclusion in Asset Management Plan (AMP)
Scoping	• Development of initial (preliminary) project scope • Cost estimation • Assessment of alternate project options • Determination of key project risks • Procurement analysis (identification of long lead time items) • Prepare Development Funding Application (CEJ)
Feasibility	• Identification and assessment of project-specific risks/issues • Surveying and/or Geotech investigation, flood risk assessment etc. • Early Contractor Investigations • Design concepts development and review • Safety in Design (SID) • Finalise project scope • Detailed design • Cost estimation and detailed materials list • Early procurement (long lead time items only) • Prepare Full Funding Application (CEJ) – Business case
Procurement	• Assess supply chain risks and delivery times • Tendering for construction • Procurement tendering • Preparation of contract documentation
Delivery	• Cost, Schedule and Quality performance monitoring • Risk and issues management • Construction • Commissioning • Handover / Project close

TABLE 16-1 PROJECT LIFECYCLE DELIVERABLES

16.2.1 SUPPLY CHAIN MANAGEMENT

Over the last four years Vector has worked with suppliers and field service providers to reduce risk and complexity in our supply chain. The Covid-19 pandemic presented significant operational challenges including constrained supply, increased freight costs and longer delivery times. Vector has overcome these challenges by building deeper, more transparent relationships with trusted suppliers, forecasting demand for long lead-time items, rationalising the range of "standard" items purchased and introducing new suppliers to mitigate the impact of bottlenecks.

The risk of delay to the delivery of capital works due to long lead times on equipment is mitigated using inventory of commonly used items. For capital projects that use one-off items such as primary switchgear for substations, this risk is mitigated by ordering equipment as early as possible.

We have standardised equipment configurations to reduce the variety of materials used, enabling diversification of sourcing through minimum specification levels in place of Vector-only custom builds. Inventory of frequently used items such as distribution transformers and switchgear enables forecast project and network maintenance requirements to be met from stock. We have invested in building supply chain management systems and capability to transition from a just-in-time ordering model to an integrated business planning process that aggregates demand projections from planning, delivery and operations functions to forecast demand requirements. An overhauled process for the introduction of new equipment to the network not only validates technical efficacy but also operational impact, whole of life value and network need. We have found that many of the lead times have reduced close to pre-Covid levels.

Conflict in the Middle East and drought in Central America have reduced freight capacity on the Suez and Panama routes, lengthening freight lead times which had started to improve after Covid. The impact of this disruption has been mitigated by the relationships we have built with manufacturers in-region, delivering shorter and less complex supply routes and diversifying sourcing within asset classes. We have also strengthened relationships with peer electricity distributors to drive alignment on equipment specifications, which has reduced portfolio complexity and risk. Our focus on optimising inventory holdings is enabling more efficient and timely fulfilment. We have partnered with logistics expert Rohlig to manage physical inventory, improving the quality and consistency of our warehousing function and enabling more dynamic inventory management.

Most of the distribution equipment required for Vector's capital, customer and maintenance delivery programmes is sourced by Vector and free issued to contractors for installation. Less complex, high volume equipment such as poles and cross arms are sourced by contractors, to Vector's specifications, with the cost passed through to Vector when the item is installed. Procurement of the works is through our MUSA contract using our FSPs for maintenance works and NZ3910 contracts for major capital works.

16.2.2 CUSTOMER INITIATED CAPITAL PROJECTS – CUSTOMER DELIVERY TEAM

The Customer Delivery team delivers customer-initiated capital projects like subdivisions and commercial connections. We use an outsourced delivery model where our FSPs design and deliver works by geographic region. With around 800 customer-initiated projects per year, the FSPs knowledge of the local network is critical in delivering these smaller, short-duration capital projects effectively.

Within Vector we have a team of customer advisors that administer the project delivery and maintain the interface with the customer and liaise with the Planning team and Network Performance team.

The MUSA capital works job sheet provides a simple and well-understood contract engagement that reduces the administrative costs associated with tendering works while ensuring we demonstrate value for money through comparison with similar recent works and standard negotiated rates.

RESOURCE SCHEDULING

The priority of customer-initiated projects is generally governed by when the client contracts Vector to deliver the works. FSP resource levelling and outage scheduling are then used to fine-tune delivery scheduling.

FEASIBILITY AND DETAILED DESIGN

The electrical design of projects delivered by the Customer Delivery Team consist mostly of distribution designs that include an 11 kV network, distribution substations and a low-voltage distribution network. These designs do not require a multi-disciplinary approach and so is ideally suited for design by our FSPs. If a customer-initiated project requires multi engineering disciplines to be involved say for example a large datacentre that requires structural, civil, protection and detailed substation designs, such a project will be delivered by the Major Projects team. The design and capital project cost is presented to the client as our offer to complete the works.

DELIVERY

Historically, Vector relied on two FSPs to deliver all customer-initiated works. However, larger projects, delivered by the Major Projects team, are delivered by the extended pool of contractors.

Vector's customer advisors use our Customer Management System, Siebel, to monitor project progress through the various delivery stages. Change control of projects within the Customer Delivery team is through a client-agreed variation.

Our FSPs commission equipment being brought onto the network to ensure it complies with our standards and can be operated and maintained safely. Once complete they update Vector's information systems and hand the installation over to Vector's Electricity Operations and Maintenance team.

16.2.3 MAJOR CAPITAL PROJECTS – MAJOR PROJECTS TEAM

Major capital projects are works identified from an assessment of network risk, high level assessment of a solution, and the project is then ranked, and included and scheduled in the AMP for capital delivery. Major capital projects are delivered by the Major Projects Team. However, large customer-initiated projects that require multi-discipline engineering input and thus higher commercial risk fall outside the remit of the Customer Delivery Team and are delivered by the Major Projects team.

To generate competitive tension while ensuring that we maintain extremely high quality and safety standards, we tender works through two closed contractor groups:

1. **Electrical** – We retain a panel of four electrical installation contractors. These contractors were pre-approved under a five-year umbrella agreement. Work is competitively tendered within the panel with no guarantee of work volume. These contractors are free to subcontract elements of the work but are required to initially seek subcontractors that are part of a pre-qualified specialist pool. This ensures that works are carried out by contractors who are familiar with our processes and critical risks.
2. **Specialist and civil contractors** - We have a pool of specialist and civil contractors; comprising pre-qualified builders, designers, civil works contractors, and specialists. This restricted pool of contractors ensures that we maintain our quality and safety standards and provides the contractors with the confidence to invest in processes, equipment and people to deliver high-quality work, safely. There is no overarching agreement with these contractors or any work volume commitment.

To help our contractors manage their workflow we provide a forward works view looking out 18 months in six-month horizons. Additionally, all our major projects are published on the National Forward Works Viewer to help identify synergies across electricity, gas, and other utility projects.

Due to the higher volumes of work carried out by the electrical contractors they are also provided with a monthly report showing our tender schedule.

RESOURCING AND SCHEDULING

Resourcing and scheduling of major projects is managed by the Project Management Office (PMO) team within the Capital Project Delivery team. The delivery schedule is based on the AMP and the priorities and timelines set in the AMP. The PMO uses Microsoft Project Online to schedule and track our project portfolio.

The PMO uses the priorities set out in the AMP, by our Network Planning team, to provide an outline programme which is optimised by the delivery team based on a number of inputs, including customer and external stakeholder requirements, operational constraints and resource availability. The schedule is developed in conjunction with the Network Performance teams. Vector has an in-house team of project managers supplemented by external project managers as required to provide additional capacity to deliver project surge programmes, etc.

SCOPE OF WORKS AND DESIGN

The delivery of a major capital project is initiated when a scope of work is issued to the PMO office. The PMO office prepares a project brief based on the scope which is issued to the assigned project manager (PM). A project is then "kicked-off" in a meeting that is attended by all stakeholders e.g. the project owner (the scope author), and other representatives from within Vector as appropriate (e.g. Protection and Control team, Operations and Maintenance team, etc.). Thereafter concept designs are developed which goes through a stage-gate design review cycle and safety in design reviews. These are then converted into detail designs.

Vector uses a pool of electrical, civil and structural engineering consultants for detailed designs. During the life of a project the project owner and various asset specialists for the different asset classes provide input and reviews to designs but the engineering consultants and stage gate meetings are managed by the PM.

PROCUREMENT OF WORKS DELIVERY

Depending on the nature and scale of a project, we will either competitively tender or sole-source projects to our construction contractor pool and engage the contractors on contract based on NZ3910 form of contract. An invitation to tender is sent to the contractors, typically allowing the contractor six weeks to prepare their offer. The tender period will increase or decrease depending on the complexity of the works and/or the volume of tenders in progress.

The contractor's offer is provided electronically in two parts: non-priced information and priced information. The tendering process is managed by the Major Projects Team and once the contractor's offer is received the PM leads a team that assess the offers. The non-priced sections of the offer are assessed before reviewing the pricing. This ensures we focus on the quality of the solution before we consider the price. Once an offer has been selected, we engage the contractor using NZS3910 form of contract.

DELIVERY

Our project delivery model is based around the PMI delivery framework, using Microsoft Project Online to track and monitor projects. Additional support is provided through an internal team, including HSE, procurement, Engineer to Contract, RMA, quantity survey and risk specialists.

Projects are reviewed by the the Capital Project Delivery team on a monthly basis. The reviews include:

- Project health checks, produced by the project manager and the contractor. These are reviewed by senior members of the team and discussed at regular performance meetings with each contractor.
- Review of each project's performance against schedule, budget, scope, resourcing and risk. Vector's executive team receive a monthly exception report.

As noted previously in section 16.2, a Governance Group provides additional oversight of the programme.

COMMISSIONING AND OPERATIONAL HANDOVER

Commissioning is undertaken in line with Vector's commissioning standards and specific equipment requirements. Once construction is complete and the equipment has been commissioned, a final site over walk-through and inspection is undertaken. The meeting is attended by in-house asset specialists, the project team, and representatives from the Operations and Maintenance team. The general quality of the works checked as well as confirming that the scope has been delivered, with "snag" lists compiled as necessary. Once all outstanding issues have been resolved and the works proven, the project is formally handed over to the Electricity Operations and Maintenance team and an OMAC (operational maintenance acceptance certificate) is signed as the formal proof of acceptance of the works and put on record. The final step is a lessons learnt session and the issuing of a lessons learnt report.

16.3 Maintenance works delivery

16.3.1 FIELD SERVICE MODEL

Vector has four main field service providers who undertake maintenance activities on Vector's behalf:

- Omexom Ltd is Vector's maintenance contractor for the Northern network area;
- Northpower Ltd is Vector's maintenance contractor for the Auckland network area; and
- Treescape Ltd is responsible for vegetation management om the Northern network area.
- Asplundh Ltd is also responsible for vegetation management in the Auckland network area

Omexom and Northpower operate under the Multi-Utility Services Agreement (MUSA). The scope of the electricity maintenance contracts is to deliver the reactive, preventative, and corrective maintenance works programmes, based on the requirements set by our suite of maintenance standards as well as in accordance with our Maintenance Strategy and associated notification protocols.

Our Operations and Maintenance Team is responsible for managing the relationship coordination and performance of our service providers. The MUSA contract defines the responsibilities, obligations and Key Performance Indicators (KPIs) to complete scheduled works. Vector maintains a library of maintenance standards which contractors must comply with when performing their duties. The Maintenance Strategy and its associated notification protocols are governed by the Network Performance team.

Treescape and Asplundh operate under separate services contracts managed by our Operations and Maintenance Team. The prioritization of tree maintenance is guided by an external service provider, Arborlab Limited, who use a combination of tree fall risk, potential SAIDI impact, safety, etc. to establish the forward programme of vegetation control work activities.

The delivery of all these maintenance activities is closely monitored and adjusted monthly and quarterly by our Operations and Maintenance team , to ensure the agreed annual target volumes are achieved. Extensive monthly feedback is obtained on actual versus planned progress, KPI performance, causality and issues impacting progress or performance, new risks, action plans and focal points for the coming months.

The overall effectiveness of the programme is evaluated by contract KPI performance and the roll-up to Vector's corporate performance metrics, of which environmental compliance, public, employee and contractor safety and network SAIDI (via a CAIDI KPI) are the core measures.

Standard MUSA rates for prescribed activities are reviewed on an annual basis. Out of cycle rate increases or new rates arising from changes to standards, legislative requirements or other special circumstances are negotiated and managed using the contract change management process.

16.3.2 GOVERNANCE – REPORTING AND APPROVALS

Performance against the annual budgets is closely monitored, with formalised change management procedures in place. Regular reports monitor:

- Health, safety and environmental issues;
- Monthly overall expenditure against budget;
- Reliability performance – SAIDI, SAIFI, CAIDI;
- Progress with risk register actions (the board has a risk committee with a specific focus on risks to the business); and
- Progress by the Strategic Reliability Management Plan of identified actions

Implementation of the AMP requires decisions to be made by both the board and management at all levels, reflecting their functional responsibilities and level of delegated financial authorities (DFAs), as set under the Vector governance rules. Functional responsibilities define the role of each staff member in the organisation. The DFAs specify the level of financial commitment that individuals can make on behalf of the company.

16.4 Equipment selection

16.4.1 USE OF STANDARDISED EQUIPMENT TO MINIMISE COSTS

We have a policy of using standardised equipment sizes and types on our network to minimise long-term costs and keep a check on stocks of spare parts. Also, when specifying equipment, we consider climate change by seeking to understand the potential changes to environmental conditions that could impact our assets such as extended long periods of high temperatures, high winds and low rainfall.

The following gives a high-level overview of some of our equipment selection strategies. Further details are provided in Section 12 (Asset Replacement and Renewal).

Transformers: Since 2000, we have standardised our fleet to 15MVA and 20MVA power transformers but in 2021 it became clear that a larger transformer is required to supply the demand. A 28MVA unit has been added as a standard transformer model in our power transformer fleet. The power transformer technical specification was recently updated to include the latest technical requirements.

With regard to distribution transformers, we have rationalised our type and ratings of distribution transformers to reduce the requirement to hold many types under strategic stock.

Subtransmission Cables: Our subtransmission cable range has been standardised to a certain range. The standard range mitigates the requirement to hold multiple types of cables in strategic stock. For new subtransmission reinforcement or subtransmission cable replacement projects, the cable and its installation parameters are modelled to ensure target network ratings can be achieved under various ground moisture conditions using our in-house CymCap cable-rating software. Moisture levels, field-tested ground thermal conductivity results, cable laying installation method and proximity of other cables are all input into the model.

Distribution cables and overhead conductors: Similarly to subtransmission cables we have standardised and rationalised our range of low voltage underground cables and overhead conductors. This negates the need to hold multiple types in strategic stock. The requirements for the type of cable or overhead conductor to be installed in a project are modelled using our Powerfactory Digsilent network modelling software.

Communications: Our communications network routers, switches, antennae, synchronous clocks, media convertors and power quality meters have all been standardised to a simple and rationalised range. This makes procurement simple and quick and makes holding of spares small in scale. It also allows for standardised design architecture for communications networks

Automation systems: For our remote terminal units (RTUs) we have standardised on two types from two different manufacturers. Each of the types are covered under its own standard design. For our transformer management system (TMS) equipment we have also standardised on two types from two different suppliers each with its own standard design. The selection of two types for each of the automation systems provides options with the present supply chain constraints.

Auxiliary systems: We have standardised secondary systems on switchgear to be powered using 110 V DC systems. Our program of works to replace ageing battery chargers and controllers at our zone substations is almost complete. All new zone substations will be fitted with 110V DC systems. Where switchgear is upgraded or refurbished or new protection schemes installed, legacy 24V DC and 30 V DC systems and voltage transformer supplied DC systems are replaced with 110V DC systems. Our DC systems are equipped with battery monitoring devices.

Buildings: Our zone substation buildings have a template design standard approach to minimise the cost and complication of bespoke engineering, design and construction.

SECTION 17

Appendices

17 – Appendices

17.1 Appendix 1 – Glossary and terms

AAAC	All Aluminium Alloy Conductor
AAC	Aluminium Alloy Conductor
ABC	Aerial Bundled Cable
ABI	Air break isolator
ABS	Air break switch
AC	Alternating current
ACSR	Aluminium Conductor Steel Reinforced
ADMS	Advanced Distribution Management System
ADSL	Asymmetric Digital Subscriber Line
AFG	Auckland Forecasting Group
AIS	Air-insulated switchgear
AKL	Auckland
ALR	Auckland Light Rail
AMETI	Auckland Manukau Eastern Transport Initiative
AMMAT	Asset Management Maturity Assessment Tool
AMP	Asset management plan
AMS	Asset Management Standard
ARM	Active Risk Manager
ARP	Asset replacement project
AS/NZ	Australian/New Zealand Standard
AT	Auckland Transport
BESS	Battery Energy Storage Solutions
BI	Business Intelligence
BRAC	Board Risk and Assurance Committee
BSP	Bulk supply point
Bulk supply substation	A substation owned by Vector that directly connects the Vector network to the national grid. A bulk supply substation may contain more than one supply bus (of same or different voltages).
CAB	Citizens Advisory Board
CAD	Computer Aided Design
CAIDI	Customer average interruption duration index
CAPEX	Capital expenditure
CB	Circuit breaker
CBARM	Condition based asset risk management
CBD	Central business district
CCT	Covered conductor type
CDEM	Civil Defence and Emergency Management
CEJ	Capital Expenditure Justification
CEMS	Customer Effort Mean Score
CEO	Chief Executive Officer
CGPI	Capital Goods Price Index
CM	Corrective Maintenance
CO2e	Carbon Dioxide Equivalent

COO	Chief Operating Officer Electricity, Gas, Fibre
CRL	City Rail Link
CRLL	City Rail Link Limited
CRM	Customer relationship management
DA	Delegated Authority
DAF	Delegated Authority Framework
DC	Direct current
DER	Distributed energy resource
DERMs	Distributed energy resource management system
DGA	Dissolved Gas Analysis
Distribution substation	A substation for transforming electricity from distribution voltage (22 kV or 11 kV) to 400V distribution voltage.
DMR	Digital Microwave Radio
DNO	Distribution network operator
DP	Degree of polymerization
DPP	Default price-quality path
DPP2	The price-quality path set under Part 4 of the Commerce Act for the period 1 April 2015 to 31 March 2020
DPP3	The price-quality path set under Part 4 of the Commerce Act for the period 1 April 2020 to 31 March 2025
DPP4	The price-quality path set under Part 4 of the Commerce Act for the period 1 April 2025 to 31 March 2030
DSM	Demand Side Management
EDB	Electricity distribution business
EECA	Energy Efficiency and Conservation Authority
EGF	Electricity, gas, and fibre
EDIM	Enterprise Data and Information Management
EIPC	Electricity Industry Participation Code
ENA	Electricity Networks Association
ENS	Electricity Network specification
EOC	Electricity Operations Centre
ERM	Enterprise Risk Management
ERP	Enterprise resource planning
ESE	Electricity Standard Engineering
ESM	Electricity Standard Maintenance
ESS	Electricity Standard Specification
EV	Electric vehicle
FCAS	Frequency control ancillary services
FENZ	Fire and Emergency New Zealand
FMEA	Failure Mode Effect Analysis
FNR	Future Network Roadmap
FPI	Fault Passage Indicator
FSP	Field Service Provider
FY	Vector financial year (year ending 30th June)
GHG	Greenhouse Gas
GIS	Geographic information system
GOS	Grade of Service
GXP	Grid Exit Point
HILP	High impact low probability
HR	Human resources

HSE	Health, safety and environment
HSNS	High Speed Network Services
HSWA	Health and Safety at Work Act
HV	High voltage: a nominal AC voltage of 1000 volts and more
HVAC	Heating, Ventilation and Air Conditioning
HV-GIS	High voltage gas insulated switchgear
HWLC	Hot water load control
ICCC	Interim Climate Change Committee
ICP	Installation control point
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IED	intelligent electronic device
IEECP	Institute for European Energy and Climate Policy
IND	Industrial
IP	Internet Protocol
IPCC	Intergovernmental Panel for Climate Change
ISO	International Organization for Standardization
IT	Information Technology
KPI	Key Performance Indicator
kV	Kilovolt
kW	Kilowatt
LAN	Local area network
LBS	Load break switch
LCI	Labour Cost Index
LiDAR	Light Detection and Ranging
LRT	Light Rail Transit
LV	Low voltage – a nominal AC voltage of less than 1000 volts
MO	Minimum Oil
MSM	Macro Strategic Model.
MUSA	Multi-Utility Services Agreement
MV	Medium voltage
MVA	Megavolt amperes
MW	Mega Watt
MWh	Megawatt Hour
National grid (or grid)	The 110 kV and/or 220 kV AC network and the DC link between the North Island and the South Island owned by Transpower for connecting electricity generation stations to grid exit points.
NBS	New building standard
NIWA	National Institute of Water and Atmospheric Research
NPV	Net present value
NTHN	Northern
NWA	Non-Wires Alternative
N-x security	Subtransmission security class rating.
NZS	Standards New Zealand
NZSEE	New Zealand Society of Earthquake Engineering
NZTA	New Zealand Transport Agency
OD	Outdoor
ODID	Outdoor to Indoor
ODV	Optimised deprival value

OEM	Original equipment manufacturer
OH	Overhead
ON	Oil Natural
ONAF	oil natural air forced
ONAN	oil natural air natural
OPEX	Operational Expenditure
OT	Operational Technology
PD	Partial Discharge
PE	Polyethylene
PI	Plant Information
PICAS	Paper Insulated Corrugated Aluminium Sheath
PII	Personally Identifiable Information
PILC	Paper insulated lead sheath
PM	Planned Maintenance
PMI	Project Management Institute
PMO	Programme Management office
PPI	Producer Price Index
PQM	Power Quality Meter
PV	Photovoltaic
PVC	Polyvinyl acetate
QTRA	Quantitative Tree Risk Assessment
RAB	Regulatory Asset Base
RBA	Risk Based Approach
Reliability	The ability of the network to deliver electricity consistently when demanded.
RES	Residential
Resilience	The ability of the network to recover quickly and effectively from an event.
RM	Reactive Maintenance
RMU	Ring-main Units
RNF	Reinforcement project
ROU	Right of use
RTU	Remote terminal unit
RY	Regulatory year (year ending 31st March)
SAA/SNZ HB	Standards Association Australia / Standards New Zealand Handbook
SAIDI	System average interruption duration index
SAIFI	System average interruption frequency index
SAMP	Strategic asset management plan
SAP	Enterprise Resource Planning (ERP) System (SAP)
SAP PM	Plant maintenance module of SAP
SCADA	Supervisory control and data acquisition
SF6	Sulfur Hexaflouride
SFRA	Sweep Frequency Response Analysis
SH	State Highway
SID	Safety in Design
SIP	Sandwich insulated panel
SME	Small and medium-sized enterprises
SMF	Special moment frame
SO	System Operator
SOC	Security Operations Centre

SoSS	Security of Supply Standard
SQL	Structured Query Language
SRMP	Strategic Reliability Management Plan
Substation	A network facility containing a transformer for the purpose of transforming electricity from one voltage to another. A substation may contain switchboards for dispatch or marshalling purpose. A substation may also contain more than one building or structure on the same facility.
SUBT	Subtransmission
SWA	Steel wire armoured
SWBD	Switchboard
Switching station	A facility containing one or more switchboards (or switches) for the purpose of rearranging network configuration or marshalling the network through switching operation.
TASA	Tap Changer Activity Signature Analysis
TCA	Transformer Condition Assessment
TCO	Total cost of ownership
TERP	Transport Emissions Reduction Pathway
TMS	Transformer Management Systems
TOTEX	Total cost of expenditure
TOU	Time of use
TRIFR	Total recordable injury frequency rate
TX	Transformer
UHF	Ultra-high frequency
UPS	Uninterruptible power supply
VAMS	Vegetation asset management strategy
VHF	Very high frequency
VOX	Outdoor deadtank circuit breaker
VSP	Vegetation Service Provider
VT	Voltage transformer
WAN	Wide Area Network
WIP	Work in progress
XLPE	Cross-linked Polyethylene
Zone substation	A substation for transforming electricity from subtransmission voltage (110 kV, 33 kV or 22 kV) to distribution voltage (22 kV or 11 kV).
ZSS	Zone Sub Station

17.2 Appendix 2 – Key Asset Strategies and Standards

Vector has a set of asset strategies and standards that together define Vector's approach to Asset Management. An overview of the key policies and standards are set out below.

ASSET CLASS	GENERAL
Strategies	EAA010 Reliability and Resilience Strategy EAA018 Asset health Modelling Strategy
Technical Specifications	ENS-0099 General technical requirements ESP005 Technical Requirements for the connection of generation ESP009 Technical Requirements for small scale Inverter connected DG ESP010 Security of Supply EGP503 Smart Metering Guideline
Maintenance Standards	ESM001 General Maintenance Requirements
Engineering Standards	ESE001 Computer Aided Design (CAD) Drawing Standard ESE003 Electricity Network Drawing Management ESE004 Engineering Management Standard

ASSET CLASS	100 SUBTRANSMISSION SWITCHGEAR
Strategies	EAA100 Sub transmission Switchgear
Technical Specifications	ENS-0005 Specification for 11 kV to 33 kV indoor switchboards ENS-0022 Specification for 110 kV GIS indoor switchboards ENS-0106 Specification for 33 kV outdoor circuit breakers
Maintenance Standards	ESM101 Maintenance of Primary Switchgear – MV fixed pattern ESM102 Maintenance of Primary Switchgear – 110 kV GIS ESM103 Maintenance of Indoor and Outdoor Conventional Switchgear ESM104 Primary Switchgear -Outdoor
Engineering Standards	ESE101 Primary Indoor Switchgear ESE102 Instrument Transformers Indoor ESE103 33 kV Switchyard Renewal and Extension Design Criteria

ASSET CLASS	200 POWER TRANSFORMERS
Strategies	EAA200 Power Transformers
Technical Specifications	ENS-0124 Specification for 110 kV-22 kV two-winding power transformers ENS-0149 Specification for neutral earthing resistors ESS-0200 Specification for Two-Winding Transformer
Maintenance Standards	ESM201 Maintenance of Transformers 22-110 kV Power Transformers in Zone Substation
Engineering Standards	ESE201 Power Transformers Zone Substations

ASSET CLASS	300 HV CABLES
Strategies	EAA300 11 – 110 kV cable systems
Technical Specifications	ENS-0032 Specification for SC-triplex 22-33 kV cable ENS-0110 Thermal backfill for underground cables ENS-0191 Specification for single core 110 kV cable ENS -0028 Testing of High Voltage Cables and Switchgear ENS -0102 Specification FOR Polymetric cable protection covers ENS-127 Specification for 11& 22kV underground distribution cable ENS-0169 11 kV cable current ratings for planning purposes SCOTT ESS301 Ducting for Electrical Installations
Maintenance Standards	ESM-301 Maintenance of cables
Engineering Standards	ESE301 Cable Support Systems-in enclosed basements ESE302 Design requirements for sub transmission and distribution cables ESE303 Installation requirements for cables and ducts

ASSET CLASS	400 OVERHEAD LINES
Strategies	EAA400 Overhead lines
Technical Specifications	ENS-0094 Specification for prestressed concrete utility services poles ENS-0091 Specification for treated timber utility services poles ENS- 101 Specification for Surge Arrestors ENS-0153 Specification for overhead conductors ENS-0159 Specification for galvanised steel fittings for overhead construction ENS-0160 Specification for LV ABC fittings ENS-0163 Specification for overhead line connectors ENS-0109 Specification for helical fittings and accessories ENS-0084 Specification for pole mounted fuse carriers and links ENS-0088 Specification for overhead insulators ENS-0112 Specification for hazard marking for poles ENS-0134 Overhead conductor current ratings for planning purposes ESS -0401 Specification for hardwood and composite crossarms ESS-0402 Specification for fault passage indicators
Maintenance Standards	ESM401 Maintenance of Overhead Lines
Engineering Standards	ESE401 Overhead Line Design Requirements ESE402 Overhead Standard Design Applications ESE406 Overhead Standard Applications Structures with Streetlights ESE413 Aerial Fibre Cables Installation

ASSET CLASS	500 DISTRIBUTION NETWORK
Strategies	EAA500 Distribution Equipment
Technical Specifications	ENS-0028 Testing of High Voltage Cables and Switchgear ENS-0078 Specification for 400V underground cable ENS-0093 Specification for fluid filled distribution transformers ENS-0097 Specification for pole mounted SF_6 switches ENS-0098 Specification for sectionalisers and remote switchesENS-0101 Specification for Surge ArrestorsENS-0103 Specification for 11 kV and 22 kV distribution switchgear ENS-0121 Specification for auto-reclosers ENS-0154 Specification for LV distribution service pits ENS-0155 Specification for IPPCs for LV distribution Pit ENS-0162 Specification for fault passage indicators ENS-0170 Refurbishment of distribution Transformers and oil filled switchgear ENS-0224 Standard for Design of Customer Supply ESP001 Residential Subdivision Design Standard ESP002 Non-residential subdivision design and planning standard ESP004 LV Voltage Drop Calculation
Maintenance Standards	ESM501 Maintenance of Overhead Switchgear ESM502 Maintenance of Pole Mounted Distribution Transformers ESM503 Maintenance of Ground Mounted Distribution Equipment and Voltage Regulators ESM505 Maintenance of LV Distribution Systems ESM607 Maintenance of Earthing System
Engineering Standards	ESE501 Distribution Substations in Buildings ESE502 Outdoor Ground Mounted Distribution Equipment ESE503 Distribution Switchgear ESE504 Low Voltage Underground Distribution ESE505 Ground Mounted Distribution Transformer ESE506 Distribution Earthing

ASSET CLASS	600 AUXILIARY SYSTEMS
Strategies	EAA600 Auxiliary Systems
Technical Specifications	ENS-0080 Specification for earthing rods and accessories
Maintenance Standards	ESM601 Maintenance of DC and AC Supply Systems ESM602 Maintenance of Capacitor and Reactor Banks

ASSET CLASS	600 AUXILIARY SYSTEMS
	ESM603 Maintenance of Building Security, Air and Fire Management Systems ESM604 Maintenance of Ripple Plant ESM607 Maintenance of Earthing System
Engineering Standards	ESE601 DC Systems ESE602 AC Systems

ASSET CLASS	700 INFRASTRUCTURE AND FACILITIES
Strategies	EAA700 Infrastructure and Facilities
Technical Specifications	ENS-0206 Specification for crushed rock for switchyards
Maintenance Standards	ESM701 Maintenance of Building, Structures and Facilities ESM708 Maintenance of Minor Tunnels ESM709 Maintenance of Penrose-Hobson Tunnel
Engineering Standards	ESE701 Zone Substation Buildings ESE702 Zone Substation Grounds ESE703 Zone Substation Building Services ESE704 Zone Substation Earthing ESE002 Zone substation signage

ASSET CLASS	800 PROTECTION AND CONTROL
Strategies	EAA800 Protection
Technical Specifications	ENS-4002 Protection and Control – Protection Settings Management System ENS-4003 Protection and control – Technical documentation
Maintenance Standards	ESM801 Maintenance of Protection and Control Systems ESM804 Maintenance of Pilot Cables ESM805 Maintenance of Radio Equipment
Engineering Standards	ESE801 Protection System ESE802 Automation and Control in Zone Substations ESE803 Protection and Control for Overhead Distribution Feeders ESE805 Secondary Cabling ESE806 Protection distribution Substation ESE807 Protection Philosophy Subtransmission Zone Substations and Distribution ESE810 Testing and Commissioning of Protection Relays

ASSET CLASS	900 NEW ENERGY SOLUTIONS
Strategies	EAA900 Distributed (Decentralized) Energy Systems
Technical Specifications	Being developed – work in progress
Maintenance Standards	ESM901 Generation and Energy storage ESM903 Maintenance of Residential PV and Battery Energy Systems
Engineering Standards	Being developed – work in progress

HEALTH, SAFETY AND ENVIRONMENT MANAGEMENT STANDARDS
HSEMS01 Management systems framework and HSE policies HSEMS02 Leadership and Accountability HSEMS03 Competence and Behaviour HSEMS04 Engagement, Participation and Consultation HSEMS05 Contractor HSE Management HSEMS06 Emergency Management HSEMS07 Wellness and Fitness to Work HSEMS08 Risk Management HSEMS09 Incident Management HSEMS10 Audits, Reviews and Performance Reporting HSEMS11 Operational Control

HEALTH, SAFETY AND ENVIRONMENT MANAGEMENT STANDARDS
HSEMS12 HSE in Project Management HSEMS13 Legal Compliance HSEMS14 Document, Data and Record management HSEMS15 Action Management

ELECTRICITY OPERATING STANDARDS
ESH001 Electricity Network Safety and Operating Plan EOS001 Operational Control of the Network EOS002 Release of Network Equipment EOS003 Procedures for Operations on the Vector Network EOS004 Switching Schedules and Permits Preparation Use and Operating Terms EOS006 Live Line Operating Standard EOS007 Zone Substation Access and Security EOS009 Commissioning of Network Equipment EOS010 Operational Numbering of Vector Equipment EOS011 Protocol for Communications with the Electricity Operations Centre EOS012 Operation of Ground Mounted Switchgear up to and including 33 kV EOS013 Standard Operational Terms and Abbreviations EOS014 Operation of Circuit Breakers and associated Equipment EOS015 Procedures for Operation of OH Equipment up to and including 110 kV EOS018d Tunnel Procedures Rail Maintenance Planning EOS019 Contingency Plans (36 documents) EOS020 Procedures for Management and Operations on the Vector Low Voltage Network EOS026 Managing Asset Rating Changes

NETWORK INFORMATION STANDARDS
ECD005 HV Event Quality Assurance Process ECD010 HVSpec Planned Work Data Capture (DRAFT – work in progress) EGD003 Calculation Guidelines for Electricity Reliability Metrics ENSD001 Asset Data Standards SAP and GIS (Electricity) EOC-009 HV Event Quality Control Procedure ESD001 Functional Location Structure Electricity ESD002 Reactive Maintenance Data Standard ESD003 HV Event Data Standard ESD005 Asset Data and GIS Data Standard ESD006 Planned and Corrective Maintenance Data Standard ESD007 Vegetation Cut or Trim Data Standard (DRAFT – work in progress) USD003 Data Update Request Data Standard

17.3 Appendix 3 – Typical Load Profiles

Figures 17.1, 17.2 and 17.3 show typical demand profiles for residential, commercial and CBD customer segments.

The profiles are normalised so that the shape characteristics can be compared. The true peak demand of each profile can differ significantly between winter and summer and is discussed in the sections below.

17.3.1 RESIDENTIAL DEMAND PROFILE

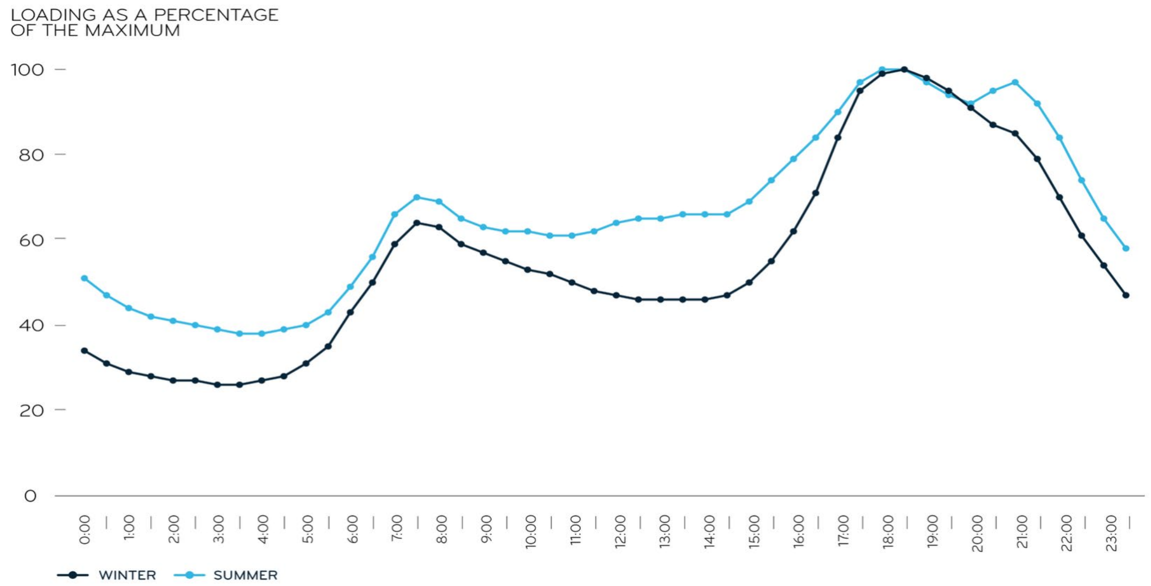


FIGURE 17-1: TYPICAL RESIDENTIAL DEMAND PROFILE (NORMALISED – LOADING AS A PERCENTAGE OF MAXIMUM)

The key characteristics of the residential demand profile are the distinct morning and evening peaks. There is a significant difference in demand between summer and winter profiles, where in absolute usage terms, winter is almost double that of summer. The profile characteristics are viewed at an 11 kV distribution feeder level rather than an individual customer profile

Capturing the profiles at this level in the network hierarchy shows a diversified demand profile illustrating the length of the evening winter peak which can extend upwards of three hours. There is no evidence of significant solar/PV in the summer profile which would show up as significantly reduced demand from late morning until late afternoon.

17.3.2 COMMERCIAL DEMAND PROFILE

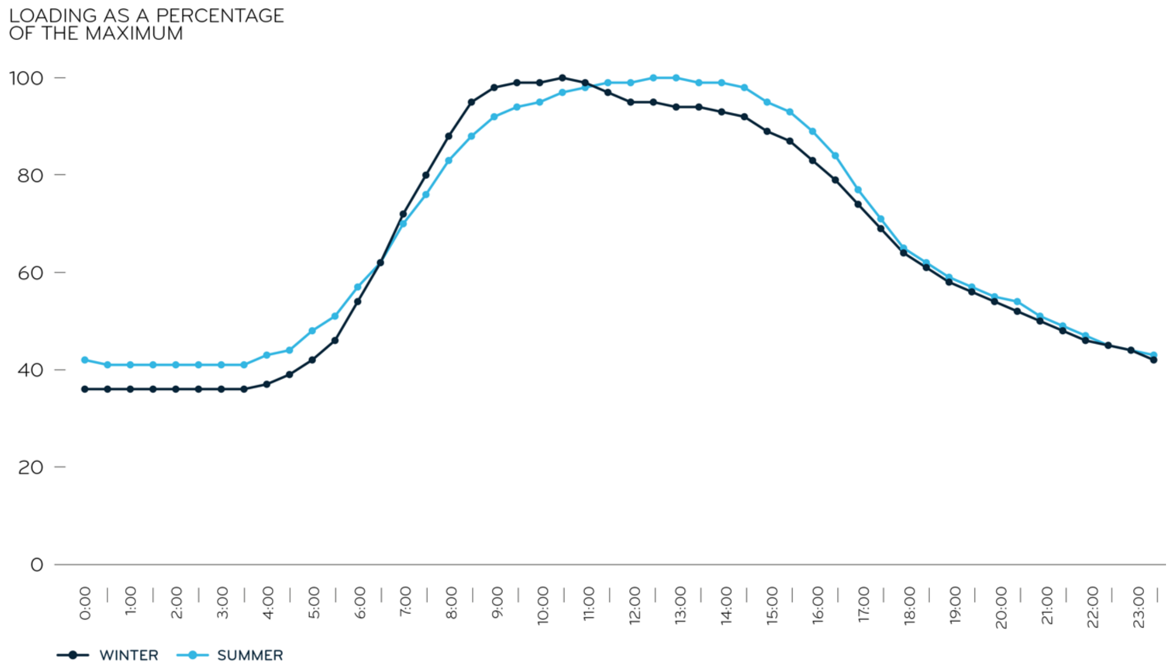


FIGURE 17-2: TYPICAL COMMERCIAL DEMAND PROFILE

Commercial demand follows a similar profile and loading as residential for both winter and summer.

17.3.3 CBD DEMAND PROFILE

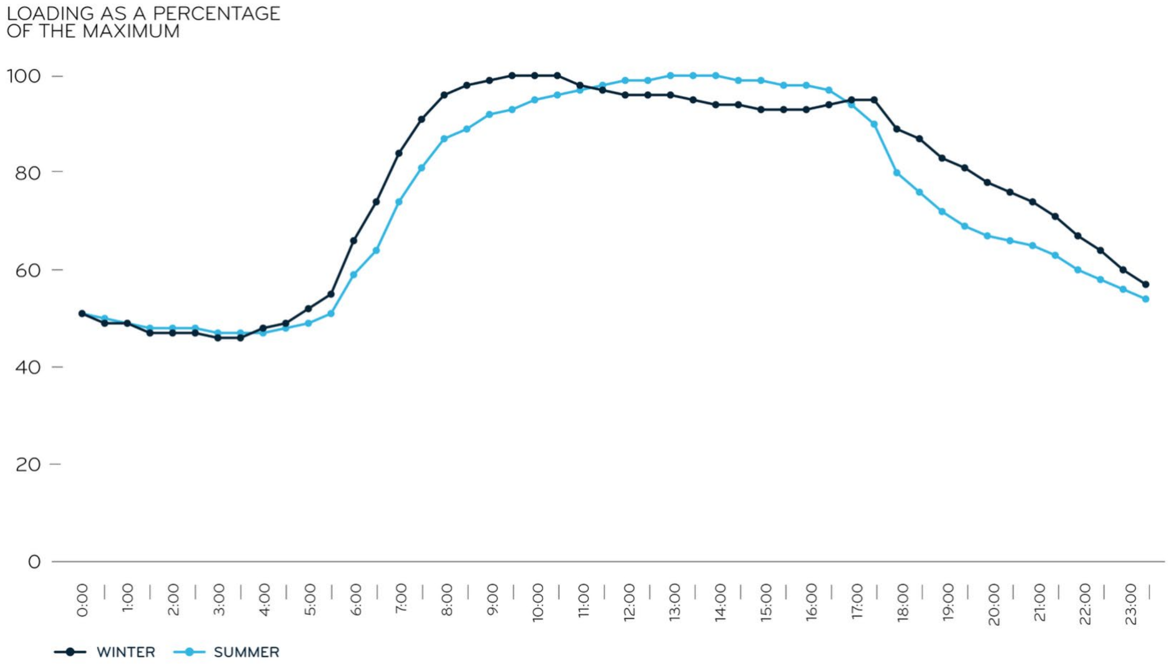


FIGURE 17-3: TYPICAL CBD DEMAND PROFILE

The Auckland CBD load is characterised by the summer profile where load rises quickly in the morning and drops off equally as rapidly in the evening. The winter load profile demonstrates a similar characteristic to the summer although more aggressive uptake before 7.00am and a slower ramp-down in the evenings. The peak load is summer driven mainly by air-conditioning, adding an extra 10% load above the winter demand profile.

17.3.4 LARGE CUSTOMERS THAT HAVE A SIGNIFICANT IMPACT ON THE NETWORK

Vector has several large customer sites at various locations in its network. The following are those customer sites with individual demand above 5 MVA, which are considered to have a significant impact on network operations and asset management:

- Fonterra at Lichfield;
- Auckland International Airport;
- Mangere Waste Water Treatment Plant;
- Bluescope Steel at Mangere;
- Pacific Steel at Mangere;
- Auckland Hospital at Newmarket;
- Carter Holt Harvey at Penrose
- Owens Illinois at Penrose

There has also been an increase in large customer queries supplied from Henderson and Silverdale GXPs.

17.4 Appendix 4 – AMP information disclosure compliance

INFORMATION DISCLOSURE DETERMINATION REQUIREMENT (EXISTING)

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
	Overview	
3.1.	A summary that provides a brief overview of the AMP contents and highlights information that the EDB considers significant;	Sections: 1.1 - 1.6
3.2.	Details of the background and objectives of the EDB's asset management and planning processes;	Sections: 5.1 - 5.3
3.3.	A purpose statement which -	
3.3.1.	makes clear the purpose and status of the AMP in the EDB's asset management practices. The purpose statement must also include a statement of the objectives of the asset management and planning processes;	Sections: 1.8.1, 5.2, 5.3, 10.2, 12.1
3.3.2.	states the corporate mission or vision as it relates to asset management;	Sections: 1.8.5
3.3.3.	identifies the documented plans produced as outputs of the annual business planning process adopted by the EDB;	Section 5
3.3.4.	states how the different documented plans relate to one another, with particular reference to any plans specifically dealing with asset management; and	Section 5
3.3.5.	includes a description of the interaction between the objectives of the AMP and other corporate goals, business planning processes, and plans; The purpose statement should be consistent with the EDB's vision and mission statements and show a clear recognition of stakeholder interest.	Sections: 1, 2, 5
3.4.	Details of the AMP planning period, which must cover at least a projected period of 10 years commencing with the disclosure year following the date on which the AMP is disclosed;	Section 1.8.2
3.5.	The date that it was approved by the directors;	Section 1.8.3
3.6.	A description of stakeholder interests (owners, consumers etc) which identifies important stakeholders and indicates -	
3.6.1.	how the interests of stakeholders are identified	Sections: 4.6
3.6.2.	what these interests are;	Sections: 4.6.3, 4.7
3.6.3.	how these interests are accommodated in asset management practices; and	Sections: 4.6.3, 4.7
3.6.4.	how conflicting interests are managed;	Section 4.8
3.7.	A description of the accountabilities and responsibilities for asset management on at least 3 levels, including -	Sections: 6.1, 6.2
3.7.1.	governance—a description of the extent of director approval required for key asset management decisions and the extent to which asset management outcomes are regularly reported to directors;	Sections: 6.1, 6.2
3.7.2.	executive—an indication of how the in-house asset management and planning organisation is structured; and	Sections: 6.1, 6.2
3.7.3.	field operations—an overview of how field operations are managed, including a description of the extent to which field work is undertaken in-house and the areas where outsourced contractors are used;	Sections: 6.2, 16.3.1
3.8.	All significant assumptions -	
3.8.1.	quantified where possible;	Sections: 1, 15.6
3.8.2.	clearly identified in a manner that makes their significance understandable to interested persons, including-	Sections: 1, 15.6
3.8.3.	a description of changes proposed where the information is not based on the EDB's existing business;	Sections: 1, 15.6

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
3.8.4.	the sources of uncertainty and the potential effect of the uncertainty on the prospective information; and	Sections: 1, 15.6
3.8.5.	the price inflator assumptions used to prepare the financial information disclosed in nominal New Zealand dollars in the Report on Forecast Capital Expenditure set out in Schedule 11a and the Report on Forecast Operational Expenditure set out in Schedule 11b;	Appendix 13
3.9.	A description of the factors that may lead to a material difference between the prospective information disclosed and the corresponding actual information recorded in future disclosures;	Sections: 1, 15.6
3.10.	An overview of asset management strategy and delivery; To support the Report on Asset Management Maturity disclosure and assist interested persons to assess the maturity of asset management strategy and delivery, the AMP should identify- • how the asset management strategy is consistent with the EDB's other strategy and policies; • how the asset strategy takes into account the life cycle of the assets; • the link between the asset management strategy and the AMP; and • processes that ensure costs, risks and system performance will be effectively controlled when the AMP is implemented.	Section 5
3.11.	An overview of systems and information management data; To support the Report on Asset Management Maturity disclosure and assist interested persons to assess the maturity of systems and information management, the AMP should describe- a) the processes used to identify asset management data requirements that cover the whole of life cycle of the assets; b) the systems used to manage asset data and where the data is used, including an overview of the systems to record asset conditions and operation capacity and to monitor the performance of assets; c) the systems and controls to ensure the quality and accuracy of asset management information; d) the extent to which these systems, processes and controls are integrated; e) how asset management data informs the models that an EDB develops and uses to assess asset health; and f) how the outputs of these models are used in developing capital expenditure projections.	Sections: 5, 6.6, 6.7, 12.1, 12.2
3.12.	A statement covering any limitations in the availability or completeness of asset management data and disclose any initiatives intended to improve the quality of this data;	Section 6.7.3
3.13.	A description of the processes used within the EDB for -	
3.13.1.	managing routine asset inspections and network maintenance;	Section 8
3.13.2.	planning and implementing network development projects; and	Section 10.4
3.13.3.	measuring network performance;	Sections: 7.5, 7.6
3.14.	An overview of asset management documentation, controls and review processes.	Sections: 5.4, 5.5, 5.6, 16.3
3.15.	An overview of communication and participation processes;	Section 5.6.6
3.16.	The AMP must present all financial values in constant price New Zealand dollars except where specified otherwise; and	Compliant
3.17.	The AMP must be structured and presented in a way that the EDB considers will support the purposes of AMP disclosure set out in clause 2.6.2 of the determination	Compliant
	Assets Covered	
4	The AMP must provide details of the assets covered, including-	
4.1.	a high-level description of the service areas covered by the EDB and the degree to which these are interlinked, including-	Section 3.1
4.1.1.	the region(s) covered;	Section 3.1
4.1.2.	identification of large consumers that have a significant impact on network operations or asset management priorities;	Sections: 9.3.3, Appendix 3

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
4.1.3.	description of the load characteristics for different parts of the network;	Sections: 3 (overview) 10 (detail), Appendix 3
4.1.4.	peak demand and total energy delivered in the previous year, broken down by sub-network, if any.	Sections: 10.6, Appendix 10
4.2.	A description of the network configuration, including-	
4.2.1.	identifying bulk electricity supply points and any distributed generation with a capacity greater than 1 MW. State the existing firm supply capacity and current peak load of each bulk electricity supply point;	Sections: 3, 10.6, Appendix 9
4.2.2.	a description of the subtransmission system fed from the bulk electricity supply points, including the capacity of zone substations and the voltage(s) of the subtransmission network(s). The AMP must identify the supply security provided at individual zone substations, by describing the extent to which each has n-x subtransmission security or by providing alternative security class ratings;	Sections: 3, 10.6, Appendix 9
4.2.3.	a description of the distribution system, including the extent to which it is underground;	Section 3 (overview). Section 12 (detail)
4.2.4.	a brief description of the network's distribution substation arrangements;	Section 3 (overview). Section 12 (detail)
4.2.5.	a description of the low voltage network including the extent to which it is underground; and	Section 3 (overview). Section 12 (detail)
4.2.6.	an overview of secondary assets such as protection relays, ripple injection systems, SCADA and telecommunications systems.	Section 3 (overview). Section 12 (detail)
4.3.	If sub-networks exist, the network configuration information referred to in clause 4.2 must be disclosed for each sub-network.	N/A
	Network assets by category	
4.4	The AMP must describe the network assets by providing the following information for each asset category-	
4.4.1.	voltage levels;	Sections: 12.3 - 12.11
4.4.2.	description and quantity of assets;	Sections: 12.3 - 12.11
4.4.3.	age profiles; and	Sections: 12.3 - 12.11
4.4.4.	a discussion of the condition of the assets, further broken down into more detailed categories as considered appropriate. Systemic issues leading to the premature replacement of assets or parts of assets should be discussed.	Sections: 12.3 - 12.11
4.5.	The asset categories discussed in clause 4.4 should include at least the following-	
4.5.1.	the categories listed in the Report on Forecast Capital Expenditure in Schedule 11a(iii);	Section 12
4.5.2.	assets owned by the EDB but installed at bulk electricity supply points owned by others;	N/A
4.5.3.	EDB owned mobile substations and generators whose function is to increase supply reliability or reduce peak demand; and	Section 12.10
4.5.4.	other generation plant owned by the EDB.	Section 12.10
	Service Levels	
5.	The AMP must clearly identify or define a set of performance indicators for which annual performance targets have been defined. The annual performance targets must be consistent with business strategies and asset management objectives and be provided for each year of the AMP planning period. The targets should reflect what is practically achievable given the current network configuration, condition and planned expenditure levels. The targets should be disclosed for each year of the AMP planning period.	Section 7
6.	Performance indicators for which targets have been defined in clause 5 must include SAIDI values and SAIFI values for the next 5 disclosure years.	Section 7.5

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
7.	Performance indicators for which targets have been defined in clause 5 should also include-	
7.1.	Consumer oriented indicators that preferably differentiate between different consumer types; and	Sections: 7.1, 7.2
7.2.	Indicators of asset performance, asset efficiency and effectiveness, and service efficiency, such as technical and financial performance indicators related to the efficiency of asset utilisation and operation.	Section 7
8.	The AMP must describe the basis on which the target level for each performance indicator was determined. Justification for target levels of service includes consumer expectations or demands, legislative, regulatory, and other stakeholders' requirements or considerations. The AMP should demonstrate how stakeholder needs were ascertained and translated into service level targets.	Section 7
9.	Targets should be compared to historic values where available to provide context and scale to the reader.	Section 7
10.	Where forecast expenditure is expected to materially affect performance against a target defined in clause 5, the target should be consistent with the expected change in the level of performance.	Sections: 7, 15
	Network Development Planning	
11.	AMPs must provide a detailed description of network development plans, including—	
11.1.	A description of the planning criteria and assumptions for network development;	Sections: 10.3 - 10.4
11.2.	Planning criteria for network developments should be described logically and succinctly. Where probabilistic or scenario-based planning techniques are used, this should be indicated and the methodology briefly described;	Sections: 10.3 - 10.4
11.3.	A description of strategies or processes (if any) used by the EDB that promote cost efficiency including through the use of standardised assets and designs;	Sections: 9.3, 10.1 – 10.5, 16.4
11.4.	The use of standardised designs may lead to improved cost efficiencies. This section should discuss-	Sections: 9.3, 10.1 – 10.5, 16.4
11.4.1.	the categories of assets and designs that are standardised; and	Sections: 9.3, 10.1 – 10.5, 16.4
11.4.2.	the approach used to identify standard designs;	Sections: 9.3, 10.1 – 10.5, 16.4
11.5.	A description of strategies or processes (if any) used by the EDB that promote the energy efficient operation of the network;	Sections: 9.3, 10.1 – 10.5, 16.4
11.6.	A description of the criteria used to determine the capacity of equipment for different types of assets or different parts of the network;	Section 10.4, 12.2
11.7.	A description of the process and criteria used to prioritise network development projects and how these processes and criteria align with the overall corporate goals and vision;	Sections: 10.1 - 10.4
11.8.	Details of demand forecasts, the basis on which they are derived, and the specific network locations where constraints are expected due to forecast increases in demand;	Section 10.3, 10.4
11.8.1.	explain the load forecasting methodology and indicate all the factors used in preparing the load estimates;	Section 10.3, 10.4
11.8.2.	provide separate forecasts to at least the zone substation level covering at least a minimum five year forecast period. Discuss how uncertain but substantial individual projects/developments that affect load are taken into account in the forecasts, making clear the extent to which these uncertain increases in demand are reflected in the forecasts;	Section 10.6
11.8.3.	identify any network or equipment constraints that may arise due to the anticipated growth in demand during the AMP planning period; and	Sections: 10.6, 10a
11.8.4.	discuss the impact on the load forecasts of any anticipated levels of distributed generation in a network, and the projected impact of any demand management initiatives;	Sections: 10.3.4, 10.3.5, 10.5, 10.6, 10a
11.9.	Analysis of the significant network level development options identified and details of the decisions made to satisfy and meet target levels of service, including-	Sections: 10.6, 10a
11.9.1.	the reasons for choosing a selected option for projects where decisions have been made;	Sections: 10.6, 10a

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
11.9.2.	the alternative options considered for projects that are planned to start in the next five years and the potential for non-network solutions described; and	Sections: 10.6, 10a
11.9.3.	consideration of planned innovations that improve efficiencies within the network, such as improved utilisation, extended asset lives, and deferred investment;	Sections: 10.6, 10a
11.10.	A description and identification of the network development programme including distributed generation and non-network solutions and actions to be taken, including associated expenditure projections. The network development plan must include-	Sections: 10.3.4-10.3.5, 10.5,10.6, 10a
11.10.1.	a detailed description of the material projects and a summary description of the non-material projects currently underway or planned to start within the next 12 months;	Sections: 10.6. 10a
11.10.2.	a summary description of the programmes and projects planned for the following four years (where known); and	Sections: 10.6, 10a
11.10.3.	an overview of the material projects being considered for the remainder of the AMP planning period;	Sections: 10.6, 10a
11.11.	A description of the EDB's policies on distributed generation, including the policies for connecting distributed generation. The impact of such generation on network development plans must also be stated; and	Sections: 9.3.4, 10
11.12.	A description of the EDB's policies on non-network solutions, including-	Sections: 10.3.4, 10.3.5, 10.5, 10.6, 10a
11.12.1.	economically feasible and practical alternatives to conventional network augmentation. These are typically approaches that would reduce network demand and/or improve asset utilisation; and	Sections: 10.3.4, 10.3.5, 10.5, 10.6, 10a
11.12.2.	the potential for non-network solutions to address network problems or constraints.	Sections: 10.3.4, 10.3.5, 10.5, 10.6, 10a
	Lifecycle Asset Management Planning (Maintenance and Renewal)	
12.	The AMP must provide a detailed description of the lifecycle asset management processes, including—	
12.1.	The key drivers for maintenance planning and assumptions;	Sections: 8, 12.1, 12.2, 15.6
12.2.	Identification of routine and corrective maintenance and inspection policies and programmes and actions to be taken for each asset category, including associated expenditure projections. This must include-	Sections: 8, 12.3 - 12.11
12.2.1.	the approach to inspecting and maintaining each category of assets, including a description of the types of inspections, tests and condition monitoring carried out and the intervals at which this is done;	Sections: 8, 12.3 - 12.11
12.2.2.	any systemic problems identified with any particular asset types and the proposed actions to address these problems; and	Sections: 8, 12.3 - 12.11
12.2.3.	budgets for maintenance activities broken down by asset category for the AMP planning period;	Sections: 8, 12.3 - 12.11
12.3.	Identification of asset replacement and renewal policies and programmes and actions to be taken for each asset category, including associated expenditure projections. This must include-	
12.3.1.	the processes used to decide when and whether an asset is replaced or refurbished, including a description of the factors on which decisions are based, and consideration of future demands on the network and the optimum use of existing network assets;	Sections: 8, 12.3 - 12.12
12.3.2.	a description of innovations that have deferred asset replacements;	Section: 12.10.1
12.3.3.	a description of the projects currently underway or planned for the next 12 months;	Section 12a
12.3.4.	a summary of the projects planned for the following four years (where known); and	Section 12a
12.3.5.	an overview of other work being considered for the remainder of the AMP planning period; and	Section 12a
12.4.	The asset categories discussed in clauses 12.2 and 12.3 should include at least the categories in clause 4.5.	Sections: 12, 12a

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
12.5	Identification of the approach used for developing capital expenditure projections for lifecycle asset management. This must include an explanation of -	
12.5.1	the approach that the EDB uses to inform its capital expenditure projections for lifecycle asset management; and	Sections: 5, 12, 15
12.5.2	the rationale for using the approach for each asset category.	Sections: 12.3
12.6	Identification of vegetation management related maintenance. This must include an explanation of the approach and assumptions that the EDB uses to inform its vegetation management related maintenance.	Section: 11.4.1, 11.5.2, 11.6.2
12.7	The EDB's consideration of non-network solutions to inform its capital and operational expenditure projections for lifecycle asset management. This must include an explanation of the approach and assumptions the EDB used to inform these expenditure projections;	Sections: 10.3 – 10.5
	Non-Network Development, Maintenance and Renewal	
13.	AMPs must provide a summary description of material non-network development, maintenance and renewal plans, including—	
13.1.	a description of non-network assets;	Section 14.3
13.2.	development, maintenance and renewal policies that cover them;	Sections: 14.4 - 14.8
13.3.	a description of material capital expenditure projects (where known) planned for the next five years; and	Sections: 14.4 - 14.10
13.4.	a description of material maintenance and renewal projects (where known) planned for the next five years.	Sections: 14.4 - 14.8
	Risk Management	
14.	AMPs must provide details of risk policies, assessment, and mitigation, including—	
14.1.	Methods, details and conclusions of risk analysis;	Section 6.3
14.2.	Strategies used to identify areas of the network that are vulnerable to high impact low probability events and a description of the resilience of the network and asset management systems to such events;	Section 6.3
14.3.	A description of the policies to mitigate or manage the risks of events identified in clause 14.2; and	Section 6.3
14.4.	Details of emergency response and contingency plans.	Section 6.4
	Evaluation of Performance	
15.	AMPs must provide details of performance measurement, evaluation, and improvement, including—	
15.1.	A review of progress against plan, both physical and financial;	Sections: 15, Appendix 5
15.2.	An evaluation and comparison of actual service level performance against targeted performance;	Sections: 7
15.3.	An evaluation and comparison of the results of the asset management maturity assessment disclosed in the Report on Asset Management Maturity set out in Schedule 13 against relevant objectives of the EDB's asset management and planning processes.	Sections: 5.6, Appendix 12
15.4.	An analysis of gaps identified in clauses 15.2 and 15.3. Where significant gaps exist (not caused by one-off factors), the AMP must describe any planned initiatives to address the situation.	Sections: 5.6, Appendix 12
	Capability to Deliver	
16.	AMPs must describe the processes used by the EDB to ensure that-	
16.1.	The AMP is realistic and the objectives set out in the plan can be achieved; and	Sections: 1, 15, 16
16.2.	The organisation structure and the processes for authorisation and business capabilities will support the implementation of the AMP plans.	Sections: 6, 16

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
	Planned / Unplanned Interruptions	
17.1	A description of how the EDB provides notice to and communicates with consumers regarding planned interruptions and unplanned interruptions, including any changes to the EDB's processes and communications in this area;	Section 7.5.1
	Power Quality	
17.2	A description of the EDB's practices for monitoring voltage, including -	Section: 7.3
17.2.1	the EDB's practices for monitoring voltage quality on its low voltage network;	Section: 7.3
17.2.2	work the EDB is doing on its low voltage network to address any known non-compliance with the applicable voltage requirements of the Electricity (Safety) Regulations 2010;	Section: 7.3
17.2.3	how the EDB responds to and reports on voltage quality issues when the EDB identifies them, or when they are raised by a stakeholder;	Section: 7.3
17.2.4	how the EDB communicates with affected consumers regarding the voltage quality work it is carrying out on its low voltage network; and	Section: 7.3
17.2.5	any plans for improvements to any of the practices outlined at clauses 17.2.1-17.2.4 above;	Section: 7.3
	Customer Service Practices	
17.3	A description of the EDB's customer service practices, including -	
17.3.1	the EDB's customer engagement protocols and customer service measures – including customer satisfaction with the EDB's supply of electricity distribution services;	Sections: 2.5, 4.4, 4.5, 7.2, 10.3.2
17.3.2	the EDB's approach to planning and managing customer complaint resolution;	Section: 7.8
	Connecting New Customers and Altering Connections	
17.4	A description of the EDB's practices for connecting consumers, including -	Section: 9.3
17.4.1	the EDB's approach to planning and management of (a) connecting new consumers (offtake and injection connections), and overcoming commonly encountered issues; and (b) alterations to existing connections (offtake and injection connections);	Section: 9.3
17.4.2	how the EDB is seeking to minimise the cost to consumers of new or altered connections;	Section: 9.3
17.4.3	the EDB's approach to planning and managing communication with consumers about new or altered connections; and	Section: 9.3
17.4.4	commonly encountered delays and potential timeframes for different connections.	Section: 9.3
	New Connection Impact to Network and Asset Management	
17.5	A description of the following:	
17.5.1	how the EDB assesses the impact that new demand, generation, or storage capacity will have on the EDB's network, including: (a) how the EDB measures the scale and impact of new demand, generation, or storage capacity; (b) how the EDB takes the timing and uncertainty of new demand, generation, or storage capacity into account; (c) how the EDB takes other factors into account, e.g., the network location of new demand, generation, or storage capacity; and	Sections: 10.3, 10.4, 10.5
17.5.2	how the EDB assesses and manages the risk to the network posed by uncertainty regarding new demand, generation, or storage capacity;	Sections: 10.3, 10.4, 10.5
	Innovation	
17.6	Must include a description of the following -	Sections: 2, 4, 10.3

CONTENTS OF THE AMP	CLAUSE	AMP SECTION
17.6.1	any innovation practices the EDB has planned or undertaken since the last AMP or AMP update was publicly disclosed, including case studies and trials;	Sections: 2, 4, 10.3
17.6.2	the EDB's desired outcomes of any innovation practices, and how they may improve outcomes for consumers;	Sections: 2, 4, 10.3
17.6.3	how the EDB measures success and makes decisions regarding any innovation practices, including how the EDB decides whether to commence, commercially adopt, or discontinue these practices;	Sections: 2, 4, 10.3
17.6.4	how the EDB's decision-making and innovation practices depend on the work of other companies, including other EDBs and providers of non-network solutions; and	Sections: 2, 4, 10.3
17.6.5	the types of information the EDB uses to inform or enable any innovation practices, and the EDB's approach to seeking that information.	Sections: 2, 4, 10.3

17.5 Appendix 5 – Significant changes from AMP2023

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
FY29	Quay	Quay St ZSS 110kV SGEAR and 3rd TX	FY33	Brought forward due to new E-ferry load
FY25	Silverdale	Silverdale GXP & Manly Subtrans Cable Reinforcement	FY33	Brought forward due to updated load forecast
Cancelled	Waiheke	Waiheke 11kV SWBD replace	FY33	Cancelled due to alternative solution
Cancelled	Milford	Milford 33/11 TX Replace T1	FY33	Cancelled due to alternative solution
Cancelled	Ngataringa Bay	Ngataringa Bay 33/11 TX Replace T1	FY33	Cancelled due to alternative solution
Beyond AMP Period	Onehunga	Onehunga 11kV reinforcement	FY33	Deferred due to updated load forecast
Beyond AMP Period	Sandringham	Sandringham Mt Albert Rd 11kV feeders new	FY33	Uncertainty with accelerated EV uptake
Beyond AMP Period	Waiake	WAIA K04 overhead replacement	FY33	Updated asset condition and prioritisation
Beyond AMP Period	Bush Rd	Bush Rd ZS 33/11kV TX upgrade T1+T2	FY33	Updated load forecast
FY30	St Johns	St Johns Apirana Ave 11kV feeders new	FY32	Brought forward due to updated load forecast
FY29	Mt Albert	Mt Albert Zone Substation capacity upgrade	FY32	Brought forward due to updated load forecast
FY27	Sabulite	Sabulite 33/11kV TX capacity upgrade	FY32	Brought forward due to updated asset condition
FY27	Manly	Manly 33/11kV TX capacity upgrade	FY32	Brought forward due to updated asset condition
Cancelled	Manurewa	Manurewa Sub-trans reinforcement	FY32	Replaced by alternative solution
Beyond AMP Period	White Swan	White Swan substation upgrade	FY32	Uncertainty with accelerated EV uptake
Beyond AMP Period	Papakura	Takanini Walters Road 11kV feeder new	FY32	Deferred due to updated load forecast
Beyond AMP Period	Chevalier	Chevalier subtran upgrade	FY32	Uncertainty with accelerated EV uptake
Beyond AMP Period	East Coast	East Coast Road ZS 2nd 33/11kV TX & 33kV cable	FY32	Uncertainty with accelerated EV uptake
FY34	Newmarket	Newmarket substation capacity upgrade	FY31	Uncertainty with accelerated EV uptake
FY34	Glen Innes	Glen Innes 33kV SWBD New	FY31	Uncertainty with accelerated EV uptake
FY34	Kingsland	Kingsland substation 110/22kV reinforcement	FY31	Uncertainty with accelerated EV uptake
FY34	Tamaki	Tamaki Zone Substation New	FY31	Uncertainty with accelerated EV uptake
Beyond AMP Period	Helensville	HELE overhead replacement	FY31	Updated asset condition and prioritisation
FY28	Henderson valley	Henderson Valley 33kV SWBD ODID	FY30	Align with another project for cost synergy
FY27	Te Atatu	Te Atatu 33/11kV T1+T2 TX capacity upgrade	FY30	Brought forward due to updated asset condition
Cancelled	Wairau	Wairau 110/33kV TX Replace T2	FY30	Cancelled due to alternative solution
Cancelled	Ranui	Ranui 2nd 33/11kV TX & 11kV switchgear	FY30	Replaced by alternative solution
Beyond AMP Period	Riverhead	RIVE overhead replacement	FY30	Updated asset condition and prioritisation
FY34	Hobson	Hobson to Waterfront 3rd 22kV feeder new	FY29	Uncertainty with accelerated EV uptake

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
FY32	St Johns	St Johns Pilkington Rd 11kV feeders new	FY29	Uncertainty with accelerated EV uptake
FY32	Coatesville	Albany GXP Coatesville Subtrans Cable Replacement	FY29	Uncertainty with accelerated EV uptake
FY26	Mangere South	Mangere South Zone Substation New	FY29	Align with customer project requirement
Cancelled	Wairau	Wairau 110/33kV TX Replace T1	FY29	Cancelled due to alternative solution
Cancelled	Mt Albert	Mt Albert SUBT Cable replace	FY29	Cancelled due to alternative solution
Cancelled	Dairy Flat	Dairy Flat ZS Stage 3rd transformer and subtrans circuits	FY29	Change in customer requirement
Beyond AMP Period	Waikaukau	Waikaukau 33/11kV 2nd TX	FY29	Deferred with alternative solutions
Beyond AMP Period	Manly	MANL K04 overhead replacement	FY29	Updated asset condition and prioritisation
Beyond AMP Period	Warkworth	WARK overhead replacement	FY29	Updated asset condition and prioritisation
Beyond AMP Period	Sandringham	Sandringham subtran upgrade	FY29	Uncertainty with accelerated EV uptake
FY26	Rosedale	Albany GXP Rosedale Subtrans Cable Reinforcement	FY28	Align with third party project
Cancelled	Henderson valley	Henderson Valley 11kV SWBD replace	FY28	Combined with 33kV project for cost synergy
Cancelled	Waikaukau	Waikaukau 11kV SWBD replace	FY28	Combined with 33kV project for cost synergy
Beyond AMP Period	Waimauku	Waimauku ZS 33/11kV T2 TX and 11kV switchgear	FY28	Updated load forecast
Beyond AMP Period	Red Beach	RBEA K03 overhead replacement	FY28	Updated asset condition and prioritisation
Beyond AMP Period	Manly	MANL K04 overhead replacement	FY28	Updated asset condition and prioritisation
FY29	New Lynn	New Lynn 33kV SWBD ODID	FY27	Align with another project for cost synergy
FY29	Glenvar	East Coast Rd and Glenvar Rd	FY27	Align with third party project
Cancelled	Belmont	Belmont 33/11kV T1+T2 TX capacity upgrade	FY27	Replaced with alternative solution
Cancelled	Bush road	Vocus Data Centre Parkhead Dr new 11kV feeder	FY27	Change in customer requirement
Beyond AMP Period	Warkworth	WARK K09 overhead replacement	FY27	Updated asset condition and prioritisation
FY29	Various	AMETI EB2, 3 and 4	FY26	Align with third party project
Cancelled	New Lynn	New Lynn 11kV SWBD replace	FY26	Combined with 33kV project for cost synergy
Cancelled	Dairy Flat	Dairy Flat ZS Stage 2 transformers and switchgear	FY26	Change in customer requirement
Beyond AMP Period	Waimauku	WAIM K09 overhead replacement	FY26	Updated asset condition and prioritisation
Beyond AMP Period	Swanson	SWAN K07 overhead replacement	FY26	Updated asset condition and prioritisation
On-hold	Papakura/Takanini	Fonterra Takanini two 11kV Feeders	FY25	Change in customer requirement
FY27	Hobsonville	CDC Hobsonville - Bulk Supply (33kV)	FY25	Change in customer timeline
Beyond AMP Period	Waimauku	WAIM K09 overhead replacement	FY25	Updated asset condition and prioritisation
Beyond AMP Period	Warkworth	WARK K03 overhead replacement	FY25	Updated asset condition and prioritisation

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
On-hold	Helensville	Helensville Solar Farm Rogan Ave	FY24	Detail work pending
FY28	Waimauku	SH16 Kumeu to Brigham Creek future proofing ducts	FY24	Align with third party project
FY26	Westfield	Westfield SUBT cable replace	FY24	Align with another project for cost synergy
Cancelled	Dairy Flat	Dairy Flat ZS Stage 1 subtrans cable	FY24	Change in customer requirement
FY34	Sunset Road	Sunset Road 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY32	New Lynn	New Lynn 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY32	Forrest Hill	Forrest Hill 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY30	Wellsford	Wellsford 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY26	Wairau	Wairau 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY34	Various	Fluid filled replacement programme	-	New Project
FY34	Remuera	Remuera transformer capacity upgrade	-	New Project
FY33	CBD	CBD Quay 11kV to 22kV conversion for security	-	New Project
FY33	Hans	Hans Middlemore Cres 11kV feeder new	-	New Project
FY33	Avondale	Avondale transformer capacity upgrade	-	New Project
FY33	Balmain 2nd	Balmain 2nd 33/11kV TX & 33kV switchroom	-	New Project
FY33	Highbury	Highbury 11kV switchboard upgrade	-	New Project
FY33	Flat Bush	Flat Bush Murphys Rd 11kF feeder new	-	New Project
FY32	Mt Roskill	Mt Roskill Precinct futureproof ducts and cables	-	New Project
FY32	Tamaki	Tamaki futureproof ducts and cables	-	New Project
FY32	Mangere Central	Mangere Central Massey Rd 11kV feeder new	-	New Project
FY32	Liverpool	Live-Kingsland interconnector replacement	-	New Project
FY32	Otara	Otara Springs Road 11kV feeder new	-	New Project
FY32	Westfield	Westfield Abattoir Lane new 11kV feeders for security	-	New Project
FY32	Mangere	Mangere South 11kV Switchgear and 33/11kV TX	-	New Project
FY30	Wellsford	Wellsford 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY26	Wairau	Wairau 33/11kV TX upgrade T1+T2	Beyond AMP Horizon	Brought forward due to updated asset condition
FY34	Various	Fluid filled replacement programme	-	New Project
FY34	Remuera	Remuera transformer capacity upgrade	-	New Project

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
FY33	CBD	CBD Quay 11kV to 22kV conversion for security	-	New Project
FY33	Hans	Hans Middlemore Cres 11kV feeder new	-	New Project
FY33	Avondale	Avondale transformer capacity upgrade	-	New Project
FY33	Balmain 2nd	Balmain 2nd 33/11kV TX & 33kV switchroom	-	New Project
FY33	Highbury	Highbury 11kV switchboard upgrade	-	New Project
FY33	Flat Bush	Flat Bush Murphys Rd 11kF feeder new	-	New Project
FY32	Mt Roskill	Mt Roskill Precinct futureproof ducts and cables	-	New Project
FY32	Tamaki	Tamaki futureproof ducts and cables	-	New Project
FY32	Mangere Central	Mangere Central Massey Rd 11kV feeder new	-	New Project
FY32	Liverpool	Live-Kingsland interconnector replacement	-	New Project
FY32	Otara	Otara Springs Road 11kV feeder new	-	New Project
FY32	Westfield	Westfield Abattoir Lane new 11kV feeders for security	-	New Project
FY32	Mangere	Mangere South 11kV Switchgear and 33/11kV TX	-	New Project
FY31	St John	St John CCT1 replacement	-	New Project
FY31	Henderson valley	Henderson Valley 33/11kV TX upgrade T1+T2	-	New Project
FY31	Woodford	Woodford ZS 33/11kV TX upgrade T1	-	New Project
FY30	Te Papapa	Te Papapa new 11kV feeders to off load ROCK K10	-	New Project
FY30	Mt Roskill	Mt Albert new 11kV feeders for capacity in MALB K16	-	New Project
FY30	Onehunga	Onehunga new 11kV feeders to supply Neilson St e-bus	-	New Project
FY30	The Drive	Drive 33/11kV TX Replace T2	-	New Project
FY29	The Drive	Drive 33/11kV TX Replace T1	-	New Project
FY29	Albany GXP	Rosedale GXP subtransmission cables	-	New Project
FY29	Hobson	Hobson ZSS 2nd 75MVA 110-22 TX	-	New Project
FY29	CBD	CBD distribution sub 11kV to 22kV conversion	-	New Project
FY28	Belmont	Belmont K09 & K03 reinforcement for E-Ferry	-	New Project
FY28	Rosedale	RDAL 11kV reinforcement/Dedicated feeder E-Bus	-	New Project
FY28	Waiheke	Waiheke 2nd 33/11kV TX and Subtrans	-	New Project
FY28	Newton	Newton 33/11kV TX Replace T2	-	New Project
FY28	James St	James St 33/11kV TX upgrade T1+T2	-	New Project
FY28	Milford	Milford 33/11kV TX upgrade T1	-	New Project

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
FY28	Clendon	Clendon Weymouth Rd 11kV feeder new	-	New Project
FY28	Hobson & Quay	Precinct Properties Downtown Development	-	New Project
FY28	Quay/Hobson	AT -EV Ferry 20 MVA	-	New Project
FY27	Mt Albert	Carrington Rd future-proofing ducts	-	New Project
FY27	Mangere Central	Mangere Central Idlewild Ave 11kV feeder new	-	New Project
FY27	Maraetai	Maraetai - Pine Harbour E-Ferry	-	New Project
FY27	Gulf Harbour	GULF K13 & K07 reinforcement for E-Ferry	-	New Project
FY27	Manurewa	Manurewa Alfriston Rd 11kV feeder new	-	New Project
FY27	Waiake	Waiake 33/11kV TX upgrade T1	-	New Project
FY27	McLeod	McLeod Rd 33/11kV TX upgrade T1	-	New Project
FY27	Silverdale	Silverdale GXP expansion Vector 33kV cable works	-	New Project
FY26	CBD	CBD Hobson St Bradnor Lane 22kV extension	-	New Project
FY26	Mt Eden	Mt Eden Precinct futureproof ducts and cables	-	New Project
FY26	Southdown	Southdown on-site future-proofing ducts	-	New Project
FY26	Hillsborough	Hillsborough new 11kV feeder to supply Carr Rd E-bus	-	New Project
FY26	Otara	Otara Chapel Heights 11kV feeder new	-	New Project
FY26	Highbury	Highbury k11 and k03 reinforcement for E-Ferry	-	New Project
FY26	Ngataringa Bay	NGAT K01 & BMON K01 reinforcement for E-Ferry	-	New Project
FY26	Hobsonville	HOBV K01 & HPOI K06 reinforcement for E-Ferry	-	New Project
FY26	Howick	Half Moon Bay E-Ferry Phase 2	-	New Project
FY26	Takanini	Takanini Heb Place 11kV feeder new E-Bus	-	New Project
FY26	Takanini	Takanini ZSS capacity upgrade	-	New Project
FY26	Belmont	Belmont 33/11kV T3	-	New Project
FY26	Wellsford	WELL K09 overhead replacement	-	New Project
FY26	Torbay	Torbay 33/11kV TX upgrade T1	-	New Project
FY26	Waikaukau	Waikaukau 33/11kV TX Capacity Upgrade T1	-	New Project
FY26	Mangere East	Mangere East Third Transformer and 33kV cable	-	New Project
FY26	Mangere East	Mangere East Puhinui Rd 11kV feeder new	-	New Project
FY26	Quay/Hobson	AT -EV Ferry 7 MVA	-	New Project
FY25	Mangere Central	Mangere Central Robertson Rd 11kV feeder new	-	New Project
FY25	Mangere	Mangere E-Bus feeder	-	New Project

2024 AMP SCHEDULE DATE	SUBSTATION	PROJECT AND PROGRAMME DESCRITPION	2023 AMP SCHEDULE DATE	REASON FOR CHANGE
FY25	Helensville	HELE K05 overhead replacement	-	New Project
FY25	Henderson valley	HVAL K13 overhead replacement	-	New Project
FY25	Warkworth	WARK K13 overhead replacement	-	New Project
FY25	Horseshoe	Horseshoe bush 33kV SWBD New	-	New Project
FY25	Wiri west	West Wiri Southern Gateway 11kV feeder - Stage 1	-	New Project

17.6 Appendix 6 – Forecast Capital Expenditure (Schedule 11a)

Company Name **Vector Limited**
AMP Planning Period **1 April 2024 – 31 March 2034**

SCHEDULE 11a: REPORT ON FORECAST CAPITAL EXPENDITURE

sch ref

		Current Year CY	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
8	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
9	**11a(i): Expenditure on Assets Forecast**	**$000 (in nominal dollars)**										
10	Consumer connection	126,675	213,843	166,126	123,380	102,819	98,181	99,581	95,603	95,578	97,522	99,472
11	System growth	92,195	106,903	108,741	86,750	82,387	78,312	71,181	56,078	57,829	67,175	83,571
12	Asset replacement and renewal	179,114	120,602	188,782	211,432	181,473	160,108	156,087	184,181	179,635	167,428	166,061
13	Asset relocations	26,047	37,800	39,861	36,030	35,528	36,154	36,734	37,381	38,115	38,877	39,655
14	Reliability, safety and environment:											
15	Quality of supply	-	-	-	-	-	-	-	-	-	-	-
16	Legislative and regulatory	(2)	-	-	-	-	-	-	-	-	-	-
17	Other reliability, safety and environment	33,301	52,191	78,419	65,838	63,829	59,300	57,743	61,732	63,282	63,403	63,372
18	**Total reliability, safety and environment**	33,299	52,191	78,419	65,838	63,829	59,300	57,743	61,732	63,282	63,403	63,372
19	**Expenditure on network assets**	457,330	531,339	581,929	523,430	466,036	432,055	421,326	434,975	434,439	434,405	452,131
20	Expenditure on non-network assets	67,409	38,083	46,607	38,467	26,938	22,321	23,001	26,734	30,300	28,354	45,815
21	**Expenditure on assets**	524,739	569,422	628,536	561,897	492,974	454,376	444,327	461,709	464,739	462,759	497,946
22												
23	*plus* Cost of financing	10,612	11,803	13,012	11,083	9,881	9,167	8,879	8,840	9,029	9,216	10,351
24	*less* Value of capital contributions	177,202	317,913	288,864	231,166	206,714	208,912	214,543	203,409	191,862	185,167	176,782
25	*plus* Value of vested assets											
26												
27	**Capital expenditure forecast**	358,149	263,312	352,684	341,814	296,141	254,631	238,663	267,140	281,906	286,808	331,515
28												
29	Assets commissioned	308,324	382,111	329,295	291,070	282,720	254,745	237,407	266,336	281,563	286,459	331,159
30		*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
31	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
32		**$000 (in constant prices)**										
33	Consumer connection	126,675	207,555	157,648	114,771	93,850	87,929	87,434	82,295	80,660	80,687	80,687
34	System growth	92,195	103,759	103,192	80,697	75,200	70,134	62,498	48,272	48,803	55,579	67,789
35	Asset replacement and renewal	179,114	117,056	179,148	196,678	165,643	143,389	137,047	158,543	151,598	138,526	134,701
36	Asset relocations	26,047	36,688	37,827	33,516	32,429	32,379	32,253	32,178	32,166	32,166	32,166
37	Reliability, safety and environment:											
38	Quality of supply	-	-	-	-	-	-	-	-	-	-	-
39	Legislative and regulatory	(2)	-	-	-	-	-	-	-	-	-	-
40	Other reliability, safety and environment	33,301	50,656	74,417	61,244	58,261	53,108	50,699	53,139	53,405	52,458	51,404
41	**Total reliability, safety and environment**	33,299	50,656	74,417	61,244	58,261	53,108	50,699	53,139	53,405	52,458	51,404
42	**Expenditure on network assets**	457,330	515,714	552,232	486,906	425,383	386,939	369,931	374,427	366,632	359,416	366,747
43	Expenditure on non-network assets	67,409	36,963	44,229	35,783	24,588	19,990	20,195	23,013	25,571	23,459	37,163
44	**Expenditure on assets**	524,739	552,677	596,461	522,689	449,971	406,929	390,126	397,440	392,203	382,875	403,910

Subcomponents of expenditure on assets (where known)

**EDBs' must disclose both a public version of this Schedule (excluding cybersecurity cost data) and a confidential version of this Schedule (including cybersecurity costs)*

Energy efficiency and demand side management, reduction of energy losses											
Overhead to underground conversion	13,777	12,264	12,705	12,705	12,705	12,705	12,705	12,705	12,705	12,705	12,705
Research and development	-	-	-	-	-	-	-	-	-	-	-
Cybersecurity (Commission only)											

	Current Year CY	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
Difference between nominal and constant price forecasts	**$000**										
Consumer connection	-	6,288	8,478	8,609	8,969	10,252	12,147	13,308	14,918	16,835	18,785
System growth	-	3,144	5,549	6,053	7,187	8,178	8,683	7,806	9,026	11,596	15,782
Asset replacement and renewal	-	3,546	9,634	14,754	15,830	16,719	19,040	25,638	28,037	28,902	31,360
Asset relocations	-	1,112	2,034	2,514	3,099	3,775	4,481	5,203	5,949	6,711	7,489
Reliability, safety and environment:											
Quality of supply	-	-	-	-	-	-	-	-	-	-	-
Legislative and regulatory	-	-	-	-	-	-	-	-	-	-	-
Other reliability, safety and environment	-	1,535	4,002	4,594	5,568	6,192	7,044	8,593	9,877	10,945	11,968
Total reliability, safety and environment	-	1,535	4,002	4,594	5,568	6,192	7,044	8,593	9,877	10,945	11,968
Expenditure on network assets	-	15,625	29,697	36,524	40,653	45,116	51,395	60,548	67,807	74,989	85,384
Expenditure on non-network assets	-	1,120	2,378	2,684	2,350	2,331	2,806	3,721	4,729	4,895	8,652
Expenditure on assets	-	16,745	32,075	39,208	43,003	47,447	54,201	64,269	72,536	79,884	94,036

Commentary on options and considerations made in the assessment of forecast expenditure

EDBs may provide explanatory comment on the options they have considered (including scenarios used) in assessing forecast expenditure on assets for the current disclosure year and a 10 year planning period in Schedule 15

Row			Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
73	**11a(ii): Consumer Connection**	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**
74	*Consumer types defined by EDB**		**$000 (in constant prices)**					
75	Service Connection		23,033	30,108	28,876	26,814	26,457	27,470
	Customer Substations		44,042	125,014	86,383	48,991	28,902	20,422
	Business subdivisions		3,196	1,730	1,001	1,004	1,004	1,004
76	Residential Subdivisions		49,631	43,330	36,392	33,508	33,033	34,579
77	Capacity Changes		5,426	5,881	3,687	3,145	3,145	3,145
78	Street Lighting		1,345	1,492	1,309	1,309	1,309	1,309
79	Easements		2	-	-	-	-	-
80	**include additional rows if needed*							
81	**Consumer connection expenditure**		126,675	207,555	157,648	114,771	93,850	87,929
82	*less* Capital contributions funding consumer connection		124,637	209,636	160,064	116,529	95,287	89,276
83	**Consumer connection less capital contributions**		2,038	(2,081)	(2,416)	(1,758)	(1,437)	(1,347)
84	**11a(iii): System Growth**							
85	Subtransmission		21,276	22,503	20,758	9,065	6,241	5,391
86	Zone substations		25,407	45,563	43,835	33,368	33,095	29,655
87	Distribution and LV lines		5,279	1,408	-	-	-	-
88	Distribution and LV cables		20,899	34,254	38,599	38,264	35,864	35,088
89	Distribution substations and transformers		17,176	7	-	-	-	-
90	Distribution switchgear		170	-	-	-	-	-
91	Other network assets		1,988	24	-	-	-	-
92	**System growth expenditure**		92,195	103,759	103,192	80,697	75,200	70,134
93	*less* Capital contributions funding system growth		40,250	76,000	90,523	80,265	76,604	81,297
94	**System growth less capital contributions**		51,945	27,759	12,669	432	(1,404)	(11,163)
95								
96			*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
97		for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**
98	**11a(iv): Asset Replacement and Renewal**		**$000 (in constant prices)**					
99	Subtransmission		1,099	4,036	26,672	24,927	13,893	6,925
100	Zone substations		53,792	27,040	62,558	73,510	57,191	44,381
101	Distribution and LV lines		13,448	10,942	12,374	13,785	13,185	12,893
102	Distribution and LV cables		64,604	42,456	42,932	47,544	45,509	44,575
103	Distribution substations and transformers		29,202	10,495	7,455	8,102	7,720	7,534
104	Distribution switchgear		10,013	14,628	19,784	21,769	21,294	21,062
105	Other network assets		6,956	7,459	7,373	7,041	6,851	6,019
106	**Asset replacement and renewal expenditure**		179,114	117,056	179,148	196,678	165,643	143,389
107	*less* Capital contributions funding asset replacement and renewal							
108	**Asset replacement and renewal less capital contributions**		179,114	117,056	179,148	196,678	165,643	143,389
109								

11a(v): Asset Relocations

		Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
	for year ended	31 Mar 24	31 Mar 25	31 Mar 26	31 Mar 27	31 Mar 28	31 Mar 29
*Project or programme**		$000 (in constant prices)					
Overground to underground conversions		13,777	12,264	12,705	12,705	12,705	12,705
**include additional rows if needed*							
All other project or programmes - asset relocations		12,270	24,424	25,122	20,811	19,724	19,674
Asset relocations expenditure		26,047	36,688	37,827	33,516	32,429	32,379
less Capital contributions funding asset relocations		12,315	22,928	23,536	18,241	16,791	16,524
Asset relocations less capital contributions		13,732	13,760	14,291	15,275	15,638	15,855

11a(vi): Quality of Supply

		Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
	for year ended	31 Mar 24	31 Mar 25	31 Mar 26	31 Mar 27	31 Mar 28	31 Mar 29
*Project or programme**		$000 (in constant prices)					
**include additional rows if needed*							
All other projects or programmes - quality of supply							
Quality of supply expenditure		-	-	-	-	-	-
less Capital contributions funding quality of supply							
Quality of supply less capital contributions		-	-	-	-	-	-

11a(vii): Legislative and Regulatory

		Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
	for year ended	31 Mar 24	31 Mar 25	31 Mar 26	31 Mar 27	31 Mar 28	31 Mar 29
*Project or programme**		$000 (in constant prices)					
**include additional rows if needed*							
All other projects or programmes - legislative and regulatory		(2)					
Legislative and regulatory expenditure		(2)	-	-	-	-	-
less Capital contributions funding legislative and regulatory							
Legislative and regulatory less capital contributions		(2)	-	-	-	-	-

11a(viii): Other Reliability, Safety and Environment

		Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
	for year ended	31 Mar 24	31 Mar 25	31 Mar 26	31 Mar 27	31 Mar 28	31 Mar 29
*Project or programme**		$000 (in constant prices)					
		33,301	50,656	74,417	61,244	58,261	53,108
**include additional rows if needed*							
All other projects or programmes - other reliability, safety and environment							
Other reliability, safety and environment expenditure		33,301	50,656	74,417	61,244	58,261	53,108
less Capital contributions funding other reliability, safety and environment							
Other reliability, safety and environment less capital contributions		33,301	50,656	74,417	61,244	58,261	53,108

11a(ix): Non-Network Assets

		Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
	for year ended	31 Mar 24	31 Mar 25	31 Mar 26	31 Mar 27	31 Mar 28	31 Mar 29
Routine expenditure							
*Project or programme**		$000 (in constant prices)					
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
**include additional rows if needed*							
All other projects or programmes - routine expenditure		40,393	10,277	19,724	14,781	12,021	12,430
Routine expenditure		40,393	10,277	19,724	14,781	12,021	12,430
Atypical expenditure							
*Project or programme**							
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
[Description of material project or programme]							
**include additional rows if needed*							
All other projects or programmes - atypical expenditure		27,016	26,686	24,505	21,002	12,567	7,560
Atypical expenditure		27,016	26,686	24,505	21,002	12,567	7,560
Expenditure on non-network assets		67,409	36,963	44,229	35,783	24,588	19,990

17.7 Appendix 7 – Forecast Operational Expenditure (Schedule 11b)

											Company Name	**Vector Limited**
											AMP Planning Period	**1 April 2024 – 31 March 2034**
	SCHEDULE 11b: REPORT ON FORECAST OPERATIONAL EXPENDITURE											
sch ref												
7		*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
8	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
9	**Operational Expenditure Forecast**	**$000 (in nominal dollars)**										
10	Service interruptions and emergencies	13,693	17,287	17,861	24,411	20,907	19,420	19,958	20,511	27,749	23,887	22,265
11	Vegetation management	6,769	8,008	7,705	7,474	7,628	6,944	6,804	6,940	7,079	7,220	7,365
12	Routine and corrective maintenance and inspection	22,117	25,015	26,318	26,862	27,644	28,179	28,708	29,816	29,457	31,063	31,431
13	Asset replacement and renewal	14,891	16,421	17,512	15,494	14,665	14,933	15,351	15,780	16,221	16,675	17,141
14	**Network Opex**	57,470	66,732	69,396	74,241	70,844	69,477	70,821	73,047	80,506	78,846	78,203
15	System operations and network support	54,909	57,581	61,278	63,235	65,387	67,310	70,217	72,516	75,059	77,596	80,865
16	Business support	54,583	59,063	60,880	62,338	63,863	65,360	66,827	68,425	70,119	71,886	73,733
17	**Non-network opex**	109,492	116,645	122,159	125,573	129,249	132,669	137,044	140,941	145,179	149,482	154,598
18	**Operational expenditure**	166,962	183,376	191,555	199,815	200,093	202,146	207,865	213,988	225,684	228,328	232,800
19		*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
20	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
21		**$000 (in constant prices)**										
22	Service interruptions and emergencies	13,693	16,931	17,080	22,833	19,212	17,468	17,599	17,732	23,492	19,877	18,139
23	Vegetation management	6,769	7,830	7,375	7,000	7,000	6,250	6,000	6,000	6,000	6,000	6,000
24	Routine and corrective maintenance and inspection	22,117	24,490	25,168	25,158	25,365	25,347	25,316	25,775	24,972	25,807	25,609
25	Asset replacement and renewal	14,891	16,071	16,747	14,522	13,458	13,432	13,536	13,642	13,749	13,856	13,964
26	**Network Opex**	57,470	65,322	66,369	69,513	65,036	62,496	62,452	63,149	68,212	65,540	63,713
27	System operations and network support	54,909	56,367	58,598	59,221	59,996	60,542	61,914	62,692	63,616	64,478	65,874
28	Business support	54,583	57,843	58,221	58,382	58,601	58,789	58,931	59,156	59,432	59,735	60,068
29	**Non-network opex**	109,492	114,209	116,819	117,603	118,597	119,331	120,844	121,848	123,048	124,213	125,941
30	**Operational expenditure**	166,962	179,531	183,188	187,116	183,633	181,827	183,296	184,997	191,260	189,753	189,654
31	**Subcomponents of operational expenditure (where known)**											
	**EDBs' must disclose both a public version of this Schedule (excluding cybersecurity cost data) and a confidential version of this Schedule (including cybersecurity costs)*											
32	Energy efficiency and demand side management, reduction of											
33	energy losses											
34	Direct billing*											
35	Research and Development											
36	Insurance	4,929	5,546	6,139	6,798	7,535	8,358	9,278	10,307	11,458	12,745	14,185
37	Cybersecurity (Commission only)											
38	** Direct billing expenditure by suppliers that direct bill the majority of their consumers*											
39												
40		*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*	*CY+6*	*CY+7*	*CY+8*	*CY+9*	*CY+10*
41	for year ended	**31 Mar 24**	**31 Mar 25**	**31 Mar 26**	**31 Mar 27**	**31 Mar 28**	**31 Mar 29**	**31 Mar 30**	**31 Mar 31**	**31 Mar 32**	**31 Mar 33**	**31 Mar 34**
42	**Difference between nominal and real forecasts**	**$000**										
43	Service interruptions and emergencies	-	357	781	1,578	1,694	1,953	2,359	2,779	4,257	4,010	4,127
44	Vegetation management	-	178	330	474	628	694	804	940	1,079	1,220	1,365
45	Routine and corrective maintenance and inspection	-	525	1,150	1,704	2,279	2,832	3,392	4,041	4,485	5,256	5,822
46	Asset replacement and renewal	-	350	765	972	1,207	1,502	1,814	2,138	2,473	2,819	3,177
47	**Network Opex**	-	1,410	3,026	4,728	5,808	6,981	8,369	9,897	12,293	13,306	14,490
48	System operations and network support	-	1,214	2,681	4,014	5,390	6,768	8,303	9,824	11,443	13,118	14,991
49	Business support	-	1,221	2,659	3,956	5,262	6,571	7,897	9,269	10,687	12,152	13,665
50	**Non-network opex**	-	2,435	5,340	7,970	10,652	13,339	16,200	19,093	22,131	25,270	28,657
51	**Operational expenditure**	-	3,845	8,366	12,698	16,460	20,319	24,569	28,991	34,424	38,575	43,147
52												
53	**Commentary on options and considerations made in the assessment of forecast expenditure**											
54	*EDBs may provide explanatory comment on the options they have considered (including scenarios used) in assessing forecast operational expenditure for the current disclosure year and a 10 year planning period in Schedule 15.*											
55												

17.8 Appendix 8 – Asset Condition (Schedule 12a)

Company Name **Vector Limited**

AMP Planning Period **1 April 2024 – 31 March 2034**

SCHEDULE 12a: REPORT ON ASSET CONDITION

sch ref												
7					**Asset condition at start of planning period (percentage of units by grade)**							
8												
9	**Voltage**	**Asset category**	**Asset class**	**Units**	**H1**	**H2**	**H3**	**H4**	**H5**	**Grade unknown**	**Data accuracy (1–4)**	**% of asset forecast to be replaced in next 5 years**
10	All	Overhead Line	Concrete poles / steel structure	No.	0.01%	0.09%	21.66%	31.24%	47.01%		4	6.47%
11	All	Overhead Line	Wood poles	No.	0.06%	0.99%	84.26%	8.23%	6.46%		4	37.22%
12	All	Overhead Line	Other pole types	No.	-	-	4.44%	6.91%	88.65%		4	-
13	HV	Subtransmission Line	Subtransmission OH up to 66kV conductor	km	-	0.03%	89.51%	7.63%	2.83%		3	0.27%
14	HV	Subtransmission Line	Subtransmission OH 110kV+ conductor	km	-	-	72.35%	25.70%	1.95%		3	-
15	HV	Subtransmission Cable	Subtransmission UG up to 66kV (XLPE)	km	-	2.94%	1.87%	37.22%	57.97%		2	3.24%
16	HV	Subtransmission Cable	Subtransmission UG up to 66kV (Oil pressurised)	km	-	-	-	97.51%	2.49%		2	2.74%
17	HV	Subtransmission Cable	Subtransmission UG up to 66kV (Gas pressurised)	km	-	-	-	-	-		N/A	
18	HV	Subtransmission Cable	Subtransmission UG up to 66kV (PILC)	km	-	45.53%	34.15%	17.21%	3.11%		2	64.95%
19	HV	Subtransmission Cable	Subtransmission UG 110kV+ (XLPE)	km	-	-	-	85.70%	14.30%		2	-
20	HV	Subtransmission Cable	Subtransmission UG 110kV+ (Oil pressurised)	km	-	-	61.69%	31.13%	7.17%		2	-
21	HV	Subtransmission Cable	Subtransmission UG 110kV+ (Gas Pressurised)	km							N/A	
22	HV	Subtransmission Cable	Subtransmission UG 110kV+ (PILC)	km							N/A	
23	HV	Subtransmission Cable	Subtransmission submarine cable	km	-	-	97.37%	2.63%	-		2	-
24	HV	Zone substation Buildings	Zone substations up to 66kV	No.	-	-	7.83%	68.70%	23.48%		4	5.22%
25	HV	Zone substation Buildings	Zone substations 110kV+	No.	-	-	-	33.33%	66.67%		4	-
26	HV	Zone substation switchgear	22/33kV CB (Indoor)	No.	-	-	11.36%	13.31%	75.32%		3	-
27	HV	Zone substation switchgear	22/33kV CB (Outdoor)	No.	-	21.70%	41.51%	26.42%	10.38%		3	27.36%
28	HV	Zone substation switchgear	33kV Switch (Ground Mounted)	No.							N/A	
29	HV	Zone substation switchgear	33kV Switch (Pole Mounted)	No.	-	19.74%	67.76%	10.53%	1.97%		3	33.55%
30	HV	Zone substation switchgear	33kV RMU	No.	-	16.67%	33.33%	33.33%	16.67%		3	16.67%
31	HV	Zone substation switchgear	50/66/110kV CB (Indoor)	No.	-	-	-	40.91%	59.09%		3	-
32	HV	Zone substation switchgear	50/66/110kV CB (Outdoor)	No.	-	-	100.00%	-	-		3	100.00%
33	HV	Zone substation switchgear	3.3/6.6/11/22kV CB (ground mounted)	No.	-	8.41%	24.02%	12.69%	54.88%		3	15.89%
34	HV	Zone substation switchgear	3.3/6.6/11/22kV CB (pole mounted)	No.							N/A	

36					Asset condition at start of planning period (percentage of units by grade)							
37	Voltage	Asset category	Asset class	Units	H1	H2	H3	H4	H5	Grade unknown	Data accuracy (1–4)	% of asset forecast to be replaced in next 5 years
38												
39	HV	Zone Substation Transformer	Zone Substation Transformers	No.	-	8.86%	42.19%	18.57%	30.38%		4	6.75%
40	HV	Distribution Line	Distribution OH Open Wire Conductor	km	-	0.76%	84.96%	11.44%	2.83%		3	1.22%
41	HV	Distribution Line	Distribution OH Aerial Cable Conductor	km							N/A	
42	HV	Distribution Line	SWER conductor	km							N/A	
43	HV	Distribution Cable	Distribution UG XLPE or PVC	km	0.37%	0.25%	1.97%	20.69%	76.72%		2	0.63%
44	HV	Distribution Cable	Distribution UG PILC	km	0.25%	1.16%	4.61%	77.26%	16.72%		2	1.41%
45	HV	Distribution Cable	Distribution Submarine Cable	km	-	-	86.16%	13.80%	0.04%		2	-
46	HV	Distribution switchgear	3.3/6.6/11/22kV CB (pole mounted) - reclosers and sectionalisers	No.	0.89%	-	1.18%	45.27%	52.66%		4	11.36%
47	HV	Distribution switchgear	3.3/6.6/11/22kV CB (Indoor)	No.	-	2.72%	8.42%	10.40%	78.47%		4	6.19%
48	HV	Distribution switchgear	3.3/6.6/11/22kV Switches and fuses (pole mounted)	No.	1.25%	0.46%	43.89%	23.26%	31.13%		4	9.13%
49	HV	Distribution switchgear	3.3/6.6/11/22kV Switch (ground mounted) - except RMU	No.	4.56%	10.25%	63.55%	15.10%	6.53%		3	22.58%
50	HV	Distribution switchgear	3.3/6.6/11/22kV RMU	No.	3.10%	3.68%	35.94%	16.05%	41.24%		3	7.81%
51	HV	Distribution Transformer	Pole Mounted Transformer	No.	3.53%	8.47%	40.25%	24.85%	22.90%		3	9.64%
52	HV	Distribution Transformer	Ground Mounted Transformer	No.	5.63%	3.01%	31.40%	27.13%	32.83%		3	8.74%
53	HV	Distribution Transformer	Voltage regulators	No.	-	-	-	47.06%	52.94%		4	-
54	HV	Distribution Substations	Ground Mounted Substation Housing	No.	2.26%	2.03%	73.83%	8.38%	13.51%		4	4.39%
55	LV	LV Line	LV OH Conductor	km	-	-	85.90%	7.66%	6.45%		3	2.33%
56	LV	LV Cable	LV UG Cable	km	0.48%	6.36%	20.06%	36.93%	36.17%		2	6.96%
57	LV	LV Streetlighting	LV OH/UG Streetlight circuit	km						100.00%	1	
58	LV	Connections	OH/UG consumer service connections	No.						100.00%	1	
59	All	Protection	Protection relays (electromechanical, solid state and numeric)	No.	-	0.42%	57.26%	21.33%	20.99%		3	0.46%
60	All	SCADA and communications	SCADA and communications equipment operating as a single system	Lot	-	3.32%	39.10%	35.07%	22.51%		4	3.52%
61	All	Capacitor Banks	Capacitors including controls	No.	-	-	85.96%	7.02%	7.02%		3	-
62	All	Load Control	Centralised plant	Lot	-	-	100.00%	-	-		4	-
63	All	Load Control	Relays	No.							N/A	
64	All	Civils	Cable Tunnels	km	-	-	8.62%	-	91.38%		4	-

17.9 Appendix 9 – Forecast Capacity (Schedule 12b)

Company Name **Vector Limited**
AMP Planning Period **1 April 2024 – 31 March 2034**

SCHEDULE 12b: REPORT ON FORECAST CAPACITY

sch ref	*Existing Zone Substations*	Current Peak Load (MVA)	Installed Firm Capacity (MVA)	Security of Supply Classification (type)	Transfer Capacity (MVA)	Utilisation of Installed Firm Capacity %	Installed Firm Capacity +5 years (MVA)	Utilisation of Installed Firm Capacity + 5yrs %	Installed Firm Capacity Constraint +5 years (cause)	Explanation
7										
8										
9	Atkinson Road	20.5	17	N-1 switched	37.3	123%	17	131%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
10	Auckland Airport	14.3	25	N-1	0.0	57%	25	57%	No constraint within +5 years	Meets Vector security criteria
11	Avondale	29.8	20	N-1 switched	24.9	149%	20	166%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
13	Bairds	28.6	20	N-1 switched	19.4	143%	20	166%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
14	Balmain	9.5	-	N-1 switched	24.7	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
15	Balmoral	14.1	20	N-1	12.2	71%	20	92%	No constraint within +5 years	Meets Vector security criteria
16	Belmont	13.9	13	N-1 switched	22.0	111%	13	126%	No constraint within +5 years	Constraint relieved by the installation of 3rd transformer and 11kV cable reinforcement
17	Big Omaha	7.5	-	N-1 switched	9.5	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
	Birkdale	22.4	20	N-1 switched	20.7	112%	20	118%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
18	Brickworks	10.3	-	N-1 switched	24.0	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and planned 2nd transformer
19	Browns Bay	17.3	13	N-1 switched	37.9	138%	16	122%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
20	Bush Road	22.2	23	N-1	23.9	98%	23	114%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
21	Carbine	12.6	20	N-1	7.9	63%	20	67%	No constraint within +5 years	Meets Vector security criteria
22	Chevalier	21.0	14	N-1 switched	13.8	149%	24	119%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
23	Clendon	20.6	20	N-1 switched	11.5	103%	20	106%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
24	Clevedon	3.2	-	N	3.2	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup, Counties backup and Kawakawa Bay BESS
25	Coatesville	11.7	13	N-1	22.0	94%	13	105%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
26	Drive	28.7	20	N-1 switched	23.9	144%	20	182%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup.
27	East Coast Road	15.6	-	N-1 switched	31.1	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
28	East Tamaki	22.1	20	N-1 switched	6.4	111%	20	154%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
29	Flatbush	26.7	20	N-1 switched	14.3	134%	20	155%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
30	Forrest Hill	16.5	13	N-1 switched	31.4	132%	13	147%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
31	Freemans Bay	18.3	18	N-1 switched	15.0	102%	18	119%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup

32	Glen Innes	10.9	20	N-1	11.8	55%	24	78%	No constraint within +5 years	Meets Vector security criteria
33	Greenhithe	10.7	-	N-1 switched	24.1	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
34	Greenmount	41.0	40	N-1 switched	24.1	103%	40	121%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
35	Gulf Harbour	9.3	-	N-1 switched	10.0	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
36	Hans	25.2	20	N-1 switched	10.4	127%	20	155%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
37	Hauraki	7.6	-	N-1 switched	32.5	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
38	Helensville	11.8	8	N-1 switched	40.4	157%	8	174%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and South Head Diesel generator
39	Henderson Valley	15.5	13	N-1 switched	49.4	124%	13	148%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and Piha Diesel generator
40	Highbrook	10.0	21	N-1	0.0	47%	21	52%	No constraint within +5 years	Meets Vector security criteria
41	Highbury	12.7	-	N-1 switched	22.8	-	16	99%	No constraint within +5 years	Constraint relieved by the installation of the second transformer
42	Hillcrest	22.1	22	N-1 switched	52.1	102%	22	127%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
43	Hillsborough	21.6	19	N-1 switched	18.2	117%	19	134%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
44	Hobson 110/11kV	8.9	25	N-1	6.5	36%	25	41%	No constraint within +5 years	Meets Vector security criteria
45	Hobson 22/11kV	12.6	15	N-1	6.6	84%	15	90%	No constraint within +5 years	Meets Vector security criteria
46	Hobson 22kV	52.6	80	N-1	25.4	66%	80	110%	No constraint within +5 years	Meets Vector security criteria
47	Hobsonville	13.4	13	N-1 switched	54.8	107%	13	139%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
48	Hobsonville Point	19.4	20	N-1	23.0	97%	20	152%	No constraint within +5 years	New Whenuapai ZSS will offload Hobsonsonville Point to meet security criteria
49	Howick	40.8	39	N-1 switched	16.2	105%	39	118%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
50	James Street	20.4	13	N-1 switched	37.5	163%	13	181%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
51	Kaukapakapa	6.2	-	N-1 switched	40.4	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
52	Keeling Road	16.5	20	N-1	0.0	88%	20	88%	No constraint within +5 years	Meets Vector security criteria
53	Kingsland	24.8	20	N-1 switched	20.5	124%	20	164%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
54	Laingholm	8.8	8	N-1 switched	29.1	117%	8	122%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
55	Lichfield	16.0	20	N-1	0.0	80%	20	80%	No constraint within +5 years	Meets Vector security criteria
56	Liverpool	35.4	40	N-1	31.8	89%	40	103%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
57	Liverpool 22kV	93.8	139	N-1	37.0	67%	139	85%	No constraint within +5 years	Meets Vector security criteria
58	Mangere Central	36.3	40	N-1	16.2	91%	48	91%	No constraint within +5 years	Meets Vector security criteria
59	Mangere East	32.5	20	N-1 switched	25.6	163%	20	201%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
60	Mangere West	24.4	30	N-1	1.5	81%	30	100%	No constraint within +5 years	Meets Vector security criteria
61	Manly	19.5	13	N-1 switched	27.3	156%	13	168%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
62	Manukau	32.7	40	N-1	25.8	82%	40	100%	No constraint within +5 years	Meets Vector security criteria
63	Manurewa	60.8	38	N-1 switched	34.5	161%	38	175%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
64	Maraetai	10.8	15	N-1	5.1	72%	15	122%	No constraint within +5 years	Meets Vector security criteria
65	McKinnon	17.9	20	N-1	52.1	90%	20	109%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
66	Mcleod Road	9.8	-	N-1 switched	29.6	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
67	McNab	50.7	40	N-1 switched	25.9	127%	40	152%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
68	Milford	8.3	-	N-1 switched	26.3	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
69	Mt Albert	8.7	-	N	7.8	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
70	Mt Wellington	16.0	20	N-1	16.2	80%	20	93%	No constraint within +5 years	Meets Vector security criteria
71	New Lynn	13.7	13	N-1 switched	23.9	110%	13	131%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
72	Newmarket	38.1	40	N-1	32.3	95%	40	95%	No constraint within +5 years	Meets Vector security criteria
73	Newton	18.7	15	N-1 switched	17.9	123%	15	160%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup

74		Ngataringa Bay	9.4	-	N	5.8	-	-		No constraint within +5 years	Constraint relieved by the installation of 3rd Belmont transformer and 11kV cable reinforcement
75		Northcote	6.4	-	N-1 switched	21.4	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
76		Onehunga	15.7	12	N-1 switched	11.2	132%	24	85%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
77		Orakei	23.9	18	N-1 switched	14.4	137%	18	158%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
78		Oratia	5.3	-	N-1 switched	22.5	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
79		Orewa	22.7	16	N-1 switched	26.6	138%	16	167%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
80		Otara	29.2	30	N-1	22.7	97%	30	124%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
81		Pacific Steel	16.1	36	N-1	0.0	44%	36	44%	No constraint within +5 years	Meets Vector security criteria
82		Pakuranga	22.4	20	N-1 switched	11.8	112%	20	122%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
83		Papakura	30.0	20	N-1 switched	11.5	151%	20	173%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
84		Parnell	14.5	15	N-1	10.8	97%	18	98%	No constraint within +5 years	Meets Vector security criteria
85		Ponsonby	13.8	12	N-1 switched	7.9	119%	12	149%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
86		Quay	17.9	20	N-1	13.9	90%	20	116%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
87		Quay 22kV	42.4	50	N-1	23.0	85%	50	127%	No constraint within +5 years	Meets Vector security criteria
88		Ranui	14.0	-	N-1 switched	45.5	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
89		Red Beach	22.6	17	N-1 switched	29.2	132%	17	169%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
90		Remuera	26.8	20	N-1 switched	21.3	134%	20	162%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
91		Riverhead	13.8	8	N-1 switched	20.9	184%	8	253%	No constraint within +5 years	Meets Vector security criteria due to planned transformer upgrades and cable reinforcement
92		Rockfield	21.7	20	N-1 switched	23.3	110%	20	136%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
93		Rosebank	22.3	21	N-1 switched	16.3	106%	21	134%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
94		Rosedale	15.0	20	N-1	26.2	75%	24	111%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
95		Sabulite Road	21.3	13	N-1 switched	36.3	170%	13	191%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
96		Sandringham	20.7	19	N-1 switched	19.9	108%	19	156%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
97		Simpson Road	5.4	-	N-1 switched	19.4	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
98		Snells Beach	7.1	-	N-1 switched	8.7	-	-		No constraint within +5 years	Constraint relieved by the BESS and new Sandspit Zone Substation
99		South Howick	26.3	20	N-1 switched	13.6	132%	20	144%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
100		Spur Road	15.0	20	N-1	44.8	75%	20	119%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
101		St Heliers	21.9	17	N-1 switched	18.8	130%	17	150%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
102		St Johns	19.3	20	N-1	15.9	97%	20	141%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
103		Sunset Road	13.6	13	N-1 switched	31.3	109%	13	137%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup

104	Swanson	12.4	-	N-1 switched	23.0	-	13	114%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and planned 2nd transformer
105	Sylvia Park	17.1	20	N-1	9.1	86%	20	88%	No constraint within +5 years	Meets Vector security criteria
106	Takanini	31.5	15	N-1 switched	17.0	210%	15	244%	Other	Zone substation relieved by adding 3rd Transormer. Individual feeder constraint relieved by new feeders
107	Takapuna	10.1	-	N-1 switched	16.3	-	20	67%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
108	Te Atatu	22.6	13	N-1 switched	24.4	181%	13	201%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and transformer upgrades
109	Te Papapa	21.7	20	N-1 switched	16.5	109%	20	130%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
110	Torbay	9.6	-	N-1 switched	18.3	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
111	Triangle Road	17.7	10	N-1 switched	40.8	177%	10	176%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
112	Victoria	17.3	20	N-1	12.6	87%	20	100%	No constraint within +5 years	Meets Vector security criteria
113	Waiake	8.2	-	N-1 switched	21.7	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
114	Waiheke	12.7	13	N	0.0	102%	13	124%	No constraint within +5 years	Meets Vector security criteria
115	Waikaukau	8.5	-	N-1 switched	13.6	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
116	Waimauku	12.8	-	N-1 switched	20.1	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
117	Wairau Road	18.5	13	N-1 switched	34.7	148%	16	152%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
118	Warkworth	15.8	15	N-1 switched	29.6	105%	15	142%	No constraint within +5 years	Constraint relieved by the Omaha substation
119	Wellsford	9.3	8	N-1 switched	21.3	124%	8	156%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
120	Westfield	28.4	20	N-1 switched	20.7	142%	20	166%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
121	Westgate	17.6	20	N-1	32.0	88%	20	83%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup and future Red Hill ZSS
122	White Swan	28.5	24	N-1 switched	15.4	118%	24	151%	No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup
123	Wiri	38.5	40	N-1	39.4	96%	40	117%	No constraint within +5 years	Future Constraint relieved by new feeders and West Wiri zone substation
124	Woodford	9.7	-	N-1 switched	30.3	-	-		No constraint within +5 years	Meets Vector security criteria due to sufficient 11kV backup

17.10 Appendix 10 – Forecast Network Demand (Schedule 12c)

Centre Text

Company Name **Vector Limited**
AMP Planning Period **1 April 2024 – 31 March 2034**

SCHEDULE 12c: REPORT ON FORECAST NETWORK DEMAND

sch ref			Current Year CY	CY+1	CY+2	CY+3	CY+4	CY+5
7	**12c(i): Consumer Connections**							
8	*Number of ICPs connected during year by consumer type*				**Number of connections**			
9			*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
10		for year ended	**31-Mar-24**	**31-Mar-25**	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**
11	*Consumer types defined by EDB**							
12	Residential & Small Medium Enterprise (SME)		16,414	14,958	13,262	12,574	12,586	13,113
13	Industrial & Commercial		232	185	185	185	185	175
14								
15								
16								
17	**Connections total**		16,646	15,143	13,447	12,759	12,771	13,288
18	**include additional rows if needed*							
19								
20								
21								
22	**Distributed generation**		*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
23	Number of connections made in year		1,476	1,585	1,585	1,585	1,585	1,585
24	Capacity of distributed generation installed in year (MVA)		11	13	13	13	13	13
25	**12c(ii) System Demand**							
26			*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
27	**Maximum coincident system demand (MW)**	for year ended	**31-Mar-24**	**31-Mar-25**	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**
28	GXP demand		1,890	2,006	2,122	2,262	2,370	2,499
29	*plus* Distributed generation output at HV and above		16	16	16	16	16	16
30	**Maximum coincident system demand**		1,906	2,022	2,138	2,278	2,386	2,515
31	*less* Net transfers to (from) other EDBs at HV and above							
32	**Demand on system for supply to consumers' connection points**		1,906	2,022	2,138	2,278	2,386	2,515
33	**Electricity volumes carried (GWh)**							
34	Electricity supplied from GXPs		8,864	8,505	9,325	9,519	9,711	9,903
35	*less* Electricity exports to GXPs							
36	*plus* Electricity supplied from distributed generation		173	173	173	173	173	173
37	*less* Net electricity supplied to (from) other EDBs							
38	**Electricity entering system for supply to ICPs**		9,037	8,678	9,498	9,692	9,884	10,076
39	*less* Total energy delivered to ICPs		8,692	8,346	9,136	9,322	9,507	9,692
40	**Losses**		345	332	362	370	377	384
41								
42	**Load factor**		54%	49%	51%	49%	47%	46%
43	**Loss ratio**		3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
44								

17.11 Appendix 11 – Forecast Interruptions and Duration (Schedule 12d)

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Network / Sub-network Name	**Vector Limited**

SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

sch ref			*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
8								
9		for year ended	**31-Mar-24**	**31-Mar-25**	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**
10	**SAIDI**							
11	Class B (planned interruptions on the network)		117.1	117.1	117.1	117.1	117.1	117.1
12	Class C (unplanned interruptions on the network)		104.8	104.8	104.8	104.8	104.8	104.8
13	**SAIFI**							
14	Class B (planned interruptions on the network)		2.88	2.88	2.88	2.88	2.88	2.88
15	Class C (unplanned interruptions on the network)		1.34	1.34	1.34	1.34	1.34	1.34

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Network / Sub-network Name	**Southern Network**

SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

sch ref			*Current Year CY*	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
8								
9		for year ended	**31-Mar-24**	**31-Mar-25**	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**
10	**SAIDI**							
11	Class B (planned interruptions on the network)		50.4	50.4	50.4	50.4	50.4	50.4
12	Class C (unplanned interruptions on the network)		48.9	48.9	48.9	48.9	48.9	48.9
13	**SAIFI**							
14	Class B (planned interruptions on the network)		1.50	1.50	1.50	1.50	1.50	1.50
15	Class C (unplanned interruptions on the network)		0.64	0.64	0.64	0.64	0.64	0.64

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Network / Sub-network Name	**Northern Network**

SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

sch ref

		Current Year CY	*CY+1*	*CY+2*	*CY+3*	*CY+4*	*CY+5*
8							
9	for year ended	**31-Mar-24**	**31-Mar-25**	**31-Mar-26**	**31-Mar-27**	**31-Mar-28**	**31-Mar-29**
10	**SAIDI**						
11	Class B (planned interruptions on the network)	66.7	66.7	66.7	66.7	66.7	66.7
12	Class C (unplanned interruptions on the network)	56.0	56.0	56.0	56.0	56.0	56.0
13	**SAIFI**						
14	Class B (planned interruptions on the network)	1.38	1.38	1.38	1.38	1.38	1.38
15	Class C (unplanned interruptions on the network)	0.69	0.69	0.69	0.69	0.69	0.69

17.12 Appendix 12 – Asset Management Maturity (Schedule 13)

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Asset Management Standard Applied	

SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY

This schedule requires information on the EDB'S self-assessment of the maturity of its asset management practices .

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
3	Asset management policy	To what extent has an asset management policy been documented, authorised and communicated?	3	Vector's Asset Management Policy has been reviewed in February 2023, authorised by our Chief Operating Officer - Electricity, Gas, Fibre and Chief Executive Officer. The document is part of the controlled document management system and reviewed periodically.		Widely used AM practice standards require an organisation to document, authorise and communicate its asset management policy (eg, as required in PAS 55 para 4.2 i). A key pre-requisite of any robust policy is that the organisation's top management must be seen to endorse and fully support it. Also vital to the effective implementation of the policy, is to tell the appropriate people of its content and their obligations under it. Where an organisation outsources some of its asset-related activities, then these people and their organisations must equally be made aware of the policy's content. Also, there may be other stakeholders, such as regulatory authorities and shareholders who should be made aware of it.	Top management. The management team that has overall responsibility for asset management.	The organisation's asset management policy, its organisational strategic plan, documents indicating how the asset management policy was based upon the needs of the organisation and evidence of communication.
10	Asset management strategy	What has the organisation done to ensure that its asset management strategy is consistent with other appropriate organisational policies and strategies, and the needs of stakeholders?	2.5	Good asset management is practiced implicitly based on the policies and strategies which are approved by Vector's Board, the Board also approves the asset management plans and associated budget. The Asset management plan (AMP) section 5 shows the line of sight from the Electricity, Gas and Fibre business strategy through the asset management principles and into the asset management objectives.		In setting an organisation's asset management strategy, it is important that it is consistent with any other policies and strategies that the organisation has and has taken into account the requirements of relevant stakeholders. This question examines to what extent the asset management strategy is consistent with other organisational policies and strategies (eg, as required by PAS 55 para 4.3.1 b) and has taken account of stakeholder requirements as required by PAS 55 para 4.3.1 c). Generally, this will take into account the same polices, strategies and stakeholder requirements as covered in drafting the asset management policy but at a greater level of detail.	Top management. The organisation's strategic planning team. The management team that has overall responsibility for asset management.	The organisation's asset management strategy document and other related organisational policies and strategies. Other than the organisation's strategic plan, these could include those relating to health and safety, environmental, etc. Results of stakeholder consultation.
11	Asset management strategy	In what way does the organisation's asset management strategy take account of the lifecycle of the assets, asset types and asset systems over which the organisation has stewardship?	3	Asset header class (asset fleet) strategies have been prepared and reviewed for all primary asset classes. Lifecycle cost and service implications are adequately considered in maintenance and replacement decisions. Asset strategies are reviewed on an annual basis. This is an ongoing program of work with the opportunity to improve and integrate the results with Vector's Condition Based Asset Risk Management (CBARM) models.		Good asset stewardship is the hallmark of an organisation compliant with widely used AM standards. A key component of this is the need to take account of the lifecycle of the assets, asset types and asset systems. (For example, this requirement is recognised in 4.3.1 d) of PAS 55). This question explores what an organisation has done to take lifecycle into account in its asset management strategy.	Top management. People in the organisation with expert knowledge of the assets, asset types, asset systems and their associated life-cycles. The management team that has overall responsibility for asset management. Those responsible for developing and adopting methods and processes used in asset management	The organisation's documented asset management strategy and supporting working documents.
26	Asset management plan(s)	How does the organisation establish and document its asset management plan(s) across the life cycle activities of its assets and asset systems?	3	The Asset management plan (AMP) is documented, implemented and maintained with alignment to asset management strategies and cover all asset life cycle activities (documented in the form of header class strategies, standards covering planning, design, equipment selection, operation, maintenance, inspection, testing and decommissioning.)		The asset management strategy need to be translated into practical plan(s) so that all parties know how the objectives will be achieved. The development of plan(s) will need to identify the specific tasks and activities required to optimize costs, risks and performance of the assets and/or asset system(s), when they are to be carried out and the resources required.	The management team with overall responsibility for the asset management system. Operations, maintenance and engineering managers.	The organisation's asset management plan(s).

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Asset Management Standard Applied	

SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
3	Asset management policy	To what extent has an asset management policy been documented, authorised and communicated?	The organisation does not have a documented asset management policy.	The organisation has an asset management policy, but it has not been authorised by top management, or it is not influencing the management of the assets.	The organisation has an asset management policy, which has been authorised by top management, but it has had limited circulation. It may be in use to influence development of strategy and planning but its effect is limited.	The asset management policy is authorised by top management, is widely and effectively communicated to all relevant employees and stakeholders, and used to make these persons aware of their asset related obligations.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
10	Asset management strategy	What has the organisation done to ensure that its asset management strategy is consistent with other appropriate organisational policies and strategies, and the needs of stakeholders?	The organisation has not considered the need to ensure that its asset management strategy is appropriately aligned with the organisation's other organisational policies and strategies or with stakeholder requirements. OR The organisation does not have an asset management strategy.	The need to align the asset management strategy with other organisational policies and strategies as well as stakeholder requirements is understood and work has started to identify the linkages or to incorporate them in the drafting of asset management strategy.	Some of the linkages between the long-term asset management strategy and other organisational policies, strategies and stakeholder requirements are defined but the work is fairly well advanced but still incomplete.	All linkages are in place and evidence is available to demonstrate that, where appropriate, the organisation's asset management strategy is consistent with its other organisational policies and strategies. The organisation has also identified and considered the requirements of relevant stakeholders.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
11	Asset management strategy	In what way does the organisation's asset management strategy take account of the lifecycle of the assets, asset types and asset systems over which the organisation has stewardship?	The organisation has not considered the need to ensure that its asset management strategy is produced with due regard to the lifecycle of the assets, asset types or asset systems that it manages. OR The organisation does not have an asset management strategy.	The need is understood, and the organisation is drafting its asset management strategy to address the lifecycle of its assets, asset types and asset systems.	The long-term asset management strategy takes account of the lifecycle of some, but not all, of its assets, asset types and asset systems.	The asset management strategy takes account of the lifecycle of all of its assets, asset types and asset systems.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
26	Asset management plan(s)	How does the organisation establish and document its asset management plan(s) across the life cycle activities of its assets and asset systems?	The organisation does not have an identifiable asset management plan(s) covering asset systems and critical assets.	The organisation has asset management plan(s) but they are not aligned with the asset management strategy and objectives and do not take into consideration the full asset life cycle (including asset creation, acquisition, enhancement, utilisation, maintenance decommissioning and disposal).	The organisation is in the process of putting in place comprehensive, documented asset management plan(s) that cover all life cycle activities, clearly aligned to asset management objectives and the asset management strategy.	Asset management plan(s) are established, documented, implemented and maintained for asset systems and critical assets to achieve the asset management strategy and asset management objectives across all life cycle phases.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Asset Management Standard Applied	

SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
27	Asset management plan(s)	How has the organisation communicated its plan(s) to all relevant parties to a level of detail appropriate to the receiver's role in their delivery?	3	The AMP is communicated to all stakeholders including employees and Field Service Providers (FSPs). The organisation, end to end process, Vector's Delegated Financial Authorities (DFA) and works programmes are all set up to deliver the works effectively. The AMP is also published on the Vector web site. Project Governance meetings are held every two weeks to ensure effective delivery of the AMP. Vector maintains a range of asset management information systems, such as SAP that contain plans for asset management activities which are accessible to Vector personnel and FSPs as required.		Plans will be ineffective unless they are communicated to all those, including contracted suppliers and those who undertake enabling function(s). The plan(s) need to be communicated in a way that is relevant to those who need to use them.	The management team with overall responsibility for the asset management system. Delivery functions and suppliers.	Distribution lists for plan(s). Documents derived from plan(s) which detail the receivers role in plan delivery. Evidence of communication.
29	Asset management plan(s)	How are designated responsibilities for delivery of asset plan actions documented?	3	The AMP outlines the key roles responsible for its delivery. Vector's delegated authorities framework and policy, and position descriptions for each role further define the roles and authorities. Key tasks and responsibilities are allocated to team members who report on progress against plan on a monthly basis.		The implementation of asset management plan(s) relies on (1) actions being clearly identified, (2) an owner allocated and (3) that owner having sufficient delegated responsibility and authority to carry out the work required. It also requires alignment of actions across the organisation. This question explores how well the plan(s) set out responsibility for delivery of asset plan actions.	The management team with overall responsibility for the asset management system. Operations, maintenance and engineering managers. If appropriate, the performance management team.	The organisation's asset management plan(s). Documentation defining roles and responsibilities of individuals and organisational departments.
31	Asset management plan(s)	What has the organisation done to ensure that appropriate arrangements are made available for the efficient and cost effective implementation of the plan(s)? (Note this is about resources and enabling support)	3.5	The AMP is physically delivered by our Field Service Providers for both Capex projects and Opex works. Capex delivery of works is governed by a staged gate process that is defined in detail. A project can only move to the next stage gate once the actions for a specific stage-gate is completed. Works are competitively tendered in accordance with standard contract arrangements including NZS3910. For large programs of works the workload are split between a larger panel of service providers to ensure a workload balance		It is essential that the plan(s) are realistic and can be implemented, which requires appropriate resources to be available and enabling mechanisms in place. This question explores how well this is achieved. The plan(s) not only need to consider the resources directly required and timescales, but also the enabling activities, including for example, training requirements, supply chain capability and procurement timescales.	The management team with overall responsibility for the asset management system. Operations, maintenance and engineering managers. If appropriate, the performance management team. If appropriate, the performance management team. Where appropriate the procurement team and service providers working on the organisation's asset-related activities.	The organisation's asset management plan(s). Documented processes and procedures for the delivery of the asset management plan.
33	Contingency planning	What plan(s) and procedure(s) does the organisation have for identifying and responding to incidents and emergency situations and ensuring continuity of critical asset management activities?	3.5	Our response to emergency situations, e.g., extreme weather events, natural disasters and similar is governed by our operational document, the Emergency Response Guide. This guide sets the scene for responses, reactions and actions. During an emergency event a specific response group will be assigned with tasks to and for each member. The group will meet daily until the contingency plan is in place and during the contingency. Reviews of pending risks or pending events are conducted fortnightly during which action plans are reviewed, renewed and/or closed		Widely used AM practice standards require that an organisation has plan(s) to identify and respond to emergency situations. Emergency plan(s) should outline the actions to be taken to respond to specified emergency situations and ensure continuity of critical asset management activities including the communication to, and involvement of, external agencies. This question assesses if, and how well, these plan(s) triggered, implemented and resolved in the event of an incident. The plan(s) should be appropriate to the level of risk as determined by the organisation's risk assessment methodology. It is also a requirement that relevant personnel are competent and trained.	The manager with responsibility for developing emergency plan(s). The organisation's risk assessment team. People with designated duties within the plan(s) and procedure(s) for dealing with incidents and emergency situations.	The organisation's plan(s) and procedure(s) for dealing with emergencies. The organisation's risk assessments and risk registers.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
27	Asset management plan(s)	How has the organisation communicated its plan(s) to all relevant parties to a level of detail appropriate to the receiver's role in their delivery?	The organisation does not have plan(s) or their distribution is limited to the authors.	The plan(s) are communicated to some of those responsible for delivery of the plan(s). OR Communicated to those responsible for delivery is either irregular or ad-hoc.	The plan(s) are communicated to most of those responsible for delivery but there are weaknesses in identifying relevant parties resulting in incomplete or inappropriate communication. The organisation recognises improvement is needed as is working towards resolution.	The plan(s) are communicated to all relevant employees, stakeholders and contracted service providers to a level of detail appropriate to their participation or business interests in the delivery of the plan(s) and there is confirmation that they are being used effectively.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
29	Asset management plan(s)	How are designated responsibilities for delivery of asset plan actions documented?	The organisation has not documented responsibilities for delivery of asset plan actions.	Asset management plan(s) inconsistently document responsibilities for delivery of plan actions and activities and/or responsibilities and authorities for implementation inadequate and/or delegation level inadequate to ensure effective delivery and/or contain misalignments with organisational accountability.	Asset management plan(s) consistently document responsibilities for the delivery of actions but responsibility/authority levels are inappropriate/ inadequate, and/or there are misalignments within the organisation.	Asset management plan(s) consistently document responsibilities for the delivery actions and there is adequate detail to enable delivery of actions. Designated responsibility and authority for achievement of asset plan actions is appropriate.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
31	Asset management plan(s)	What has the organisation done to ensure that appropriate arrangements are made available for the efficient and cost effective implementation of the plan(s)? (Note this is about resources and enabling support)	The organisation has not considered the arrangements needed for the effective implementation of plan(s).	The organisation recognises the need to ensure appropriate arrangements are in place for implementation of asset management plan(s) and is in the process of determining an appropriate approach for achieving this.	The organisation has arrangements in place for the implementation of asset management plan(s) but the arrangements are not yet adequately efficient and/or effective. The organisation is working to resolve existing weaknesses.	The organisation's arrangements fully cover all the requirements for the efficient and cost effective implementation of asset management plan(s) and realistically address the resources and timescales required, and any changes needed to functional policies, standards, processes and the asset management information system.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
33	Contingency planning	What plan(s) and procedure(s) does the organisation have for identifying and responding to incidents and emergency situations and ensuring continuity of critical asset management activities?	The organisation has not considered the need to establish plan(s) and procedure(s) to identify and respond to incidents and emergency situations.	The organisation has some ad-hoc arrangements to deal with incidents and emergency situations, but these have been developed on a reactive basis in response to specific events that have occurred in the past.	Most credible incidents and emergency situations are identified. Either appropriate plan(s) and procedure(s) are incomplete for critical activities or they are inadequate. Training/ external alignment may be incomplete.	Appropriate emergency plan(s) and procedure(s) are in place to respond to credible incidents and manage continuity of critical asset management activities consistent with policies and asset management objectives. Training and external agency alignment is in place.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
37	Structure, authority and responsibilities	What has the organisation done to appoint member(s) of its management team to be responsible for ensuring that the organisation's assets deliver the requirements of the asset management strategy, objectives and plan(s)?	3.5	Overall responsibility to deliver the AMP rests with the Chief Operating Officer, Electricity, Gas and Fibre. The Chief Engineer together with the General Managers of the Network Performance Team, Capital Programme Delivery Team, Customer Excellence Team and Commercial Strategy, report to the COO. Each GM is assigned the appropriate authority to deliver a certain part(s) of the asset management plan in accordance with the asset management policy. The AMP is delivered by our panel of external field service providers in terms of contractual agreements and arrangements and they understand their roles in the delivery of the asset management strategy, its objectives and plans		In order to ensure that the organisation's assets and asset systems deliver the requirements of the asset management policy, strategy and objectives responsibilities need to be allocated to appropriate people who have the necessary authority to fulfil their responsibilities. (This question, relates to the organisation's assets eg, para b), s 4.4.1 of PAS 55, making it therefore distinct from the requirement contained in para a), s 4.4.1 of PAS 55).	Top management. People with management responsibility for the delivery of asset management policy, strategy, objectives and plan(s). People working on asset-related activities.	Evidence that managers with responsibility for the delivery of asset management policy, strategy, objectives and plan(s) have been appointed and have assumed their responsibilities. Evidence may include the organisation's documents relating to its asset management system, organisational charts, job descriptions of post-holders, annual targets/objectives and personal development plan(s) of post-holders as appropriate.
40	Structure, authority and responsibilities	What evidence can the organisation's top management provide to demonstrate that sufficient resources are available for asset management?	3.5	A dedicated team is in place to compile the annual asset management plan. Each member is assigned his/her part of the AMP to be compiled, arrange for its review to publishing. A dedicated team exists to assess network risk, compile scopes of work and/or programmes of work to address the risk and then after the works have been delivered, review the residual risks. Two dedicated teams schedule and program the delivery of capex works and maintenance works respectively. A dedicated Supply Team has been setup for the planning of long lead items, establishment of umbrella agreements and other procurement arrangements. A Governance Group has been setup that meets weekly to discuss the delivery of the asset management plan, risks, delays and action plans. Agreements are in place for external specialist consultancies to provide advice		Optimal asset management requires top management to ensure sufficient resources are available. In this context the term 'resources' includes manpower, materials, funding and service provider support.	Top management. The management team that has overall responsibility for asset management. Risk management team. The organisation's managers involved in day-to-day supervision of asset-related activities, such as frontline managers, engineers, foremen and chargehands as appropriate.	Evidence demonstrating that asset management plan(s) and/or the process(es) for asset management plan implementation consider the provision of adequate resources in both the short and long term. Resources include funding, materials, equipment, services provided by third parties and personnel (internal and service providers) with appropriate skills competencies and knowledge.
42	Structure, authority and responsibilities	To what degree does the organisation's top management communicate the importance of meeting its asset management requirements?	3	Service Levels and KPI's are set and monitored across the organisation through readily accessible dashboards. In addition, monthly reporting, quarterly team updates and strong engagement with programme delivery and service providers ensure that there is a strong focus on the delivery of asset management requirements. Weekly update sessions are held to convey network events, network reliability targets and specific project updates and challenges. "All Hands" sessions have been introduced quarterly to convey the asset management objectives to the wider EGF team. Asset performance metrics including SAIFI, CAIDI and SAIDI are continually monitored, reviewed in governance meetings and interventions determined.		Widely used AM practice standards require an organisation to communicate the importance of meeting its asset management requirements such that personnel fully understand, take ownership of, and are fully engaged in the delivery of the asset management requirements (eg, PAS 55 s 4.4.1 g).	Top management. The management team that has overall responsibility for asset management. People involved in the delivery of the asset management requirements.	Evidence of such activities as road shows, written bulletins, workshops, team talks and management walk-abouts would assist an organisation to demonstrate it is meeting this requirement of PAS 55.
45	Outsourcing of asset management activities	Where the organisation has outsourced some of its asset management activities, how has it ensured that appropriate controls are in place to ensure the compliant delivery of its organisational strategic plan, and its asset management policy and strategy?	3.5	Maintenance standards, design standards and planning standards are in place for Vector and its service providers to guide the delivery of the asset management plan. Standards are controlled, changed and improved via a strict and well-defined change control process that involves our field service providers in the formal review and approval process. A strict as-building regime is in place to ensure works are delivered, checked and recorded in accordance with our standards. The recording of faults is done via clear guidance in our maintenance standards and network fault information collected and recorded in our software application for this purpose. Its corrective actions and outcomes are checked and controlled via this software app. A team of dedicated field assessors provide assurance by means of inspections in the field against the standards. A full time standards engineer is in place to record proposed improvements to standards and then arrange for their change controlled reviews, updates, revisioning and publishing. This person also reviews requests for deviations, their approval or rejection.		Where an organisation chooses to outsource some of its asset management activities, the organisation must ensure that these outsourced process(es) are under appropriate control to ensure that all the requirements of widely used AM standards (eg, PAS 55) are in place, and the asset management policy, strategy objectives and plan(s) are delivered. This includes ensuring capabilities and resources across a time span aligned to life cycle management. The organisation must put arrangements in place to control the outsourced activities, whether it be to external providers or to other in-house departments. This question explores what the organisation does in this regard.	Top management. The management team that has overall responsibility for asset management. The manager(s) responsible for the monitoring and management of the outsourced activities. People involved with the procurement of outsourced activities. The people within the organisations that are performing the outsourced activities. The people impacted by the outsourced activity.	The organisation's arrangements that detail the compliance required of the outsourced activities. For example, this this could form part of a contract or service level agreement between the organisation and the suppliers of its outsourced activities. Evidence that the organisation has demonstrated to itself that it has assurance of compliance of outsourced activities.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
37	Structure, authority and responsibilities	What has the organisation done to appoint member(s) of its management team to be responsible for ensuring that the organisation's assets deliver the requirements of the asset management strategy, objectives and plan(s)?	Top management has not considered the need to appoint a person or persons to ensure that the organisation's assets deliver the requirements of the asset management strategy, objectives and plan(s).	Top management understands the need to appoint a person or persons to ensure that the organisation's assets deliver the requirements of the asset management strategy, objectives and plan(s).	Top management has appointed an appropriate people to ensure the assets deliver the requirements of the asset management strategy, objectives and plan(s) but their areas of responsibility are not fully defined and/or they have insufficient delegated authority to fully execute their responsibilities.	The appointed person or persons have full responsibility for ensuring that the organisation's assets deliver the requirements of the asset management strategy, objectives and plan(s). They have been given the necessary authority to achieve this.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
40	Structure, authority and responsibilities	What evidence can the organisation's top management provide to demonstrate that sufficient resources are available for asset management?	The organisation's top management has not considered the resources required to deliver asset management.	The organisations top management understands the need for sufficient resources but there are no effective mechanisms in place to ensure this is the case.	A process exists for determining what resources are required for its asset management activities and in most cases these are available but in some instances resources remain insufficient.	An effective process exists for determining the resources needed for asset management and sufficient resources are available. It can be demonstrated that resources are matched to asset management requirements.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
42	Structure, authority and responsibilities	To what degree does the organisation's top management communicate the importance of meeting its asset management requirements?	The organisation's top management has not considered the need to communicate the importance of meeting asset management requirements.	The organisations top management understands the need to communicate the importance of meeting its asset management requirements but does not do so.	Top management communicates the importance of meeting its asset management requirements but only to parts of the organisation.	Top management communicates the importance of meeting its asset management requirements to all relevant parts of the organisation.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
45	Outsourcing of asset management activities	Where the organisation has outsourced some of its asset management activities, how has it ensured that appropriate controls are in place to ensure the compliant delivery of its organisational strategic plan, and its asset management policy and strategy?	The organisation has not considered the need to put controls in place.	The organisation controls its outsourced activities on an ad-hoc basis, with little regard for ensuring for the compliant delivery of the organisational strategic plan and/or its asset management policy and strategy.	Controls systematically considered but currently only provide for the compliant delivery of some, but not all, aspects of the organisational strategic plan and/or its asset management policy and strategy. Gaps exist.	Evidence exists to demonstrate that outsourced activities are appropriately controlled to provide for the compliant delivery of the organisational strategic plan, asset management policy and strategy, and that these controls are integrated into the asset management system	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
48	Training, awareness and competence	How does the organisation develop plan(s) for the human resources required to undertake asset management activities - including the development and delivery of asset management strategy, process(es), objectives and plan(s)?	3	Core competencies required to undertake asset management activities are identified by our HR department in the job design process. Such requirements are determined and defined in conjunction with asset managers and included in Vector's job profiles-position descriptions. Our HR in-house training division has a suite of formal learning modules to increase knowledge of our requirements to develop and improve asset management capability. We also have a formal engineering progression scheme in place that encourages employees to develop their skills. Regular inspections of worksites is a requirement to hone asset management skills and ensure contact with the real world asset environment		There is a need for an organisation to demonstrate that it has considered what resources are required to develop and implement its asset management system. There is also a need for the organisation to demonstrate that it has assessed what development plan(s) are required to provide its human resources with the skills and competencies to develop and implement its asset management systems. The timescales over which the plan(s) are relevant should be commensurate with the planning horizons within the asset management strategy considers e.g. if the asset management strategy considers 5, 10 and 15 year time scales then the human resources development plan(s) should align with these. Resources include both 'in house' and external resources who undertake asset management activities.	Senior management responsible for agreement of plan(s). Managers responsible for developing asset management strategy and plan(s). Managers with responsibility for development and recruitment of staff (including HR functions). Staff responsible for training. Procurement officers. Contracted service providers.	Evidence of analysis of future work load plan(s) in terms of human resources. Document(s) containing analysis of the organisation's own direct resources and contractors resource capability over suitable timescales. Evidence, such as minutes of meetings, that suitable management forums are monitoring human resource development plan(s). Training plan(s), personal development plan(s), contract and service level agreements.
49	Training, awareness and competence	How does the organisation identify competency requirements and then plan, provide and record the training necessary to achieve the competencies?	3.5	Our competency requirements (worker type competency - WTC) are clearly defined for different roles and responsibilities to achieve our asset management plan. Record is kept of the competency training of Vector employees and training refreshers are scheduled as necessary to ensure WTC competency compliance and currency. For our FSPs, we conduct random audits of their competency compliance and check that competencies are maintained in their internal database. Vector also maintains an internal database of the competencies of our internal staff as well as our FSP qualified personnel. Under our letters of authorisation to access our network, all FSPs and contractors have a legal obligation to maintain competency currencies.		Widely used AM standards require that organisations to undertake a systematic identification of the asset management awareness and competencies required at each level and function within the organisation. Once identified the training required to provide the necessary competencies should be planned for delivery in a timely and systematic way. Any training provided must be recorded and maintained in a suitable format. Where an organisation has contracted service providers in place then it should have a means to demonstrate that this requirement is being met for their employees. (eg, PAS 55 refers to frameworks suitable for identifying competency requirements).	Senior management responsible for agreement of plan(s). Managers responsible for developing asset management strategy and plan(s). Managers with responsibility for development and recruitment of staff (including HR functions). Staff responsible for training. Procurement officers. Contracted service providers.	Evidence of an established and applied competency requirements assessment process and plan(s) in place to deliver the required training. Evidence that the training programme is part of a wider, co-ordinated asset management activities training and competency programme. Evidence that training activities are recorded and that records are readily available (for both direct and contracted service provider staff) e.g. via organisation wide information system or local records database.
50	Training, awareness and competence	How does the organization ensure that persons under its direct control undertaking asset management related activities have an appropriate level of competence in terms of education, training or experience?	3	For our FSPs, we conduct random audits of their competency compliance and check that competencies are maintained in their internal database. Vector also maintains an internal database of the competencies of our internal staff as well as our FSP qualified personnel. Under our letters of authorisation to access our network, all FSPs and contractors have a legal obligation to maintain competency currencies.		A critical success factor for the effective development and implementation of an asset management system is the competence of persons undertaking these activities. organisations should have effective means in place for ensuring the competence of employees to carry out their designated asset management function(s). Where an organisation has contracted service providers undertaking elements of its asset management system then the organisation shall assure itself that the outsourced service provider also has suitable arrangements in place to manage the competencies of its employees. The organisation should ensure that the individual and corporate competencies it requires are in place and actively monitor, develop and maintain an appropriate balance of these competencies.	Managers, supervisors, persons responsible for developing training programmes. Staff responsible for procurement and service agreements. HR staff and those responsible for recruitment.	Evidence of a competency assessment framework that aligns with established frameworks such as the asset management Competencies Requirements Framework (Version 2.0); National Occupational Standards for Management and Leadership; UK Standard for Professional Engineering Competence, Engineering Council, 2005.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
48	Training, awareness and competence	How does the organisation develop plan(s) for the human resources required to undertake asset management activities - including the development and delivery of asset management strategy, process(es), objectives and plan(s)?	The organisation has not recognised the need for assessing human resources requirements to develop and implement its asset management system.	The organisation has recognised the need to assess its human resources requirements and to develop a plan(s). There is limited recognition of the need to align these with the development and implementation of its asset management system.	The organisation has developed a strategic approach to aligning competencies and human resources to the asset management system including the asset management plan but the work is incomplete or has not been consistently implemented.	The organisation can demonstrate that plan(s) are in place and effective in matching competencies and capabilities to the asset management system including the plan for both internal and contracted activities. Plans are reviewed integral to asset management system process(es).	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
49	Training, awareness and competence	How does the organisation identify competency requirements and then plan, provide and record the training necessary to achieve the competencies?	The organisation does not have any means in place to identify competency requirements.	The organisation has recognised the need to identify competency requirements and then plan, provide and record the training necessary to achieve the competencies.	The organisation is the process of identifying competency requirements aligned to the asset management plan(s) and then plan, provide and record appropriate training. It is incomplete or inconsistently applied.	Competency requirements are in place and aligned with asset management plan(s). Plans are in place and effective in providing the training necessary to achieve the competencies. A structured means of recording the competencies achieved is in place.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
50	Training, awareness and competence	How does the organization ensure that persons under its direct control undertaking asset management related activities have an appropriate level of competence in terms of education, training or experience?	The organization has not recognised the need to assess the competence of person(s) undertaking asset management related activities.	Competency of staff undertaking asset management related activities is not managed or assessed in a structured way, other than formal requirements for legal compliance and safety management.	The organization is in the process of putting in place a means for assessing the competence of person(s) involved in asset management activities including contractors. There are gaps and inconsistencies.	Competency requirements are identified and assessed for all persons carrying out asset management related activities - internal and contracted. Requirements are reviewed and staff reassessed at appropriate intervals aligned to asset management requirements.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
53	Communication, participation and consultation	How does the organisation ensure that pertinent asset management information is effectively communicated to and from employees and other stakeholders, including contracted service providers?	3.5	A group meeting is held every Wednesday in which the SAIDI and SAIFI performance of the network is presented and discussed. Network risks, incidents and asset management challenges are also presented and discussed. Asset management information is conveyed to other stakeholders via their involvement in the control of update and improvement of standards. Asset management information and asset performance information are presented in detailed and comprehensive dashboards and daily fault reports. Our planning standards are available on our website for external parties and the same applies for the connection of distributed generation. Monthly operational meetings are held with our FSPs where progress, risks and challenges against targets, are discussed and actions agreed. Short update meetings are held every second day for more granular updates on specific programmes and projects. Under contingency or emergency scenarios specific teams are setup and daily meetings are scheduled for the duration of such events. Specific network instructions are issued to FSPs via a numbered and controlled formal instruction in which FSPs are required to acknowledge receipt.		Widely used AM practice standards require that pertinent asset management information is effectively communicated to and from employees and other stakeholders including contracted service providers. Pertinent information refers to information required in order to effectively and efficiently comply with and deliver asset management strategy, plan(s) and objectives. This will include for example the communication of the asset management policy, asset performance information, and planning information as appropriate to contractors.	Top management and senior management representative(s), employee's representative(s), employee's trade union representative(s); contracted service provider management and employee representative(s); representative(s) from the organisation's Health, Safety and Environmental team. Key stakeholder representative(s).	Asset management policy statement prominently displayed on notice boards, intranet and internet; use of organisation's website for displaying asset performance data; evidence of formal briefings to employees, stakeholders and contracted service providers; evidence of inclusion of asset management issues in team meetings and contracted service provider contract meetings; newsletters, etc.
59	Asset Management System documentation	What documentation has the organisation established to describe the main elements of its asset management system and interactions between them?	2.5	Vector's Controlled Document Management standard, USD001, defines asset management documents and sets out the hierarchy of documentation for our asset management plan. This standard also sets out in detail how changes to documents are to be managed, as well as the change control, approval and acceptance process. Similarly there are numerous standards for asset management systems and activity plans such as SAP and data governance standards. Our Asset Management Plan (AMP) is communicated to our Board and internal stakeholders and is available to external parties via our web portal. Our AMP is shared widely with our FSPs. Supporting the asset management plan and its objectives is a comprehensive set of design, maintenance and operating standards. The latest copies are held in our Information portal. We have made good progress with our asset management framework that describes the overarching requirements for asset management system.		Widely used AM practice standards require an organisation maintain up to date documentation that ensures that its asset management systems (ie, the systems the organisation has in place to meet the standards) can be understood, communicated and operated. (eg, s 4.5 of PAS 55 requires the maintenance of up to date documentation of the asset management system requirements specified throughout s 4 of PAS 55).	The management team that has overall responsibility for asset management. Managers engaged in asset management activities.	The documented information describing the main elements of the asset management system (process(es)) and their interaction.
62	Information management	What has the organisation done to determine what its asset management information system(s) should contain in order to support its asset management system?	3.5	Vector's primary information systems of record supporting Asset Management are SAP-PM, GE Small World GIS, and the Data Analytics platform. Collectively these systems capture, manage and allow the use of data for asset management decision making. In order to ensure that these systems contain the data necessary to support asset management, Vector has the following processes in place. A set of data standards have been developed governing the asset master data required to be captured in GIS and SAP-PM. These standards define the asset data model, which are based upon (and aligned to) Vector's asset and maintenance standards. A set of data standards have been developed for planned, corrective and reactive maintenance data capture. The data standards are based upon Vector's maintenance standards and define in detail the data to be captured in the field when performing the respective forms of maintenance. The systems of record have been designed and built based upon these two sets of data standards. Change management processes exist to ensure changes to maintenance standards or asset standards (including the introduction of new asset types) flow into the data standards and respective system of record. The data analytics platform has been developed to facilitate improved reporting and analysis of data, and also to develop complex analytical models, providing deeper insights into asset management not available or apparent from the raw data.		Effective asset management requires appropriate information to be available. Widely used AM standards therefore require the organisation to identify the asset management information it requires in order to support its asset management system. Some of the information required may be held by suppliers. The maintenance and development of asset management information systems is a poorly understood specialist activity that is akin to IT management but different from IT management. This group of questions provides some indications as to whether the capability is available and applied. Note: To be effective, an asset information management system requires the mobilisation of technology, people and process(es) that create, secure, make available and destroy the information required to support the asset management system.	The organisation's strategic planning team. The management team that has overall responsibility for asset management. Information management team. Operations, maintenance and engineering managers	Details of the process the organisation has employed to determine what its asset information system should contain in order to support its asset management system. Evidence that this has been effectively implemented.
63	Information management	How does the organisation maintain its asset management information system(s) and ensure that the data held within it (them) is of the requisite quality and accuracy and is consistent?	2	Vector has implemented a number of steps to ensure the data contained in SAP-PM and GE Small World GIS are consistent, accurate and of requisite quality. Data standards are in place for the capture of data. This includes asset master data, spatial data, connectivity, and maintenance data. Systems of record (SAP-PM and GIS) have been developed to align to these data standards. Data validation routines exist in all systems, based up data standards, to ensure all data captured conforms to the defined data standards. Service levels are in place for data updaters to ensure data is captured according to the defined standards and in a timely fashion. System automation and integration has been developed to reduce manual data capture wherever possible. Vector has established an Asset Information Team responsible for ensuring the data and systems are curated and continually improved, and ensure that the data standards are adhered to. Independent data quality assurance testing is conducted on key data sets.		The response to the questions is progressive. A higher scale cannot be awarded without achieving the requirements of the lower scale. This question explores how the organisation ensures that information management meets widely used AM practice requirements (eg, s 4.4.6 (a), (c) and (d) of PAS 55).	The management team that has overall responsibility for asset management. Users of the organisational information systems.	The asset management information system, together with the policies, procedure(s), improvement initiatives and audits regarding information controls.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
53	Communication, participation and consultation	How does the organisation ensure that pertinent asset management information is effectively communicated to and from employees and other stakeholders, including contracted service providers?	The organisation has not recognised the need to formally communicate any asset management information.	There is evidence that the pertinent asset management information to be shared along with those to share it with is being determined.	The organisation has determined pertinent information and relevant parties. Some effective two way communication is in place but as yet not all relevant parties are clear on their roles and responsibilities with respect to asset management information.	Two way communication is in place between all relevant parties, ensuring that information is effectively communicated to match the requirements of asset management strategy, plan(s) and process(es). Pertinent asset information requirements are regularly reviewed.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
59	Asset Management System documentation	What documentation has the organisation established to describe the main elements of its asset management system and interactions between them?	The organisation has not established documentation that describes the main elements of the asset management system.	The organisation is aware of the need to put documentation in place and is in the process of determining how to document the main elements of its asset management system.	The organisation in the process of documenting its asset management system and has documentation in place that describes some, but not all, of the main elements of its asset management system and their interaction.	The organisation has established documentation that comprehensively describes all the main elements of its asset management system and the interactions between them. The documentation is kept up to date.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
62	Information management	What has the organisation done to determine what its asset management information system(s) should contain in order to support its asset management system?	The organisation has not considered what asset management information is required.	The organisation is aware of the need to determine in a structured manner what its asset information system should contain in order to support its asset management system and is in the process of deciding how to do this.	The organisation has developed a structured process to determine what its asset information system should contain in order to support its asset management system and has commenced implementation of the process.	The organisation has determined what its asset information system should contain in order to support its asset management system. The requirements relate to the whole life cycle and cover information originating from both internal and external sources.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
63	Information management	How does the organisation maintain its asset management information system(s) and ensure that the data held within it (them) is of the requisite quality and accuracy and is consistent?	There are no formal controls in place or controls are extremely limited in scope and/or effectiveness.	The organisation is aware of the need for effective controls and is in the process of developing an appropriate control process(es).	The organisation has developed a controls that will ensure the data held is of the requisite quality and accuracy and is consistent and is in the process of implementing them.	The organisation has effective controls in place that ensure the data held is of the requisite quality and accuracy and is consistent. The controls are regularly reviewed and improved where necessary.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
64	Information management	How has the organisation's ensured its asset management information system is relevant to its needs?	3	Vector has a number of processed in place to ensure the Asset Information System remains relevant to its needs. Asset information systems are a core aspect of the wider Asset Management System. A key element of this is the alignment of asset standards and maintenance standards with data standards and system or record. An established Asset Information Team is responsible for ensuring the data and systems are curated and continually improved. Data quality improvement programmes are funded to address legacy data issues and make improvements to data. A change management process is in place to ensure all changes to asset standards and maintenance standards are flowed through into the system of record and associate data capture and maintenance standards. Innovation projects are run to develop new data sets to support and optimise asset management. A data analytics platform has been implemented to improve access to data in a consistent and integrated fashion. Condition based risk models and CBARM models have been developed using the analytical platform, to inform and improve asset decision making with regard to asset management replacement and refurbishment programs and projects.		Widely used AM standards need not be prescriptive about the form of the asset management information system, but simply require that the asset management information system is appropriate to the organisations needs, can be effectively used and can supply information which is consistent and of the requisite quality and accuracy.	The organisation's strategic planning team. The management team that has overall responsibility for asset management. Information management team. Users of the organisational information systems.	The documented process the organisation employs to ensure its asset management information system aligns with its asset management requirements. Minutes of information systems review meetings involving users.
69	Risk management process(es)	How has the organisation documented process(es) and/or procedure(s) for the identification and assessment of asset and asset management related risks throughout the asset life cycle?	3.5	A dedicated Risk Assessment team is in place in Vector. They investigate, assess, evaluate and document incidents and make recommendations for the asset management of such assets. Each incident investigation report is numbered, registered, stored and issued for action, information and learning. Risks are recorded in our risk recording application known as ARM (active risk manager). Vector also records the failure modes and effects analysis (FMEA), action plans and target dates to address risks across the asset lifecycle. Regular meetings are held to address, assess and record progress with regard to risks. The networks risk management process is defined in standard UCD001, which states how risks are managed		Risk management is an important foundation for proactive asset management. Its overall purpose is to understand the cause, effect and likelihood of adverse events occurring, to optimally manage such risks to an acceptable level, and to provide an audit trail for the management of risks. Widely used standards require the organisation to have process(es) and/or procedure(s) in place that set out how the organisation identifies and assesses asset and asset management related risks. The risks have to be considered across the four phases of the asset lifecycle (eg, para 4.3.3 of PAS 55).	The top management team in conjunction with the organisation's senior risk management representatives. There may also be input from the organisation's Safety, Health and Environment team. Staff who carry out risk identification and assessment.	The organisation's risk management framework and/or evidence of specific process(es) and/ or procedure(s) that deal with risk control mechanisms. Evidence that the process(es) and/or procedure(s) are implemented across the business and maintained. Evidence of agendas and minutes from risk management meetings. Evidence of feedback in to process(es) and/or procedure(s) as a result of incident investigation(s). Risk registers and assessments.
79	Use and maintenance of asset risk information	How does the organisation ensure that the results of risk assessments provide input into the identification of adequate resources and training and competency needs?	3	The outcomes of risk and incidents are recorded and a formal and numbered network instruction issued to our FSPs where training and/or a change in asset management process is required. We also work with our equipment suppliers, training facility and FSPs to setup up training sessions on the use of specific equipment to reduce the risk of failure. In some instances, risks and incidents will require a change in procurement standards, planning standards and/or operational standards. Such recommendations will be made in our Active Risk Management system and/or incident reports and will be followed up under our change control system		Widely used AM standards require that the output from risk assessments are considered and that adequate resource (including staff) and training is identified to match the requirements. It is a further requirement that the effects of the control measures are considered, as there may be implications in resources and training required to achieve other objectives.	Staff responsible for risk assessment and those responsible for developing and approving resource and training plan(s). There may also be input from the organisation's Safety, Health and Environment team.	The organisations risk management framework. The organisation's resourcing plan(s) and training and competency plan(s). The organisation should be able to demonstrate appropriate linkages between the content of resource plan(s) and training and competency plan(s) to the risk assessments and risk control measures that have been developed.
82	Legal and other requirements	What procedure does the organisation have to identify and provide access to its legal, regulatory, statutory and other asset management requirements, and how is requirements incorporated into the asset management system?	3	Our Active Risk Management are operated and updated by our Risk Assessment team but falls under the governance of our corporate risk manager who is assisted by our corporate legal team to assess such risks that require legal, regulatory or statutory assessment. If and where necessary for risks that require regulatory, statutory and/or legal input are registered in the corporate risk register and governed by a change control process in which risk owners are required to update progress and provide asset management plans to manage such risks. Vector is also subject to annual NZS 7901 public safety audits during which the network is physically inspected and issues and actions recorded.		In order for an organisation to comply with its legal, regulatory, statutory and other asset management requirements, the organisation first needs to ensure that it knows what they are (eg, PAS 55 specifies this in s 4.4.8). It is necessary to have systematic and auditable mechanisms in place to identify new and changing requirements. Widely used AM standards also require that requirements are incorporated into the asset management system (e.g. procedure(s) and process(es))	Top management. The organisations regulatory team. The organisation's legal team or advisors. The management team with overall responsibility for the asset management system. The organisation's health and safety team or advisors. The organisation's policy making team.	The organisational processes and procedures for ensuring information of this type is identified, made accessible to those requiring the information and is incorporated into asset management strategy and objectives

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
64	Information management	How has the organisation's ensured its asset management information system is relevant to its needs?	The organisation has not considered the need to determine the relevance of its management information system. At present there are major gaps between what the information system provides and the organisations needs.	The organisation understands the need to ensure its asset management information system is relevant to its needs and is determining an appropriate means by which it will achieve this. At present there are significant gaps between what the information system provides and the organisations needs.	The organisation has developed and is implementing a process to ensure its asset management information system is relevant to its needs. Gaps between what the information system provides and the organisations needs have been identified and action is being taken to close them.	The organisation's asset management information system aligns with its asset management requirements. Users can confirm that it is relevant to their needs.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
69	Risk management process(es)	How has the organisation documented process(es) and/or procedure(s) for the identification and assessment of asset and asset management related risks throughout the asset life cycle?	The organisation has not considered the need to document process(es) and/or procedure(s) for the identification and assessment of asset and asset management related risks throughout the asset life cycle.	The organisation is aware of the need to document the management of asset related risk across the asset lifecycle. The organisation has plan(s) to formally document all relevant process(es) and procedure(s) or has already commenced this activity.	The organisation is in the process of documenting the identification and assessment of asset related risk across the asset lifecycle but it is incomplete or there are inconsistencies between approaches and a lack of integration.	Identification and assessment of asset related risk across the asset lifecycle is fully documented. The organisation can demonstrate that appropriate documented mechanisms are integrated across life cycle phases and are being consistently applied.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
79	Use and maintenance of asset risk information	How does the organisation ensure that the results of risk assessments provide input into the identification of adequate resources and training and competency needs?	The organisation has not considered the need to conduct risk assessments.	The organisation is aware of the need to consider the results of risk assessments and effects of risk control measures to provide input into reviews of resources, training and competency needs. Current input is typically ad-hoc and reactive.	The organisation is in the process ensuring that outputs of risk assessment are included in developing requirements for resources and training. The implementation is incomplete and there are gaps and inconsistencies.	Outputs from risk assessments are consistently and systematically used as inputs to develop resources, training and competency requirements. Examples and evidence is available.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
82	Legal and other requirements	What procedure does the organisation have to identify and provide access to its legal, regulatory, statutory and other asset management requirements, and how is requirements incorporated into the asset management system?	The organisation has not considered the need to identify its legal, regulatory, statutory and other asset management requirements.	The organisation identifies some its legal, regulatory, statutory and other asset management requirements, but this is done in an ad-hoc manner in the absence of a procedure.	The organisation has procedure(s) to identify its legal, regulatory, statutory and other asset management requirements, but the information is not kept up to date, inadequate or inconsistently managed.	Evidence exists to demonstrate that the organisation's legal, regulatory, statutory and other asset management requirements are identified and kept up to date. Systematic mechanisms for identifying relevant legal and statutory requirements.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
88	Life Cycle Activities	How does the organisation establish implement and maintain process(es) for the implementation of its asset management plan(s) and control of activities across the creation, acquisition or enhancement of assets. This includes design, modification, procurement, construction and commissioning activities?	3	Our asset management plan for the acquisition, creation and enhancement of assets is done in accordance with a circular lifecycle asset management process underpinned by suites of standards and operational instructions. The life cycle process is initiated by a recorded network risk that is assessed and scored, a needs statement is established that is converted into a monetized asset management item, included into the asset management plan, a scope is compiled and the works are physically delivered. Where a new type of asset is to be introduced it will be via a formal asset introduction process that goes through a formal change control that involves our field service providers. As and where necessary this will include field trials. The consideration of climate change and carbon footprint form an important part of this process. Enhanced assets are recorded in our regulated asset base and formal drawing repository application and handed over for maintenance and acceptance via a formal process		Life cycle activities are about the implementation of asset management plan(s) i.e. they are the "doing" phase. They need to be done effectively and well in order for asset management to have any practical meaning. As a consequence, widely used standards (eg, PAS 55 s 4.5.1) require organisations to have in place appropriate process(es) and procedure(s) for the implementation of asset management plan(s) and control of lifecycle activities. This question explores those aspects relevant to asset creation.	Asset managers, design staff, construction staff and project managers from other impacted areas of the business, e.g. Procurement	Documented process(es) and procedure(s) which are relevant to demonstrating the effective management and control of life cycle activities during asset creation, acquisition, enhancement including design, modification, procurement, construction and commissioning.
91	Life Cycle Activities	How does the organisation ensure that process(es) and/or procedure(s) for the implementation of asset management plan(s) and control of activities during maintenance (and inspection) of assets are sufficient to ensure activities are carried out under specified conditions, are consistent with asset management strategy and control cost, risk and performance?	3	Our suite of maintenance standards is very specific and clear in their requirements for the recording of asset condition data for all our asset classes. The recording of asset condition data is done via field handheld tables by our field service providers via our SAP software. This uses a so-called SAP-PM application in which defects, their severity and corrective actions are recorded and immediately updated. This SAP-PM software application also records the corrective actions and costs for corrective actions and provides a quick and efficient overview of costs, remaining risks, remaining activities and performance. Our SAP-PM is closely aligned with the requirements of our maintenance standards		Having documented process(es) which ensure the asset management plan(s) are implemented in accordance with any specified conditions, in a manner consistent with the asset management policy, strategy and objectives and in such a way that cost, risk and asset system performance are appropriately controlled is critical. They are an essential part of turning intention into action (eg, as required by PAS 55 s 4.5.1).	Asset managers, operations managers, maintenance managers and project managers from other impacted areas of the business	Documented procedure for review. Documented procedure for audit of process delivery. Records of previous audits, improvement actions and documented confirmation that actions have been carried out.
95	Performance and condition monitoring	How does the organisation measure the performance and condition of its assets?	3	Our detailed maintenance standards form the basis for the condition and performance of our assets. Asset are inspected in accordance with the requirements of our maintenance standards under a planned maintenance regime. The conditions and performance of our assets are recorded by our field service providers in our SAP-PM application and further corrective actions undertaken as required. For our asset replacement and enhancement programmes and projects we have adopted condition based asset risk models to inform our works		Widely used AM standards require that organisations establish implement and maintain procedure(s) to monitor and measure the performance and/or condition of assets and asset systems. They further set out requirements in some detail for reactive and proactive monitoring, and leading/lagging performance indicators together with the monitoring or results to provide input to corrective actions and continual improvement. There is an expectation that performance and condition monitoring will provide input to improving asset management strategy, objectives and plan(s).	A broad cross-section of the people involved in the organisation's asset-related activities from data input to decision-makers, i.e. an end-to end assessment. This should include contactors and other relevant third parties as appropriate.	Functional policy and/or strategy documents for performance or condition monitoring and measurement. The organisation's performance monitoring frameworks, balanced scorecards etc. Evidence of the reviews of any appropriate performance indicators and the action lists resulting from these reviews. Reports and trend analysis using performance and condition information. Evidence of the use of performance and condition information shaping improvements and supporting asset management strategy, objectives and plan(s).
99	Investigation of asset-related failures, incidents and nonconformities	How does the organisation ensure responsibility and the authority for the handling, investigation and mitigation of asset-related failures, incidents and emergency situations and non conformances is clear, unambiguous, understood and communicated?	3	Asset related failures, incidents and emergency situations are recorded in incident reports complete with recommendations and actions. Incident reports are registered, numbered and stored in a SharePoint repository. Risks, corrective actions and responsibility assignments are stated in our asset risk management application (ARM) and followed up with regular meetings. Where specific actions and responses are required by our field service providers, numbered and registered network instructions are used to our FSPs. They have to acknowledge receipt. Progress is checked during the monthly operational meetings with our FSPs and/or the second daily update meetings		Widely used AM standards require that the organisation establishes implements and maintains process(es) for the handling and investigation of failures incidents and non-conformities for assets and sets down a number of expectations. Specifically this question examines the requirement to define clearly responsibilities and authorities for these activities, and communicate these unambiguously to relevant people including external stakeholders if appropriate.	The organisation's safety and environment management team. The team with overall responsibility for the management of the assets. People who have appointed roles within the asset-related investigation procedure, from those who carry out the investigations to senior management who review the recommendations. Operational controllers responsible for managing the asset base under fault conditions and maintaining services to consumers. Contractors and other third parties as appropriate.	Process(es) and procedure(s) for the handling, investigation and mitigation of asset-related failures, incidents and emergency situations and non conformances. Documentation of assigned responsibilities and authority to employees. Job Descriptions, Audit reports. Common communication systems i.e. all Job Descriptions on Internet etc.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
88	Life Cycle Activities	How does the organisation establish implement and maintain process(es) for the implementation of its asset management plan(s) and control of activities across the creation, acquisition or enhancement of assets. This includes design, modification, procurement, construction and commissioning activities?	The organisation does not have process(es) in place to manage and control the implementation of asset management plan(s) during activities related to asset creation including design, modification, procurement, construction and commissioning.	The organisation is aware of the need to have process(es) and procedure(s) in place to manage and control the implementation of asset management plan(s) during activities related to asset creation including design, modification, procurement, construction and commissioning but currently do not have these in place (note: procedure(s) may exist but they are inconsistent/incomplete).	The organisation is in the process of putting in place process(es) and procedure(s) to manage and control the implementation of asset management plan(s) during activities related to asset creation including design, modification, procurement, construction and commissioning. Gaps and inconsistencies are being addressed.	Effective process(es) and procedure(s) are in place to manage and control the implementation of asset management plan(s) during activities related to asset creation including design, modification, procurement, construction and commissioning.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
91	Life Cycle Activities	How does the organisation ensure that process(es) and/or procedure(s) for the implementation of asset management plan(s) and control of activities during maintenance (and inspection) of assets are sufficient to ensure activities are carried out under specified conditions, are consistent with asset management strategy and control cost, risk and performance?	The organisation does not have process(es)/procedure(s) in place to control or manage the implementation of asset management plan(s) during this life cycle phase.	The organisation is aware of the need to have process(es) and procedure(s) in place to manage and control the implementation of asset management plan(s) during this life cycle phase but currently do not have these in place and/or there is no mechanism for confirming they are effective and where needed modifying them.	The organisation is in the process of putting in place process(es) and procedure(s) to manage and control the implementation of asset management plan(s) during this life cycle phase. They include a process for confirming the process(es)/procedure(s) are effective and if necessary carrying out modifications.	The organisation has in place process(es) and procedure(s) to manage and control the implementation of asset management plan(s) during this life cycle phase. They include a process, which is itself regularly reviewed to ensure it is effective, for confirming the process(es)/ procedure(s) are effective and if necessary carrying out modifications.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
95	Performance and condition monitoring	How does the organisation measure the performance and condition of its assets?	The organisation has not considered how to monitor the performance and condition of its assets.	The organisation recognises the need for monitoring asset performance but has not developed a coherent approach. Measures are incomplete, predominantly reactive and lagging. There is no linkage to asset management objectives.	The organisation is developing coherent asset performance monitoring linked to asset management objectives. Reactive and proactive measures are in place. Use is being made of leading indicators and analysis. Gaps and inconsistencies remain.	Consistent asset performance monitoring linked to asset management objectives is in place and universally used including reactive and proactive measures. Data quality management and review process are appropriate. Evidence of leading indicators and analysis.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
99	Investigation of asset-related failures, incidents and nonconformities	How does the organisation ensure responsibility and the authority for the handling, investigation and mitigation of asset-related failures, incidents and emergency situations and non conformances is clear, unambiguous, understood and communicated?	The organisation has not considered the need to define the appropriate responsibilities and the authorities.	The organisation understands the requirements and is in the process of determining how to define them.	The organisation are in the process of defining the responsibilities and authorities with evidence. Alternatively there are some gaps or inconsistencies in the identified responsibilities/authorities.	The organisation have defined the appropriate responsibilities and authorities and evidence is available to show that these are applied across the business and kept up to date.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

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SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Score	Evidence—Summary	User Guidance	Why	Who	Record/documented Information
105	Audit	What has the organisation done to establish procedure(s) for the audit of its asset management system (process(es))?	2	The asset management plan is reviewed annually, and full updates are undertaken every second year. For our design and maintenance standards we have a full-time person that manages the continuous improvement of standards, their change control process and formal publishing. Each document has a current date and proposed review date which is governed automatically by the change control SharePoint site settings. For our capital works asset management process we have in place a stage-gate process that clearly demarcates the actions and gates that need to be achieved before works can progress. Risks and actions are recorded in minutes of meeting and risk registers for each capital works project that can be audited post works completion under the lessons learnt stage		This question seeks to explore what the organisation has done to comply with the standard practice AM audit requirements (eg, the associated requirements of PAS 55 s 4.6.4 and its linkages to s 4.7).	The management team responsible for its asset management procedure(s). The team with overall responsibility for the management of the assets. Audit teams, together with key staff responsible for asset management. For example, Asset Management Director, Engineering Director. People with responsibility for carrying out risk assessments	The organisation's asset-related audit procedure(s). The organisation's methodology(s) by which it determined the scope and frequency of the audits and the criteria by which it identified the appropriate audit personnel. Audit schedules, reports etc. Evidence of the procedure(s) by which the audit results are presented, together with any subsequent communications. The risk assessment schedule or risk registers.
109	Corrective & Preventative action	How does the organisation instigate appropriate corrective and/or preventive actions to eliminate or prevent the causes of identified poor performance and non conformance?	3	The first step in assessing poor performance and non-conformance is an assessment by the Risk Incident Team, relevant asset specialists and if required the Principal Engineer Asset Standards and Quality. The works will involve forensic analysis if and where necessary. If a product is found to not comply with our requirements, the supplier will be informed and instructed to take corrective actions. In extreme cases continued use of a product will be halted. If the non-performance is delivery related a meeting will be held with the field service provider in which corrective actions will be conveyed and formally recorded. Training will be provided if necessary		Having investigated asset related failures, incidents and non-conformances, and taken action to mitigate their consequences, an organisation is required to implement preventative and corrective actions to address root causes. Incident and failure investigations are only useful if appropriate actions are taken as a result to assess changes to a businesses risk profile and ensure that appropriate arrangements are in place should a recurrence of the incident happen. Widely used AM standards also require that necessary changes arising from preventive or corrective action are made to the asset management system.	The management team responsible for its asset management procedure(s). The team with overall responsibility for the management of the assets. Audit and incident investigation teams. Staff responsible for planning and managing corrective and preventive actions.	Analysis records, meeting notes and minutes, modification records. Asset management plan(s), investigation reports, audit reports, improvement programmes and projects. Recorded changes to asset management procedure(s) and process(es). Condition and performance reviews. Maintenance reviews
113	Continual Improvement	How does the organisation achieve continual improvement in the optimal combination of costs, asset related risks and the performance and condition of assets and asset systems across the whole life cycle?	2.5	The premise to address an asset is underpinned by the network risk that it poses, its performance in the field and its cost to maintain versus the cost to replace or refurbish. Where it is clear that continued maintenance will result in undue and persistent maintenance costs, i.e. high whole lifecycle costs, replacement will be selected. Whether or not, the asset presents a health and safety risk to personnel, or the public will also inform whether an asset will be replaced or its maintenance continued. If asset replacement is selected the selection will undergo a rigorous options analysis and safety in design reviews underpinned by detailed cost estimates. If necessary, NPV calculations will be undertaken		Widely used AM standards have requirements to establish, implement and maintain process(es)/procedure(s) for identifying, assessing, prioritising and implementing actions to achieve continual improvement. Specifically there is a requirement to demonstrate continual improvement in optimisation of cost risk and performance/condition of assets across the life cycle. This question explores an organisation's capabilities in this area—looking for systematic improvement mechanisms rather that reviews and audit (which are separately examined).	The top management of the organisation. The manager/team responsible for managing the organisation's asset management system, including its continual improvement. Managers responsible for policy development and implementation.	Records showing systematic exploration of improvement. Evidence of new techniques being explored and implemented. Changes in procedure(s) and process(es) reflecting improved use of optimisation tools/techniques and available information. Evidence of working parties and research.
115	Continual Improvement	How does the organisation seek and acquire knowledge about new asset management related technology and practices, and evaluate their potential benefit to the organisation?	3	The performance of the network is a driver to explore new technologies to improve the performance of the network. For this purpose, the Vector Asset specialists will liaise with equipment suppliers and other electricity lines businesses to explore the use of other technologies and products. Tests will be undertaken to check the viability of such technologies. Where necessary trials will be instigated and formally recorded by our Asset Standards and Quality engineer and if the trial proves successful the asset will be formally introduced for use in the network. This introduction of the asset will involve our field service providers via a change control process. Vector also participates in a number of international and Australia-NZ working groups to identify new asset management technologies and practices		One important aspect of continual improvement is where an organisation looks beyond its existing boundaries and knowledge base to look at what 'new things are on the market'. These new things can include equipment, process(es), tools, etc. An organisation which does this (eg, by the PAS 55 s 4.6 standards) will be able to demonstrate that it continually seeks to expand its knowledge of all things affecting its asset management approach and capabilities. The organisation will be able to demonstrate that it identifies any such opportunities to improve, evaluates them for suitability to its own organisation and implements them as appropriate. This question explores an organisation's approach to this activity.	The top management of the organisation. The manager/team responsible for managing the organisation's asset management system, including its continual improvement. People who monitor the various items that require monitoring for 'change'. People that implement changes to the organisation's policy, strategy, etc. People within an organisation with responsibility for investigating, evaluating, recommending and implementing new tools and techniques, etc.	Research and development projects and records, benchmarking and participation knowledge exchange professional forums. Evidence of correspondence relating to knowledge acquisition. Examples of change implementation and evaluation of new tools, and techniques linked to asset management strategy and objectives.

Company Name	**Vector Limited**
AMP Planning Period	**1 April 2024 – 31 March 2034**
Asset Management Standard Applied	

SCHEDULE 13: REPORT ON ASSET MANAGEMENT MATURITY (cont)

Question No.	Function	Question	Maturity Level 0	Maturity Level 1	Maturity Level 2	Maturity Level 3	Maturity Level 4
105	Audit	What has the organisation done to establish procedure(s) for the audit of its asset management system (process(es))?	The organisation has not recognised the need to establish procedure(s) for the audit of its asset management system.	The organisation understands the need for audit procedure(s) and is determining the appropriate scope, frequency and methodology(s).	The organisation is establishing its audit procedure(s) but they do not yet cover all the appropriate asset-related activities.	The organisation can demonstrate that its audit procedure(s) cover all the appropriate asset-related activities and the associated reporting of audit results. Audits are to an appropriate level of detail and consistently managed.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
109	Corrective & Preventative action	How does the organisation instigate appropriate corrective and/or preventive actions to eliminate or prevent the causes of identified poor performance and non conformance?	The organisation does not recognise the need to have systematic approaches to instigating corrective or preventive actions.	The organisation recognises the need to have systematic approaches to instigating corrective or preventive actions. There is ad-hoc implementation for corrective actions to address failures of assets but not the asset management system.	The need is recognized for systematic instigation of preventive and corrective actions to address root causes of non compliance or incidents identified by investigations, compliance evaluation or audit. It is only partially or inconsistently in place.	Mechanisms are consistently in place and effective for the systematic instigation of preventive and corrective actions to address root causes of non compliance or incidents identified by investigations, compliance evaluation or audit.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
113	Continual Improvement	How does the organisation achieve continual improvement in the optimal combination of costs, asset related risks and the performance and condition of assets and asset systems across the whole life cycle?	The organisation does not consider continual improvement of these factors to be a requirement, or has not considered the issue.	A Continual Improvement ethos is recognised as beneficial, however it has just been started, and or covers partially the asset drivers.	Continuous improvement process(es) are set out and include consideration of cost risk, performance and condition for assets managed across the whole life cycle but it is not yet being systematically applied.	There is evidence to show that continuous improvement process(es) which include consideration of cost risk, performance and condition for assets managed across the whole life cycle are being systematically applied.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.
115	Continual Improvement	How does the organisation seek and acquire knowledge about new asset management related technology and practices, and evaluate their potential benefit to the organisation?	The organisation makes no attempt to seek knowledge about new asset management related technology or practices.	The organisation is inward looking, however it recognises that asset management is not sector specific and other sectors have developed good practice and new ideas that could apply. Ad-hoc approach.	The organisation has initiated asset management communication within sector to share and, or identify 'new' to sector asset management practices and seeks to evaluate them.	The organisation actively engages internally and externally with other asset management practitioners, professional bodies and relevant conferences. Actively investigates and evaluates new practices and evolves its asset management activities using appropriate developments.	The organisation's process(es) surpass the standard required to comply with requirements set out in a recognised standard. The assessor is advised to note in the Evidence section why this is the case and the evidence seen.

17.13 Appendix 13 – Mandatory explanatory notes on forecast information (Schedule 14a)

1. This Schedule requires EDBs to provide explanatory notes to reports prepared in accordance with clause 2.6.6.
2. This Schedule is mandatory - EDBs must provide the explanatory comment specified below, in accordance with clause 2.7.2. This information is not part of the audited disclosure information, and so is not subject to the assurance requirements specified in Section 2.8.

Commentary on the difference between nominal and constant price capital expenditure forecasts (Schedule 11a)

3. In the box below, comment on the difference between nominal and constant price capital expenditure for the current disclosure year and 10 year planning period, as disclosed in Schedule 11a..

BOX 1: COMMENTARY ON DIFFERENCE BETWEEN NOMINAL AND CONSTANT PRICE CAPITAL EXPENDITURE FORECASTS

Vector has used the capital expenditure inflator based on the model used by the Commerce Commission in its DPP price reset on 1 April 2020. We have used a forecast of the Capital Goods Price Index (CGPI) as the inflator.

Vector has used the NZIER (New Zealand Institute of Economic Research) September 2023 CGPI forecast up to December 2028. Thereafter, we have assumed a long-term inflation rate of 2.0%.

The CGPI forecast reduces from 4.94% in RY24 to 2.02% in RY27 and is stable thereafter.

The constant price capital expenditure forecast is inflated by the above-mentioned index to convert to a nominal price capital expenditure forecast.

Commentary on the difference between nominal and constant price operational expenditure forecasts (Schedule 11b)

4. In the box below, comment on the difference between nominal and constant price operational expenditure for the current disclosure year and 10-year planning period, as disclosed in Schedule 11b.

BOX 2: COMMENTARY ON DIFFERENCE BETWEEN NOMINAL AND CONSTANT PRICE OPERATIONAL EXPENDITURE FORECASTS

Vector has used the operational expenditure inflator based on the model used by the Commerce Commission in its DPP price reset on 1 April 2020. We have used an inflator which is a mix of the Producer Price Index (PPI) and the Labour Cost Index (LCI). The weighting between PPI (40%) and LCI (60%) is as per the Commission's model.

Vector has used the NZIER (New Zealand Institute of Economic Research) September 2023 PPI (Producer Price Index-inputs) and LCI (Labour Cost Index) forecasts up to December and June 2027 respectively. Thereafter, we have assumed a long-term inflation rate of 2.0% for both metrics.

The constant price operational expenditure forecast is inflated by the above-mentioned index to convert to a nominal price operational expenditure forecast.

17.14 Appendix 14 – Schedule 17 Certification for year-beginning disclosures

Schedule 17 Certification for Year-beginning Disclosures

Clause 2.9.1

We, Bruce Turner, and Paul Hutchison, being directors of Vector Limited certify that, having made all reasonable enquiry, to the best of our knowledge:

a) The following attached information of Vector Limited prepared for the purposes of clauses 2.6.1, 2.6.6 and 2.7.2 of the Electricity Distribution Information Disclosure Determination 2012 in all material respects complies with that determination.

b) The prospective financial or non-financial information included in the attached information has been prepared on a basis consistent with regulatory requirements or recognised industry standards.

c) The forecasts in Schedules 11a, 11b, 12a, 12b, 12c, 12d and 13 are based on objective and reasonable assumptions which both align with Vector Limited's corporate vision and strategy and are documented in retained records.

Director

Director

21 March 2024

Date

vector

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