vector

**2021—2031**

# electricity asset management plan

# Table of Contents


**SECTION 01**

# Introduction

# 1 – Introduction

## 1.1 Executive summary

### 1.1.1 SYMPHONY IS OUR STRATEGY FOR THE NEW ENERGY FUTURE

The current energy system our customers rely on cannot flex to the demands and challenges ahead of us. Climate change and the need to decarbonise, the electrification of transport, consumers expecting choice and control over their energy production, storage and usage, as well as real-time information during outages, plus the never-ending goal of providing safe, affordable and reliable energy are demands we must actively address. For several years Vector has been forging ahead to create a different energy future, not sitting around and waiting for someone else to do it. We see it as our responsibility to proactively lead and create the energy future for our customers, shareholders, our people and the communities in which we live and work.

At its core, our Symphony strategy is about creating a system for our customers that fits the future, delivering safe, cleaner, more reliable and affordable energy solutions that are developed with customers at the centre, and which helps us navigate future uncertainty. Symphony is how we intend to transform the traditional poles and wires of the electricity networks serving the Auckland region into an intelligent energy system where customers have more choice and control.

We understand the significant role that the electricity industry has in achieving the transition to a low carbon future. Our Symphony strategy calls for a system which reduces peak loads, helps manage demand profiles, and provides customers with choice and control, while maintaining service. By focusing on network flexibility, resilience and smart technologies, we're not only easing pressure on electricity supply but also removing obstacles to transition customers to more sustainable energy options, including electric transportation (currently, emissions from the energy sector make up 41% of NZ's total emissions). Many of the same technologies that provide customers with low-carbon options, such as electric vehicles (EVs), solar, or batteries, can also provide greater levels of resilience, which are all critical to both lowering our emissions, and adapting to the impacts of climate change that are already baked in.

Symphony unites our teams on a clear path into the future and directs our activity. Our teams work together to achieve maximum benefit for our customers, communities and shareholders.

### 1.1.2 INCREASING UNCERTAINTY

The Climate Change Commissions' (CCC) draft advice to government calls for wide-reaching and lasting changes to the way our society operates. Policy response will likely drive the degree and pace of change, however this makes it clear there is also significant and increasing uncertainty over the regulatory, technology and investment spheres in which we operate. We share the CCC's desire to avoid investing in infrastructure which locks in cost for future generations, but which may no longer deliver value, as well as their focus on leveraging 'co-benefits' for citizens through our transition. For network management this is about avoiding large network upgrades in the context of future demand uncertainty, and supporting smart, integrated energy systems which can deliver additional benefits for customers – including greater efficiency and resilience. For example, there is a lot that we still don't know about the impact of EV integration in future years, but we need to be able to respond to it effectively for customers. This is why we must acknowledge the uncertainty ahead of us and ensure our network is capable of responding and optimising dynamically in response to changing trends. Aligned with the uncertainty we also need to make operational assumptions, such as the ability to manage EV charging, and our investment forecasts are predicated on this key assumption.

### 1.1.3 MANAGING UNCERTAINTY IN PLANNING HORIZONS

*This Asset Management Plan sets out our view of the investments we believe will deliver the best outcomes, however 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 views 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.*

We are facing uncertainty at unprecedented levels around future electricity demand, the impact of climate change and associated policy response, and the extent of regulatory change required to support new technology investment to avoid over investment in traditional assets in our network.

If the Climate Change Commission's draft advice is implemented by Government it will have a potentially material impact on electricity distribution networks, both in terms of EVs and the potential transition from gas to electricity. As such, the degree of any certainty within our forecasts is significantly lower given we do not know, particularly in these changing times, what may happen.

To this end, we have developed our AMP with a higher degree of accuracy in the near term, and reducing level of accuracy thereafter. 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 network solutions.

### 1.1.4 THE CASE FOR INDUSTRY CHANGE

For several years we have been advocating the opportunity to transform our energy systems – to start with customer demand, not supply – putting New Zealanders' needs at the heart of what we do and unlocking new value across energy supply chains. Vector has long held the view that we must move away from the current central planning mindset and recognise the value for customers, and our increased reliance on low emission electricity, which can be leveraged across the whole supply chain. This requires the smart use of data analytics, the integration of digital energy solutions and storage, as well as localisation, to ensure that energy systems are built around the needs of customers and communities, and that energy infrastructure is able to respond to changes in future demand efficiently. The public and political desire to decarbonise our energy systems had already created a need for electricity infrastructure and supply chains to change and Covid-19 has increased the imperative for essential infrastructure to be safe, efficient, adaptable, resilient, and affordable.

Now is the time to act. If we don't, and Electricity Distribution Businesses (EDBs) in New Zealand and around the world carry on doing what they've always done, the changes to the electricity system will result in higher costs to consumers, slower growth of clean technology, like electric vehicles and solar, and we will have failed to take the opportunity to make our infrastructure more resilient in the face of climate change. The recent release of the Climate Change Commission's draft advice to government has put these challenges into stark, and urgent, focus.

### 1.1.5 ENABLING A LOW CARBON FUTURE

Vector is committed to a low carbon future, both in reducing our own emissions to net carbon zero by 2030, and in enabling emission reductions across society. Our board has recently approved a strategy that covers our carbon footprint, handprint, and ensures a strong focus on decarbonisation. We agree with the Climate Change Commission's comments in their draft report that distribution companies have a key role to play in enabling the adoption of emissions-reducing technologies, like solar, batteries, and EVs. Furthermore, our view for several years has been that, while we will continue to follow our Symphony strategy and invest in innovation, for New Zealand to make the most of this opportunity, work should be done to ensure incentives are in place across the energy sector to make the right type of investments more widespread. We strongly support the CCC's recommendation that "the Government assess whether electricity distributors are equipped, resourced and incentivised to innovate and support the adoption on their networks of new technologies, platforms and business models, including the successful integration of EVs to implement their necessary action – maximise the use of electricity as a low emissions fuel".

Vector's commitment to a low carbon future is called out in our Symphony strategy through the drive to create affordable, clean energy systems.

Our role as an enabler of lower carbon emissions is illustrated through the handprint we provide to enable customers to choose low-carbon alternatives. Our work supporting the adoption of EVs is the clearest example. We have led the way in smart EV charging in Auckland and are currently running the biggest network EV trial in New Zealand, with 200 Aucklanders. Their EVs are connected to our system so we can see how to manage the impact of increased demand for electricity, now and as the number of EVs on the road increases.

This work is critical; we are ready for faster uptake of EVs, but only if EV charging is integrated into our system, so we can manage demand. Otherwise, we see affordability problems becoming clear as those without EVs subsidise those with them, by contributing to the cost of network reinforcements needed to accommodate increased peak load driven by charging behaviour.

For this reason it's crucial we can tweak the energy supply so everyone's cars are charged when they need them but without overloading the network. We have found, through our trial, that smart charging can effectively reduce demand during peak hours without affecting customer satisfaction.

In the context of the Climate Change Commission's draft advice, there is a critical need for distribution businesses to have access to data to understand the impact of these trends to build a smart and efficient network that meets the needs of customers now and into the future. The absence of that data leads to a network that is inefficient and not customer-focused

We also continue to analyse the potential impact to the electricity network of the transition away from gas and to inform this thinking as consultation with the CCC continues.

### 1.1.6 DELIVERING RELIABILITY

We remain committed to delivering a safe, reliable, resilient network to meet customers' needs, and we are proud of the concerted efforts by the Vector team and our field service providers to improve our electricity network reliability. As reported in our half year results in February 2021, in the nine months to 31 December 2020 our combined planned and unplanned SAIDI had improved by 21%. But we continue to believe that the current aggregated view of network reliability needs to be reworked towards a much more customer-focused disaggregated view that better reflects customer experience.

### 1.1.7 MAINTAINING RESILIENCE

As climate change increases weather volatility, we continue to develop our understanding of the consensus view of what the impacts of climate change will mean for Auckland. In response we are evolving our approach to asset management to ensure the ability of the electricity network to anticipate, absorb, accommodate and recover from the effects of a potentially hazardous event related to climate change. Further details of how we are doing this are provided in Section 2 - Climate Resilience.

One of the more significant changes we have made to increase our resilience has been moving to operating two control centres. This was a decision taken partly within our Covid-19 response framework, but will deliver resilience benefits beyond that specific risk.

### 1.1.8 LONG-TERM TRENDS DRIVING CHANGE

There are several long-term drivers of change, and increasing uncertainty, to electricity systems around the world. In New Zealand, the Climate Change Commission's draft advice shows how significant the uncertainty is over future policy direction, particularly around the impact on electricity demand from EV uptake and the potential demand shift from gas to electricity. This uncertainty makes it even more critical that distribution companies are provided access to metering data around energy use and power quality so we can understand trends and invest in smarter networks.

Here, we set out our interpretation of how these long-term trends are impacting our responsibilities to our customers, communities, and stakeholders.


### AUCKLAND GROWTH AND OVERCOMING THE INFRASTRUCTURE DEFICIT

Auckland's growth continues at pace requiring us to spend significantly on network integrity and reinforcement. In the last financial year we spent $296m on the Auckland network, the most we've invested in 10 years. The investment in infrastructure and maintenance over the past 10 years has reached $2.3b, largely driven by the region's growth and to replace, upgrade and maintain infrastructure. This level of funding is necessary both to keep pace and avoid burdening future generations with the costs of an infrastructure deficit. To put the growth component in perspective, we have needed to build new network equivalent to that needed for a city the size of Tauranga, every few years. Our preference is for investment into non-wired solutions, where feasible, to complement traditional network solutions.

Complicating this investment is our need to understand other infrastructure and investment pipelines, including significant, politically sensitive projects such as light rail or large housing developments.

### DECARBONISATION

As signalled by the analysis of the Climate Change Commission in its first draft report to Government, electrification will have a key role to play to reduce emissions from transport and process heat, which together account for around 30% of New Zealand's total emissions. Integrating EVs and electrifying process heat at the scale that is required will change network requirements, both at a system level right down to the low voltage network. The need to rapidly expand renewable generation only increases these challenges. The level required to reach our decarbonisation goals is significant, and will rely not just on a top-down approach that replaces current generation capacity with lower-carbon alternatives, but also from the bottom-up with demand-side initiatives such as energy efficiency, new customer technology, and new market opportunities.

We expect that EV uptake will accelerate in the future, and we must remain responsive should policy be established to facilitate this acceleration.

**29% of our customers would like to see information about carbon emissions associated with their electricity use.**

SOURCE: VECTOR CUSTOMER SURVEY, JANUARY 2021

### CLIMATE RESILIENCE

Adapting to the extreme weather caused by climate change means our infrastructure must seek to become more resilient. In addition to reinforcing existing network assets and designs, decentralised designs must be considered as a complementary solution to reduce reliance on a central point of failure. Microgrids and other distributed energy resources can be seen as key tools for climate change adaptation as well as network asset management. Embedding greater localisation of solutions also means designing the distribution network to facilitate customer uptake of distributed energy resources such as solar and battery, as well as working with communities to design local, network solutions that respond to their needs.

We have added a Climate Resilience section to the AMP for the first time (see Section 2, where we summarise how we are responding operationally to this challenge, with supporting initiatives and associated investment described elsewhere in the AMP.

We also acknowledge the work of the CCC and welcome its draft advice to Government. We will participate in submission process and have engaged with Dr Rod Carr and his team to understand their work more fully and discuss the challenges together. We watch with great interest how the Government will respond during 2021 and beyond.

### CHANGING CUSTOMER BEHAVIOUR

Evolving customer needs and expectations, centered around the use of new technology and digitalisation, is resulting in massive shifts in service industries across the world. Energy is no different, and we need to be flexible to accommodate significant changes in behaviour at scale. As more adopt new technology to enhance and support their lives, they are becoming stakeholders and participants in the energy system, as opposed to legacy "connection points" or "behind the meter loads". We are seeing this already with smart EV charging in domestic environments. This shift demands a flexibility and preparedness from Vector to enable a customer-centric electricity distribution system and the integration of new technology in line with technology availability, desired policy outcomes, and customers' expectations.

**More than two thirds of our customers would like to see information about the difference in the cost of electricity at peak time vs off peak**

(SOURCE: VECTOR CUSTOMER SURVEY, JANUARY 2021)

The experience of lockdowns and societal change because of Covid-19 supports this need for flexibility and responsiveness to change, with less certainty now over future network demands as load profiles reflect changing work practices, such as an increase in working from home.

Metering data on electricity use and power quality can illustrate these changing behaviours, and so it is critical for distribution companies to be able to access this data in order to understand and respond effectively.

### AFFORDABILITY

Investing in assets to meet demand peaks, which are underutilised during other times, could result in overbuilding of infrastructure and a significant cost associated with the electrification of the economy. To minimise this, we need to actively manage demand and unlock new value at the demand side of the electricity supply chain to exert a new, downward price pressure. EDBs will play a role in unlocking this new value, and should be supported by appropriate investment returns and incentives to make a broader mix of investments, and to leverage a wider range of solutions. For Vector, these include data analytics, distributed energy solutions, and the digitalisation of the network. Through making these investments now, we believe we can manage peak demand and avoid unnecessary investments in traditional pole and wire solutions which will burden future generations with long-term cost recoveries.

## 1.2 What is in this AMP?

**We recognise that much of the information contained in this AMP is highly technical, yet we have attempted to describe our strategies and activities in ways that are accessible and can help those without technical knowledge to learn more about how Vector manages the electricity distribution networks for the Auckland region. For those with limited time to read the full document, we have set out notable changes or additions which we consider may be of interest to a more general audience.**

This table sets out, at a high level, notable changes or additions to this year's AMP, illustrating how we have evolved our capability or strategy and which we consider to be useful for our stakeholders and customers to see in our asset management practices.

| NOTABLE IN AMP 2021 | PURPOSE | FURTHER DETAILS |
|---|---|---|
| Symphony is our strategy for a new energy future | Included to illustrate how Vector's strategy will result in the transformation of the traditional poles and wires of the electricity networks serving the Auckland region into an intelligent energy system where customers have more choice and control. | Section 1 |
| Climate Resilience | To provide an overview of how Vector considers the risk from climate change on network assets and show how this consideration has been incorporated into our asset management practice. | Section 2 |
| Customer Insights | An overview of results from our most recent customer survey which provide insight on our customer delivery service and customer perception on the number and duration of network outages. | Section 4 |
| Asset Management Policy and Objectives | Our Asset Management Policy and Objectives have been revised to closer align to our vision and Symphony strategy. | Section 5 |
| SAP-PM project delivered | Noted in previous AMPs as a planned project, the SAP-PM project has now been delivered and is underpinning our planned maintenance activities. | Section 8 |
| Auckland Granular Customer Model | Described in previous AMPs as a modeling and planning tool, the Auckland Granular Customer Model is now more advanced and more embedded in our planning processes. | Section 10 |
| Strategic Reliability Management Plan (SRMP) | In RY20 Vector formalised the Strategic Reliability Management Plan (SRMP) which reinforces our commitment to compliance with the Default Price Path (DPP) Quality Standards. | Section 11 |
| Advanced Distribution Management System (ADMS) project underway | Noted in previous AMPs as a planned project, the ADMS project is now underway, and example our investment in platforms that support and improve core network operations. | Section 14 |

### 1.2.1 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 practices support the decision-making process.

*This Asset Management Plan sets out our view of the investments we believe will deliver the best outcomes, however 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 views 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.*

### 1.2.2 AMP PLANNING PERIOD

This AMP covers a 10-year planning period, from 1 April 2021 to 31 March 2031. Consistent with Information Disclosure requirements, a greater level of detail is provided for the first five years of this period.

### 1.2.3 CERTIFICATION DATE

This AMP was certified and approved by our Board of Directors on 31 March 2021.

### 1.2.4 OVERVIEW OF VECTOR

The Vector Group is New Zealand's largest energy solutions business. The Group is a diverse portfolio of regulated and unregulated business units delivering products and services across electricity, gas, fibre, metering and new technologies.

We are 75.1% owned by the community trust Entrust, which represents over 340,000 electricity customers in Auckland. The remainder of our shares are listed on the New Zealand stock exchange, an ownership model that achieves both commercial and community objectives. On behalf of our customers and shareholders, and in collaboration with our suppliers and partners, we are committed to facilitating a decarbonised, resilient and affordable energy future for our customers.

Vector's asset management is a multi-utility practice that includes both electricity and gas distribution, as well as fibre assets. However, for the purposes of this AMP, the scope of asset management practices described is limited to Vector's electricity distribution network. We manage more than 19,000 kms of overhead lines and underground cables, delivering power to over 500,000 homes and 60,000 businesses throughout the wider Auckland region.

### 1.2.5 VECTOR'S CORPORATE VISION

Our vision is to create a new energy future that delivers clean, affordable and reliable energy with the customer at the centre of everything we do. Our Symphony strategy shows us how we will do this. Throughout this AMP we attempt to show how our Symphony strategy informs our asset management practice.

## 1.3 Investing in the network of the future: embedding Symphony

**The following examples illustrate how Vector is investing in the network of the future, while delivering on the near-term needs of our customers.**

### 1.3.1 INVESTING IN CYBER SECURITY

Digital platforms that reduce the cost and improve the efficiency and effectiveness of our core network operations are becoming increasingly important. Consequently, it is becoming even more critical to ensure safe and secure connectivity. At the same time, there is a rapidly escalating threat to cyber security. Vector has invested in improving our cyber security capabilities and maturity and we will continue to do so. It is our view that allowance should be made for distribution businesses to invest in this capability, to ensure that, as the sector transforms, it does so safely and securely.

We also hold the view that as digitalisation continues to gain importance, allowance should be made for costs associated with procuring the necessary data.

Partly because of these omissions from the current DPP regime, we are spending above our allowance in these areas (while remaining within the DPP3 envelope). We remain committed to maintaining our existing network to meet reliability targets but note the Commerce Commission significantly reduced our allowable expenditure in the latest DDP regime.

### 1.3.2 IMPROVING CUSTOMER EXPERIENCE THROUGH DIGITAL INVESTMENT

Putting customers at the heart of our Symphony strategy means, while we continue to meet investment requirements in delivering new connection requests, we also need to invest in delivering seamless, and great, experiences for our customers as they engage with us. One way we have done this is by designing experiences that allow for richer and more informative interactions.

Through ongoing investment into, and development of, our customer experience capabilities, we have a continuous focus on incremental improvement to our communication capability, including self-service, proactive and inbound engagements. Some of our more recent improvements include:

- data corrections to improve planned outage notifications so the right customers get the right information via the channel they choose;
- enhanced and improved interface and better information available through our online Outage Centre web-app, including the ability to interact directly with Vector to report outages and receive ongoing information on the progress of resolving outages; information detailing upcoming planned outages, including cancellations and postponements during outages, meaning customers are now able to get more information on planned outages so they can plan and minimise the impact to their lives;
- customers can request a live chat with one of our call centre agents via our chatbot; and
- following specific customer feedback, we have streamlined account management on our Outage Centre through removing the requirement to create and remember a password.

### 1.3.3 GRANULAR AUCKLAND CUSTOMER MODEL

In the current dynamic environment of rapid technology and behaviour change, customer centricity is essential to gain granular understanding of an increasingly diverse customer base. Vector has embraced this new ethos by developing a bottom-up, data driven model to understand customer energy use - the Granular Auckland Customer Model.

The Granular Auckland Customer Model has been the foundation for new impactful business applications that engrain a data-driven customer-centric approach throughout Vector's business. The insights and tools derived from this approach support decision-making at all levels; from simple day-to-day operational and customer management choices, through to the myriad of more complex strategic and risk-based decisions. Some examples of where Vector has applied this granular customer-centric approach include the below.

### COST ALLOCATION BY DEPRIVATION INDEX

Analysis of cost allocation on different customer demographics and neighbourhoods; with a particular focus on equity and understanding energy poverty and hardship. This is achieved through greater understanding of demographic energy use patterns. For example, by linking the four typical load profiles to household income we have been able to quantify the distribution of the load profiles across income levels. Overall, the four typical load profiles are quite evenly distributed across income levels, albeit with an increasing proportion of 'High Day Load' customers at the expense of 'Twin Peak' customers for low income levels. Understanding load profiles across a range of customer segmentation is important for the design of cost-reflective electricity tariffs which need to consider the impact on lower-income customers who spend a higher share of their income on electricity bills.

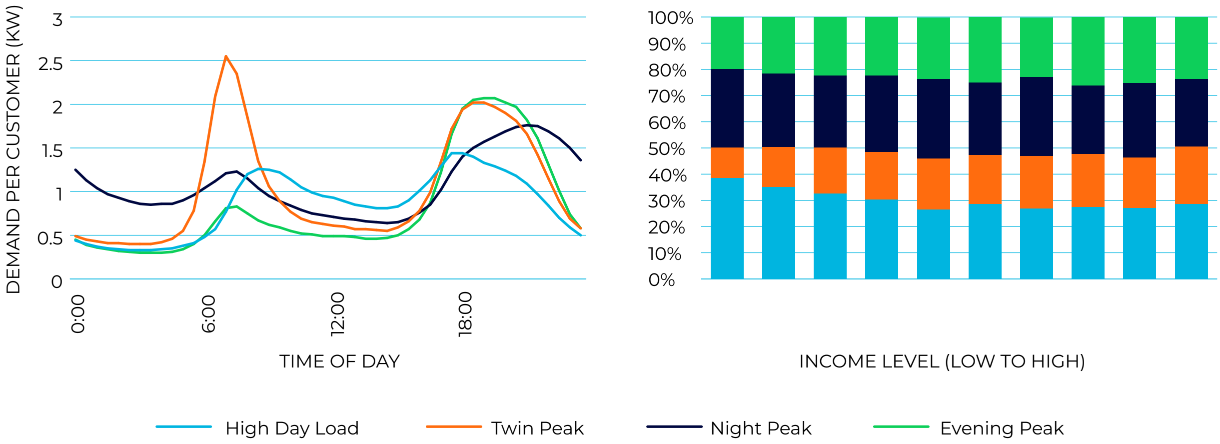



FIGURE 1-1: TYPICAL RESIDENTIAL HALF-HOURLY LOAD PROFILES DURING NETWORK PEAK TIMES AND THEIR DISTRIBUTION BY CUSTOMER INCOME LEVELS

### EV OWNERSHIP BY GEOGRAPHIC LOCATION

A granular bottom-up Scenario Model which provides a tool used to inform load growth and planning, and which evaluates the impact of the uptake of new customer technologies (such as EVs and rooftop solar), energy efficiency and changing customer behaviour. The Scenario Model estimates consumption and demand over a 30-year period at a granular suburb level. The suburb level input is derived from the Granular Auckland Customer Model by aggregating every customer by suburb. The output of the Scenario Model is used in various areas of interest to the business such as customer pricing development and network infrastructure planning. For example, in terms of EV adoption, a common working assumption before this analysis was that more affluent central Auckland city dwellers buy EVs. However, our analysis revealed that EV uptake is also occurring in a belt of more remote areas. These customers will commute more than 60 km a day, while the average Aucklander commutes less than half that (28 km), making the cost savings from EV more attractive in such locations. This model highlighted a need to evaluate different customer charging behaviours and the impacts on the LV network, while explicitly focusing on the very different urban and rural LV networks.

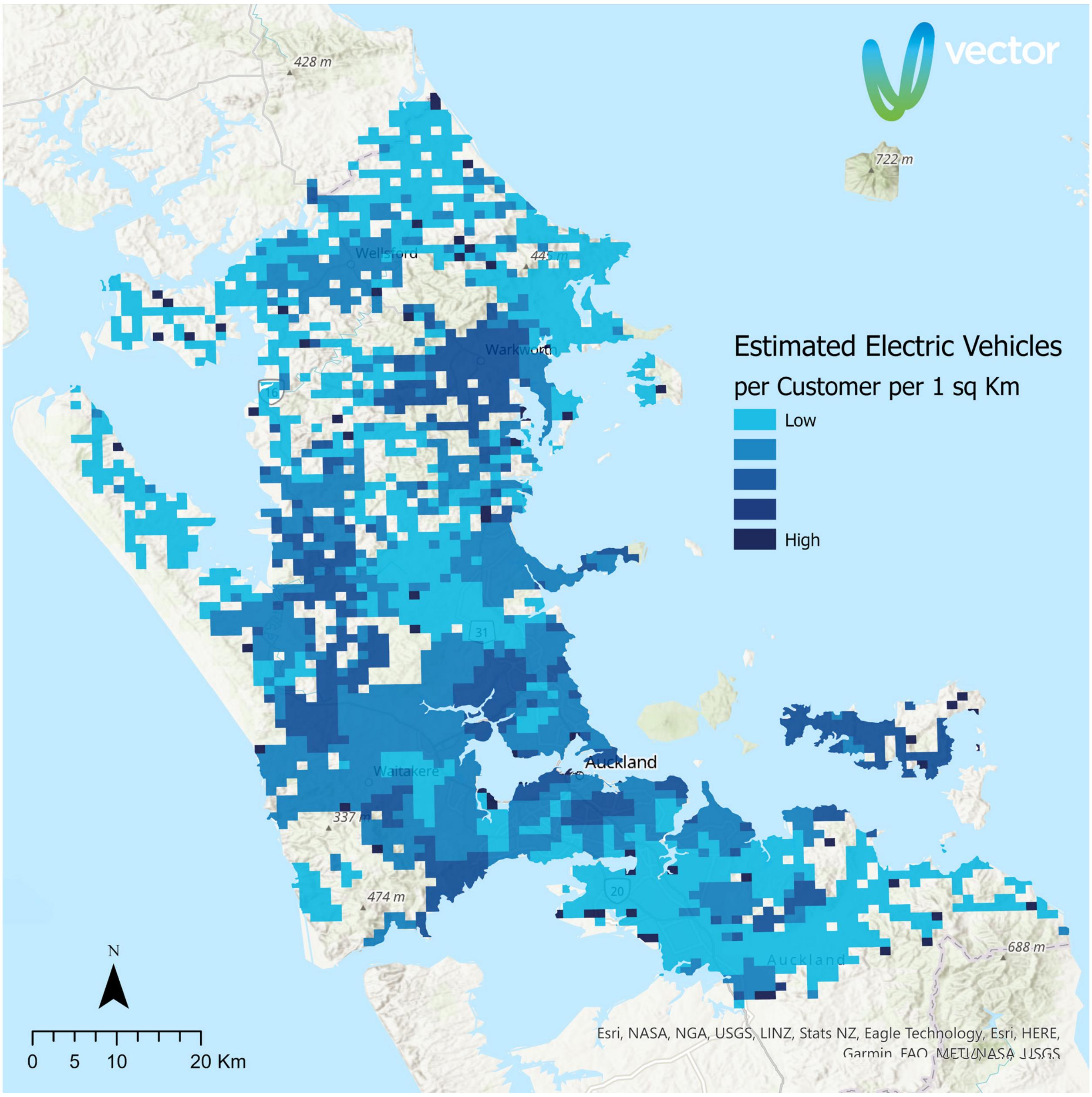



FIGURE 1-2: GEOSPATIAL DISTRIBUTION OF EVS PER CUSTOMER (2020)

The model informs our distribution network planning (see section 10) and allows for strategies to mitigate risks created by the rapid energy transition that is taking place, recognising the role that non-traditional investment can play. Due to the long lifetimes of traditional distribution assets, investment decisions made now will affect customers for many years into the future and may unfairly burden future generations if the wrong decisions are made.

### 1.3.4 Vector DERMS platform

As noted in our 2019 AMP, Vector has been developing a Distributed Energy Resources Management System (DERMS). In 2018, we successfully introduced the first stage onto our network, and have been continuing to build and refine it since. DERMS is a highly intelligent software system, able to connect distributed energy assets like solar panels and storage battery connections to our traditional infrastructure and management systems.

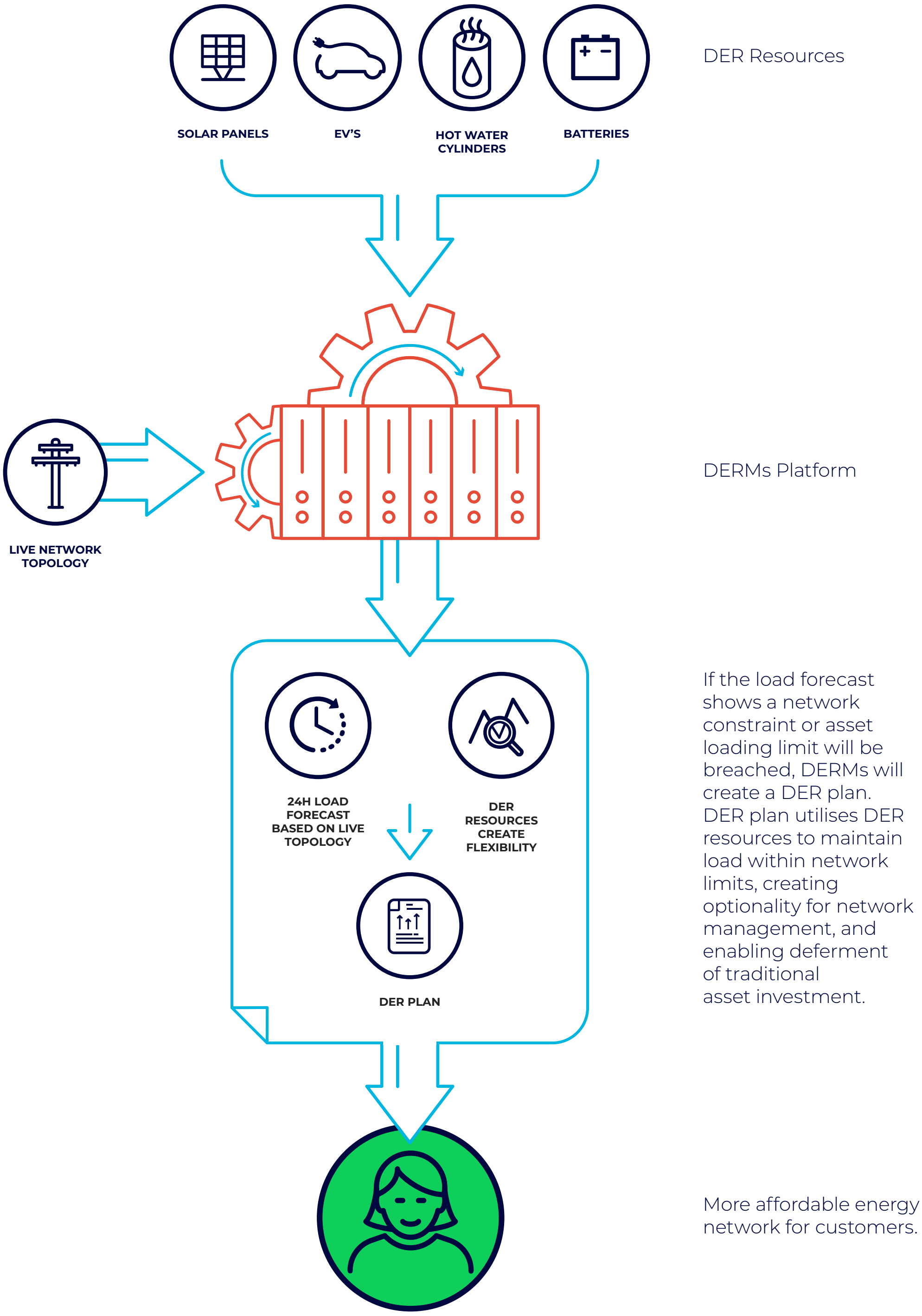



FIGURE 1-3: THE FUNCTION OF A DERMS PLATFORM WITHIN THE ELECTRICITY NETWORK

Over the past year, more than 400 customer and network connected resources (rooftop solar, EV chargers, batteries) have been integrated with the network using the DERMS platform to provide visibility and ability to manage the complex interactions between the network and distributed energy assets. As the number of network connected resources grows, DERMS is capable of providing an unmatched level of security and reliability to our energy management, including predictions around loading on critical infrastructure assets such as power transformers, user-defined allowable limits on loadings, and automated load reduction plans utilising available DER assets to maintain load below the defined limit. DERMS also supports improved response to unexpected events, including extreme weather. We are confident we can scale up the DER connections into DERMS as they continue to grow, and consequently we expect this system to be a key enabler for a future-ready network.

### 1.3.5 USING DATA AND TECHNOLOGY TO DRIVE A STEP CHANGE IN MAINTENANCE DELIVERY

Vector maintains all its asset management information within SAP Plant Maintenance (SAP PM), which includes maintenance planning, scheduling, planned maintenance inspection and asset observations (corrective maintenance). The process operates in partnership with Vector's two key Field Service Providers (FSP) (Electrix and Northpower) and manages our investment to keep the electricity network reliable and resilient for its customers.

Over RY21, a project has been completed to deliver significant improvement to the depth and quality of information about each asset, standardised across Field Service Providers and Vector, and to build end-to-end integration with intelligence in between Vector and FSP systems to drive efficiency.

With implementation now complete, the following high-level objectives are beginning to be realised:

- Improved timeliness, reliability, consistency, completeness, and accuracy of asset maintenance data
- Near real time data exchange from and to SAP PM for planned, corrective and asset replacement maintenance events
- An efficient solution for adding new equipment and removal of retired equipment
- Improved automation to minimise Vector and FSP manual handling of transactional data
- Provide the necessary data to support condition-based risk management – to form a justified and robust risk-based replacement programme for the 10-year asset management plan (AMP).

### 1.3.6 ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

As noted in our previous AMP Update (2020), a business case for an Advanced Distribution Management System (ADMS) has been approved and work is now underway on a project to introduce ADMS functionality (see section 14 for a schedule of investment into this project), The ADMS will include modules that provide outage management, electronic switching, automated fault identification and service restoration, as well as integration with Vector's Distributed Energy Resource Management System (DERMS), all of which are key requirements and enablers for our Symphony strategy.

The same functionality will also benefit our customers in the near term, through delivering the following benefits:

1. **Customer Experience:** Customers will receive more 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 digitalisation and automation of manual processes
3. **Resilience:** Improved SAIDI performance through faster outage response and restoration times – including major event recovery, enabled by:
    a. efficient utilisation of smart assets in the field using automated fault identification and restoration sequences;
    b. supported decision-making and better situational awareness in the Electricity Control Room through integrated tools and automated processes;
    c. Increased focus on network operations by controllers through intelligent systems and system visibility drawing attention to critical issues; and
    d. 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 and Information Technology network convergence through utilising security by design principles enabled by a modern ADMS ecosystem.

## 1.4 Reliability commitment

**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.**

### 1.4.1 STRATEGIC RELIABILITY MANAGEMENT PLAN

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 as specified in the AMP.

The Strategic Reliability Management Plan concept was formally introduced in DPP2 (August 2019), as part of Vector's commitment to compliance with the regulatory quality standards.

The SRMP builds upon the actions taken as part of our response to our SAIDI performance from RY2016-20, with a heightened focus on initiatives aimed at improving outage duration times, which has been identified as Vector's key reliability challenge.

The initial SRMP comprised of the following initiatives.

- Specific reliability strategies and supporting initiatives including;
  - Generation;
  - Mitigating the impact of new Health & Safety practices;
  - Vegetation;
  - Automation deployment;
  - FSP enablement comprising an additional depot, a CAIDI performance framework and optimizing first responder operations and increased resourcing;
  - Corrective Maintenance.;
- Initiatives to improve asset management capability.
- Initiation of a programme to implement a formalised asset management system aligned to ISO 55001:2014.

The SRMP was revised for RY21 to take into account the changes introduced by the DPP3 quality standards, particularly the separation of Planned and Unplanned SAIDI, and sees a continuation of the reliability initiatives comprising the RY20 SRMP (however, where appropriate, the RY20 initiatives were embedded into business as usual practice). These initiatives involve both work in the asset portfolio, as well as changes to asset management processes and improvements to supporting capabilities.

As at the end of RY20 the compliance gap was 13 minutes for Unplanned SAIDI. The RY21 SMRP therefore targets a further improvement of 13 minutes SAIDI while including a margin to allow for the variability in network operating conditions from year to year.

As at February 2021, Unplanned SAIDI and SAIFI for the regulatory year to date have improved as a result of the SRMP initiatives which has led to a decrease in the quantum of outage events on the network and also the duration of those outages.

### 1.4.2 EVOLUTION OF RISK-BASED APPROACH TO CORRECTIVE MAINTENANCE

We have continued our focus on becoming more risk based in our approach to corrective maintenance and vegetation management, in part through improvements in our systems and standards, such as those introduced through our SAP-PM project (as noted above). The new systems and standards improve our asset lifecycle information and will enable long term improvements to reliability, performance and quality of service to our customers.

The risk based approach, together with higher quality and more comprehensive asset lifecycle information also delivers the following benefits:

- Improved analytics and asset lifecycle modelling capability
- Work planned and executed at a TOTEX level through enhanced risk assessments
- Improved efficiency and reduced customer impact from planned works through work package optimisation

More information about how we are evolving our risk based approach is available in Section 8.

## 1.5 Policy and economic issues

### 1.5.1 NEW SOLUTIONS FOR NEW CHALLENGES

Energy systems in New Zealand and globally are under pressure to respond to many critical issues, including:

- the uptake of new consumer energy technology
- electrification of transport
- demands for decarbonisation
- an increasing need for resilience against weather impacts from climate change
- greater reliance on renewable energy
- digitalisation and cyber security
- energy poverty

Disruption is here and, while we've played an active part in this disruption for years, we encourage the public and our stakeholders to consider how the wider policy and economic framework could be shaped to realise the potential benefits of energy sector transformation.

We are working collaboratively with energy market regulators to discuss these challenges, and work together to deliver the best outcomes for consumers.

#### CLEAR AND JOINED UP REGULATORY AND POLICY FRAMEWORKS

The Climate Change Response (Zero Carbon) Amendment Act 2019 has provided a legislative framework for New Zealand's climate change mitigation and adaptation, but our regulatory frameworks must align with this to enable and incentivise the right investments from industry. For example, in order to respond to changes in future demand associated with decarbonisation, electricity infrastructure needs to be adaptable and resilient. This requires the integration of new solutions with network asset management.

#### A MINISTRY OF ENERGY TO LEAD A COORDINATED APPROACH

We have long recognised that the current energy system cannot flex to the demands and challenges ahead of us, including climate change, electrification, and customer expectations. The current regulatory approach of market segmentation silos energy market participants, inhibiting the uptake of solutions which can unlock new value – like distributed generation or smart EV chargers – and

which tend to cut across market silos. This regulatory framework, which was designed decades ago, seeks to maximise competition in the competitive segments of the market whilst holding the monopoly segments to account. Because technology now enables innovation right across the value chain, from generation through to consumer, there is, under the current framework, a missed opportunity to introduce a new competitive pressure to the entire supply chain through new distributed generation. Our focus has been on customer solutions and affordability, and we have long called for a Ministry of Energy to lead a coordinated approach.

#### DEMAND SIDE INNOVATION

By encouraging innovation on the demand side of the supply chain, there is an opportunity to find competitive offerings for customers through energy-as-a-service business models. This requires the integration of blended assets – which transform energy as a commodity to a service. These assets cannot be integrated without network businesses – nor a regulatory framework that enables coordination across market segments – which these assets cut across.

### 1.5.2 ENABLING INVESTMENT IN THE FUTURE

Overall, delivering services in the long-term interests of customers is about making the right investments at the right time. This includes investments in smart network solutions which can respond to changes in demand that result from population growth and the integration of energy solutions – like EVs. The integration of these solutions requires EDBs to leverage smart digital platforms and there is a need for price quality regulation to incentivise the right mix of capex and opex investments.

Regulation change is vital to support the integration of EV charging on electricity networks to ensure that peak load can be suitably controlled to avoid costly network reinforcement. Our investment forecasts are predicated on the introduction of suitable EV charging control regulation. The goal of better regulation is to provide distribution businesses with confidence in the regulatory regime such that they can invest with confidence of achieving a fair commercial return.

We have made several changes to our operations to enable greater investment flexibility, including a transition to a service-based operating model, however there are further options available within the regulatory framework.

Vector Technology Services (VTS) has been established as our vehicle for providing Vector's electricity network and other EDBs with core technology based services to underpin operations. These include services relating to both cyber security and the provision of Vector's DERMS platform.

#### PERSISTENT IMPACTS FROM INFLATION OVER-FORECASTS

In November 2019, our Default Price-quality Path 3 (DPP3) regulatory settings were confirmed through to 2025 – providing targets for electricity network quality and allowable revenues for the five-year period, which commenced 1 April 2020. A significant issue we are facing is the impact of the inflation assumptions that form part of the price path. Those assumptions have, for a decade, systematically over-forecast inflation and, in turn, reduced our revenues below levels consistent with the forecasted return. This is an impact that is likely to be further exacerbated through to 2025, given radically different inflation expectations since DPP3 was determined in late 2019. We do not believe this is a sustainable outcome or one that is consistent with the legislation intended to ensure regulated businesses can invest for the long-term interests of consumers and earn an appropriate return.

This is not an issue that is exclusive to Vector, as other regulated entities in New Zealand face the same challenges. Vector considers this to be a critical matter that must be worked through to ensure wider policy goals are supported through aligned regulatory settings, while ensuring fair returns to our shareholders.

### THE NEED FOR CYBER SECURITY

As our energy systems change with decarbonisation and digitalisation, and as more and more systems supporting critical infrastructure services rely on digital platforms and migrate to the cloud, there is an increasing need to proactively invest in cyber security. Through the intelligence provided to us by our cyber security partners, we have seen a range of attacks on some of New Zealand's highest profile organisations, illustrating starkly that the threat of cyber-attack has now become a reality. Not only is there an increase in large-scale, well publicised breaches, but they are worsening in severity, as malicious actors have vastly increased their sophistication. In this context we note that no new investment was provided for networks to invest in cyber security under the latest DPP, meaning the sector is likely to remain in a state of varied levels of preparedness. Consequently, we are concerned about the overall lack of preparedness of New Zealand's electricity networks to cyber threats as critical enabling infrastructure. We have, however, prioritised and increased our own investment in cyber security significantly in this AMP submission (see Section 14 Non-network Assets).

**SECTION 02**

# Climate resilience

# 2 – Climate resilience

Electricity infrastructure is vulnerable to changes in climate and extreme weather events. This section discusses Vector's approach to climate change resilience. In the context of the asset management plan, climate resilience refers to the ability of the electricity network to anticipate, absorb, accommodate and recover from the effects of a potentially hazardous event related to climate change.

## 2.1 Background

Vector commissioned EY in 2017 to model the physical effects of climate change on its electricity network. The report concluded that the Auckland electricity network will, from a climate modelling perspective, experience more frequent and sustained high wind events, longer, drier summers and more frequent occurrences of flooding and inundation.

Our analysis shows that if unmitigated this will have a significant impact on network reliability, resilience and security of supply. The impact of climate change is already being observed through Vector's experience of severe storms in recent years that resulted in extensive damage to the Auckland network and significant disruption to our customers.

Vector also manages other climate related risks including bushfire risk during sustained periods of dry weather and the risk of asset flooding due to inundation following storm surges and high tides that are already driving some of our investments.

## 2.2 Climate resilience conceptual framework

In discussing our approach to climate change resilience, it is useful to reference the International Energy Agency's (IEA) conceptual framework for climate resilience. This framework is shown in Figure 2-1 below.

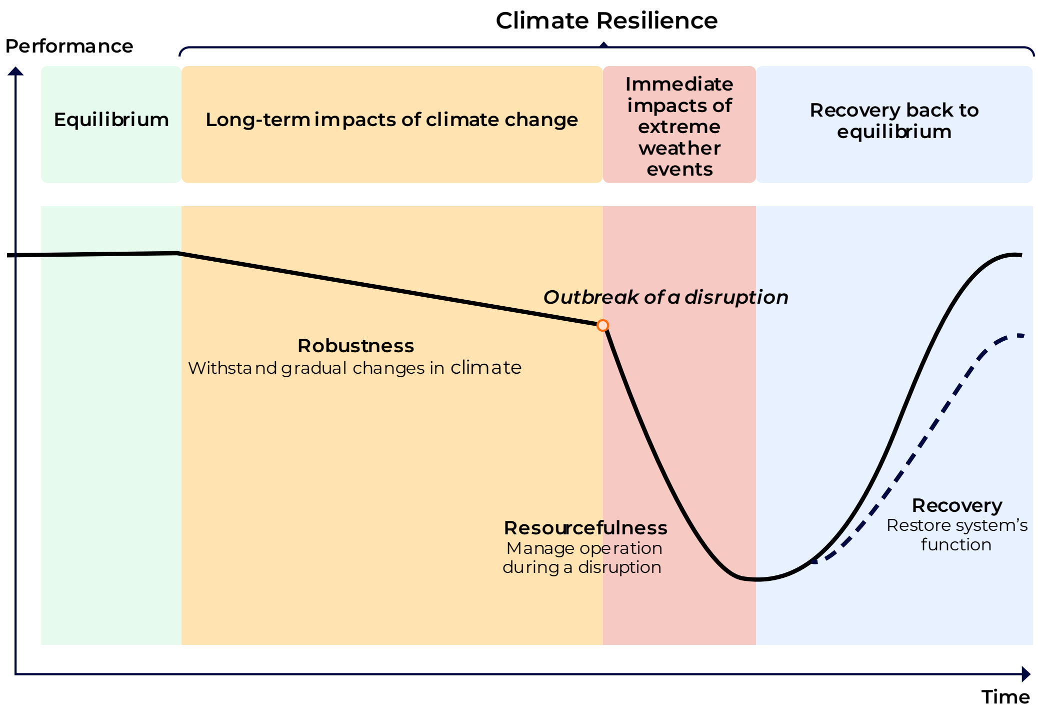



FIGURE 2-1: CONCEPTUAL FRAMEWORK FOR CLIMATE RESILIENCE

As illustrated in Figure 2-1, an electricity network's climate resilience can be grouped into three dimensions: robustness, resourcefulness and recovery. It demonstrates that a resilient electricity network supported by well-coordinated contingency planning and recovery strategies will recover faster from the disruption caused by climate impacts.

## 2.3 Robustness

Robustness refers to the ability of the network to withstand the gradual long-term changes in climate patterns to continue operations and deliver on customer expectations. Vector has implemented the following initiatives to improve the robustness of the network:

- Pioneering a risk-based approach to vegetation management, supplemented by LiDar based inspections, independent scoping of high-risk vegetation sections and collaboration with the Auckland Council to improve the management of council trees in the proximity of powerlines.
- Hardening the network by selective replacement of bare overhead conductor with aerial bundled and covered conductor to improve the susceptibility of the lines to vegetation during high wind conditions, converting radial networks to a meshed configuration and using composite crossarms where economic.
- Mitigating the risk of accidental fire starts on extreme fire risk days by utilising data from Fire Services and NIWA to identify areas at risk; and remotely disabling automatic fault restoring devices on overhead lines to these areas.
- Implementing additional processes for managing equipment ratings during periods of warm and dry weather conditions, using soil moisture levels, published by NIWA, to revise the capacity ratings of underground cables. The revised ratings are then used to update the alarms in supervisory and control systems to match it to the loading on the network to avoid an inadvertent overload, which could result in power outages to the community.
- Relocating assets and performing site-specific civil works to manage rising sea, flood and storm surge levels.
- Deploying Microgrids to support local communities during weather related outages.
- Partnering with global companies like IBM to develop weather and outage modelling tools to enhance operational response using advanced and predictive analysis.
- Investing in a distributed energy management system (DERMS).

## 2.4 Resourcefulness

Resourcefulness refers to the effectiveness of the business continuity plan to support operations during immediate shocks such as extreme weather events. Vector has implemented the following initiatives to improve the resourcefulness of the business and operations:

- Effective business continuity planning and testing including incorporating lessons learnt by doing post event reviews. The 2020 Covid-19 outbreak highlighted a different need, that of pandemic resilience. The learnings from this on-going challenge have been incorporated in the development strategy and designs for Vector's two new control centres. The pandemic has identified the need to provide facilities that allow physical isolation of the operational teams so that the rest of the business can continue normal operations even within shared locations. The need for physical isolation required provision of improved communications and collaboration tools between the control centre sites to compensate for the inability to physically interact when operating under elevated pandemic alert level lockdown scenarios.
- Leveraging global partnerships and relationships to learn from others following major international events. The learnings are used to challenge existing practices and inform improvement plans.
- Maintaining an effective emergency response plan, which includes proactive deployment and prioritisation of field resources.
- Investing in an advanced outage management system.
- Civil defence collaboration in preparation for and during events.
- Investing in effective customer communication channels and digital platforms to support the call centre during events.

## 2.5 Recovery

Recovery refers to the ability to restore the network's function after an interruption resulting from climate hazards. Vector has implemented the following initiatives to improve the ability of the network to recover following an event:

- Effective management of fulltime and temporary resources (e.g. out of region resources) during extended recovery periods.
- Effective stock management to ensure the availability of equipment and spares.
- Effective systems to track and report against restoration progress.
- Ongoing post events reviews and continuous improvement.
- Trialling vehicle to home (V2H) technology to enable customers to power home appliances from their EVs in the case of an outage.
- Using temporary generation to restore power to customers while repairs are being done.
- Developing effective communication strategies to keep customers informed during events.

The total investment in these initiatives during the period covered by the asset management plan is covered in subsequent sections of this plan.

**SECTION 03**

# Network overview

# 3 – Network overview

## 3.1 Our network

The Vector network is centred on the Auckland isthmus, supplying approximately 580,000 ICPs between Mangawhai Heads in the north (Northern region) and Papakura in the south (Auckland region), 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 and energy distributed.

This section provides an overview of the network regions, network configurations and assets in these regions.

While Vector operates its network in Auckland as a single system, there are some legacy differences in network architecture and distribution practices associated with previous Vector Limited ownership structures. Due to this it is convenient to separately describe the Auckland and Northern regions.

The geographical area map in Figure 3-1 shows the network boundaries, with neighbouring distribution networks operated by Northpower to the North and Counties Power to the South. Table 3-1 provides a summary of the key network statistics of the Auckland and Northern regions as disclosed in the Electricity Information Disclosure 2020. In addition, Vector supplies a large customer at Lichfield (South Waikato) which is a stand-alone supply.

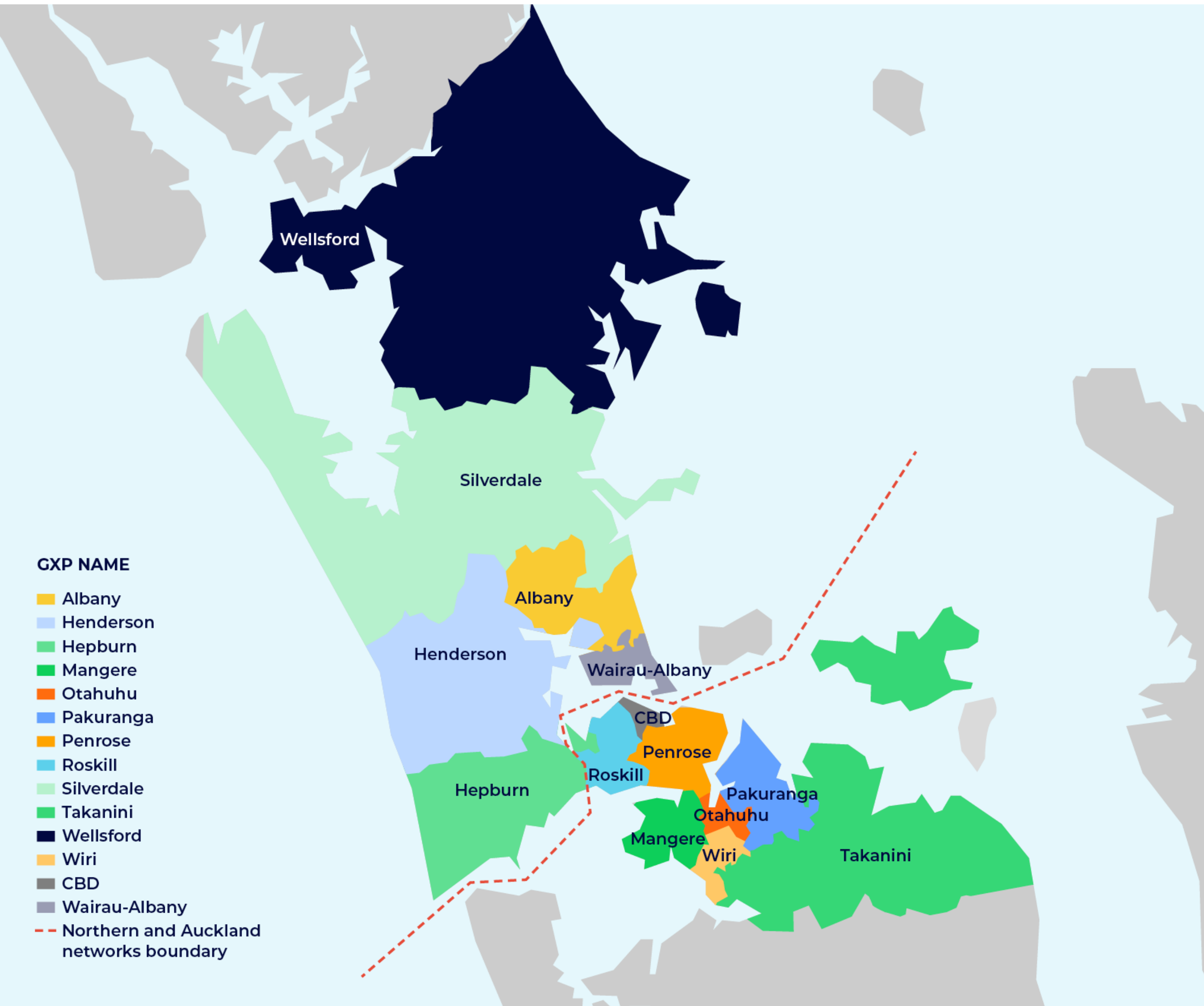



FIGURE 3-1: VECTOR NETWORK GEOGRAPHICAL AREA

| MEASURE | AUCKLAND | NORTHERN | VECTOR TOTAL |
|---|---|---|---|
| Customer Connections[1] | 341,324 | 232,536 | 573,860 |
| Overhead circuit network length (km) | 2,868 | 5,427 | 8,295 |
| Underground circuit network length (km) | 6,522 | 4,132 | 10,654 |
| Grid Exit Points (GXP) | 9 | 6 | 15 |
| Zone substations | 58 | 55 | 113 |
| Peak demand (MW)[2] | 1,080 | 704 | 1,745 |
| Energy throughput (GWh) | 5,665 | 2,762 | 8,427 |

TABLE 3-1: KEY NETWORK STATISTICS

## 3.2 Our role in the electricity sector

Vector distributes electricity to the Auckland region and is one of the 29 electricity distribution companies in New Zealand. The Vector network connects to Transpower's transmission grid at voltages of 110 kilovolt (kV), 33 kV and 22 kV at 15 points of supply known as grid exit points (GXPs).

Transpower owns most of the assets at the GXPs, although Vector owns circuit breakers, and protection and control equipment at some GXP sites. GXPs are the key upstream connection points supplying local communities. In order to avoid loss of supply to large numbers of consumers during an outage or failure, both Vector and Transpower build redundancy into the GXPs by duplicating incoming lines, transformers, and switchgear.

## 3.3 Network configuration

As mentioned, Vector takes supply from the national grid at 110 kV, 33 kV and 22 kV. This is then 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 the local suburbs 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 supplied 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

## 3.4 Auckland region

### 3.4.1 OVERVIEW

Our network in the Auckland region has 56 zone substations which supply a mix of Auckland central business district (CBD), Urban and Rural areas. These zone substations connect to the National grid at 220 kV, 110 kV, 33 kV and 22 kV via nine GXPs. The Auckland region can be broken down into three primary zones:

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

The Auckland region covers areas administered by the previous Auckland City Council, the Manukau City Council and the Papakura District Council, and 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 GXP)

Vector takes supply from Penrose GXP and Hobson GXP at 110 kV for bulk supply to the Auckland CBD. The CBD has three bulk supply substations Hobson, Liverpool and Quay substations. The two GXPs, with two Penrose – Liverpool 110 kV circuits and two Liverpool – Hobson 110 kV circuits, form a close ring that is owned by Vector that supplies the three bulk substations. Vector-owned 110 kV switchboards are installed at both Liverpool substation and Hobson substation. The Penrose – Liverpool – Hobson 110 kV circuits are installed in the Vector tunnel. A 110 kV circuit connected between Roskill GXP and Liverpool is standby (normal open) providing backup to the CBD 110 kV ring.

[1] Average number of customer connections for disclosure year 2020.

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

### 3.4.3 CENTRAL ZONE (ROSKILL AND PENROSE GXP)

The central zone covers the Roskill and Penrose GXPs.

Roskill GXP provides a 110 kV supply to two 110/22 kV transformers at Kingsland zone substation and a separate 22 kV to Avondale and Sandringham zone substations. The Roskill area covers Avondale, Hillsborough, Mt Albert, Sandringham, Balmoral through to Point Chevalier and Ponsonby. The customer base in these areas is largely residential, with industrial customers in the White Swan area.

Vector takes supply from Penrose GXP at 33 kV and 22 kV for local distribution to 15 zone substations in the area surrounding the Penrose substation. This is Vector's largest planning area by demand and is mostly supplied by Transpower Penrose 33 kV and two zone substations supplied from Transpower Penrose 22 kV. The customer base in this area is a mix of residential, commercial and industrial.

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

The Southern zone covers Mangere, Wiri, Otahuhu, Pakuranga and Takanini GXPs. Vector takes supply from these GXPs at 33 kV and 22 kV.

Mangere covers the Mangere township and surrounding residential commercial and industrial areas, extending south to the developing commercial areas surrounding the Auckland airport.

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

Takanini covers the urban areas of Manurewa, Takanini and Papakura township, extending east to the more remote areas of Clendon, Maraetai, Beachlands and Waiheke Island. The customer base in this area is a mix of residential, commercial and industrial.

Otahuhu covers Highbrook, Otara and Braids area. The customer base in this area is mainly industrial with some residential.

## 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 connect to the National grid at 33 kV via six GXPs. The Northern region can be broken down into three primary zones:

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

The Northern region covers those areas administered by the previous North Shore City Council, the Waitakere City Council and the Rodney District Council, and consists of residential and commercial areas in the southern urban areas, light industrial and commercial developments around the Albany Basin, and residential and farming communities in the northern rural areas.

### 3.5.2 ALBANY AND WAIRAU-ALBANY GXP

Vector takes supply from the Albany 33 kV bus. Thirteen zone substations are supplied from this 33 kV bus, growth in this area is driven by the conversion of rural area into more intensive residential urban areas. The Albany area covers Albany, Milford, Browns Bay, Torbay and Greenhithe. The customer base in this area is largely commercial and residential.

Supply to Wairau zone substation is taken from Albany GXP at 110 kV and Wairau at 220 kV, Vector takes supply from the 33 kV bus via three 110/33 kV transformers and one 220/33 kV transformer, twelve zone substations are supplied from this 33 kV bus. Wairau area covers the Devonport, Takapuna, Northcote, Birkenhead, Beach Haven and Glenfield areas. The customer base in this area is largely residential, with commercial customers mainly in the Takapuna and Highbury area.

### 3.5.3 HENDERSON AND HEPBURN GXP

Vector takes supply from the Henderson 33 kV bus via two 220/33 kV transformers which supply ten zone substations. The area covers, Ranui, Swanson, Woodford, Hobsonville, Te Atatu, Riverhead, Greenhithe 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 extending northward towards Whenuapai, Riverhead, and Kumeu and Westgate and Red Hills to the west. The customer base in the Henderson area is largely residential.

Vector takes supply from the Hepburn 33 kV bus via three 110/33 kV transformers, ten zone substations are supplied from this 33 kV bus. The Hepburn area extends from Te Atatu and Ranui to New Lynn, extending westward out to the coast. The customer base in this area is largely residential with commercial customers mainly in the Henderson township and industrial customers in Rosebank.

### 3.5.4 SILVERDALE AND WELLSFORD GXP

Vector takes supply from the Silverdale 33 kV bus via two 220/33 kV transformers. Eight zone substations are supplied from this 33 kV bus. The Silverdale area consists mainly of the greater Orewa emerging city area and extends from Albany in the south to Waiwera in the north, west to Helensville and the west coast. The highest population density is to the east of SH1 and comprises Whangaparaoa, Gulf Harbour, Orewa, Millwater, Red Beach and Silverdale areas. The customer base in this area is largely residential.

The Wellsford area is the most northern area in Vector's network and stretches from Wellsford to Warkworth and includes the townships of Matakana, Sandspit, Omaha and Snells Beach, Leigh in the south and east and Tapora in the west. Wellsford GXP supplies 33 kV to three zone substation, Wellsford, Warkworth and Snells Beach via two 110/33 kV transformers. A fourth zone substation is under construction at Big Omaha. This area comprises of a large rural area 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.

## 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 HEADER CLASSES

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

1. Subtransmission Switchgear
2. Power Transformers
3. 11 kV – 110 kV Cable Systems
4. Overhead Lines
5. Distribution Equipment
6. Auxiliary Systems
7. Infrastructure and Facilities
8. Protection and Control
9. Distributed Energy Systems

### 3.6.2 ASSET POPULATIONS

Table 3-2 provides an overview of our asset population across our full electricity network.

| ASSET TYPE | POPULATION |
|---|---|
| **Subtransmission Switchgear** | |
| Indoor switches | 1,755 |
| **Power Transformers** | |
| Power transformers | 219 |
| **11 kV – 110 kV Cable Systems** | |
| Subtransmission (km) | 608 |
| Distribution (km) | 3,680 |
| **Overhead Lines** | |
| Subtransmission (km) | 392 |
| Distribution (km) | 3,729 |
| LV overhead lines (km) | 4,136 |
| Poles | 124,636 |
| **Distribution Equipment** | |
| Transformers | 21,850 |
| Switches | 19,921 |
| LV cables (km) | 5,837 |
| **Infrastructure and Facilities** | |
| Buildings (including customer substation buildings) | 244 |
| **Protection and Control** | |
| Protection relays | 3,408 |

TABLE 3-2: ASSET POPULATION SUMMARY

**SECTION 04**

# Customers and stakeholders

# 4 – Customers and stakeholders

## 4.1 Symphony for our customers and stakeholders

Our customers are at the heart of everything we do, and our operations are designed to reflect this, in our decision-making and our approach to the future of energy. This is the core of our Symphony strategy. Our focus is on bringing customer benefits including cost efficiencies, reliability and resilience, more choice, and decarbonisation through enabling and supporting New Zealand's electrification.

**COVID-19: REMAINING VIGILANT AND PREPARED**

**Before Covid-19 arrived in New Zealand in early 2020 Vector was already working hard to ensure we could manage and overcome any disruption. Actively starting our preparations early meant we were able to manage the ongoing disruption brought on by the Covid-19 pandemic, and continue delivering for our customers seamlessly. As a provider of critical infrastructure services, we took early steps to protect all our people, and in particular those in critical roles, to ensure the safe and reliable operation of our electricity network. Under lockdown we knew our customers would be based at home and even more reliant on the continuity of power so we took steps to minimise disruption. Communication was key, so we provided more information through communication channels such as our website, Outage Centre and contact centre. The extra information enabled customers to see where previously planned and communicated work involving shut-downs had been re-prioritised and ensured they could talk to us about their concerns.**

**What we heard loud and clear from them was that being without power while under lockdown was even less acceptable than under more normal circumstances. Accordingly, where works still needed to continue – for example where essential upgrades were required for safety reasons or in support of the provision of other essential services – we took further steps to minimise customer impact. This meant applying revised criteria over the use of temporary generation, night works, or other techniques to keep power on during the day wherever possible. All actions were taken within the parameters of health and safety best practice.**

**We also let our customers know that, because of the additional Covid-safe working protocols our crews were following, our responses to unplanned outages would be different than normal and it was possible that it could take longer to get power back on under some circumstances. For example, crews were operating in smaller teams to ensure social distancing guidelines could be followed, but with more teams available to reduce the impact.**

**Vector also came together with other electricity lines companies Orion, Powerco, and Wellington Electricity to offer network payment deferral programmes to business customers on our networks. Since then, we have developed a comprehensive and enduring site response plan to ensure that should there be a regional or national outbreak, we are ready to respond appropriately and quickly. The plan is designed to ensure the safety and wellbeing of our people, and communities, and the continuity of the critical services we provide. Our Pandemic Response Team actively monitors incidents and evolving situations and determines our level of operational response according to our Plan.**

## 4.2 Knowing and delivering for our customers

Vector's electricity network delivers power to Aucklanders, from Wellsford to Papakura. Our customers are at each of those ICPs and are hugely diverse with varying needs.

We value our relationship with our customers, dedicating time and resources into building those relationships, making sure we listen, and prioritise outcomes that will meet their needs when making our investment decisions.

### 4.2.1 TALKING TO OUR CUSTOMERS AND UNDERSTANDING THEIR PRIORITIES

Our customers range from rural residential consumers through small business to large corporate or commercial entities. The following table illustrates the variety of customers we serve and how we talk with them to understand their priorities.

| CUSTOMER TYPE | INTEREST AND PRIORITIES | HOW WE ENGAGE |
|---|---|---|
| Residential (517,000 ICPs) | Absolute minimum of outages resulting from planned maintenance and unplanned events (e.g. car crashes with power poles)<br><br>Consistent, accurate and timely information where outages are required, including notification of any deviation from any previously communicated timeframe, whether resolution is brought forward or pushed back. | Contact Centre manages phone calls, social media interactions and emails for outages and general enquiries.<br>Direct, proactive engagement via Community Engagement Manager<br>Outage Centre is a web-app providing self-service information on planned and unplanned outages<br>Customer Communications team manages proactive notification of planned outages required for maintenance work<br>Regular Citizens Advisory Board (CAB) meetings. The CAB provides a forum to listen to individuals and community representatives representing a variety of sectors with a wide array of perspectives and understand their concerns, issues and the opportunities they see associated with our electricity network<br>Regular customer surveys |
| Residential DER owners (EV, solar, battery owners) (there are almost 6000 solar connections as at 31 December 2020) | Opportunity to realise value from their investment in DER, in financial and non-financial terms (for example in relation to lowering their own carbon footprint) | Customer Projects team manages individual requests (e.g. connecting a new rooftop solar system)<br>Data and Insights team analyses, models and develops future DER capabilities for customers on the network (e.g. managed EV charging) |
| Community groups | Community resilience planning, and investment and affordability | Dedicated Community Engagement Manager<br>Relationship managers spanning community groups, local boards and community media organisations |
| Small business and CBD locations | Absolute minimum of outages preventing trade<br>Amenity considerations such as tidy infrastructure (or underground) | Contact Centre manages phone calls, social media interactions and emails for outages and general enquiries |
| Corporate and commercial (more than 68,000 businesses from Wellsford to Papakura) | Larger commercial entities make individual decisions around network resilience and configuration to manage their unique requirements | Key account team manage the direct electricity conveyance contracts with large customers on our network |
| Infrastructure providers (e.g. road, rail, water) | Ensuring large infrastructure projects have the greatest possible synergies and cause the least possible disruption for the public (e.g. City Rail Link) | Key account team have direct account management relationships with all major infrastructure operators in the region |
| Developers of residential sub-divisions | Ease, process and cost of new connections to the network<br>Coordination with other utilities<br>Transparency and availability of job progress | Two streams for engagement, including (for projects larger than five lots or greater than 100-amps) a dedicated team arranges the electrical engineering design, commercial terms and pricing for residential subdivisions and developments |
| Developers of large commercial projects | New commercial connections (e.g. Westfield Newmarket, data centres) often require bespoke connection plans.<br>Increasing interest in the implications of new technology such as commercial batteries, distributed generation and rapid EV charging | Dedicated team providing individual management of their engagement with Vector quote, design and contract |

TABLE 4-1: CUSTOMER TYPES, PRIORITIES AND ENGAGEMENT METHODS

### 4.2.2 MONITORING WHAT HALF A MILLION KIWIS PREFER

We understand that no two individuals are the same, and as we serve around 511,000 residential households, it's important we understand where individual preferences diverge and where they align strongly behind certain themes. One of the ways we do this is through regular surveying of our residential customers to identify and monitor and track their preferences for the electricity services we provide.

Our most recent survey (undertaken in January 2021 via an online quantitative survey of Auckland residents reflecting our customer profile), confirmed the following trends which are consistent with our previous surveys over several years:

1. Our customers' perception of our service delivery performance is generally meeting or exceeding their expectations
2. The number of power outages our customers experience is within what they consider an acceptable level
3. The duration of power outages experienced by our customers falls below their expectations of what they consider acceptable

While those trends remain apparent, across a range of service deliver measures, our surveys show our customers rate our performance as improving year on year.

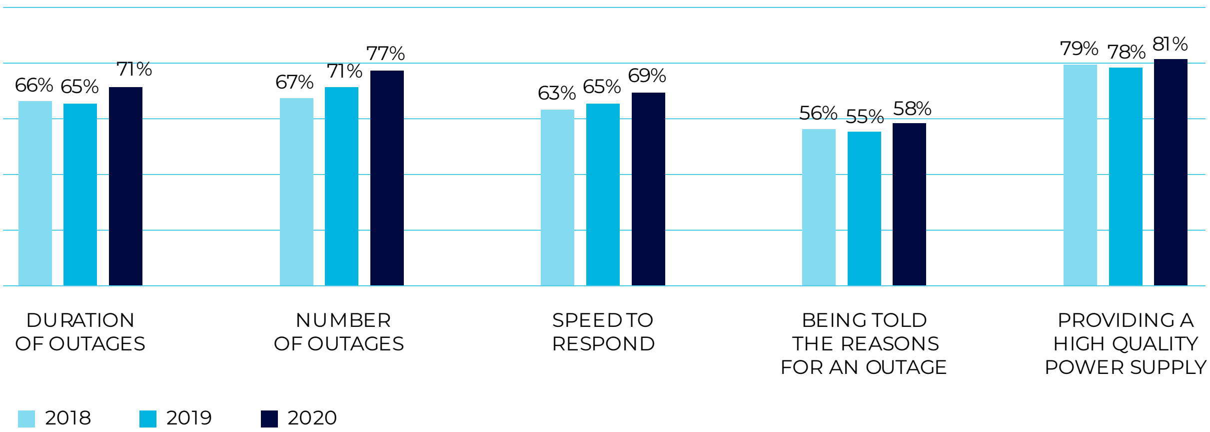



FIGURE 4-1: CUSTOMER PERCEPTION OF PERFORMANCE, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

When we look further into our customer's perception of their individual experience compared to what they believe is acceptable, we see that customers feel the acceptable number of outages has remained constant in recent years while their experience has improved.

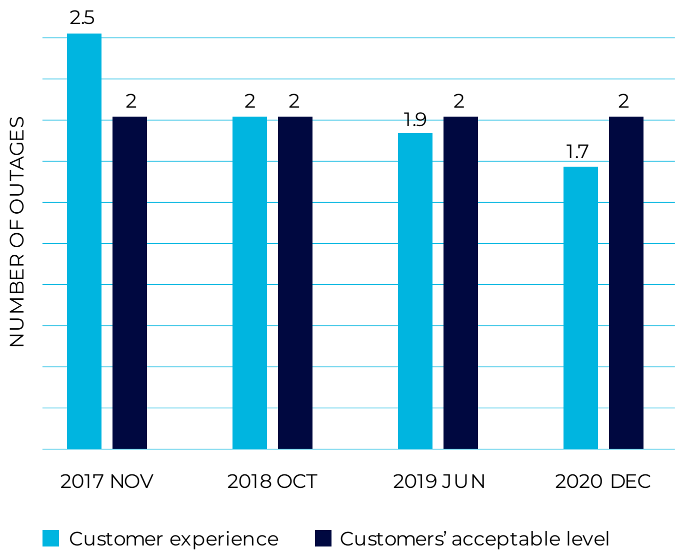



FIGURE 4-2: CUSTOMER PERCEPTION OF NUMBER OF OUTAGES, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

What customers consider an acceptable duration has fallen roughly in line with their experience of outage duration.

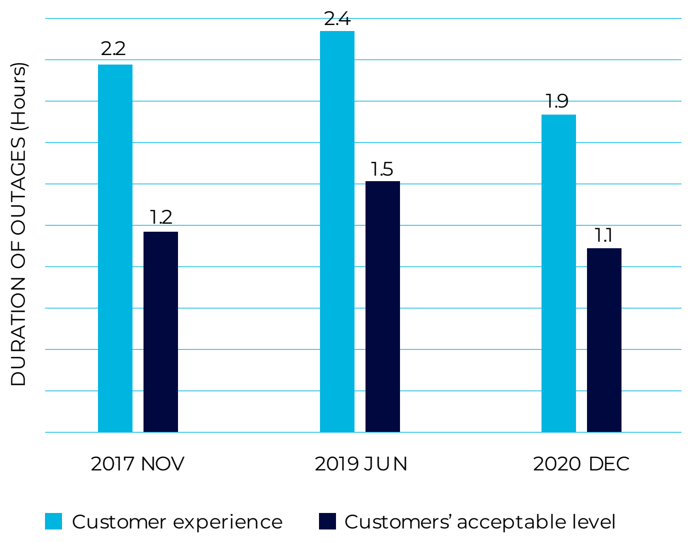



FIGURE 4-3: CUSTOMER PERCEPTION OF DURATION OF OUTAGES, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

When we look further into the survey results to identify what outage duration customers consider acceptable, a clear trend is apparent that shorter is better, and that the level of acceptability decreases more sharply after three hours.

We continue to focus on ways to reduce the severity of impact from power outages by refining our temporary generation strategy, and optimising the time window for planned outages (both of which are detailed below in section 4.2.3).

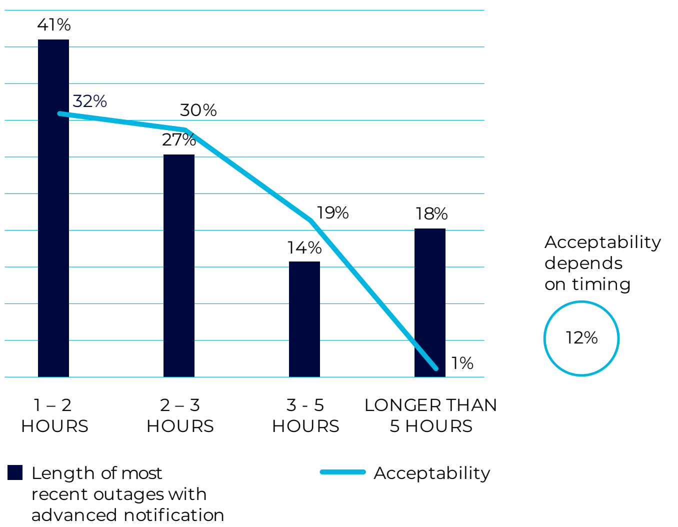



FIGURE 4-4: LENGTH OF PLANNED OUTAGE AND THE ACCEPTABILITY OF THIS LENGTH, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

#### 4.2.2.1 CHANGES IN CUSTOMER PREFERENCES BROUGHT ON BY COVID-19

In our most recent survey on January 2021, we asked customers to tell us when they prefer planned outages to happen, so that essential maintenance work can be carried out. Compared with 2019, customers are less accepting of planned outages occurring on a weekday afternoon. We consider this to reflect changing customer preferences as a result of Covid lockdowns requiring more people to be at home during the day. This reinforces the need to plan for uncertainty and flexibility in order to meet the demands of customers as our environment changes due to the long term trends outlined in section 1.

### 4.2.3 RESPONDING TO WHAT OUR CUSTOMERS TELL US

To meet the expectations of our residential consumers, we maintain a commitment to improving customer service and delivering a reliable network through the investments we make. The following paragraphs illustrate how we are responding to specific concerns.

#### 4.2.3.1 REDUCING THE SEVERITY OF IMPACT FROM POWER OUTAGES

Our outage planning team go through a rigorous process to minimise the impact of outages needed for undertaking maintenance by reviewing mechanisms to reduce the duration of the outage or the number of customers it will affect, based on the feedback of our customers.

The mechanisms we consider for minimizing a planned works outage include reviewing whether back feeding can be used to provide alternate supply to customers whose main supply is isolated for works, whether live line procedures are safe and appropriate to maintain supply while works are carried out, and whether generation is possible and advisable given the additional cost and complexity, and noise level impact on residents. The following table provides an overview of how we consider generation for any given customer outage.

| CONSIDERATIONS FOR SUPPORTING CUSTOMERS WITH TEMPORARY GENERATION | |
|---|---|
| Always proposed for critical customers if outage impacts their operations;<br>• Hospitals<br>• Schools/Kindergartens<br>• Medical centres<br>• Retirement villages<br>• Vets<br>• Dentists<br>• Large commercial and industrial customers | Always considered where:<br>• a generation point and land access is available<br>• works are scheduled to run for several days<br>• works would significantly interrupt a number of businesses during work hours (with regard to the trading environment such as holidays or Christmas period)<br>• the cost of generation vs. SAIDI saved is justified |

### CASE STUDY: PIHA GENERATION

West Auckland's Piha beach community receives its electricity supply from a single 11 kV feeder circuit. The circuit is a one-way overhead line that runs along an easement through the dense bush of the Waitakere Ranges. Unfortunately, this makes the line more vulnerable to outages compared to more populated areas of Auckland, where multiple feeders often make it easier to back-feed electricity to customers during a power outage.

To improve the customer experience for Piha residents, Vector has installed stand-by backup generation equipment able to be operated remotely to continue to provide power if a fault occurred along the feeder line.

These generators were needed in early 2021 when a broken HV pin arm caused a fault at a challenging location along the feeder line. With no vehicle access to the fault location, repair crews had to traverse a track through the dense bush to attend the fault. The stand-by generators were able to provide power within 5 minutes of the fault occurring and provide cover to more than one thousand residents for longer than eight hours while the repairs were completed.


THE LOCATION OF THE FAULT ON THE FEEDER LINE SUPPLYING POWER TO PIHA IN EARLY JANUARY 2021

### 4.2.3.2 CONSIDERING CUSTOMER PREFERENCE FOR PLANNED OUTAGE TIMING

Our customers have told us that, where outages are required for maintenance work, they prefer these to occur at times that are convenient for them. Our urban and rural customers have similar 'convenient' times for planned outages, while in general, customers don't want planned outages to occur during the weekend day times and weekday evenings.

Especially considering the shift in outage timing preference away from weekday afternoons observed since Covid-19, we look carefully at how we can be more flexible in planning outage timing, which could include greater use of weekend or night work scheduling, provided the cost to customers remains acceptable.

| | URBAN | RURAL |
|---|---|---|
| WEEKDAY OVERNIGHTS 12 MIDNIGHT – 6AM | 40% | 40% |
| WEEKEND OVERNIGHTS 12 MIDNIGHT – 6AM | 29% | 20% |
| WEEKDAY AFTERNOONS 12 MIDDAY – 5PM | 28% | 35% |
| WEEKDAY MORNINGS 6AM – 12 MIDDAY | 15% | 15% |
| WEEKEND MORNINGS 6AM – 12 MIDDAY | 6% | 4% |
| WEEKEND EVENINGS 5PM – 12 MIDNIGHT | 3% | 2% |
| WEEKEND AFFTERNOONS 12 MIDDAY – 5PM | 7% | 10% |
| WEEKDAY EVENINGS 5PM – 12 MIDNIGHT | 5% | 8% |

FIGURE 4-5: PLANNED OUTAGE TIMING PREFERENCE, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

### 4.2.3.3 IMPROVING OUR COMMUNICATIONS WITH CUSTOMERS

For planned outages, customers tell us their preference is for digital communications such as text messages and email rather than letters. For reporting unplanned outages to us, or getting information about the unplanned outages, their preference is for phone or text message.

Customers have told us they want more proactive communications from Vector when their power is off and digital access to information on outages. Customers want to know the how long it will take to restore power and when power restoration work begins.

We have put considerable effort into improving our communication channels, including our digital channels such as our online Outage Centre and text message services. Our most recent customer survey shows this effort is having an impact with customer rating the usefulness of the Outage Centre as having improved over the least two years.

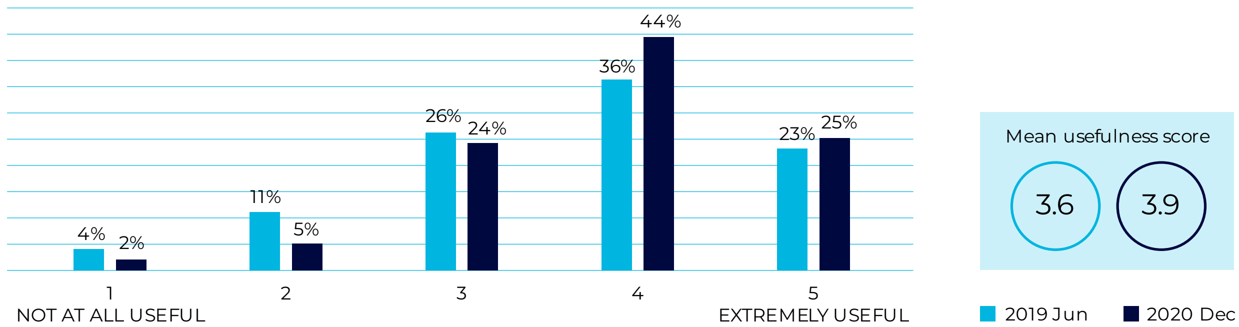



FIGURE 4-6: USEFULNESS OF THE OUTAGE CENTRE, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

Similarly, customers tell us that the usefulness of our text message services has also increased year on year.

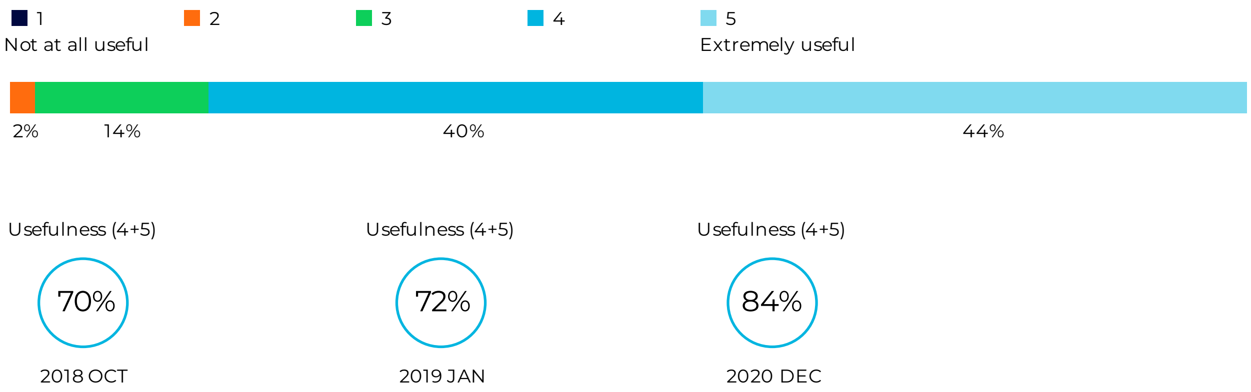



FIGURE 4-7: USEFULNESS OF A TEXT MESSAGE FROM VECTOR DURING AN OUTAGE, VECTOR CUSTOMER ENGAGEMENT SURVEY 2021

### 4.2.4 DATA-DRIVEN INSIGHTS

In addition to our relationships with our customers, and regular surveys, we use a data-driven approach to gather insights beyond what is available from other means. Our approach continues to mature and helps extend our knowledge of customer behaviour and identify opportunities to build a network that serves them well now and into the future. With the cost of investments distributed equally and consistently across all Aucklanders, we have long recognised the need for a sophisticated understanding of the impact of our investment decisions on the diverse households and businesses that make up Auckland.

To achieve this, we complement the knowledge we gain from the relationships we have with our customers with data and insights generated from analytics, regular structured surveys, daily feedback from customers, and qualitative techniques such as interviews.

One of the more recent tools we have built to inform our network planning and ensure it will deliver the best outcomes for customers is our Granular Auckland Customer Model. The Granular Auckland Customer Model is built by including all customers connected to Auckland's electricity and gas networks. This approach allows building a model that can zoom in on specific customer attributes, specific network locations and extreme events, without being exposed to the limitations of small samples and/or representativeness. The importance of such robust analysis cannot be understated in the context of reliability of supply, multi-million-dollar investment decisions for critical electricity network and the societal paradigm shift to decarbonisation.

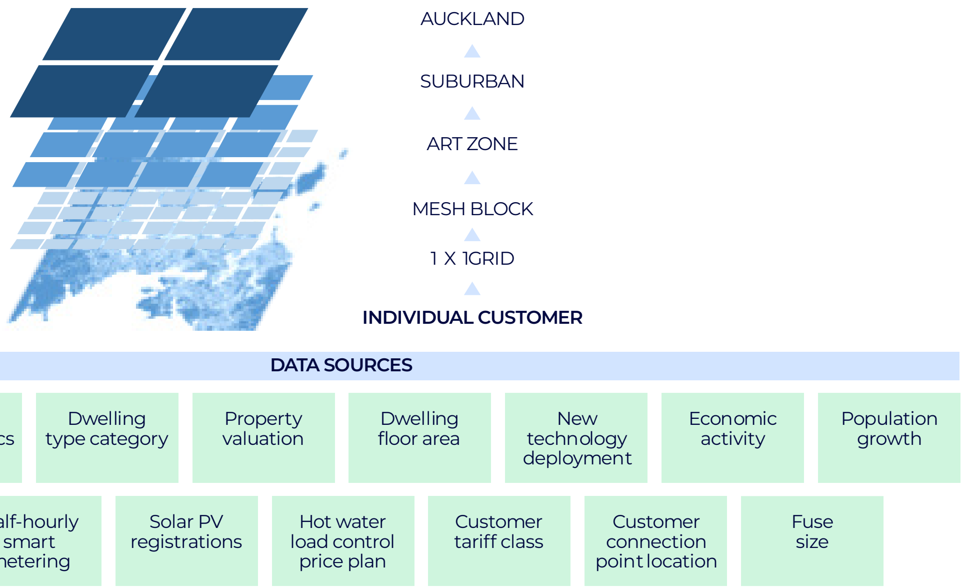



FIGURE 4-8: DATA SOURCES AND GEOSPATIAL LAYERS, GRANULAR AUCKLAND CUSTOMER MODEL

The goal of the Granular Auckland Customer Model is to enable customer-centric decision-making. The model is a tool to provide understanding of customer behaviour trends and drivers with regards to energy usage. Some examples of new insights gained are given below (and further examples are also given in section 1):

- Differences in energy consumption in dwelling type (i.e. house, detached dwelling or lifestyle dwelling) are generally due to differences in floor area. Lifestyle dwellings are typically properties with large houses on large rural sections with potentially lower efficiency levels and high occupancy rates, which may explain why they use about 20 % more energy by floor area than other dwelling types.


- High-income customers use considerably more energy on an annual basis; the common hypothesis being that they likely use more heating and have more energy applications. However, when normalizing energy use per floor area low-income homes use more energy per floor area than wealthier homes, indicating that low-income dwellings have lower efficiencies and likely poorer outcomes per unit of energy consumed.

**CASE STUDY: EV SMART CHARGING TRIAL**

With the Interim Climate Change Commission (ICCC) calling for the electrification of up to half our national vehicle fleet by 2035, and almost half of those expected to be in Auckland, in 2019 Vector and Auckland residents embarked on a trial to test smart technology that could help manage the change. This was the first time a trial of this nature and scale has been conducted in New Zealand.

120 EV users across Auckland signed up to participate in the trial, in which Vector has installed a 7kW smart EV charger at each participant's home. The trial was set to last up to 18 months, but was impacted by the Auckland lockdowns and has been extended. Vector is working with the participants throughout to collect data on their EV charging preferences and better understand how smart EV charging can satisfy their expectations.

We are conducting this trial to determine if optimising EV charging schedules could help alleviate peak demands on the network, a key benefit of which could include avoiding the need to invest in expensive network infrastructure upgrades. If uptake is left unmanaged, the distribution network will start to become constrained and require costly reinforcement.

Vector is interested in finding out how smart EV charging, combined with intelligent load management, can help us seamlessly integrate and support EV uptake. Our aim is to determine how we can all benefit from the environmental advantages of EVs, and ensure we have affordable and reliable infrastructure as Auckland grows, while avoiding the need for large infrastructure investments.

VECTOR GROUP CEO SIMON MACKENZIE WITH PARTICIPANTS OF VECTOR'S EV SMART CHARGING TRIAL

### 4.2.5 ALIGNING OUTAGE PLANNING WITH DPP

To align with the introduction of the third Default Price-quality Pathway as of 1 April 2020, Vector's outage planning processes have been re-engineered with customer experience front of mind. A team of outage planners is responsible for coordinating efforts across the business to minimise customer impact and ensure notifications not only comply with regulatory requirements, but also provide customers the information they want within the timeframes they expect.

## 4.3 Partnering with our stakeholders

As the engine room of the New Zealand economy, a successful Auckland is essential to the future wellbeing of New Zealand. Vector has a key role to play in supporting Auckland's future through ensuring our customers are provided with a safe, reliable and resilient network and our stakeholders are confident the network is fit for the future and ready for the electrification of transport, greater use of renewable energy and wider decarbonisation efforts.

To identify our stakeholder's interests we engage with them proactively and regularly. We share our insights and what we've learned to help the industry develop its knowledge and capability to adapt to meet the future needs of our customers.

The following table sets out our stakeholders and their interests in our network.

| STAKEHOLDER | MAIN INTERESTS |
|---|---|
| Customers | *Detailed in Section 4.2* |
| Communities and community groups | Community resilience planning and investment |
| Iwi | Specific project-based interests |
| Commerce Commission and Electricity Authority | Quality, security and reliability of electricity supply<br>Provide cost-effective and efficient operations<br>Participate in policy proposals and engaging in regulatory consultation |
| Worksafe | Public and worker health and safety risk management |
| Office of the Privacy Commissioner | Customer information is appropriately managed<br>Good governance, reputation, and ethical behaviour |
| Entrust (majority shareholder) | Confidence in board and management<br>Confidence in customer and community outcomes<br>Return on investment and sustainable growth |
| Other shareholders, debt and equity markets | Confidence in board and management<br>Return on investment and sustainable growth<br>Risk management |
| Field service providers | Ensure service providers have stable forward work volumes and construction standards<br>Public and worker health and safety risk management |
| Employees | Confidence in board and management<br>Public and worker health and safety risk management<br>Sustainability and the environment<br>Sound management of customer issues and information, including timely outage management<br>Good governance, reputation, and ethical behaviour |
| Transpower | Ensure transmission network interface is well maintained<br>Technical performance and compliance<br>Network planning for resilience |
| Industry participants | Good governance, reputation, and ethical behaviour<br>Share our experience and what we've learnt with the industry |
| Central and local government | Good governance, reputation, and ethical behaviour<br>Alignment with public outcomes as enabling infrastructure<br>Information, insights and engagement to support the development of solutions which deliver better outcomes for customers and constituents |
| Electricity retailers | Maintain effective relationships and ensure ease of doing business<br>Customer service<br>Reliability |
| Infrastructure providers (e.g. road, rail, water) | Timely asset relocations and connections<br>Ensure effective co-ordination of planning and operations with other utilities and infrastructure |

### 4.3.1 ACCOMMODATING STAKEHOLDER INTERESTS AND MANAGING CONFLICTING INTERESTS

We accommodate our stakeholders' interests in our asset management practices by, amongst other things:

- due consideration of the health, safety and environmental impact of Vector's operations;
- looking after the health, safety and wellbeing of our employees, their families, and our communities
- providing a safe, reliable and resilient distribution network;
- due consideration for the affordability of our services;
- quality of supply performance meeting consumers' needs and expectations, subject to trade-off of capital and operational expenditures (capex and opex);
- maintaining a sustainable business that caters for consumer growth requirements; comprehensive risk management strategies and contingency planning;
- complying with regulatory and legal obligations;
- looking ahead and planning for future innovation and disruption
- removing barriers to innovation
- supporting and enabling the uptake of Distributed Energy Resources (such as EVs and solar)

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

- clearly identifying and analysing stakeholder conflicts (existing or potential);
- seeking an acceptable alternative or commercial solution based on a set of fundamental, consistent and transparent principles;
- effective communication with affected stakeholders to assist them to understand Vector's position, as well as that of other stakeholders that may have different requirements;

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


**SECTION 05**

# Asset management systems

# 5 – Asset management systems

## 5.1 Overview

Section 5 provides insight into Vector's asset management practices. Vector's asset management policy principles and objectives are presented which, through our asset management capability, reinforce a commitment and link to both our vision and strategic pillars. A summary of our asset management system is provided which includes the identification of key documents. To highlight continuous improvement initiatives, an overview of asset management maturity is also included along with identified areas of ongoing development.

Vector's asset management is a multi-utility practice that includes electricity, digital, gas, metering, technology and fibre assets. However, for the purposes of this AMP, the scope of asset management is limited to Vector's electricity distribution network.

## 5.2 How asset management is informed by our symphony strategy

The global and local context set out in Section 1 shapes the environment within which Vector operates and, as mentioned in previous sections, emphasises a requirement for the energy sector to transform in order to meet societal goals around decarbonisation, and the provision of reliable and affordable energy. This is encompassed in our symphony strategy. To align with this strategy, Vector's asset management planning is focused on creating affordable energy systems to meet customer needs and control the uncertainty in network demand.

## 5.3 Asset management policy

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 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. The Health and Safety of our employees, contractors and the public are always a priority.
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.

## 5.4 Asset management objectives

In line with our vision and strategic pillars, our principles are translated, at an operational level, into asset management objectives which further consider our operating context and represent specific stakeholder requirements. These are considered at a more detailed and defined level, enabling appropriate asset management plans and activities to be developed and set. The asset management objectives below are mapped to our Policy Principles to ensure objectives remain tied to Vector's strategic pillars.

| FOCUS AREA | OBJECTIVES | AM POLICY ITEM |
|---|---|---|
| Safety and Environment | • Prevent harm to workers, contractors and the public through our work practices and assets.<br>• Ensure health and 'safety always' is at the forefront of decision making for the business.<br>• Comply with relevant legislation, regulation and planning requirements.<br>• All staff are competent and trained in their applicable roles with the right equipment available to work safely and effectively.<br>• Asset management activities align with environmentally responsible and sustainable behaviours, in line with industry best practice, enabling wider emissions reductions.<br>• Minimise the impact on the environment with regards to our assets and work practices.<br>• Proactively adapt the network to allow and prepare for the growing impact of climate change. | 1, 6 |
| Customers and Stakeholders | • Enable customers' future energy and technology choices.<br>• Provide a high-quality customer service experience across all interactions.<br>• Listen to and learn from our customers to ensure our service offering aligns with customer expectations.<br>• Consider the impact of our operational decisions on customers and minimise the disruption of planned outages and unplanned outage response times. | 2, 4, 5, 6, 7, 9 |
| Network Performance & Operations | • Comply with regulatory quality standards set out in the DPP3 Determination.<br>• Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations.<br>• Continual improvement of our asset management system and alignment to ISO 55001.<br>• Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact-based investment profiling.<br>• Utilise clear business case processes, integrate risk management and complete post investment reviews to inform our decision making and analysis.<br>• Maintain compliance with security of supply standards through risk identification and mitigation.<br>• Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice.<br>• Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities.<br>• Ensure continuous improvement by reviewing and investigating performance and embedding learnings.<br>• Manage performance of field service providers through effective commercial arrangements and regular review. | 2, 3, 4, 5, 7, 8, 9, 10 |
| Future Energy Network | • Prepare the network for future changes that will be driven by:<br>– technology: DER's, electric transportation, increased active customer participation/customer choice, dynamic ratings etc.<br>– environment: climate change including decarbonisation of the economy.<br>• Prioritise network flexibility to meet customer changing needs.<br>• Enable consumption of energy on the customers' terms and facilitate customer adoption of new technology.<br>• Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to network sustainability and transformation.<br>• Develop and enable platforms to optimise and grow Vector "Symphony Partner" services.<br>• Improve our knowledge of, and ability to control, the LV network (grid edge) and management of the information required.<br>• Collaborate with partners, thought leaders and subject matter experts to ensure Vector remains at the leading edge of future energy solutions. | 2, 3, 4, 5, 6, 7, 9, 10 |

TABLE 5-1: VECTOR'S ASSET MANAGEMENT OBJECTIVES

## 5.5 Asset management system

Vector's Asset Management System consolidates all practices associated with optimising value from assets across the full asset lifecycle. The system creates a clear link between Vector's vision, strategic objectives and asset management plans and has been designed in accordance with international best practices.

Continuous improvements in our Asset Management System, 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 organisational objectives to individual asset level performance. We continuously measure and review the progress against the stated objectives to provide assurance and to respond quickly to changes in our operating environment.

Our Asset Management System is shown as follows:

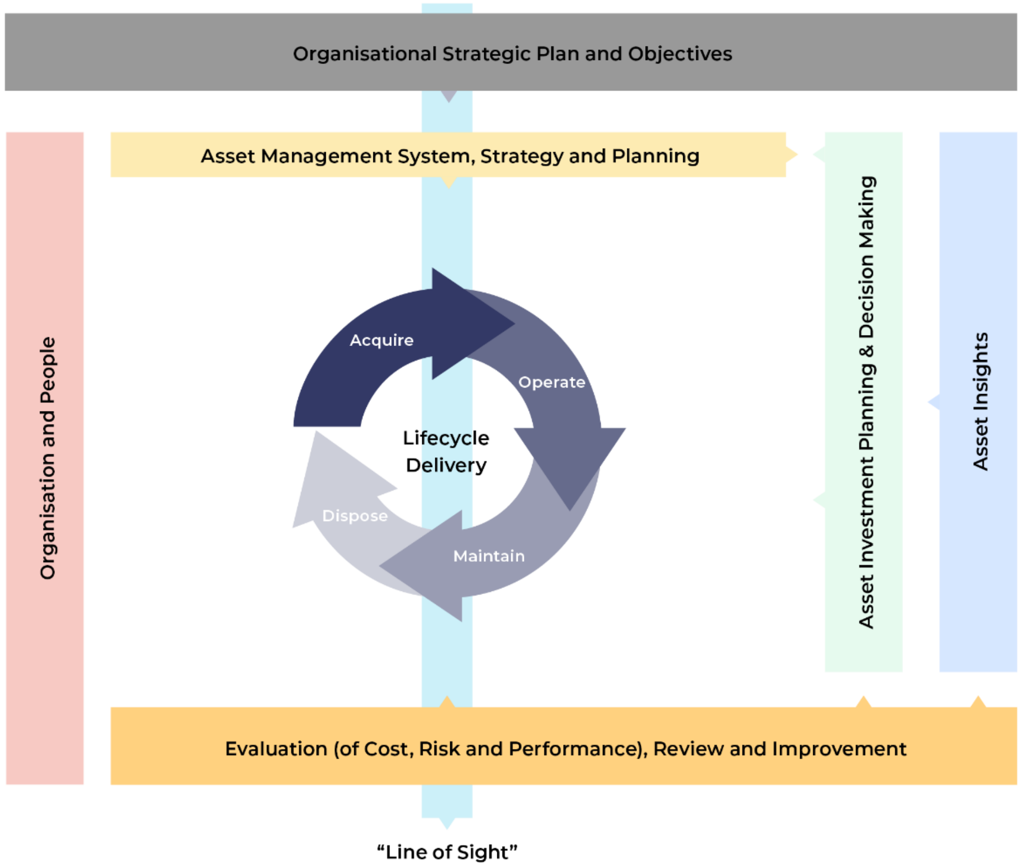



FIGURE 5-1: VECTOR'S ASSET MANAGEMENT SYSTEM

Table 5-1 provides an overview of the standards and sub-elements that form the foundation of our asset management system. 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 aligning our asset management system with the requirements of ISO 55001 and developing and improving the various components (detailed below) of the system accordingly.

| 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<br>• Asset Management Policy<br>• 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<br>• Network Development Planning<br>• Asset Replacement and Refurbishment Planning<br>• Asset Relocation Planning<br>• Customer Planning<br>• Project Planning<br>• 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<br>• Asset Creation and Acquisition<br>• Asset Performance and Reliability Management<br>• Maintenance Delivery<br>• Programme Delivery<br>• Fault and Incident Response<br>• 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<br>• 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<br>• Procurement 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<br>• Asset Performance and Health Monitoring<br>• Post Investment Reviews<br>• Stakeholder Engagement<br>• Sustainable Development |

TABLE 5-2: VECTOR'S ASSET MANAGEMENT STANDARDS

### 5.5.1 KEY DOCUMENTS

Vector's AMP is a cornerstone document produced to define and deliver key projects and activities in line with our objectives and asset management policy. It provides a tactical approach for managing Vector's asset portfolio. Through Vector's annual business planning process, the AMP brings together plans and business cases from Vector's operational and capital programmes which drive OPEX and CAPEX on Vector's electricity network respectively to allow for optimisation of expenditure. To achieve this, Vector's decision making and operational performance is guided by a suite of policies and standards used to inform our asset management practice.

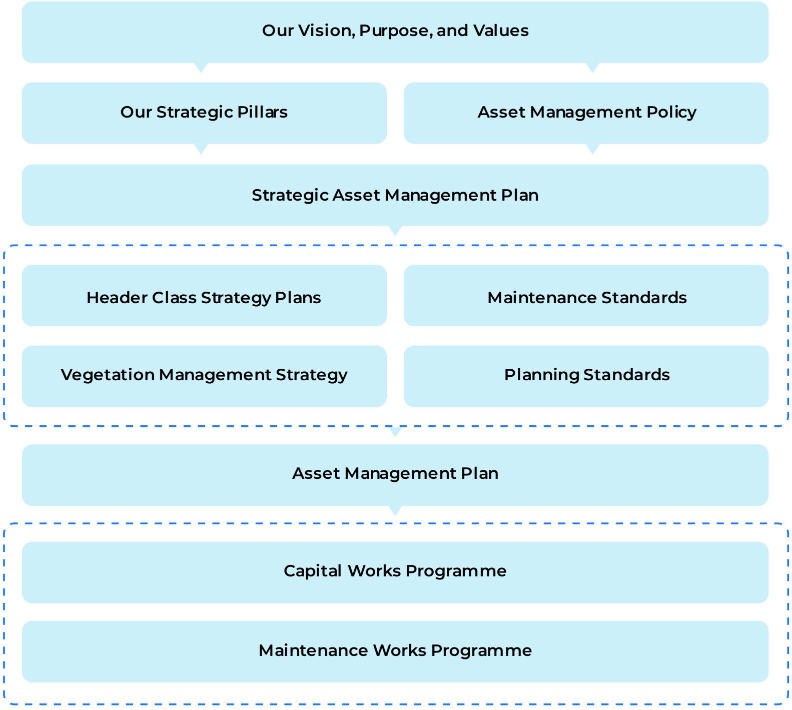



FIGURE 5-2: VECTOR'S ASSET MANAGEMENT DOCUMENT HIERARCHY

### 5.5.2 STRATEGIC PLANS AND POLICIES

Vector's strategic plans and policies related to asset management are listed in the table below with a description of how each document informs our asset management practice.

| 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 alignment with ISO 55001, we are developing and defining the SAMP which documents our asset management objectives in line with our policy and operating context. |
| Delegated Authority (DA) framework | The DA framework applies to all business activities that have financial or non-financial consequences including contracts and expenses.<br>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:<br>a) outline our key management objectives and the principles underpinning them,<br>b) provide a framework for optimising opportunities and minimising risks,<br>c) demonstrate Vector's understanding and commitment to promoting a culture of risk awareness throughout the organisation, and<br>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. |
| Environmental policy | This policy sets out Vector's commitment to managing the environmental aspects of its businesses and sets out the standards expected of all workers. |

| DOCUMENT | ROLE IN ASSET MANAGEMENT PRACTICE |
| --- | --- |
| 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. |
| 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. |

TABLE 5-3: VECTOR STRATEGIC PLANS AND POLICIES RELATED TO ASSET MANAGEMENT

### 5.5.3 STANDARDS

Standards and specifications are an integral part of our asset management framework and Vector applies many of these standards to the management of our electricity distribution assets. 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 Appendix 2.

| ASSET STANDARD | ROLE IN ASSET MANAGEMENT PRACTICE |
| --- | --- |
| Planning standards<br>(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<br>(ENS and ESM series) | Vector has developed a set of maintenance standards for each major class of asset that detail the required inspection, 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<br>(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<br>(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<br>(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 shall comply. |
| AS/NZ standards<br>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 5-4: VECTOR'S ASSET STANDARDS

## 5.6 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). In addition, Entrust, Vector's majority shareholder, biennially conducts an independent review of the state of Vector's network that includes an assessment of asset management. With support from external asset management specialists, we use these reviews to address gaps and inform our plans to improve our asset management practice.

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 to 2.87 in 2021. Our score of 2.87 reflects the effort made to continuously improve our asset management practice and objective to align to ISO 55001 to achieve a target score of three on each AMMAT rating criteria. Appendix 12 provides details of the latest AMMAT self-assessment.

Set out below is an overview of the primary areas where ongoing improvements in our asset management practise are being implemented.

### 5.6.1 IMPROVED DATA-DRIVEN DECISION MAKING

Investments have been made to our core systems through the SAP Planned Maintenance (SAP-PM) project which has allowed for further integration with our field service providers to enable a consistent approach to the management and delivery of planned maintenance. In accordance with a new suite of maintenance standards, the new systems represent a step change in asset management and provide for improved asset data quality and volume.

Condition Based Asset Risk Management (CBARM) models have been developed for all distribution assets with verification in progress. Data from SAP-PM supports and underpins these models, which in turn inform our asset health knowledge and support the development of our asset strategy, renewal and replacement programme, and the AMP.

Further improvements have been made through the development of asset fleet (header class) strategies for all primary asset classes. These strategy documents facilitate the annual creation of the AMP through continuous updates and an annual review coinciding with the end of the financial year.

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.

### 5.6.2 ISO 55001 ALIGNMENT PROGRAMME

Vector has progressed its alignment with the ISO 55001 framework through the ongoing delivery of dedicated activities targeted at defining our Strategic Asset Management Plan (SAMP) and clarifying and confirming our asset management system description. The SAMP confirms our approach to achieve specified objectives in line with our policy and operating context. It presents a consolidated plan at the portfolio level that in turn provides direction for asset level activities. As part of this work, Vector's asset management objectives have been revised to confirm alignment with the updated Asset Management Policy and Vector's Strategic Pillars.

Going forward, Vector's focus is on further consolidating our asset management practice through refining documentation for key processes. A dedicated resource has been assigned to ensure focus on these activities is maintained with external resource retained for advice and review.

This improvement initiative will provide benefits through more effective and efficient asset management practices and greater alignment of asset investment. This will be evidenced through progressive increases in Vector's self-assessment against the AMMAT model.


**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 with specific 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 remains at the leading edge of the new energy future.

## 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.

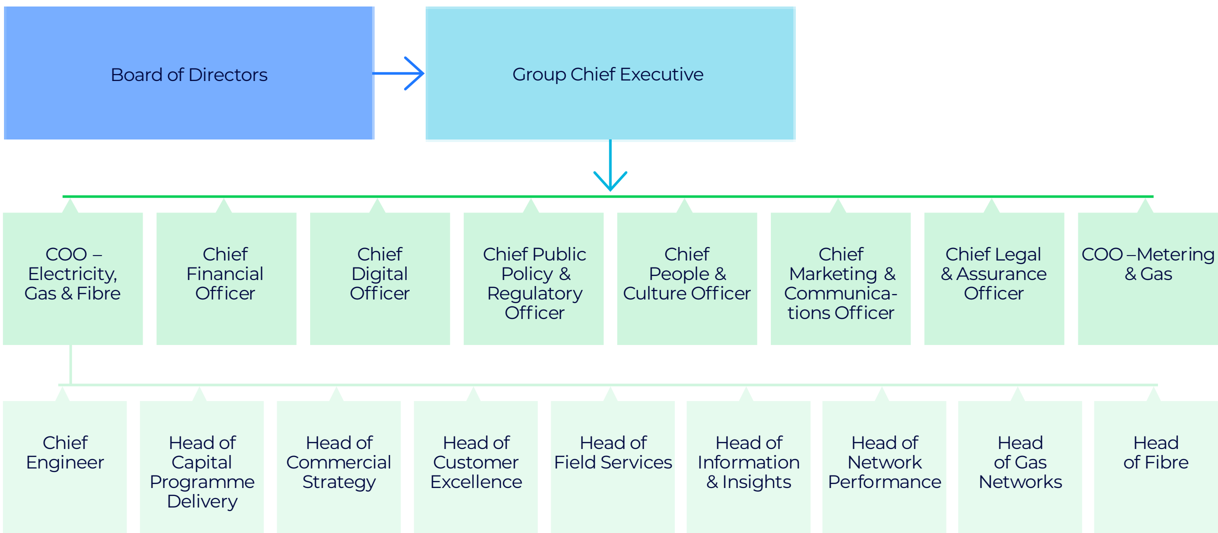



FIGURE 6-1: VECTOR'S ASSET MANAGEMENT GOVERNANCE AND ORGANISATIONAL STRUCTURE

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 operates under the Board Charter, and provides governance over all aspects of Vector's asset management practices on behalf of Vector's owners and the broader stakeholder community. The board exercises oversight of the objectives of asset management, its strategic direction, 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.

- **Group Chief Executive** – 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 Group Chief Executive (GCE). The GCE 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 GCE 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 GCE, the Chief Legal and Assurance Officer is accountable for providing Vector's legal counsel as well as policy, frameworks and governance for enterprise risk, internal audit, health and safety, compliance and privacy. 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 GCE, 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 with 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 and gas networks and services are of the best practicable quality, delivered safely and effectively.
- **Head of Field Services** – Vector's field staff are managed through an outsourced contracting model. As such, the Head of Field Services is accountable for the contractual relationships and performance of field crews delivering our maintenance programme and customer initiated works. Work is centred around delivery of maintenance plans in accordance with Vector standards and reactive response to outages.
- **Head of Network Performance** – This role is accountable for 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.
- **Head of 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.
- **Head of 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.
- **Head of 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.
- **Head of Commercial Strategy** – This role supports Vector's commitment to its asset management objectives and vision by driving key reliability and strategic initiatives.
- **Head of 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.
- **Head of 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 defined 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 GCE 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 a 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 corporate objectives.

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

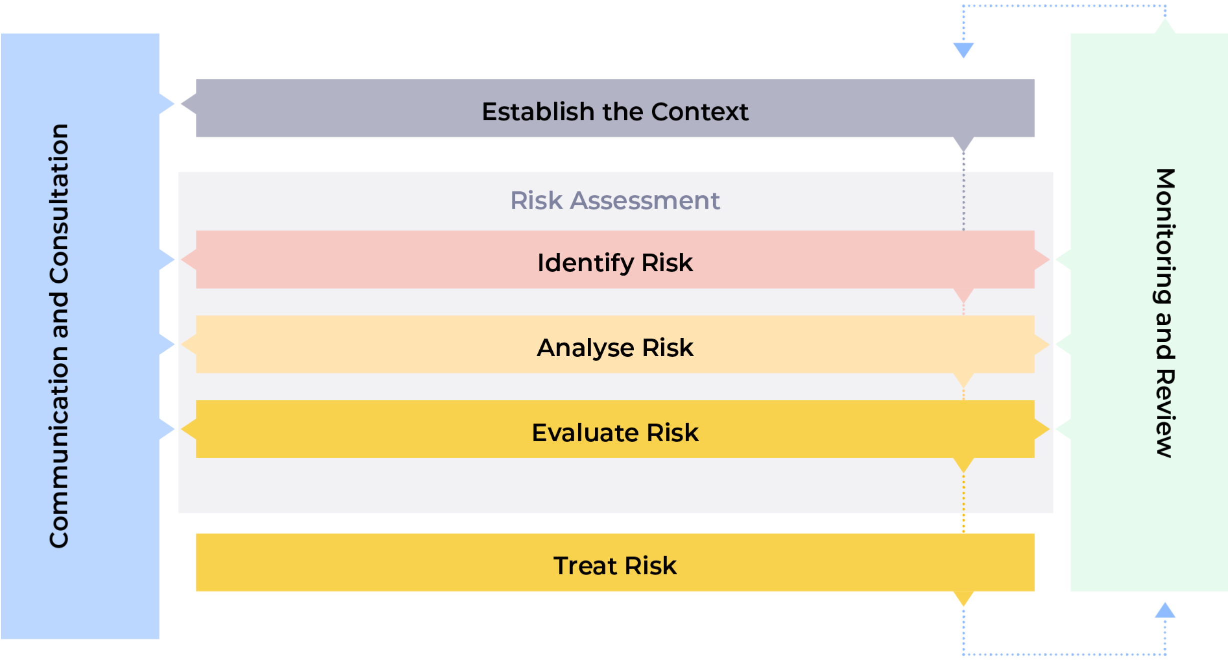



FIGURE 6-2: VECTOR'S ENTERPRISE RISK MANAGEMENT FRAMEWORK

### 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)[3] which assists the board in fulfilling its responsibilities to protect the interests of shareholders, customers, employees and the communities in which Vector operates. The BRAC provides 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.

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.

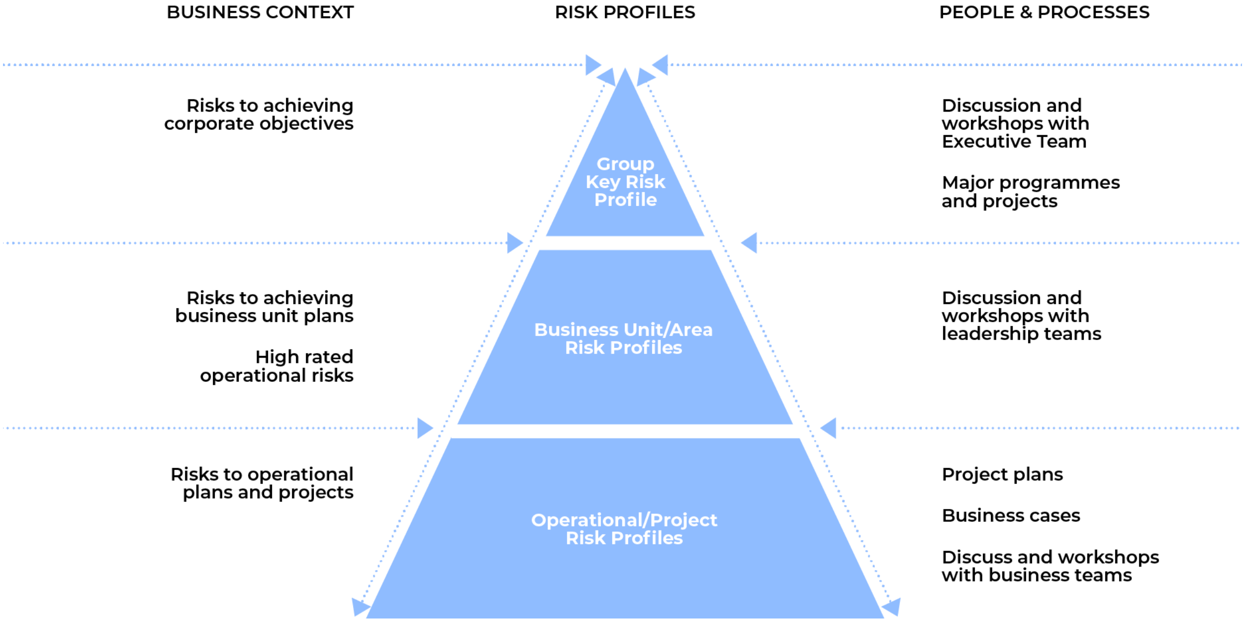



FIGURE 6-3: VECTOR'S RISK PROFILING STRUCTURE

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

### 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 against a bespoke business unit 7x7 risk matrix which is mapped directly to the Vector Group matrix allowing all risks to be aggregated to develop the Group risk profile. All risks are evaluated against five risk levels which consider Vector's risk appetite and escalation requirements. Finally, risk treatments are applied as appropriate. 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 treatments plans (which supplement existing controls) are developed and prioritised. Maintenance standards are linked to asset risks through Failure Mode and Effects Analysis and further maintenance activities are prioritised using a targeted risk approach. 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. Additionally, risks requiring tailored treatment plans and specific attention may be escalated into ARM using the dedicated Asset Risk grouping.

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 internal / externals 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. Vector defines HILP risks as events with a low likelihood of occurrence (typically less than once in 50 years) and high consequence or impact (e.g. significant loss of supply to customers or a critical health and safety event). 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<br>e.g. Widespread supply loss | Critical safety incident (worker or Public)<br>e.g. Fatality from public accessing restricted area | Health event impacting critical workforce<br>e.g. Essential workforce incapacitated by virus | Climate change creating a hazardous environment<br>e.g. Extreme winds impacting Vector's assets | Loss of system control<br>e.g. Widespread failure of SCADA system | Natural disaster<br>e.g. Volcanic eruption or earthquake |
| **Controls** | • Zone substation review programme<br>• Network contingencies and security of supply standards<br>• Major event planning | • Risk and safety management systems<br>• Site auditing and assurance management<br>• "Safety in design" standards | • Staff segregation, multiple site configurations and hygiene protocols<br>• Business continuity and contingency planning; risk control strategies | • Enhancing weather modelling capabilities<br>• Developing network climate strategies<br>• Storm response and major event planning | • Cyber security controls and management systems<br>• Control room, SCADA and field worker contingency planning | • Critical site contingency plans<br>• Environmental due diligence on land purchases for major network assets<br>• Major event planning |

FIGURE 6-5: EXAMPLE OF HILP EVENTS

## 6.4 Event management and emergency response

As a supplier of an essential service to more than 500,000 ICPs across Auckland and a nominated "lifeline utility" under the Civil Defence and 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.<br>• Defines key business continuity management roles, responsibilities, accountabilities and reporting requirements.<br>• Approved by the Board, it is consistent with the following Standards:<br>– Australian/New Zealand Standard AS/NZ 5050:2010 "Business Continuity - Managing disruption-related risk"<br>– ISO 22313:2013 "Societal security - Business continuity management systems - Guidance"<br>– SAA/SNZ HB 221:2004: "Business Continuity Management"<br>– AS/NZS ISO 31000:2009 "Risk management - Principles and guidelines. |
| 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.<br>• Takes account of both the operational response and broader considerations including staff, customer and wider stakeholder engagement and support.<br>• 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.<br>• Annual crisis management exercises and regular plan reviews are undertaken to ensure usability, understanding and to 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.<br>• The process defines the approach such that Vector can:<br>– Recognise, assess and respond to an event quickly and effectively<br>– Notify the appropriate individuals and organisations about the event<br>– Organise response activities<br>– Escalate response efforts based on the severity of the event<br>– Recover from event<br>– Gather evidence to support and complete investigations |

| DOCUMENT | DESCRIPTION |
|---|---|
| Specific Event Response Processes | • Individual 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. |
| 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.<br>• Vector's network control centre has a fully operational disaster recovery site.<br>• 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 Data and privacy

### 6.5.1 ENABLING THE ASSET MANAGEMENT SYSTEM THROUGH INFORMATION SYSTEMS

The asset management information systems enable the asset management systems to achieve cyber-security and privacy outcomes, as well as the targeted customer experience. To achieve this, we have aligned our operational and supporting infrastructure systems with the IEC (International Electrotechnical Commission) network distribution reference model.

### 6.5.2 VECTOR'S ASSET INFORMATION MANAGEMENT FRAMEWORK

The management of the network asset management information systems follows our Digital lifecycle framework to ensure the information systems are fit for purpose to support and enable the delivery of Network services.

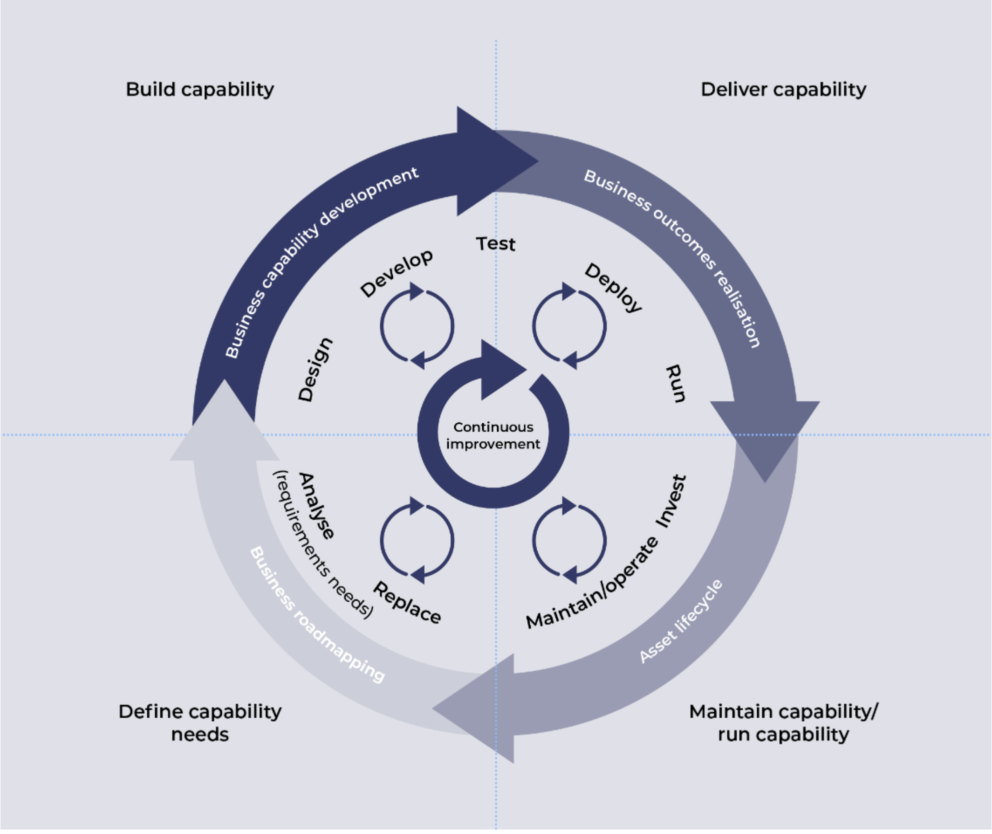



FIGURE 6-6: INFORMATION SYSTEMS LIFECYCLE MANAGEMENT FRAMEWORK

## 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 |
| 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. A supporting system, RIMS is used to record any associated incidents |
| Stationware | Stationware is Vector's system to record and manage all protection settings in its primary and distribution networks |

TABLE 6-2: 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 and minimise customer impact. 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;
- **Backstop 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
- **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 aggregated into a single centre of excellence reflecting the operational, strategic and governance overlaps across the disaggregated functions.

**Enterprise Information Management:** This function delivers and supports the 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.

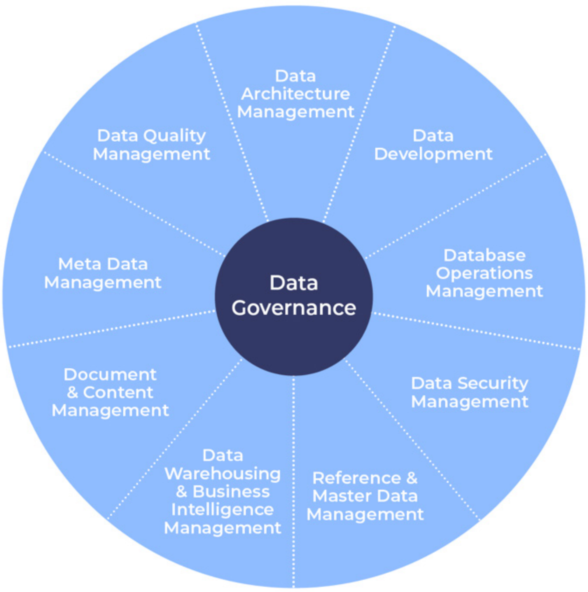
**Data Platforms:** A technical function, this team is responsible for the management and development of the data and analytics application platforms.

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

**Analytics:** 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 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[4].




Copyright© DAMA International

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.

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

### 6.7.2 OPERATING MODEL

Vector's data and information management model is represented in the diagram below. Operationally, the Enterprise Information Management (EIM) 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 Information Management

The Group Information Governance Council has responsibility for setting and enforcing the Group Data and Information policy. This includes being the escalation point for data related events and conflict. Importantly the council is made up of the core disciplines and functions from across the business that impact privacy and data management including, but not limited to, the Privacy Officer, Cyber Security, Digital Architecture, Information Management and Data and Analytics. The council reports directly to our Chief Executive Officer.

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.

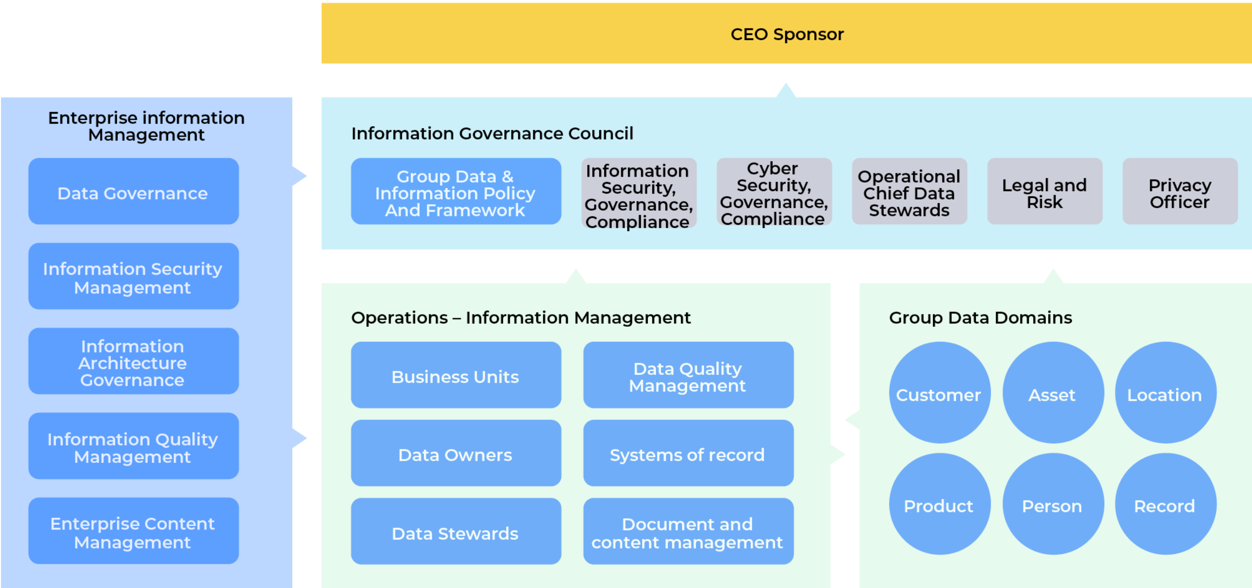



FIGURE 6-7: VECTOR'S DATA AND INFORMATION MANAGEMENT MODEL

### 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 system. The programme has the following key areas of focus to address a limitation in the current data set :

1. Improvement of SCADA, GIS and SAP data alignment.
2. Improvement of GIS network connectivity.
3. Improvement of Zone Substation internal schematic consistency.
4. Resolution of legacy unknown cable types.
5. Improvement of Customer Email address data.
6. Improved access to smart meter data from retailers.
7. Capture of network designs in GIS.
8. Improvement of LV connectivity, including ICP service fuse connection and phase assignments.
9. Enhancement of asset master data.

## 6.8 Cybersecurity and privacy

In the context of our Asset Management Plan, our strategic intent regarding cybersecurity is focused on addressing two key risks:

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

Effectively managing these risks requires the implementation of a combination of technical, process and behavioural controls that will allow us to quickly detect, respond and recover from potential cybersecurity threats. The security threats, the nature of network assets and the volume of data required to manage the network is constantly evolving. This requires continual reassessment of the effectiveness of the risk and the corresponding controls.

In this environment, balancing resilience and security provides both challenges and opportunities. These challenges are not new – resiliency and security have always been cornerstone principles of how we deliver our services. However, as the network becomes more open in terms of protocols, communication channels and technologies, and the perimeter of the network extends more into the consumer domain, this will inevitably increase the attack surface and therefore the risk of compromise. New technologies present a significant opportunity to provide enhanced services and a more robust network for end consumers, however, it is important that we also embed appropriate security controls across the network to maintain trust and integrity.

As Vector embraces digital transformation, it also navigates numerous risks. Risk from cyber-criminal activity is one of the increasing challenges Vector will face over the next two years as such we must ensure we are appropriately prepared and can quickly respond to limit any impacts. Maintaining effective security controls and response strategies is a key priority and an area in which we continue to invest heavily to ensure we appropriately manage this risk. We have improved our ability to prevent and detect potential cybersecurity threats via our Security Operations Centre (SOC) which provides 24/7/365 monitoring of our Information Technology (IT) and Operational Technology (OT) environments and continue to improve our preventative and detective controls through key initiatives such as network modernisation, user awareness and education, identity and management as well as external assurance. In addition to working with global tier-1 security providers, we continue to actively contribute to key New Zealand industry security forums, across public and private sectors and our SOC constantly monitors available threat intelligence feeds for the latest attack trends which are automatically deployed to enhance our perimeter security controls.

We have a clear vision of the level of process and control maturity required to adequately protect the network and data for which we are custodians and a roadmap that supports how this will be achieved.

### 6.8.1 PRIVACY

As part of managing network assets, privacy and our obligations under the Privacy Act 2020 must be considered. This includes the context of cybersecurity but extends beyond into effective data management and governance. The volume and potential sources of data required to effectively manage and operate the network continue to expand. New network and customer devices generate increasingly important information about consumption patterns, faults, performance and resilience which enables us to efficiently and effectively manage the network. This information could be sensitive, and this means there is an increased risk that we may be targeted by malicious actors wishing to gain unauthorised access to this information.

Accordingly, and as part of our commitment to customers, we are elevating our internal controls to manage and govern this information effectively, particularly where Personally Identifiable Information (PII) is involved. Effective governance and management of information are critical to maintaining trust in the network and Vector as its custodians and we take our obligations seriously. As a result, our data governance programme takes a holistic view of how our data is managed and governed and specifically considers privacy across all areas of our data.

**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 Customer experience

### 7.1.1 CUSTOMER EFFORT MEAN SCORE (CEMS)

#### 7.1.1.1 DEFINITION

The Customer Effort Mean Score (CEMS) service level measures the ease of customers' experience with Vector. In other words, how easy we are to deal with.

#### 7.1.1.2 MEASUREMENT

The average Mean Score is calculated on a scale of 0-10. We measure both single interaction experiences as well as multi-interaction experiences with customers. We align this metric to customer journeys to continually improve our customers' experiences. CEMS is measured quarterly and a yearly average is calculated.

#### 7.1.1.3 OUR HISTORICAL PERFORMANCE

Historically we measured the level of customer satisfaction using an overall customer satisfaction score, however, CEMS was adopted in RY2017 to establish a measurement that better aligns with the needs of customers and incentivises improvements in customer centric efficiencies. CEMS has been measured quarterly for the past four years. Table 7-1 summarises this service level performance out of a rating of 10.

| DESCRIPTION | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Customer Effort Means Score | - | - | 6.9 | 6.7 | 7.0 | 6.7 |

TABLE 7-1: CUSTOMER EFFORT MEANS SCORE

#### 7.1.1.4 OUR TARGET

The target is to improve the Customer Effort Mean Score for RY21 to 6.8 and maintain this in RY22. Our aim to achieve a CEMS level of 7.2 by RY25 This will be reassessed every two years over the AMP period.

### 7.1.2 SPEED OF QUOTES FOR NEW CONNECTIONS (SMALL CONNECTION CUSTOMERS)

#### 7.1.2.1 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.

#### 7.1.2.2 MEASUREMENT

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

#### 7.1.2.3 OUR HISTORICAL PERFORMANCE

At present, 93 per cent of standard quotes are sent out within two days, and 73 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 | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Speed of quotes for new connections – Standard | - | - | - | 84% | 95% | 93% |
| Speed of quotes for new connections – Non-standard | - | - | - | 68% | 85% | 75% |

TABLE 7-2: SPEED OF QUOTES FOR NEW CONNECTIONS

#### 7.1.2.4 OUR TARGET

We aim to have 95 per cent of standard quotes sent out within two days by RY22, and 75 per cent of non-standard quotes sent out within seven days by RY22. These are reassessed every two years and we will continue this practice over the AMP period.

## 7.1.3 ADVANCE NOTIFICATION OF PLANNED OUTAGES

### 7.1.3.1 DEFINITION

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

### 7.1.3.2 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 their preferences.

These changes have been implemented and will be measured from the start of the RY21 year.

### 7.1.3.3 OUR HISTORICAL PERFORMANCE

Due to the system and operational changes made under DPP3, Vector is unable to provide a consistent measure for the years before the implementation of these changes.

### 7.1.3.4 OUR TARGET

Under the DPP3 regulatory framework, Vector is required to give residential & commercial customers a minimum of 4 working days' notice of a planned outage, and direct billed customers a minimum of 10 working days' notice. To better meet customer's expectations and to allow for postage and handling delays (where applicable) Vector has chosen to adopt a target of 7 working days' notice for Residential and Commercial customers.

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

1. 100% of direct billed customers at least 10 working days in advance.
2. 80% of all other customers to receive 10 working days advance notice of a planned outage, and 100% within 7 working days.

## 7.1.4 CALL CENTRE GRADE OF SERVICE (GOS)

### 7.1.4.1 DEFINITION

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

### 7.1.4.2 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.

### 7.1.4.3 OUR HISTORICAL PERFORMANCE

| DESCRIPTION | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Average Grade of Service (GOS) | 86% | 87% | 81% | 75% | 79% | 80% |

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.

### 7.1.4.4 OUR TARGET

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

## 7.2 Safety

Lag indicators such as lost time injuries and medical treatment injuries are providing fewer opportunities to learn and improve. They are also backwards-looking and not preventative measures. Each year the company performs millions of work activities where the outcome is achieved without harm. We are thinking of safety differently and attempting to understand what are the success factors to achieve safe work. By doing this and tapping into a new philosophy around safety called safety II or Safety differently, we will achieve a far richer and deeper learning around risks and how effective the controls are to manage work safely. As a result of this thinking, a target has not been set for TRIFR, which will continue as a lagging measure of safety performance. Vector is currently investigating suitable leading indicators for inclusion in the next AMP.

### 7.2.1 TOTAL RECORDABLE INJURY FREQUENCY RATE

#### 7.2.1.1 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.

#### 7.2.1.2 MEASUREMENT

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

#### 7.2.1.3 HISTORICAL PERFORMANCE

Table 7-4 shows the Networks TRIFR performance under the definition of this service level metric. Over the last three years, we have created a change in focus to enhance reporting and drive improved wellness which has caused an increase in this calculated rate. Increasingly, the focus is being given to underlying issues and treatment with more targeted at critical risk events. This movement in the rate is a temporary situation with the RY19 showing the expected decrease.

| DESCRIPTION | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Total recordable injury frequency rate (TRIFR) | 6.89 | 7.17 | 5.28 | 14.07 | 5.01 | 5.82 |

TABLE 7-4: TRIFR

#### 7.2.1.4 TARGET

In line with Vector's move towards Pro-Active safety measures, a target has not been set for TRIFR in RY21.

### 7.2.2 ASSET SAFETY INCIDENT MEASURE

#### 7.2.2.1 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.

#### 7.2.2.2 MEASUREMENT

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

#### 7.2.2.3 HISTORICAL PERFORMANCE

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

| DESCRIPTION | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Asset safety incident | 0 | 2 | 1 | 7 | 5 | 4 |

TABLE 7-5: ASSET SAFETY INCIDENTS

The number of asset safety incidents reduced in RY19 and RY20. For RY20, two incidents relate to operations on the electricity network, and two relate to incidents involving members of the public or their property.

#### 7.2.2.4 TARGET

Our asset safety target is Zero incidents. With safety always being Vector's highest priority, we strive to achieve no asset safety related incidents causing harm to employees, contractors, and the public.

## 7.3 Reliability

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

### 7.3.1 SYSTEM AVERAGE INTERRUPTION FREQUENCY INDEX (SAIFI)

#### 7.3.1.1 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.

#### 7.3.1.2 MEASUREMENT

$$SAIFI = (\text{total number of interruptions}) / (\text{average number of customers})$$

SAIFI only measures outages caused by an event on the HV network and does not include the LV network. The SAIFI dataset is normalised using a process defined by the Commerce Commission in the DPP. This process reduces planned interruptions by 50% as it is considered that customers are less impacted by interruptions that are planned. It also limits unplanned SAIFI on days 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:

$$SAIFI_{Normalised} = (0.5 \times SAIFI_{planned}) + SAIFI_{unplanned}$$

Where:

$SAIFI_{planned}$ is the sum of daily planned SAIFI values in the assessment period; and

$SAIDI_{unplanned}$ is the sum of daily unplanned SAIFI values in the assessment period, where if any daily value of unplanned SAIFI is greater than the SAIFI Unplanned Boundary Value then the daily value equals the SAIFI Unplanned Boundary Value. (The SAIFI Unplanned Boundary Value is calculated as per the Commerce Commission process. This value is set to 0.039 for the regulatory period 1 April 2015 to 31 March 2020.)

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 measured 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.

Vector's SAIFI target is set by the Commerce Commission's regulatory determination every 5 years.

| DESCRIPTION | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| SAIFI | 1.41 | 1.11 | 1.85 | 2.14 | 1.76 | 1.58 |

TABLE 7-6: SAIFI

For the RY2020 assessment period, Vector exceeded its reliability limits and is non-compliant with the DPP Determination. This was mainly due to the greater volume of planned maintenance works, higher third-party damage, overhead faults and vegetation. The last two causes are impacted by weather causing debris and out of zone vegetation coming into contact with overhead circuits.

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. These initiatives were progressively rolled out through RY2020 and will have an enduring impact on reliability.

#### 7.3.1.3 TARGET

For the Regulatory Period, 1 April 2015 to 31 March 2020, Vector's annual SAIFI target has been set based on the limits defined within the Electricity Distribution services default price-quality path determination 2015.

Annual SAIFI Limit = 1.395

For the Regulatory Period, 1 April 2020 to 31 March 2025 Vector's annual SAIFI target have been set based on the limits defined within the Electricity distribution services default price-quality path determination 2020. It is worth noting that from 1 April 2020 these targets have been split according to Planned and Unplanned events.

Unplanned annual SAIFI Limit = 1.3366

Planned accumulated SAIFI Limit for a 5-year period = 2.8783

### 7.3.2 SYSTEM AVERAGE INTERRUPTION DURATION INDEX (SAIDI)

#### 7.3.2.1 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.

#### 7.3.2.2 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 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:

*〖SAIDI〗_Normalised=(0.5 x 〖SAIDI〗_planned ) + 〖SAIDI〗_unplanned*

Where:

〖SAIDI〗_planned is the sum of daily planned SAIDI values in the assessment period; and

〖SAIDI〗_unplanned is the sum of daily unplanned SAIDI values in the assessment period, where if any daily value of unplanned SAIDI is greater than the SAIDI Unplanned Boundary Value then the daily value equals the SAIDI Unplanned Boundary Value. (The SAIDI Unplanned Boundary Value is calculated as per the Commerce Commission process. This limit is set to 3.374 minutes per day for the regulatory period 1 April 2015 to 31 March 2020.)

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 measured 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 | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Customer interruptions performance | 128.5 | 117.0 | 173.6 | 226.2 | 198.2 | 167.5 |

TABLE 7-7: SAIDI

For the 2020 assessment period, Vector exceeded its reliability limits and is non-compliant with the DPP Determination. This was mainly due to the greater volume of planned maintenance works, higher third-party damage, overhead faults and vegetation. The last two causes are impacted by weather causing debris and out of zone vegetation coming into contact with overhead circuits.

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. These initiatives were progressively rolled out through RY2020 and will have an enduring impact on reliability.

#### 7.3.2.3 TARGET

For the Regulatory Period, 1 April 2015 to 31 March 2020, Vector's annual SAIDI target has been set based on the limits defined within the Electricity Distribution services default price-quality path determination 2015.

Annual SAIDI Limit = 104.173

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 Electricity distribution services default price-quality path determination 2020. It is worth noting that from 1 April 2020 these targets have been split according to Planned and Unplanned events.

Planned Annual SAIDI Limit = 117.08

Unplanned Annual SAIDI Limit = 104.83

### 7.3.3 NUMBER OF CUSTOMER INTERRUPTIONS PERFORMANCE AGAINST AGREED SERVICE STANDARDS

#### 7.3.3.1 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 that enables us to effectively engage customers affected by outages on issues such as cost quality trade-offs, etc.

The Use of System 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.

#### 7.3.3.2 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 | RY15 | RY16 | RY17 | RY18 | RY19 | RY20 |
|---|---|---|---|---|---|---|
| Customer interruptions performance | 99.3% | 97.8% | 96.6% | 92.6% | 97.1% | 97.3% |

TABLE 7-8: 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).

#### 7.3.3.3 TARGET

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

## 7.4 Cybersecurity

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 can therefore no longer solely rely 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 cybersecurity 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 define security incidents for our targets:

| PRIORITY | DESCRIPTION | NARRATIVE |
|---|---|---|
| 1 | Critical Incident | Interruption making a critical function inaccessible or a complete network interruption causing a severe impact on service availability. There is no possible alternative function/service available. |
| 2 | Priority Incident | Critical functions or network services are interrupted, degraded or unusable, having a severe impact on availability. No acceptable alternative is possible. |
| 3 | Standard Incident | Non-critical functions or services, are unusable or have intermittent issues resulting in an operational impact, but with no significant or direct impact on availability. |

TABLE 7-9: INCIDENT LEVELS FOR CYBERSECURITY

### 7.4.1 INCIDENT DETECTION SERVICE LEVEL

#### 7.4.1.1 DEFINITION

This service level measures the effectiveness of our Security Operations Centre (SOC) to analyse potential security threats and detect actual security events that require action and containment by the cyber security team.

#### 7.4.1.2 MEASUREMENT

The service level is based on the time from the detection of an actual cyber event or threat by our SOC to the alerting/escalation for action to the cybersecurity team.

### 7.4.2 INCIDENT RESPONSE SERVICE LEVEL

#### 7.4.2.1 DEFINITION

This service level measures the effectiveness of our Security Operations Centre (SOC) to analyse actual security events and provide an appropriate containment strategy that minimises the impact on the Vector network.

#### 7.4.2.2 MEASUREMENT

This service level measures the time from the detection of an actual cyber event or threat by our Security Operations Centre (SOC) to the development of the containment strategy to be implemented and managed by the cyber security team.

### 7.4.3 INCIDENT CONTAINMENT SERVICE LEVEL

#### 7.4.3.1 DEFINITION

This service level measures the time between the response notification/containment plan to effectively containing the immediate threat. The measure excludes full remediation activities.

#### 7.4.3.2 MEASUREMENT

We measure the time from the release of the initial response notification/containment plan to the implementation of all containment strategies and actions such that any further loss or disruption is minimised.

**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 meeting our customers and overall network performance expectations.

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.

In addition to the foregoing, a key focus has been our transition to become more risk based in our approach to corrective maintenance and vegetation management supported by improvements in our systems and standards. These improvements are forecast to continue to drive efficiencies in the medium to longer term, and these are highlighted in the respective elements.

As maintenance is the primary source of ongoing asset condition information, the improvement 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 and Environment | • Preventing harm to workers, contractors and the public through our work practices and assets.<br>• Ensuring health and 'safety always' is at the forefront of decision making for the business.<br>• Complying with relevant legislation, regulation and planning requirements |
| Customers and Stakeholders | • Provide a high-quality customer service experience across all interactions.<br>• Listen to and learn from our customers to ensure our service offering aligns with customer expectations.<br>• 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.<br>• Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations.<br>• Maintain compliance with Security of Supply Standards through risk identification and mitigation.<br>• Ensure continuous improvement by reviewing and investigating performance and embedding learnings. |
| Future Energy Network | • Prioritise network flexibility to meet customer changing needs.<br>• Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to network sustainability and transformation. |

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 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's maintenance standards 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 DELIVERY – SAP PM

In FY21, Vector implemented a new planned maintenance regime that is underpinned by core digital and field-based systems developed in collaboration between Vector and our Field Service Providers (FSP). The regime is supported by a new suite of maintenance standards as well as significant enhancements to our core systems through the SAP Planned Maintenance (SAP PM) project. These system changes extend through to our Field Service Providers and their respective field and back office work management systems. Having integrated systems has enabled a consistent and fully systemised approach to the management and delivery of planned maintenance. This is a significant step forward as we now have a single system of record with both FSP's fully integrated with Vector's SAP system.

The new systems and standards support a primary objective to improve our asset lifecycle information to enable long term improvements to reliability, performance and quality of service to our customers. These improvements to the quality, quantity and visibility of the asset information we hold will form the cornerstone of our predictive and risk-based approach to asset management. This will enable improved analytics and lifecycle modelling for our CBARM initiatives as well as supporting our new Risk Based Approach to corrective maintenance. SAP PM also supports better decision making through the availability of improved information and insight. Planned maintenance becomes the primary source of asset lifecycle and condition assessment information from any time after the asset is commissioned.

### 8.4.3 PLANNED MAINTENANCE OBJECTIVES

We have identified the following high-level objectives to guide our Planned Maintenance programme:

| PLANNED MAINTENANCE | OBJECTIVE |
|---|---|
| Safety and Environment | Ensure that our planned maintenance regime is an effective control for the risks associated with owning and operating a network and our commitments to environmental and public safety are not compromised. |
| Our Customers | Minimise planned outages to our customers by grouping and prioritising works effectively, and where economically practical use generation to reduce planned interruptions. |
| Asset Reliability | Maximise asset life and improve reliability by ensuring that planned maintenance is completed in accordance with our maintenance strategies.<br>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.<br>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

### 8.4.4 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 and SAP Planned Maintenance (SAP PM) | Implementation of a new planned maintenance regime that is underpinned by core digital and field-based systems developed in collaboration between Vector and our Field Service Providers (FSP). The regime is supported by a new suite of maintenance standards as well as significant enhancements to our core systems through the SAP PM project. |
| Acoustic Inspection | Acoustic inspections are an effective early detection method for electrical discharge associated with early stage defects that would otherwise be difficult to detect visually. These inspections are now carried out on the entire distribution and sub transmission overhead network.<br>In addition, we are also assessing the effectiveness of acoustic technology for inspecting outdoor switchyards and selected ground mounted equipment and cable terminations. |
| Thermographic Inspection | Thermographic inspections are used to identify localised overheating and to predict asset failure before it occurs. These periodic inspections are specified in our maintenance standards.<br>In addition, out of cycle inspections are carried out on assets that are more prone to thermal degradation. |
| Critical network section inspections | A programme of network inspections introduced in response to Covid-19 lockdown to ensure the required level of focus is maintained on feeders supplying essential service businesses, utilities, emergency and medical facilities. This capability can be initiated when required. |
| Partial Discharge Testing | Routine requirements for partial discharge (PD) testing are specified in our maintenance standards. In addition, high accuracy PD testing is now being planned where there are specific elevated risks. |
| Cable Testing 11 kV | Proactive testing of cable sections to assess asset condition. Cable testing results will be used to inform future asset replacement plans driven by CBARM. |
| LiDAR | A LiDAR survey of our entire network was completed in FY21. This is a pro-active initiative that involves an aerial survey of our entire network using light detection and ranging technology to model the network. The LiDAR dataset will support our work to identify line clearance and vegetation encroachment issues. Non-conformances will be prioritised for remediation through our risk-based corrective and vegetation management processes. |
| Transformer Testing | A more comprehensive suite of testing is being introduced across our fleet of primary transformers to improve condition assessment information and enhance renewal and refurbishment decisions. The suite of testing will include Tan Delta, Winding Resistance HV & LV, Short Circuit Impedance and Sweep Frequency Response Analysis (SFRA). |
| Ring-main Units (RMU) Oil Insulated | A newly introduced test has been developed to improve our ability to assess the condition and integrity of oil filled ring-main units while they are being serviced. |

TABLE 8-3: PLANNED MAINTENANCE IMPROVEMENT INITIATIVES

### 8.4.5 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.

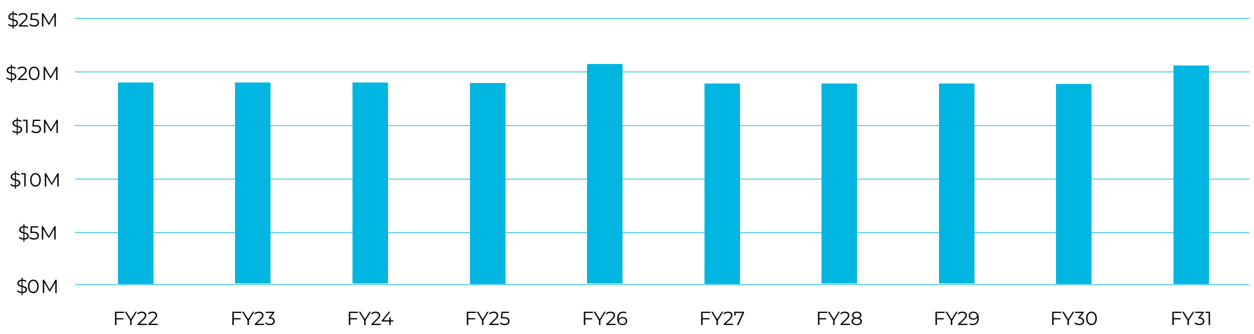



FIGURE 8-1: PLANNED MAINTENANCE OPEX EXPENDITURE FORECAST

## 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 initiatives.

The introduction of the Targeted Risk Approach (TRA) to corrective work in 2018, and other SAIDI related initiatives since, including proactive CBARM asset replacement, has begun to show improvement as evident in the normalised profile of unplanned events shown in Figure 8-2 below. The unplanned events profile includes asset failures that occur from either inherent or environmental causes. Corrective maintenance work has a direct influence on reducing our inherent network events.

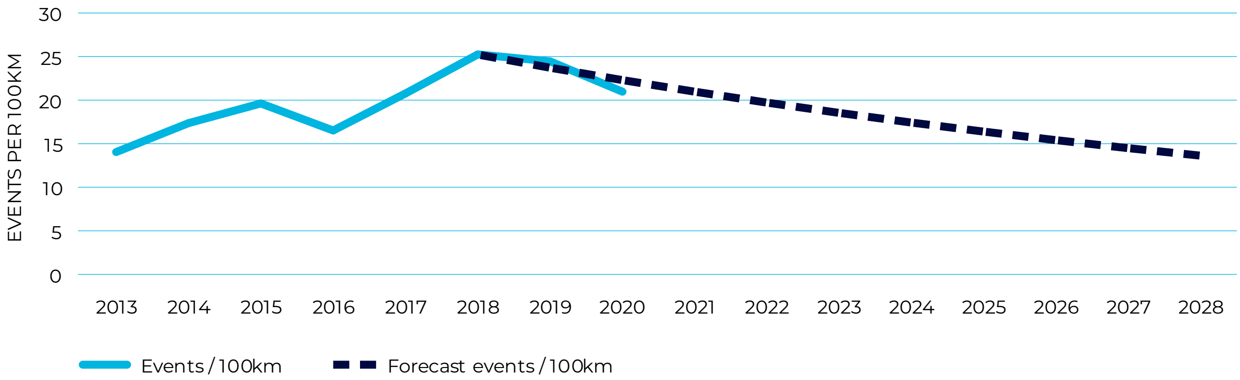



FIGURE 8-2: UNPLANNED EVENTS PER 100KM

Vector's corrective maintenance program has benefited significantly from our recent implementation of system improvements through the SAP PM project. We now have a fully integrated approach to corrective work and both our FSP's field and back office work management systems are now fully integrated into Vectors SAP system. This step change in enhancing the transparency, consistency and visibility of asset information was introduced in RY21.

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. This means that work is able to be planned and executed at a TOTEX level through assessing the risk associated with each notification. The new systems and methodology have enabled capability that allows our FSP's to easily select and assemble packages of work that optimise 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 SAP PM, 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 has replaced the earlier Targeted Risk Approach, which was entirely rule based, and required the FSP's to manually process and assign a risk rating to each notification, determine the potential SAIDI consequence from a static table and then prioritise their corrective work.

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 impact on our customers 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 high-level objectives to guide our Corrective Maintenance programme:

| CORRECTIVE MAINTENANCE | OBJECTIVE |
|---|---|
| Safety and Environment | 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. |
| Our Customers | 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 | 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 |
|---|---|
| Risk based Approach, SAP PM | The implementation of a fully integrated approach to corrective work planning and execution, supported by our FSP's work management systems and our own SAP system. SAP PM and RBA provides a step change in transparency, consistency and visibility of asset information. |
| Corrective notifications data cleansing | With the introduction of the SAP PM system changes we have improved visibility of the total pool of open notifications. An initiative to cleanse legacy data sets will be undertaken to improve the quality of our asset condition and notification data. |
| Asset information improvements | An ongoing initiative to improve the accuracy, quality and completeness of historic asset data sets. |

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.

Our corrective maintenance OPEX and CAPEX expenditure forecasts are presented in Figure 8-3 and Figure 8-4 respectively.

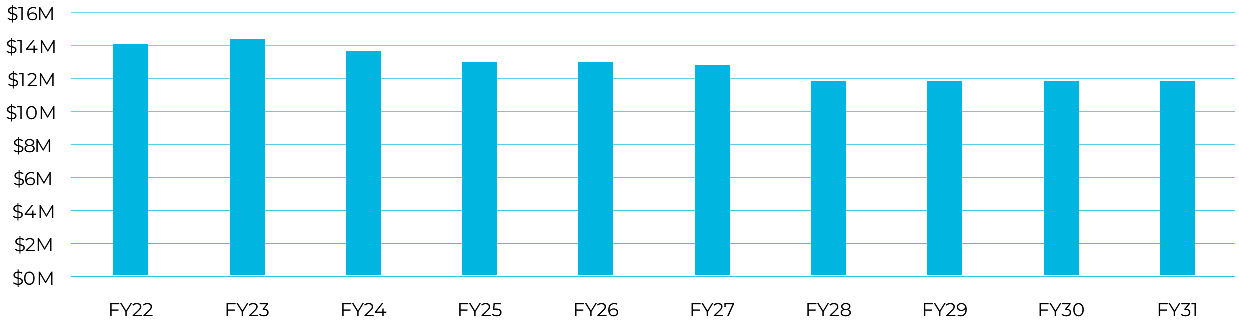



FIGURE 8-3: CORRECTIVE MAINTENANCE OPEX EXPENDITURE FORECAST

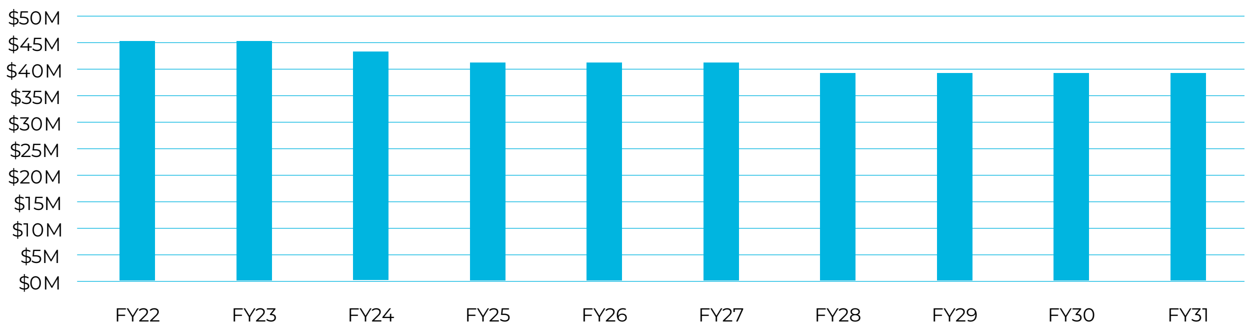



FIGURE 8-4: CORRECTIVE MAINTENANCE CAPEX EXPENDITURE FORECAST

## 8.6 Reactive maintenance

### 8.6.1 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 site. 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 addressees 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 (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.

### 8.6.2 REACTIVE MAINTENANCE OBJECTIVES

| REACTIVE MAINTENANCE | OBJECTIVES |
|---|---|
| Safety and Environment | 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. |
| Our Customers | Minimise impact to our customers and optimise restoration through faster response times, fault isolation and partial feeder restoration, and repairs. |
| 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 8-6: REACTIVE MAINTENANCE OBJECTIVES

### 8.6.3 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:

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

| INITIATIVE | DESCRIPTION |
|---|---|
| Network Automation | High voltage switching apparatus with capability to be remotely controlled by our EOC have been placed at strategic locations across our network. This enables our electricity network controllers to remotely operate switches to enable partial restoration without waiting for field crews to arrive on site. |
| Expansion of the use of auto-reclose functionality | The intention is to maintain continuity of the electricity supply by re-instating the use of automatic reclosing functionality in urban areas (where appropriate) to clear non-permanent, transient faults. |
| Fault Passage Indicators (FPIs) | Vector continues to trial new technology around our overhead network to enable rapid identification of fault locations.<br>Smart FPI's can be integrated with our existing SCADA system and gives our EOC better visibility of the network during outages allowing for quicker response times by our field service providers. |

| INITIATIVE | DESCRIPTION |
|---|---|
| Optimisation of service provider's fault response model | Vector has introduced a complete overhaul of 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 reducing travel times across Auckland to allow our field services teams to respond to faults as quickly as possible. |
| Vehicle fitout and fault response staff competence | These initiatives allow for the right resources to get to site more rapidly to facilitate partial restoration to narrow the area affected by the fault and to maximise the number of faults repaired by the first responders, without the reliance on secondary teams providing assistance. |
| Zone substations used to warehouse essential equipment | Vector facilities are being used as storage sites for crucial components allowing quicker restoration times by our field crews. |
| Field Service Provider Incentives | Incentives set by Vector to our field service providers using fault restoration times as a financial incentive if they meet their KPIs. |

TABLE 8-7: REACTIVE MAINTENANCE INITIATIVES

### 8.6.4 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.

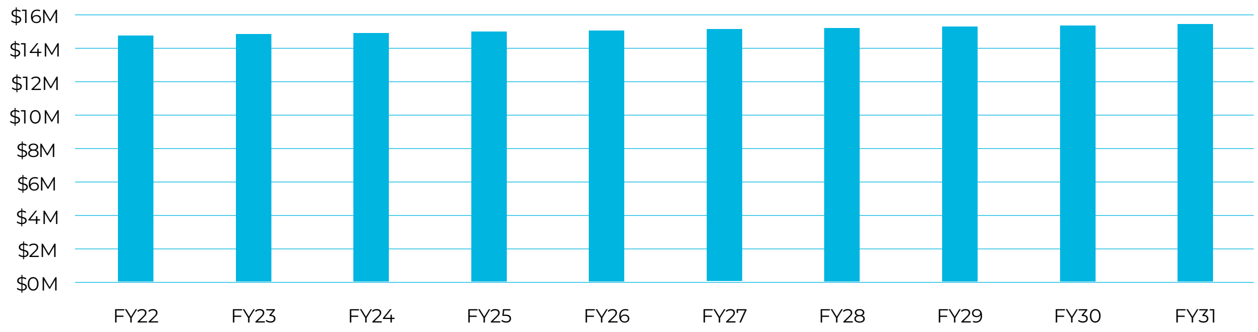



FIGURE 8-5: REACTIVE MAINTENANCE OPEX EXPENDITURE FORECAST

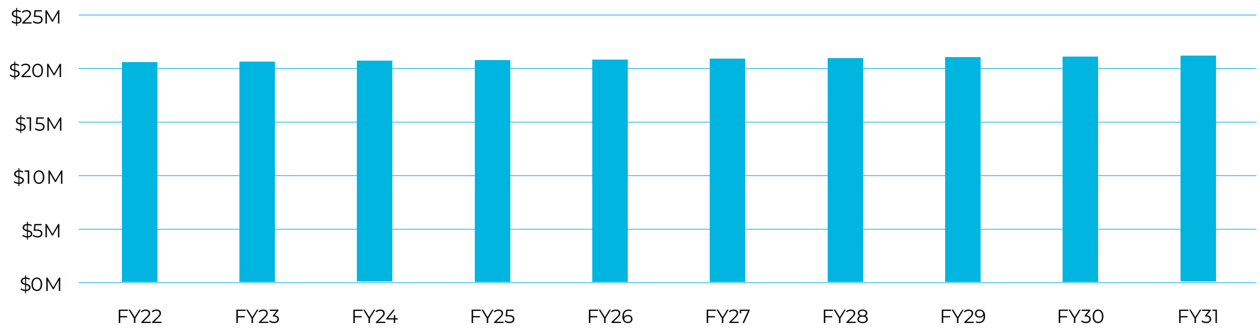



FIGURE 8-6: REACTIVE MAINTENANCE CAPEX EXPENDITURE FORECAST

## 8.7 Vegetation management

### 8.7.1 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.

Vector is working to reach agreement with Auckland City Council, for them to take responsibility for addressing council owned vegetation encroaching on the electricity network.

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 as well as catalogue high risk 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 inspections and administration are dealt to by a separate contractor to the delivery works.

### 8.7.2 VEGETATION MANAGEMENT PERFORMANCE

Our increased investment in vegetation is beginning to show improvement in the area of network performance. 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 is advocating 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.

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.

Vector's vegetation asset management strategy (VAMS) forms an integral part of its strategic reliability management plan (SRMP). The following key changes have also been implemented during DPP2:

1. We have developed a risk-based prioritisation model based on likelihood of failure and network impact derived from our network SAIDI criticality model.
2. We have onboarded a specialist vegetation scoping provider and auditing service to separate our vegetation programme functions.
3. We have increased our arborist capacity with our incumbent vegetation provider and taken the unprecedented step of onboarding a second arborist contractor to manage work volume.
4. We have progressed a full review of our contractual agreement with our vegetation service providers (VSPs)

### 8.7.3 VEGETATION MANAGEMENT OBJECTIVES

Vector's vegetation management strategy reflects our strategic asset management objectives of delivering a safe, reliable and affordable network to an engaged customer base. Vector's overhead network exposure to vegetation comprises approximately 8295 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.

| VEGETATION MANAGEMENT | OBJECTIVE |
|---|---|
| Safety and Environment | 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. |
| Our Customers | 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 | 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 8-8: VEGETATION MANAGEMENT OBJECTIVES

### 8.7.4 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.<br>Investigate the use of temporary conductor covers to reduce tree contact in circumstances where negotiations with tree owners are ongoing.<br>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 | Develop capability to leverage new inspection technologies like LiDAR to improve understanding of growth rates in specific locations to be able to better forecast potential vegetation intrusions.<br>Partnering with IBM's Weather Company for data analytics to better predict the impact of storms and improve our levels of preparedness to respond to storm events. |
| Improved engagement with tree owners | Pro-actively notify responsible parties/owners of vegetation that is not Vector's responsibility to clear, of their obligations to clear vegetation in accordance with relevant standards, so they are aware of a potential breach in advance of it becoming an issue. This would provide the third party with more time to address the issue.<br>Collaborating with large private tree owners, e.g. Auckland City Council, to coordinate vegetation management efforts. |
| Operational performance monitoring | Implement an external audit program to provide inspection and clearance works quality assurance and influence appropriate contractor behaviour/performance. |

TABLE 8-9: VEGETATION MANAGEMENT INITIATIVES

### 8.7.5 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, and the transition to a collaborative partnership with Auckland City Council which will see them take responsibility for addressing Council owned vegetation encroaching on the electricity network.

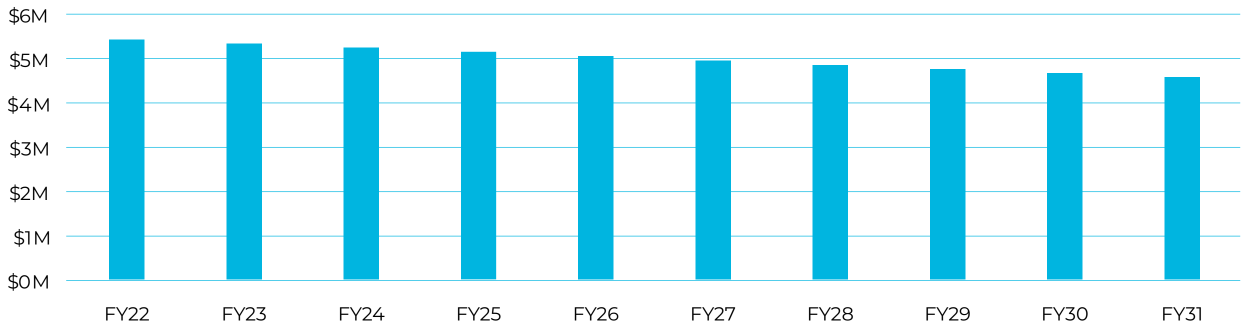



FIGURE 8-7: VEGETATION OPEX EXPENDITURE FORECAST

**SECTION 09**

# Customer connections

# 9 – Customer connections

## 9.1 Section overview

This Section explains our approach to forecasting Auckland growth, connecting new customers and how we forecast expenditure for these connections. Vector's engineering teams have developed robust design standards to ensure that a safe and resilient network is built to maintain the integrity of our network and the quality of supply to existing and new customers.

## 9.2 Customer connection growth

The establishment of a unified council for Auckland in 2010 resulted in a regional approach to housing, transport and environmental infrastructure. Auckland's population has grown by around a quarter of a million people since 2010, which has resulted in an increased demand for electricity connections. Reflecting Auckland's continued growth, new electricity connections on our network increased from 527,096 in year ending 31 March 2010 to 586,480 at 31 December 2020). These additional connections include all types of connections; from a small connection for a single residential property to large connections for commercial or industrial properties.

A variety of political, economic and environmental factors impact on the long-term growth of the Auckland Region and subsequently the region's infrastructure. At Vector we utilise our pipeline data in conjunction with modelling based on consent statistics and other economic indicators to forecast connection growth. We also work closely with developers and consultants to understand their planned development activities and indicative timeframes for these.

### 9.2.1 IMPACT OF COVID-19

It is vital for Vector to understand the timing and forecast of customer connection growth and its impact on the network in order to ensure a reliable, affordable and resilient supply of electricity. COVID-19 caused significant initial uncertainty on market growth in 2020. Instead of the anticipated downturn in growth, a building boom commenced. For the year ending July 2020 14,895 dwellings had been consented in Auckland. This trend may change over the next couple of years as it is anticipated that population growth may decline due to migration patterns. New Zealand has had record numbers of citizens return to New Zealand as the COVID-19 pandemic continued to spread in other countries; migration from other countries has reduced significantly with no indication at this time when this trend will be reversed.

Medium term connection growth will be impacted by changes in unemployment numbers, the sharp reduction in the tourism industry and increased work from home practices with the knock-on effect an increase of unoccupied commercial space. On the other hand, it is expected that the government will continue to invest in infrastructure projects as well as social housing and Kiwi-Build. Infrastructure providers will need to be flexible and able to adjust quickly to market conditions in this uncertain environment.

## 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.

### 9.3.1 DESIGN AND BUILD PROCESS

Customers can initiate a connection request through several different channels, including our web portal, contact centre or by contacting our customer contracts team or their key account manager directly. Depending on the complexity of the proposed connection(s) the connection request will be managed by either our Connections Team (small / simple connections) or our Customer Projects Team (large / complex connections).

The Vector network is divided into two areas, each of which has a Field Service Provider (FSP) that are responsible for designing and building the network in their area required for a customer's connection. Small or simple connections are priced using agreed unit rates and the connection will always be built by the 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.

Vector's engineering teams have developed robust design standards to ensure that a safe and resilient network is built in accordance with legislative requirements. 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 CAPITAL CONTRIBUTION

Vector provide a standard electricity connection cost for new single-phase (60 Amp) connections in urban residential areas, where rock breaking is not required. The standard connection assessment criteria are published on our website.

All other electricity connections are considered non-standard and a price will be quoted on the design and build assessment.

Vector's Capital Contribution Policy requires customers to pay a capital contribution when any additions to the network are required to provide new or upgraded connection services. The amount of a capital contribution is determined by the cost that would be incurred by Vector from augmenting the network that Vector would not otherwise face 'but for' the new or upgraded connection.

These capital contributions take the form of an upfront one-off payment and will be netted off the value of new assets added to the Regulatory Asset Base (RAB) per the Input Methodologies. The current policy anticipates 100% contribution for all new consumer connection activity.

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 includes by way of example, 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. Examples include the proposed light rail line (Auckland Light Rail or ALR) from the city to the airport; Kāinga Ora's large-scale redevelopment of existing neighbourhoods; the Penlink access route project; electrification of buses and ferries as well as the development of several Data Centres and continuing investment related to Watercare, Auckland Transport, Auckland Council, universities and District Health Boards.

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.

As noted in the 2020 Electricity Asset Management Plan Update, under the Symphony strategy our network planning approach needs to go beyond traditional solutions to building solutions that are able to adapt and respond as time progresses. Our Symphony network planning approach starts with the customer and builds its understanding about the future electricity network from the bottom-up incorporating a mix of traditional infrastructure and new technologies best suited for each unique environment. This iterative process enables us to keep pace with the everchanging external environment and fast developing technologies.

### 9.3.4 CONNECTION OF CUSTOMER DISTRIBUTED ENERGY RESOURCES (DER)

One of our stated asset management objectives is to prepare the network for future changes that will include amongst others, the connection of customer DERs, which in essence means customers will partake in the future energy and technology choices. 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 two days and will review and approve (or decline if there is a reason), an application within ten 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.

### 9.3.5 CUSTOMER OPTIONS TO IMPROVE RESILIENCE

Some options, such as household solar and battery storage installations, and Vehicle-to-Home (V2H) electric vehicle technology, provide extra benefits. For example, they can off-set energy costs and provide carbon benefits. These new technologies increase resilience options for consumers and don't require investment in long life network assets. They provide households and businesses with greater control, have shorter financial returns that don't burden future generations and can provide consumers will direct resilience benefit.

Vector supports customers' uptake of DER and wherever possible assist them to understand the options available to them, and the necessary trade-offs should they take more direct action with respect to their energy resilience.

Customers now have a number of options available to them for improving resilience, thanks to existing and new technologies, whose costs are steadily reducing. These include:

- Mobile on-site generation
- Permanent on-site generation
- Renewable generation with on-site energy storage
- Battery energy storage
- Solar and battery storage solutions
- Innovative V2H solutions that use the energy stored in an electric vehicle, so customers can supply their home with energy during an unplanned outage.

## 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 FY21 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.

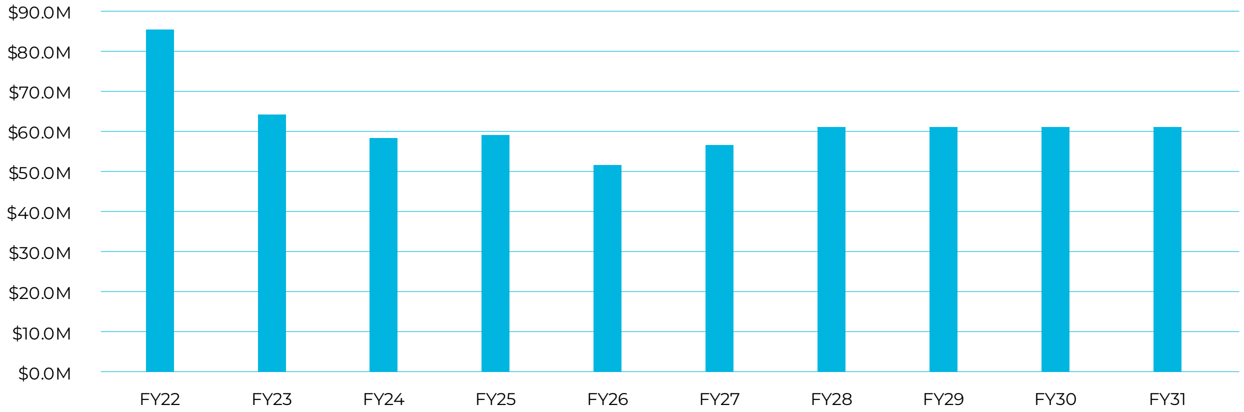



FIGURE 9-1: CUSTOMER CONNECTION EXPENDITURE FORECAST (GROSS)

**SECTION 10**

# Network growth and security

# 10 –Network growth and security

## 10.1 Overview

This chapter 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. Our approach to network development aligns with the objectives of Vector's Symphony strategy by balancing investment in traditional network assets with investment in digital, decentralised and distributed alternatives in response to the decarbonisation of the economy and the electrification of transport.

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, planning for the future is implicitly also about understanding 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 these uncertainties 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 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 reality 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 10.1 and 10.2)
- security of supply and power quality standards (Section 10.3 and 10.4)
- our approach to network planning, including (Section 10.5):
  - 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
- the impact of COVID 19 on network demand (Section 10.6)
- finally, the major investment in security and growth projects to address identified constraints and demand growth are described (Section 10.7).

## 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 and Environment | • Complying with relevant legislation, regulation and planning requirements<br>• Proactively adapt the network to allow and prepare for the growing impact of climate change. |
| Customers and Stakeholders | • Manage the increasing uncertainty due to the unpredictability of the timing of large customer projects and the rate of our customers' adoption of climate change and carbon emission mitigation technologies.<br>• Ensure a secure, resilient and reliable network to meet present and future demand.<br>• Enable customers' future energy and technology choices.<br>• Ensure the long term interest of our customers by providing an affordable and equitable network.<br>• Manage the risk of overbuilding the network, which could result in stranded assets. |
| Network Performance & Operations | • Utilise clear business cases processes, integrate risk management and complete post investment reviews to inform our decision making and analysis.<br>• Maintain compliance with Security of Supply Standards through risk identification and mitigation.<br>• Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice.<br>• 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:<br>– technology: DER's, electric transportation, increased active customer participation/customer choice, dynamic ratings, etc.<br>– environment: climate change including decarbonisation of the economy.<br>• Prioritise network flexibility to meet customer changing needs.<br>• Enable consumption of energy on the customers' terms and facilitate customer adoption of new technology.<br>• Improve our knowledge of, and ability to control, the LV network (grid edge) and management of the information required. |

TABLE 10-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

## 10.3 Strategies to achieve the objectives

To meet the network objectives, the following strategies are employed by Vector. As electricity networks are complex interconnected systems, each strategy addresses multiple objectives.

### 10.3.1 UNDERSTAND FUTURE TRENDS FOR LONG TERM PLANNING

Auckland continues to be a city of rapid growth, with an increase in customer density in the older parts of the network and new developments on the fringes, as well large-scale infrastructure developments such as City Rail Link. At the same time, there is a focus on the decarbonization of our economy, supported by continued uptake in electric vehicles and electrification of industry, as well as uptake of distributed energy resources (DERs) and energy efficiency technologies. As a result, the electricity demands in Auckland are very dynamic and understanding and predicting these changes is key to our network planning strategy.

Our integrated Symphony planning process uses a Customer Scenario Model to forecast these trends and their impact on our network, to gain a clearer understanding or predictions of the future energy demand out to 2050. 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 historical customer usage trends and changes to customer behaviour, as well as through consultation with stakeholders. 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 10.5.

### 10.3.2 COMPLY WITH RELEVANT REGULATIONS AND STANDARDS

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

Our SoSS, detailed in this section, set the standards and requirements for network planning. 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. 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 a Customer Scenario Model and Database to identify any short-term capacity constraints on any of our assets that would result in a breach of our SoSS. The model uses information from our customers to provide information on demand and how it is changing, which is then overlaid on our Network Connectivity model to identify where we see capacity shortfalls over the next 10- year period. 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.

### 10.3.3 APPLY A FUTURE FOCUSED APPROACH TO NETWORK DEVELOPMENT

To meet increased network demands and meet our SoSS, we typically have looked solely at projects that increase the capacity of existing assets or that 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, we are now focused on being more diverse in our approach to network planning. Our new approach promotes a lower cost, smarter, more decentralised but more connected network, rather than potentially overcapitalizing in projects that could result in or creating stranded assets.

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;
- and risk based scenario models
- 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 optimisation;
- Use of data analytics and advanced operational practices;
- Non-network solutions such as demand side management strategies 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.

### 10.3.4 DEMAND MANAGEMENT AND OUR DISTRIBUTED ENERGY RESOURCE MANAGEMENT SYSTEM (DERMS)

We are actively enabling the new energy future through our use of demand management and our DERMS to control and manage Distributed Energy Resources (DERs). The DERMS is an integrated platform that enables Vector to manage a large fleet of geographically distributed energy resources (DERs) as a single system. Demand management enables Vector to remotely control when specific loads are turned on to manage the demand on the network. 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.

## 10.4 Planning criteria for network development

### 10.4.1 SECURITY OF SUPPLY STANDARDS

Vector uses a probabilistic approach to setting security of supply standards (SoSS). These are based on 7 categories, classified according to subtransmission, distribution and CBD or non-CBD, as shown in Table 10-2 below.

#### 10.4.1.1 SECURITY OF SUPPLY STANDARDS

| CLAUSE | CATEGORY | STANDARD |
|---|---|---|
| 1 | CBD substation and subtransmission | N-1: 100 percentile demand (no interruption)<br>N-2: 100 percentile demand restored in 2 hours |
| 2 | Zone substations (non-CBD) | N-1: 100 percentile demand restored in 2.5 hours (urban), 4.5 hours (rural).<br>This requirement to be met for 95 percentile of the year for primarily residential substations and 98 percentile of the year for primarily commercial substations |
| 3 | CBD distribution feeders, 11 kV or 22 kV | Demand restored to all but a single distribution substation in 2.0 hours. Remainder restored in repair time |
| 4 | Distribution feeders (non-CBD), 11 kV or 22 kV | Primarily underground: demand restored to all but 800 kVA within 2.5 hours (urban). Remainder restored in repair time<br>Primarily overhead: Demand restored to all but 2.5 MVA within 2.5 hours (urban) and 4 hours rural. Remainder restored in repair time |
| 5 | Distribution substations (11 kV/400 kVA) | Restored within repair time |
| 6 | Distribution feeders (400 V) | Restored within repair time |
| 7 | Subtransmission and zone substations | Spatial separation of primary network assets sufficient to avoid common mode failure |

TABLE 10-2: SOSS

## 10.5 Power quality

Vector delivers supply voltages as required under the Electricity (Safety) Regulations 2010. Maintaining the network so it operates within the permissible range is proving increasingly challenging. Local distributed generation (for example, solar PV) is pushing the network voltage beyond the upper levels, while winter demand is testing the lower threshold.

Without access to customer smart-metering data, Vector has taken two approaches to managing power quality. Firstly, we have installed power quality meters (PQMs) at a number of our zone substations to monitor the network and secondly, we take a reactive approach to investigate any incidents identified by customers. Vector has an active programme to install PQM meters at all its zone substations.

Vector has installed PQMs to primarily baseline and trend harmonic[5] levels on the network. Variable speed drives and power electronics create harmonics on the network and while they have been used by industry for a long time, we are interested in monitoring and understanding the impact of power electronics operating at the residential level, particularly inverters associated with solar PV, electric vehicle and battery charging. This enables Vector to proactively address any power quality issues identified.

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 10% of the nominal voltage
- AS/NZS 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

## 10.6 Network planning process

This section describes the network planning process by starting with customer needs and how it is used to identify constraints and potential solutions to meet our Security of Supply Standards, Quality Standards and Power Quality requirements.

### 10.6.1 OVERVIEW

To face the challenges of rapid customer transformation and heightened uncertainty (Sections 10.6.2, 10.6.3 and Section 6), Vector has defined its integrated Symphony planning approach. Symphony planning starts with the customer and builds its understanding about the future electricity network bottom-up. The advantage is that locational differences are reflected and can inform options analysis. Also, new customer behaviour and technology adoption can be observed and considered in the planning process before exponential uptake make them rapidly mass market, therefore, allowing for more foresight and preparedness in the planning process, as well as more active customer engagement. Finally, options analysis is expanding to consider not only wire solutions (e.g. cables, lines, transformers) which continue to serve us well, but also innovative non-wire solutions (e.g. smart hot water control, batteries, smart EV charging). In the context of heightened uncertainty, non-wire solutions offer additional interesting benefits: they are less intrusive in road corridors and heavy engineering works are reduced (i.e. a smaller public works footprint 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.

[5] 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

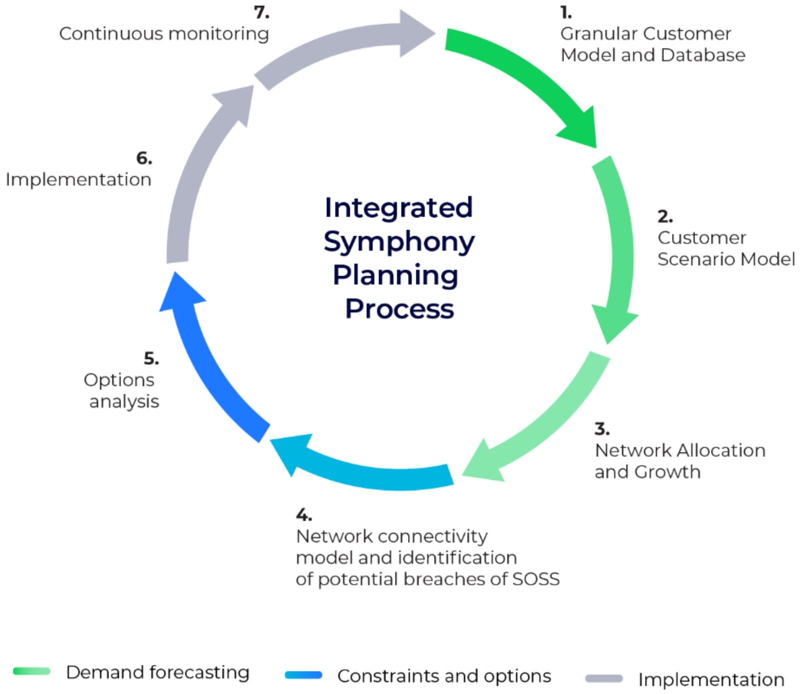



FIGURE 10-1: STEPS IN INTEGRATED SYMPHONY PLANNING PROCESS

The planning process is initiated by an annual assessment of the peak loading on all distribution feeders and zone substations. This reassesses the summer and winter 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.

### 10.6.2 DEMAND FORECASTING

The first three steps of the network planning 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[6].

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, distributed solar PV and battery energy storage systems, electric vehicles, water heating load and gas-to-electricity conversion. Non-wire alternatives that can be managed via DERMS 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 10-2 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 Auckland Forecasting Network.

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

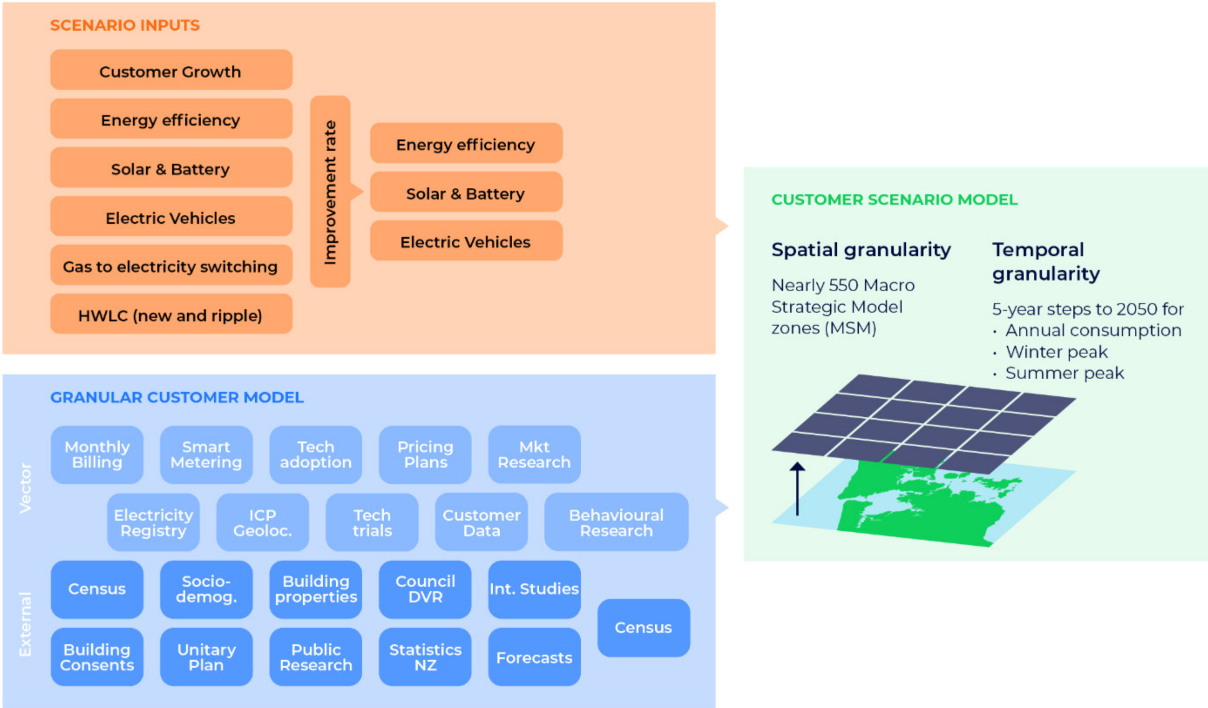



FIGURE 10-2: OVERVIEW OF CUSTOMER SCENARIO MODEL

**Network Allocation and Growth (Step 3)** allocates the results from the Customer Scenario results to the electricity network assets. The asset future loading for distribution feeders and zone substations is then computed by adding the allocated incremental customer scenario results based on network topology to the present asset loading of zone substations, taking diversity into account. Customer-level smart meter data is essential to link the Customer Scenario results to network assets. The present asset peak loading is established based on preceding years and normalization for abnormal network configurations. The final step to create the base network demand forecast involves adding in non-standard or large customer projects such as known large housing developments, a new factory or data centres.

### 10.6.3 CONSTRAINTS AND OPTIONS

Steps four and five of the planning process identify the network constraints caused by the demand forecast and develop solutions. The constraints and options are identified through a sub-process as shown in the diagram below.

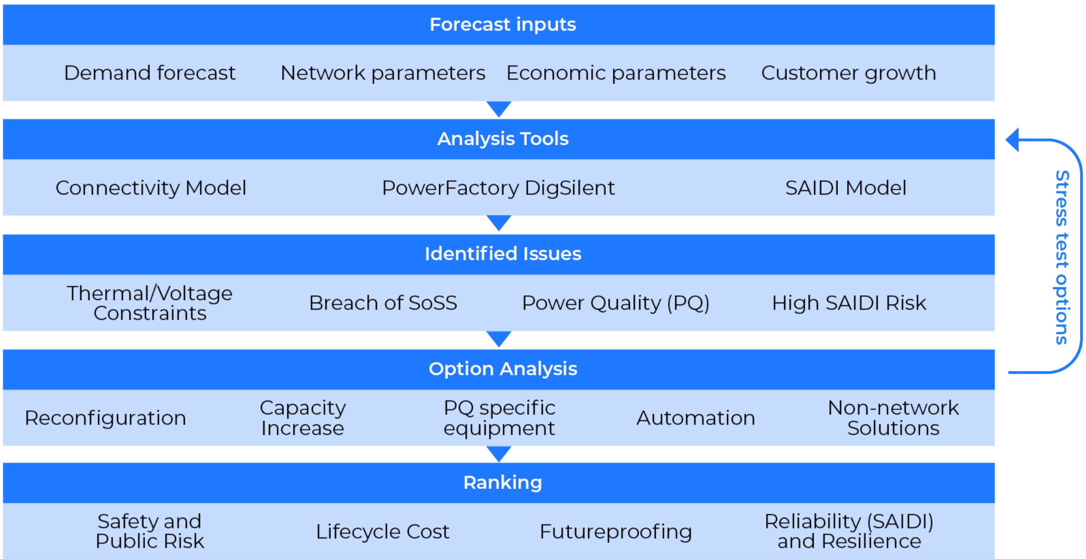



FIGURE 10-3: CONSTRAINTS AND OPTIONS PLANNING PROCESS

The **Network connectivity model (Step 4)** uses the demand forecast to identify where and when capacity shortfalls, resulting in a breach of our SoSS, 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. If more detailed analysis on network loading is required, we will run power flow simulations (using Digsilent PowerFactory modelling software) to identify thermal and voltage breaches and stress-test options that have been identified.

Once the type, location and timing of a constraint is identified**, Options Analysis (Step 5)** is undertaken to identify and evaluate the best solution. In line with our data strategy and business intelligence platforms, Vector employs a data driven approach using number of analytical tools and visualizations to assist with identifying the demand, network constraints and benefits of different options.

With the change in customers' behaviours' and needs, the current and future advancement of technologies and the attention to carbon emissions, we are now focused on being more diverse in our options identification. 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.

As shown in the diagram above, a full suite of options is developed. These include traditional network solutions such as:

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

In addition, non-network solutions are also considered as they can defer or prevent the need for major investment, provide flexibility not available from traditional network solutions, improve asset utilisation and reduce cost. Non-network solutions also help Vector transition the network to meet expected future energy requirements, such as increasing penetration of DERs, especially solar PV and electric vehicles. This transition is supported by the recent report from the Climate Change Commission[7]. Solutions typically considered 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 on-premises (customer) solutions
- Load control e.g. hot water
- 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 (initial investment plus ongoing operational costs), reduction to network risk and ability to meet performance requirements.

[7] https://www.climatecommission.govt.nz/get-involved/our-advice-and-evidence

### 10.6.4 IMPLEMENTATION

The final steps of the process are implementing the project and then ongoing monitoring to ensure it is achieving the intended outcomes.

**Implementation (Step 6)** involves, for both network and non-network 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
- Sustainable Development

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

## 10.7 Monitoring the long-term impact of the Covid-19 pandemic

Like many of our customers, we needed to learn to rapidly adapt to the new realities resulting from the COVID-19 pandemic. We have closely monitored the immediate impact on demand and consumption, and the projections on economic growth. Most importantly, from a planning perspective, will be to understand the long-term persistence of new societal use and behavioural patterns to define how transformational events like COVID-19 will be. In particular, understanding how the future use of CBD office space will change, how sustained changes will be, and how the growth of e-commerce and e-business models will impact businesses in the long term.

Given that this pandemic is a truly unprecedented event with no evidence in recent history to learn from, predictions about the changes to businesses and the resulting electricity demand are highly speculative. However, the pandemic and the resulting economic recovery certainly increase uncertainty about where and when the network will grow. To ensure that we build what is needed for our customers, our planning response to Covid-19 involves close and frequent monitoring of customer and demand data, while continuously re-evaluating risks and investments from our 10-year plans.

In the short term, load and demand changes experienced in the CBD stand out as different compared to other network areas. We have observed that demand and consumption outside the CBD have bounced back to pre-COVID levels after heightened Alert Levels, so called 'lockdown' periods, ended. However, the CBD impact has been more pronounced and recovered much slower, barely reaching pre Covid-19 levels by the end of 2020.

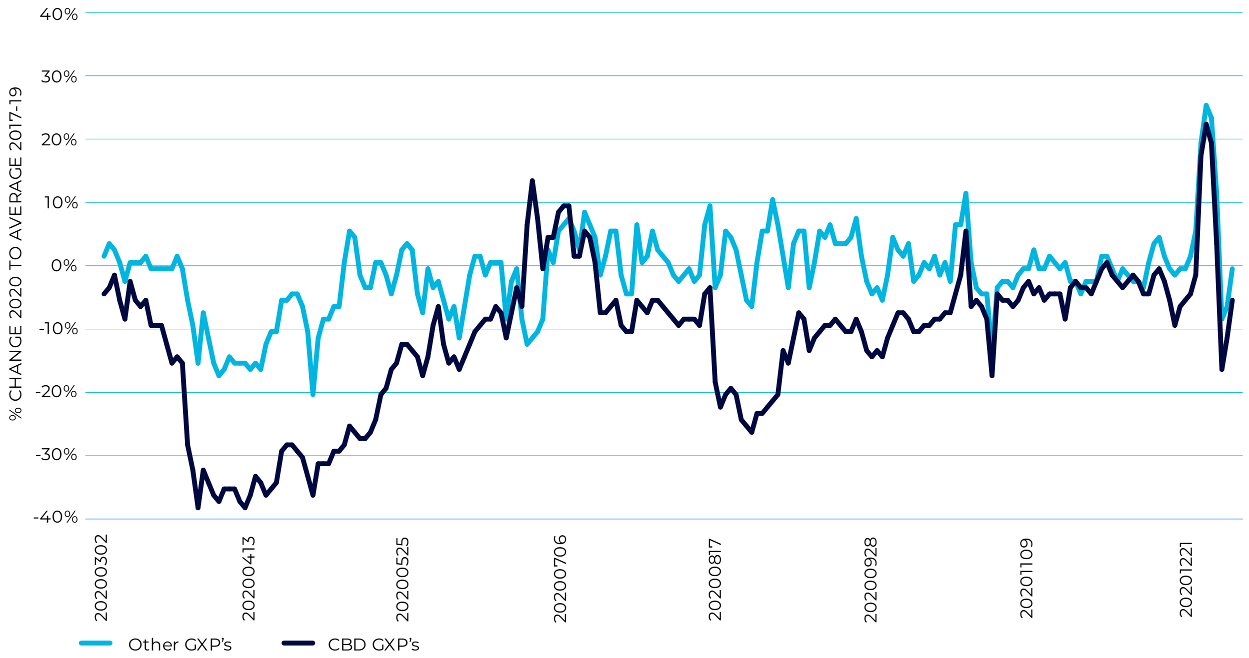



FIGURE 10-4: DAILY CONSUMPTION DURING WEEKDAYS (MON-FRI) FOR CBD GXPS AND OTHER GXPS IN AUCKLAND FOR 2020 AND AVERAGE OF 2017-2019

While this trend may allude to some long-term changes that we will continue to monitor, it does not impact our CBD investments planned for the next two years, which are required independently of changes to loading. The following CBD projects therefore remain key investments to support Auckland:

- two new 22 kV Liverpool feeders that are required for the CRL station supply
- Installation of cable ducts to gain synergies from the CRL and road development projects currently underway in the Auckland CBD.

We will continue to closely monitor the demand forecast for the CBD to assess the COVID recovery and will amend any demand related investments as needed. The course of the next two years provides us time to identify the longer-term trends as business and the community return to a normal situation.

## 10.8 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.

To effectively manage investment planning, the network has been divided into geographical areas based on existing GXPs at the top level and then building from the top down to each ZSS supplied from the respective GXP. Where a new GXP is forecast to be needed in the future a separate plan is provided for the new GXP and the ZSSs planned to be supplied from the GXP. 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 Security and Growth Appendix.

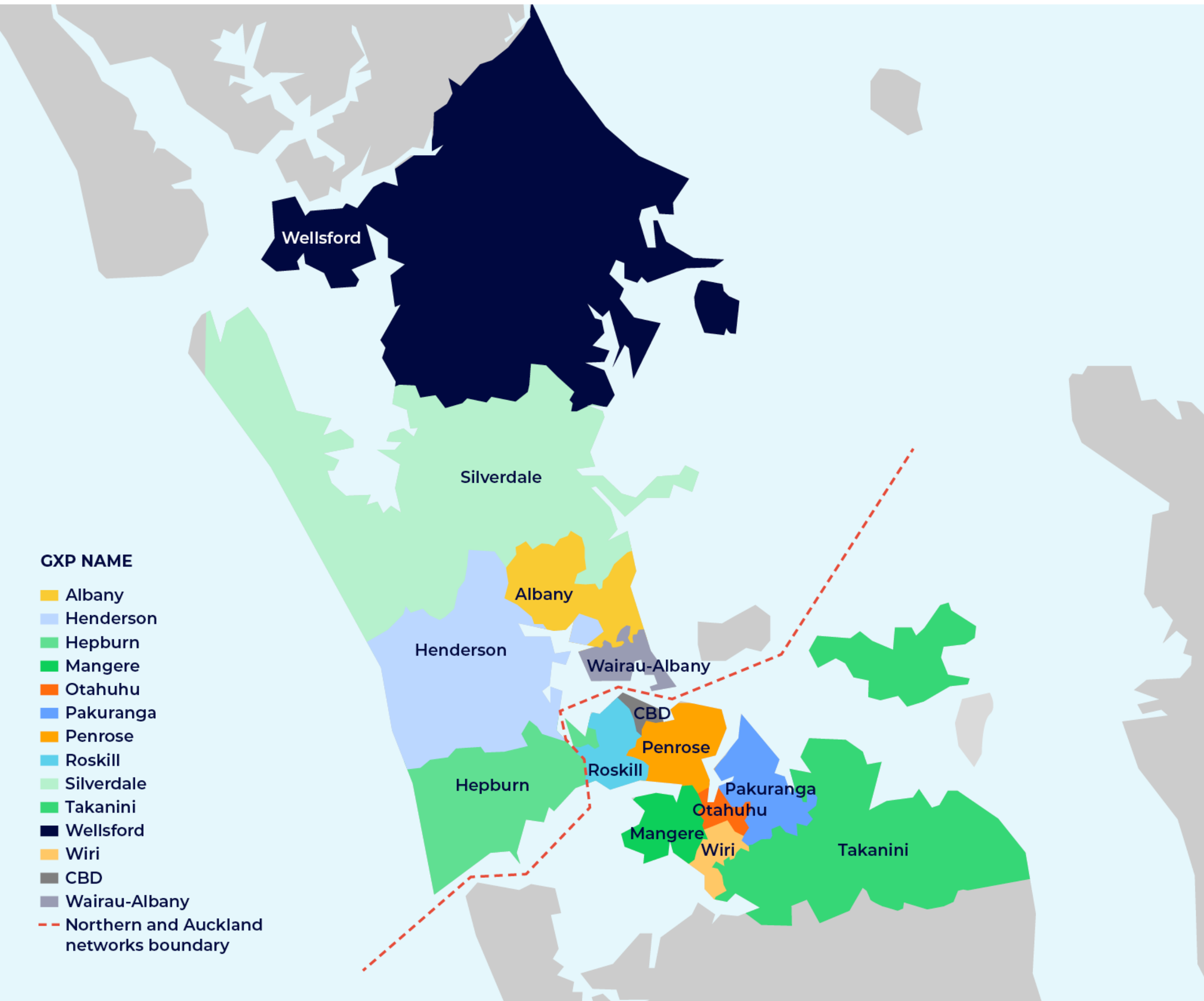



FIGURE 10-5: NETWORK PLANNING AREAS

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.

Figure 10-6 shows the forecast peak winter demand across Vector's network to 2050[8]. The 'Base' case shows the expected increase in peak demand without any non-network solutions. The 'Potential' case incorporates the outcome of the expected highest benefit achieved through distributed energy resources and non-network solutions. The inflection point around 2025 shows a significant increase in demand as Auckland growth continues and electrification of transport accelerates. This highlights the importance of the next 5 years to trial, develop and implement plans to meet the challenges ahead around integrating customer-side technologies.

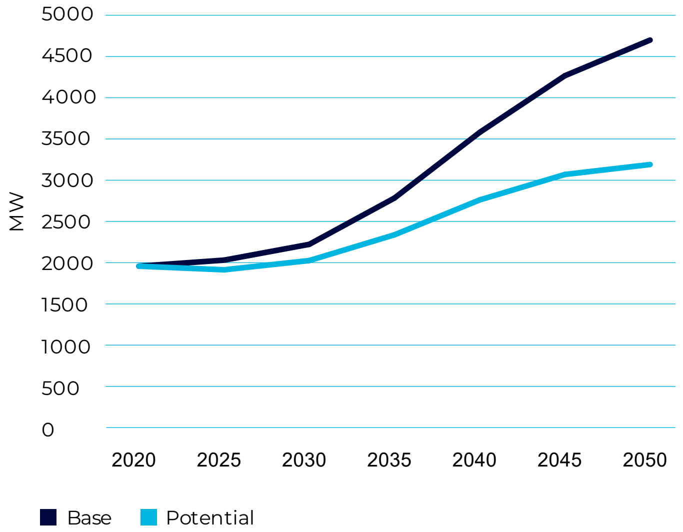



FIGURE 10-6: WINTER PEAK DEMAND TO 2050

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 RY22 through to RY31.

## 10.8.1 WELLSFORD PLANNING AREA

### 10.8.1.1 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 three existing zone substations at Wellsford, Warkworth and Snells Beach, with a fourth zone substation under construction at Omaha. The sub transmission 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 soon to be completed Puhoi to Warkworth motorway 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, including a confirmed new large customer. As a result, the number of ICPs is forecast to grow from 16,000 at present to 25,000 over 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.

[8] Vector's network experiences its highest demand during the winter peak. Therefore, the network must be designed to support this peak load.

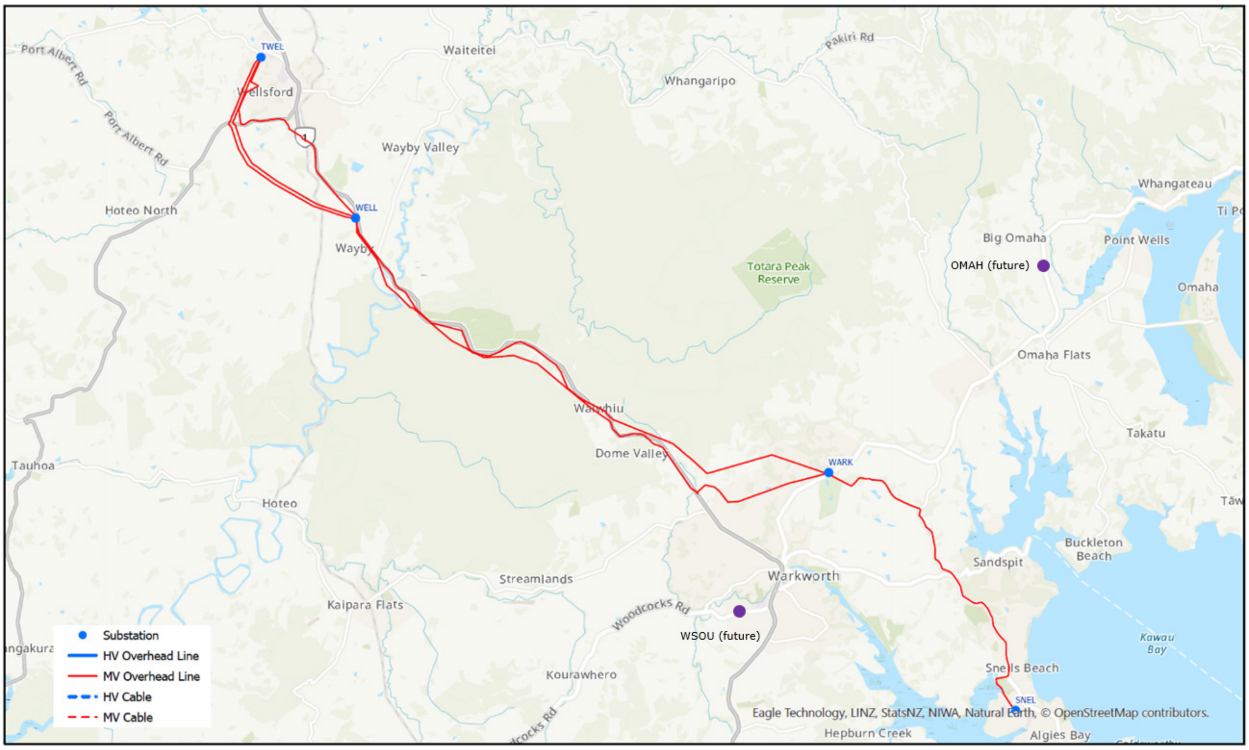



FIGURE 10-7: WELLSFORD SUBTRANSMISSION NETWORK

### 10.8.1.2 SUBTRANSMISSION

Recent Transmission Planning Reports from Transpower have identified the Wellsford GXP is at its N-1 security limit. Vector's demand reduction and optimization at distribution level will enable Transpower to defer investment to upgrade the GXP security to later in the AMP period.

As shown in Figure 10-7, 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 a single 33 kV overhead circuit supplies a single transformer at Snells Beach 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 can prove 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 security of supply standard capacity in 2022. To address this constraint, Vector plans to install 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 will be installed in the ducts.

The long term 30-year forecast is for the greater Warkworth demand to reach 49 MVA if all non-network and demand management solutions are implemented, and up to 82 MVA if there is no demand management. Due to this forecast growth, the long term area plan is to establish a new zone substation to the west of Warkworth and another at Mahurangi to the north 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 will be designed for 110 kV cables.

In accordance with Vector's Symphony strategy, steps have been taken to use non-network solutions to reduce the peak demand on the existing subtransmission circuits, 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 ( 2.0 MW / 4.8 MWh) to flatten the demand profile, and a new project is planned to increase the use of load control in greater Warkworth to further flatten the demand profile.

### 10.8.1.3 ZONE SUBSTATIONS

Wellsford GXP supplies three ZSSs: Wellsford (2 transformers), Warkworth (3 transformers) and Snells Beach (single transformer). A fourth ZSS Omaha (single transformer initially) is under construction and expected to be commissioned in 2022 at Big Omaha, which is centrally located between the townships of Leigh, Omaha and Matakana.

Warkworth ZSS, Snells Beach ZSS and the new Omaha ZSS will operate as a combined group providing inter zone substation security. In assessing the ZSS security for the purposes of this AMP it is assumed new Omaha ZSS has been completed.

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

The table below shows that Omaha and Snells Beach are expected to exceed their Security of Supply Standards in 2029 and 2027, respectively. The current plan is to install a second transformer by 2027 at Snells Beach and redistribute the load between the group of three substations.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Omaha | RES | | 6.8 | 6.8 | 6.8 | 6.8 | 6.9 | 6.9 | 6.9 | 7.0 | 7.3 | 7.5 |
| Winter | Snells Beach | RES | 8.1 | 8.2 | 8.3 | 8.4 | 8.5 | 8.7 | 8.8 | 9.0 | 9.1 | 9.5 | 9.9 |
| Winter | Warkworth | RES | 21.9 | 15.7 | 16.1 | 16.5 | 17.3 | 18.1 | 18.9 | 19.7 | 20.5 | 22.6 | 24.8 |
| Winter | Wellsford | RES | 8.3 | 8.8 | 8.8 | 8.7 | 8.8 | 8.9 | 9.0 | 9.1 | 9.2 | 9.7 | 10.1 |

TABLE 10-3: WELLSFORD LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.1.4 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-network solutions. The new Omaha ZSS (refer to the zone substation section above) will increase distribution feeder capacity to serve the greater Matakana, Leigh, and Omaha areas and, by shortening the feeder lengths, improve the quality of supply and reliability performance to these areas.

In addition, Vector has installed a 1.149 MW / 1.254 MWh BESS at Tapora to provide improved quality of supply to the Tapora Peninsula, an emerging avocado growing area currently supplied by a long spur feeder.

New voltage regulators in Matakana and Sandspit will improve power quality and resolve backstopping constraints.

A new zone substation (Kaukapakapa ZSS) on the southern boundary has provided significant feeder backup capacity on the Kaipara Flats feeders and further opportunities for quality of supply improvements.

### 10.8.1.5 CONSTRAINTS AND NETWORK REINFORCEMENT

The following network reinforcement projects are planned for this area.

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Subtransmission circuits to Warkworth breaching SoSS in 2022 | Warkworth load control<br>Implement hot water load control to reduce peak demand and defer major subtransmission upgrades | FY22-23 | 4.40 |
| New reticulation supply is required for new residential developments. A new road is being constructed which also needs lighting. | Matakana Link Road reinforcement<br><br>Ducts will be installed during the construction of the road to futureproof the Wellsford – Warkworth subtransmission SoSS circuits (2029) and for immediate 11 kV feeder. | FY22 | 0.73 |
| Low voltage on Matakana feeder on loss of the single transformer Omaha zone substation | Matakana voltage regulator | FY22 | 0.35 |
| Future constraints on the 33 kV and 11 kV networks (post 2031) | land procurement for a future 33/11 kV Mahurangi ZSS and 110/33 kV bulk supply substation | FY22 | 1.00 |
| High SAIDI on Whangateau and Matakana feeder spur circuits. Warkworth ZSS is heavily loaded. | Omaha Zone Substation<br>Establish a new ZSS at Omaha and rebalance network load | FY22 | 3.19 |
| High SAIDI on Omaha and Matakana feeder spur circuits | SAIDI Initiative - Omaha Tawharanui link.<br>Providing interconnection of two spurs to establish backstop capability. | FY22 | 0.75 |
| High SAIDI on Tomarata and Te Hana feeder spur circuits | Tomarata 11 kV feeder SAIDI link<br>Providing interconnection of two spurs to establish backstop capability. | FY22 | 0.81 |
| Wellsford – Warkworth subtransmission SoSS breached by 2029. | SH1 Dome Valley future proof ducts<br>Construction of 110 kV rated ducts to align with SH1 redevelopment and minimize cost and public disruption. | FY23 | 9.93 |
| Snells Beach ZSS breaches transformer capacity by 2028 | Snells Beach Second transformer | FY27 | 1.80 |
| Omaha ZSS breaches ZSS SoSS by 2030 | Snells Beach Second transformer | FY29 | |

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Wellsford – Warkworth subtransmission security breaches SOSS by 2029 | Wellsford-Warkworth 33 kV upgrade | FY29 | 11.50 |
| Wellsford – Warkworth subtransmission breaches SOSS by 2029 | Warkworth Matakana Rd subtransmission duct.<br>A continuation of the ducts planned for installation along State Highway One (SH1). Will be implemented in FY29 as this section of road is not part of a roads upgrade project, so there is no benefit to bringing forward construction. | FY29 | 3.00 |
| Wellsford – Warkworth subtransmission breaches SOSS by 2029 | Wellsford 33 kV switchgear replacement. Related to the Wellsford-Warkworth subtransmission upgrade | FY29 | 2.40 |
| Warkworth area transformer capacity security breaches by 2032 | New Warkworth South Zone Substation | FY32 | Note 1 |

TABLE 10-4: WELLSFORD CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

Note 1: the total capital investment for the new Warkworth South ZSS is $12.0M, but only $7.75M falls within this amp period.

## 10.8.2 SILVERDALE PLANNING AREA

### 10.8.2.1 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. 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 to allow for a planned population increase of 12,000 over the 10-year AMP period. The Unitary Plan forecasts 5,800 new residential ICPs plus industrial and commercial growth, which will increase demand by 18 MW (excluding major customers) over the next 10 years.

Significant new land is available for commercial and industrial development with one new large customer identified.

To meet the growing electricity demand primarily due to population growth, a new zone substation at Kaukapakapa has just been commissioned and upgrades are in progress at Orewa ZSS substation and at Spur Road ZSS.

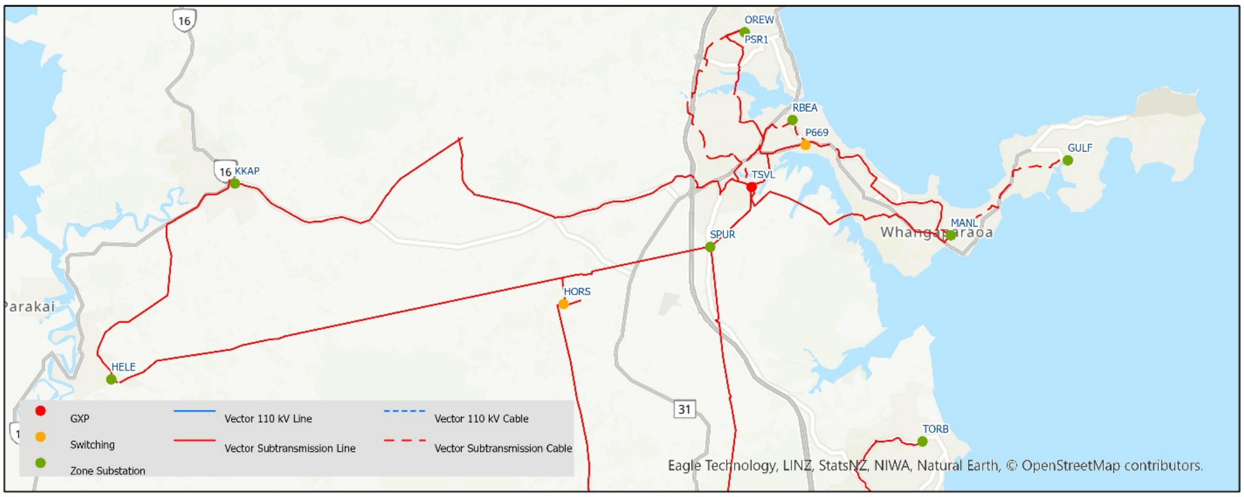



FIGURE 10-8: SILVERDALE SUBTRANSMISSION NETWORK

### 10.8.2.2 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 under normal operating conditions (N) in 2030, and in the case where a subtransmission line is out of service (N-1), the constraints will occur in 2024 and 2029 if the Silverdale – Red Beach line or the Silverdale – Manly line are out of service, respectively. To resolve these constraints, Vector has identified the need to establish a new zone substation at Millwater.

#### 10.8.2.3 ZONE SUBSTATIONS

Silverdale GXP supplies five two-transformer ZSSs at Helensville, Manly, Red Beach, Orewa and Spur Road (2nd transformer to be commissioned prior to winter 2021). 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, plus a major customer facility in construction. Vector has a suitable site and associated subtransmission ducts.

There are no constraints identified at any of the zone substations.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SEASON** | **ZONE SUBSTATION** | **SOSS CATEGORY** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** |
| Winter | Gulf Harbour | RES | 8.7 | 8.7 | 8.7 | 8.7 | 8.8 | 8.9 | 9.0 | 9.1 | 9.2 | 9.7 | 10.1 |
| Winter | Helensville | RES | 9.4 | 9.3 | 9.3 | 9.3 | 9.4 | 9.6 | 9.7 | 9.8 | 9.9 | 10.4 | 10.8 |
| Winter | Kaukapakapa | RES | 4.4 | 5.4 | 5.4 | 5.4 | 5.5 | 5.6 | 5.7 | 5.8 | 5.9 | 6.2 | 6.4 |
| Winter | Manly | RES | 19.3 | 19.2 | 19.1 | 19.0 | 19.2 | 19.4 | 19.5 | 19.7 | 19.9 | 20.7 | 21.5 |
| Winter | Orewa | RES | 17.9 | 18.6 | 19.3 | 20.0 | 20.8 | 21.7 | 22.6 | 23.5 | 24.4 | 26.2 | 28.0 |
| Winter | Red Beach | RES | 20.4 | 22.4 | 22.5 | 23.5 | 24.8 | 26.0 | 27.2 | 28.5 | 29.7 | 31.6 | 33.6 |
| Winter | Spur Road | RES | 13.5 | 13.2 | 15.5 | 17.0 | 18.6 | 20.2 | 21.8 | 23.4 | 24.9 | 27.5 | 30.0 |

TABLE 10-5: SILVERDALE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

#### 10.8.2.4 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. Two projects (Northern SAIDI Initiative Makarau and South Head voltage regulator) have been established to address these reliability and voltage issues.

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 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.

#### 10.8.2.5 CONSTRAINTS AND NETWORK REINFORCEMENT

The following network reinforcement projects are planned for this area.

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Poor reliability and power quality performance at Kaukapakapa | Northern SAIDI Initiative Makarau | FY22 | 0.35 |
| Low voltages (poor power quality) in the South Head area | South Head voltage regulator | FY23 | 0.35 |
| Insufficient security of supply on the Whangaparaoa peninsula | PenLink 11 kV reinforcement | FY23 | 0.30 |
| Forecast breach of SoSS on the subtransmission network under N and N-1 scenarios as well as constraints on the distribution network | Millwater Zone Substation | FY22 | 3.00 |

TABLE 10-6: SILVERDALE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

### 10.8.3 HENDERSON PLANNING AREA

#### 10.8.3.1 OVERVIEW

The Henderson area is one of the major growth areas in the Auckland region, with large population growth of 39,000 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 15,000 net additional dwellings and an approximate additional load of 30 MW over the next 10 years.

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.

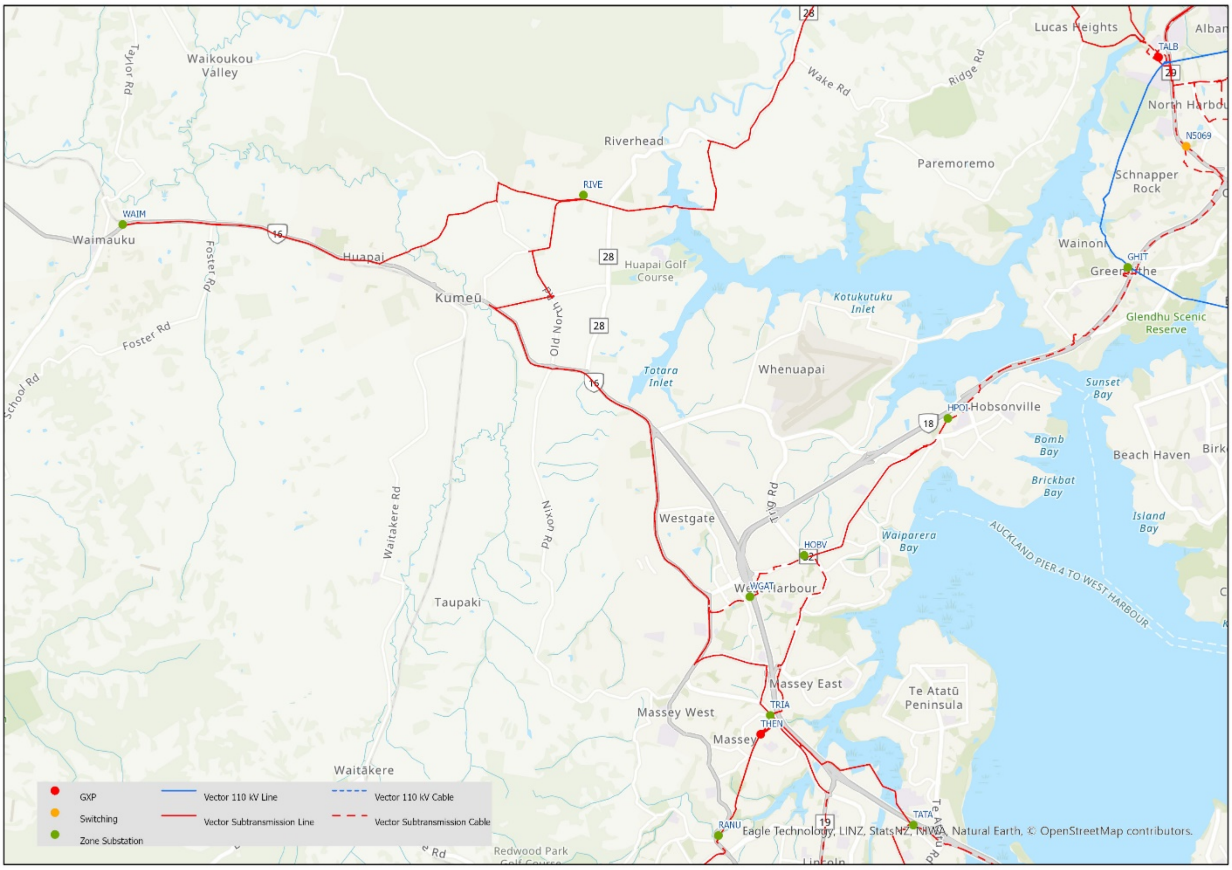



FIGURE 10-9: HENDERSON SUBTRANSMISSION NETWORK

### 10.8.3.2 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 2023 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 (discussed in section 10.8.5 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 therefore, 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 South 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.

### 10.8.3.3 ZONE SUBSTATIONS

Henderson GXP supplies 10 zone substations of which 4 are single-transformer ZSSs, namely Simpson Road, Swanson, Ranui, and Woodford and 6 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), Simpson Road ZSS (2024) and Swanson ZSS (2030). As these three 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.

Demand growth and a new major customer connection are driving an emerging constraint in Whenuapai. The preferred solution is to construct a new zone substation at Whenuapai and another at Redhills to provide the required capacity and defer capacity upgrades at Waimauku and Riverhead ZSS.

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

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Greenhithe | RES | 11.0 | 11.9 | 11.9 | 11.9 | 12.0 | 12.1 | 12.2 | 12.3 | 12.4 | 12.9 | 13.3 |
| Winter | Hobsonville | RES | 12.8 | 14.2 | 15.6 | 17.0 | 18.5 | 21.4 | 23.3 | 25.1 | 26.0 | 27.0 | 28.0 |
| Winter | Hobsonville Point | RES | 15.7 | 18.1 | 20.5 | 22.9 | 25.1 | 25.6 | 27.5 | 29.3 | 30.6 | 32.4 | 34.2 |
| Winter | Ranui | RES | 11.7 | 12.2 | 12.6 | 13.0 | 13.7 | 14.3 | 14.9 | 15.6 | 16.2 | 17.3 | 18.4 |
| Winter | Riverhead | RES | 11.8 | 12.0 | 12.2 | 12.4 | 12.8 | 13.3 | 13.7 | 14.1 | 14.6 | 16.0 | 17.4 |
| Winter | Simpson Road | RES | 5.8 | 5.8 | 5.9 | 5.9 | 6.0 | 6.0 | 6.1 | 6.2 | 6.2 | 6.5 | 6.7 |
| Winter | Swanson | RES | 11.6 | 11.6 | 11.6 | 11.6 | 11.7 | 11.8 | 11.9 | 12.0 | 12.1 | 12.6 | 13.0 |
| Winter | Te Atatu | RES | 21.8 | 21.8 | 21.7 | 21.7 | 21.9 | 22.1 | 22.4 | 22.6 | 22.8 | 23.7 | 24.6 |
| Winter | Triangle Road | RES | 15.4 | 15.6 | 17.0 | 18.3 | 19.9 | 16.1 | 16.3 | 16.5 | 16.8 | 17.5 | 18.2 |
| Winter | Waimauku | RES | 15.8 | 15.8 | 15.7 | 15.7 | 15.9 | 16.0 | 16.2 | 16.4 | 16.5 | 17.3 | 18.2 |
| Winter | Westgate | COM | 10.5 | 11.3 | 13.3 | 15.3 | 17.4 | 14.2 | 15.0 | 15.9 | 16.7 | 17.9 | 19.1 |
| Winter | Woodford | COM | 8.3 | 8.3 | 8.3 | 8.3 | 8.5 | 8.6 | 8.7 | 8.9 | 9.0 | 9.4 | 9.9 |

TABLE 10-7: HENDERSON LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.3.4 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.

There are two confirmed and two prospective major customer sites are in planning that have been incorporated into the demand forecast and constraints identification process.

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.

### 10.8.3.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Waimauku ZSS security breach and feeder SAIDI improvement | Northern Muriwai SAIDI improvement Initiative | FY22 | 0.80 |
| Project coordinated with NZTA roadworks | SH16 to Waimauku future proofing ducts | FY23 | 1.64 |
| Simpson ZSS, Ranui ZSS and Swanson ZSS zone substation security | Swanson 2nd transformer | FY26 | 1.80 |
| Waimauku backstop shortfall; Whenuapai 11 kV feeder capacity; Whenuapai major customer | Whenuapai Zone Substation land purchase | FY26 | 1.50 |
| Waimauku backstop shortfall; Whenuapai 11 kV feeder capacity; Whenuapai major customer | New Whenuapai ZSS | FY30 | 16.25 |
| Constraints on the 11 kV distribution network in the Redhills area | Redhills Zone Substation land purchase | FY28 | 1.2 |
| SOSS breaches under both N and N-1 conditions on the Henderson to Hobsonville, Hobsonville to Hobsonville Point, and Henderson to Westgate subtransmission lines. | Albany-Greenhithe subtransmission upgrade (refer to Albany planning area) | FY29 | Note 1 |
| Constraints on the 11 kV distribution network in the Redhills area | New Redhills Zone Substation | FY33 | Note 2 |

TABLE 10-8: HENDERSON CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

Note 1: the cost is $1.5M and is included in the Albany planning area expenditure forecast.

Note 2: the total capital investment for the new Redhills ZSS is $12.0M, but only $0.5M falls within this AMP period.

## 10.8.4 HEPBURN PLANNING AREA

### 10.8.4.1 OVERVIEW

The Hepburn area extends from Te Atatu and Ranui to New Lynn, extending out to the west coast. Relatively low growth is forecast except for pockets of re-development around the old Brickworks site in New Lynn and the Sabulite areas.

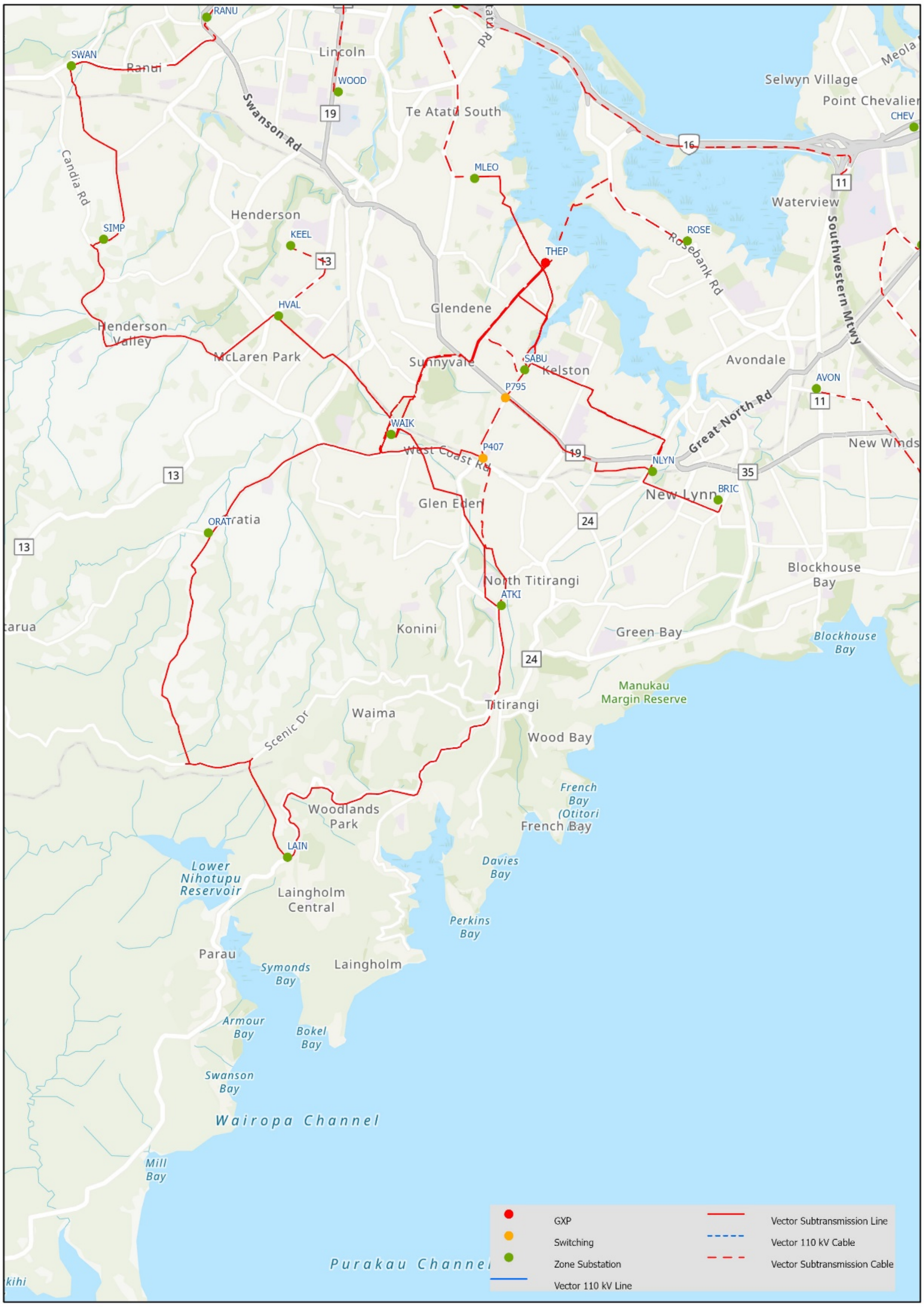



FIGURE 10-10: HEPBURN SUBTRANSMISSION NETWORK

### 10.8.4.2 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 Oratia, Atkinson Road to Laingholm subtransmission loop which traverses mountainous 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 be caused when either of the Hepburn to Waikaukau circuits are out of service, the Waikaukau to Henderson Valley line is out of service or the Hepburn to Rosebank line is out of service. Each of these constraints will cause the back-up circuit to exceed its rated capacity.

Vector is investigation options, with the augmentation of the Waikaukau subtransmission loop currently the preferred option.

### 10.8.4.3 ZONE SUBSTATIONS

Hepburn GXP supplies 10 zone substations of which 4 are single-transformer ZSSs, namely Oratia, Brickworks, Waikaukau, and McLeod Road and 6 are two-transformer ZSSs, namely Keeling Road, Henderson Valley, Atkinson Road, Laingholm, Sabulite Road, and New Lynn.

There are no constraints forecast at the zone substations.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Atkinson Road | RES | 18.8 | 18.7 | 18.6 | 18.5 | 18.7 | 18.8 | 19.0 | 19.1 | 19.3 | 20.0 | 20.8 |
| Winter | Brickworks | COM | 9.6 | 10.0 | 10.4 | 10.8 | 11.3 | 11.8 | 12.2 | 12.7 | 13.2 | 14.2 | 15.2 |
| Winter | Henderson Valley | COM | 16.3 | 16.4 | 16.5 | 16.6 | 16.9 | 17.2 | 17.5 | 17.9 | 18.2 | 19.2 | 20.3 |
| Winter | Keeling Road | RES | 14.8 | 14.9 | 15.0 | 15.2 | 15.4 | 15.7 | 16.0 | 16.2 | 16.5 | 17.3 | 18.1 |
| Winter | Laingholm | RES | 9.0 | 8.9 | 8.8 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.8 | 9.0 | 9.3 |
| Winter | McLeod Road | COM | 9.6 | 9.6 | 9.6 | 9.7 | 9.8 | 9.9 | 10.0 | 10.2 | 10.3 | 10.8 | 11.2 |
| Winter | New Lynn | RES | 14.1 | 14.3 | 14.6 | 14.8 | 15.2 | 15.6 | 15.9 | 16.3 | 16.7 | 17.6 | 18.6 |
| Winter | Rosebank | COM | 21.7 | 21.7 | 21.7 | 21.7 | 22.0 | 22.2 | 22.5 | 22.7 | 23.0 | 24.0 | 25.0 |
| Winter | Oratia | RES | 5.1 | 5.1 | 5.0 | 5.0 | 5.0 | 5.0 | 5.1 | 5.1 | 5.1 | 5.3 | 5.5 |
| Winter | Sabulite Road | COM | 21.7 | 21.7 | 21.7 | 21.7 | 22.0 | 22.2 | 22.5 | 22.7 | 23.0 | 24.0 | 25.0 |
| Winter | Waikaukau | COM | 21.7 | 21.7 | 21.6 | 21.6 | 21.9 | 22.1 | 22.3 | 22.5 | 22.8 | 23.7 | 24.6 |

TABLE 10-9: HEPBURN LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.4.4 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 identified and a long-term generation solution is in planning.

Feeder capacity constraints have been identified in the Brickworks ZSS area and will be addressed by construction of a new feeder and reconfiguration of the network to balance load.

### 10.8.4.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Brickworks feeder capacity and security | Brickworks new 11 kV feeder Clark Street | FY23 | 1.36 |
| Henderson Valley and Simpson zone substation capacity and security | Henderson Valley third transformer | FY30 | 1.5 |
| Hepburn subtransmission network capacity constraints under N-1 scenarios | Waikaukau subtransmission upgrade | FY31 | 1.5 |

TABLE 10-10: HEPBURN CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.5 ALBANY PLANNING AREA

### 10.8.5.1 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 and Rosedale. The overall growth by 2031 is forecast to be 35 MVA.


FIGURE 10-11: ALBANY SUBTRANSMISSION NETWORK

### 10.8.5.2 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.

There are no constraints currently forecast to occur on the subtransmission network within the AMP forecast period.

### 10.8.5.3 ZONE SUBSTATION

Albany GXP supplies 12 zone substations of which 5 are single-transformer ZSSs, namely Coatesville, Greenhithe, Waiake, Torbay and East Coast Road and 7 are two-transformer ZSSs, namely Waimauku, McKinnon, Browns Bay, Rosedale, Bush Road, Sunset Road, and Forrest Hill.

Capacity constraints have been identified at Coatesville ZSS and East Coast Road ZSS. The capacity shortfall is being managed through the addition of a second transformer at Coatesville ZSS which will be completed in FY22 and a feeder reinforcement project along Apollo Drive will provide additional backstop capacity for East Coast Road ZSS.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Browns Bay | RES | 15.8 | 15.8 | 15.7 | 15.7 | 15.9 | 16.0 | 16.2 | 16.4 | 16.5 | 17.3 | 18.2 |
| Summer | Bush Road | COM | 23.6 | 23.4 | 23.2 | 24.0 | 23.8 | 23.6 | 23.7 | 23.7 | 23.8 | 24.0 | 24.7 |
| Winter | Coatesville | RES | 10.3 | 10.2 | 10.2 | 10.1 | 10.2 | 10.2 | 10.2 | 10.3 | 10.3 | 11.1 | 11.8 |
| Winter | East Coast Road | RES | 15.3 | 15.3 | 15.2 | 15.2 | 15.3 | 15.5 | 15.6 | 15.8 | 15.9 | 16.7 | 17.5 |
| Winter | Forrest Hill | RES | 16.6 | 16.5 | 16.4 | 16.4 | 16.5 | 16.6 | 16.7 | 16.8 | 16.9 | 17.5 | 18.1 |
| Winter | Greenhithe | RES | 20.3 | 20.2 | 20.1 | 20.0 | 20.2 | 20.4 | 20.6 | 20.7 | 20.9 | 21.8 | 22.7 |
| Winter | James Street | RES | 18.3 | 18.8 | 19.3 | 19.8 | 20.5 | 21.1 | 21.7 | 22.4 | 23.0 | 24.5 | 25.9 |
| Winter | McKinnon | RES | 13.9 | 15.2 | 17.4 | 17.4 | 18.2 | 18.1 | 18.2 | 18.3 | 18.4 | 18.7 | 19.3 |
| Summer | Rosedale | COM | 15.4 | 15.4 | 15.3 | 15.3 | 15.5 | 15.7 | 15.9 | 16.1 | 16.3 | 17.3 | 18.2 |
| Winter | Sunset Road | COM | 9.1 | 9.1 | 9.2 | 9.3 | 9.4 | 9.5 | 9.6 | 9.7 | 9.8 | 10.2 | 10.5 |
| Winter | Torbay | RES | 8.6 | 8.6 | 8.5 | 8.5 | 8.6 | 8.7 | 8.8 | 8.9 | 8.9 | 9.3 | 9.7 |
| Winter | Waiake | RES | 11.9 | 12.2 | 12.3 | 12.5 | 12.8 | 13.2 | 13.6 | 13.9 | 14.3 | 15.4 | 16.5 |

TABLE 10-11: ALBANY LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.5.4 DISTRIBUTION NETWORK

The distribution network operates at 11 kV, being overhead in the rural areas and underground in the urban areas. Two constraints have been identified due to the forecast load growth in the Rosedale ZSS area.

Organic load growth in Rosedale has caused the capacity of existing low capacity PILC (paper insulated lead sheath) cables to be exceeded. The cables are supplied from the Bush Road ZSS and are installed along Piermark Drive. Vector’s analysis has found that the preferred solution is to replace the old cables with new cables with higher capacity.

The second constraint has been identified as insufficient capacity to support East Coast Road ZSS during contingency events. Vector’s analysis found the preferred solution is to augment feeders along Apollo Drive, rather than augment the zone substation.

### 10.8.5.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Coatesville zone substation security | Coatesville second 33-11 kV Transformer | FY22 | 2.58 |
| Bush Rd PILC feeders’ capacity and security breach | Piermark Drive 11 kV reinforcement of the front end of two 11 kV feeders | FY22 | 2.17 |
| Rosedale feeder security breaches | Apollo Drive 11 kV reinforcement | FY23 | 0.25 |
| Henderson subtransmission network capacity constraint | Albany-Greenhithe 33 kV upgrade | FY29 | 1.50 |

TABLE 10-12: ALBANY CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.6 WAIRAU PLANNING AREA

### 10.8.6.1 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 Akarana campus.

Modest demand growth in the Wairau Valley area including the Kainga Ora redevelopment in Northcote is driving brownfields investment. Zone rule changes introduced with the Auckland Unitary Plan allow for significant densification and strong future demand growth is likely.

As a relatively low lying coastal area, Vector has identified risks related to climate change and resilience.

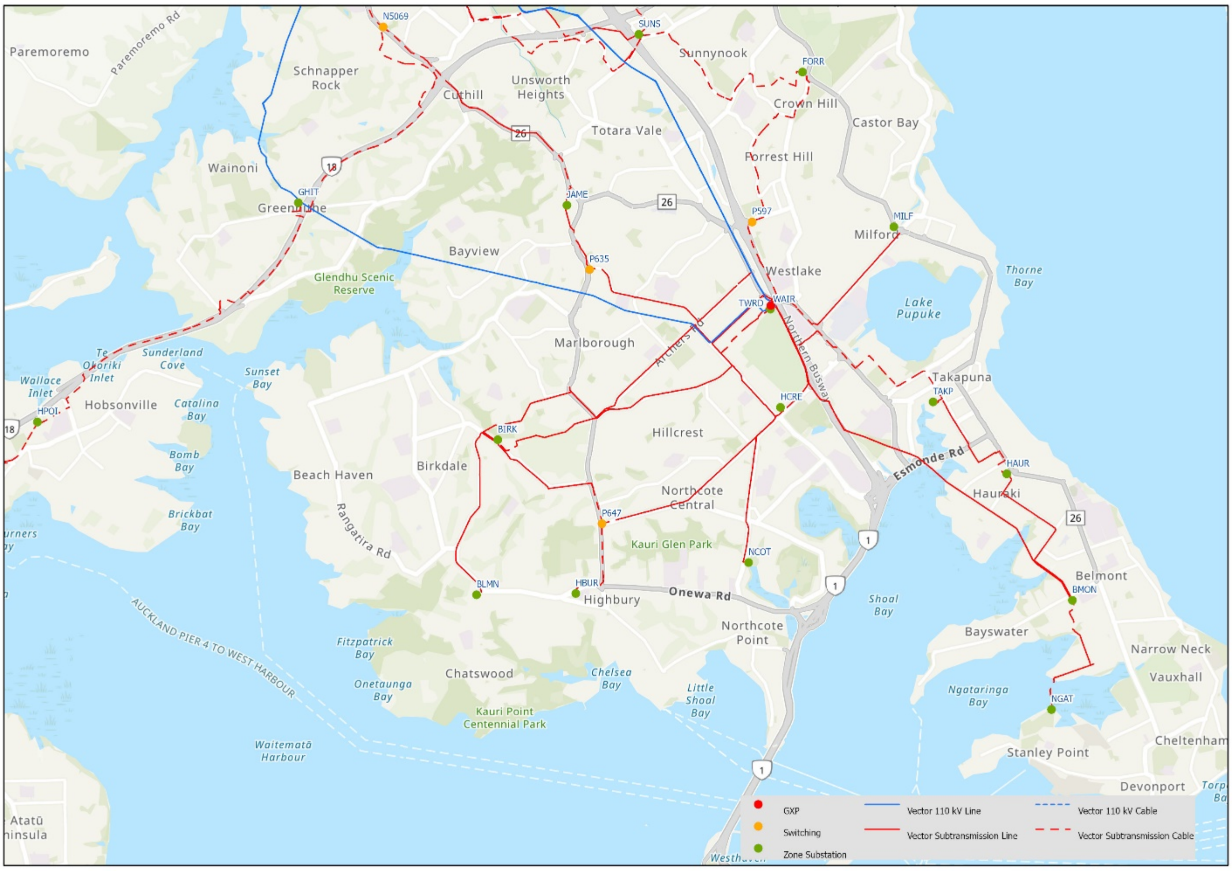



FIGURE 10-12: WAIRAU SUBTRANSMISSION NETWORK

### 10.8.6.2 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.

There are no constraints currently forecast to occur on the subtransmission network within the AMP forecast period.

### 10.8.6.3 ZONE SUBSTATION

Wairau GXP supplies 11 zone substations of which 7 are single-transformer ZSSs, namely Highbury, Balmain, Northcote, Milford, Hauraki, Ngataringa Bay and Takapuna and 4 are two-transformer ZSSs, namely Wairau Valley, Birkdale, Hillcrest, and Belmont.

A capacity constraint has been identified at Takapuna ZSS which breaches the SoSS. A project to install a second transformer at Takapuna ZSS is currently underway and it will be commissioned in FY22.

A backstop shortfall at Highbury ZSS can be mitigated in the medium term by cascade switching (switching load away from the backstopping ZSS to other ZSS's to release capacity).

Three 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 ZSS has insufficient 11 kV backstop capacity for an outage at peak demand.
- 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 33 kV cable replacement project in FY23, and the third will be temporarily mitigated by flood protection works. The permanent solution is planned for FY27 and will involve installation of a third transformer at Belmont ZSS to supply the area via new cables and decommissioning and removal of Ngataringa Bay ZSS.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Balmain | RES | 8.4 | 8.3 | 8.3 | 8.2 | 8.3 | 8.4 | 8.4 | 8.5 | 8.6 | 8.9 | 9.3 |
| Winter | Belmont | RES | 12.7 | 12.7 | 12.7 | 12.7 | 12.9 | 13.1 | 13.3 | 13.5 | 13.7 | 14.5 | 15.3 |
| Winter | Birkdale | RES | 22.5 | 22.3 | 22.2 | 22.1 | 22.2 | 22.4 | 22.5 | 22.6 | 22.8 | 23.6 | 24.4 |
| Winter | Hauraki | RES | 9.3 | 9.4 | 9.5 | 9.6 | 9.8 | 10.0 | 10.2 | 10.4 | 10.6 | 11.3 | 11.9 |
| Winter | Highbury | COM | 12.9 | 13.0 | 13.1 | 13.2 | 13.5 | 13.8 | 14.2 | 14.5 | 14.8 | 15.8 | 16.8 |
| Winter | Hillcrest | RES | 21.3 | 21.8 | 22.3 | 22.5 | 22.9 | 23.4 | 23.9 | 24.4 | 24.9 | 26.1 | 27.4 |
| Winter | Milford | RES | 7.4 | 7.5 | 7.6 | 7.8 | 8.0 | 8.2 | 8.4 | 8.6 | 8.8 | 9.4 | 10.0 |
| Winter | Ngataringa Bay | RES | 7.1 | 7.1 | 7.1 | 7.1 | 7.2 | 7.2 | 7.3 | 7.4 | 7.5 | 7.9 | 8.3 |
| Winter | Northcote | RES | 6.1 | 6.1 | 6.2 | 6.2 | 6.3 | 6.4 | 6.5 | 6.6 | 6.7 | 7.0 | 7.4 |
| Summer | Takapuna | COM | 9.3 | 9.6 | 9.9 | 10.2 | 10.7 | 11.1 | 11.5 | 11.9 | 12.4 | 13.2 | 14.0 |

TABLE 10-13: WAIRAU LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

#### 10.8.6.4 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 and commercial areas, steady densification (taller buildings and higher density construction) is driving an increase in demand causing capacity constraints on the 11 kV feeders. To address this constraint, a feeder upgrade for Hillcrest ZSS is planned for FY22.

#### 10.8.6.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Hillcrest ZSS feeder security breach | Smales Farm 11 kV reinforcement | FY22 | 0.20 |
| Takapuna ZSS backstop shortfall | Takapuna 2nd 33/11 kV transformer and Subtrans | FY22 | 6.50 |
| Ngataringa Bay oil-filled submarine cable at end of life; Ngataringa Bay backstop shortfall | Ngataringa Bay 33 kV cable replacement | FY23 | 1.80 |
| Ngataringa Bay flood risk; Ngataringa Bay security of supply | Ngataringa Bay Direct Supply Belmont ZSS | FY27 | 3.50 |

TABLE 10-14: WAIRAU CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

### 10.8.7 AUCKLAND CBD PLANNING AREA

#### 10.8.7.1 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 37,000 customers (ICPs) with a total demand of 180 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, however, it is showing a trend of returning back toward pre-COVID levels. Vector will continue to monitor the demand and amend any forecast works to suit changes in demand and security related constraints.

The CBD is undergoing a transformation driven largely by the redevelopment of existing commercial sites, the City Rail Link (CRL) project and potentially the Light Rail Transit (LRT) project.

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 cable ducts at very low cost. These opportunities are assessed on a case by case basis.

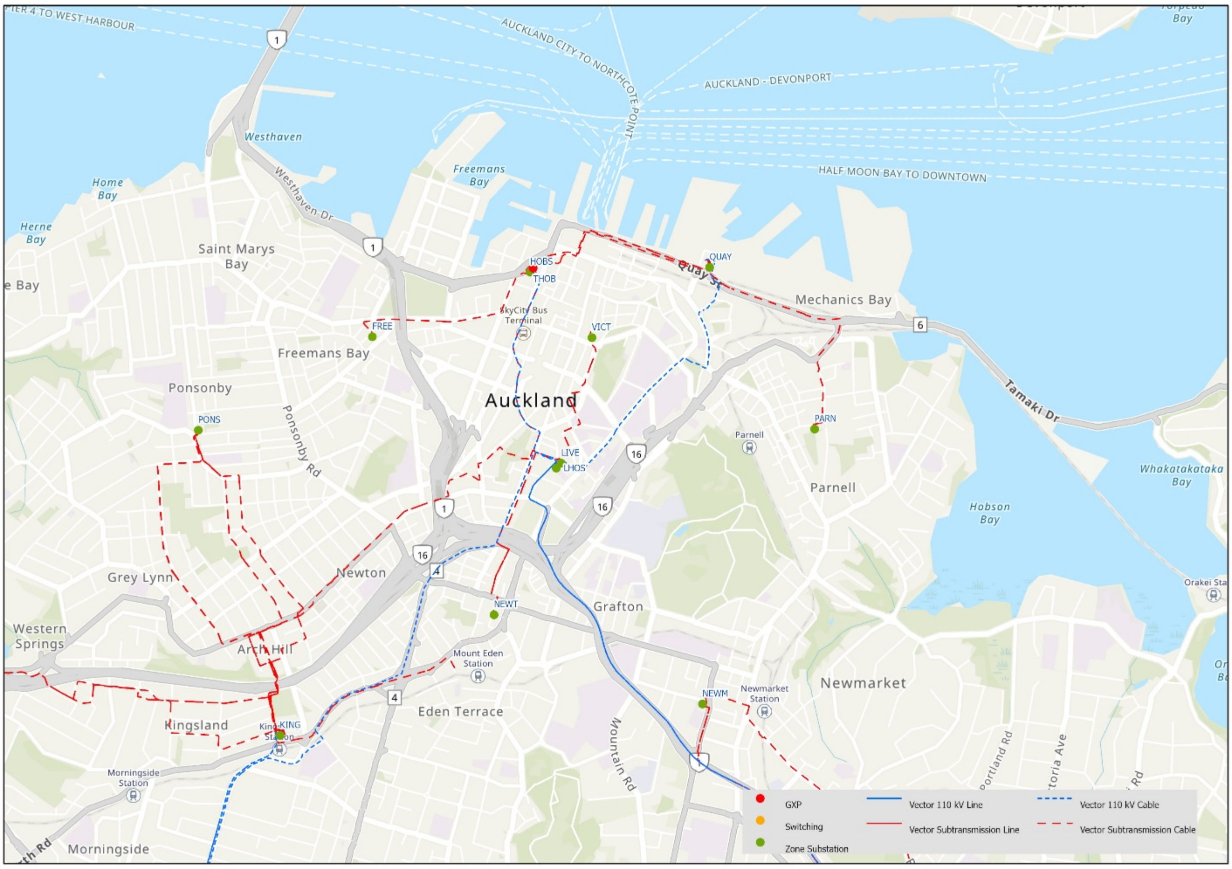



FIGURE 10-13: AUCKLAND CBD SUBTRANSMISSION NETWORK

### 10.8.7.2 SUBTRANSMISSION

The CBD area is supplied by subtransmission lines at 110 kV and 22 kV. All subtransmisison lines 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.

As a critical supply area, Vector considers the impact of common mode failure and high impact low probability risks on supply security and capacity when planning CBD augmentations. A number of major projects are in progress and nearing completion that will remove operational constraints and enhance the existing and long-term resilience and security of the 110 kV network:

- The four-way Roskill – Liverpool – Quay T3A – Quay T3B loop is in the process of being separated out into conventional individual feeders and this work will be completed by the end of 2021. The new configuration will be as follows:
  - Roskill – Liverpool 110 kV
  - Liverpool – Quay 110/22 kV T3
  - Hobson – Quay 110/22 kV T2 circuit is already completed
- Liverpool 110 kV switchboard is being extended to address the need for a complete switchboard shutdown to complete repairs under certain conditions.
- Liverpool T3 transformer is being replaced with a transformer identical to the existing Liverpool T1, Liverpool T2 and Hobson T5. This will ensure optimal load sharing and improve network operations.

No constraints are identified to occur in the subtransmission network, during the AMP planning period, following completion of the above projects.

### 10.8.7.3 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.

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 2031, due to the load growth in the existing 11 kV network. Vector plans 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.

| | | | ACTUAL | LOAD FORECAST (MVA) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SEASON** | **ZONE SUBSTATION** | **SOSS CATEGORY** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** |
| Winter | Freemans Bay | COM | 18.5 | 18.9 | 19.3 | 19.7 | 20.4 | 21.1 | 21.8 | 22.5 | 23.1 | 24.7 | 26.3 |
| Summer | Hobson 110/11 kV | CBD | 14.3 | 14.5 | 14.7 | 14.9 | 15.3 | 15.6 | 16.0 | 16.4 | 16.7 | 17.4 | 18.0 |
| Summer | Hobson 22/11 kV | CBD | 15.4 | 15.6 | 15.8 | 15.9 | 16.3 | 16.6 | 17.0 | 17.3 | 17.7 | 18.3 | 18.9 |
| Summer | Hobson 22 kV | CBD | 55.1 | 56.0 | 56.8 | 61.9 | 64.1 | 66.9 | 69.6 | 71.0 | 72.3 | 74.7 | 77.2 |
| Summer | Liverpool 22 kV | CBD | 87.4 | 89.2 | 97.2 | 99.2 | 105.9 | 110.3 | 112.6 | 114.5 | 116.4 | 122.0 | 126.1 |
| Summer | Liverpool | CBD | 30.9 | 32.3 | 38.7 | 34.1 | 35.2 | 36.2 | 37.3 | 37.9 | 38.6 | 39.9 | 41.3 |
| Summer | Newton | COM | 18.2 | 18.4 | 18.6 | 18.8 | 20.8 | 21.5 | 22.1 | 22.8 | 23.5 | 24.8 | 26.2 |
| Winter | Parnell | COM | 11.0 | 11.2 | 11.3 | 11.5 | 11.8 | 12.2 | 12.5 | 12.8 | 13.2 | 14.2 | 15.2 |
| Summer | Quay 22 kV | CBD | 43.5 | 46.7 | 49.7 | 49.9 | 52.8 | 53.6 | 54.4 | 55.2 | 56.0 | 58.2 | 60.4 |
| Summer | Quay | CBD | 20.4 | 20.5 | 20.6 | 20.8 | 23.3 | 23.7 | 24.2 | 24.6 | 25.0 | 26.1 | 27.3 |
| Summer | Victoria | CBD | 21.7 | 21.7 | 21.7 | 21.7 | 21.9 | 22.2 | 22.4 | 22.6 | 22.8 | 23.5 | 24.2 |

TABLE 10-15: CBD LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.7.4 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.

Capacity and security constraints are identified in two existing 11 kV feeders from Liverpool ZSS, starting from 2023 due to load growth in CBD and the new load from City Rail Link. The constraint will be resolved by installing two new 22 kV feeders out of Liverpool ZSS. The project is planned for completion by the end of 2022.

Auckland Transport is carrying out 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 at low cost. 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.

### 10.8.7.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $ |
|---|---|---|---|
| CBD 11 kV network breaches capacity and security in the long term | CBD 22 kV Network Rollout | FY22 to FY31 | 14.3 |
| Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth | CBD 22 kV extension Britomart | FY22 | 0.8 |
| Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth | CBD 22 kV extension Commerce Tyler St | FY22 | 0.6 |
| Feeder LIVE J17 breaches security | Liverpool 22 kV feeder new | FY23 | 3.0 |
| Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth | CBD 22 kV extension Wyndham St | FY23 | 1.7 |
| Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth | CBD 22 kV extension Albert Wellesley St | FY24 | 4.2 |
| Synergy opportunity to future proof for CBD 22 kV distribution network to meet long term growth | CBD 22 kV extension Tyler St east | FY24 | 1.2 |
| Strategically important route for CBD 22 kV distribution network to meet long term growth | CBD 22 kV ducts Bradnor Lane | FY28 | 2.2 |
| Quay 11 kV breaches security | CBD 22 kV conversion to off load Quay 11 kV | FY29 | 4.3 |
| Victoria substation breaches security | CBD 22 kV conversion to off load Victoria | FY30 | 4.3 |
| Quay 22 kV breaches security | Quay 22 kV fast switching scheme to maintain no break security | FY30 | 0.3 |
| Feeders HOBS J02 & J09 breach security | Hobson to Waterfront 3rd 22 kV feeder new | FY32 | 1.6 |

TABLE 10-16: CBD CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.8 ROSKILL PLANNING AREA

### 10.8.8.1 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 68,000 customers (ICPs) with a total load of about 180 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.

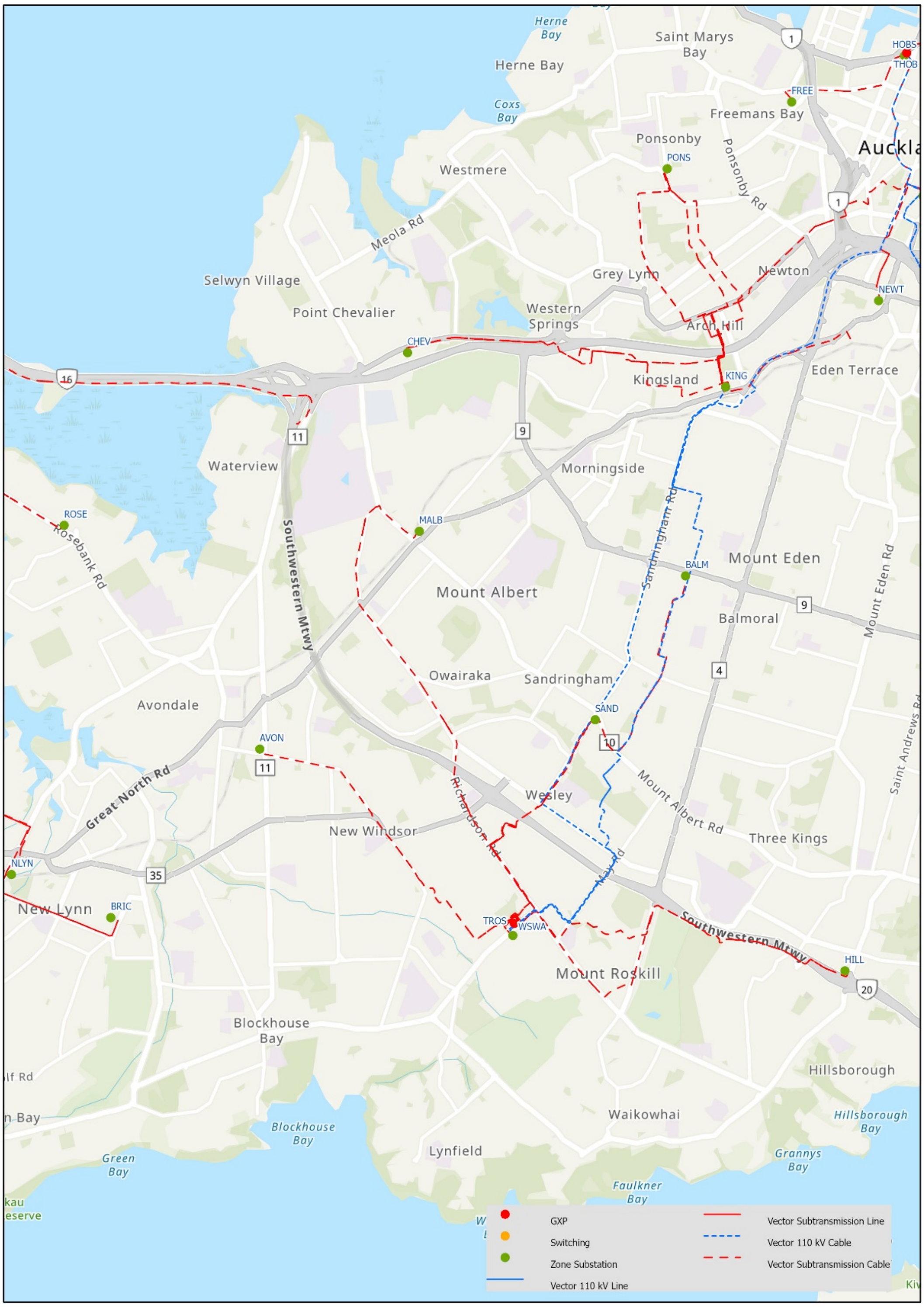



FIGURE 10-14: ROSKILL SUBTRANSMISSION NETWORK

### 10.8.8.2 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.

There are no constraints forecast on the subtransmission network at either 110 kV or 22 kV within the AMP forecast period.

### 10.8.8.3 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 is planned for replacement in 2023, and the subtransmission circuit in 2030, 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 expected to start in FY29.

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 2031. 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.

| | | | ACTUAL | LOAD FORECAST (MVA) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SEASON** | **ZONE SUBSTATION** | **SOSS CATEGORY** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** |
| Winter | Avondale | RES | 27.8 | 28.8 | 29.8 | 30.8 | 32.1 | 33.4 | 33.7 | 34.1 | 34.5 | 35.9 | 37.3 |
| Winter | Balmoral | RES | 15.2 | 15.3 | 15.4 | 15.6 | 17.3 | 17.6 | 18.0 | 18.3 | 18.6 | 19.7 | 20.8 |
| Winter | Chevalier | RES | 21.0 | 21.1 | 21.2 | 21.3 | 21.8 | 22.3 | 22.7 | 23.2 | 23.6 | 25.0 | 26.5 |
| Winter | Hillsborough | RES | 15.9 | 16.3 | 16.6 | 16.9 | 17.4 | 17.9 | 18.3 | 18.8 | 19.3 | 20.4 | 21.6 |
| Winter | Kingsland 22 kV | RES | 65.7 | 66.0 | 66.4 | 65.9 | 67.4 | 68.9 | 70.4 | 71.9 | 73.4 | 78.1 | 82.8 |
| Winter | Kingsland | RES | 25.1 | 25.3 | 25.6 | 25.9 | 26.7 | 27.6 | 28.4 | 29.2 | 30.1 | 32.3 | 34.6 |
| Winter | Mt Albert | RES | 7.5 | 7.5 | 7.6 | 7.6 | 7.8 | 8.0 | 8.2 | 8.4 | 8.6 | 9.1 | 9.6 |
| Winter | Ponsonby | RES | 14.9 | 14.9 | 14.9 | 15.0 | 15.2 | 15.5 | 15.8 | 16.1 | 16.4 | 17.7 | 18.9 |
| Winter | Sandringham 22 kV | RES | 37.8 | 38.5 | 39.2 | 40.0 | 43.8 | 45.0 | 46.2 | 47.4 | 48.6 | 51.5 | 54.4 |
| Winter | Sandringham | RES | 23.7 | 24.3 | 24.9 | 25.6 | 27.8 | 28.7 | 29.6 | 30.5 | 31.5 | 33.3 | 35.2 |
| Winter | White Swan | IND | 32.8 | 32.9 | 32.9 | 33.0 | 29.8 | 30.1 | 30.5 | 30.8 | 31.2 | 32.3 | 33.5 |

TABLE 10-17: ROSKILL LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.8.4 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.

An existing 11 kV feeder from Sandringham ZSS is expected to breach security from 2031. It is proposed to install two new 11 kV feeders from Sandringham substation connecting to the existing network and rearrange the feeders in the area to manage the constraint.

#### 10.8.8.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Newton substation, Kingsland substation, and various 11 kV feeders in the area breach capacity and security from 2031. | Land purchase and designation for a new substation at Mt Eden to resolve the capacity constraints | FY26 | 4.0 |
| Newton substation, Kingsland substation, and various 11 kV feeders in the area breach capacity and security from 2031 | Mt Eden new substation | FY30 | 17.9 |
| Mt Albert substation and Sandringham substation breach capacity and security standard from 2032 and 2035, respectively | Mt Albert substation upgrade | FY31 | 16.0 |
| Feeder SAND K11 breaches security | Sandringham new 11 kV feeders to Mt Albert Rd, KO driven | FY32 | 2.4 |

TABLE 10-18: ROSKILL CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

### 10.8.9 PENROSE PLANNING AREA

#### 10.8.9.1 OVERVIEW

This is Vector's largest planning area from Mt Eden east to the Tamaki River. The area has over 83,000 customers (ICPs) with a total demand of 294 MVA. The area is supplied by Transpower's Penrose GXP at 33 kV and 22 kV.

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.

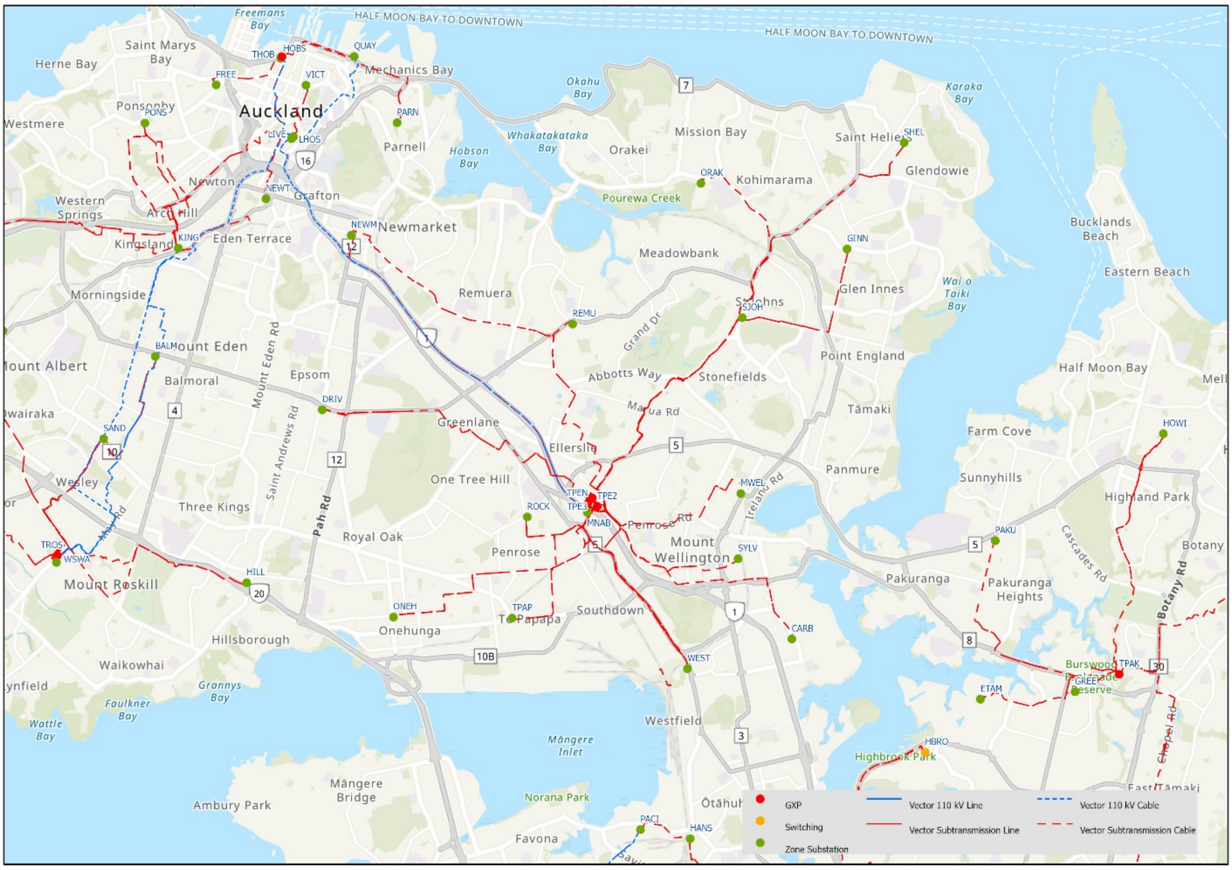



FIGURE 10-15: PENROSE SUBTRANSMISSION NETWORK

### 10.8.9.2 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.

There are no constraints currently forecast to occur on the subtransmission network within the AMP forecast period.

### 10.8.9.3 ZONE SUBSTATION

There are 15 zone substations supplied from Penrose GXP. 10 are supplied directly from Penrose GXP at33 kV, 3 are supplied via the switching station at St Johns substation, and 2 are supplied directly from Penrose at 22 kV.

The Newmarket ZSS is forecast to breach the SoSS from 2031 due to commercial redevelopment. Vectors 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 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.

| | | | ACTUAL | LOAD FORECAST (MVA) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Summer | Carbine | IND | 15.1 | 15.0 | 14.9 | 14.8 | 14.8 | 14.8 | 14.8 | 14.8 | 14.8 | 15.0 | 15.2 |
| Winter | Drive | RES | 27.0 | 28.2 | 28.9 | 29.6 | 30.6 | 31.1 | 31.5 | 32.0 | 32.5 | 34.0 | 35.5 |
| Winter | Glen Innes | RES | 13.2 | 13.6 | 14.1 | 14.6 | 15.2 | 15.9 | 16.5 | 17.1 | 17.7 | 19.0 | 20.2 |
| Winter | McNab | IND | 41.5 | 41.5 | 41.5 | 41.5 | 41.9 | 42.2 | 42.6 | 42.9 | 43.3 | 44.6 | 45.9 |
| Winter | Mt Wellington | IND | 18.7 | 19.2 | 19.8 | 20.4 | 21.1 | 21.9 | 22.6 | 23.4 | 24.1 | 25.5 | 27.0 |
| Winter | Newmarket | COM | 38.6 | 41.6 | 43.5 | 45.4 | 47.6 | 49.7 | 51.9 | 54.0 | 56.2 | 60.1 | 63.1 |
| Winter | Onehunga | IND | 16.1 | 16.3 | 16.5 | 16.8 | 17.3 | 17.8 | 18.3 | 18.7 | 19.2 | 20.7 | 22.1 |
| Winter | Orakei | RES | 23.8 | 23.9 | 24.0 | 24.1 | 24.4 | 24.7 | 25.1 | 25.4 | 25.7 | 26.9 | 28.1 |
| Winter | Remuera | COM | 27.3 | 27.4 | 27.5 | 27.6 | 28.1 | 28.6 | 29.0 | 29.5 | 30.0 | 31.8 | 33.6 |
| Winter | Rockfield | RES | 21.5 | 21.5 | 21.5 | 21.5 | 21.7 | 21.9 | 22.2 | 22.4 | 22.6 | 23.6 | 24.6 |
| Winter | St Johns 33 kV | RES | 61.6 | 62.1 | 62.7 | 63.3 | 64.5 | 65.8 | 67.1 | 68.3 | 69.6 | 73.4 | 77.1 |
| Winter | St Johns | RES | 18.7 | 19.0 | 19.4 | 19.8 | 20.5 | 21.1 | 21.7 | 22.3 | 23.0 | 24.5 | 26.0 |
| Summer | Sylvia Park | COM | 18.4 | 18.4 | 18.4 | 18.5 | 18.6 | 18.8 | 19.0 | 19.1 | 19.3 | 19.6 | 20.0 |
| Winter | St Heliers | RES | 21.5 | 21.5 | 21.6 | 21.7 | 22.1 | 22.5 | 22.8 | 23.2 | 23.6 | 24.8 | 26.0 |
| Summer | Te Papapa | IND | 21.7 | 21.6 | 21.5 | 21.4 | 21.6 | 21.8 | 22.0 | 22.3 | 22.5 | 23.2 | 24.0 |
| Summer | Westfield | IND | 26.8 | 26.6 | 28.2 | 29.8 | 29.9 | 30.1 | 30.2 | 30.4 | 30.5 | 31.4 | 32.3 |

TABLE 10-19: PENROSE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)DISTRIBUTION

The distribution network operates at 11 kV, being predominately overhead in the urban areas. The feeders are generally radial and interconnected with open points in between to meet Vector's N-1 security of supply standard.

The existing 11 kV feeder supplying the Greenlane area including Alexandra Park, Greenlane Hospital and Showground is forecasted to breach capacity in 2027. Vector proposes to install a new 11 kV feeder from Drive zone substation and rebalance the load to resolve the constraint.

### 10.8.9.4 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| 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 | FY26 | 2.0 |
| Feeder DRIV K04 breaches capacity | Drive to Alexandra Park 11 kV feeder reinforcement | FY27 | 1.9 |
| Newmarket substation breaches capacity and security from 2031 | Newmarket substation development | FY32 | 10.5 |

TABLE 10-20: PENROSE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.10 PAKURANGA PLANNING AREA

### 10.8.10.1 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 5 MVA increase in demand is expected by 2031.

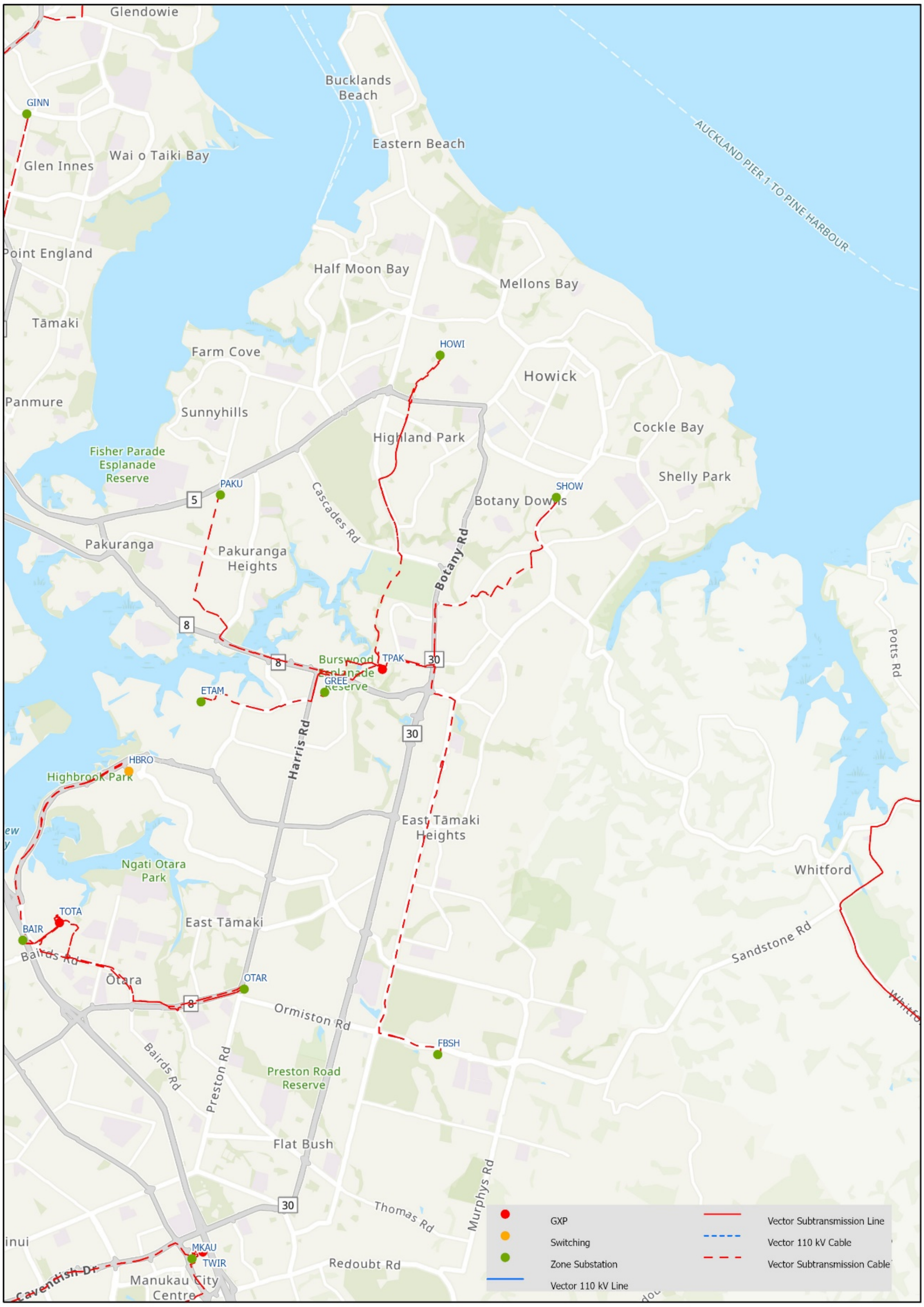



FIGURE 10-16: PAKURANGA SUBTRANSMISSION NETWORK

#### 10.8.10.2 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.

#### 10.8.10.3 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.

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

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | East Tamaki | COM | 15.8 | 15.7 | 15.6 | 15.5 | 19.2 | 19.2 | 19.2 | 19.2 | 19.3 | 19.5 | 19.8 |
| Winter | Flatbush | RES | 16.5 | 17.1 | 17.6 | 18.1 | 18.6 | 19.0 | 19.5 | 20.0 | 20.5 | 21.2 | 22.0 |
| Winter | Greenmount | COM | 39.6 | 39.6 | 39.6 | 39.6 | 39.9 | 40.2 | 40.6 | 40.9 | 41.3 | 42.6 | 44.0 |
| Winter | Howick | RES | 42.5 | 42.2 | 42.0 | 41.7 | 41.7 | 41.6 | 41.6 | 41.5 | 41.5 | 41.9 | 42.3 |
| Winter | Pakuranga | RES | 22.0 | 21.9 | 21.7 | 21.6 | 21.6 | 21.6 | 21.6 | 21.7 | 21.7 | 22.0 | 22.3 |
| Winter | South Howick | RES | 21.3 | 21.1 | 20.9 | 20.8 | 20.7 | 20.7 | 20.7 | 20.7 | 20.7 | 21.1 | 21.5 |

TABLE 10-21: PAKURANGA LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

#### 10.8.10.4 DISTRIBUTION NETWORK

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

New road development projects being implemented by the Council within the Flat bush area provide opportunities for Vector to install cable ducts at low cost to provide future options for network development. The decision to install ducts is assessed on a case by case basis.

The available capacity of the existing backstop supply is forecast to decrease towards the end of the AMP period for a Greenmount distribution feeder. A distribution switch will be installed to connect to an adjacent feeder to enable an alternative point of supply under a contingency and maintain the required level of backstop capacity available.

#### 10.8.10.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| SOSS backstop constraint. GREE K16 (Harris road south) summer backstop shortfall requires RMU install. | Greenmount - Harris road 11 kV feeder capacity optimisation - RMU installation | FY31 | 0.25 |
| Flat Bush ZSS - Feeder Security and Capacity constraints beyond the AMP period | Flatbush Link road future proofing distribution cable ducts | FY26 | 0.45 |

TABLE 10-22: PAKURANGA CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

### 10.8.11 MANGERE PLANNING AREA

#### 10.8.11.1 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 7,800 dwellings that are planned by Kāinga Ora over the next 15 years with a total demand increase of 32 MVA. 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.

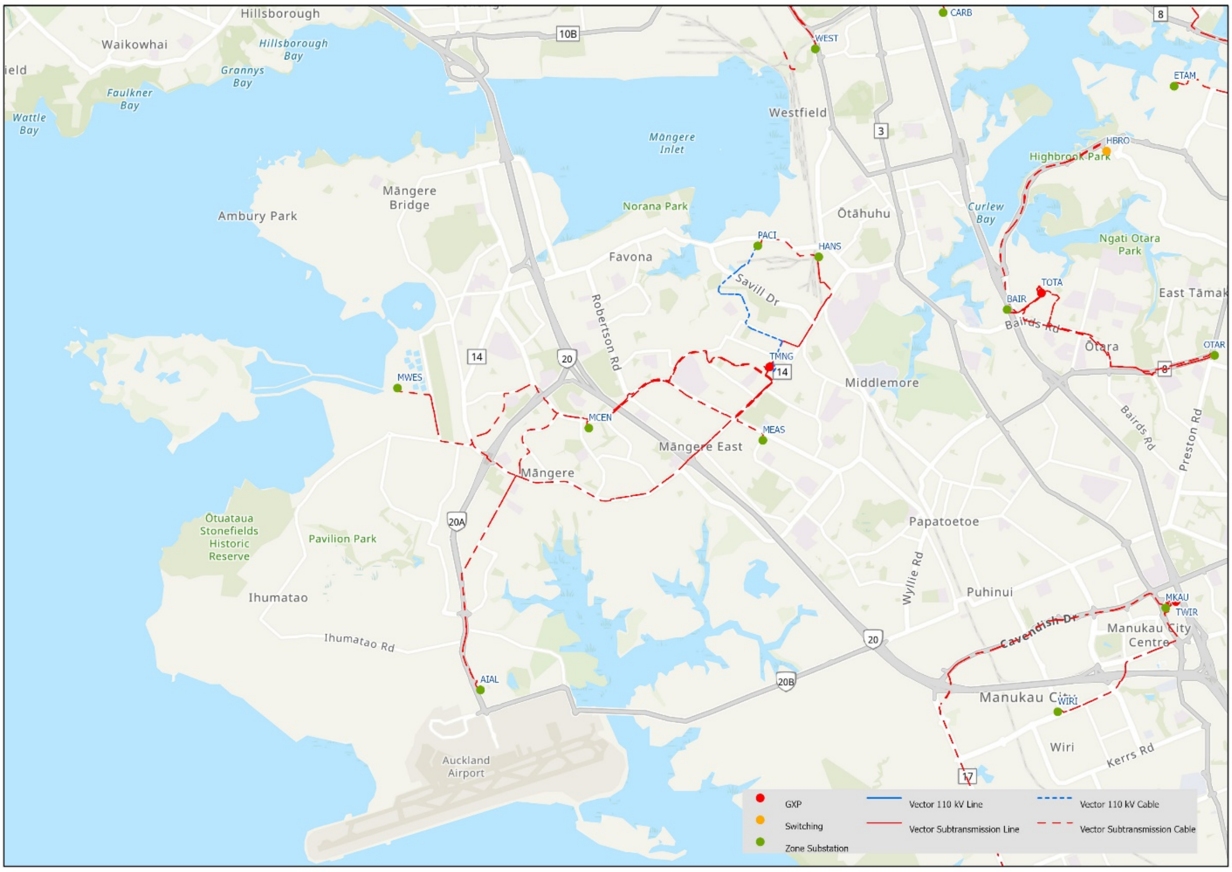



FIGURE 10-17: MANGERE SUBTRANSMISSION NETWORK

### 10.8.11.2 SUBTRANSMISSION

The area is supplied from the Mangere GXP. The subtransmission network operates ad 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 five 33 kV feeders supply four 33/11 kV zone substations.

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

### 10.8.11.3 ZONE SUBSTATION

Mangere GXP supplies four zone substations, all with multiple 33/11 kV transformers which provide security of supply.

There is no demand constraint identified during the AMP period. However, since 50% of the capacity at Mangere West ZSS is reserved for one major customer and the long-term forecast growth is for an additional 32 MVA, there are both potential capacity and security constraints. Due to the significant residential growth in the area, Vector will purchase land in FY22 for a future zone substation (to be called Mangere South and expected to be commissioned in FY27) to ensure we are able to secure land in an optimal location.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Hans | COM | 28.0 | 28.1 | 28.2 | 28.2 | 28.6 | 29.0 | 29.4 | 29.8 | 30.2 | 31.3 | 32.4 |
| Winter | Mangere Central | RES | 31.2 | 31.7 | 32.2 | 32.7 | 33.4 | 33.6 | 33.9 | 34.1 | 34.4 | 35.1 | 35.9 |
| Winter | Mangere East | RES | 30.7 | 31.5 | 31.4 | 31.4 | 31.5 | 31.6 | 31.7 | 31.8 | 31.9 | 32.2 | 32.6 |
| Summer | Mangere West | COM | 28.5 | 29.0 | 29.5 | 30.9 | 32.5 | 33.3 | 36.7 | 37.5 | 38.2 | 39.2 | 40.1 |

TABLE 10-23: MANGERE LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

#### 10.8.11.4 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.

Increased demand caused by the extensive Kāinga Ora future housing development from Mangere Central towards Mangere Bridge is forecast to cause a breach of the SoSS on the 11 kV feeders originating from Mangere Central ZSS towards the end of the AMP period. This constraint has resulted in three projects:

- The installation of a new feeder along Bader Drive that is currently under construction and will be commissioned in FY22.
- Distribution automation to improve reliability performance in the Mangere Bridge area.
- A new customer funded feeder that will be installed along Bader Drive towards the end of the AMP period.

New private residential and commercial developments along with the Kainga Ora housing developments have caused backstop shortfalls within different parts of Mangere, this requires further meshing of feeders to increase 11 kV backup capacity. This will be achieved through installation of distribution switches to create connection points between feeders.

Distribution feeder security is expected to be breached on the 11 kV feeders supplying the Ihumatatao Business Park due to insufficient backup capacity. While the existing commercial agreements do not require this backup supply, Vector has identified a feasible solution and will resolve the constraint when initiated by the customer as a customer funded project.

#### 10.8.11.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Automation to reduce customer outage – improve SAIDI for growing customer numbers within this region. | Feeder capacity optimisation - Bader Drive automation | FY22 | 0.25 |
| Mangere East ZSS - Raglan and Winthorp 11 kV feeder SOSS breach in 2021. | Mangere East ZSS - Raglan and Winthorp 11 kV feeder capacity optimisation - RMU installation. | FY22 | 0.25 |
| Mangere West ZSS - Ihumatatao Business Park 11 kV feeder breaches SoSS in 2021 | Mangere West - Ihumatatao Business Park feeder -RMU installation | FY22 | 0.20 |
| Mangere West ZSS - SoSS breach in FY27 and distribution feeder capacity constraints to supply Airport Park industrial development area beyond 2027 | Mangere South secure site for new zone substation | FY22 | 1.00 |
| Mangere West ZSS - SoSS breach in FY27 and distribution feeder capacity constraints to supply Airport Park industrial development area beyond 2027 | Mangere South new zone substation | FY28 | 17.58 |
| Mangere Central - K10 11 kV feeder breaches SoSS in 2028 | Mangere Central K10 Backfeed 11 kV Reinforcement | FY27 | 0.25 |
| SOSS backstop constraint. Backstop reinforcement for Mangere bridge area | Mangere Bridge South 11 kV feeder reinforcement - new feeder | FY26 | 1.20 |

TABLE 10-24: MANGERE CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

### 10.8.12 TAKANINI PLANNING AREA

#### 10.8.12.1 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.

Waiheke Island has a relatively static load of about 12 MVA, supplied by two 33 kV subtransmission cables from Maraetai. The feeders start off as overhead lines and then switch to submarine cabling to cross the Tamaki Strait, and then convert to underground cabling upon reaching the island. The overhead circuits are 26km each, and submarine cabling components are 6 km each.

The Takanini area, excluding Waiheke Island, is forecast to have 16 MVA growth by 2031, driven predominantly by residential growth in Papakura, Manurewa and Takanini.

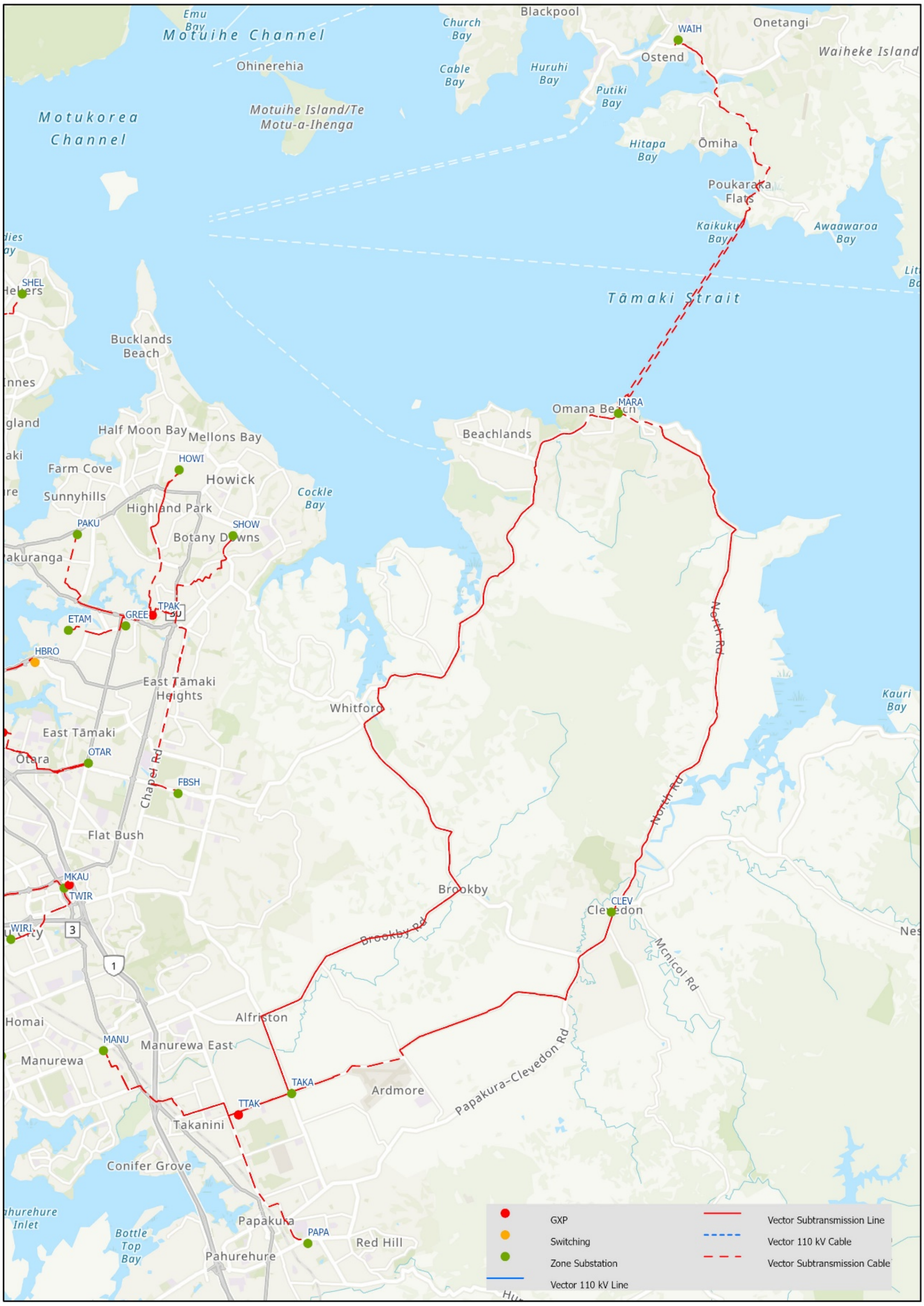



FIGURE 10-18: TAKANINI SUBTRANSMISSION NETWORK

### 10.8.12.2 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 mitigate 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.

No capacity constraints on the subtransmission network have been identified during the AMP planning period.

#### 10.8.12.3 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.

No capacity constraints at the zone substations have been identified during the AMP planning period.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Clevedon | RES | 2.7 | 2.7 | 2.7 | 2.8 | 2.8 | 2.8 | 2.9 | 2.9 | 3.0 | 3.0 | 3.1 |
| Winter | Manurewa | RES | 52.5 | 52.4 | 52.4 | 52.3 | 52.5 | 52.7 | 53.0 | 53.2 | 53.4 | 54.3 | 55.1 |
| Winter | Maraetai | RES | 9.6 | 9.6 | 9.6 | 9.7 | 9.8 | 9.9 | 10.0 | 10.1 | 10.2 | 10.4 | 10.6 |
| Winter | Papakura | RES | 27.4 | 27.6 | 27.8 | 28.1 | 28.5 | 28.9 | 29.4 | 29.8 | 30.2 | 31.3 | 32.4 |
| Winter | Takanini | COM | 19.0 | 19.3 | 19.5 | 19.8 | 20.3 | 20.7 | 21.2 | 21.7 | 22.1 | 22.9 | 23.7 |
| Winter | Waiheke | COM | 11.5 | 11.6 | 11.6 | 11.6 | 11.7 | 11.8 | 12.0 | 12.1 | 12.2 | 12.5 | 12.9 |

TABLE 10-25: TAKANINI LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

#### 10.8.12.4 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, except on Waiheke Island which is predominately underground cable.

Vector forecasts that some of the Clevedon ZSS feeders 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 4). 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 in FY26 in the central region of Takanini. This growth is also forecast to cause voltage dips on the long radial distribution feeders supplying the Kawakawa Bay community. Two voltage regulators will be installed near the end of the feeder to mitigate the voltage issues.

During recent years, large greenfield residential developments in the Maraetai region, near Beachlands, have required feeders to be extended. To ensure sufficient backup is available to meet the SoSS, Vector will undertake feeder reinforcement (including installing switches and some underground cables) to optimise the network configuration and create new interconnection points between adjacent feeders. The programme of works is required to be completed by FY27.

The Kawakawa Bay community has backup provided from Counties Power, the adjacent EDB. However, due to capacity constraints on the Counties Power feeder, Vector has installed a 1 MW / 1.7 MWh BESS to provide the security required under the SoSS.

#### 10.8.12.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Waiheke island subtransmission supply resilience | Third subtransmission submarine cable | FY26 | 9.0 |
| Takanini ZSS – 11 kV feeder SoSS breach in FY27 | Takanini - new eastward 11 kV feeder | FY26 | 1.0 |
| Clevedon ZSS SoSS in 2028. Takanini ZSS - Hamlins 11 kV feeder is voltage constraint in 2028 in to back-feed Clevedon ZSS | Takanini - Hamlins 11 kV feeder reinforcement - Voltage Regulator installation | FY27 | 0.4 |
| Takanini ZSS - Brookby 11 kV feeder reinforcement distribution feeder Voltage constraint | Takanini - Brookby 11 kV feeder reinforcement - Voltage Regulator installation | FY27 | 0.4 |
| Maraetai - Beachlands 11 kV feeder spur SoSS breach. | Maraetai - Beachlands 11 kV feeder spur link | FY27 | 0.7 |

TABLE 10-26: TAKANINI CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.13 OTAHUHU PLANNING AREA

### 10.8.13.1 OVERVIEW

Otahuhu Planning area is one the smallest non-CBD planning areas. It consists of Highbrook, Bairds and Otara. The old power station site at Otahuhu is planned for redevelopment as an industrial area and Vector has received connection enquiries for a large industrial development to be located near Highbrook. A total demand growth of 5 MVA is forecast by the end of the AMP period.

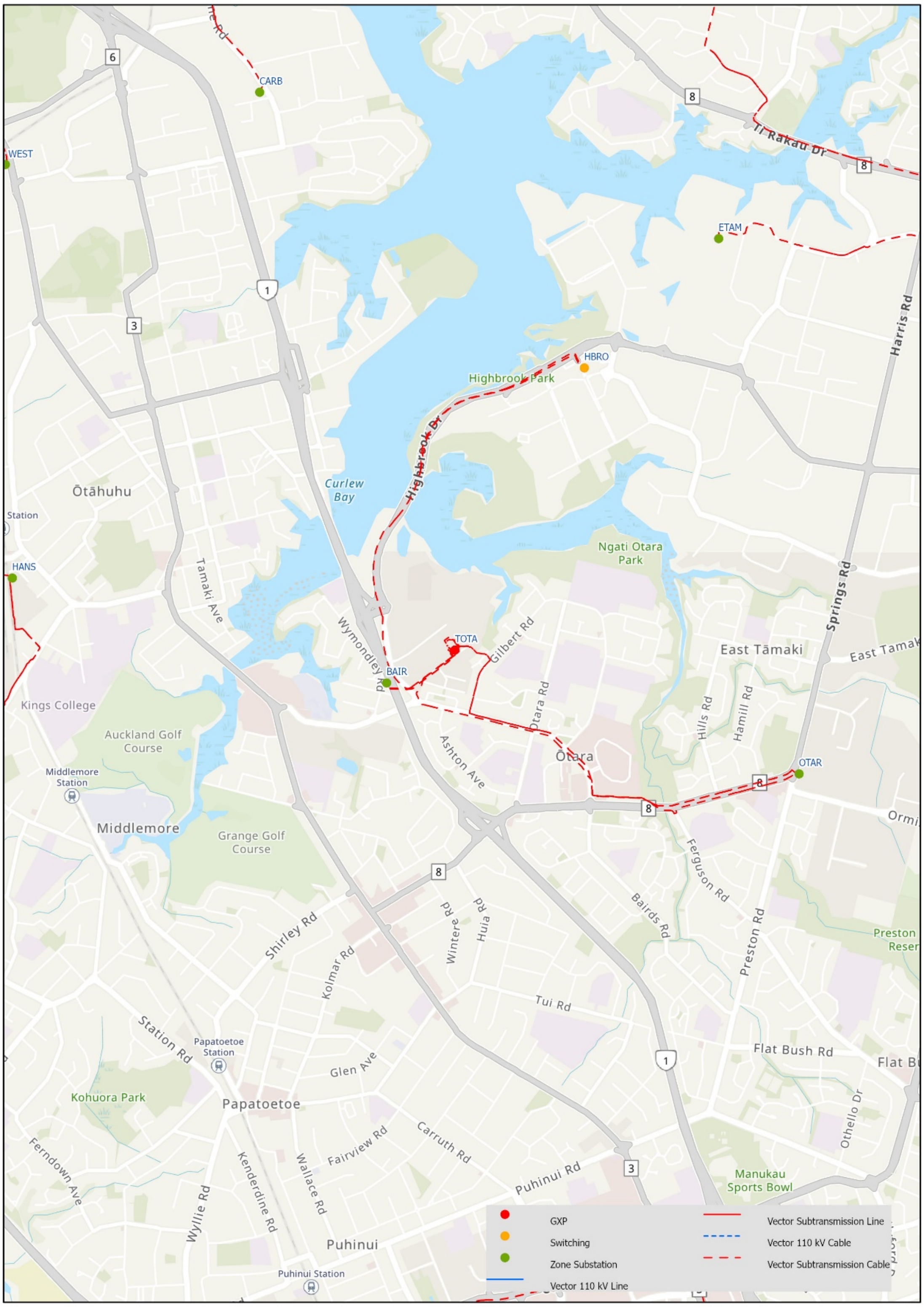



FIGURE 10-19: OTAHUHU SUBTRANSMISSION NETWORK

### 10.8.13.2 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.

### 10.8.13.3 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.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Bairds | RES | 24.6 | 24.7 | 24.7 | 24.8 | 25.0 | 25.3 | 25.5 | 25.8 | 26.0 | 26.8 | 27.7 |
| Winter | Highbrook | COM | 12.5 | 12.4 | 12.4 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.3 | 12.4 | 12.4 |
| Winter | Otara | COM | 29.0 | 28.8 | 28.7 | 28.6 | 28.8 | 29.0 | 29.2 | 29.4 | 29.6 | 30.6 | 31.6 |

TABLE 10-27: OTAHUHU LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.13.4 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 extensive industrial growth in the Highbrook region, there is sufficient capacity to supply the growth without breaching the SoSS.

Vector has identified an 11 kV feeder from Otara ZSS that will breach the SoSS in FY30. 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.

### 10.8.13.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Otara ZSS - K15 11 kV feeder breaches SOSS in summer 2031 | Otara - K15 11 kV feeder capacity optimisation - RMU installation | FY30 | 0.25 |

TABLE 10-28: OTAHUHU PLANNING AREA CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

## 10.8.14 WIRI PLANNING AREA

### 10.8.14.1 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. The load increase is forecast to be 20 MVA in total and Vector plans to supply it from the new West Wiri ZSS that is expected to be commissioned in FY23.

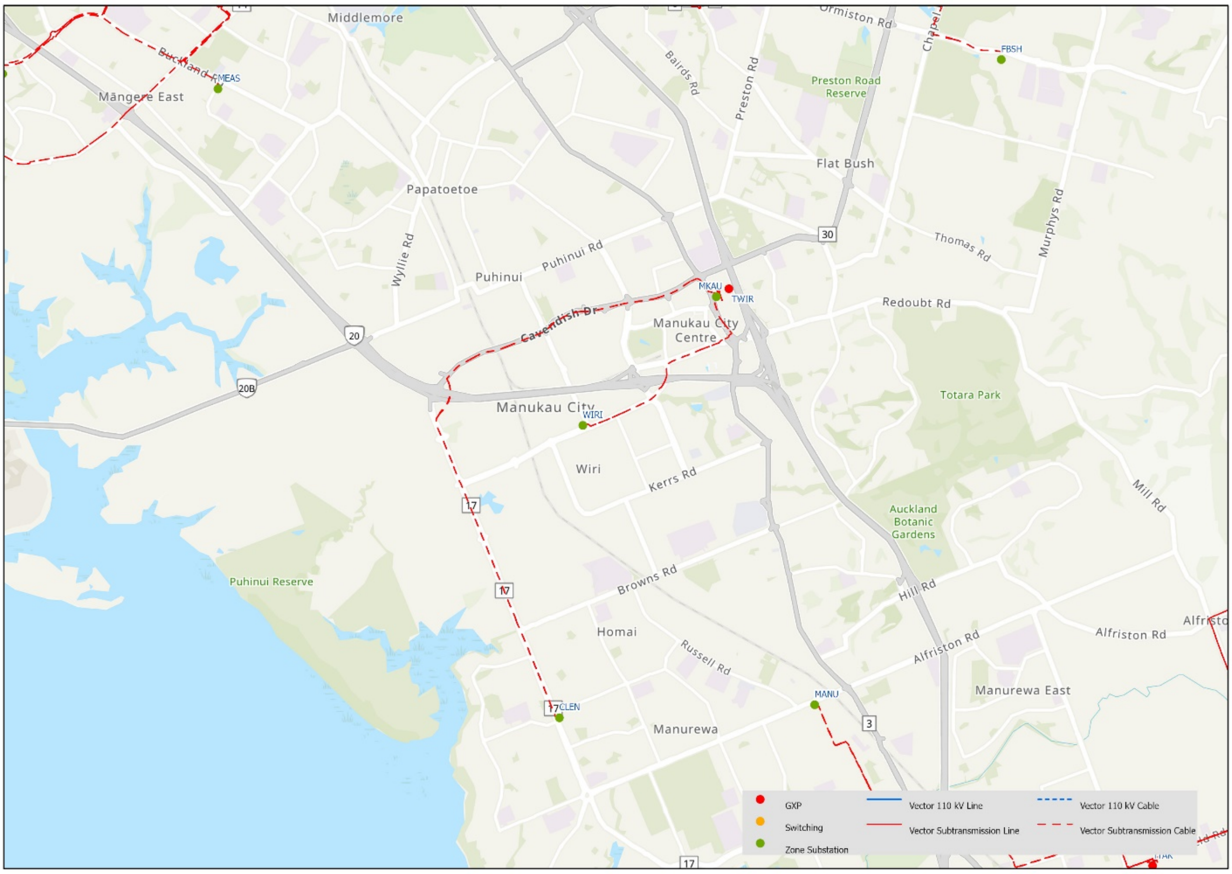



FIGURE 10-20: WIRI SUBTRANSMISSION NETWORK

### 10.8.14.2 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.

### 10.8.14.3 ZONE SUBSTATION

There are three zone substations currently supplying the Wiri area with a fourth zone substation undergoing detailed design with an expected commissioning date of FY23.

There are large industrial developments coming online within the next two years near the Wiri ZSS. The network will be reconfigured so that West Wiri ZSS will supply the northern and western loads and Wiri ZSS will supply the southern areas.

No other zone substation security breaches anticipated within the AMP period.

| | | | LOAD FORECAST (MVA) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEASON | ZONE SUBSTATION | SOSS CATEGORY | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
| Winter | Clendon | RES | 25.5 | 25.4 | 25.4 | 25.4 | 25.5 | 25.6 | 25.7 | 25.8 | 25.9 | 26.1 | 26.3 |
| Winter | Manukau | COM | 31.9 | 32.1 | 32.3 | 32.5 | 32.9 | 33.3 | 33.8 | 34.2 | 34.6 | 35.8 | 36.9 |
| Winter | Wiri | COM | 43.8 | 45.5 | 47.3 | 48.2 | 49.4 | 50.7 | 51.9 | 53.2 | 54.4 | 56.4 | 58.4 |

TABLE 10-29: WIRI LOAD FORECAST AND FORECASTED BREACHES OF THE SECURITY OF SUPPLY STANDARD (SOSS)

### 10.8.14.4 DISTRIBUTION

The distribution feeders from Wiri westward towards the airport are close to full capacity and are forecast to breach the SoSS in FY23. This will be resolved by reconfiguring loads across Wiri ZSS and the future West Wiri ZSS once it is commissioned in FY23.

In addition, the overall industrial growth in the Wiri area has resulted in a shortfall in backstop capacity, with the SoSS forecast to be breached in FY25 and FY26 on two feeders. Vector's preferred solution is to create additional interconnections between feeders to increase backstop capacity and mitigate the risk.

### 10.8.14.5 CONSTRAINTS AND SOLUTIONS

| CONSTRAINT | SOLUTION / PROJECT NAME | COMMISSIONING FY | ESTIMATED INVESTMENT $M |
|---|---|---|---|
| Significant increase in demand due to several large customers and residential load growth will cause a breach of the SoSS by FY24. | West Wiri new zone substation<br>Commission a new zone substation in FY23 to resolve the capacity issues. | FY24 | 12.4 |
| Wiri ZSS - Frucor 11 kV feeder SoSS breach in 2026 | Wiri - Frucor 11 kV feeder capacity optimisation - RMU installation | FY25 | 0.3 |
| Wiri ZSS - feeder SoSS breach in FY27 | Wiri - Roscommon 11 kV feeder link | FY26 | 1.3 |

TABLE 10-30: WIRI CONSTRAINTS AND NETWORK REINFORCEMENT PROJECTS

**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.

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 RELIEVING WELLSFORD-WARKWORTH FORECAST CAPACITY CONSTRAINTS

The Warkworth Area is forecast to see significant urban growth as changes to the urban boundary open up significant new areas for development of all types. Access to the area will be significantly improved following the completion of the Puhoi to Warkworth motorway and the proposed Warkworth to Te Hana motorway, increasing the area's attraction to residential, commercial and industrial customers alike. Long-term forecasts predict that the number of ICPs will grow by more than 60% in the next 30 years, with demand in the Warkworth area increasing to between 49 MVA and 82 MVA in the same time frame.

Managing this growth will necessitate a range of projects aimed at controlling the rate of increase in demand, whilst enhancing the capacity of the distribution network to supply it securely and reliably. Taking a long-term view to the management of the issues results in a portfolio of projects which, taken together, progressively manage the network's response to the growth in customer demand and the resulting network capacity and security constraints.

The four related projects identified are:

- Wellsford-Warkworth 110 kV future proof ducts
- Warkworth load control
- Wellsford-Warkworth 33 kV upgrade stage 1
- Wellsford 33 kV Outdoor to Indoor (ODID) switchboard conversion

The future proof ducts and load control are discussed below. The 33 kV upgrade Stage 1 and ODID conversion are outside the 5-year horizon.

#### 10A.2.1.1. WELLSFORD-WARKWORTH 110 KV FUTURE PROOF DUCTS

**WELLSFORD-WARKWORTH 110 KV FUTURE PROOF DUCTS**

**CONSTRAINTS**

Three capacity constraints have been identified in the Wellsford-Warkworth area:

- Transpower has identified that Wellsford GXP demand is at or above its N-1 security limit.
- Forecast demand growth for the two overhead 33 kV subtransmission circuits from Wellsford ZSS to Warkworth ZSS show that they are expected to breach their capacity and SoSS constraints in 2022 without hot water load control demand management equipment upgrades, and by 2029 with HWLC upgrades.
- 11 kV security shortfall is developing at Snells Beach and Warkworth.

The long-term 30-year demand forecasts for the Warkworth area is for demand to increase to between 49 MVA and 82 MVA, necessitating an additional ZSS planned to be located north of Warkworth at Mahurangi, designed ultimately to be supplied by 110 kV subtransmission circuits.

**OPTIONS**

1. **Do Nothing**: Imminent SoSS breaches through the network from GXP, to subtransmission and zone substations will mean that customer services will be put at significant risk. Transpower will also need to bring forward the Wellsford GXP upgrade, which will result in near-term increased cost to all customers.
2. **Wellsford-Warkworth 110 kV Future Proof Ducts**: Install ducts during SH1 road upgrade to accommodate future subtransmission reinforcement circuits. NZTA is undertaking a road safety improvement programme that will allow access for Vector to install cable ducts along SH1 from Wellsford to Warkworth, sharing the cost of traffic management and civil works, and not impacting future road usage. The ducts are to be designed for 110 kV cables to accommodate the future 110 kV subtransmission circuits for Mahurangi - $34m in total over the life of the project with $17.4m remaining to be spent in this AMP period.

3. **Defer installation of the ducts** proposed in Option 1 until the additional subtransmission circuit is needed. The cost of installing the ducts in the completed highway with a median barrier is estimated to be more than double that of Option 1 due to loss of benefits arising from works shared with NZTA and there is considerable risk of obtaining permissions to undertake the work.
4. **Install a new subtransmission supply** along the SH1 motorway from Silverdale GXP. Silverdale is further away from Warkworth than Wellsford, and there is no opportunity for shared civil works with NZTA road projects making the project significantly more expensive than Option 1.
5. **Construct a new GXP near Tauhoa** and install a new subtransmission supply through Kaipara Flats to Wellsford. Whilst the distance is similar to Option 1/2, and it avoids SH1, there would be no opportunity for shared costs of civil works with NZTA road projects, and the construction of a new GXP will make the project significantly more expensive than the combined cost of Options 1 and 2 (Rejected)
6. **Upgrade existing subtransmission overhead circuits** to provide additional capacity in the short-term and defer the requirement for a third subtransmission circuit (Option 2) for four years. However, these overhead lines are mostly on private property without formalised easements allowing access by Vector. The cost and feasibility of an upgrade is not certain as the towers and conductors may need to be completely rebuilt. Under very optimistic cost estimate assumptions, the NPV of this option is poorer than Option 2 by at least $3m.

**PREFERRED SOLUTION**

Option 2 has been selected (and is currently being constructed) on the basis that the Warkworth Load Control project is also implemented to enable deferral of the subtransmission circuit installation to progressively manage the developing growth in demand and the resulting network security constraints.

By planning the timing of the individual phases of the projects, some options can be deferred until they are necessary to keep pace with the growth in demand. Option 2 is preferred for duct installation as it is much cheaper and less disruptive to install cable ducts when trenches are open in a new road, rather than shortly after the civil works are completed.

### 10A.2.1.2. WARKWORTH/SNELLS BEACH LOAD CONTROL

**WELLSFORD/WARKWORTH/SNELLS BEACH LOAD CONTROL AND HOT WATER LOAD MANAGEMENT**

**CONSTRAINT**

Warkworth subtransmission (bulk) supply and Snells Beach are on the cusp of breaching SoSS; Wellsford GXP security is also on the cusp of breaching N-1 security.

No load management exists in this network area; hot water load management equipment is outdated and either non-functional or unreliable

The Wellsford zone substation legacy cyclo-ripple equipment that performed this function has been decommissioned due to unreliability. Warkworth and Snells Beach zone substations legacy equipment is also at significant risk of failure and unable to keep pace with the rapid rate of subdivision development and customer requirements. These factors are forecast to result in capacity shortfalls by FY22 if peak demand is not controlled.

**OPTIONS**

1. **Do Nothing**: There is a high risk of the existing Warkworth, Wellsford and Snells Beach legacy load management systems being unable to continue to reliably ensure management of customer hot water cylinders and that as a result SoSS will be breached.
2. **Transmission network augmentation**: Undertake investment in the refurbishment of primary assets and network reinforcement to increase capacity and mitigate the SoSS breaches.
3. **Demand Side Management (DSM)**: Implement measures to reduce load at Warkworth and Snells Beach substations, integrated (by DERMS) with existing battery energy storage systems (BESS) already installed at Snells Beach substation and in Warkworth township.
4. **Replacement of legacy Hot Water Load Control (HWLC)**: Replace the legacy HWLC assets and integrated them with the existing BESS to provide an IoT hot water load management system for customers within the Warkworth, Wellsford and Snells Beach areas. Expanding Warkworth urban load growth provides an opportunity to embed this new load shifting system as a network utilisation gain while generating increased revenue via the Electricity Reserve Market and pass-through transmission cost savings to customers.

**PREFERRED SOLUTION**

Options 3 and 4 are preferred for the reasons provided above, plus deferment of new Wellsford-Warkworth subtransmission circuits by two years until 2027, a second transformer at Snells Beach for six years to beyond 2030, and a new Warkworth South zone substation for a further two years until FY32.

Hot water load control is one of the most cost effective and easy-to-install load management solutions available to EDB's (EECA Report, September 2020), particularly in residential areas, and apart from the objective to install a reliable replacement scheme, this system will assist to defer expensive refurbishment of primary assets. To most effectively provide this Vector requires a system that is more granular, remotely reconfigurable, reliable and vendor supported than that of its present end of life provision.

### 10A.2.2 MAHURANGI ZSS LAND PROCUREMENT

**MAHURANGI ZSS LAND PROCUREMENT**

**CONSTRAINT**

The long term (30-year) load growth forecast for the Warkworth area is for demand to increase to at least 49 MVA if all non-network and demand management solutions are implemented, and up to up to 82 MVA if there is no demand management. The planned response to this demand growth is to establish a new zone substation at Mahurangi to the north of Warkworth ZSS, which will initially be supplied at 33 kV, with the ultimate objective of being supplied at 110 kV. There is presently no site identified for a future 110/33 kV bulk supply substation or a future 33/11 kV zone substation to serve the fast-growing area on the western fringe of the expanding Warkworth urban development.

**OPTIONS**

1. **Do Nothing:** There is a risk of being unable to acquire a suitable site when needed or needing to pay excessive costs.
2. **Identify and acquire a suitable site** for a future Warkworth West (Mahurangi) zone substation. The site will be suitable for a future 110/33 kV bulk supply substation as well as a 33/11 kV zone substation.

**PREFERRED SOLUTION**

Option 2 is preferred so a suitable site for a future zone substation can be secured. 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. Land investigation negotiations are underway.

### 10A.2.3 OMAHA ZONE SUBSTATION

**CONSTRUCTION OF A NEW OMAHA ZONE SUBSTATION**

**CONSTRAINTS**

The demand on Warkworth zone substation exceeds the firm capacity and major development is underway in the area.

Two of the 11 kV feeders which serve the region north of Warkworth zone substation are very long, have high SAIDI and are capacity constrained by minimum voltage breaches. Modelling indicates that voltage is low under normal peak load conditions and breaches the acceptable minimum under backstop conditions, which limits the available backstopping capacity.

**OPTIONS**

1. **Do Nothing:** Voltage constraints and reliability issues will continue.
2. **Install voltage regulator:** This will address the voltage constraint but not the reliability and transformer capacity issues.
3. **Construct Warkworth South ZSS:** This will address the transformer capacity issue but would still require long feeders to supply the northern areas, so will not resolve the reliability or voltage constraints. This is also the most expensive option.
4. **Construct Omaha ZSS**. All constraints addressed and the more expensive Warkworth South ZSS deferred.

**PREFERRED SOLUTION**

Option 4 is preferred as it addresses all constraints at the lowest cost.

We note that Option 3 is scheduled for 2032, triggered by future distribution network constraints that are independent of the constraints described here.

## 10a.3 Silverdale planning area

### 10A.3.1 MILLWATER ZONE SUBSTATION

**MILLWATER ZONE SUBSTATION**

**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 2027, and a major customer in Silverdale requires a large capacity connection.

**OPTIONS**

1. **Do Nothing**: Existing Milldale cables will become overloaded. Vector is required to connect customers.
2. **Provide feeders from Spur Road ZSS**: Supplying the large customer 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 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. It will also mitigate the need for 11 kV cabling from a more distant ZSS to supply the large customer.
4. **Install feeder cables from Orewa ZSS and Red Beach ZSS**: this would require very costly 11 kV cabling and switchgear extensions at both substations to supply Milldale.
5. **Bring forward construction of Dairy Flat zone substation**: this would not be required until well beyond the AMP period as we have presently spare capacity at Spur Road ZSS to supply start-up densification development stages in Dairy Flat.

**PREFERRED SOLUTION**

Option 3 is preferred as it provides the least-cost combined Vector and major customer solution and delivers improved network security and resilience. The Millwater ZSS site is close to the major load centres and is a more efficient option than long feeder cables from more distant alternative substations.

## 10a.4 Henderson planning area

### 10A.4.1 SH16 TO WAIMAUKU FUTURE PROOFING DUCTS

**SH16 TO WAIMAUKU FUTURE PROOFING DUCTS**

**CONSTRAINT**

The Waimauku ZSS supplies the rapidly growing Kumeu-Huapai district. The ZSS has a single overhead 33 kV supply. As demand grows the security of supply standard will not be met.

**OPTIONS**

1. **Do Nothing**: Accept the forecast SoSS breaches and overloads thereby risking the loss of customer supplies and increasing unreliability.
2. **Install voltage regulators to increase backstop reach** from Helensville and Riverhead ZSS. This distribution project will proceed in 2022 and defer further investment for several years.
3. **Install a second 33 kV supply to Waimauku ZSS**. A second subtransmission circuit will address the security shortfall. This major project is deferred by the regulator project.
4. **Install future-proofing ducts for the second 33 kV circuit**. A Waka Kotahi SafeRoads project is upgrading the highway on the cable route. Ducts will be installed in combination with the roadworks to reduce the cost and public disruption of the standalone civil project later.

**PREFERRED SOLUTION**

Option 2 and 4 are preferred as the lowest cost, staged solution.

### 10A.4.2 SWANSON SECOND 33/11 KV TRANSFORMER

**SWANSON SECOND 33/11 KV TRANSFORMER**

**CONSTRAINT**

Increasing demand is forecasted to result in SoSS breaches at Simpson Road ZSS and Ranui ZSS by more than 1 MVA in 2026 and increasing, and at Swanson ZSS the transformer 15 MVA capacity limit will be reached by 2029.

**OPTIONS**

1. **Do Nothing**: Accept the forecasted SoSS breaches and overloads thereby risking the loss of customer supplies and increasing unreliability. This will result in non-compliance with the SoSS.
2. **Install second transformers** at both Simpson Road (15 MVA) and Ranui (20 MVA) ZSS. Eliminates future SoSS breaches at each of these zone substations, and both substations have space to install a second transformer.
3. **Install a second 12.5 MVA or 15 MVA transformer** at Swanson ZSS. A second transformer addresses the shortfalls at both Simpson Road and Ranui ZSS, in addition to the constraint that develops at Swanson by 2029. This is the least cost compliance option.
4. **Build a new zone 2x20 MVA substation (Waitakere ZSS)**. A new zone substation at Waitakere would address the developing constraints, but due to its location and the distance to forecasted high growth priority areas, would require an accompanying 11 kV cable network that would make the option's cost non-competitive.

**PREFERRED SOLUTION**

Option 3 is preferred. The cost is less than both options 2 and 4, and it relieves the developing constraints at all three zone substations. The cost of a new zone substation plus an 11 kV cable network is much greater than upgrading an existing zone substation.

### 10A.4.3 WHENUAPAI ZONE SUBSTATION LAND PURCHASE

**WHENUAPAI ZONE SUBSTATION LAND PURCHASE**

**CONSTRAINT**

Whenuapai is a fast-growing area which is forecast to cause constraints to develop on existing feeders to the area from Waimauku and Riverhead zone substations. Also, there is a requirement to allow for a major customer connection.

**OPTIONS**

1. **Do Nothing**: Due to development, there is a risk of being unable to purchase a suitable site when needed or needing to pay an excessive price.
2. **Identify and acquire a suitable site for a future Whenuapai zone substation**. This option proposes the advanced purchase of land to secure a suitable site in an optimal location. The site should be purchased by FY26 to allow for new zone substation construction in FY28.

**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.5 Hepburn planning area

### 10A.5.1 BRICKWORKS NEW 11 KV FEEDER CLARK STREET

**BRICKWORKS NEW 11 KV FEEDER CLARK STREET**

**CONSTRAINT**

Load growth on two feeders from Brickworks ZSS (K05 and K09) are forecast to exceed their capacities and breach SoSS by 2024. Further, in the event of the failure of the single transformer at Brickworks ZSS, customers are not assured of an adequate back-up supply provided by load transfers from nearby New Lynn and Avondale zone substations via K03.

**OPTIONS**

1. **Do Nothing:** Accept two feeders at full capacity (summer ratings) in 2024 and accept one feeder breaching SOSS in 2024. Supply to customers will become increasingly unreliable.
2. **Install new 11 kV feeder cables:** Install a new feeder to relieve the load on the K09 feeder and to provide back-up capacity during outage scenarios. Also, uprate one underrated section of cable on K05 feeder to relieve the other capacity constraint.
3. **Implement demand side management and non-network solutions:** Implement non-network options such as hot water load control (HWLC). As the area is dominated by large commercial loads to retail and other commercial customers, there are insufficient residential customers with controllable loads such as hot water systems for this option to result in enough demand reduction to make this option effective in relieving the identified constraints. Other demand management options have not been identified and the scale of growth reduces the likelihood of this being a feasible long term solution.

**PREFERRED SOLUTION**

Option 2 is the least cost and technically preferred option. This option addresses both the feeder loading constraints and the zone substation SoSS shortfall. Brickworks is a high-growth area of mainly commercial loads, and the existing zone substation demand is expected to almost double during the AMP period, meaning that demand side management and other non-network solutions do not deliver sufficient benefits to be technically feasible.

## 10a.6 Albany planning area

### 10A.6.1 COATESVILLE SECOND 33-11 KV TRANSFORMER

**COATESVILLE SECOND 33-11 KV 12.5 MVA TRANSFORMER**

**CONSTRAINT**

Increasing urbanisation and consequential increasing demand on Coatesville ZSS is forecast to breach SoSS in 2021 by 3.2 MVA, rising to as much as 4.1 MVA in 2031. Furthermore, as Coatesville ZSS is a single transformer zone substation, the loss of the single transformer results in an inability to back-up 95th percentile load using load transfers from adjacent ZSSs. Mobile generation must be used as a back-up with a consequent impact to fuel costs, O&M costs, and $CO_2$ and particulate emissions.

**OPTIONS**

1. **Do Nothing**: Accept the 3.2 MVA breach of Vector's SoSS and continue to use mobile generation as a backup.
2. **Install a second transformer at Coatesville ZSS and extend the 11 kV switchboard**. Coatesville ZSS has very secure 33 kV subtransmission supplies from three sources and has ample space to accommodate a second transformer and switchboard extension. The 12.5 MVA transformer at Spur Road ZSS will be re-redeployed at Coatesville following the Spur Road upgrade project.
3. **Construct a new zone substation at Dairy Flat including 11 kV feeder reinforcement.** A new zone substation at Dairy Flat is in Vector's long-term plan, however, it is not forecast to be required until beyond the current AMP planning horizon. The full cost of a new zone substation and interconnections is over $15m and advancing its construction by more than 10 years is not justifiable by this requirement alone.
4. **Reinforcement of 11 kV back-up supplies**. Augment the 11 kV network from Spur Road, McKinnon and/or Riverhead zone substations. The cost of installing relatively long-distance 11 kV cables to provide back-up supplied to Coatesville ZSS at the 11 kV level is much greater than the cost of the second transformer option and will also require access to properties and road infrastructure outside Vector's existing permits.
5. **Implement demand side management and non-network solutions**. Implement non-network options as hot water load control (HWLC). The load on Coatesville ZSS includes one large single customer load and has a large rural load characteristic with a small residential component making Coatesville ZSS not ideal for non-network solutions. Reduction in demand from controllable loads will not deliver the demand reductions required to eliminate the constraint.

**PREFERRED SOLUTION**

The preferred option is Option 2. This option is the least cost option and provides improved network resilience and customer reliability of supply.

### 10A.6.2 PIERMARK DRIVE 11 KV REINFORCEMENT OF THE FRONT END OF TWO 11 KV FEEDERS

**PIERMARK DRIVE 11 KV REINFORCEMENT OF THE FRONT END OF TWO 11 KV FEEDERS**

**CONSTRAINT**

Increasing summer demand on feeders from Bush Rd ZSS has resulted in two feeders exceeding their summer cable ratings (90% cable capacity) in 2020. This is forecast to increase to five feeders exceeding 80% capacity by 2026. As a result, one feeder has been in breach of SoSS since 2020, with one additional feeder forecast to be in breach of SoSS by 2026. Vector has identified that the constraint applies to sections of PILC cable first installed from this ZSS that have low capacity ratings.

**OPTIONS**

1. **Do Nothing**: The two feeders already operating over their summer rating are at increased risk of failure due to potential overheating. An additional three feeders will see an increased risk of failure as their demand increases towards, and then exceeds, their cable ratings. SoSS breaches on two feeders by 2026 mean that supply reliability is being put at risk in the affected feeders.
2. **Reinforce cable feeders**: Replace segments of the two overloaded cable feeders with cable section of higher capacity. The cables located nearest to the Bush Rd ZSS along Piermark Drive are causing he constraint and will be replaced. The network will be reconfigured to optimise the resultant network capacity.
3. **11 kV feeder reinforcement from alternative ZSS**: Areas served by affected feeders can also be fed from Greenhithe ZSS and James Street ZSS if the relevant feeders from these ZSSs were reinforced; however, the cable route lengths requiring reinforcement would be considerably greater than those required under option 2, leading to much greater capital cost for no additional benefit.
4. **Demand management**: given the type of load and growth rate, demand management has not been identified as a feasible option.

**PREFERRED SOLUTION**

Option 2 is the least cost option; it addresses the feeder loading and the feeder SoSS and reduces network losses.

# 10a.7 Wairau planning area

## 10A.7.1 TAKAPUNA SECOND 33/11 KV TRANSFORMER AND SUBTRANS

**TAKAPUNA SECOND 33/11 KV TRANSFORMER AND SUBTRANS**

**CONSTRAINT**

The Takapuna ZSS is a single-transformer site supplying the North Shore CBD and surrounding hi-density residential area. There is an impending backstop shortfall in the event of an outage during peak demand.

The capacity of the Devonport peninsula subtransmission ring is limited by an old oil-filled cable section of the 33 kV Wairau-Takapuna cable.

**OPTIONS**

1. **Do Nothing**: The growing security of the supply deficit will continue.
2. **Reinforce the area** at 11 kV and install a new 33 kV Wairau-Takapuna cable
3. **Install a second transformer** at Takapuna and replace the oil-filled cable section: a second transformer will add the required capacity at a similar cost to 11 kV reinforcement but will better provide for future growth. The major expense of a second subtransmission circuit can be deferred by the replacement of the limiting section of the existing circuit.

**PREFERRED SOLUTION**

Option 3 is preferred as the least cost credible option that resolves the network need.

## 10A.7.2 NGATARINGA BAY DIRECT SUPPLY BELMONT ZSS

**NGATARINGA BAY DIRECT SUPPLY BELMONT ZSS**

**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. **Decommission Ngataringa Bay zone substation**: To eliminate the risk to the network that would occur if Ngataringa Bay ZSS is inundated, Vector would decommission the ZSS by removing equipment, and remove (or drain and seal) the oil-filled submarine cable. Customers presently supplied by 11 kV feeders from Ngataringa Bay ZSS would in future be supplied by new 11 kV feeders and XLPE submarine cables 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.8 Auckland CBD planning area

### 10A.8.1 CBD 22 KV NETWORK ROLLOUT TO FACILITATE THE CONNECTION OF NEW LOAD TO THE 22 KV NETWORK

**CBD 22 KV NETWORK ROLLOUT TO FACILITATE THE CONNECTION OF NEW LOAD TO THE 22 KV NETWORK**

**CONSTRAINT**

The legacy 11 kV CBD distribution network is increasingly unable to keep pace with the demands required of it by new connections, resulting in numerous capacity and security breaches being identified in the short and medium term and expected to develop further in the long-term. Continuing to supply new connections from the 11 kV network will result in increasing 11 kV feeder and 11 kV inner city zone substation SoSS breaches by 2026.

**OPTIONS**

1. **Do Nothing**: Connect the new inner-city load to the existing 11 kV network. This will result in breaches of capacity and security by 2025 and increasing levels of unreliability and customers experiencing poor service.
2. **Extend 22 kV distribution network coverage**: Within the Auckland inner city, connect all new inner-city load to the 22 kV network. Long-term forecasts of load growth indicate that an efficient allowance for the ongoing cost of the 22 kV roll-out programme is approximately $3.3m per annum. As localised infrastructure developments planned for the CBD proceed and provide more definition for discrete projects affecting specific zone substations, annual allowances under this project will be superseded in the overall expenditure plan by project-specific estimates (see below projects). This is a programme that has been in progress since 2004.
3. **Reinforce inner city 11 kV zone substation capacity and reinforce the 11 kV network**: Continue to supply CBD customers at 11 kV by reinforcing the existing 11 kV network. This will require an ongoing commitment to major capital works and disruption to existing installations. Three of the four 11 kV zone substations presently serving the inner city are at the cusp of breaching SoSS and will require additional transformers, an extension of existing switchboards and additional feeders to provide the energy transfer capacity. The increasing load will result in feeder SoSS breaches and feeder reinforcement and replacement projects to extend the life of ageing infrastructure.

**PREFERRED SOLUTION**

The preferred solution is Option 2. By extending 22 kV distribution network coverage and connecting all new load to the 22 kV network. Vector has built-up significant 22 kV network coverage within the inner city since commencing the 22 kV network roll-out in 2004. The 22 kV zone substations have higher N-2 network security levels (meeting the CBD subtransmission network security standard) and have significant spare capacity to connect additional new load before being at risk of breaching N-2 security. The 22 kV distribution cable network is more robust than the ageing 11 kV cable network. The 22 kV network extension is the most cost-efficient option.

### 10A.8.2 LIVERPOOL 22 KV FEEDER NEW

**LIVERPOOL 22 KV FEEDER NEW**

**CONSTRAINT**

As part of the City Rail Link project, a new station, Aotea Station, is planned for the centre of the CBD. A new connection point is required to meet the general (non-traction) demand of the station, which will be supplied from feeder J17 at Liverpool 22 kV zone substation. Whilst the initial forecast demand during construction does not breach the feeder capacity and security limits, once the station becomes operational in FY 24, the increased demand will cause them to be breached.

**OPTIONS**

1. **Do Nothing**: The operational load of Aotea Station starting in FY24 will result in breaches of capacity and security limits on the existing Liverpool (LIVE J17) 22 kV feeder.
2. **Install two new 22 kV feeders from the Liverpool zone substation**. To address the immediate need, it would be sufficient initially to install just one feeder. But in anticipation of future growth in demand, and to take advantages of cost economies of scale, there are cost benefits in taking the opportunity to install a second feeder at the same time. Both new feeders will integrate approximately midway into the existing 22 kV feeders.
3. **Install two new 11 kV feeders**. Vector's overall strategy for the CBD is to roll out the 22 kV distribution network. New 11 kV feeders would not align with this strategy, as they would use the available space less effectively, each feeder will provide lower capacity, and would not provide shared increased capacity for further future expansion.

**PREFERRED SOLUTION**

Option 2 is preferred as the most cost-effective long-term solution. It conforms with Vector's overall 22 kV roll-out strategy, it eliminates the feeder capacity and security constraints that would be caused by the Aotea Station operational demand, and it additionally future-proofs the network against the additional forecast demands on the zone substation resulting from more large CBD loads requiring to be connected in the future.

### 10A.8.3 CBD 22 KV EXTENSION WYNDHAM ST

**CBD 22 KV EXTENSION WYNDHAM ST**

**CONSTRAINT**

Long-term growth forecasts indicate a general need to extend the 22 kV distribution network across the CBD. The construction of City Rail Link and subsequent public realm works presented a synergistic opportunity to extend the 22 kV network into the area 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 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**: Take advantage of the CRL construction work to 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.

**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.8.4 CBD 22 KV EXTENSION ALBERT WELLESLEY ST

**CBD 22 KV EXTENSION ALBERT WELLESLEY ST**

**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 between Upper Albert and Wellesley Streets has caused major disruption to the existing electricity distribution network in this area but has also presented a synergistic opportunity to extend the 22 kV network into the area 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 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**: Take advantage of the CRL construction work to 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.

**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.8.5 CBD 22 KV EXTENSION TYLER ST EAST

**CBD 22 KV EXTENSION TYLER ST EAST**

**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 install sub-grade services and cabling, and 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.9 Roskill planning area

### 10A.9.1 LAND PURCHASE AND DESIGNATION FOR MT EDEN NEW SUBSTATION

**LAND PURCHASE AND DESIGNATION FOR MT EDEN NEW SUBSTATION**

**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 FY30.

**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 FY30. 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.

**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 FY30.

## 10a.10 Penrose planning area

### 10A.10.1 LAND PURCHASE AND DESIGNATION FOR TĀMAKI NEW SUBSTATION

**LAND PURCHASE AND DESIGNATION FOR TĀMAKI NEW SUBSTATION**

**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 exceed capacity from FY34.

**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 FY34. 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 will not relieve the developing 33 kV constraints that will cause an issue by FY34. Furthermore, supplying the Tāmaki Regeneration project from Glen Innes ZSS will prove 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 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 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 FY26. 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 FY34.

## 10a.11 Pakuranga planning area

There are no forecast growth or security related projects identified for the Pakuranga planning area that exceed $1m within the next five-year period.

## 10a.12 Mangere planning area

### 10A.12.1 LAND PURCHASE FOR MANGERE SOUTH ZSS

**MANGERE SOUTH LAND PURCHASE FOR ZSS**

**CONSTRAINT**

Expansion of the Watercare wastewater treatment plant at Mangere and expansions planned for the Airport Park industrial development precinct will increase demands in the Mangere Planning Area. These loads will predominantly impact Mangere West Zone Substation, which Vector is forecasting will cause feeder capacity constraints and breach SoSS requirements from FY27.

**OPTIONS**

1. **Do Nothing**: Failure to secure a site for Mangere 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 FY27. Consequently, customers supplied from Mangere West ZSS will increasingly suffer from supply reliability issues and possible equipment failure from FY27.
2. **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 at Mangere Wastewater Treatment Plant and the Airport Park precinct. 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. 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 Takanini planning area

### 10A.13.1 WAIHEKE 3RD SUBTRANSMISSION CABLE

**WAIHEKE 3RD SUBTRANSMISSION CABLE**

**CONSTRAINT**

Waiheke Island is supplied by two 33 kV submarine subtransmission cables originating from Maraetai zone substation 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 a 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 availability of a suitable cable ship, the depth at which the cable is located (shallow sections may have been ploughed into the sea bed), seismic activity, and most importantly, the weather, can all have a significant effect on submarine cable fault repair times.

The supply to the island will be reliant on a single cable for the time it takes to repair a failed cable and may have only N security while repairs are implemented.

**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 failure, age-related failure risk, and long repair times due to the nature of repairing submarine cables. Accept the supply resilience risk of the supply to the island (listed in Vector's active risk management system, ARMS).
2. **Installation of a 12 MW fleet of diesel generators on Waiheke Island**: High capital and operational 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 33 kV submarine cable to Waiheke Island**: A third fully rated 33 kV subtransmission cable would provide N-2 security of supply so that up to two of the three 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 preferred. It would increase the security of the supply to Waiheke Island and improve its resilience to common-mode failures and coincident faults.

## 10a.14 Wiri planning area

### 10A.14.1 WEST WIRI ZONE SUBSTATION NEW

**WEST WIRI ZONE SUBSTATION NEW**

**CONSTRAINT**

Expanding commercial development west of Roscommon Road and along Puhunui Road towards the airport is driving growth and causing forecasts of demand on Wiri zone substation to jeopardise capacity and SoSS constraints by FY24.

**OPTIONS**

1. **Do Nothing**: Wiri ZSS distribution feeders and substation load will breach security and very costly distribution reinforcement from alternative ZSS sources will be required.
2. **Build a new West Wiri zone substation**: Vector has an existing site in Jerry Green St located close to the expanding load centre and adjacent to the existing subtransmission cable route between Manukau ZSS/GXP and Clendon ZSS that is designated for a new zone substation. A new West Wiri ZSS would relieve demand primarily on Wiri ZSS and provide backstop reinforcement to adjacent substations.
3. **Install new 11 kV feeders from alternative ZSS**: Feeders from alternative zone substations (Wiri, Manukau, and Mangere East) would be expensive owing to the long cable route lengths from the existing zone substations to the development area. Planning reviews have also identified these to be a temporary short-term solution, due to the scale of the growth, the available feeder easements and potential issues crossing the train tracks.

**PREFERRED SOLUTION**

Option 2 is preferred. Building a new zone substation will relieve the emerging feeder capacity and SoSS constraints and will be used to supply the new large greenfield commercial development along Puhunui road towards the airport.


**SECTION 11**

# Reliability, safety and environmental

# 11 – Reliability, safety and environmental

## 11.1 Overview

Network reliability is managed through several investment portfolios. Renewal and replacement work programmes address reliability concerns of our older assets, while system growth and reinforcement projects help to strengthen network resilience by providing alternative options for electricity supply. This section sets out reliability expenditure not specifically covered in other sections of the AMP.

## 11.2 Asset management objectives

The asset management objectives that are addressed through our network reliability activity and investments are set out in the table below:

| FOCUS AREA | OBJECTIVES |
|---|---|
| Safety and Environment | • Preventing harm to workers, contractors and the public through our work practices and assets.<br>• Ensuring health and 'safety always' is at the forefront of decision making for the business.<br>• Complying with relevant legislation, regulation and planning requirements.<br>• Minimise the impact on the environment with regards to our assets and work practices.<br>• Proactively adapt the network to allow and prepare for the growing impact of climate change. |
| Customers and Stakeholders | • Provide a high-quality customer service experience across all interactions.<br>• Listen to and learn from our customers to ensure our service offering aligns with customer expectations.<br>• 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.<br>• Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact based investment profiling.<br>• Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice. |
| Future Energy Network | • Prepare the network for future changes that will be driven by:<br>– technology: DERs, electric transportation, increased active customer participation/customer choice, dynamic ratings etc.<br>– environment: climate change including decarbonization of the economy.<br>• Prioritise network flexibility to meet customer changing needs. |

TABLE 11-1: ALIGNMENT WITH ASSET MANAGEMENT OBJECTIVES

## 11.3 Strategic Reliability Management Plan

In RY20 Vector formalised the Strategic Reliability Management Plan (SRMP) which reinforces our commitment to compliance with the Default Price Path (DPP) Quality Standards.

Vector undertook a significant programme of work to improve network outage data and asset data quality to improve analysis of the root causes for the SAIDI and SAIFI performance. This analysis confirmed that the main challenge for the underlying SAIDI performance of the business was to improve the duration of outages. Following this analysis, the business commenced a programme of work in 2019 to achieve an improvement of 50 minutes of unplanned SAIDI on an annualised basis by the end of RY20. This programme of work contained specific reliability strategies and associated initiatives, which were a mix of new initiatives and the acceleration of some existing programs to bring forward the forecast benefits. Some of the strategies also delivered benefits to the planned SAIDI performance.

To focus the business on improving SAIDI performance, Vector established the 'Finding 50' campaign. This campaign was high-profile and communicated across our business, Field Service Providers (FSPs) and vegetation contractors. The visibility of the campaign across businesses and organisational hierarchies was a purposeful strategy to demonstrate the collective commitment across our stakeholders for this programme.

Through celebration of milestones and cultivation of new thought for delivery of reliability initiatives, we embedded the culture of reliability focused network management into business as usual practice.

In assessing and prioritising programmes, Vector has taken considerable care to ensure each initiative will deliver an enduring reliability benefit for the business in an economically responsible manner, proportionate to the need and with explicit regard to the long-run expectations of our customers. The SRMP analysis has also challenged fundamental processes such as our practices for managing transient faults to ensure reliability compliance is adequately considered in our policies.

The analysis and outcomes of the Finding 50 campaign formed the basis of an updated SRMP for RY21. The revised SRMP also incorporated the changes to quality standards for DPP3, in particular, the split of unplanned and planned SAIDI, and focused further on unplanned SAIDI performance.

In this section, we describe the ongoing strategies, investment and initiatives underpinning our Strategic Reliability Management Plan.

### 11.3.1 TRACK AND SHARE RELIABILITY PERFORMANCE

A key focus of the SRMP is to ensure that network reliability is considered as part of each investment and during the day to day operations. To facilitate this, Vector has implemented an improved reliability dashboard to provide up to date performance information.

### 11.3.2 GENERATION STRATEGY

Initiatives for this strategy include the use of mobile generation to mitigate the impact of increased planned work on the customer experience and fixed relocatable generation as a contingency plan to manage SAIDI on long rural feeders where other options to improve network resilience are not viable.

### 11.3.3 STRATEGY TO MITIGATE THE IMPACT OF HEALTH AND SAFETY PRACTICES

This strategy focused on a comprehensive review of all work tasks performed live line, before the change to de-energised work practices in RY16, considering both the risk and the complexity of the task. Following this review the following actions were taken;

- Reintroduction of certain hot stick procedures and tasking following risk assessments;
- Introduction of new technologies and operating procedures to enable indirect live line working and safely reduce the volume of emergency shutdowns;
- Risk based evaluation of all direct live line work tasks; and
- Evaluation of changes to recloser operation following protection review and risk assessments.

### 11.3.4 RISK BASED VEGETATION MANAGEMENT

Vegetation strikes and damage, transient or sustained, were found to be one of the most common causes of outages on the network. To address this, Vector has established a new risk based approach to plan remediation work as well as new contracting arrangements. This involves engaging an independent company to plan work packages using the risk based approach and also audit that the work has been undertaken correctly. Also, two vegetation management businesses (one incumbent plus an additional business) have been engaged to increase the volume of works that can be completed each year.

### 11.3.5 DEPLOYMENT OF NETWORK AUTOMATION

Vector's asset management strategy included a programme to continue the deployment of automation and sectionalisation on the network. This programme provided for automation projects on 11 kV feeders over ten years. The programme was accelerated with the first six years of the deployment to be completed during 2020 but it will continue albeit not as an accelerated programme. Further details on the nature of this initiative are provided in section 11.6.2 below.

### 11.3.6 FSP ENABLEMENT TO IMPROVE DURATION TIME OF OUTAGES

The analysis undertaken as part of the SRMP identified that the main issue faced by Vector was the response and restoration time when addressing faults. Since RY20, several initiatives have been developed to address this, including:

- Establishing an incentive scheme for FSPs concerning the average outage duration (CAIDI) performance for unplanned outages;
- Establishment of a new depot at Helensville;
- Deployment of additional fault passage indicators to enable quicker identification of fault location;
- Deploying 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 have already been observed in the RY20 and RY21 reliability performance.

### 11.3.7 CORRECTIVE MAINTENANCE STRATEGY AND IMPROVED INSPECTION TECHNIQUES

The strategy comprised an increase in resources 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. This work built on improved inspections techniques and an improvement in data quality through SAP PM.

Acoustic surveys are a highly effective technology for identifying certain asset failure modes and have become a key part of Vector's routine inspections and monitoring strategies for the overhead network and other asset classes going forward. It is expected that this programme and the associated corrective work will enable Vector to manage down the frequency of insulator and overhead conductor joint failures.

A programme was introduced to complete thermographic inspections of all 11 kV overhead terminations. A small number of terminations in an advanced state of degradation were identified and corrective work for these issues was expedited. In addition to thermography of overhead cable terminations, Vector has also introduced thermal inspections of complex and high criticality HV pole configurations including junction poles and T-offs.

## 11.4 Safety, health, environment and quality strategies

### 11.4.1 ENVIRONMENT AND CLIMATE CHANGE

As discussed in Section 2, Vector commissioned EY in 2017 to model the physical effects of climate change on its electricity network. The report concluded that the Auckland electricity network will, from a climate modelling perspective, experience more frequent and sustained high wind events, longer, drier summers and more frequent occurrences of flooding and inundation.

Our analysis shows that if unmitigated this will have a significant impact on network reliability, resilience and security of supply.

The impact of climate change is being observed through Vector's experience of severe storms in recent years that resulted in extensive damage to the Auckland network and significant disruption to our customers. Vector also manages other climate related risks including bushfire risk during sustained periods of dry weather and the risk of asset flooding due to inundation following storm surges and high tides that are already driving some of our investments.

We are responding to these challenges through adopting operational practices and design standards, deploying new technology, greater decentralisation, digitalisation, and leading data analytics. Some practical examples include:

- New zone substations (ZSS) on our network are constructed with increased floor height above flood levels in which models take into account rising levels due to climate change. Wairau zone substation was constructed in a flood plain and was designed for a 1 in 500 year flood which it had to endure shortly after its completion in 2012 with a good outcome – no damage or failures – the photo below shows the substation equipment floor well above the flood level.
- At Ngataringa ZSS, one of our (few) ZSS in a low lying coastal area, a temporary bund will be constructed with a temporary roof to prevent sea level inundation during king tides until the ZSS is replaced in the longer term.
- We are preparing for a windy future by utilising fully insulated covered conductors (CCT) in our 11 kV distribution network that will prevent power outages due to falling branches and bark or small animals. Vector has historically experienced a significant increase in outages at high wind speeds. With CCT conductors, phases can touch during a storm without a risk of an outage and can withstand rubbing against a pole or tree for several hours.
- We are working with Auckland Council to improve our tree trimming and cutting to reduce the risk of outages for our bare conductor overhead line routes.
- Our programme to install additional isolation devices to keep the number of customers affected during an outage to less than 500 is continuing and so is our MV feeder automation programme.
- The temperature and moisture in the earth surrounding an underground power cable have a direct impact on how much current can be carried before there is a risk of damage to the cable. We have developed an operating standard that sets out the actions to be undertaken during a hot dry summer. This involves monitoring soil moisture at three locations spread over the network and the application of different capacity ratings for our subtransmission cable fleet on a certain level of moisture in the earth.
- We are investigating the use of dynamic ratings for our subtransmission underground cable fleet by using distributed temperature sensing to dynamically measure the operating temperature of a cable to allow higher ratings to be applied when the soil is cold and wet and lower ratings when the soil is hotter and drier.
- The risk of fire is most prevalent during hot dry summers because if a conductor should fail and fall into dry scrub or if an 11 kV dropout fuse should operate and cause molten metal to fall onto scrub there is a real risk of a fire. As part of our operating strategy for hot dry summers, reclosers are disabled at a certain minimum soil moisture content. We also work very closely with NIWA and FENZ to ascertain areas of high risk during hot dry summers. Modelled temperature rises are not believed to pose a risk in terms of increasing line-sag but in the longer term, towards the middle of this century, Vector will need to consider an integrated approach for the longer term in this regard.
- Where customers have DERs, e.g. solar, batteries, electric vehicles for vehicle-to-home charging, this will provide customers with the ability to ride through storms, increasing their overall resilience of supply.

FIGURE 11-1: WAIRAU ZSS FLOOD

### 11.4.2 APPLY SAFETY IN DESIGN

In response to societal and regulatory demands for safer workplaces, designers and decision makers are seeking greater consideration of safety issues in design. In this regard, the EEA has issued a guide on Safety in Design specifically for the NZ electricity supply industry. In response, 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.

## 11.5 Climate change and sustainability strategies

The risks posed to Vector's network by climate change and our response are summarised in chapter 2, Climate Change. Besides, when designing, building and operating the various components of the network, sustainability will be a key consideration. Under Vector's sustainability strategy, we are in the process of adopting the framework developed by the Infrastructure Sustainability Council of Australia to deliver sustainability outcomes through the asset management lifecycle.

### 11.5.1 APPLY A CIRCULAR ECONOMY APPROACH TO MATERIALS

Along with reducing carbon emissions, we are taking a broader view of materials entering the network, applying the principle of kaitiakitanga (stewardship) to ensure the maximum recovery of materials at end of life. This is a natural progression from normal practices such as resource efficiency, where we aim to reduce our consumption of resources in the management of the network, generating revenue through the sale of surplus materials, and reducing waste that goes to landfill.

Taking a circular economy approach calls for a different approach to procurement and technical specifications. We have begun and will continue to work with both suppliers and internal teams to pilot the use of new materials and end-of-life approaches and new service models.

Network components such as transformers, cabling and switchgear contain high percentages of relatively easily recoverable materials which are processed by scrap metal companies. Hardwood poles generally have a second life while concrete poles can be crushed with the recovery of any steel reinforcing.

Other items like oil used in transformers are recovered and reused in applications in other sectors where a lower quality product is acceptable.

Vector has been working with other participants in the battery value chain to develop a product stewardship scheme that ensures there is a maximum recovery of materials at end of life and safe disposal of any residual materials. Where practicable and condition allows, batteries will be repurposed for 2nd and 3rd lives and then ultimate disposal.

### 11.5.2 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 many instances, this framework provides for Vector's assets and network activities as 'permitted activities'.

Where possible, Vector designs installs, maintains or upgrades the network in a way that ensures this permitted activity threshold applies. 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 or mitigated.

### 11.5.3 FOCUS ON CARBON REDUCTION

Decarbonisation is a key Symphony strategic project. To achieve our commitment of net zero emissions by 2030, we are in the process of developing a carbon reduction strategy that includes setting annual reduction targets; reviewing opportunities relating to transmission losses, business travel, electricity consumption, waste minimization, and possible investment in New Zealand based carbon offsets.

Through the work on sustainable procurement and the circular economy, the scope of emissions being managed is continually expanded to incorporate more supply chain elements.

In support of this, we are considering the feasibility of applying principles such as the carbon emissions reduction hierarchy specified in the UK Publicly Available Standard for Carbon Management in Infrastructure Verification (PAS 2080). This approach ensures that carbon is considered in the earliest stages of asset management. The greatest opportunities to reduce carbon are during the needs analysis for an asset and these reductions reduce further along the asset management process.

## 11.6 Proactive risk management of asset portfolios

Renewal capex that is specifically focused on addressing and improving network reliability includes planned investment in the overhead line fleet, underground cable fleet, overhead switches, cable terminations, distribution transformers, MV feeder automation and the use of microgrids. The chart below shows the forecast capex for this portfolio during the AMP planning period. Details of the programmes of work and detailed forecast tables are shown further below. The graph below includes the forecast cost of some protection related projects but to keep protection projects grouped, the narrative and individual forecast tables are included in Chapter 12.

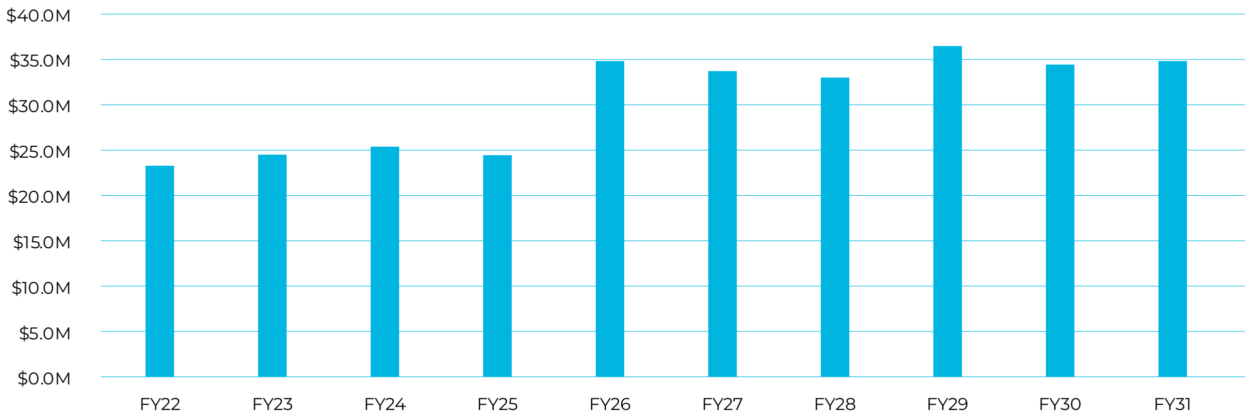



FIGURE 11-2: FORECAST RELIABILITY IMPROVEMENT

### 11.6.1 PROACTIVE RELIABILITY FLEET PROGRAMMES

Vector has identified several asset fleets with known type issues that present a risk to network reliability. To manage the associated volume of works, Vector has established testing and replacement programmes to ensure the long-term reliability of the network and deliverability of the replacements required. The key programmes are:

- Preventative conductor replacement based on the CBARM modelling as well as SAIDI and SAIFI performance. The existing conductors will be replaced with an overhead conductor or underground cable based on the local network topology and site conditions, environment and cost analysis. Commensurate upgrade of hardware e.g. crossarms, insulators, etc. will also form part of the works as required.
- Renewal of 11 kV overhead switches with identified type issues. Where the network topology requires, automated switches will be deployed in place of manual switches.
- 11 kV cable replacement based on a condition testing programme and prioritization using the CBARM models.
- Replacement of 11 kV and 33 kV cable 'cast iron' pot heads.
- Proactive replacement of approximately 6,400 distribution transformers that will reach the end of design life by 2030, prioritised using the CBARM models.
- Minor resilience improvements including, for example, strengthening areas of our network affected by high wind, installation of specialised overhead conductor covers, installation of fault passage indicators with remote signalling capability, and installation of crash barriers around poles in high crash zones.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland OH Conductor renewal | 5.01 | 5.30 | 6.10 | 6.90 | 7.70 | 7.70 | 7.70 | 7.70 | 7.70 | 7.70 | **69.51** |
| Northern OH Conductor renewal | 5.01 | 5.30 | 6.10 | 6.90 | 7.70 | 7.70 | 7.70 | 7.70 | 7.70 | 7.70 | **69.51** |
| Auckland OH 11 kV switch renewal | 0.40 | 0.32 | 0.08 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.12 | 0.12 | **1.84** |
| Northern OH 11 kV switch renewal | 0.80 | 0.80 | 1.12 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 | **3.84** |
| Auckland 11 kV cable replacement | 1.95 | 1.41 | 1.92 | 2.50 | 2.50 | 3.73 | 4.47 | 5.37 | 6.16 | 6.16 | **36.17** |
| Northern 11 kV cable replacement | 0.30 | 0.30 | 0.30 | 0.40 | 0.40 | 0.50 | 0.50 | 0.50 | 0.50 | 0.60 | **4.30** |
| Auckland 11 kV and 33 kV cable termination replacement | 0.42 | 0.40 | 0.40 | | | | | | | | **1.22** |
| Northern 11 kV and 33 kV cable termination replacement | 0.42 | 0.40 | 0.40 | | | | | | | | **1.22** |
| Auckland distribution transformer replacement | 0.45 | 1.30 | 1.98 | 2.41 | 2.43 | 2.23 | 2.21 | 2.73 | 2.58 | 2.92 | **21.22** |
| Northern distribution transformer replacement | 1.42 | 1.18 | 0.75 | 0.84 | 1.61 | 1.30 | 1.28 | 0.98 | 0.93 | 0.92 | **11.18** |
| **Total** | **16.18** | **16.71** | **19.14** | **20.27** | **22.65** | **23.47** | **24.18** | **25.29** | **25.85** | **26.28** | **220.01** |

TABLE 11-2: FORECAST EXPENDITURE PROACTIVE RELIABILITY FLEET PROGRAMME

### 11.6.2 INCREASE DISTRIBUTION NETWORK AUTOMATION

In the previous two regulatory years, we have accelerated the automation in our distribution network with a specific focus to reduce SAIDI. This programme saw 313 remotely controllable or automated devices that increase both the visibility and controllability of our distribution system, installed on 191 of our 11 kV distribution feeders. We have installed devices such as automatic circuit reclosers: circuit breakers that trip on faults but will automatically reclose if the fault is transient. The programme also included remotely controlled switches used in conjunction with reclosers, to open and close feeder sections as required to isolate a faulty section of a feeder to improve the time to restore supply following a fault. For the remaining regulatory years in this DPP period, our focus will be on the installation of additional isolating switches in the network to reduce the number of customers that will be affected by an outage, whether planned or unplanned, where possible, to less than 500 customers.

From FY26, the planned expenditure will continue with the installation of isolation devices, but the focus will again be placed to install additional automated devices that would reduce SAIDI further. These remaining 11 kV feeders will be studied and investigated in depth to ensure that the investment is for devices in locations that provide optimal benefits for the cost to install as well as to provide the best SAIDI outcomes for customers.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern MV Feeder Automation and isolation | 0.48 | 0.72 | 0.32 | 0.48 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | 1.60 | **11.60** |
| Auckland MV Feeder Automation and isolation | 0.80 | 0.56 | 0.96 | 0.80 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | **16.80** |
| **Total** | **1.28** | **1.28** | **1.28** | **1.28** | **3.88** | **3.88** | **3.88** | **3.88** | **3.88** | **3.88** | **28.41** |

TABLE 11-3: FORECAST EXPENDITURE MV FEEDER AUTOMATION AND ISOLATION

### 11.6.3 USE OF MICRO-GRIDS WHERE ECONOMICAL

Ensuring reliability in remote areas using traditional network solutions is often costly relative to the number of customers served. 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.

Permanent generation sites will be established at two remote communities reliant on single 11 kV supplies: Piha which is supplied by a 62 km long 11 kV feeder that services 1,744 customers and South Head that is supplied by a 116 km 11 kV feeder from Helensville ZSS that services 1,133 customers. Both of these feeders are in the SAIDI top 10 worst performing feeders, backstopping is not available, and a traditional network backstop solution is not economic.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Piha permanent standby generation | 0.20 | 1.38 | | | | | | | | | **1.58** |
| South Head permanent standby generation | | | 1.58 | | | | | | | | **1.58** |
| **Total** | **0.20** | **1.38** | **1.58** | | | | | | | | **3.16** |

TABLE 11-4: FORECAST EXPENDITURE MICROGRIDS

### 11.6.4 DISTRIBUTION TRANSFORMER OIL BUNDING

The Auckland Unitary Plan defines electricity transformers and substations containing 1,000 litres or more of oil as hazardous facilities. All hazardous facilities are required to comply with the permitted standards which require that secondary containment (bunding) is provided to prevent the spill of hazardous substances into the environment. There is some historic distribution substation and transformers in Vector's network that contains more than 1,000 litres of oil and are non-compliant. A programme of works will be undertaken to install bunding at distribution substations and transformers.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland distribution TX bunding | 0.20 | 0.20 | 0.20 | | | | | | | | **0.60** |
| Northern distribution TX bunding | 0.20 | 0.20 | 0.20 | | | | | | | | **0.60** |
| **Total** | **0.60** | **0.60** | **0.60** | | | | | | | | **1.20** |

TABLE 11-5: FORECAST EXPENDITURE DISTRIBUTION TRANSFORMER BUNDING

**SECTION 12**

# Asset replacement and renewal

# 12 – Asset replacement and renewal

This chapter describes the processes and systems Vector has implemented to identify where investment is required on the network to manage the condition and risk of our asset fleets.

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 of electricity to customers.

The following sections describe:

- an overview of the asset management objectives and strategies applicable to replacement and renewal
- 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 2021 and 2031

## 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 and Environment | • Complying with relevant legislation, regulation and planning requirements<br>• Proactively adapt the network to allow and prepare for the growing impact of climate change. |
| Customers and Stakeholders | • Enable customers' future energy and technology choices. |
| Network Performance & Operations | • Utilise clear business cases processes, integrate risk management and complete post investment reviews to inform our decision making and analysis.<br>• Maintain compliance with Security of Supply Standards through risk identification and mitigation.<br>• Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice.<br>• 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:<br>– technology: DERs, electric vehicles and the electrification of transport, increased active customer participation/customer choice, dynamic ratings, and the increasing societal dependence on electricity<br>– environment: climate change including decarbonization of the economy<br>• Prioritise network flexibility to meet customer changing needs.<br>• Enable consumption of energy on the customers' terms and facilitate customer adoption of new technology, the modern economy that is gravitating to larger cities<br>• Improve our knowledge of, and ability to control, the LV network (grid edge) and management of the information required |

TABLE 12-1: ALIGNMENT TO ASSET MANAGEMENT OBJECTIVES

### 12.1.2 STRATEGIES TO ACHIEVE THE OBJECTIVES

To meet the network 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 and industry standards. The most relevant to 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 to enable advanced analytics. Initiatives under this strategy have included investing in new systems to improve the quality and accuracy of asset data, such as SAP PM, and establishing KPIs for our Field Service Providers (FSP) that focus on asset data capture, completeness and quality.

#### 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.

#### 12.1.2.4 MAINTAINING NETWORK SAFETY

Safety of the public and staff 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. Vector is required to operate its network in compliance with NZS7901 which details safety management systems for public safety.

Where an asset is identified to pose a risk to safety, Vector will prioritise remedial actions to remove the risk.

#### 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 resolve the constraint, 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 inspection. 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[9] (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.

Vector's CBARM models are at different stages of maturity in their development cycle. The level of maturity of each CBARM model is largely dependent on the quality and accuracy of asset information used in the model. As such, 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 heighted risk of failure. Requires immediate remedial actions.

[9] DNO Common Network Asset Indices Methodology

### 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 oil and insulation testing 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 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 |
|---|---|---|
| Subtransmission switchgear | Obsolescence, condition, age, safety, reliability | Condition based risk assessment, Historical |
| Power transformers | Obsolescence, condition, age, safety, reliability | Condition based assessment |
| Underground cables | Condition, age, safety, reliability, environmental | Condition based risk assessment (CBARM model in development), Historical for LV |
| Overhead lines | Condition, age, safety, reliability, environmental | CBARM and Condition based assessment |
| Support structures | Condition, age, safety | CBARM |
| HV Distribution equipment | Condition, age, safety, reliability | Condition based risk assessment (CBARM model in development) |
| Distribution transformer | Condition, age, safety, reliability, environmental | Condition based risk assessment (CBARM model in development) |
| LV Distribution equipment | Obsolescence, condition, age, safety, reliability | Historical |
| 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 and overhead lines, 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 $SF_6$ puffer circuit breaking technology.

#### 12.3.1.2 POPULATION AND AGE

The two outdoor 110 kV GIS circuit breakers at Lichfield GXP are 27 years old. The 110 kV GIS switchboards at Liverpool and Hobson zone substations are 23 and 8 years old, respectively.

#### 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 this is not an issue at this time, 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 operating drives on the GIS switchboard at Liverpool substation are approaching the timeframe for mid-life refurbishment and upgrade. Vector has been working with the OEM on a solution for renewing these components and ancillary devices and there is a project scheduled in FY22 to address this.

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. The condition and availability of spare parts will likely drive a replacement of these circuit breakers within the AMP planning period.

#### 12.3.1.4 CONDITION AND HEALTH

Provided there are no major failures, indoor GIS switchboards technically have no end of life assuming proper maintenance is undertaken and there is a supply of spares. The Merlin Gerin D-TH7 switchboard installed at Liverpool zone substation is no longer in production but is still supported by the OEM for parts and service. Some of its components are vulnerable to age related deterioration such as gaskets and "O" rings but these will be replaced within the next 24 months. These assets are well maintained and this asset class can be described as being in good condition with no foreseeable issues beyond routine component replacement over the next ten years.

As the Lichfield 110 kV circuit breakers are located outdoors, they are prone to the typical issues associated with AIS outdoor switchgear such as corrosion, pollution or animal interference. These circuit breakers have performed in line with expectations but their age and 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 and 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. There is currently no need identified to replace these assets within the next ten years.

The outdoor circuit breakers installed at Lichfield zone substation are planned to be replaced for legacy, reliability and economic reasons.

## 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 location of the equipment on the network. The 33 and 22 kV switchgear are used for subtransmission but 22 kV is used for distribution in certain areas of higher density load. 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 and 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 use 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 | 33 KV FIXED PATTERN - OUTDOOR | 33 KV CONVENTIONAL - OUTDOOR | 33 KV FIXED PATTERN – INDOOR | 33 KV CONVENTIONAL - INDOOR | 22 KV FIXED PATTERN - INDOOR | 22 KV CONVENTIONAL - INDOOR | 11 KV FIXED PATTERN - INDOOR | 11 KV CONVENTIONAL - INDOOR |
|---|---|---|---|---|---|---|---|---|
| Oil | | 71 | | | | | | 382 |
| Vacuum | 20 | 8 | 149 | 2 | 81 | | 510 | 335 |
| SF6 | | 21 | | 10 | | 28 | 1 | 137 |

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.

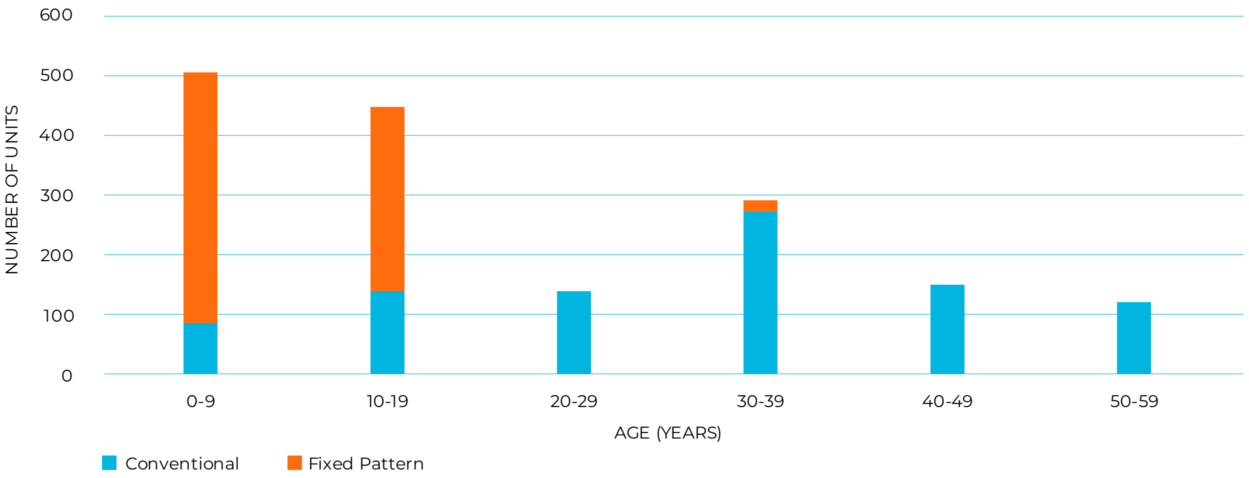



FIGURE 12-1: INDOOR SWITCHGEAR FLEET AGE PROFILE

### 12.3.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Despite adopting best practice maintenance regimes, Vector has experienced some incidents where conventional switchgear has failed. 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. There have been a number of cable bushing failures on this type of switchgear. However, post incident investigations have concluded the this is a result of improper cable installation design rather than defective equipment. Consequently, Vector's standard designs have been updated to remediate this issue.

### 12.3.2.4 CONDITION AND HEALTH

Vector has developed an in-house switchboard ranking tool to assess the condition and risk of failure of indoor switchgear. This tool considers a range of factors such as:

- Safety risk,
- Load at risk,
- Type and number of connected customers,
- Environmental risk,
- Condition of equipment, and
- Age of equipment.

Vector has assessed each switchboard and awarded an overall risk score. This allows each switchboard to be benchmarked against the fleet and ranked in order of risk and criticality. The present (RY21) risk level for the indoor switchboard fleet is shown in Figure 12-2.

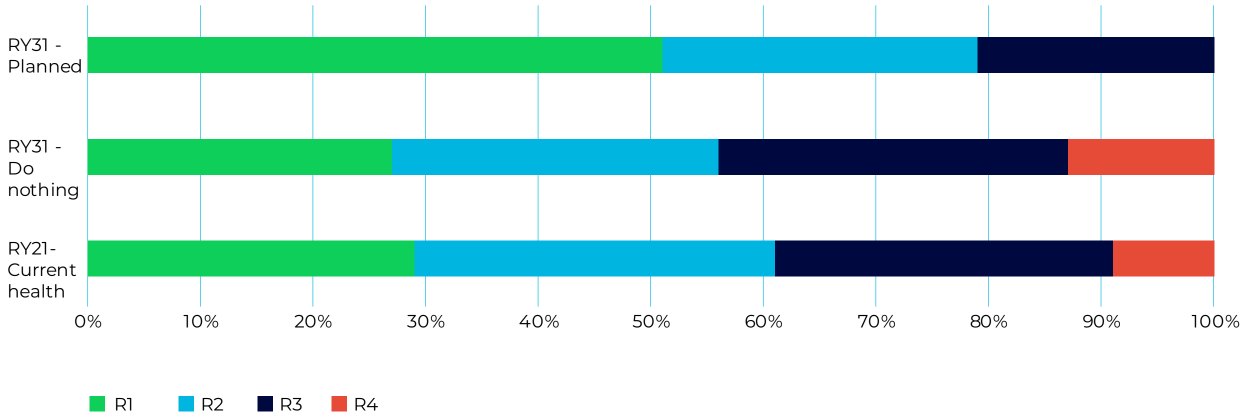



FIGURE 12-2: INDOOR SWITCHBOARD FLEET RISK PROFILE

This indicates that the indoor switchboard fleet is in good condition and approximately 8% 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. Full details of this programme are provided in Appendix 12.

### 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 testing (dissolved gas analysis) |
|---|---|---|---|---|
| **FREQUENCY** | 2 Months | 1 Year | 2 Years | 2 Years |

TABLE 12-4: PLANNED MAINTENANCE ACTIVITIES FOR INDOOR 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[10], 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.

### 12.3.3.2 POPULATION AND AGE

Vector has 120 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 Outdoor 33 kV switchgear fleet age profile.

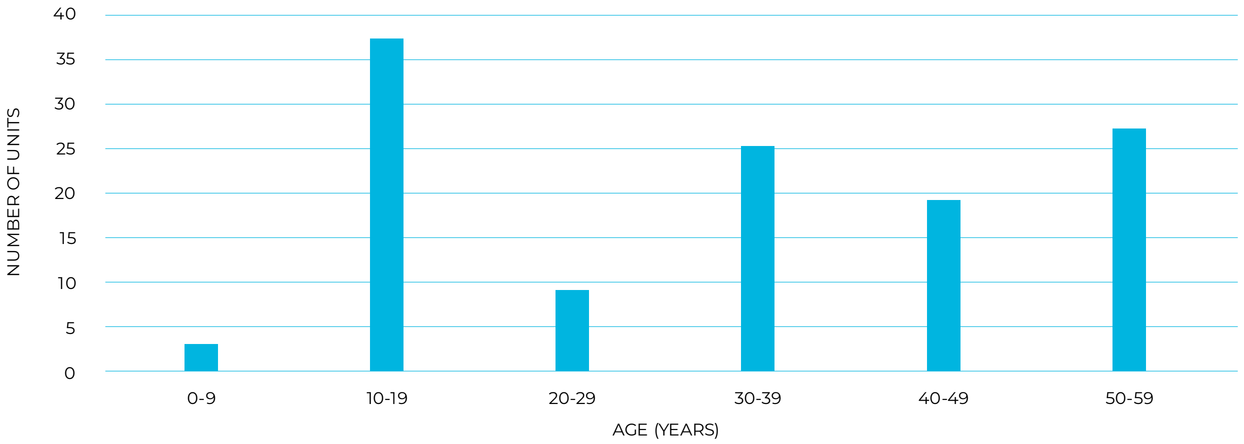



FIGURE 12-3: OUTDOOR 33 KV SWITCHGEAR FLEET AGE PROFILE

### 12.3.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

In 2013, a Vector owned 33 kV 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 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 34 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 Hepburn GXP in 2013. In both cases, complete replacements were undertaken.

### 12.3.3.5 MANAGEMENT STRATEGY

Air break switches are maintained in accordance with Vector's maintenance standard ESM501. 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. However, there are instances where a complete conversion to indoor fixed pattern switchgear is not economical in which case new $SF_6$ outdoor circuit breakers will be utilised. 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. The intention is to replace them with modern indoor fixed pattern switchgear given its safety, spatial, maintenance and economic benefits as the need arises through developed business cases. There is a planned set of projects for outdoor to indoor conversions known as the 'ODID' programme which is undertaken together with Transpower (refer to Chapter 10 for further details).

[10] Note that 'outdoor circuit breakers' excludes the 110 kV circuit breakers at Lichfield GXP

### 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 in light of 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 such as a risk of flooding as an example, will also drive the need and timing for replacement of primary switchgear: Waimauku zone substation is a good example of a zone substation that is driven by a high risk of flooding: full details described in Appendix 12. 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 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.

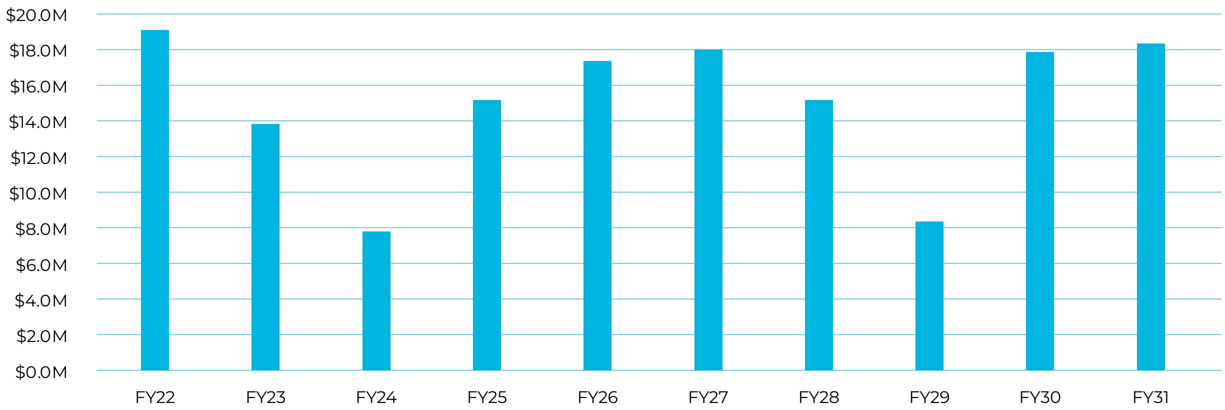



FIGURE 12-4: FORECAST CAPEX – PRIMARY SWITCHGEAR

## 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 are 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 limits. Failures of power transformers are rare, but, if they occur, they are often sudden, can be catastrophic and can cause 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 219 power transformers in service ranging from 10 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 distribution. The transformer fleet is composed of 21 different manufacturers encompassing 37 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.

Table 12-5 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 | 7 | 1 | 157 | 45 |

TABLE 12-5: POWER TRANSFORMER POPULATION

Figure 12-5 illustrates the age profile of our power transformers. The average age of our power transformers is 32 years. Forty power transformers are 50 years and older with the oldest 64 years of age.

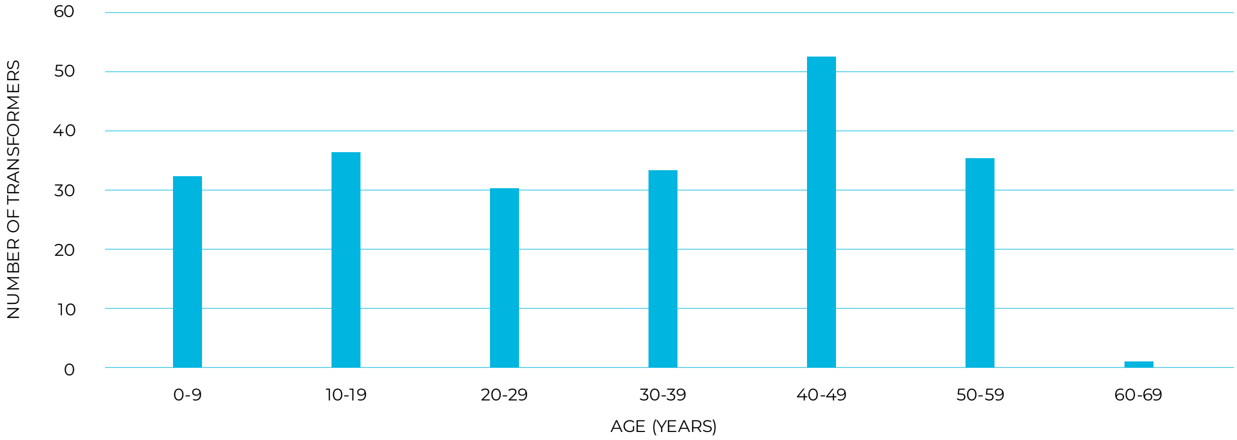



FIGURE 12-5: POWER TRANSFORMER FLEET AGE PROFILE

### 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. Nine transformers have been identified with high levels of acid and sludge and the transformer oil will be treated using the so-called Fullers Earth process; a process that used fine clay to remove impurities. A number of transformers have been identified for which the oil will be stream-lined, i.e. the oil will be dried out but the more extensive Fuller's Earth process is not required.

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 loading and we ensure they undergo regular testing in accordance with our maintenance regime.

Vector utilises a VIA analytics model to provide a view of the condition of its power transformers. Using the available asset health data, 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 (RY21) condition level for the indoor switchboard fleet is shown in Figure 12-6.

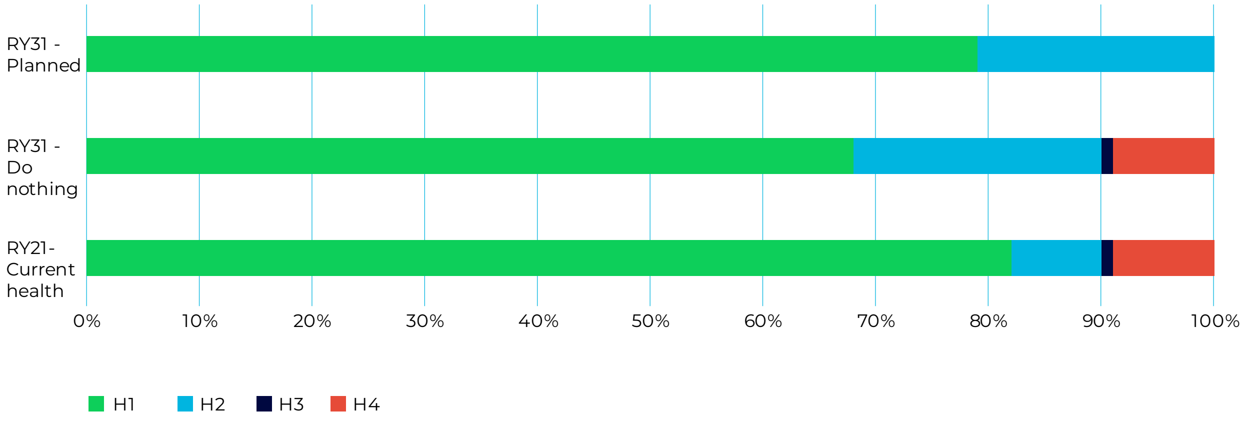



FIGURE 12-6: POWER TRANSFORMER FLEET CONDITION PROFILE

This indicates that Vector's power transformer fleet is in good condition and approximately 8% 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 improved compared to present levels.

### 12.4.1.4 MANAGEMENT STRATEGY

Vector's long-term asset management strategy is to maintain a safe, efficient and reliable network, while adhering to an optimum level of life cycle investment. 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. 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:

- ENS-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. However, there has recently been demand from customers for transformers with a rating of 28 MVA that will now be introduced into the network.

### 12.4.1.6 OPERATE AND MAINTAIN

Power transformers have very long in-service life expectations and are designed to operate at full continuous rating for approximately 25 years. Continuous use at full rating will result in the insulation life of the paper being exhausted and failure will become imminent. 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 the majority of its operating life. At this level of loading, we can expect service lives well in excess of 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 shorts in 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 12-6.

| 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 |
| Testing | Testing of oil in the power transformer tap changer | 1 Year |
| Testing | Testing of oil in the power transformer tap changer (Vacu-tap) | 4 Years |
| Testing | Testing of oil for auto-transformers | 2 Years |
| 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 |

TABLE 12-6: PLANNED MAINTENANCE ACTIVITIES FOR POWER TRANSFORMERS

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.

One area of improvement is addressing the lack of benchmark electrical tests following the commissioning of in-service aged transformers (>20 years of in-service). Vector is planning to embark on a program of periodic electrical and condition-based testing on a 5 to 8-year basis. These tests provide a pre- and post-fault condition benchmark for comparison. This requirement will be included in an update of the maintenance standards scheduled in 2021.

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 three 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 teamed up 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 catastrophic failure but can contribute to power quality issues.

### 12.4.2.3 CONDITION AND HEALTH

Tap changers are highly reliable and Vector relies on oil analysis to trigger maintenance activities.

Vector is currently developing a CBARM model for its tap changer fleet.

#### 12.4.2.4 OPERATE AND MAINTAIN

Vector relies on TASA (Tap Change Activity Signature Analysis) oil test to trigger maintenance activities. All power transformer tap changers are tested annually.

### 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 transformers; bulk oil cooling and heat exchanger systems. The oil radiator system is by far the most common and uncomplicated system used. The heat exchanger system relies on the continuous operation of the 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 as long as 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 a majority 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 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.

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 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.

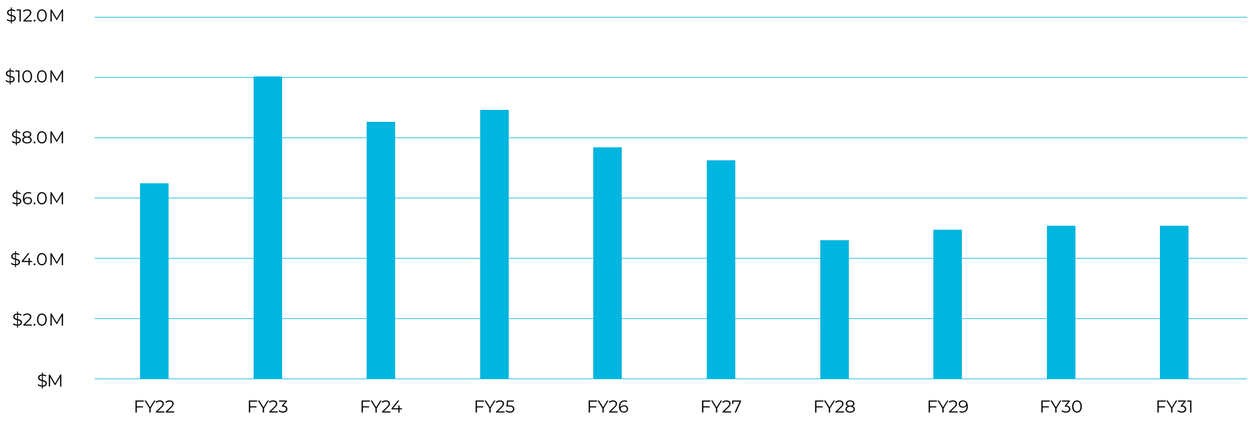



FIGURE 12-7: FORECAST CAPEX – POWER TRANSFORMERS

## 12.5 Underground cables

This section describes our cable fleet and provides a summary of our associated asset management practices. The cable fleet comprises:

- 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 in underground 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 ducts or in Vector's tunnels.

#### 12.5.1.1 FLEET OVERVIEW

Key statistics of the 110, 33 and 22 kV subtransmission feeder assets are shown in Table 12-7.

| 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 | 14 | 28 km | 21 km | 274 | 547 km | 12 km |

TABLE 12-7: SUBTRANMISSION CABLES FLEET OVERVIEW

### 12.5.1.2 POPULATION AND AGE

The expected life for subtransmission cables is indicated below in Table 12-8:

| 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 12-8: EXPECTED LIFE OF SUBTRANMISSION 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 10 kV, 33 kV and 22 kV subtransmission cable fleets.

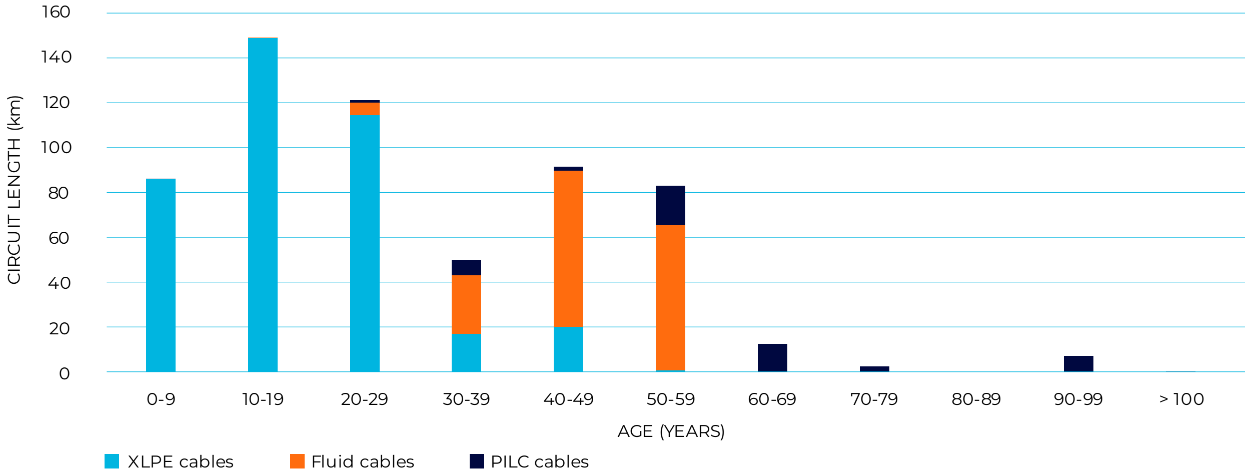



FIGURE 12-8: SUBTRANSMISSION CABLE FLEET AGE PROFILE

### 12.5.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

**General**: Subtransmission cables have faulted 71 times over the last 9 years with most of these attributed to joint failures. Piecemeal repair or replacement for these types of cables and joints is not cost effective. Because subtransmission cables operate at an N-1 security level, faults do not normally result in loss of supply and therefore contribution towards SAIDI and SAIFI is mitigated under normal operating scenarios.

We have identified that the trend of increasing frequency of sustained high temperatures over the summer months presents a risk of premature degradation to all underground cables when it coincides with low soil moisture content and increased cyclic loading. To manage this risk Vector reviews the ratings of its subtransmission cable fleet using CYMCAP cable thermal rating software every two years.

**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 (55 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.

**22 kV/33 kV PILC Cables**: We have identified that for some 33 kV and 22 kV PILC cables in our aging 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 oil 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 XPLE Cables**: Vector's 22 kV and 33 kV XLPE cables have been performing well and no notable risks or trends have been identified.

### 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 (RY21) risk level for the subtransmission cables fleet is shown below in Figure 12-9.

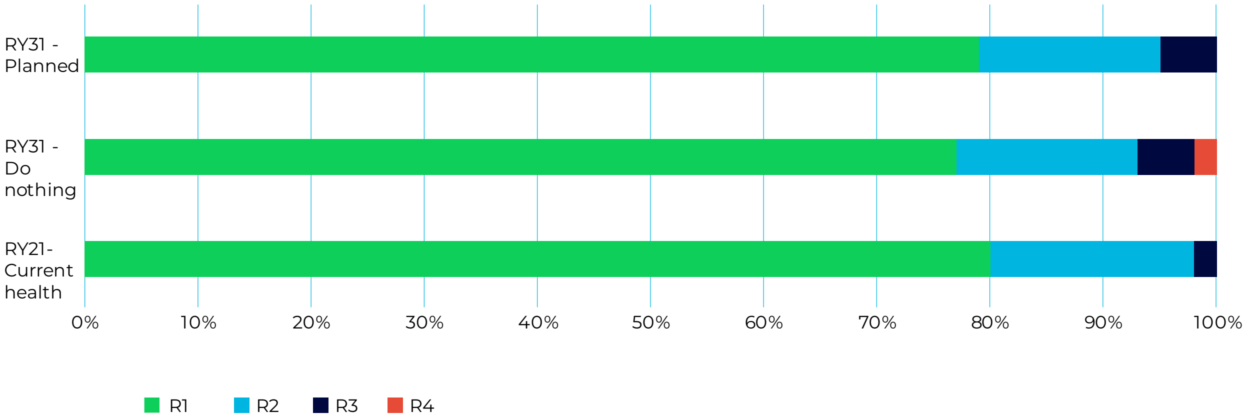



FIGURE 12-9: SUBTRANSMISSION CABLE FLEET RISK LEVEL

This indicates that the substation cable fleet is in good condition and approximately 2% 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.

### 12.5.1.5 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 the spares and accessories and simplify the procurement and maintenance activities. Vector utilises CYMCAP cable thermal rating software to model the installation details and backfilling within the installation corridor to 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 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.

In addition, Vector maintains a strategic stockpile of common cables types and sizes to ensure that critical spares are available in the event of a fault event.

Vector have 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

Maintenance activities for subtransmission cables revolve around preventing third party damage via proactive patrolling and inspection of construction and subdivision sites. In terms of checking the condition of existing cables, partial discharge testing is undertaken on older cables in the fleet to identify any issues or emerging trends and inform a proactive cable replacement programme of works

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 12-9.

| 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 12-9: 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. To identify and quantify leaks in the oil filled cable fleet, we are investigating the use of perfluorocarbon tracers. Vector uses a risk based approach for this type of activity as part of its overall corrective maintenance regime.

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.

Cable circuit ratings are reviewed periodically against recorded rating data to check the impact of new circuits that might have been installed and update the ratings in SCADA if necessary. In addition, highly loaded (>60%) circuits are remodelled every two years to review their ratings to ensure it is not exceeded. Vector is investigating the use of distributed temperature sensing to allow the use of dynamic ratings for the subtransmission cable fleet.

## 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 12-10.

| | |
|---|---|
| Number of 11 kV and 22 kV underground distribution circuits | 993 |
| Length of 11 kV and 22 kV underground distribution circuits (km) | 3680 |

TABLE 12-10: DISTRIBUTION CABLES FLEET OVERVIEW

### 12.5.2.2 POPULATION AND AGE

The expected life for distribution cables are indicated below in Table 12-11:

| 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 12-11: 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 12-10 below summarises the population and age of our 11 kV and 22 kV distribution cables.

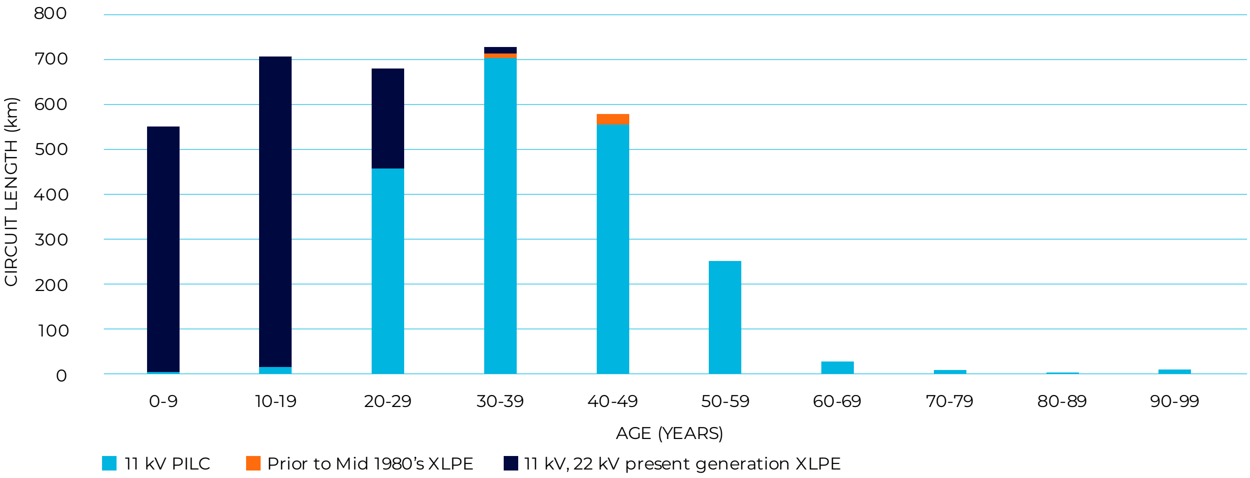



FIGURE 12-10: DISTRIBUTION CABLES FLEET AGE PROFILE

### 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. Most of Vector's distribution PILC cables were installed between 1950 and 1980 and are approaching the end of their reliable working life. A proactive programme of replacement is being developed 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. 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.

### 12.5.2.4 CONDITION AND HEALTH

Our CBARM model for distribution cables is based on age, condition and criticality. The present (RY21) risk level for the distribution cables fleet is shown below in Figure 12-11.

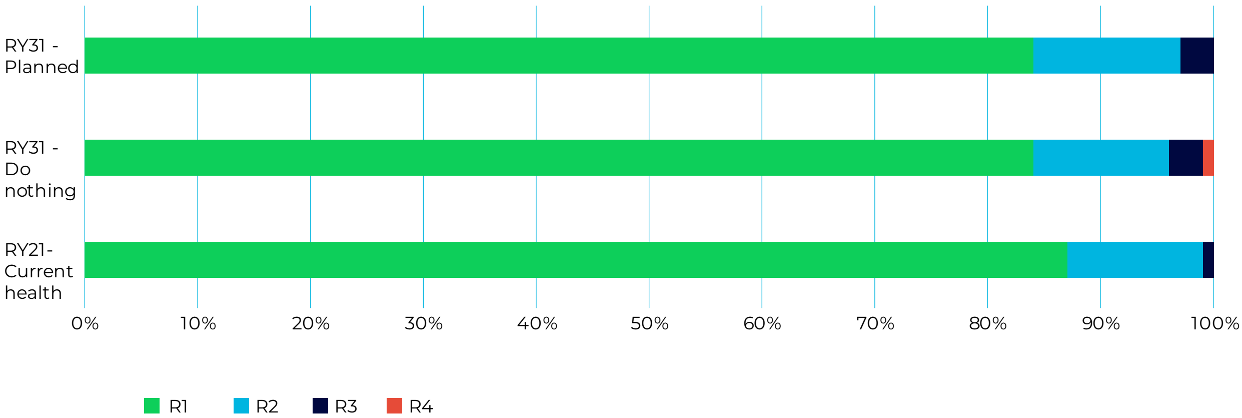



FIGURE 12-11: DISTRIBUTION CABLES RISK PROFILE

This indicates that the distribution cable fleet is in an aging condition. This is predominately due to the PILC cable fleet which has an average age of 40 years. Our analysis shows that approximately 2% 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.

#### 12.5.2.5 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 required types of the spares and accessories and simplify the procurement and maintenance activities. Generally, new cables are specified to be three-core or single core cables with XLPE insulation, copper wire screen, PE or PVC outer sheathes 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 common cables types and sizes to ensure that critical spares are available in the event of a fault event.

Vector has design standards 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 in Section 17 for the list of design standards).

#### 12.5.2.7 OPERATE AND MAINTAIN

Vector's maintenance standard ESM-301 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 high-risk distribution cables.

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 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 12-12.

| | |
|---|---|
| Circuit length of LV underground cable distribution feeders (km) – Auckland network | 3,470 |
| Circuit length of LV underground cable distribution feeders (km) – Northern network | 2,367 |

TABLE 12-12: DISTRIBUTION CABLES FLEET OVERVIEW

#### 12.5.3.2 POPULATION AND AGE

Approximately 63% 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, notably in St Heliers and Mission Bay. 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 low impact on the network.

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 formal asset 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 connection to busbars or overhead lines. They are a critical component of the cable system for subtransmission, distribution and low voltage cable systems as they are often the source of failure.

### 12.5.4.1 FLEET OVERVIEW

Key statistics of the 110, 33 and 22 kV cable ancillary assets are shown in Table 12-13.

| TYPE | UNITS |
|---|---|
| 110 kV subtransmission cable joints | 132 |
| 33 kV subtransmission cable joints | 1879 |
| 22 kV subtransmission cable joints | 775 |
| 33 kV distribution cable joints | 210 |
| 22 kV distribution cable joints | 547 |
| 11 kV distribution cable joints | 25,801 |

TABLE 12-13: DISTRIBUTION CABLES FLEET OVERVIEW

### 12.5.4.2 POPULATION AND AGE

The expected life for cables joints and terminations are indicated below in Table 12-14.

| 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 12-14: 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.

Figure 12-12: The graph below summarises the population and age of our 110 kV, 33 kV and 22 kV cable joints and terminations.

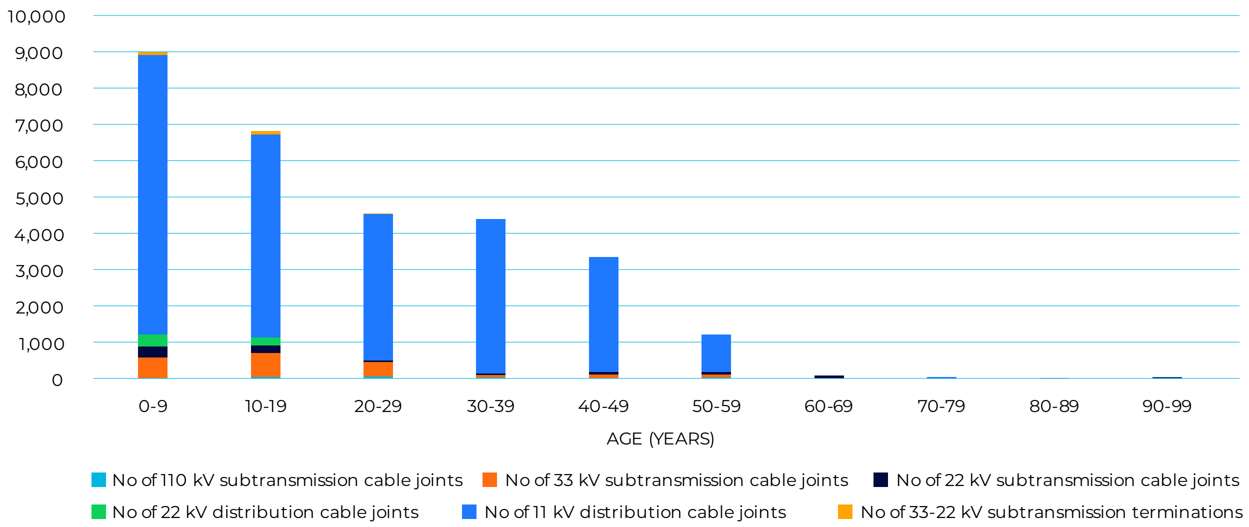



FIGURE 12-12: CABLE JOINT AND TERMINATION FLEET AGE PROFILE

### 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 TRANDS 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 11,102 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. We have 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 of joints.

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 also experienced a few termination failures in ABB SafeLink ring main units, mainly associated with terminations on PILC cables. There appears to be a range of contributing causes and Vector continues to investigate the underlying causes.

#### 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.

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 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 Appendix 12 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 is when specific programmes of work designed to address specific risks are undertaken, for example, the programme of work to replace metal pothead terminations, a programme 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 approaches detailed above reduce the risk of deficiencies in historical data quality issues affecting investment decisions. Figure 12-13 below shows the forecast capital spend on the subtransmission cable fleet for the AMP period. In response to Vector's focus on improving reliability, the forecast chart for the 11 kV and 22 kV distribution cable, pothead cable terminations as well as LV cable fleet are contained in Section 11, Network Reliability.

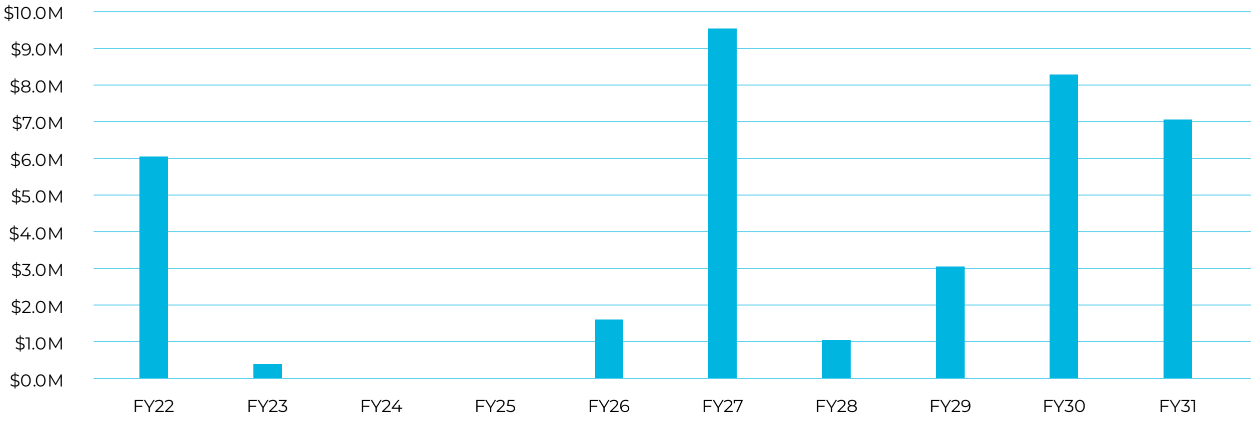



FIGURE 12-13: FORECAST CAPEX – UNDERGROUND CABLES

## 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 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 12-15 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 | 326 |
| Aluminium Conductor Steel Reinforced (ACSR) >100mm2 | 55 | 0 | 29 |
| Copper (Cu) > 60mm$^2$ | 70 | 0 | 6 |
| **Total** | | **27** | **365** |

TABLE 12-15: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet is shown in Figure 12-14 below. It shows that 67% of the assets are up to 60 years old and there are approximately 6% of assets that have exceeded their expected serviceable life. By the end of this AMP, an additional 24% of the conductor fleet is expected to exceed its asset life.

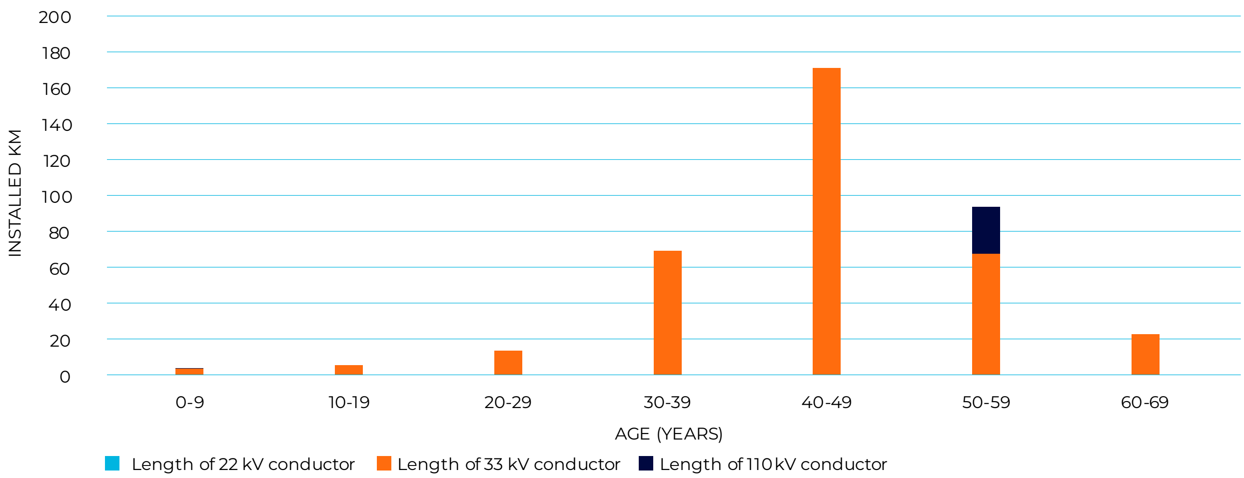



FIGURE 12-14: SUBTRANSMISSION CONDUCTOR FLEET AGE PROFILE

### 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 12-15 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. So, a fault doesn't necessarily result in a power outage to customers. There is a general downward trend but a significant increase in 2019 and this trend needs further investigation.

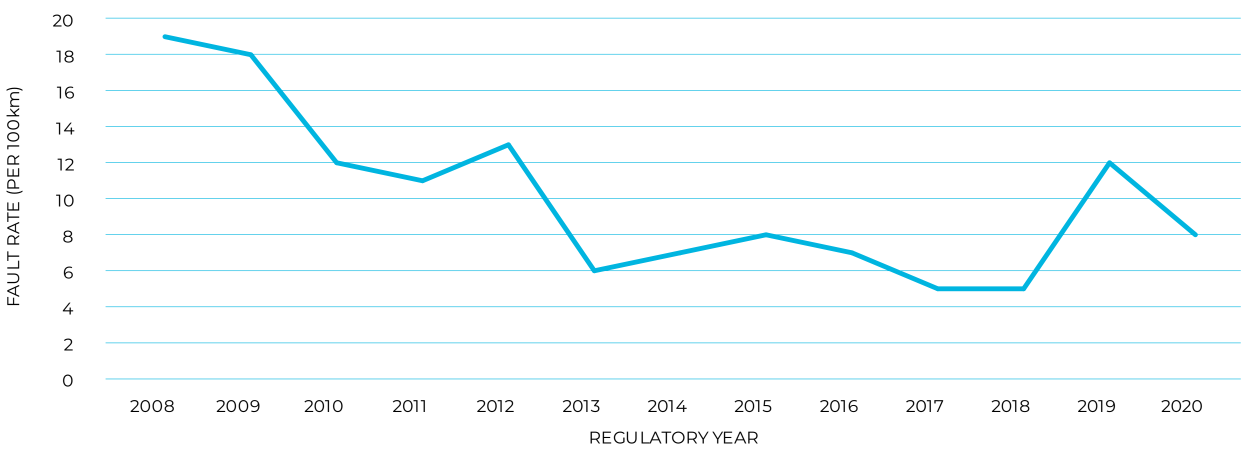



FIGURE 12-15: SUBTRANSMISSION OVERHEAD LINE PERFORMANCE (FAULT RATE)

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. The model is not fully developed but is already assisting to demonstrate the risks in the fleet. Figure 12-16 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.

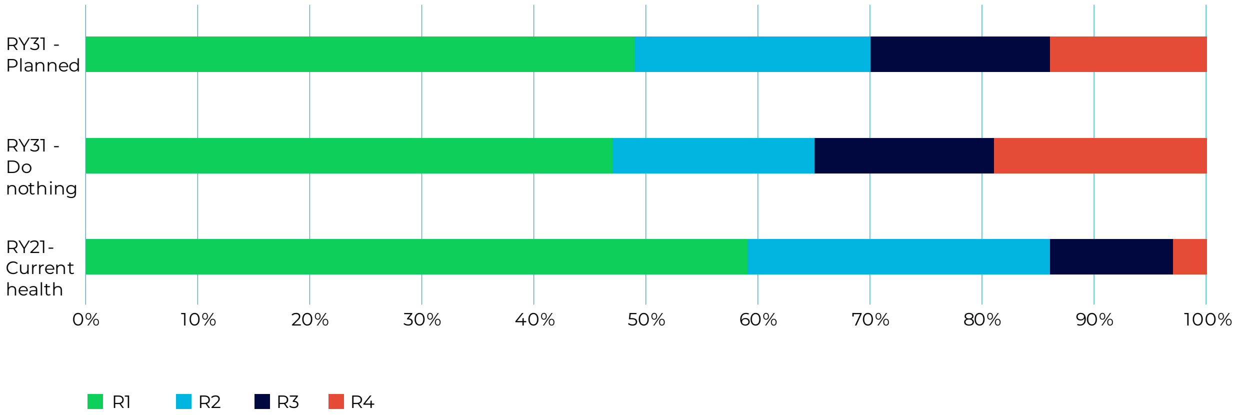



FIGURE 12-16: SUBTRANSMISSION OVERHEAD FLEET RISK PROFILE

### 12.6.1.5 MANAGEMENT STRATEGY

Vector's long-term asset management strategy is to maintain a safe, efficient and reliable network, but balanced against an optimum level of lifecycle investment. 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's focus is to move from a reactive to a proactive approach where replacement and refurbishment are undertaken as proactive programmes of work 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.

### 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.

Vector has also implemented the use of LiDAR technology as a tool to carry out height measurements and assessing clearance from vegetation and large tracts of the network has already been surveyed. A body of work is on-going to evaluate the data to assist in developing a programme of works to address height breaches. Any identified defects that render a potentially unsafe situation to the public or property are repaired, replaced or isolated as soon as practicable.

## 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 manual repairs.

### 12.6.2.2 POPULATION AND AGE

Vector has over 3,729 km (route length) of distribution overhead conductor circuits, representing 46% of its total network line length. Table 12-16 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.

There are historical data quality issues with 1.5% of the distribution conductor that does not have a material type identified and 22% doesn't have an installation date recorded in the asset database. Based on the installation dates of similar networks and visual observation these conductors have been assessed as likely to be copper and are treated as such for modelling purposes. The issues and risks are described in the following section.

| TYPE | EXPECTED LIFE (YEARS) | LENGTH (KM) | |
|---|---|---|---|
| | | 22 KV | 11 KV |
| All Aluminium Alloy Conductor (AAAC) | 60 | 2 | 73 |
| Aluminium Alloy Conductor (AAC) | 60 | 0 | 794 |
| Aluminium Conductor Steel Reinforced (ACSR) >100mm2 | 55 | 0 | 234 |
| Aluminium Conductor Steel Reinforced (ACSR) <100mm2 | 50 | 0 | 1,590 |
| Copper (Cu) > 60mm2 | 70 | 0 | 219 |
| Copper (Cu) < 60mm2 | 55 | 0 | 762 |
| Unknown type | 55 | 0 | 55 |
| **Total** | | **2** | **3,727** |

TABLE 12-16: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet is shown in Figure 12-17 below. It shows that 55% of the assets are between 30 and 50 years old and approximately 9% of this fleet has exceeded its expected serviceable life. In this AMP period an additional 17% of the conductor is expected to approach the end of expected life.

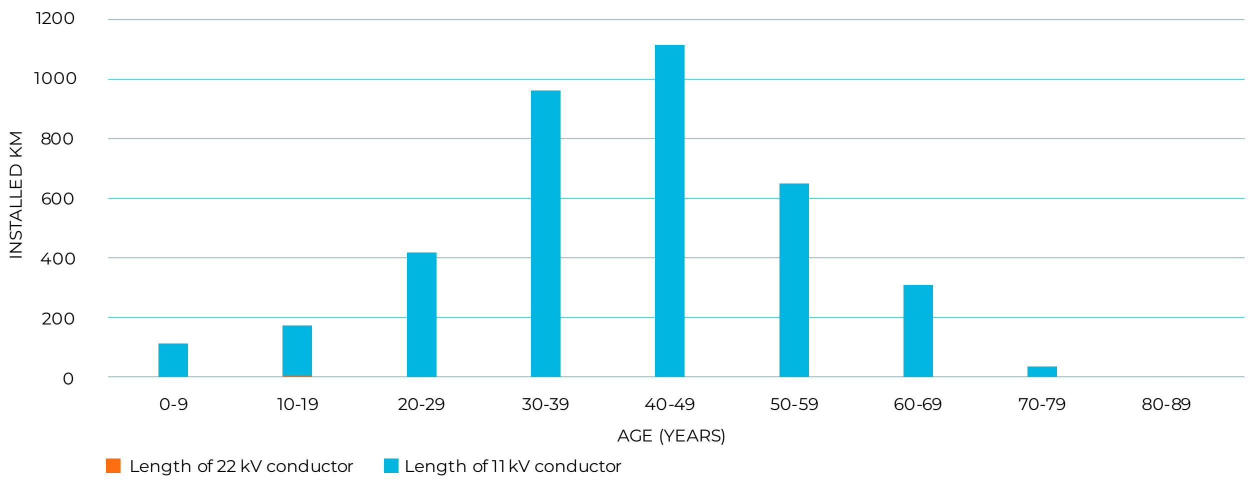



FIGURE 12-17: DISTRIBUTION CONDUCTOR AGE PROFILE

### 12.6.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Over the last decade, approximately 50% more conductor has been removed (158km) from the network than has been installed (97km). 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 councils require undergrounding of existing overhead reticulation. This trend is expected to continue for the planning horizon of this AMP.

Conductor diameter is 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. Once they have failed 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 and as conductors deteriorate and have increasing numbers of joints installed as repairs, their reliability is expected to decrease.

As shown in Figure 12-18 below, there has been a long-term trend of increasing faults on the 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:

- 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.
- Vegetation in the proximity of our overhead power lines is a major factor in network outages especially during storms and high winds. This can cause power outages and damage to the conductors that can result in immediate or delayed failure.

By then end of this planning period, 26% of the overhead conductor population is expected to exceed its expected serviceable life and in the past four years Vector has embarked on an accelerated proactive replacement programme for this fleet.

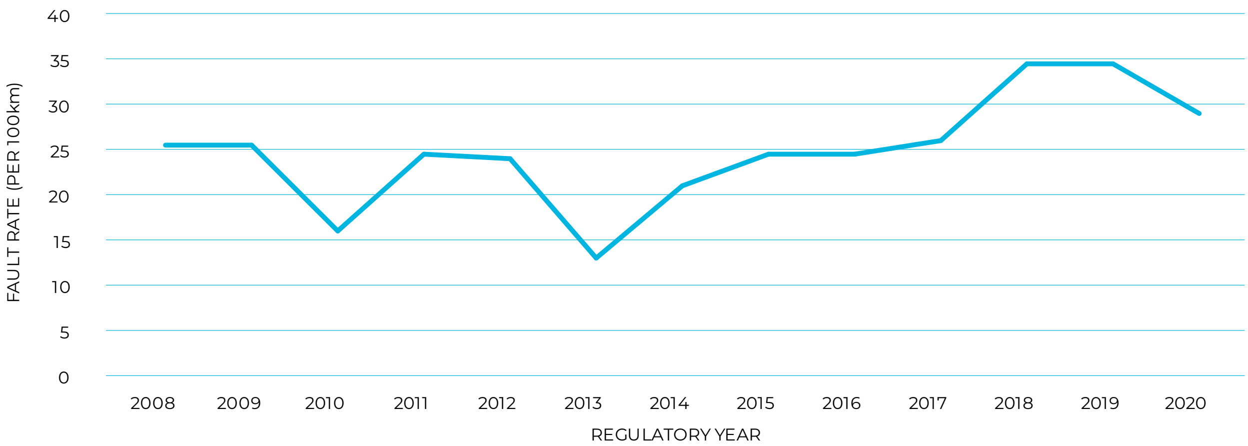



FIGURE 12-18: DISTRIBUTION OVERHEAD CONDUCTOR FAILURE RATE PER 100KM

#### 12.6.2.4 CONDITION AND HEALTH

The condition of the distribution conductor fleet is modelled using CBARM refer to Figure 12-19. This model is reasonably 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 limits.

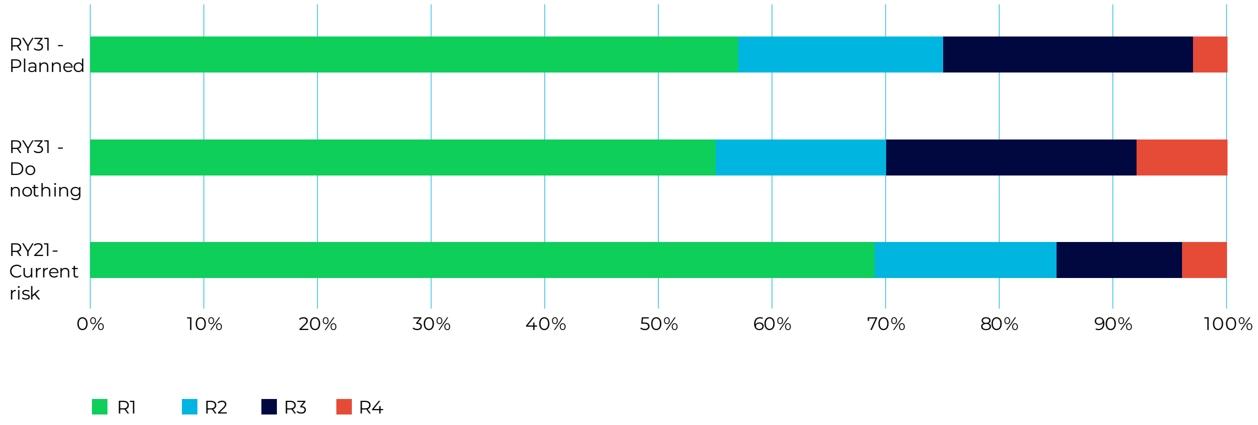



FIGURE 12-19: DISTRIBUTION OVERHEAD CONDUCTOR FLEET RISK PROFILE

#### 12.6.2.5 MANAGEMENT STRATEGY

Vector's long-term asset management strategy is to maintain a safe, efficient, and reliable network, while maintaining an optimum level of lifecycle investment. 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's focus is to move from a reactive to a proactive approach where replacement and refurbishment are undertaken as proactive programmes of work 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 following sections describe how Vector is managing this asset class through the key lifecycle phases.

#### 12.6.2.6 DESIGN AND CONSTRUCT

The design of new or replacement distribution lines are completed by Vector assisted by appointed engineering consultants and input from the FSPs. The design and performance characteristics are prescribed in Vector Standard ENS-0153: Specification for overhead conductors. The completed designs are issued to the FSPs for construction and commissioning according to Vector's standards.

#### 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 is also currently assessing the use of LiDAR technology as a tool to carry out height measurements and assessing clearance from vegetation.

Any identified defects that render a potentially unsafe situation to the public or property are repaired, replaced or isolated as soon as practicable. Remediation timeframes are based on the likelihood of failure creating an unsafe situation and interruption to consumers.

### 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 to a 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 4,136 km (route length) of low voltage overhead conductor circuits, which is 50% of its total overhead network fleet length. Table 12-17 shows a summary of the typical expected lives of the different conductor types along with the installed route length. Each of these types of conductor have different expected asset lives and failure modes 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.

| TYPE | EXPECTED LIFE (YEARS) | LENGTH (KM) |
|---|---|---|
| All Aluminum Alloy Conductor (AAAC) | 60 | 5 |
| Aluminum Alloy Conductor (AAC) | 60 | 1,262 |
| Aluminum Conductor Steel Reinforced (ACSR) <100mm2 | 50 | 455 |
| Copper (Cu) > 60mm2 | 70 | 217 |
| Copper (Cu) < 60mm2 | 55 | 1,589 |
| Aerial Bundled Cable (ABC) | 30 | 142 |
| Unknown type | 55 | 466 |
| **Total** | | **4,136** |

TABLE 12-17: ASSET FLEET TYPE COMPOSITION AND EXPECTED LIFE

The age profile of the asset fleet is shown in Figure 12-20 below. It shows that 70% of the assets are between 30 and 60 years old and there are approximately 22% of assets that have exceeded their standard asset life. During the planning period of this AMP, an additional 24% of LV conductor is expected to exceed its standard asset expected life. 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. This represents the best estimate of the LV conductor age profile and is estimated to circa 55% accurate.

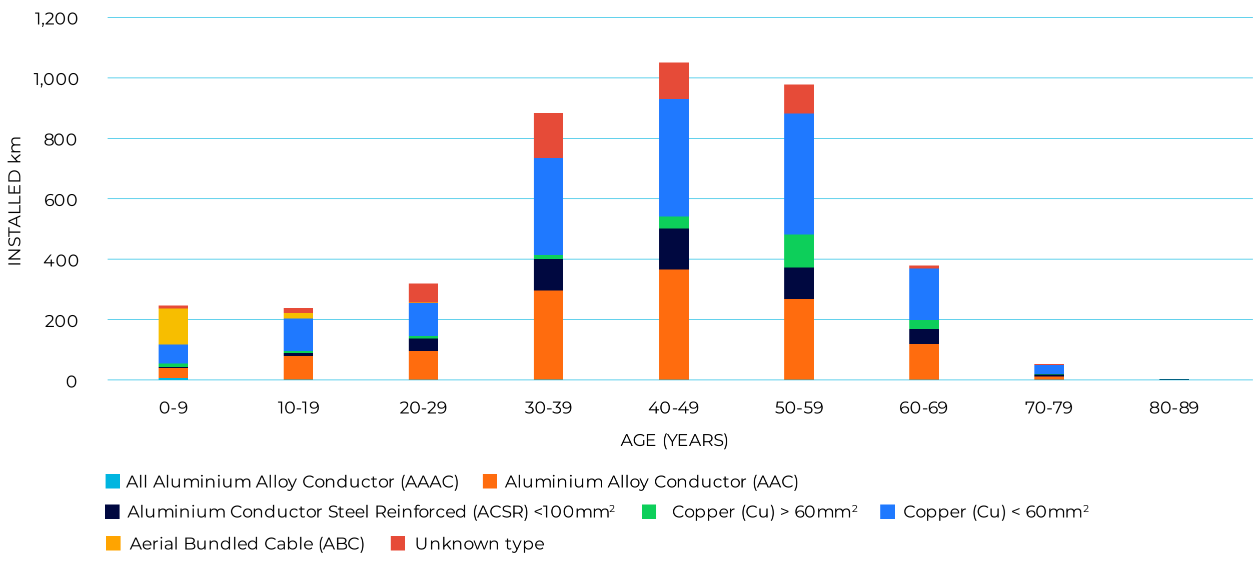



FIGURE 12-20: LOW VOLTAGE OVERHEAD CONDUCTOR FLEET AGE PROFILE

### 12.6.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

The expected life of each conductor is related to conductor type, operating conditions and environmental factors. 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 and joints are known to be a likely point of failure, especially under fault conditions where secondary failures can occur. As conductors deteriorate and an increasing numbers of joints are installed, 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: failure modes are discussed below.

- 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.
- 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.
- 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.

### 12.6.3.4 CONDITION AND HEALTH

Because of legacy data deficiencies we do not presently have robust data regarding the condition and health of the LV overhead network apart from information that is gained through planned maintenance inspections. However, based on the information available we are starting to utilize the model as a guide to point out risk areas in the LV overhead line fleet.

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 ageing LV network is resulting in the failure of some hardware components such as neutral conductor clamps and this has impacted customer service levels.

The increasing importance of the LV network as the platform for the flow of energy under the new energy future, with increasing penetration of distributed energy sources such as solar PV and batteries, means that our knowledge of the LV network is already receiving increased focus and this will expand as we go forward.

### 12.6.3.5 MANAGEMENT STRATEGY

Vector's long-term asset management strategy is to maintain a safe, efficient and reliable network, while adhering to an optimum level of lifecycle investment. The optimal lifecycle investment considers the balance between asset renewal requiring capital expenditure and the combination of preventive, corrective and reactive operational maintenance expenditure.

With the Symphony scenario, 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 the traditional ways to keep the network fit for purpose and fit in terms of H&S requirements but our strategy will now make provision for the increasing volumes of variable and renewable distributed electricity resources (DERs) connected to the network. This aligns with our Symphony model to create an LV network suitable for customers to become active participants, i.e., produce, consume, store and sell electricity.

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. Smart meters and advanced metering infrastructure offer a whole new range of LV supervision capabilities and we are investigating the options offered by smart metering technology to monitor network performance such as voltage and quality of supply to assist with the operation of the LV network and restoration of supply following storms, etc.

Vector's focus is to move from a reactive to a proactive approach where replacement and refurbishment are undertaken as proactive programmes of work 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.

### 12.6.3.6 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 ESM-401. 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 as soon as practicable. 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.

In addition, we are trialling the installation of a variety of equipment to improve network resilience against strong winds and vegetation. Approaches found to be effective will be assessed to see if they can be implemented across the network efficiently.

## 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 12-18, approximately 92% of Vector's fleet of 124,636 poles are concrete poles. Approximately 5% are wood and the remaining 3% are either steel (predominantly on the subtransmission network), composite materials or unknown material.

Vector recently completed a data cleansing and validation exercise to improve the accuracy of the pole age and type data. Because these are long lived assets, records do not exist for all poles and where information could not be obtained from field inspection, estimates were calculated based on a set of rules and associated location information, e.g. date of development of a sub-division.

| MATERIAL | LIFE EXPECTANCY (YEARS) | VOLUME NORTHERN | | | VOLUME AUCKLAND | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | HV | MV | LV | HV | MV | LV | |
| Wood – Softwood | 40 | | 424 | 1,243 | | 89 | 2,094 | **3,850** |
| Wood – Australian Hardwood | 60 | 64 | 169 | 56 | | 879 | 659 | **1,827** |
| Steel – Lattice Tower | 100 | 52 | 62 | | | | | **114** |
| Steel - Monopole | 100 | 13 | 4 | 4 | | | 4 | **25** |
| Composite | 80 | | 120 | 479 | | 43 | 391 | **1,033** |
| Concrete – Prestressed | 80 | 9 | 9,077 | 6,155 | | 22,916 | 25,501 | **63,658** |
| Concrete – Reinforced | 80 | 40 | 36,989 | 10,735 | | 983 | 784 | **49,531** |
| Unclassified | | 7 | 2,679 | 817 | | 20 | 75 | **3,598** |

TABLE 12-18: POLE FLEET COMPOSITION BY NETWORK REGION

Figure 12-21 below shows that approximately 0.5% of poles currently exceed their expected serviceable life and during the next 10-year planning period, this will increase by an additional 1% poles.

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.

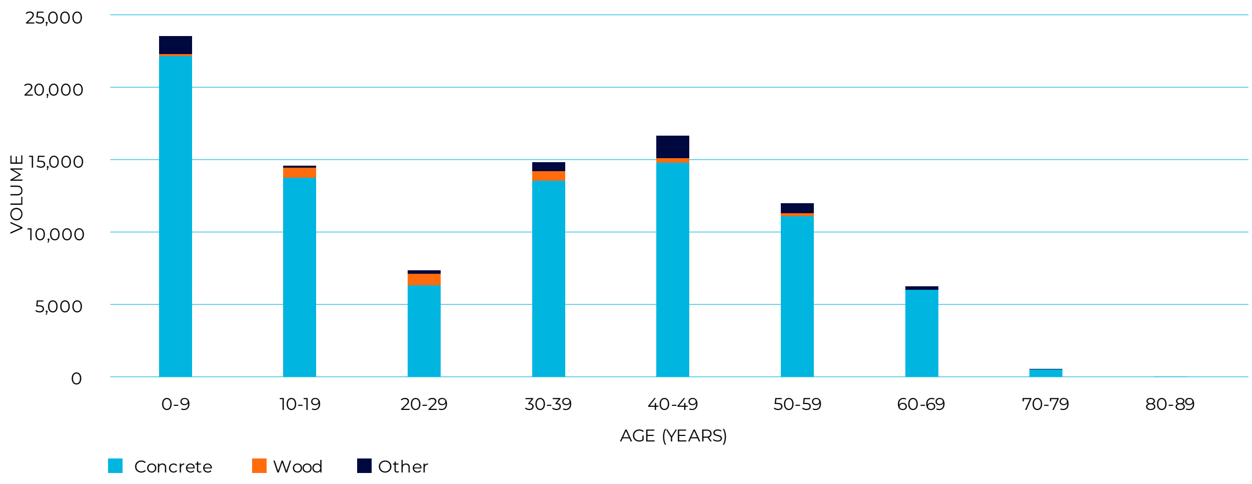



FIGURE 12-21: POLES FLEET AGE PROFILE BY MATERIAL TYPE

### 12.6.4.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISK

Although the events shown in Figure 12-22 below have been recorded in our outage recording system as being a 'Pole' failure, investigations have found that an external factor caused the outage in all cases. For example, if a car hit a pole, it is recorded as 'Pole' in the system but there has been no unassisted failure of a Vector overhead support structure in recent times. Vector has recently improved the way it categorises pole failures which is reflected in the number of events recorded in 2020.

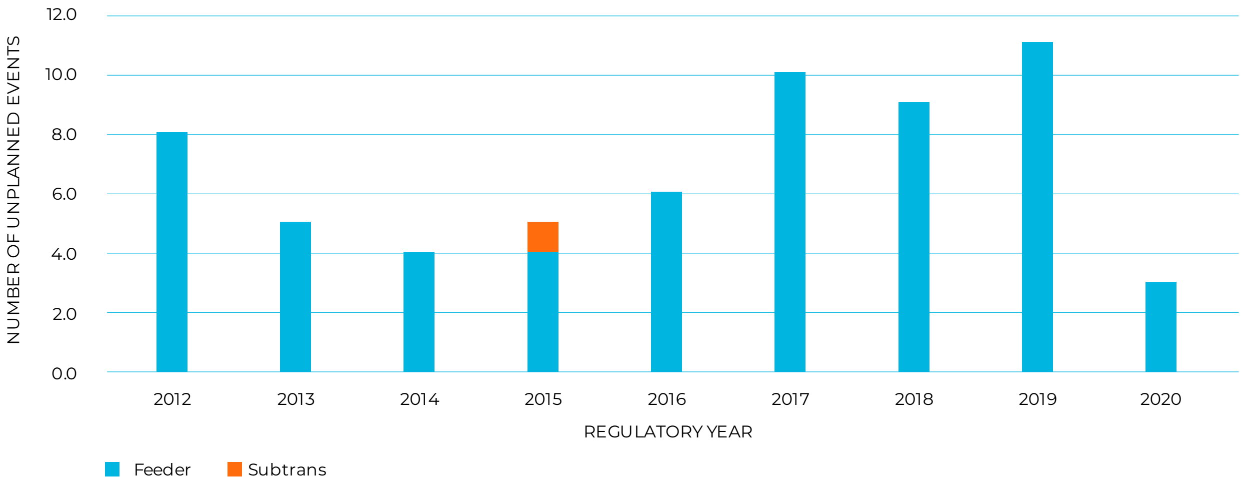



FIGURE 12-22: POLE FAILURES RECORDED ON THE NETWORK

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 which are susceptible to the concrete cancer failure mode. This poses a risk to field crews. Prior to any Vierendeel 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 | No current treatment |
| 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 12-19: KNOWN ISSUES AND RESOLUTION FOR POLES

### 12.6.4.4 CONDITION AND HEALTH

Vector has embarked on the development of a CBARM model for its pole fleet and even though the model is still in development, it will be used to point out areas of risk. The forecast risk of the network is used to develop an intervention strategy that will manage the risk to within acceptable limits for Vector.

In the absence of a developed CBARM model, Vector has used an aged based assessment to describe the condition of its pole fleet. Figure 12-22 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 ensure the condition of the fleet is maintained at current levels.

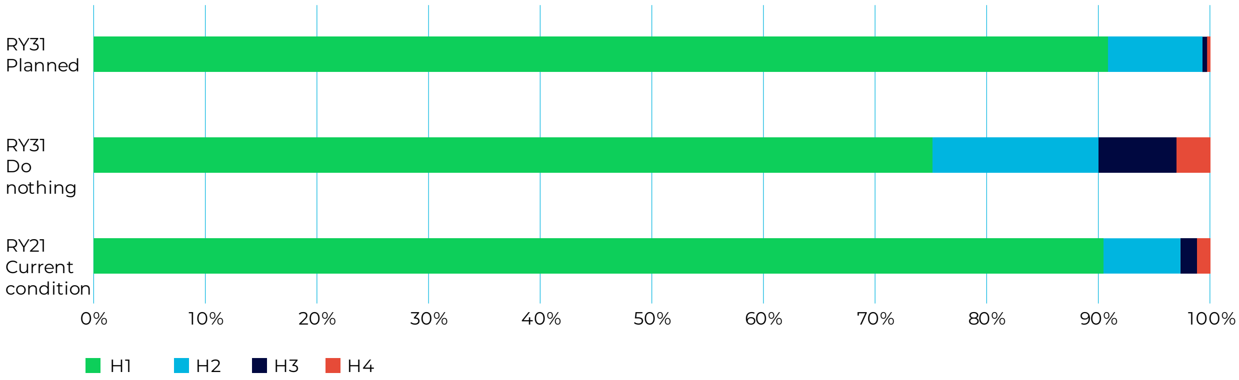



FIGURE 12-23: POLE FLEET CONDITION PROFILE

#### 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.

#### 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 color 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. 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.

Vector generally relies on visual inspections to assess the condition of conductors but a conductor testing regime has 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.

In 2017, recognizing the growing population of aging overhead conductor, Vector established a program to systematically replace end-of-life overhead conductors. This is prioritised by using the CBARM tool. Most overhead conductors will be replaced with modern equivalent (AAAC) overhead conductors, while small portions may be undergrounded where this is more cost effective.

For the overhead distribution network fleet a targeted program has been established to replace over 600km of small diameter 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 be 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 not forecast as part of the proactive asset replacement programme in Section 12 but under the capitalizable works in Section 8. 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.

#### 12.6.5.3 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 Reliability.

## 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 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 12-20.

| EQUIPMENT TYPE | POPULATION |
|---|---|
| ABS/ABI (air break switch/air break isolator) | 762 |
| Drop out fuses | 8,776 |
| SF6 gas switch | 587 |
| Solid and sectionalising links | 325 |
| Vacuum recloser | 148 |
| Vacuum switch | 13 |

TABLE 12-20: KEY STATISTICS

### 12.7.1.2 POPULATION AND AGE

The expected life for the overhead switchgear fleet is indicated in Table 12-21

| CATEGORY | DESIGN LIFE SPAN |
|---|---|
| ABS/ABI | 30 years |
| $SF_6$ gas switch | 30 years |
| Circuit breaker | 30 years |
| Drop out fuse holder | 20 years |
| Drop out fuse | Single use |
| Solid and sectionalising links | 20 years |

TABLE 12-21: 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, maintenance completed throughout the life of the equipment, etc. This results in the retention of equipment within our network beyond their design life as long as the asset is serviceable and can be operated safely.

Figure 12-24 summarises the population and age of our overhead switchgear. The data in the chart is assessed as 93% accurate.

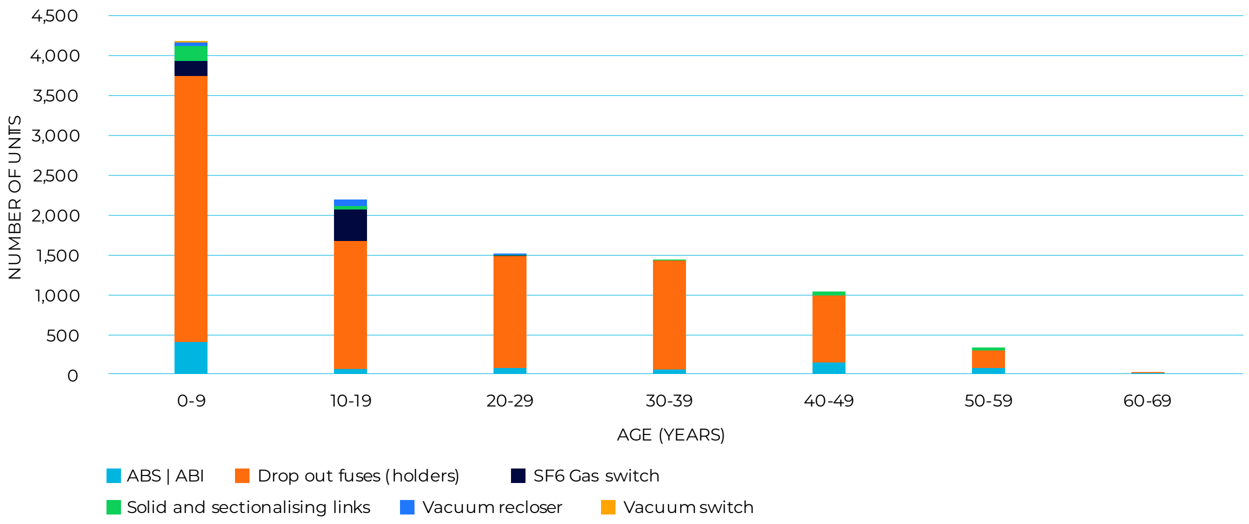



FIGURE 12-24: DISTRIBUTION EQUIPMENT FLEET AGE PROFILE

### 12.7.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

#### Asset performance

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 these 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 limit 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 350 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.

#### Emerging trends

There has been a considerable growth in the number of transformers in the network over the past ten years due to expansion in the Auckland 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 SF6 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 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. Gas switches are now being utilised in locations where remote-controlled switching is required.

Risks

Recently an ABI was mistakenly operated as an on load switching device which is contrary to its intended use of being an off load isolating device. Vector has now implemented an operational restriction banning live operation on all ABI devices. Concurrently, we are investigating ways to return the ABI as a live operation device but at lower load currents – this is to alleviate the practical constraints that the ban has placed on network operations.

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 present year (RY21) fleet condition level is shown in Figure 12-25. 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 levels.

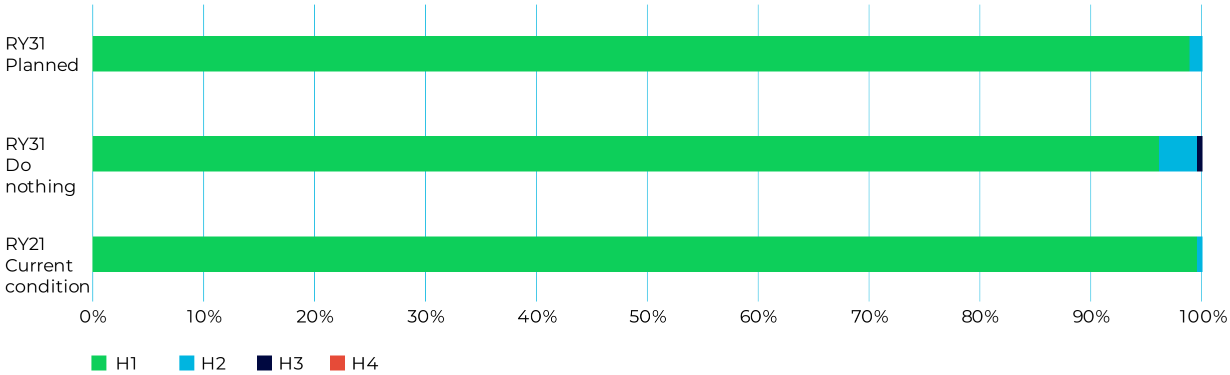



FIGURE 12-25: OVERHEAD SWITCHGEAR FLEET CONDITION PROFILE

### 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 current practice is to replace the switch with a new modern equivalent. The old switch will be scrapped because of outdated designs or obsolescence and 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 to identify other suitable equipment suppliers in order to establish a minimum of two suppliers for each equipment type to alleviate supply chain and commercial risk.

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 changes through a controlled deviation 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 ESM-501 details the requirements for the distribution overhead switchgear fleet. Table 12-22 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 |
| 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 12-22: 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.

To enhance its asset management practice, 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 7,715 pole mounted distribution transformers ranging from 1 kVA to 325 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 12-23 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 | 64 |
| 15 kVA | 1,241 |
| 20 kVA | 59 |
| 25 kVA | 115 |
| 30 kVA | 3,011 |
| 50 kVA | 1,642 |
| 75 kVA | 1 |
| 100 kVA | 174 |
| 150 kVA | 28 |
| 165 kVA | 2 |
| 200 kVA | 263 |
| 220 kVA | 4 |
| 250 kVA | 1 |
| 300 kVA | 700 |

TABLE 12-23: POLE MOUNTED DISTRIBUTION TRANSFORMER POPULATION

Figure 12-26 illustrates the age profile of our pole top distribution transformers. The average age of pole top transformers is 27 years. Our pole top transformer fleet is considered young compared to the typical 30 to 40-year design life.

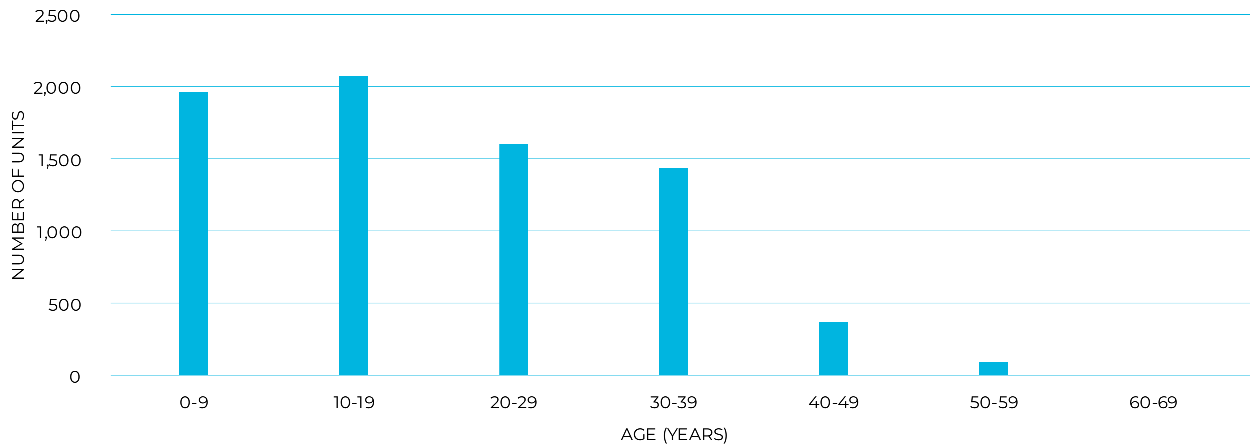



FIGURE 12-26: POLE TOP DISTRIBUTION TRANSFORMER FLEET AGE PROFILE

#### 12.7.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

Vector relies on visual inspections to determine the condition of the transformer fleet. 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.

### 12.7.2.4 CONDITION AND HEALTH

Our CBARM model for pole top transformers is based on age, condition and criticality. The present (RY21) risk level for the pole top transformer fleet is shown below in Figure 12-27.

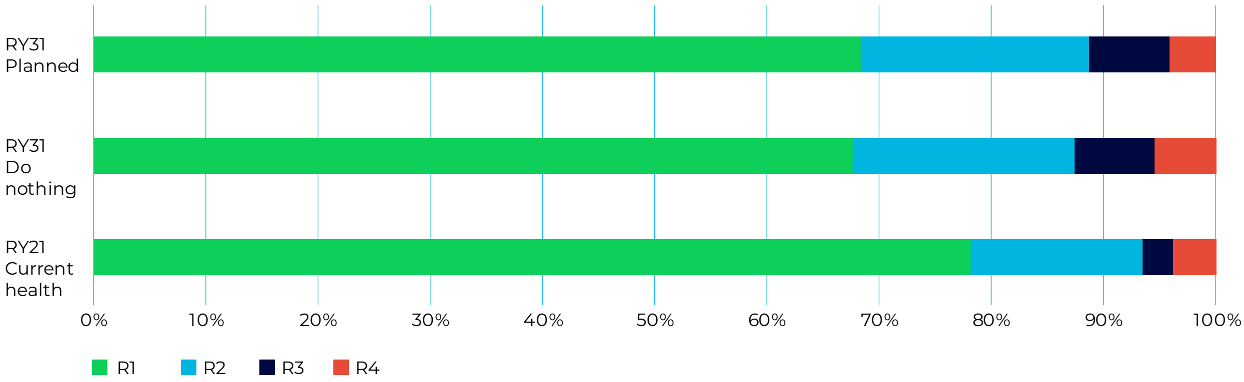



FIGURE 12-27: POLE TOP TRANSFORMER FLEET RISK PROFILE

This indicates that the pole top transformer fleet is in good condition with less than 5% of the fleet approaching 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

### 12.7.2.5 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 two 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 12-24.

| ACTIVITY TYPE | ACTIVITY DETAIL | FREQUENCY |
|---|---|---|
| Functional inspection | Visually inspect and if required undertake corrective maintenance necessary to remediate conditions observed | 1 year |
| Full inspection | Visually inspect and if required undertake corrective maintenance necessary to remediate conditions observed | 5 years |

TABLE 12-24: PLANNED MAINTENANCE ACTIVITIES FOR POWER 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 12-25.

| EQUIPMENT TYPE | POPULATION |
|---|---|
| Resin | 92 |
| $SF_6$ gas | 2,324 |
| Oil | 6,612 |
| Air | 282 |

TABLE 12-25: 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 12-26.

| CATEGORY | DESIGN LIFE SPAN |
|---|---|
| Resin | 40 years |
| $SF_6$ gas | 30 years |
| Oil | 40 years |
| Air | 30 years |

TABLE 12-26: DESIGN LIFESPAN OF RMUS

Figure 12-28 illustrates the age profile of our RMUs. The average age of the RMUs installed in the Auckland region is 29 years, while the average age of the RMUs installed in the Northern region is 16 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.

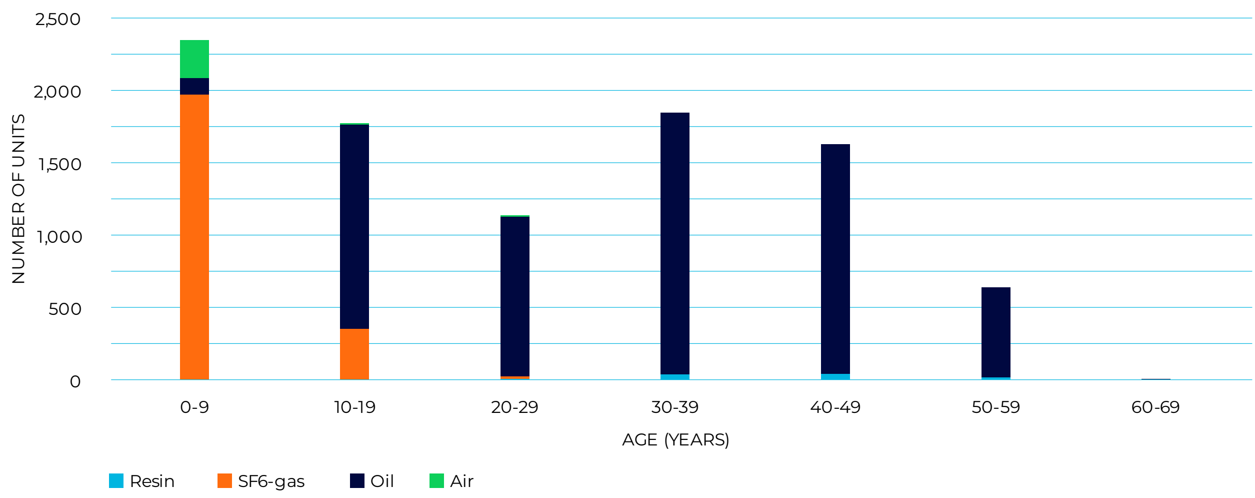



FIGURE 12-28: RMU FLEET AGE PROFILE

### 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 number 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 proper 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. Damage from vandalism or vehicle impact can also lead to equipment failure and reducing the service lifespan.

In 2017, an oil filled Long & Crawford RMU failed 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 ground mounted distribution switchgear is based on age, condition and criticality. The present (RY21) risk level for the RMUs is shown in Figure 12-29.

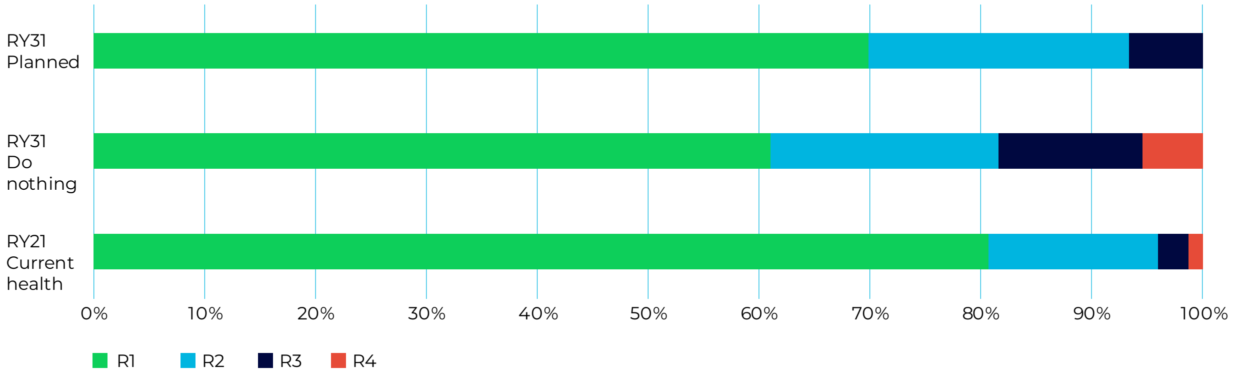



FIGURE 12-29: GROUND MOUNTED DISTRIBUTION SWITCHGEAR FLEET RISK PROFILE

This indicates that the RMU fleet is currently in good condition and approximately 9% 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.

### 12.7.3.5 MANAGEMENT STRATEGY

The management strategy for ground mounted switchgear 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.

### 12.7.3.6 DESIGN AND CONSTRUCT

There are a wide range of switchgear models and makes operating in the Vector network. All new distribution switchgear is 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 selected 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 12-27.

| 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 12-27: PLANNED MAINTENANCE ACTIVITIES FOR GROUND MOUNTED DISTRIBUTION SWITCHGEAR

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 TRANSFORMER

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. There are a range of standard sizes 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/400 V population makes up less than 2% of the entire population.

Vector records show 53 different size transformers ranging from 1 kVA to 1.5 MVA with 341 transformers recorded as installed in the 1900s or with no date recorded. Table 12-28 shows a limited breakdown of the populations by size.

| TRANSFORMER SIZE | POPULATION |
|---|---|
| <100 | 837 |
| 100 | 4,338 |
| 150 | 574 |
| 165 | 1 |
| 200 | 2,568 |
| 250 | 119 |
| 300 | 2,910 |
| 325 to 450 | 21 |
| 500 | 1,718 |
| 650/700 | 3 |
| 750 | 789 |
| 920/950 | 3 |
| 1000 | 573 |
| 1050-1400 | 8 |
| 1500 | 34 |
| >1500 | 32 |

TABLE 12-28: GROUND MOUNTED DISTRIBUTION TRANSFORMER POPULATIONS BY TRANSFORMER SIZE

#### 12.7.4.2 POPULATION AND AGE

The average age of the ground mounted distribution transformer fleet is 27 years. With a design life of 30 to 40 years, this would be considered an aging population. The distribution of ages is presented in Figure 12-30. The data for the age profile is 91% accurate

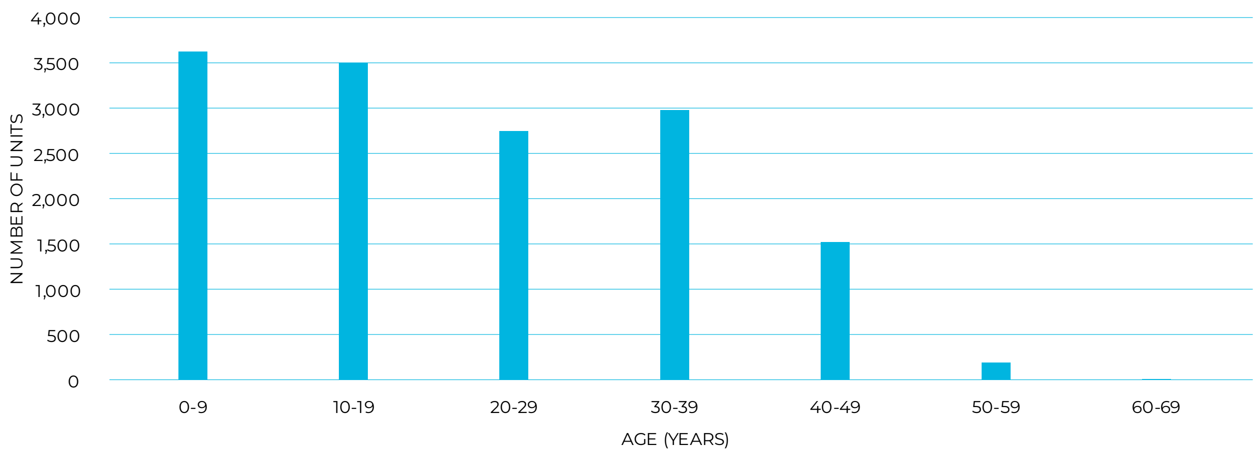



FIGURE 12-30: GROUND MOUNTED DISTRIBUTION TRANSFORMER AGE PROFILE

### 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 12-28, there are a large range of transformer sizes currently installed. Moving forward, Vector has committed to standardise the range of sizes to limit the number of spares to be held.

A considerable number of ground mounted transformers are currently connected together through the practice of 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. This practice is not applied for any new installations.

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 is therefore developing appropriate control measures to mitigate this risk.

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 un undetected earth fault exists in the HV delta winding if the faulted transformer is backfed via the LV side from the unfaulted transformer in parallel. Vector is developing appropriate controls to mitigate this risk.

There have been a number of fire-related events involving distribution transformers and the cause was found to be 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. To mitigate this risk further, Vector will continue to develop and refine the inspection and maintenance procedures to identify this risk going forward.

### 12.7.4.4 CONDITION AND HEALTH

Our CBARM model for ground mounted distribution transformers is based on age, condition and criticality. The present (RY21) risk level for the pole top transformer fleet is shown below in Figure 12-31.

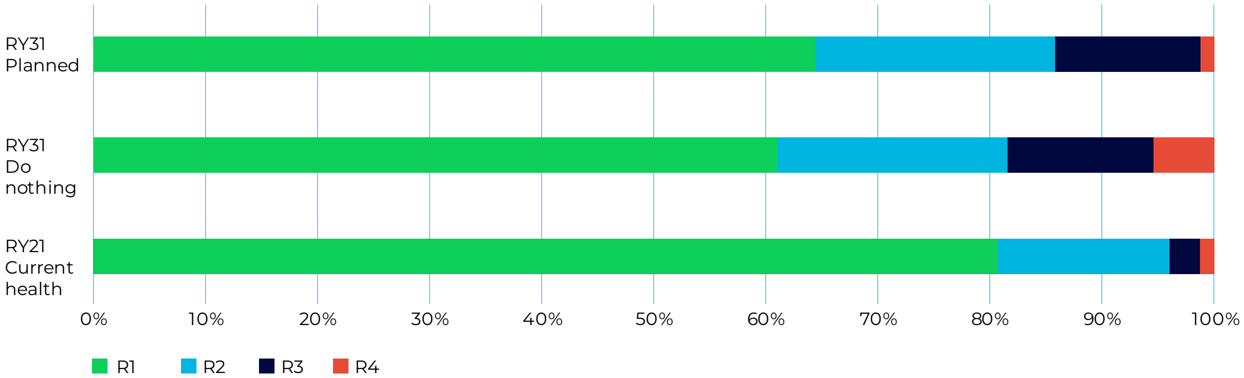



FIGURE 12-31: GROUND MOUNTED DISTRIBUTION TRANSFORMERS RISK PROFILE

This indicates that the ground mounted distribution transformer fleet is currently in good condition and approximately 4% 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 two 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 Chapter 17, Appendix 2.

#### 12.7.4.7 OPERATE AND MAINTAIN

Vector's 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 RMU assets is summarised below in Table 12-29.

| 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 12-29: 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. If major faults are detected, transformers are replaced and the failed transformer is assessed by our contracted refurbishment service provider and repaired if practicable and economical; otherwise it is scrapped

### 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 two 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 Puhoi three phase. There is a single Puhoi regulator 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

Vector first deployed voltage regulators in the late 1990s. The average age of the regulator fleet is 16 years. Considering the 25-year minimum lifespan of the asset this is considered a young fleet. Figure 12-32 shows the age profile of the installed voltage regulators.

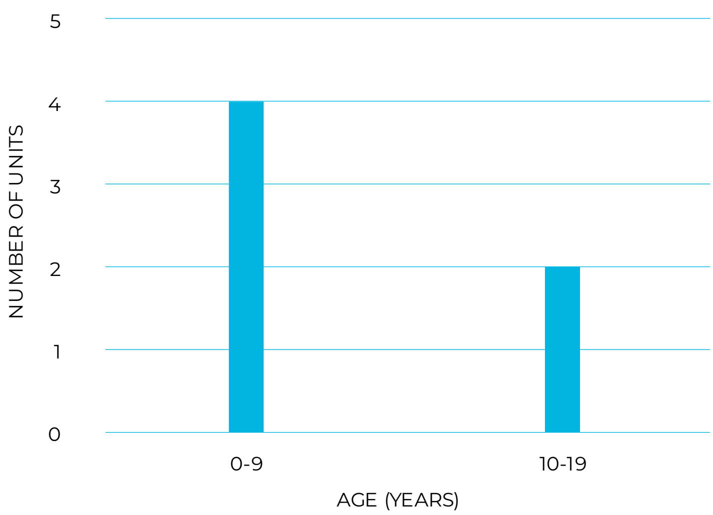



FIGURE 12-32: VOLTAGE REGULATOR FLEET AGE PROFILE

#### 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 very challenging 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. 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 12-30 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 12-30: PLANNED MAINTENANCE FREQUENCY

### 12.7.6 LV DISTRIBUTION SYSTEM (NON-OVERHEAD)

Vector's low voltage distribution network is responsible for conveying 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 feeder 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 are approximately 5,800 km of LV underground cables on our network, comprising aluminium and copper conductors with either XLPE, PVC or PILC insulation. Approximately 17% of the installed LV cable fleet lack identifying information relating to core-size or the insulation type. Of the cables with known core type, 61% are aluminium cables due to the lower cost of aluminium compared with copper.

The use of LV frames was introduced fairly recently in the Northern network with 3,100 of the 3,500 LV frames in the Northern network installed since 2000. Almost double the number of LV frames exist in the Auckland region. 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 159,000 known pillars and pits across the Vector network. This is made up substantially of service pillars and pits with only 7,000 link pillars and 341 link pits. There are a large number of assets with deficiencies in data recorded for their installation dates. These account for 7% 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 12-33 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 7%.

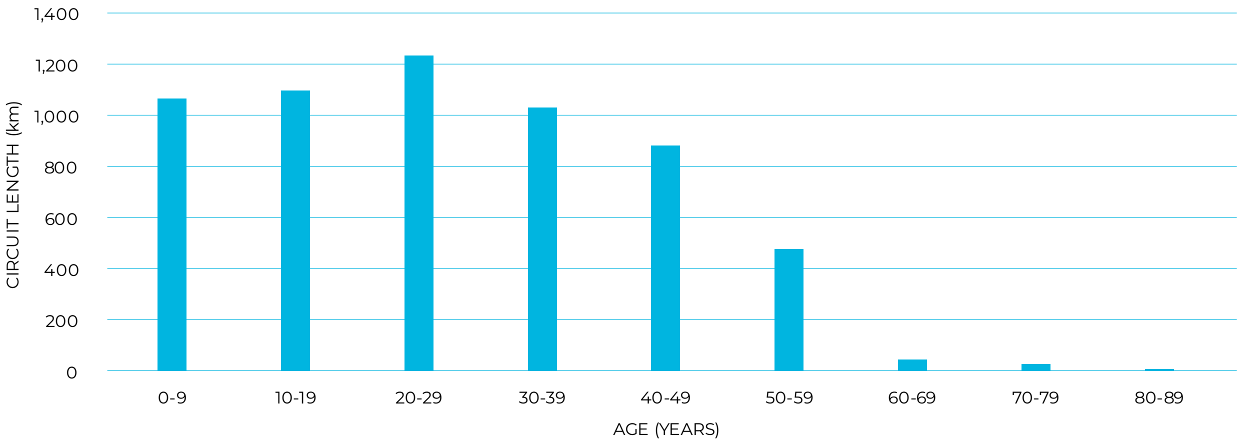



FIGURE 12-33: LV DISTRIBUTION CABLE AGE PROFILE

The average age of the LV cable fleet is 26 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 20 years and an expected life of 30 years so can be classed as aging. Figure 12-34 below shows the age profile of the LV frame fleet (Vector notes the level of data error is approximately 7%).

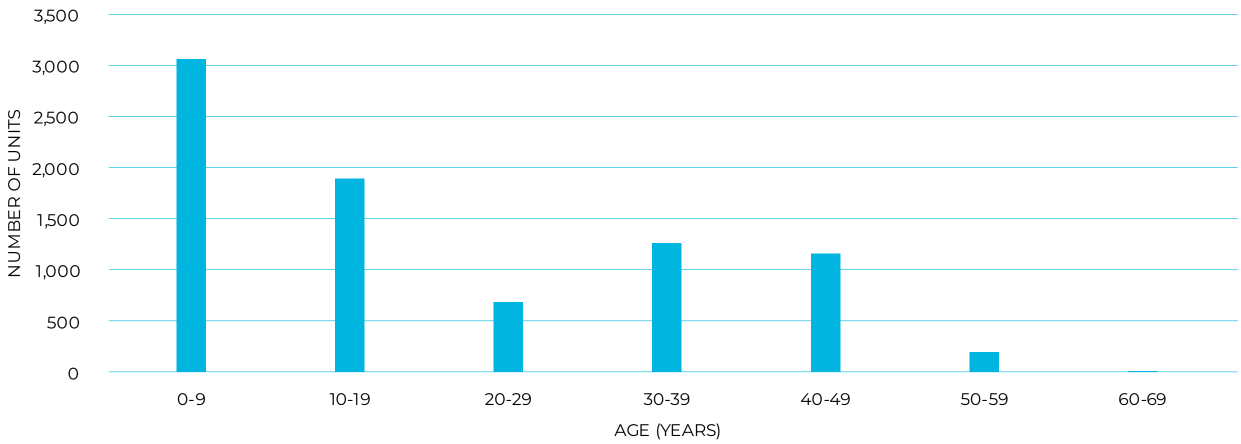



FIGURE 12-34: LV FRAME FLEET AGE PROFILE

Vector maintains over 159,000 LV pits and pillars with the majority installed in the Auckland region. Figure 12-35 below 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 7%).

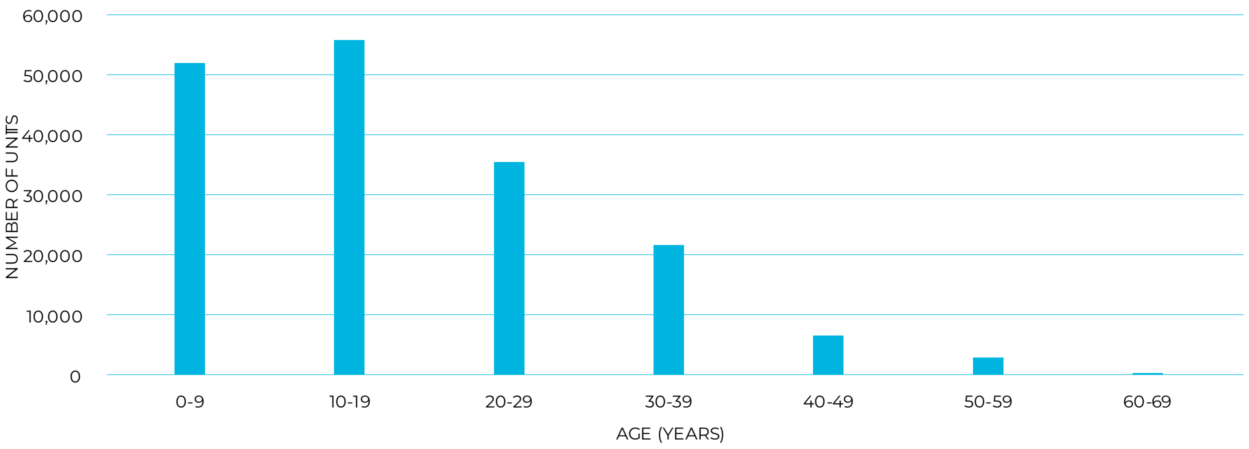



FIGURE 12-35: PILLAR AND PIT FLEET AGE PROFILE

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

#### Asset performance

Of all the above equipment only link pillars and link pits are recorded for SAIDI impact. These contribute only a small fraction of SAIDI minutes to the overall SAIDI performance. This is expected since the assets associated here are typically supplying a limited number of customers and is subject to lower network stresses than other asset categories.

#### Emerging trends

Since the 2000s there has been a preference for 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.

#### Risks

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

### 12.7.6.4 MANAGEMENT STRATEGY

The condition and health of underground LV cables, LV frames, LV switchgear and service pillars and pits are presently monitored on a limited basis. Vector is in the process of improving the data collection for this asset class. This will enable a better understanding of the condition of these assets and aligns with our wider asset management strategy and the importance that these asset types will play in the energy network of the future. The following sections describe how Vector is managing this asset class through the key lifecycle phases

### 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 developed a pool of approved manufacturers and suppliers for each LV equipment category but does not procure directly. 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 ESM-505 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 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 requirement specified in Vector's standard ESM-503.

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 12-31 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 12-31: PLANNED MAINTENANCE ACTIVITIES

### 12.7.7 REPLACE, RENEW AND DISPOSE

#### 12.7.7.1 OVERHEAD SWITCHGEAR

Vector uses its CBARM model to forecast the need to replace specific distribution overhead switchgear. The CBARM model considers asset health, probability of failure and criticality. Before committing to a decision to replace a switch, Vector validates the output of the CBARM model against test results taken in the field to ensure the model is providing accurate guidance.

#### 12.7.7.2 GROUND MOUNTED SWITCHGEAR

Given there is a significant 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. Considering the asset health in the network Figure 12-29 indicates the impact of the proactive replacement program.

#### 12.7.7.3 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 has been one 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. Pole mount distribution transformers can also be replaced as part of a wider overhead line refurbishment project where it is economical.

#### 12.7.7.4 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.

#### 12.7.7.5 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, due to these assets' low impact on network performance. 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

Because of its focus to address network reliability the forecast for overhead switches, pole and ground mounted transformers and LV non overhead assets are forecast in Section 11, Network Reliability. The forecast capex renewal chart below is for the remainder of the distribution assets including a major programme of works to replace 11 kV ring main unit ground mounted switchgear.

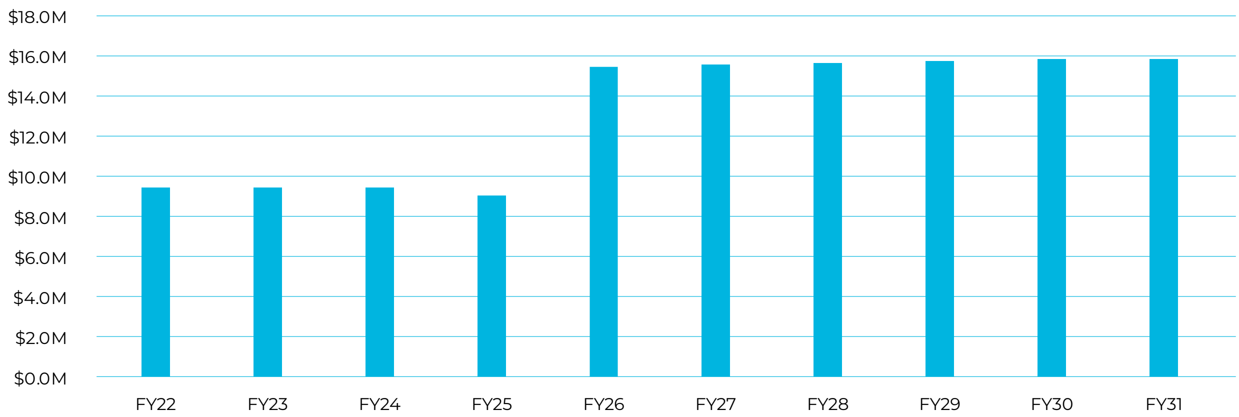



FIGURE 12-36: FORECAST CAPEX – DISTRIBUTION SYSTEMS

## 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.

There are several different types of protection relays used in Vector's network that will be discussed in the following sections. The failure of a protection relays is 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 3,400 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 use three types of relays:

- Electromechanical
- Numerical
- Static

Table 12-32 below 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 |
|---|---|---|
| 798 | 79 | 2,531 |

TABLE 12-32: 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 12-37 below (Vector notes that the level of data accuracy is approximately 94%)

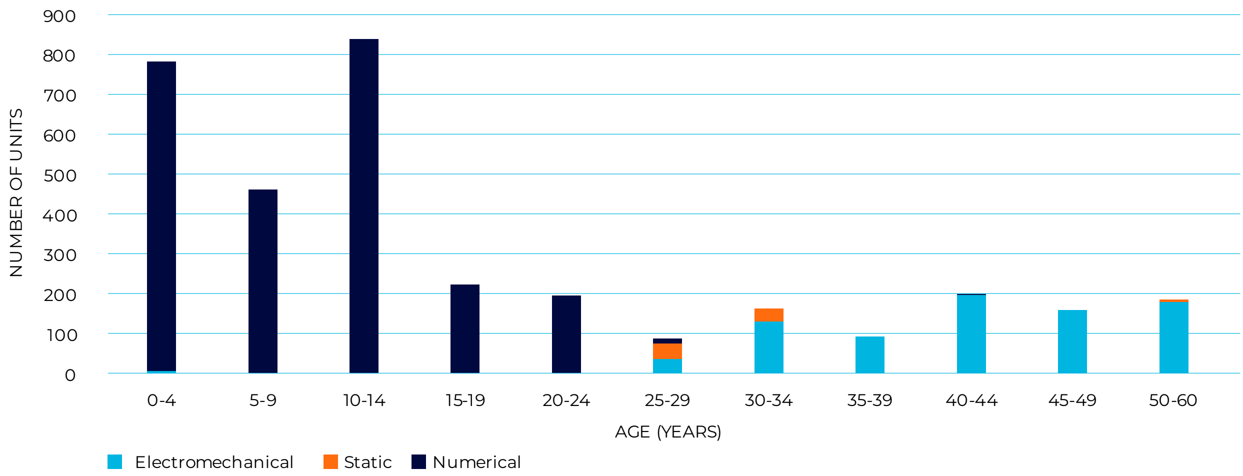



FIGURE 12-37: PROTECTION RELAY FLEET AGE PROFILE BY TYPE

### 12.8.1.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

### 12.8.1.4 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. 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 23% of the relays are electromagnetic and at least 25 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 between 25 and 34 years old.

Numerical relays are extremely flexible as they are programmable and can be configured to perform a wide range of protection functions. 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. Currently, more than half of the relays within Vector's network are of the numerical type and are less than 15 years old. To date failures of numerical relays have been rare.

#### 12.8.1.5 MANAGEMENT STRATEGY

Vector's long-term asset management strategy for protection relays is to progressively phase out static, electromagnetic and first-generation numerical relays and replace them with modern numerical relays within the next 10 years. The replacement activities will prioritise electromagnetic relays on rural overhead feeders and high load substations, followed by the remainder of the static relays. The risk of relays will be reassessed annually, and the replacement activities are reprioritised 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.

#### 12.8.1.6 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 selected 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 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.

#### 12.8.1.7 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.

### 12.8.2 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 approximately 209 TMS relays in service. These devices can be divided into four major categories as technology changed over time. The TMS Relays within Vector's network comprise:

- Numerical TMS relays
- Static TMS relays
- Programmable Logic Controller (PLC) TMS
- Electromechanical TMS relays

Table 12-33 below provides a summary of TMS fleet. This shows approximately 74% of the TMS fleet are modern numerical types.

| ELECTROMECHANICAL | STATIC | PLC | NUMERICAL | TOTAL |
|---|---|---|---|---|
| 22 | 29 | 4 | 154 | **209** |

TABLE 12-33: 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 12-38 below:

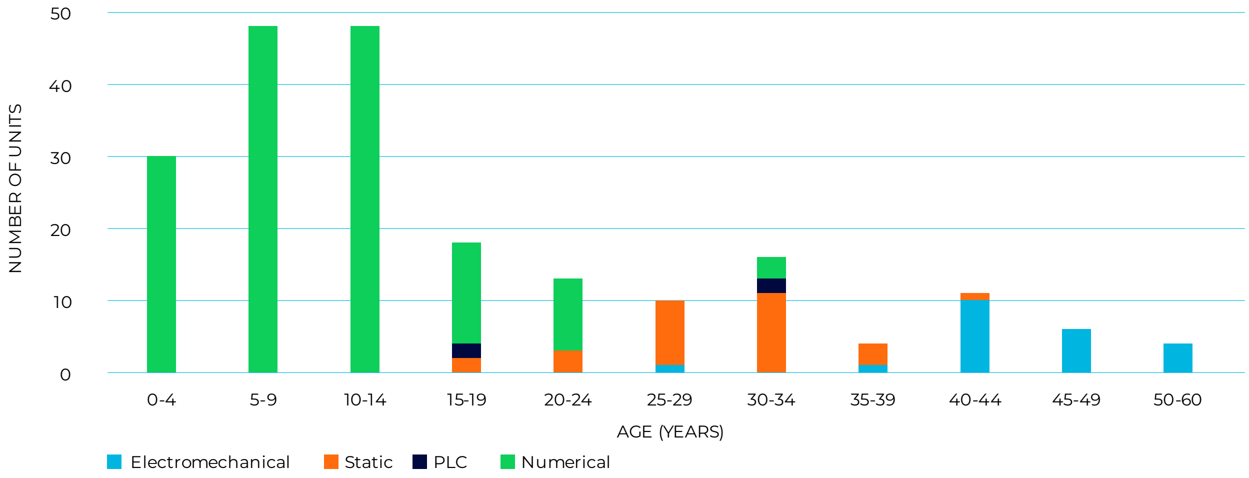



FIGURE 12-38: TMS RELAY FLEET AGE PROFILE BY TYPE

### 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 PLC based TMS and Static TMS Relays on the network are between 15 and 40 years old. They are approaching the end of their design life and are most susceptible to failures. There is a trend of increasing failures over the past few years associated with PLC based TMS and Static TMS relays. Additionally, technical support from the manufacturers is limited for these types of relays. The systems with high failure rates and known issues are being actively monitored and are prioritised for replacement with modern numerical TMS relays.

The age of the electromechanical TMS relays range between 25 and 60 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. Vector is in the process of replacing the aging electromechanical TMS relays with modern numerical TMS relays.

### 12.8.2.4 CONDITION AND HEALTH

Over the past 5 years, the use of modern numerical TMS relays on Vector's network has increased from 49% to 74%. 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.

The electromechanical TMS relays within the network ranges from 25 to 60 years old and are therefore approaching the end of their design life and are at risk of obsolescence, with spare parts and appropriately skilled technicians becoming increasingly scarce.

The PLC based TMS and Static TMS relays have the highest failure rate over the last few years. They are also at risk of obsolescence with spare parts already in an aged condition.

### 12.8.2.5 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.

### 12.8.2.6 DESIGN AND CONSTRUCT

The replacement of the TMS units will reuse existing control wiring as well as the 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.

### 12.8.2.7 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 communication systems include:

- Backhaul communication network that links the remote equipment to the centralised control and monitoring system
- Onsite communication network interfaces with the equipment on site to the Backhaul communication network

#### 12.8.3.1 FLEET OVERVIEW

The backhaul communication network used for substation connectivity includes:

- **Fibre network** used by over 80% of zone substations and GXP's for the backhaul communication system.
- **Pilot cables** used as the communications medium for telecommunications between substation sites
- **Digital Microwave Radio (DMR)** network that uses 3G where fibre connectivity is unavailable.
- **Third party networks** comprising cellular, fibre, wireless and radio network, that are employed when the fibre network becomes unavailable.
- **Legacy Communication Network** comprising aged and obsolete equipment that remains in service but is due for replacement in the near future.

The voice communication system within Vector's network comprises:

- **VHF & UHF radio systems** that enable communication between field crews and the EOC.
- **Substation IP Telephony** that provides voice communication between a zone substation and the EOC.

The on-site communication systems that utilises the backhaul communication network to interface/communicate with end devices employed by Vector include the following:

- **Routers**
- **Network Switches**

Table 12-34 provides a summary of the numbers of communications devices.

| CISCO ROUTERS | ETHERNET SWITCH | CELLULAR ROUTERS |
|---|---|---|
| 165 | 363 | 535 |

TABLE 12-34: NUMBERS OF ROUTERS AND SWITCHES

#### 12.8.3.2 POPULATION AND AGE

Backhaul communication system consists of many thousands of lines and it is not practical to compile age profiles and key statistics table. The voice communication system also doesn't have age profiles and key statistics table generated at this time of writing this document.

The population and age profile for Cisco Routers are provided in Figure 12-39 below:

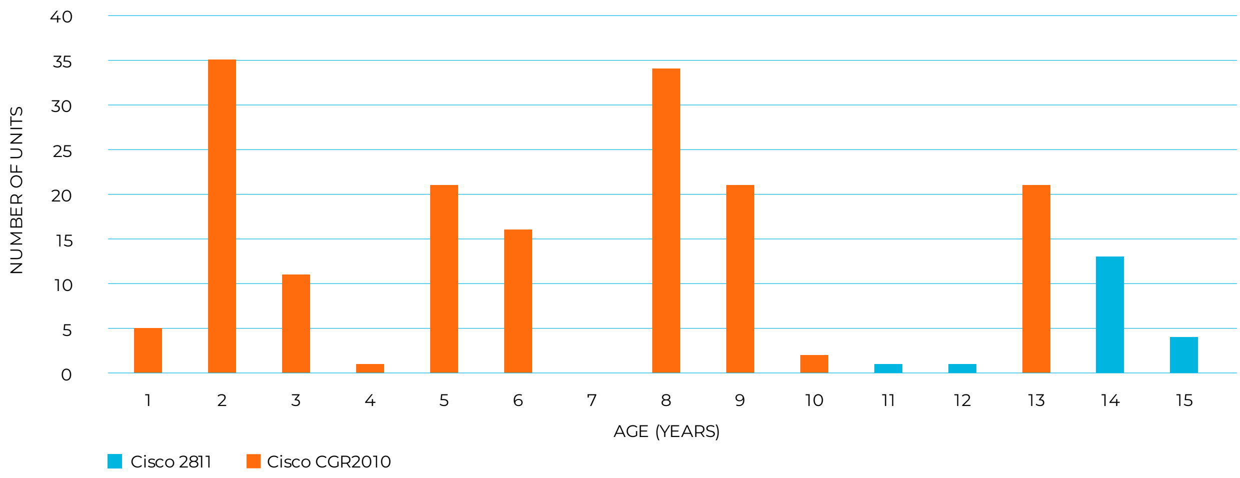



FIGURE 12-39: CISCO ROUTER FLEET AGE PROFILE

The population and age profile for Ethernet Switch are provided in Figure 12-40 below (Vector notes this data is 91% accurate)::

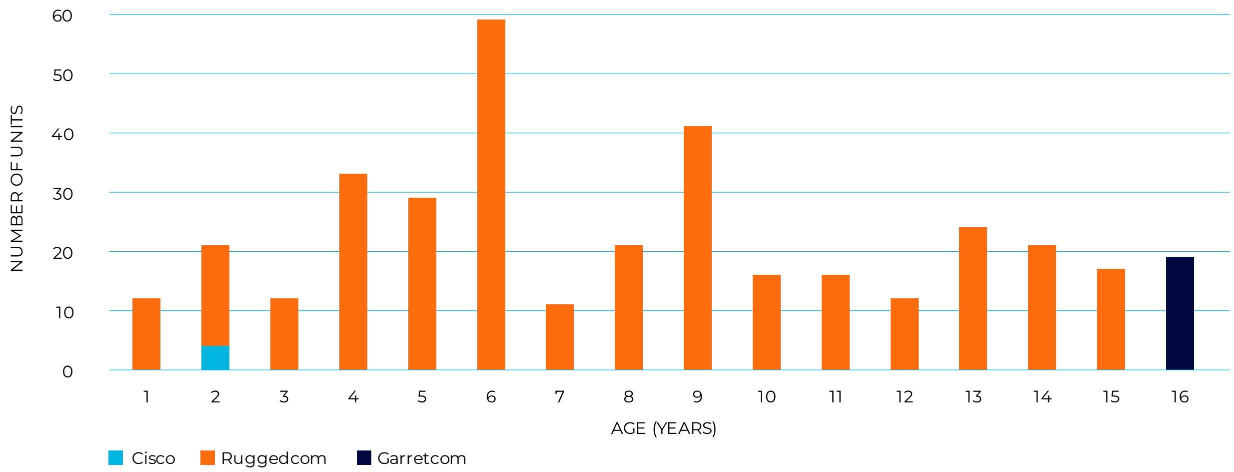



FIGURE 12-40: ETHERNET SWITCH FLEET AGE PROFILE

The population and age profile for Cellular Router are provided in Figure 12-41 below (Vector notes that this data is 91% accurate):

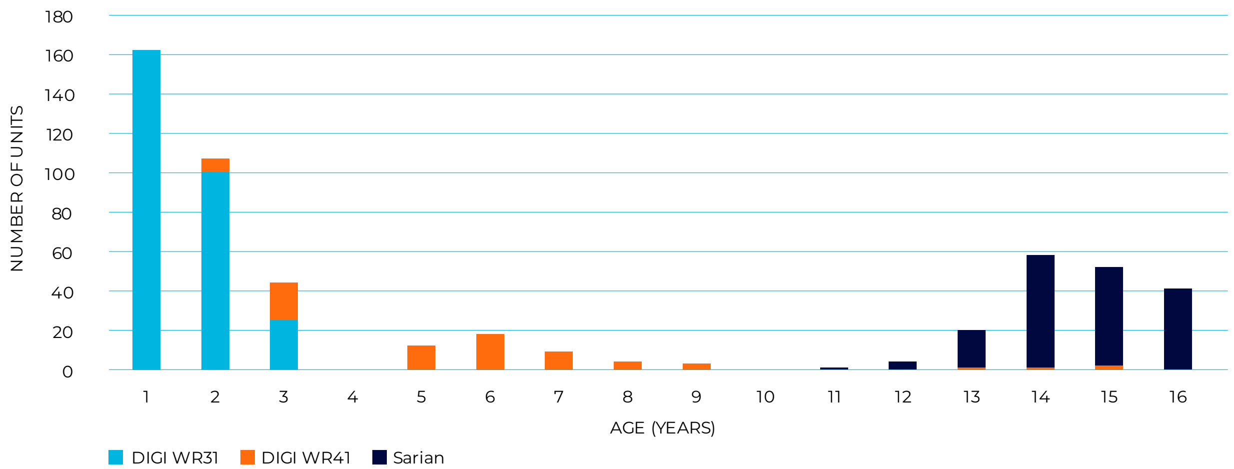



FIGURE 12-41: CELLULAR ROUTER AGE FLEET PROFILE

### 12.8.3.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

For fibre infrastructure as part of the Backhaul communication systems, the system availability figure for the last year has been above the 99.95% availability target. The fibre outages experienced over the past year have been caused by third parties. The fibre network is fit for purpose and will be expanded as required. Sites using the copper cable pilot network as the backhaul will be migrated to the fibre network over the next couple of years. The available bandwidth on the fibre network is sufficient for future expansion. The performance of the DMR system is not actively monitored. Real time remote monitoring functionality will be implemented in the future to provide performance information. The key risks associated with DMR are environmental and third-party damage.

The voice communication system's performance is not actively monitored. The performance information will be collected for future reports. They key risk associated with the radio communication system is the reliance on third-party infrastructure (e.g. repeater stations), which could cause loss of communications should there be failure of the third party infrastructure. The substation IP Telephony relies on infrastructure such as routers, which could potentially cause a communications outage.

The Cisco routers and Ruggedcom switches have an achieved availability figure above the 99.95% target over the past year. There were several recorded outages due to substation outages and network switch failures. The cellular routers achieved an overall availability of 97.3%.

### 12.8.3.4 CONDITION AND HEALTH

The fibre infrastructure for backhaul communications is in a healthy condition. The DMR equipment are also in healthy state but is approaching the end of its design life.

The voice communication radio systems are up to 30 years old and is of average to poor health due to the advanced age. The substation IP telephony system is in good condition, however the analogue telephones installed at 13 sites are becoming obsolete and will be progressively replaced with the more modern VoIP telephones.

#### 12.8.3.5 MANAGEMENT STRATEGY

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 future energy network. The DMR 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 with its functionality integrated into Vector Fibre's network management system. The legacy networks such as OTN, PDH etc. are obsolete and Vector is struggling to retain expertise to operate and maintain these systems. They will be either migrated into modern network or retired if no longer required. Vector will continue to replace the remainder of the Cisco 2811 routers that are approaching end of life and unsupported. 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.
- The infrastructure to provide real time monitoring and control capabilities to manage Vector's electricity network.

A support & maintenance agreement is in place for the fibre infrastructure, and DMR equipment will be procured and spares maintained for fault restoration purposes.

On site network equipment will be 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. Strategic spares are kept for zone substations.

#### 12.8.3.7 OPERATE AND MAINTAIN

Fibre
The fibre infrastructure for the SCADA network is managed by Vector Fibre.

Digital Microwave Radio (DMR)
The maintenance requirements for the DMR system are defined in Vector's standard ESM-805. 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.

VHF radio
Where maintenance of radio equipment is required, site specific maintenance standards are developed (ESM-805 Maintenance of Radio Equipment, ESM-709 Penrose – Hobson Tunnel Radio Systems and ESM-712 Penrose – Hobson Tunnel Radio Systems.)

Substation IP Phones, Routers and Ethernet switches and Cellular routers
There are no maintenance requirements for the IP Phones, Cisco routers or cellular routers. This equipment is monitored and managed by Vector Fibre under their support agreement.

### 12.8.4 AUTOMATION SYSTEMS

Vector employs network automation systems, comprising substation 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 SCADA system through the communications network.

#### 12.8.4.1 FLEET OVERVIEW

Vector has around 454 RTU devices from a variety of suppliers within its network. Table 12-35 below provides a summary of RTU types.

| TYPE | NUMBERS |
|---|---|
| Foxboro | 54 |
| GTP Plessey | 10 |
| SEL | 245 |
| Siemens | 8 |
| ABB | 129 |
| Unknown | 8 |

TABLE 12-35: RTU FLEET COMPOSITION

Table 12-36 below provides a summary of distribution automation devices type composition.

| DEVICE TYPE | TOTAL NUMBER |
|---|---|
| Linak Devices | 10 |
| Voltage Regulator Devices | 4 |
| Customer DC System Monitoring | 3 |
| FPI | 4,872 |

TABLE 12-36: 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 12-42 below:

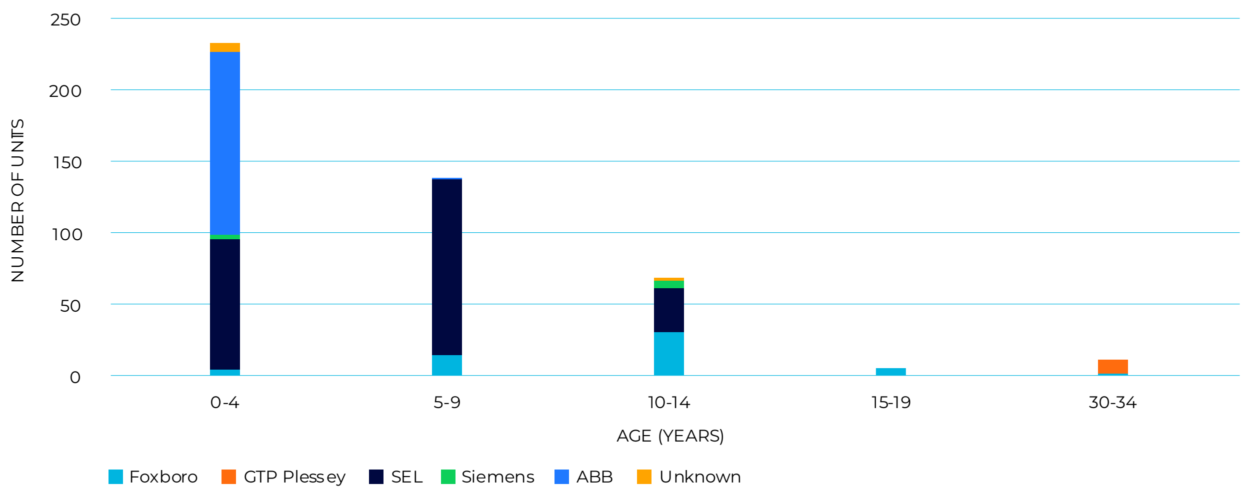



FIGURE 12-42: NETWORK AUTOMATION SYSTEM AGE PROFILE

### 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. In addition, the implementation of automation systems allows hands-off operation of the network and reducing the need for crew travel, with its associated hazards, 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 considered to be 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. Since 2012 Vector has systematically replaced legacy devices as part of switchgear and protection 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 SCADA 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 ESM-801.

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.

#### 12.8.5.1 FLEET OVERVIEW

Vector has approximately 160 power quality meters commissioned on its sub-transmission and distribution networks. There are two types of PQM used spanning multiple generations:

- Advanced PQM: ION 7700, ION 7600, ION 7650 v3XX, ION 7650 v400
- Intermediate: PQM: ION 7330, ION 7500, PM 8000, ION 7400

Table 12-37 below summarises the PQM fleet.

| TYPE | NUMBERS |
|---|---|
| ION7330 | 7 |
| ION7400 | 13 |
| ION7500 | 5 |
| ION7600 | 7 |
| ION7650 V3xx | 61 |
| ION7650 V4xx | 62 |
| ION7700 | 2 |
| PM8000 | 3 |

TABLE 12-37: PQM TYPE COMPOSITION

### 12.8.5.2 POPULATION AND AGE

The population and age profile for PQMs are provided in Figure 12-43 below:

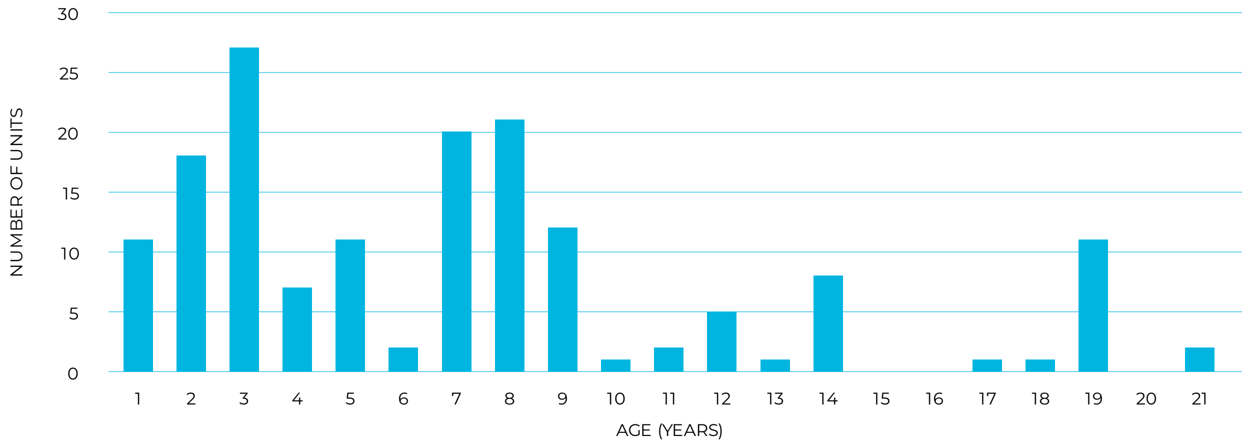



FIGURE 12-43: PQM FLEET AGE PROFILE

### 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 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 and 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 associated support issues. 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 possible PQMs will be replaced as part of other capital projects such as switchgear replacement.

### 12.8.7 FORECAST SPEND

Because of its focus to improve network reliability the forecasts for the replacement and refurbishment of all protection systems are included in Section 11, Network Reliability. The forecast capex investment in Figure 12-44 includes TMS systems, communication systems, automation and PQM metering.

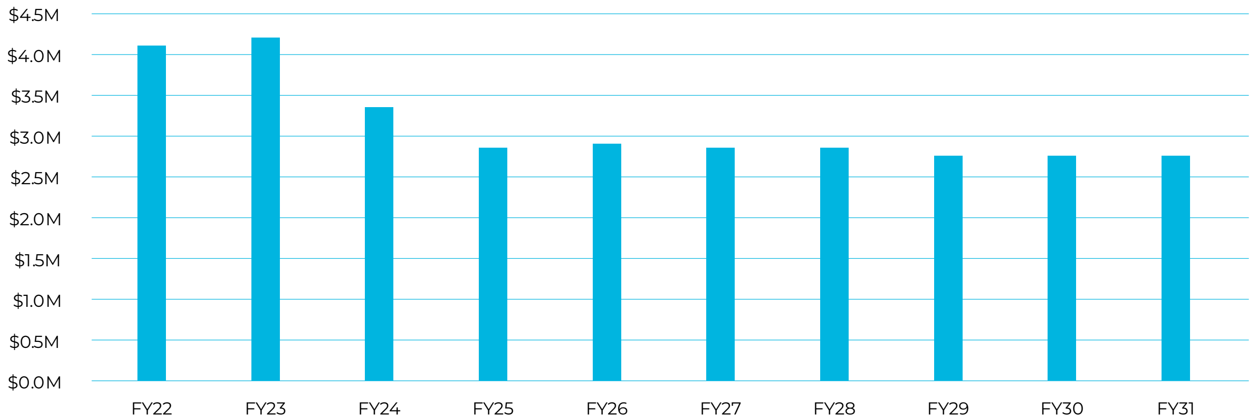



FIGURE 12-44: FORECAST CAPEX - PROTECTION CONTROL

## 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 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 to the safe and reliable operation of the 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 improve reliability and minimise disruption when undertaking maintenance activities.

#### 12.9.1.1 FLEET OVERVIEW

Key statistics of the DC charger assets are shown in Table 12-38.

| TYPE | NUMBERS |
|---|---|
| 110 V DC chargers | 165 |
| 48 V DC chargers | 10 |
| 24 V DC chargers | 79 |
| 30 V DC chargers | 114 |

TABLE 12-38: DC CHARGER FLEET OVERVIEW

The 110 V DC systems are used to provide supply 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 are used for zone substations with legacy communications and circuit breakers and are being progressively replaced with 110 V DC and 48 V DC systems as part of a wider risk-based replacement strategy for the legacy communications and circuit breakers.

#### 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.

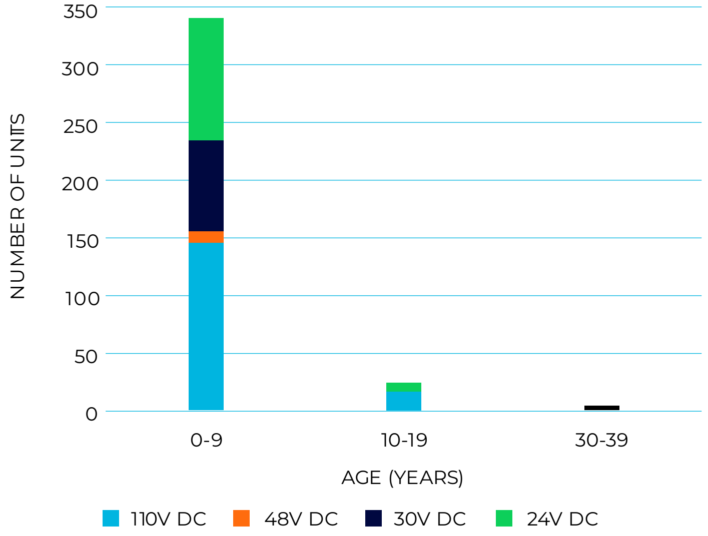



FIGURE 12-45: DC CHARGER FLEET AGE PROFILE

#### 12.9.1.3 ASSET PERFORMANCE, EMERGING TRENDS, AND RISKS

Vector's DC systems have been performing 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 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 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 refurbishment. Vector continues to test 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 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 12-39.

| 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 testing on batteries, battery chargers, DC circuitry, UPS, fittings and convertors | 2 Years |

TABLE 12-39: 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 as a customer-centric service to reduce peak demand to limit transmission charges for customers or to help with network congestion. At all other times this load is offered into the wholesale electricity market as non-instantaneous system capacity reserve.

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 balance of their streetlights not yet converted to their new management systems.

The number of ICPs per type of hot water load control system is provided in Table 12-40.

| ASSET SUBCLASS | NUMBER OF ICP'S | SYSTEM STATUS |
|---|---|---|
| Ripple | 335,509 | Active load management in Auckland region only |
| Pilot wire | 142,715 | No active load management |
| Rotary | 39,257 | No active load management |
| Cyclo | 15,353 | No active load management |

TABLE 12-40: NUMBER OF CUSTOMERS PER HOT WATER CONTROL TYPE

#### 12.9.2.2 POPULATION, AGE AND CONDITION

Vector's fleet of 32 ripple plant units is installed across twelve zone substations. The asset average age is 33 years and is approaching end of life.

#### 12.9.2.3 ASSET PERFORMANCE, EMERGING TRENDS AND RISKS

There have been recent failures of ripple plant on Vector's network including a HV inductor failure at Liverpool zone substation caused by internal short circuit and degraded insulation caused a voltage flash over at Mangere GXP.

In addition, there has been internal dielectric breakdown of capacitors used on ripple plant at Mangere East and Manukau zone substations. This is a typical symptom for aging equipment of this type. Accordingly, scheduled replacement of these units has occurred with successful return to service.

Although Vector's ripple plant is suspectable to age related failure modes, it is considered to be performing adequately as they are of a non-critical nature. This is a benefit of the architecture of this load management system which can tolerate the loss of a ripple plant without the loss of customer hot water supply.

#### 12.9.2.4 MANAGEMENT STRATEGY

To ensure the best available signal strength and resonance frequency accuracy, Vector engages the ripple plant vendor to recalibrate the output performance of Vector's ripple plant by tuning of the injection resonance and power output modules on an annual basis. This is usually done ahead of winter's generally higher network load demand that increases network impedance and degrades signal reach (penetration) into the network.

Asset maintenance is in accordance with ESM603 and undertaken at regular planned intervals by Vector's field service providers (FSP's) and where required, asset-specific specialists. ESM603 includes regulatory, code of practice, NZ and international standards, and good industry practice requirements that are applicable to the asset class. On-site assessment is by visual and thermographic inspection, and test condition, in accordance with the maintenance standard. Vector strategically replaces hot water ripple plant at the end of its operational life, as is common for other utilities and recommended by the OEM for this asset type. Our other hot water management systems no longer provide this function, and we are working up a new technology replacement for deployment.

### 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. In total, there is 30 MVAr installed across four zone substation sites in the Auckland and Northern networks. A programme based on recent network system studies will provide an additional 45 MVar at a further five sites to ensure our voltage and frequency metrics continue to be achieved.

#### 12.9.3.2 POPULATION, AGE AND CONDITION

The average age Vector's capacitor banks is 21 years. The expected operating life is around 20 years. Capacitor banks installed in an indoor environment are typically 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 capacitor banks 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 associated with ground mounted capacitor banks. Faulty units are automatically disconnected using internal fuses and circuit breakers. Due to their installation age predating arc-flash protection, no units in the fleet have this and our pending programme of asset replacements will add this personnel and asset safety feature.

#### 12.9.3.4 MANAGEMENT STRATEGY

Vector uses its DigSILENT model to determine the need for capacitor banks in the network. Modelling results will show which capacitor banks can be removed from the network altogether or where new capacitor banks need to be installed. There are instances where capacitor banks already exist but have not been in use for some time: if modelling shows that the capacitor banks should be placed back in service, refurbishment will be undertaken depending on the condition of the capacitor banks.

Planned maintenance for capacitor banks are detailed in Vector's maintenance standard ESM603 and include 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.

Capacitor banks 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.

### 12.9.4 SECURITY AND ACCESS SYSTEMS

#### 12.9.4.1 FLEET OVERVIEW

Vector security and access systems consist of keyed and electromagnetic locks, door hardware, electric and perimeter fencing and access and monitoring systems. Cardax systems with 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 cable tunnel.

Vector EOC can remotely monitor via SCADA this building entry and egress at the card reader. Motion detectors are fitted to detect intruders in switch room buildings. If an unauthorised entry event alarm occurs, the EOC contacts the FSP to investigate. If required, the Police are phoned.

#### 12.9.4.2 POPULATION, AGE AND CONDITION

Vector has recently completed an upgrade to install Cardex systems to replace end of life control units installed in the 1970s. There are 147 units installed 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 intrusions across Vector's sites. Cardex systems have proven to be robust and are performing in line with expectations.

Vector is trialling the use of thermal camera imaging systems to determine the operational value and cost effectiveness of real time monitoring systems at high critically sites. Thermal imaging technology now minimises nuisance alerts, gives more useful image resolution, and automated interfaces to information management systems such as Vector ADMS and DERMS.

#### 12.9.4.4 MANAGEMENT STRATEGY

Vector's acquisition strategy will be to continue to procure security and access systems from Gallagher CardaxTM 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 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 Cardax 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

Since the 400 V a.c. local service supply fire within Takanini zone substation in FY18 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. This is now also guided by the lessons of the Penrose GXP fire within Vector's 33 kV cable trench in 2014.

Site specific hazard reviews have found the following issues or risks:

- Legacy internal doors between adjacent transformer bay fire cells are being removed where this does not impact twin emergency egress. Auto-closers will be fitted to those that provide a second egress within the fire cell.
- The replacement programme for end of technical life legacy 1970's bespoke Guardall fire protection panels will be completed in FY22. This is to achieve H&S risk minimisation: there is no failure hazard currently.
- The Penrose Hobson tunnel fire main sprinkler heads began failing in 2020 and a targeted replacement programme is underway for full replacement by the end of FY22. The full suite of heads has been received to strategic stock, avoiding COVID-19 USA OEM supply disruption.
- For the seven minor cable tunnels, installation of heat/smoke detection and SCADA communication to EOC is being prioritised by the three tunnels with cable joints. Joints have already been treated with intumescent protection for fire.

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. 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 this 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 note the risk 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 resistivity and covering (e.g. metal chip and asphalt) are included in the overall analysis of earth system performance and are covered by step and touch voltage measurement.

#### 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 inspections as part of planned maintenance regimes are 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.

Earthing is typically copper conductor which is susceptible to corrosion in contaminated soils, by galvanic action with dissimilar metals and hazardous substances. ESM 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. Zone substations and distribution earthing are subject to a thorough testing regime that is performed every five years. Vector's asset strategy for earthing systems is described in strategy report EAA600 Auxiliary Systems.

### 12.9.7 REPLACE, RENEW AND DISPOSE

#### 12.9.7.1 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 as a result of 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 maintenance or testing.

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, asset vendors or other industry bodies with recognised technical knowledge.

#### 12.9.7.2 LOAD MANAGEMENT SYSTEMS

Ripple plant hot water load management 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.

Assisting the replacement strategy is the transfer of Vector's management of streetlights to Auckland Transport as they migrate these to LED luminaries with a new radio/cellular switching control technology. Auckland Transport's programme began in 2014 and is planned for completion in 2023, COVID-19 allowing. The same systems we use to manage streetlights are used to manage customer hot water cylinders and so must be retained. From 2023 the control of Auckland Council streetlights via Vector will no longer be required.

Over the last two years Vector has customer-trialled and evaluated an alternative digital radio/cellular-based load management system to replace the pilot wire and ripple systems in the Northern network and in the longer term, the ageing ripple plants in the Auckland network. The 'proof of concept' outcome has proven that a targeted deployment program of radio and/or cellular signalling systems can more reliably and effectively achieve customer-centric and electricity market information-based response outcomes than we have now for load shifting / load reductions. Meanwhile our existing systems s will continue to be maintained in service. The load growth area of Warkworth and Wellsford with their legacy Cyclo 'ripple' injection equipment is planned for the first introduction of this new system and return the ability for load management to this area. Ultimately it is expected this type of system will replace the retired load management systems on the Northern and then the active ripple systems on the Auckland network.

#### 12.9.7.3 CAPACITOR BANKS

Capital investment is forecast in AMP 2021 for the replacement of existing Auckland ground-mounted capacitor banks and disposal of the existing indoor population with new arc-flash rated outdoor units and replacing the existing outdoor units. This best manages the existing personnel and switchboard safety and related fire hazard.

#### 12.9.7.4 SECURITY, ACCESS AND FIRE PROTECTION SYSTEMS

The controller cards are being progressively replaced as part of a wider strategy as they will no longer be supported by the OEM beyond 2021. Security, Access and Fire Protection Systems are renewed under a proactive and targeted replacement programme described in Section 12 Appendix with detailed programme forecast capex tables.

#### 12.9.7.5 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.

### 12.9.8 FORECAST SPEND

The forecast capex chart below includes power supply systems and capacitor banks. Because of their focus on security, the forecast capex for the remainder of security, access and fire protection systems are included in Section 11, Network Reliability.

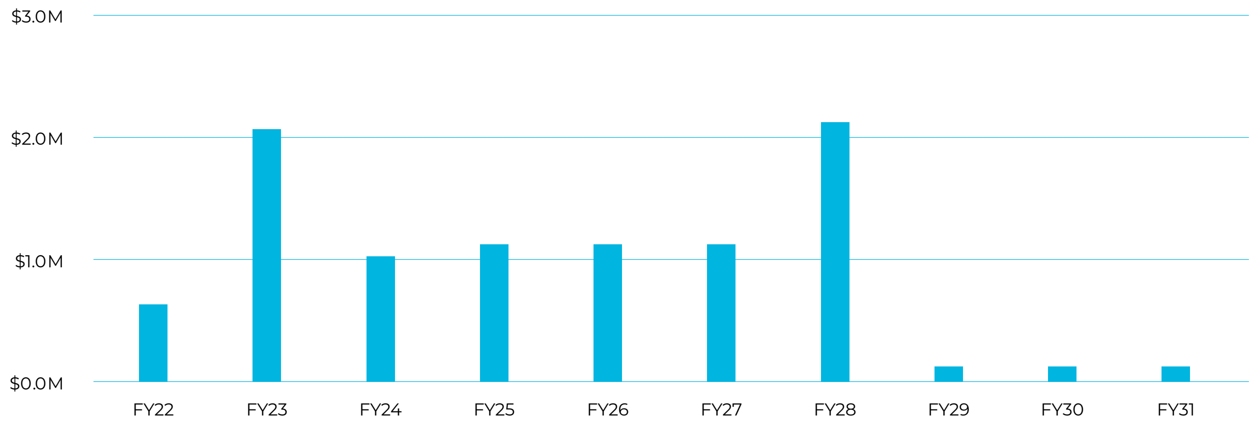



FIGURE 12-46: FORECAST CAPEX – AUXILLARY SYSTEMS

## 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.

All currently operational BESS are of the Tesla Powerpack type. They are of modular and scalable construction that can be relocated within the network. The Tesla Powerpack systems have 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.

#### POPULATION AND AGE

We have a total of six operational BESS with one BESS currently under construction. Our first 1 MW/2.3 MWh BESS at Glen Innes zone substation has now been in service since October 2016 and is being used to reduce peak demand and defer network capacity investment. 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 BESS and a solar energy PV system installed as part of Vector Lights initiative provides renewable energy for Auckland Harbour Bridge decorative lighting. The current BESS fleet uses Tesla Powerpack battery systems. The construction of a seventh 1.14 MW / 1.254 MWh BESS is currently underway at Tapora. This 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.

Key information of the BESS assets are shown in Table 12-41.

| LOCATION | RATINGS | AGE |
|---|---|---|
| Zone Substation Glen Innes | 1.0 MW / 2.3 MWh | 5 years |
| Zone Substation Warkworth South | 2.0 MW / 4.8 MWh | 3 years |
| Zone Substation Snells Beach | 2.5 MW / 6 MWh | 3 years |
| 22 kV Feeder - Vector Lights | 0.25 MW/0.475 MWh | 2 years |
| 11 kV Feeder - Kawakawa Bay | 1 MW / 1.7 MWh | 2 year |
| Zone Substation Hobsonville Point | 1 MW/2.0 MWh | 1 year |
| 11 kV Feeder - Tapora | 1.14 MW / 1.254 MWh | 1 year |

TABLE 12-41: KEY INFORMATION FOR BATTERY ENERGY STORAGE SYSTEMS

### 12.10.1.2 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. There have been teething issues with BESS operating in the microgrid, but no systemic issues encountered to date for in service units.

### 12.10.1.3 MANAGEMENT STRATEGY

The BESS assets will be used in their current locations until they have served their intended purpose. Implementing additional BESS functions or using BESS elsewhere in the network will be subject to cost and benefit analysis.

### 12.10.1.4 DESIGN AND CONSTRUCT

Tesla Powerpack systems are a technically advanced, prefabricated, modular and scalable system. The system exhibits a high level of safety features and has been tested against and demonstrated performance beyond the requirements of the international safety standards.

## 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. Establishing two permanent sites, acquiring Vector owned gensets for Southhead, and using two Vector owned mobile generator connection transformers to interface the diesel genset to the 11 kV feeders have been forecast in AMP 2021 (see Section 11, Network Reliability).

Processes are in place, to manage engagement with customers and the qualification of customers for assistance of supplying electricity from the portable diesel generators 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 2 years old and are infrequently used (i.e. used only during outages).

#### 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. 263 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. Latest Tesla Powerwall are of generation 2 with rated power 5 kW and rated energy capacity 13.5 kWh,

#### 12.10.3.2 POPULATION AND AGE

Table 12-42 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 with Battery Energy Storage Systems | 430 |
| No of Residential Battery Energy Systems | 223 |

TABLE 12-42: KEY INFORMATION FOR SOLAR/BATTERY AND STAND-ALONE BATTERY SYSTEM INSTALLATIONS

Figure 12-47 and Figure 12-48 below shows the age profiles for solar/battery installations and stand-alone battery installations, respectively.

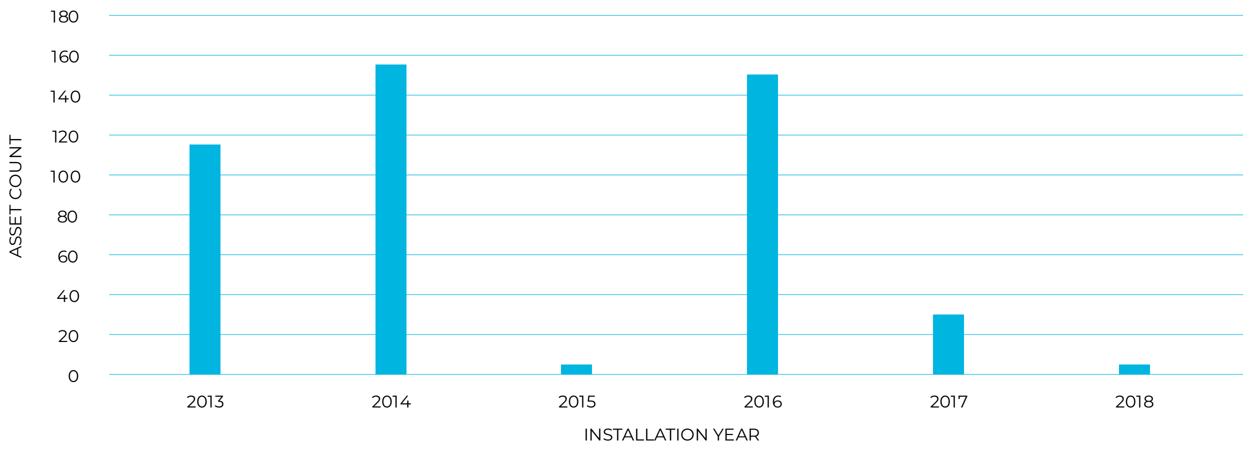



FIGURE 12-47: AGE PROFILE FOR SOLAR PV AND BATTERY ENERGY STORAGE SYSTEM INSTALLATIONS

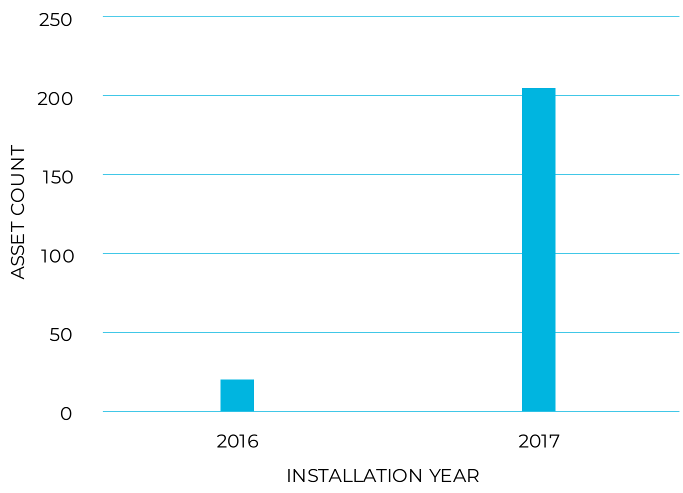



FIGURE 12-48: AGE PROFILE FOR BATTERY ENERGY STORAGE SYSTEM INSTALLATIONS

#### 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

The availability of public EV charging infrastructure supports and encourages the increased uptake of electric vehicles as it enables journeys beyond the battery range to be completed and reduces range anxiety. However, the integration of EV charging stations into the electricity network and the potential impact on infrastructure investment needs to be carefully considered to avoid overloading and excessive peaks and this is considered when sites for public charging are selected.

In 2016 we commenced on a programme of works to install EV charging stations in strategic public locations over the wider Auckland region. The Vector EV charging app was launched in 2017 providing directions to the location of EV chargers making them easier for customers to find. We also have a number of 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 has installed 200 controllable 7 kW EV charging stations in customer premises over the wider Auckland region including Waiheke island. These are 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.

#### 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 | 18 |
| D.C. EV Fast Charging Stations | 18 |
| A.C. V2G EV Charging Stations in Vector's Office Building | 2 |
| A.C. EV Charging Stations in Vector's Office Building | 12 |

TABLE 12-43: 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 very young, and apart from some teething issues that are often experienced with a new asset class, and the EV charging stations are in good health.

### 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 Chapter 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 2021.

## 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, 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 switchgear, 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 and fencing management are key to site security and for personnel, public and asset safety.

#### 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 12-44.

| TYPE | ASSET QUANTITY |
|---|---|
| Customer Substation Buildings | 126 |
| Substation Buildings and Grounds | 118 |

TABLE 12-44: 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 12-49 below illustrates the age profile of Vector zone substation buildings. Their average age is 36 years.

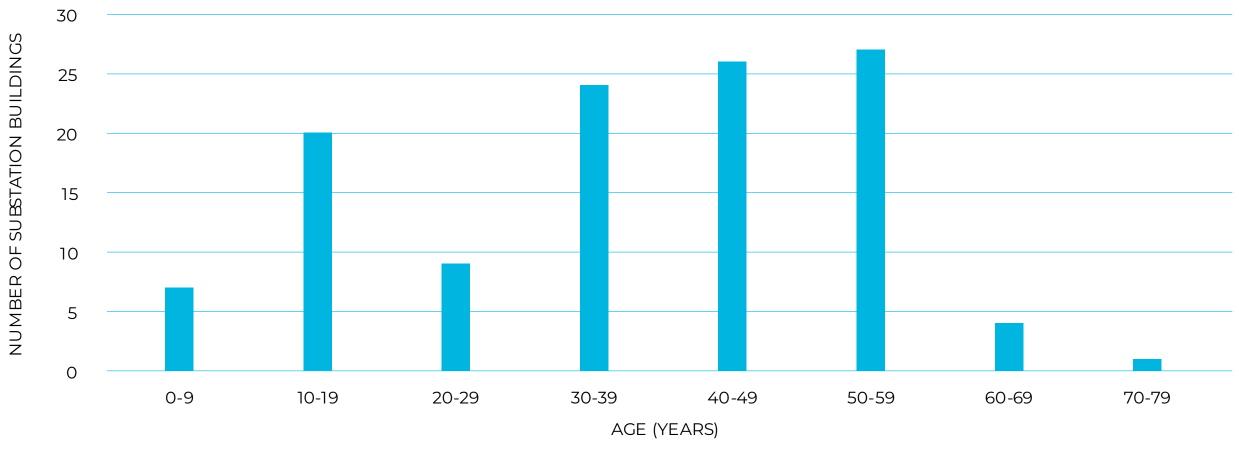



FIGURE 12-49: POPULATION AND AGE PROFIILE FOR SUBSTATION BUILDINGS

#### 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 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.

Multistory 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.

#### 12.11.1.5 MANAGEMENT STRATEGY

The management strategy for the buildings and grounds 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 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.

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 and electrical industry Standards inclusive of AS2067.

#### 12.11.1.7 OPERATE AND MAINTAIN

Vector routinely inspect buildings and grounds fleet by 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 cable. 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.

This asset class includes the tunnel's structure and access security, ground water drainage pumps 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, a light rail system for expedient access, fire sprinkler tunnel and shaft deluge fire protection, permanent gas sensors, and a digital radio system, all with remote systems status to the Vector electricity operations centre.

All the tunnels are defined as confined spaces and are restricted to entry by personnel trained in those safety procedures.

#### 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 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 inspect 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 EMS709 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, additional primary equipment (switchgear) or network growth replacements and building performance to meet its intended function. 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.

Each building and grounds site that requires asset replacement is inspected to ascertain the scope of works and site constraints. Planned maintenance findings and predicted lifecycle costs 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 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.

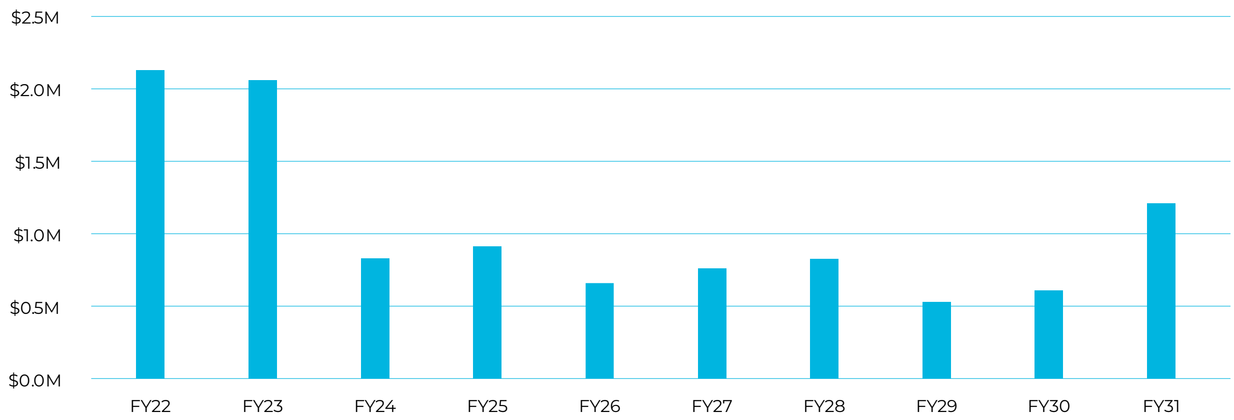



FIGURE 12-50: FORECAST CAPEX – INFRASTRUCTURE AND FACILITIES

**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 BELMONT 33 KV OUTDOOR TO INDOOR CONVERSION

Works on the Belmont 33 kV ODID commenced in FY20 and the project is scheduled for completion in FY22. This project will see the replacement of ageing outdoor oil filled 33 kV CBs in an existing outdoor switchyard in very close proximity to residential backyards. The works will also see the installation of additional 33 kV CBs to allow for bolstering of the resiliency of the network on the Devonport Peninsula in the longer term.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Belmont 33 kV SWBD ODID | 1.33 | | | | | | | | | | **1.33** |

### 12A.2.2 JAMES ST 33 KV OUTDOOR TO INDOOR CONVERSION

The project to convert the existing outdoor 33 kV switchyard commenced in FY20 with the development of the concept design and detail design in FY21. Delivery of the project will commence in FY21 and continue into FY22. The existing switchyard consists of two air break switches that act as incomers onto an aged outdoor bus structure with no bus coupler. The two transformers are supplied via Takaoka 33 kV oil filled CBs respectively, installed in 1972. Apart from the two 33 kV CBs to the transformers there is no automated switches in the 33 kV outdoor switchyard. This together with the fact that there is no bus section CB means that when a fault occurs on the lengthy overhead subtransmission circuit our faultmen need to manually attend James St ZSS to transfer the network. This has led to high SAIDI.

The outdoor to indoor conversion will see the installation of a 33 kV prefabricated type switchgear room with fixed pattern $SF_6$ 33 kV switchgear and numerical relays as per Vector's standards. The 33 kV cables will be joined and rerouted to the new switchgear. The substation fence will be refurbished and replaced to ensure public safety and prevent unauthorized ingress.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| James St 33 kV SWBD ODID | 1.49 | | | | | | | | | | **1.49** |

### 12A.2.3 HAURAKI 33 KV OUTDOOR TO COMPACT SWITCHGEAR IN ENCLOSURE CONVERSION

The scope of works and business case to convert the existing outdoor 33 kV switchyard at Hauraki ZSS to compact 33 kV switchgear in outdoor weatherproof enclosures was undertaken in early FY21. The project concept has been developed and the works will now continue to detail design with capital delivery of the works commencing in late FY21 and completion in FY22. Hauraki ZSS is supplied via two 33 kV overhead subtransmission lines from Belmont and Takapuna ZSSs respectively that terminate onto rocking disconnectors at Hauraki ZSS on an ageing outdoor concrete support structure bus without a bus coupler. The upgrade of Hauraki ZSS is one of three extensive ZSS projects that are being undertaken in the Devonport peninsula and larger isthmus: the other two being Belmont 33 kV ODID and a second transformer and subtransmission circuit at Takapuna ZSS, to improve the reliability and resilience of the subtransmission network to this area.

The single transformer at Hauraki is supplied from an outdoor VOX 33 kV $SF_6$ CB in the outdoor yard. However, the lack of 33 kV CBs on the two incoming subtransmission circuits to Hauraki makes the implementation of fast acting unit protection difficult to implement. With the normally open point at the remote end of one subtransmission circuit, the lack of CBs and protection devices at Hauraki makes fault finding on the subtransmission circuits difficult and time consuming which in turn has led to excessive SAIDI.

A suite of three compact 33 kV CBs will be installed in a protective outdoor steel enclosure. Numerical protection relays that will include unit protection will be installed in new protection panels in the existing relay room. The remote end protection relays at Belmont and Takapuna, for the supplies to Hauraki, are described under separate project headings and separately funded. The outdoor VOX $SF_6$ CB will be recovered from Hauraki and retained as a strategic spare. The requirement for a second transformer is well into the future and a 33 kV switch for this transformer will not be installed under this project.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hauraki 33 kV SWBD ODID | 0.80 | | | | | | | | | | **0.80** |

### 12A.2.4 WARKWORTH 11 KV SWITCHBOARD REPLACEMENT

Warkworth ZSS supplies one of the most extensive rural networks in Vector's electricity supply area. The rural network is 479 km long and has four of the nine longest 11 kV feeders in the network. This ZSS services approximately 8,500 customers. The existing 11 kV switchgear in Warkworth is a South Wales oil filled switchgear suite that is a combination of D4DX and D8XD CBs all fitted with GEC electro-mechanical protection relays. The switchgear was installed in 1977.

The protection relays do not provide the instantaneous protection functions that will allow additional and more sensitive protection settings to be implemented for the long rural feeders and also makes coordination with additional downstream switching devices cumbersome. The Northern Warkworth-Snells Beach-Matakana-Omaha isthmus is a growth area and extension of the existing 1977 vintage 11 kV switchgear is not possible. The 11 kV switchgear will be replaced with modern fixed pattern switchgear in a new 11 kV switchroom. The business case for this project was approved in FY20: detail design will be undertaken in FY21 with capital delivery in FY22.

The switchgear will be rated for three 15 MVA transformers to be installed in the future and will provide space for CBs for feeders to be added. There is no driver to replace the existing $SF_6$ outdoor 33 kV switchgear at Warkworth ZSS but if and when that is scheduled the existing 11 kV switchroom can be repurposed for indoor 33 kV switchgear.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Warkworth 11 kV switchgear replacement | 2.46 | | | | | | | | | | **2.46** |

### 12A.2.5 WHITE SWAN 11 KV SWITCHBOARD REPLACE

The existing Reyrolle England LM36T 1969 vintage indoor oil filled CBs and electro-mechanical protection relays have reached the end of life, is no longer vendor supported, and must be replaced. The existing 11 kV switchroom has enough space to undertake an in situ staged 11 kV switchboard replacement. The major civil component of this build will be the construction of a cable trench inside the existing switchroom with core drilling to the outside of the building to house ducts for 11 kV cables.

As part of the electrical works, the transformer management systems will be replaced. The lighting and emergency lighting will be replaced with LED lighting as per Vector's standards and signage will be updated. Schneider GMAe 11 kV fixed pattern switchgear will be installed due to the compact footprint that makes it suitable for an-situ replacement where space is at a premium. The new switchgear to be installed will be suitable to connect the third transformer and will consist of three bus sections.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| White Swan 11 kV switchboard replacement | 3.40 | 0.30 | | | | | | | | | **3.70** |

### 12A.2.6 HOBSON 22 KV SWITCHBOARD REPLACE

Hobson ZSS is one of three bulk supply substations in Auckland's CBD and it supplies a large portion of the lower CBD as well as portions of St Mary's Bay and Freemans Bay. It supplies electricity to 3,248 customers, some of which are large high-profile corporate offices in the Wynyard area, the rapidly developing tank-farm area, Fisherman's wharf, and includes the new Sky City convention centre as well as the America's Cup village. The 22 kV nodes in Hobson ZSS are also the backstopping nodes to Liverpool and Quay St CBD zone substations and as far as Ponsonby ZSS and Freemans Bay ZSS, should a contingency arise at any of these zone substations.

The existing 22 kV Yorkshire YSF6 switchgear is long out of production and spare parts for the CB mechanisms are very hard to come by. This switchgear needs to be replaced to ensure the reliability of this highly strategic 22 kV node that supplies the rapidly developing Wynyard quarter and Fisherman's Wharf area in the lower CBD.

Seismic reinforcement of the existing facility is on-going in the basement and level 1. Extension of the existing 22 kV switchroom on level 2 will be completed before the switchgear replacement. The works will include all ancillary balance of plant and extensive 22 kV cable works to cut and join 22 kV cables from the existing 22 kV switchgear to the new circuit breakers.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hobson 22 kV switchboard replacement | 2.59 | | | | | | | | | | **2.59** |

### 12A.2.7 MANUKAU 11 KV SWITCHBOARD REPLACEMENT

The scope of works and business case for the replacement of an aged portion of the 11 kV switchgear at Manukau ZSS was issued and approved in early FY21. The 11 kV switchgear consists of fourteen Reyrolle LMVP vacuum CBs and numerical protection relays installed in 1976 and thirteen Reyrolle England LMT oil filled 11 kV CBs with electro-mechanical protection relays installed in 2007. This project will see the replacement of the Reyrolle England LMT oil filled switchgear with modern fixed pattern switchgear and numerical protection relays. The works will include new 11 kV XLPE cable tails from PILC cables to the switchgear. The forecast investment summary in FY22 is a continuation from FY21 to complete the works by FY23.

The Manukau ZSS ripple injection plant in the Auckland network is underpowered risking unreliable control of customer hot water cylinders and with annual tuning no longer a solution, replacement is budgeted for as part of the switchgear replacement. The existing plant will be retained as a sole strategic spare for four other sites that are of similar capacity.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Manukau 11 kV SWBD replacement | 1.65 | 0.90 | | | | | | | | | **2.55** |

### 12A.2.8 HOBSON 11 KV SWITCHBOARD REPLACEMENT

The 11 kV switchgear located in Hobson ZSS comprises two switchboards: a Brush switchboard installed in 1969 (21 oil-filled CBs) and a Reyrolle switchboard installed in 1983 (15 oil-filled CBs). Both switchboards are fitted with electro-mechanical protection schemes that cannot store data, cannot communicate digitally and is not supervised, i.e. failure of a protection relay will not be known to operators. Additionally, the equipment is not able to be economically retrofitted with fast acting arc-flash detection connected to the protection schemes as required in our present standards. Although the short circuit rating of the switchgear is adequate, the age of these assets contributes to an increased risk of catastrophic failure during close-in fault scenarios.

The 1960s vintage Brush switchgear and protection relays are no longer supported by the vendors and we maintain an inventory of strategic spares by retaining switchgear from previous replacement projects. The 1980s Reyrolle switchgear is still supported by RPS switchgear in New Zealand and its life will be extended by approximately 30 years by replacing the oil-filled circuit breaker components with modern vacuum equivalents and numerical protection relays incorporating fast acting arc flash protection.

Seismic upgrade on the switchgear building is nearing completion and will enable the 11 kV switchgear replacement project. The works will consist of a temporary transfer of 11 kV cable circuits to be able to dismantle the existing 11 kV switchgear in a staged manner.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hobson 11 kV switchboard replacement | 4.10 | 6.18 | | | | | | | | | **10.28** |

### 12A.2.9 LIVERPOOL 110 KV SWITCHGEAR REFURBISH

The Liverpool 110 kV HV-GIS switch in the Auckland CBD was commissioned into service in 1998. This 110 kV switch is one of the two main bulk supply points into the Auckland CBD and supplied from Penrose GXP. In 2013 this switch underwent a $1M renewal to address known issues with the hydraulic systems, explosion disks, switch position indication windows as well as to upgrade the gas densitometry for future trending analysis.

The Liverpool Merlin Gerin switchboard has been out of production for a great many years but is still actively supported by Mastergrid (previously Siemens) who took over the French factory (located in Grenoble) where it was produced. Service and parts are available from Mastergrid. However, lead times for parts no longer held as stock items can be considerable as they would require remanufacture. This switch will undergo a major 20-year refurbishment that will include replacement of the hydraulic CB and switch drives with an upgraded design with monitoring functions such as oil level alarms and hydraulic safe to operate pressure monitoring. The discrete component line cards will be upgraded with integrated circuit (IC) cards. This project is scheduled for delivery in FY23 to be outside of the time envelope of a present project to extend the 110 kV switchgear.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Liverpool 110 kV switchgear refurbish | 0.71 | 1.25 | | | | | | | | | **1.96** |

### 12A.2.10 FREEMANS BAY 11 KV 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Freemans Bay 11 kV switchboard replacement | 0.51 | 4.45 | | | | | | | | | **4.96** |

### 12A.2.11 MANGERE EAST 11 KV VACUUM CIRCUIT BREAKERS RETROFIT

The ten 11 kV feeder CBs in Mangere East ZSS are first-generation 11 kV Reyrolle Pacific LMVP vacuum CBs. At the time when these Reyrolle vacuum CBs were installed at Mangere East ZSS (in 1986), the vacuum technology was only available for feeder CBs; the two incomer CBs and the bus coupler CBS were still Reyrolle Pacific ZMT2 oil filled CBs. Both types, the vacuum and oil CBs, are equipped with modern SEL numerical protection relays.

This switchboard underwent an arc-fault containment upgrade in 2018 with the addition of lateral arc containment shields and CB cubicle “behind-closed-door” racking systems. The new arc doors however are not type tested for oil filled CBs and the project will see the replacement of the two incomer and one bus coupler oil filled CBs with vacuum CB trucks and replacement of their CTs to new Vector standards. Due to rack-in alignment issues 11 kV feeder, CB K19 will also be replaced.

The vacuum CB trucks in the existing 1986 vintage vacuum feeder CBs are first-generation vacuum CBs but replacement of these CBs is not forecast in this AMP with present information in hand. Further testing is required on the feeder vacuum CBs to determine whether it is technically and economically viable to replace the vacuum interrupter bottles only or a full-scale CB replacement.

All the CB rollout plates in this ZSS are in poor condition and will be replaced on all CBs. New XLPE cables will be installed from the two transformers and the transformer oil filled termination boxes will be replaced with Guroflex filled boxes. VAMP 125 arc detection will be installed in the two incomers and bus section CB.

The existing VT powered rectifier DC substation supplies will be replaced with a Vector standard 110V DC system.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mangere East 11 kV vacuum CB retrofit | | 0.24 | 0.45 | | | | | | | | **0.69** |

### 12A.2.12 HOBSONVILLE 11 KV SWITCHBOARD REPLACEMENT

The 11 kV switchgear in Hobsonville 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 staged in-situ 11 kV switchgear replacement is not practical because of the limited space in the switchroom and a new portacom type 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 11 kV 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hobsonville 11 kV switchboard replacement | | 0.48 | 5.81 | | | | | | | | **6.29** |

### 12A.2.13 ROSEBANK 11 KV SWITCHBOARD REPLACEMENT

Rosebank ZSS supplies the whole of the Rosebank peninsula and parts of Waterview that includes a large base of small and medium enterprises (648) and industrial/commercial (144) customers as well as 4,093 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 1970s vintage 11 kV oil filled CBs have been fitted with arc flash protection doors and racking handle access to protect operating personnel against arc flash in the event of an oil CB failure but the arc flash doors in this configuration are not type tested. The oil filled switchgear and the protection relays are not vendor supported and the substation has a history of faults on VTs and CTs.

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 twelve oil filled CBs.

There is sufficient space past the RPS vacuum CBs in the existing 11 kV switchroom to extend the switchgear in situ under a staged replacement project approach and the switchgear building was assessed for seismic compliance in 2014 and achieved 75% NBS (IL3). The in-situ works will involve civil works to make a trench ready for the new fixed pattern switchgear, core drilling of ducts to make the substation ready for the extension and ancillary works. The new switchgear will be fitted with Vector standard numerical protection relays. 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rosebank 11 kV vacuum CB retrofit and protection upgrade | | | 0.38 | 3.78 | | | | | | | **4.17** |

### 12A.2.14 WIRI 11 KV VACUUM CBS RETROFIT AND PROTECTION UPGRADE

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 7 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. The peak demand in the winter of 2020 was 42.1 MVA and is forecast to reach 43.9 MVA in 2030 after consideration of Symphony modelling of customer growth, energy efficiency and EV uptake.

The Reyrolle LMT switchgear has previously been fitted with arc flash containment doors with racking handle access but retained the oil CBs: the fourteen Reyrolle LMT CBs are suitable for the retrofit of vacuum CBs that negates the need for a full-scale switchgear replacement: the electro-mechanical relays will be replaced with numerical relays. The three bus VTs will be replaced and the 11 kV cable termination boxes replaced with type tested air boxes and PILC cables into the substation replaced with XLPE tails. Arc detection sensors will be installed in the cable boxes to 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wiri 11 kV vacuum CBs retrofit and protection upgrade | | | 0.29 | 2.98 | | | | | | | **3.27** |

### 12A.2.15 HORSESHOE BUSH 33 KV SWITCH REPLACEMENT

Horseshoe Bush is a 33 kV switching station that connects eleven x 1.1 MVA generators at the Redvale landfill to the Vector subtransmission network via a 33 kV fault interrupter (not a CB). Two 33 kV subtransmision circuits, from Helensville ZSS and Coatesville respectively, are connected to Horseshoe Bush via 33 kV disconnectors. An overhead subtransmission line links to the subtransmission circuit between Silverdale ZSS and Spur Rd, via a disconnector at Horseshoe Bush.

Vector only has a few of the US manufactured S&C switches in service and the protection relays are first-generation numerical units that are orphans in Vector's relay population. The switch housing has simply not performed to expectations in the outdoor environment with rapid rusting and other metal fatigue issues that require undue maintenance. Any refurbishment of the existing enclosures will most likely require shipping to the manufacturer in Chicago. This switch, although in a rural network, will increase in importance because of the rapid expansion and development forecast under the Unitary Plan in the area north of Auckland. The switch will be replaced with a modern distribution type fixed pattern switch.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Horseshoe Bush 33 kV switch replace | | | 0.29 | 1.16 | | | | | | | **1.45** |

### 12A.2.16 NEW LYNN 11 KV SWITCHBOARD REPLACEMENT

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| New Lynn 11 kV switchboard replacement | | | 0.54 | 5.10 | | | | | | | **5.65** |

### 12A.2.17 SABULITE 33 KV 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 7,893 residential customers, 715 small and medium enterprises and 45 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 33 kV 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 33 kV outdoor switchgear will be replaced with indoor fixed pattern switchgear in the AMP 2021 planning period. The works will include cutting, joining and turning new XLPE 33 kV tails to the indoor switchgear and civil and structural works under the existing Portacom to make appropriate space for the 33 kV cable tails. Replacement of the numerical relays will be required at the remote end 33 kV zone substations connected to Sabulite.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sabulite 33 kV SWBD ODID | | | | 0.61 | 3.70 | | | | | | **4.31** |

## 12A.2.18 PAKURANGA 11 KV SWITCHBOARD REPLACEMENT

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. The winter peak demand in 2020 was 21.2 MVA and is forecast to reach 21.7 MVA in 2030 with Symphony modelled energy efficiency gains. It will thus be a like for like replacement but with space for two additional 11 kV feeder CBs in the long term. There is enough room in the existing 11 kV switchroom to undertake an in-situ staged replacement.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pakuranga 11 kV switchboard replacement | | | | 0.53 | 4.60 | | | | | | **5.13** |

## 12A.2.19 ROCKFIELD 11 KV VACUUM CBS RETROFIT

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. The two vacuum CBs are equipped with Siemens numerical protection relays.

The twelve oil filled Reyrolle UK LMT oil filled CBs will be replaced with vacuum CB trucks. The existing VT supplied rectifier units that is the source of DC to the CBs will be replaced with a Vector standard 110 V DC system. The CDG protection relays, although electro-mechanical, are in good condition and will not be replaced under this project but in the future. Non-standard air termination boxes on the switchgear will be replaced with standard type air termination boxes with new XLPE cable tails from outside the substation basement as per Vector standards.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rockfield 11 kV vacuum CBs retrofit | | | | 0.39 | 2.43 | | | | | | **2.82** |

## 12A.2.20 SANDRINGHAM 11 KV 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 push the existing buildings down the slope. Furthermore, the existing building foundations are not to seismic standards and the building addition will likely have some separation so the buildings will have separate mass responses: details yet to be confirmed in due time.

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 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 2020 winter was 21.8 MVA and its supply area is targeted for residential in-fill development and multi-storey residential buildings. The Symphony forecast peak demand, which includes a 2.3 MVA energy efficiency gain, is forecast to reach 25.8 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandringham 11 kV switchboard replacement | | | | 0.57 | 5.06 | | | | | | **5.62** |

## 12A.2.21 NEW LYNN 33 KV OUTDOOR TO INDOOR SWITCHBOARD 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 SF6 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| New Lynn 33 kV SWBD ODID | | | | | 0.53 | 4.09 | | | | | **4.61** |

## 12A.2.22 ST HELIERS 11 KV VACUUM CBS RETROFIT

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. This switchgear was modernized with arc flash rated doors with racking handle access but is also suitable for a vacuum CB retrofit and protection upgrade. The peak demand in winter 2020 was 22.1 MVA and with customer growth and energy efficiency considered, is forecast to reach 23.7 MVA in 2030 under the Symphony model. The criticality and asset health for this ZSS warrants an upgrade of the CBs and protection in FY26.

Civil works will consist of the replacement of the lighting with Vector standard LED lights and installation of emergency lighting. A solar covering will be installed on the windows to reduce solar heat gain. The fire protection system will be upgraded. The 1974 vintage Long and Crawford oil filled RMU in the local supply substation will be replaced with a modern equivalent under the works.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| St Heliers 11 kV vacuum CBs retrofit | | | | | 0.29 | 3.36 | | | | | **3.65** |

## 12A.2.23 WAIKAUKAU 33 KV SWITCHBOARD 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 SF6 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 the substation was shut down due to flooding and had to be backfed while a cleanup operation was undertaken.

FIGURE 12A-1: WAIKAUKAU ZSS FLOOD MARCH 2017

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 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Waikaukau 33 kV SWBD ODID | | | | | 0.72 | 9.01 | | | | | **9.73** |

### 12A.2.24 WAIKAUKAU 11 KV SWITCHBOARD REPLACEMENT

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 to mitigate the risk of flooding.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Waikaukau 11 kV SWBD replacement | | | | | | 0.36 | 2.76 | | | | **3.12** |

### 12A.2.25 TE PAPAPA 11 KV SWITCHBOARD REPLACEMENT

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 portacom type 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Te Papapa 11 kV SWBD replacement | | | | | | 0.53 | 5.30 | | | | **5.83** |

### 12A.2.26 HENDERSON VALLEY 11 KV SWITCHBOARD REPLACEMENT

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.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Henderson Valley 11 kV SWBD replace | | | | | | 0.52 | 4.15 | | | | **4.66** |

### 12A.2.27 HILLCREST 11 KV VACUUM CB RETROFIT

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 protection relays are first-generation numerical protection relays (GEC MCGG Micom) but one CB has a later generation Siemens numerical relay. This generation of Reyrolle oil filled switchgear lends itself to the replacement of the oil CB trucks with vacuum CB trucks. The first-generation Micom protection relays will be replaced.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hillcrest 11 kV vacuum CBs retrofit | | | | | | | 1.68 | | | | **1.68** |

### 12A.2.28 KINGSLAND 11 KV VACUUM CB RETROFIT

Kingsland ZSS is one of the larger distribution centres in Auckland's network. 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 switch via two 22 kV/11 kV transformers. The 11 kV switchboard is a Reyrolle Pacific switchboard installed in 1990. The feeder CBs all have vacuum interrupters, but the three incomer CBs and two bus coupler CBs are oil filled Reyrolle Pacific LMT2 CBs and will be replaced with vacuum CBs. Sections of 11 kV XLPE tails will be joined onto the 11 kV distribution cables and joined in air termination boxes on the 11 kV switchgear. The existing numerical protection relays will be retained.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kingsland 11 kV vacuum CBs retrofit | | | | | | | 0.52 | | | | **0.52** |

### 12A.2.29 LICHFIELD 110 KV OUTDOOR CBS 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lichfield 110 kV OD CBs replace | | | | | | | 0.51 | | | | **0.51** |

### 12A.2.30 QUAY ST 11 KV SWITCHBOARD REPLACEMENT

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 SF6 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 3s;
- 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 3s.

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 2021 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 SF6 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 2021 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quay St 11 kV SWBD replace | | | | | | | 0.21 | 3.68 | | | **3.89** |

### 12A.2.31 HENDERSON VALLEY 33 KV OUTDOOR TO INDOOR SWITCHBOARD 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 has a known safety risk that when an internal fault occurs, it could result in the explosive expulsion of porcelain parts.

The project will follow after the construction of a new switchroom building for the 11 kV switchgear replacement project described separately. The existing 33 kV cables will be extended to new fixed pattern indoor 33 kV switchgear as well as the balance of plant equipment such as a DC system and SCADA panel. This 33 kV switchgear replacement is scheduled for planning and procurement to commence in FY29 and project delivery in FY30.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Henderson Valley 33 kV SWBD ODID | | | | | | | | 1.40 | 4.86 | | **6.26** |

### 12A.2.32 NEWTON 11 KV SWITCHBOARD REPLACE

Newton ZSS supplies the large commercial area in Newton, Eden Terrace and a part of Mt Eden. The 11 kV switchboard is a double bus GEC NZ type BTVP suite with oil filled CBs and GEC CDG electro-mechanical protection relays installed in 1980. 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. The investment forecast is provisional as this project requires extensive planning and investigations to select a viable option.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Newton 11 kV SWBD replace | | | | | | | | 2.00 | 6.00 | | **8.00** |

### 12A.2.33 SUNSET RD 11 KV SWITCHBOARD REPLACE

Sunset Rd ZSS in the North Shore and 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sunset Rd 11 kV SWBD replacement | | | | | | | | 1.25 | 4.16 | | **5.41** |

### 12A.2.34 SUNSET RD 33 KV OUTDOOR TO INDOOR CONVERSION

The 33 kV 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sunset Rd 33 kV ODID | | | | | | | | | 2.08 | | **2.08** |

### 12A.2.35 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. There is a lot of industrial growth in the Hobsonville and surrounding area so this ZSS is a likely candidate amongst this group for bringing forward as we move into the future.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Woodford 11 kV SBWD replace | | | | | | | | | 0.73 | 2.08 | **2.81** |
| Hobsonville 33 kV SWBD ODID | | | | | | | | | | 2.29 | **2.29** |
| Manly 11 kV SWBD replace | | | | | | | | | | 4.37 | **4.37** |
| East Coast Rd 11 kV SWBD replace | | | | | | | | | | 1.46 | **1.46** |
| McLeod Rd 11 kV SWBD replace | | | | | | | | | | 2.00 | **2.00** |
| James St 11 kV SWBD Replace | | | | | | | | | | 4.50 | **4.50** |
| Mt Albert 11 kV SWBD replace | | | | | | | | | | 1.60 | **1.60** |

## 12a.3 Zone substation power transformers

### 12A.3.1 SOUTH HOWICK ZSS REPLACE TRANSFORMERS T1 AND T2

Transformer T1 at South Howick ZSS failed in March 2020 which put the security of supply at risk and the transformer was replaced. Extensive tests on sister transformer T2 shows a deterioration in DP values that makes continued use of this transformer under load a risk and the replacement of this transformer has been brought forward in this AMP planning period. Transformer T2 is an off-tank radiator transformer in which the main tank and the radiator exist in two separate rooms and a similar footprint pattern will be procured but as a 20 MVA/30 MVA 2-hour unit. Minor modifications will be required to the foundation pads. New XLPE single core tails will be joined to the existing oil filled 3-core Al 300 mm² subtransmission cable to the transformer terminals.

When transformer T1 failed in March 2020 it was replaced with a 15 MVA on-board radiator transformer which is not an optimal physical fit into the enclosure or for the electrical peak demand. The winter peak demand in 2020 was 27 MVA but with energy efficiency gains under the Symphony model, solar and battery uptake is forecast to reach 27.6 MVA by 2030. T1 will be replaced later in the AMP period with an off-tank radiator 20 MVA/30 MVA – 2 hour transformer that will bring this station back to two matching transformers.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| South Howick 33/11 kV TX Replace T2 | 0.33 | 2.23 | | | | | | | | | **2.56** |
| South Howick 33/11 kV TX Replace T1 | | | | | | 0.24 | 1.83 | | | | **2.07** |

### 12A.3.2 MT ALBERT ZSS REPLACE TRANSFORMER T1

Mt Albert is a single transformer ZSS supplied from Mt Roskill GXP via a 3-core 195mm² (0.3 inch) PILC SWA 22 kV cable for the largest part of the route with a 500m section of 300mm² Al 1-core XLPE cable under the 2013 south-western motorway development. The single Bonar Long 12 MVA 22/11 kV transformer was installed in 1964. The replacement of this transformer was delayed in the planning period of the previous AMP because of enough backstopping to the 11 kV bus and a low forecast rate of load growth at the time. However large tracts of land have been earmarked in the area supplied by Mt Albert ZSS for large-scale urban intensification that will include high density multiple floor apartment buildings on ex Unitec land.

The peak demand in 2020 was 7.4 MVA and is forecast to reach 8.4 MVA in 2030 From a load forecast versus transformer capacity point of view the capacity is sufficient for the 10 year planning period but from 2030 and onwards the load forecast rate of growth increases and the substation security limit will be breached by 2031.

The existing transformer had a DP value of 350 in January 2019 but this has decreased to 338 in October 2020: test results which warrants bringing forward this transformer replacement in the AMP 2021 planning period. The replacement transformer size will be based on the long- term load forecast load growth and a 20 MVA transformer has been selected. For the 10-year AMP period, the existing 11 kV backstopping will suffice to provide N-1 security but the location of the transformer enclosure on the substation designated site and its layout design will allow for easy construction and installation of a 2nd transformer when this is required in the long term. The transformer will be procured with a 33 kV winding tap to make provision for the long-term strategy to convert this subtransmission network to 33 kV.

The asset health of the existing 22 kV subtransmission cable from Mt Roskill GXP is such that replacement in the 2021 AMP period is warranted: see the separate description under Subtransmission Cables heading in this AMP. The 1969 vintage 11 kV Reyrolle England type LMT oil-filled switchgear has been ranked in the switchgear CBARM model for replacement towards the end of the 10-year AMP planning period.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mt Albert 33/11 kV TX Replace T1 | 0.35 | 3.15 | | | | | | | | | **3.50** |

### 12A.3.3 MANUKAU ZSS REPLACE TRANSFORMERS T1 AND T2

Manukau ZSS supplies the central area of the rapidly developing Manukau City and its immediate surrounds. It supplies a large commercial customer base of 1216 customers, 160 industrial customers and 8357 residential customers. The peak demand is in winter and reached 28.5 MVA in 2020 and is forecast to reach 32.3 MVA in 2030. Manukau ZSS has three transformers, T3 being the most recently installed transformer. Transformers T1 and T2 are 1978 and 1976 vintage units respectively and have had mid-life refurbishments which did not add the expected extension to their asset life. The DP levels of transformers T1 and T2 are such that replacement is required early on in the planning period to ensure the continued reliability of supply while the asset health of T3 is such that it is expected to remain in service for at least the AMP planning period. T1 and T2 will be replaced with 20 MVA/30 MVA 2-hour emergency rating transformers with off-tank radiators to suit the layout and shape of the existing transformer and radiator enclosures and of suitable impedance to keep fault levels within Vector's network standard requirement. The transformers will come complete with Eberle Reg-DA transformer management systems.

Civil works will be limited to the modification of foundation pads and the installation of new ducts for both the 33 kV supply cables and 11 kV incomer cables. The 33 kV 3-core copper PILC cables will be replaced with single core XLPE cables. New cable support stands will be installed. The 11 kV incomer PILC cables is of an unknown core dimension and will be replaced with Vector standard 11 kV incomer XLPE cables. The existing oil bunds are sufficient for the new transformers and the roof overhang provides sufficient shielding against rainwater entering.

An older portion in the 11 kV switchboard will be replaced under a separate project but scheduled to interface with the transformer replacement. The existing GEC HHTA4 electro-mechanical protection relays for transformers T1 and T2 will be replaced with numerical IEDs. The requirements for secondary cables will be determined as part of the detail design.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Manukau 33/11 kV TX Replace T1 | 2.23 | | | | | | | | | | **2.23** |
| Manukau 33/11 kV TX Replace T2 | | 2.48 | | | | | | | | | **2.48** |

### 12A.3.4 HANS ZSS REPLACE TRANSFORMERS T1 AND T2

Both 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. Transformer T2 has a slightly worse DP value than transformer T1 and will be replaced first. The existing transformers are off-tank radiator transformers in transformer enclosures to suit the off-tank radiator design. The winter 2020 peak demand is 23.5 MVA and considering the Symphony model, the combined effect of customer growth, energy efficiency gains and EV uptake, is forecast to reach 26.2 MVA in 2030. A 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 exiting transformers will be terminated to oil-to-XLPE trifurcating stop joints and XLPE tails installed to the new transformer 33 kV termination enclosure.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hans 33/11 kV TX Replace T2 | | 0.38 | 3.09 | | | | | | | | **3.47** |
| Hans 33/11 kV TX Replace T1 | | | 0.15 | 1.84 | | | | | | | **1.99** |

### 12A.3.5 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 16,261 residential customers, 1,064 small and medium enterprises and 86 industrial customers. The peak demand in 2020 was 47.2 MVA. Customer growth is modelled at 50 MVA for the 10 years until 2030 but with Symphony controls in place is modelled to reach a peak of 47.9 MVA by 2030.

During sampling in July 2020, the oil showed a high-level of moisture and high acid 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 FY23. 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Manurewa 33/11 kV TX Replace T3 | | 0.52 | 2.26 | | | | | | | | **2.78** |

## 12A.3.6 MCNAB ZSS REPLACE TRANSFORMERS T1, T2 AND T3

McNab ZSS is a highly loaded and critical zone substation that supplies a large commercial and industrial customer base (1138) as well as 4,978 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 2020 was 39.7 MVA and with a forecast growth is expected to reach 41.6 MVA in 2030. 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| McNab 33/11 kV TX Replace T1 | | 0.69 | 2.14 | | | | | | | | **2.83** |
| McNab 33/11 kV TX Replace T2 | | | | 2.14 | | | | | | | **2.14** |
| McNab 33/11 kV TX Replace T3 | | | | | | | | 2.17 | | | **2.17** |

## 12A.3.7 NEWTON ZSS REPLACE TRANSFORMER T1

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 upper lower 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 19.6 MVA in 2020. Substantial customer growth is forecast in the supply area of this ZSS. Taking the combined impact of customer growth, energy efficiency gains and EV uptake into consideration, the Symphony modelled forecast peak demand in 2030 is 25.5 MVA.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Newton 22/11 kV TX Replace T1 | | | 0.30 | 3.17 | | | | | | | **3.47** |

### 12A.3.8 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 onto 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 peak demand in winter 2020 was 14.7 MVA. The forecast demand in 2030 after the combined effect of customer growth, energy efficiency gains and EV uptake has been taken into consideration is 16.1 MVA. However, this ZSS is an ideal candidate at which to apply beyond the meter hot water load control with the potential to reduce the peak demand in 2030 to 12 MVA.

Transformer T1 has a DP value of 589 and T2 a DP value of 642 that warrants replacement later in the AMP 2021 planning period. The replacement transformers will likely be 15 MVA (22.5 MVA 2-hour emergency) Vector standard transformers and will be installed in the same locations (the ZSS has limited space because of the second EOC that exists there).

However, there is a likelihood of a large data centre to be fed off this zone substation that will either impact the size of the replacement transformers and/or the timing of replacement. The investment summary and its scheduled cash flow timing are thus subject to confirmation of the power requirements of this potential customer and the agreed date that power is required. If an agreement is reached with the data centre developer, NERs will be installed at Triangle Rd ZSS to limit earth fault levels and install supply cables with reduced earth screens.

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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Triangle Rd 33/11 kV TX Replace T1 | | | | 0.32 | 2.82 | | | | | | **3.14** |
| Triangle Rd 33/11 kV TX Replace T2 | | | | | 0.29 | 2.45 | | | | | **2.74** |

### 12A.3.9 MT WELLINGTON ZSS REPLACE TRANSFORMERS

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mt Wellington 33/11 kV TX Replace T1 | | | | 0.45 | 1.88 | | | | | | **2.33** |
| Mt Wellington 33/11 kV TX Replace T2 | | | | | | 1.88 | | | | | **1.88** |

### 12A.3.10 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 cleaning (see description further below) will not extend the life of a transformer but will assist to ensure that a transformer at least achieves its standard asset life.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Takanini 33/11 kV TX Replace T1 | | | | 0.40 | 2.11 | | | | | | **2.51** |
| Takanini 33/11 kV TX Replace T2 | | | | | | 2.11 | | | | | **2.11** |
| Otara 33/11 kV TX Replace T1 | | | | | | | 2.23 | | | | **2.23** |
| Otara 33/11 kV TX Replace T2 | | | | | | | | 2.23 | | | **2.23** |
| Wairau 110/33 kV TX Replace T1 | | | | | | | | | 2.30 | | **2.30** |
| Wairau 110/33 kV TX Replace T2 | | | | | | | | | | 2.30 | **2.30** |
| Waimauku 33/11 kV TX Replace T1 | | | | | | | | | 2.23 | | **2.23** |
| Te Papapa 33/11 kV TX Replace T1 | | | | | | | | | | 2.23 | **2.23** |

### 12A.3.11 TRANSFORMER IN SERVICE OR MID LIFE REFURBISHMENTS

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 forecast below is a bucket allowance to treat the oil of older transformers in the fleet to reduce the risk of degradation of paper insulation and allow transformers to be utilized for their full expected asset lives as far as possible. The works will be prioritized 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland ZSS TX in service mid life refurb | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.50** |
| Northern ZSS TX in service mid life refurb | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.50** |

### 12A.3.12 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland neutral earthing resistors | | 0.26 | | 0.26 | | 0.26 | | 0.26 | | | **1.02** |
| Northern neutral earthing resistors | | 0.26 | | 0.26 | | 0.26 | | 0.26 | | | **1.02** |

## 12a.4 Subtransmission cables

### 12A.4.1 CHEVALIER ZSS SUBTRANSMISSION REPLACEMENT

Chevalier ZSS is supplied from Kingsland ZSS via two underground 22 kV cable circuits directly onto two transformers, i.e. line-transformer configured circuits as per the Auckland region subtransmission network architecture. Circuit No. 2 consists of two 89 year old 22 kV PILC cables connected in parallel at either end (Kingsland end and Pt Chevalier end) to form a single cable circuit. There is a slow but observable increase in faults with eight faults recorded in the last 25 years. Circuit No. 2 is rated 16.58 MVA which is below the nominal 20 MVA rating of its connected transformer. The customer base consists of 6,774 residential customers, 510 small enterprises and 65 industrial customers. The peak demand is in winter and reached 20.2 MVA in 2020 and is forecast to reach 23 MVA in 2030.

Should the healthier circuit No. 1 be out of service for whatever reason, Chevalier will be dependent on the 89 year old cable and two 11 kV overhead backstop circuits through tree lined streets. The route length is ~3.3 km long and the works consist of the installation of ducts for three single core cables as well as a communications duct for a fibre optic cable for SCADA and protection signalling. A new fibre optic cable will be installed as part of the works and the multi-mode fibre cards in the existing protection relays will be replaced with single mode cards.

33 kV rated subtransmission cables will be installed to future proof the circuit with the long-term view to upgrading the subtransmission voltage to 33 kV. The likely cable size is 800mm$^2$ Al XLPE but this is pending soil thermal resistivity testing still to be undertaken. NERs exist at Chevalier so the cable earth screens will be rated for 6 kA. Detail design, tender and procurement will be completed in FY21 with completion of delivery in FY22.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chevalier SUBT cable replacement | 2.54 | | | | | | | | | | **2.54** |

### 12A.4.2 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; 906 SMEs and 72 industrial customers; 6,032 residential customers are also supplied. In FY21 Vector undertook the opportunity offered by a large housing and roading project to plan for the installation of ducts along 1.4 km of the 4.39 km route length to Penrose GXP. The opportunistic civil works will consist of two sets of trefoil ducts complete with a communications duct and a small diameter duct in each group for a future distributed temperature sensing cable and installation will commence in FY22.

In Vector's asset strategy the PILC subtransmission cable fleet is pointed out as a fleet with a large number of joints per km. However, these two specific circuits have performed particularly well over the last few years and will continue to be monitored closely and if this present trend continues the need for replacement will be reviewed annually and the delivery pushed out on a year by year basis or brought forward as the case may be. The actual cable replacement forecast in FY30 and 31 below are thus provisional.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Onehunga SUBT duct install | 3.50 | 0.39 | | | | | | | | | **3.89** |
| Onehunga SUBT cable replacement | | | | | | | | | 3.00 | 6.00 | **9.00** |

### 12A.4.3 MT ALBERT SUBTRANSMISSION CABLE REPLACEMENT

Mt Albert is a single transformer ZSS supplied from Mt Roskill GXP via a 1960 vintage 3-core 195mm² (0.3 inch) PILC SWA 22 kV cable for the largest part of the route with a 500m section of 300mm² Al 1-core XLPE cable under the 2013 south-western motorway development. The single Bonar Long 12 MVA 22/11 kV transformer installed in 1964 has been brought forward for replacement in FY24 due to poor asset health and a declining rate of DP (see the separate detailed description under ZSS Power Transformers). The asset health of the existing 22 kV rated PILC cable is reasonable. Its performance is such that the design of the project in FY29 and delivery of the replacement in FY30 is deemed in order. The existing 11 kV backstopping circuits will suffice for this planning period but beyond that, a second subtransmission circuit might be required. Therefore, under the opportunity of a large civil project to install the ducts for this subtransmission replacement, the second set of ducts will be installed to enable a second subtransmission cable to be installed in the long term.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mt Albert SUBT cable replacement | | | | | | | | 2.00 | 4.23 | | **6.23** |

### 12A.4.4 WAIHEKE ISLAND SUBTRANSMISSION CABLE REPLACEMENT

The peak demand of the island is in winter and reached 10.3 MVA in 2020. Without Symphony controls in place, the peak demand is modelled to reach 12.7 MVA in 2030. With Symphony controls the peak demand in 2030 could be reduced to 11 MVA: potential contributors are efficiency gains, solar, hot water control and EV control. The two 33 kV subtransmission circuits are each rated 22 MVA and each transformer has a 15 MVA ONAN rating. So, from a load growth perspective, with or without Symphony controls, there is little or no driver to reinforce the subtransmission network.

However, the submarine subtransmission cables are at the mercy of the tide and boat anchors, are near each other and could thus be at risk of a common mode failure of a single anchor strike. There have been several incidences where an anchor or the tide has damaged a subtransmission cable but thus far a double strike has not occurred. It must be noted that if one of the circuits is out of service for whatever fault that the repair time is long because of the submarine environment in which works need to take place: under such conditions, the security of supply will be at risk for potentially protracted periods.

Waiheke Island is serviced by two 33 kV submarine cables from Maraetai ZSS; each cable circuit terminates directly onto a 12.5 MVA ONAN/15MVA ONAF transformer. Both cables are copper 95 mm² PILC submarine cables: circuit 1 consists of 3 x single core PILC cable cores installed in 1970; in terms of the 70-year standard asset life for PILC cables it is thus well below the benchmark age. Circuit 2 is a 3-core PILC cable installed in 1987; a relatively young cable in terms of the standard asset life. Because the existing two cables are in good condition: when a replacement cable is installed, the intention is to retain all three subtransmission circuits; the three cables will provide an extra level of security in this marine operational environment.

The intention is to install the new subtransmission cable some distance away from the existing two circuits to provide a level of route diversity and remove the risk of common mode failure. Even though the new cable is forecast for installation in FY26, because of the length of time that the resource consent process will take to gain permission for this installation, investment to cover this portion of the investment is forecast well in advance of the proposed installation.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Waiheke SUBT cable replacement | 0.15 | 0.15 | | | 7.20 | | | | | | **7.50** |

### 12A.4.5 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 mm² (0.37 inch²) PICAS oil-filled cables both installed in 1967. Circuit 1 consists of two x 3-core copper PILC SWA cables: one is a 95 mm² (0.15 inch²) cable installed in 1928 and the other is a 150 mm² (0.25 inch²) 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 asset health of this circuit will be monitored over the next few years and if there is any sign of an increase in cable failures then its replacement project should be initiated for delivery. The peak demand at Westfield was 24 MVA in winter 2020 and energy efficiency gains is forecast to reach 24.7 MVA in 2030. 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 can take place in the second half of the AMP 2021 planning period.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Westfield SUBT cable replacement | | | | | 1.35 | 7.48 | | | | | **8.83** |

### 12A.4.6 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| East Tamaki SUBT cable replacement | | | | | 0.25 | 1.00 | | | | | **1.25** |

### 12A.4.7 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 lead 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 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern SUBT cable replacement | | | | | | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | **5.20** |

## 12a.5 Distribution equipment

The need for investment and forecast for the replacement of ring main units are shown below. Because of their focus on SAIDI and SAIFI, the remainder of the capital investment forecast for distribution equipment is not described below but included in Chapter 11, Reliability, Safety and Environmental.

### 12A.5.1 GROUND MOUNTED DISTRIBUTION SWITCHGEAR (RMU) RENEWAL

Approximately a third of Vector’s existing ground mounted distribution switchgear (RMUs) population has been in service for 40 years or longer. Almost all these ageing switches are Long & Crawford oil filled switchgear. This equipment has been in service in Vector’s network since the 1960s. Out of this ageing population, a fair number of them even had a service life of 50 years or more. Some failures of ageing oil filled RMUs have occurred in recent years, some catastrophic.

For this asset type, our strategy relied on asset condition being identified by routine maintenance inspections and replacement undertaken as required based on the identification of risks under the corrective maintenance programme. Our concern is that with a population of similar age profiles all approaching the end of expected service life together that this will result in a bathtub curve scenario where there is a risk of a sudden increase in the deterioration of a large population group that is likely to encompass a greater number of assets that can be attended to under the budgeted corrective maintenance programme, resulting in increased asset failures. It is highly questionable that we can continue to stretch the service life of our ageing oil-filled distribution switches beyond 60 years through the existing maintenance programme, due to the risk of material fatigue leading to equipment failure - especially as there are parts in the switches which cannot be maintained or replaced individually. Our CBARM model for RMUs is relatively mature and informs our replacement programme.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland RMU replacement | 8.00 | 8.00 | 8.00 | 8.00 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | 10.80 | **96.80** |
| Northern RMU replacement | 1.00 | 1.00 | 1.00 | 1.00 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | 1.50 | **13.00** |
| **Total** | **9.00** | **9.00** | **9.00** | **9.00** | **12.30** | **12.30** | **12.30** | **12.30** | **12.30** | **12.30** | **109.80** |

## 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 331 110 V DC systems in service within zone substations, communications sites and several distribution substations.

Of these, 20 Northern and 21 Auckland network Benning 110 V chargers have reached end-of-life, are non-vendor supported with no spares available and with several recent failures consuming all remaining Vector spares. A replacement programme commenced in FY21 for completion in FY23. Due to its scale, sites have been prioritised by the criticality of connected customers, plus age, condition and failure history of the charger. The project outcome ensures continued successful operation of zone substation control, protection, interlocking and other essential equipment that is reliant on a correctly functioning DC system. The Cordex replacement achieves Vector's standard, network wide.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland DC replacement | 0.29 | 0.51 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | **1.28** |
| Northern DC replacement | 0.34 | 0.65 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | **1.47** |
| **Total** | **0.63** | **1.16** | **0.12** | **0.12** | **0.12** | **0.12** | **0.12** | **0.12** | **0.12** | **0.12** | **2.75** |

### 12A.6.2 CAPACITOR BANKS

Vector commissioned 150 MVAr of ground mounted 11 kV capacitor banks at selected zone substations in early 2000. This was in response to a Transpower requirement in October 1999 to de-risk anticipated rolling voltage support brown outs for the Auckland region from restricted summer generation capacity immediately south of Auckland. This requirement ceased with the installation of cooling towers at Huntly power station. The capacitor banks are at the end of their serviceable life and do not meet present personnel and equipment safety arc flash containment standards. Many have been decommissioned due to end-of-life equipment failure or safety issues. Of the 25 sites, six are still functional and in service.

FY21 Network Planning modelling shows that 84 MVAr will be required at 12 selected Auckland sites. This is based on network performance versus customer load profiles, transformer capacity, and meeting the regulatory standard for network voltage and power factor. However, Vector currently has an agreement of non-compliance with the connection code which has been extended until further notice. Based on this we are reassessing in FY21/22 the GXP point of supply and zone substation network need for Vector continuing its embedded reactive support. Provided we continue to observe no operational safety issues, the Network Planning required capacitor banks will remain in-service. The reassessment will determine replacements required as a programme beginning in FY23 as new arc-flash IEC62271-200 type tested outdoor units, prioritised by the risk of failure. Capacitor banks no longer required by the new network strategy have been removed and disposed of in an environmentally safe manner.

Provisional allowance in term of investment year is also made in FY26 for replacement of the Wairau Rd ZSS two 18 MVAr capacitor banks. The timing of this will be dependent on the timing of the second 220 kV Transpower connection that would see the decommissioning of a Vector 110 kV ALB-WRD circuit and its 110/33 kV transformers. The exact timing of the latter has not been finalized.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland capacitor banks | | 0.90 | 0.90 | 1.00 | | | | | | | **2.80** |
| Northern capacitor banks | | | | | 1.00 | 1.00 | 2.00 | | | | **4.00** |
| **Total** | | **0.90** | **0.90** | **1.00** | **1.00** | **1.00** | **2.00** | | | | **6.80** |

### 12A.6.3 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.

Although entry incidents are very rare, we continually monitor the benefit of grounds surveillance cameras now thermal imaging detection is maturing in functionality. All buildings are monitored with intruder detection.

For site security, to minimise the risk of unauthorised entry the program of perimeter fencing 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 requires regular upgrades and its end of life controller replacement project will be completed in Q1 FY22.

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[11]. All detection systems connected to the zone substation Fire Panel must comply with NZS4512 and maintenance standard ESM603 activities ensure compliance is met during their installed life. Our program of replacing legacy fire panels to current standards will be completed in FY22, while detection systems will continue their planned replacement into FY23.

Radio huts which the northern network SCADA and EOC are dependent on, require new passive fire detection, and although the risk is low (hence an FY24 date) due to no cable joints for the cables within them, the seven minor tunnels will benefit from fire detection.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland Fire and Security upgrade | 0.50 | 0.50 | 0.41 | 0.41 | 0.33 | 0.33 | 0.33 | 0.33 | | | **3.15** |
| Northern Fire and Security upgrade | 0.50 | 0.50 | 0.41 | 0.41 | 0.33 | 0.33 | 0.33 | 0.33 | | | **3.15** |
| **Total** | **0.50** | **0.50** | **0.41** | **0.41** | **0.33** | **0.33** | **0.33** | **0.33** | | | **3.15** |

### 12A.6.4 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. 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland ZSS HVAC installations | 0.20 | 0.20 | 0.20 | 0.20 | | | | | | | **0.80** |
| Northern ZSS HVAC installations | 0.15 | 0.15 | 0.15 | 0.15 | | | | | | | **0.60** |
| **Total** | **0.35** | **0.35** | **0.35** | **0.35** | | | | | | | **1.40** |

### 12A.6.5 PORTABLE LIFTING EQUIPMENT

Hobson ZSS in downtown Auckland is fitted with a heavy-duty overhead gantry mounted crane in the tunnel portal atrium to lift heavy equipment such as cable drums or rail sections in and out of the Penrose to Hobson tunnel. A medium duty gantry crane exists in the 110 kV switchroom at Hobson for the lifting of 110 kV switchgear modules during maintenance and/or repair or the voltage transformer needs to be demounted for revenue meter testing as per the EIPC. However, there is a need for a lightweight mobile crane to lift equipment off and on to trucks and into the switchroom cable basement or the 110 kV switchroom: for example the 180 kg Dilo gas cart in and out of the switchroom or moving the voltage transformer and test bushings to the driveway for calibration testing. A 0.25 tonne crane will suffice and reduce the risk of personnel workplace injury due to lifting heavy equipment.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hobson ZSS mobile lightweight crane | 0.15 | | | | | | | | | | **0.15** |

[11] EAA600 Asset Management header class strategy: Auxiliary Systems

# 12a.7 Infrastructure and facilities

## 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 Transpower 220 kV NAaN cable from Penrose 220 kV 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 are now progressively starting to fail having reached the end of life. To also ensure the maintenance and emergency access 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 these specified auxiliary systems to 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tunnel - Newmarket Lift replacement | | 0.82 | | | | | | | | | **0.82** |
| Tunnel - Newmarket Egress Ladder Compliance New | 0.51 | | | | | | | | | | **0.51** |
| Tunnel - Rail Track and Anchor Replace | 0.05 | 0.05 | 0.05 | 0.05 | 0.25 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.70** |
| Tunnel - Sump pump control system | | | | | | | 0.10 | | | | **0.10** |
| Tunnel - Penrose portal replacement of cable supports | 0.42 | | | | | | | | | | **0.42** |
| Tunnel - Sump pump replacement | 0.05 | | 0.12 | | | | 0.10 | | | 0.10 | **0.37** |
| Tunnel - Ventilation Motor Replace | | | | | | 0.31 | | | | | **0.31** |
| Tunnel - Airlock Security New | 0.03 | | | | | | | 0.17 | | | **0.20** |
| Tunnel - Atmospheric Sensors Replace | 0.12 | | | | 0.10 | | | | 0.25 | | **0.47** |
| Tunnel - Train, Generator, Rolling Stock Replace | | 0.21 | | | | | | | | 0.50 | **0.71** |
| Tunnel - Ventilation VSD Replace | | | | | | | 0.21 | | | | **0.21** |
| Tunnel - Control Room New | 0.20 | 0.20 | | | | | | | | | **0.40** |
| Tunnel - PLC Replace | | | | 0.20 | | | | | | 0.25 | **0.45** |
| Tunnel - UPS Replace | 0.10 | | | | | 0.10 | | | | | **0.20** |
| Tunnel - Fire Main Valve Replace | | | 0.15 | | | | | | | | **0.15** |
| Tunnel - Newmarket Plant Room Exterior Replace | | | | | | | 0.05 | | | | **0.05** |
| Tunnel – Scada upgrade | | 0.12 | | | | | | | | | **0.12** |
| **Total** | **1.48** | **1.40** | **0.32** | **0.25** | **0.35** | **0.46** | **0.52** | **0.22** | **0.30** | **0.90** | **6.19** |

### 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 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. Fourteen ZSS sites have been inspected with five sites prioritized: Victoria, Greenmount, Remuera, Newmarket and Quay St. A further 50 sites remain to be inspected in this regard.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland ZSSs lighting upgrades | | 0.15 | 0.15 | 0.15 | 0.15 | | | | | | **0.61** |
| Northern ZSSs lighting upgrades | | 0.15 | 0.15 | 0.15 | 0.15 | | | | | | **0.61** |
| **Total** | | **0.31** | **0.31** | **0.31** | **0.31** | | | | | | **1.22** |

### 12A.7.3 FIRE SEGREGATION

Vector's standards specify adherence to the NZ Fire Code, NZ Building Act and AS2067, Substations and high voltage installations exceeding 1 kV a.c. These require that zone substation fire cells must be designed to prevent fire spread from one building to another, from a transformer to a building and between transformer bays.

At Wairau Rd, the side by side location of outdoor 110/33 kV power transformers poses a fire spread risk, while at Quay St based on Code changes, the power transformer distance to boundary exposes an existing commercial customer building wall adjacent to the zone substation, to fire.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wairau ZSS Tx fire segregation | | | | | 0.45 | 0.45 | | | | | **0.90** |
| Quay St ZSS boundary firewall | | 0.45 | 0.45 | | | | | | | | **0.90** |
| **Total** | | **0.45** | **0.45** | | **0.45** | **0.45** | | | | | **1.80** |

### 12A.7.4 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 simply not enough to remedy larger civil and structural defects. In such cases, a capital project must be undertaken to remedy any 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 not too distant past to construct some of our substations and these now require extensive repair work beyond normal maintenance.

Furthermore, in FY21 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. Well maintained legacy concrete roofed buildings only require a hot-bitumastic reseal which outlives alternatives of polymer sheet materials by tens of years for similar cost.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland ZSS civil structural upgrades | 0.36 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | **1.73** |
| Northern ZSS civil structural upgrades | 0.36 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 | **1.73** |
| **Total** | **0.36** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **1.73** |

## 12a.8 Protection and control

### 12A.8.1 SIPROTEC NUMERICAL RELAYS REPLACE

The Siprotec 3 range of numerical protection relays is the first-generation Siprotec based numerical relays installed in Vector's network starting in 1998. The expected asset life of this generation of numerical relay is ~15 to 20 years. The Siprotec 3 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. This programme will also include the replacement of Siprotec 4 relays that use copper pilot wire for differential protection or where possible, retain the Siprotec 4 relays and replace the communications converter so that the Siprotec 4 relays can be retained for use with fibre optic pilot cables.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland Siprotec 3 relays replace | 0.90 | 0.90 | 1.50 | 0.40 | | | | | | | **3.70** |
| Auckland numerical SIP4 on pilot wire | 0.25 | | | | | | | | | | **0.25** |

## 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 eight 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland electro-mechanical relays replace | | | | | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | **6.00** |
| Northern electro-mechanical relays replace | 1.10 | 0.80 | 0.90 | 1.10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | **9.90** |
| **Total** | **1.10** | **0.80** | **0.90** | **1.10** | **2.00** | **2.00** | **2.00** | **2.00** | **2.00** | **2.00** | **15.90** |

## 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 FY25.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern static relays replace | | | | 0.50 | 0.75 | 0.75 | 0.25 | | | | **2.25** |

## 12A.8.4 AUCKLAND AND NORTHERN TRANSFORMER MANAGEMENT SYSTEMS REPLACE

Transformer management systems (TMS) provide continuous and automatic voltage regulation ensuring voltage regulatory quality supply requirement are met as well as continuous thermal monitoring of transformers and cooling system controls. Of the 209 TMS systems in operation, 74% are modern numerical devices. The remainder of the TMS systems is a mix of electro-mechanical, static and PLC devices. Several of the electro-mechanical devices are between 40 and 60 years old and there is no vendor support or spares available. The remaining PLC based TMS systems has exhibited an increasing failure rate in recent years. The program below forecasts the replacement of the remaining electro-mechanical and PLC based TMS systems with either Reg-DA or SEL-2414 numerical TMS systems in 25 zone substations. The focus of this forecast is those ZSSs where a transformer or switchgear replacement will not be undertaken in the next five years. Where a switchgear or transformer replacement is scheduled in this AMP, the TMS systems will be included in the larger project.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland TMS replacements | 0.35 | 0.35 | 0.35 | 0.35 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | **3.80** |
| Northern TMS replacements | 0.35 | 0.35 | 0.35 | 0.35 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 | **3.80** |
| **Total** | **0.70** | **0.70** | **0.70** | **0.70** | **0.80** | **0.80** | **0.80** | **0.80** | **0.80** | **0.80** | **7.60** |

### 12A.8.5 AUCKLAND AND NORTHERN POWER QUALITY METER REPLACEMENTS

Power Quality Meters (PQM) monitor in real time the condition of the power system and analyze 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland PQM replacements | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.00** |
| Northern PQM replacements | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.00** |
| **Total** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **2.00** |

### 12A.8.6 AUCKLAND AND NORTHERN EXTENDED RESERVES UNDER-FREQUENCY INSTALLATIONS

In terms of the Electricity Industry Participation Code and the requirements of the System Operator (SO), Vector is obliged to provide under frequency load shedding under "load blocks" as defined by the SO for underfrequency events. PQM meters, described above, provide non-UF load shedding, for example, to reduce peak demand and/or to defer capital investment: by reducing peak demand in the network which then defers the need for network reinforcement but do not have the high-resolution capability to initiate under frequency load shedding as is now required by the System Operator.

This program of work is for the installation of SEL 751 IEDs that provides under frequency load shedding where very fast responses with a ride through protection is required. The requirements for underfrequency events have become more stringent under recent FCAS regulations and requires devices that have the functionality for rapid capture and control of load shedding on under/over frequency events. These IEDs also have the functionality to "ride through" <49.2 Hz under frequency events that are shorter than 100 milliseconds.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland under-frequency relays | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.50** |
| Northern under-frequency relays | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.50** |
| **Total** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **5.00** |

### 12A.8.7 AUCKLAND AND NORTHERN LOCAL AREA NETWORK SWITCH REPLACEMENT

Vector, some years ago, adopted an 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 SCADA 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 to the wide network and then to the SCADA 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. Investigation of alternatives to the Ruggedcom RSG2100 switches is on-going in FY21 and a long-term programme of replacement will commence in FY22.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland LAN switches replace | 0.13 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.13** |
| Northern LAN switches replace | 0.13 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.13** |
| **Total** | **0.25** | **0.30** | **0.30** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **2.25** |

### 12A.8.8 AUCKLAND AND NORTHERN RTU REPLACEMENT

The RTUs located at our zone substations provide an essential part of the SCADA system to collect status information from the site and allow remote control of the 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 consists of a mixture of ABB RTUs for 11 kV 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auckland RTUs replace | 0.30 | 0.30 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.40** |
| Northern RTUs replace | 0.30 | 0.30 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **1.40** |
| **Total** | **0.60** | **0.60** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **0.20** | **2.80** |

### 12A.8.9 AUCKLAND AND NORTHERN WAN ROUTERS AND COMS CABLES UPGRADES

The Zone Substation's Local Area Network (LAN) can communicate with the Vector Wide Area Network (WAN) using Routers. The Routers ensure that SCADA data traffic is prioritised and relayed across the Vector WAN to the appropriate destinations. Routers also use dynamic routing techniques to help to reduce network traffic. The programme to replace Cisco 2811 routers with new Vector standard CGR2010 routers commenced in FY18 and this programme will continue to completion and a rollover programme initiated as required.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AKL WAN routers, coms upgrade | 0.10 | 0.30 | 0.20 | 0.15 | 0.15 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 | **1.50** |
| NTHN WAN routers, coms upgrade | 0.20 | 0.30 | 0.30 | 0.15 | 0.15 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 | **1.70** |
| **Total** | **0.30** | **0.60** | **0.50** | **0.30** | **0.30** | **0.30** | **0.30** | **0.20** | **0.20** | **0.20** | **3.20** |

### 12A.8.10 AUCKLAND AND NORTHERN COMMUNICATIONS UPGRADE IN DISTRIBUTION ASSETS

Vector has ~500 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. In FY22 approximately 60 units will be replaced in the Northern network and circa 30 units in the Auckland network and this programme will continue onwards beyond FY22 on a rollover basis. The forecast for FY23 includes provision for trials and proof of concept testing of 5G based router options.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AKL coms upgrade in distribution assets | 0.50 | 0.15 | 0.20 | 0.20 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.55** |
| NTHN coms upgrade in distribution assets | 0.20 | 0.15 | 0.20 | 0.20 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | **2.25** |
| **Total** | **0.70** | **0.30** | **0.40** | **0.40** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **0.50** | **4.80** |

### 12A.8.11 SMALLER UPGRADE PROJECTS TO IMPROVE PROTECTION AND COMMUNICATIONS

The following is a summary forecast table of smaller 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northern Protection signalling Improvement mutual coupling | 0.25 | 0.30 | 0.25 | 0.10 | | | | | | | **0.90** |
| 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 DMR improvements | 0.15 | 0.10 | 0.05 | 0.10 | 0.05 | | | | | | **0.45** |
| Auckland Clock Synchronisation improvements | 0.15 | 0.15 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.70** |
| Northern Clock Synchronisation improvements | 0.15 | 0.15 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | **0.70** |
| Northern Voice Communications | 0.10 | 0.25 | 0.10 | | | | | | | | **0.45** |
| **Total** | **0.85** | **1.00** | **0.55** | **0.35** | **0.20** | **0.15** | **0.15** | **0.15** | **0.15** | **0.15** | **3.70** |

**SECTION 13**

# Asset relocations

# 13 – Asset relocations

## 13.1 Overview

This Section explains our approach to relocating assets on behalf of customers and other stakeholders. It includes an overview of 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.

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. This makes accurate forecasting and timing of spend for relocation works difficult.

## 13.3 Asset relocation growth

The establishment of a unified council for the Auckland region in 2010 resulted in a regional approach to housing, transport and infrastructure. Since then, Auckland's population has grown by around a quarter of a million people which has resulted in an increased demand for transport corridor owner requests for asset relocations. This increase has come mainly from NZTA motorway upgrades and AT roading upgrade works.

Vector liaises closely with the transport corridor owners to understand the scope and timing of their future works and looks to integrate Vector initiated works where appropriate. It is vital for Vector to understand how the corridor works will impact on the network to ensure that we can maintain an integrated network which will continue to provide a reliable supply of electricity to our customers.

## 13.4 Impact of COVID-19 on asset relocation

Whilst COVID-19 caused significant initial uncertainty it is expected that future network relocation activities will continue at the same level or increase. This will be driven by central and local government's appetite to stimulate the economy through investment in new infrastructure projects, particularly in the Auckland area. Vector remains flexible and able to respond proactively to deliver the requests from corridor owners and to identify any potential opportunities for works coordination.

## 13.5 Partnering with our stakeholders

Vector partners with a number of primary infrastructure owners/stakeholders to deliver relocation projects. Stakeholders include:

- Auckland Council
- Auckland Transport
- Chorus
- KiwiRail
- New Zealand Transport Agency (NZTA)
- Watercare Services Limited
- Transpower

Vector accommodates our stakeholder's interests in our project delivery practices through:

- due consideration of the health, safety and environmental impact of our operations;
- looking after the health, safety and wellbeing of our employees, their families, and our communities;
- providing a safe, reliable and resilient distribution network;
- due consideration for the affordability of our services;
- quality of performance in delivering stakeholders / customer's expectations;
- complying with regulatory and legal obligations;

- clearly identifying and managing any stakeholder conflicts (existing or potential);
- effective communication with affected stakeholders and working together collaboratively; and
- striving for consistency, transparency and fairness.

## 13.6 Managing the works

Vector's asset relocation works are generally small, both in terms of scope and cost, in comparison to the transport corridor infrastructure works (usually less than 5% of the total project cost). Relocation projects are driven by the wider civil works programme and this can impact the timing and duration of power outages our customers experience during the relocations, due to the requirements of traffic management, road closures etc. These parameters are outside of Vector's control and 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, Gas Act 1992 and the Telecommunications Act 2001. Access to NZTA's motorway and state highway 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.

### 13.6.1 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, Gas Act 1992, Government Roading Powers Act 1989, and the Utilities Access Act 2010). In all cases, Vector pays for any betterment (installation of new assets and upgrading of existing assets it carries out during the relocation works).

### 13.6.2 INFRASTRUCTURE AGREEMENTS

The relocation of Vector's assets and the contribution split is recorded in Vector's standard Infrastructure Agreement which provides:

- an initial estimate for the cost and cost allocation of the relocation works. The 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

Whilst Vector interacts on site with the transport corridor owner's contractor, the Infrastructure Agreement is between Vector and the Corridor Manager, (e.g. AT and NZTA), not the civil contractor.

### 13.6.3 DELIVERING SUCCESSFUL PROJECT OUTCOMES

To ensure a successful project outcome an experienced Vector project manager is involved in the early planning stage of relocation projects. This leads to the project manager taking a proactive role in ensuring the construction contractor 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 entity requesting asset relocation and are generally a change of scope. They are documented, costed and agreed as they occur.

## 13.7 Current project summary

Table 13-1 presents a summary of the anticipated relocation projects (>$1M) to be undertaken in the near term. The list excludes Transpower initiated outdoor to indoor (ODID) initiated projects.

| STAKEHOLDER | PROJECTS |
|---|---|
| NZTA | • Northern Corridor - SH18/SH1 Constellation Drive<br>• SH16 Safe Roads - Huapai – Waimauku<br>• SH20B<br>• Mill and Redoubt Road<br>• Second Harbour Crossing Relocate<br>• SH1 Safe Roads - Dome Valley<br>• SH16 Safe Roads - Brigham Creek to Kumeu<br>• Puhoi to Warkworth highway extension (NX2 Alliance) |
| Auckland Transport | • Quay St Streetscape<br>• AMETI - Eastern Busway 1 (EB1)<br>• AMETI – Eastern Busway 2, 3 and 4<br>• Lincoln Rd Stage 2 Relocate<br>• Puhinui bus priority lane relocations<br>• Matakana Link Road |
| Auckland Transport / City Rail Link Ltd (CRLL) | • CRL Stations General Relocation Works |

TABLE 13-1: CURRENT PROJECT SUMMARY (<$1M)

## 13.8 Forecast expenditure - relocations

As the timing and scope of relocation projects are driven by third parties, our ability to forecast relocation expenditure on either a project basis, by volume, or across multiple years is limited. Our expenditure profile is based on our FY20 asset relocations expenditure and incorporates our best indicator of significant projects that we have knowledge of through consultation with our stakeholders. The chart below shows our expected investment in asset relocation works during the AMP planning period.

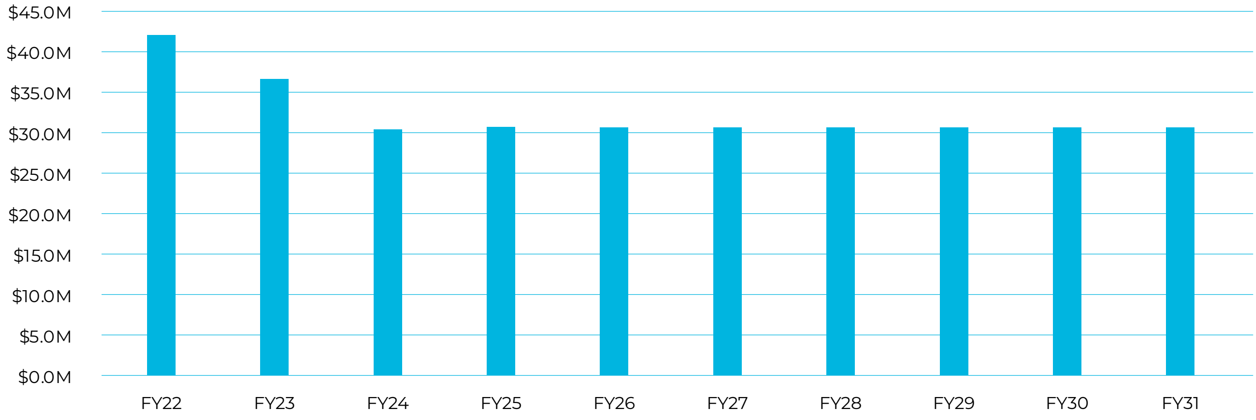



FIGURE 13-1: FORECAST EXPENDITURE - ASSET RELOCATION

**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.

In this section, we define the context for our increasing investment in Digital, our major programmes/projects, and definitions 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.

## 14.2 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 and Environment | • Preventing harm to workers, contractors and the public through our work practices and assets.<br>• Ensuring health and 'safety always' is at the forefront of decision making for the business.<br>• Complying with relevant legislation, regulation and planning requirements.<br>• Proactively adapt the network to allow and prepare for the growing impact of climate change. |
| Customers and Stakeholders | • Enable customers' future energy and technology choices.<br>• Provide a high-quality customer service experience across all interactions.<br>• Listen to and learn from our customers to ensure our service offering aligns with customer expectations.<br>• 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.<br>• Maintain accurate and comprehensive information management systems to drive continuous improvement of our asset health database and information records and meet regulatory reporting obligations.<br>• Continual improvement of our asset management system and alignment to ISO 55001.<br>• Strive to optimise asset lifecycle performance through increased asset standardisation, clear maintenance regimes and the development of fact-based investment profiling.<br>• Expand our asset strategies to both incorporate new technologies and optimise the use of existing technologies to enable future resilience and customer choice.<br>• Collaborate with teams throughout Vector to leverage different thinking, skillsets and asset management capabilities. |
| Future Energy Network | • Prepare the network for future changes that will be driven by:<br>– technology: DER's, electric transportation, increased active customer participation/customer choice, dynamic ratings etc.<br>– environment: climate change including decarbonization of the economy.<br>• Prioritise network flexibility to meet customer changing needs.<br>• Enable consumption of energy on the customers' terms and facilitate customer adoption of new technology.<br>• Treat data as an asset, protect it appropriately and manage its use in accordance with its criticality to network sustainability and transformation.<br>• Develop and enable platforms to optimise and grow Vector "Symphony Partner" services.<br>• Improve our knowledge of, and ability to control, the LV network (grid edge) and management of the information required.<br>• Collaborate with 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

Electricity lines businesses like Vector are facing significant new challenges with customers adopting new technologies to improve energy efficiency and support the decarbonisation of the economy. This disruption will continue and accelerate as the price points of the new technologies keep coming down at an increasing rate. Vector is faced with increasing uncertainty in how this will play out in upcoming years. A key disruptor is the take up of electric vehicles (EVs), and the way customers will charge their EVs.

However, at the same time, new and cost-effective asset management technologies and supporting digital and information management technologies are providing Vector with exciting opportunities to improve the way we monitor, control and manage our assets.

These new technology options also provide secure and cost-effective options for the way Vector engages with its customers, as well as how we enable customer to connect their distributed energy resources (DERs) and other new home automation technologies, seamlessly and effortlessly to the Vector network. As discussed under the Symphony strategy, we are developing the network in such a way that all customers can benefit from the connection and integration of various, on-premise DERs to the network, while developing incentives, signals and pricing structures to manage the assets in the long term interest of customers while ensuring affordability, fairness and equity.

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 manage the uncertainty we are facing in such a way that we do not burden future generations with legacy assets but create a network that is more responsive, flexible, integrated, modular and affordable.

To this end, we have developed a plan with a higher degree of certainty for the first two to three years and less certainty thereafter. In the latter years, we have less certainty over exact projects but have proportionally projected investment levels in each of the Value Streams (key areas that make up an 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. 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

### 14.4.1 ADVANCED DISTRIBUTION MANAGEMENT SYSTEM (ADMS)

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). A core component of an ADMS is the SCADA platform. Our current SCADA system is nearing its end of life and a key milestone of this project is to replace the SCADA platform before issues can pose an increased risk to network operations. This replacement will also allow better management of new technologies on the network in the medium term.

There are a number of 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ADMS | 9.3 | 1.3 | | 0.2 | | | | | | | **10.8** |

TABLE 14-2: ADMS INVESMENT FORECAST

### 14.4.2 GIS MODERNISATION

As Vector invests in modern intelligent platforms, the dependency on quality data becomes increasingly important. Modernising our GIS platform is a key investment to help manage our assets and becomes a core system that is leveraged by other operational platforms such as the ADMS (a modernised GIS is a pre-requisite for our ADMS to function to its full effectiveness). Vector's current GIS platform is becoming outdated and upgrading will enable many key functions that improve our network operations and ability to manage our assets effectively.

There are a number of drivers and benefits to investing in GIS modernisation:

**ADMS Enablement**: This project is a key enabler to the ADMS project. An upgraded GIS system will be capable of capturing and providing network connectivity and topology data to the ADMS for the As-Designed and As-Built network state. Upgraded and improved GIS tools will allow this data to be captured with improved accuracy and improved timeliness, meaning less latency between the actual state of the network and the systems that require this data.

**Improved Asset Management**: The replacement of the SAP to GIS interface (TAM) will improve the quality and timeliness of asset data being captured in the asset management information system (SAP-PM). The data available for planned, corrective and reactive maintenance will be improved and updated significantly faster from the field.

**Improved Financial Asset Management and Reduced WIP**: The upgraded GIS environment and integration with SAP will deliver improved transactional throughput and will reduce the time between asset commissioning in the field and the creation of fixed assets for WIP settlement in the financial asset register. An annual reduction in Capex WIP is targeted by this project.

**Improved Electricity Network Management and Innovation**: This project will deliver a step change in the management of asset data at Vector. This project will formally align and integrate asset data between SCADA (ADMS), GIS, Asset Management, and Financial systems. This project will also significantly improve the ability share and integrate all EGF asset data, for a significantly lower cost, allowing it to be easily consumed by ancillary systems, and shared with external partners.

This project will deliver improved tools to allow GIS access more efficiently in the field and on mobile devices, making it more accessible for decision making for both operations and planning.

**Reduction of Technical Debt**: This project specifically targets the removal of inefficient and expensive legacy system code and custom interfaces. A standardised tool will be used to replace these customisations. As a result, the cost of future system upgrades, and modifications will be reduced. The cost to support the current landscape will be reduced.

**Targeting Data Risks**: The current GIS system version has limited support and deferring an upgrade introduces substantial risk to a core system.

**Reliable Asset Data**: The TAM interface is end of life and cannot be modified without significant cost and risk. This interface is responsible for ensuring asset data is accurately represented in the GIS and the Asset Management and Finance system (SAP). This data set directly supports asset maintenance and regulatory disclosure.

**Support for new network technologies**: The current environment cannot support new network assets types (such as EV chargers), due to the fact that the systems are too fragile and expensive to update. The upgraded environment will refresh the data model, but will also provide greatly improved flexibility and extensibility, to support updates the data model.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GIS Modernisation | 1.8 | 0.25 | 0.1 | 0.1 | | | | | | | **2.25** |

TABLE 14-3: GIS MODERNISATION INVESTMENT FORECAST

### 14.4.3 DYNAMIC ASSET PLANNING TOOL

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.

Vector is investing in the development of a platform that virtualises the network, allows complex simulations that can then be leveraged to 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 this platform will create a primary tool that Vector's Network Planners will use to 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dynamic Asset Planning Tool | 3.1 | 0.8 | 0.25 | | | | | | | | **4.15** |

TABLE 14-4: DYNAMIC ASSET PLANNING TOOL INVESTMENT FORECAST

### 14.4.4 FUTURE FIELD FORCE TOOLSET

Maintenance is a critical function and major area of expenditure for Vector to ensure a reliable and resilient network. Vector is investing in developing tools that bring together rich datasets and aims to enable more efficient planning and execution of maintenance work. New technologies are also being explored to create more efficient activities and collect richer data that can feed into Vector's risk models. Collectively, these activities will help ensure that the maximum benefit can be gained from Vector's maintenance expenditure.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Future Field Force Toolset | 2.5 | 0.5 | | | | | | | | | **3.0** |

TABLE 14-5: FUTURE FIELD FORCE TOOLSET INVESTMENT FORECAST

### 14.4.5 VECTOR GROUP OT FIREWALL REFRESH

Vector group's IP based SCADA network connects substations geographically dispersed through the Auckland Region through a private IP network. As part, of life cycle management this multiprotocol label switching (MPLS) network and its associated Firewalls need to be refreshed and consolidated. Previously, there has been two separate architecture's and responsibilities across the IT and OT networks. This consolidation has been timed with both the Network Modernisation initiative and the end of life support for the firewalls that protect the OT network. The ongoing and reliable performance of the OT network is critical to continued business performance and continuity as it the network that connects the control rooms to the field. Without this network switching and monitoring would have to be performed manually, resulting in significant impact to network performance.

Although this network is not connected directly to the internet there is an increased need to allow remote support access to our partners to allow for efficient operation of network assets. This requires the creation and maintenance of safe channels into the environment. As the speed of integration and adoption of new technologies increases the operational burden of managing these Networks increases dramatically. As such Vector group wishes to optimise its use of resources by consolidating practices and rules regarding network management, vulnerability management and access management. This means that the firewall refresh will need to be compatible and congruent with the Network Modernisation phase.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OT Firewall Refresh | 0.25 | 3 | 1 | | | | | | | | 4.25 |

TABLE 14-6: VECTOR GROUP OT FIREWALL REFRESH INVESTMENT FORECAST

### 14.4.6 VECTOR GROUP 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. The current IT network has grown organically over many years and is now not fit for purpose. As more services 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 urgent piece of work as the IT network is foundational to all system technologies.

The Vector Group IT Network Modernisation project includes both, the corporate IT and 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IT Network Modernisation | 0.43 | 0.43 | 0.29 | 0.14 | 0.43 | 0.43 | 0.29 | 0.14 | 0.43 | 0.43 | **3.44** |

TABLE 14-7: VECTOR GROUP IT NETWORK MODERNISATION INVESTMENT FORECAST

### 14.4.7 CYBER SECURITY

As Vector embraces digital transformation, it also navigates numerous risks. Risk from cyber-criminal activity is one of the increasing challenges Vector will face over the next two years. The increasing amount of large-scale, well publicised breaches suggests that not only the number of security breaches are going up, but that they are increasing in severity, as well. Malicious actors have vastly increased their sophistication in the past 12 months using a variety of techniques and financial gain has increasingly become the most common motive behind data breaches where a motive is known. In addition to this cybercrime and cyberattacks have increased in frequency since the beginning of the COVID-19 pandemic.

Vector is a very diverse group of semi-independent critical infrastructure businesses that run on both shared and specific sets of complex systems. These businesses operate with independent and shared cyber security risk posture, all which require ongoing investment to maintain key cyber security capabilities and partnerships at a level which is appropriate for the energy sector. Across Vector, there is an increased adoption and roll out of sensors, IoT devices and cloud technologies. Vector is also facing significant convergence of Information Technology (IT) and Operational Technology (OT) environments via integration of IT systems with OT systems as well as connectivity with external third parties. This has further complicated the cyber security threat landscape in which Vector must operate.

Vector has developed a comprehensive cyber security operating model and capabilities which are built on Vector's cyber security principles and support the Group, Business and Digital operations to achieve Vector's strategy and vision, securely. By working with global tier-1 security providers the Vector cyber security team applies a global perspective to cyber security assurance and technology. Furthermore, by building on a strong base and through the implementation of key initiatives such as network modernisation, user awareness and education, identity and management as well as external assurance, these cyber security capabilities will be further strengthened to improve Vector's cyber security maturity and security posture to address the current and future challenges that Vector will face.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cyber Security | 1.58 | 1.71 | 2.28 | 2.28 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | 2.65 | **23.75** |

TABLE 14-8: CYBER SECURITY INVESTMENT FORECAST

### 14.4.8 SAP UPGRADE

Vector uses SAP for a number of 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 significantly more 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 ECC to S4 / HANA in the next few years.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SAP Upgrade | 0.18 | 0.36 | 2.14 | 3.21 | 2.85 | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 | **9.64** |

TABLE 14-9: SAP UPGRADE INVESTMENT FORECAST

### 14.4.9 SIEBEL UPGRADE

Over the years Vector has made great use of its Siebel CRM implementation. It has formed a core part of its Outage Management, Customer Call and Reactive Maintenance process. The success of this system means that more and more capability has been added. Over time this capability adds to the testing surface area and slows down productivity. Since 2013, the core system has not had a major version upgrade which means the system cannot take advantage of many modern functions the platform has received. Notably automation and portability from an infrastructure point of view. As part of the upgrade the system will receive an automated test suite which will allow it much greater flexibility and tolerance for change. This will greatly increase the value of Vector current investment into the platform without incurring the cost that would be associated with a full CRM refresh and solution evaluation.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Siebel Upgrade | 1.78 | 1.78 | | | 0.71 | 0.18 | | | 0.71 | 0.18 | **5.34** |

TABLE 14-10: SIEBEL UPGRADE INVESTMENT FORECAST

### 14.4.10 CLOUD MIGRATION

Our information systems, processes and data have been developed over time with the aim of providing stable, consistent and valuable customer, business and operational services. These services have traditionally been provided through on premise servers and datacentre infrastructure. 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.

This emergence of cloud technologies directly supports the objectives of asset management 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cloud Migration | 1.07 | 1.07 | | | | | | | | | **2.14** |

TABLE 14-11: CLOUD MIGRATION INVESTMENT FORECAST

### 14.4.11 IT INFRASTRUCTURE LIFECYCLE MANAGEMENT

Vector information systems, processes and data have been developed over time with the aim of providing secure, stable, performant and valuable customer, business and operational services. These services have traditionally been provided through on-premises servers and datacenter infrastructure. Across Vector, there is a rapid adoption of cloud services and technologies. These services and technologies provide the advantages of improved performance and availability, reduced operational cost and significantly improved resilience and recovery.

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 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. Furthermore, by building on a strong base and through the implementation of significant initiatives such as network modernisation and cloud migration these capabilities will be further strengthened to improve Vector's ability to deliver secure, stable, performant and valuable customer, business and operational services.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IT Infrastructure Lifecycle Management | 0.71 | 1.18 | 1.25 | 1.25 | 1.43 | 1.07 | 1.07 | 0.71 | 0.71 | 1.43 | **10.81** |

TABLE 14-12: IT INFRASTRUCTURE LIFECYCLE MANAGEMENT INVESTMENT FORECAST

### 14.4.12 CONTROL ROOM OF THE FUTURE

Digitalisation, decentralisation and data are driving forces of Vector's new energy future and our Symphony strategy will integrate new technologies and digital solutions to better manage energy flows. Vector is implementing an advanced distribution management system (ADMS) as part of our delivery of a new energy future and in additional we plan to upgrade and diversify our operations centre capability.

Vector's electricity operations centre (EOC) is located at our Newmarket premise and has been in service for 21 years and has undergone several minor upgrades. During 2020 our disaster recovery EOC site at Triangle Road Zone Substation was extended for operation as a temporary means of ensuring physical separation between groups of operational personnel to reduce the risk of impact to our operations throughout the COVID-19 pandemic lockdown periods.

Vector plans to complete the construction of a modernised control room leveraging the ADMS technology at our Newmarket premise and to establish a permanent second EOC at a remote location to provide increased resilience both in terms of personnel and equipment and on-going risk mitigation for the current pandemic and any future pandemic occurrences or natural disasters.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Control Room of the Future | 3.60 | 2.0 | | | | | | | | | **5.6** |

TABLE 14-13: CONTROL ROOM OF THE FUTURE INVESTMENT FORECAST

## 14.5 Value stream needs statements – networks digital

Please note that for all Value Stream investment breakdowns, forecasts include the major programmes/projects with the Value Stream and are not additive.

### 14.5.1 CUSTOMER OPERATIONS

Customer centricity is an important component to Vectors Symphony strategy. The Customer Operations Value Stream sole focus is to ensure that customers have a great experience as they engage with Vector. The investment is focused on new capabilities to serve customers and continuous improvement based on customer feedback.

Vector has been investing in designing experiences that allow for richer and more informative interactions during outages. Development of Vector's Outage Centre has allowed customers to directly interact with Vector to report outages and receive ongoing information on the progress of resolving outages. Additionally, customers are now able to get more 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 desire for customers to have more choice and control as they take on and manage products and services from Vector. Customer's expectations are rapidly changing, and we are no longer being compared only to other Energy providers. Customers expect a similar level of personalised interaction and engagement with all service providers. In this new world, customer experience is the currency through which organisations will be successful, and therefore we must ensure we develop fit for purpose and best in class digital customer engagement services to meet demand.

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.

Specific projects included in this investment category include continuous improvements in Vector's Outage Centre based on customer feedback, self-service for customers with a focus on connections, disconnections, alterations and providing new channels for customers to engage for support, for example via webchat and pro-active SMS notifications. Alongside this, the expected investment in capability required over time is reflected in the outer years, where there is recognition that customers' expectations are changing and Vector's service mix must also change to meet them, and this will be enabled through enhanced customer support and self-service channels. There are also allowances aimed at changing customer behaviour and providing incentives to enable Vector to undertake demand response type activity with direct customer engagement.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Customer Operations | 1.1 | 0.95 | 0.7 | 0.35 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | **13.9** |

TABLE 14-14: CUSTOMER OPERATIONS INVESTMENT FORECAST

### 14.5.2 NETWORK OPERATIONS

Network operations investment is targeted at ensuring 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.

We have identified that increasing our inhouse capability to deliver effective and efficient field services is critical to improving capability to meet customer needs, and in line with this there are specific projects and initiatives associated with permit management, scheduling and notification of planned works, field crew loading analysis and work order scheduling. Alongside this, there is investment identified to enable enhanced field crew visibility, and optimisation of routes and patterns for work completion.

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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Operations | 11.2 | 4.9 | 1.4 | 0.95 | 4.25 | 3.25 | 2.6 | 1.95 | 3.0 | 2.4 | **35.9** |

TABLE 14-15: NETWORK OPERATIONS INVESTMENT FORECAST

### 14.5.3 NETWORK CONTRUCTION & DESIGN

Network Construction and Design investment is targeted at ensuring consistent and reliable ways of running network projects (e.g. growths and asset replacement). The digital capabilities required to support achievement of this are, a state-of-the-art portfolio management system, drawing management system as well as relevant processes. The network construction and design domain include 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Construction and Design | 0.15 | 0.6 | 0.1 | 0.25 | 0.75 | 0.75 | 1.3 | 1.3 | 1.2 | 1.6 | **8.0** |

TABLE 14-16: NETWORK CONSTRUCTION AND DESIGN INVESTMENT FORECAST

### 14.5.4 MAINTENANCE & ASSET MANAGEMENT

The 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. Under the Maintenance & Asset Management stream, Vector ran a project to fully integrate Vector and its FSPs to share the required data digitally and in a timely manner. Vector now receives more standardised asset information in a timely manner that inform risk models and drives maintenance plans. Vector plans to continue investing in improving the effective use of these tools to improve reliability and resilience through better optimisation of maintenance activities.

Condition Based Asset Risk Management (CBARM), Condition Based Maintenance (CBM) and Fault Prediction are another key focus of this value stream. Starting with a small set of assets to trial different approaches and understand the best way of implementing it will help Vector to form a better rollout strategy and more accurate investment profile going forward when adding more assets, especially more complex assets.

The investment strategy for these key systems will be anchored in further developing the plant maintenance module of SAP (SAP-PM) within this AMP period to enable effective asset replacement, planning and maintenance capability. 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. Direct linkage to Vector's outage management system will be established, as will an FSP workforce management system, further improving our methods for capturing fault and maintenance data. As part of the trials on CBARM / CBM different systems will be evaluated for asset wide rollout. With the foundational improvements made to standardise asset information completed, Vector is shifting its focus 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance and Asset Management | 2.95 | 0.9 | 0.85 | 1.0 | 4.3 | 3.8 | 3.5 | 3.5 | 3.0 | 4.0 | **27.8** |

TABLE 14-17: MAINTENANCE AND ASSET MANAGEMENT INVESTMENT FORECAST

### 14.5.5 RECORDS AND INFORMATION MANAGEMENT

Records and Information Management Value Stream 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 LV network data management. Example of this are the GIS modernisation project, Asset management systems integration, BI platform enhancements for DPP3 SAIDI and SAIFI tracking and DDA data management.

We have developed in-house capabilities to support good information management practices across the business, and these include a team for data quality management, development of data standards, and data governance.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Records and Information Management | 2.75 | 1.15 | 0.5 | 1.0 | 2.85 | 2.6 | 1.8 | 2.45 | 1.65 | 2.25 | **19.00** |

TABLE 14-18: RECORDS AND INFORMATION MANAGEMENT INVESTMENT FORECAST

### 14.5.6 NETWORK PLANNING

Network Planning investment is targeted at ensuring consistent, reliable and resilient supply across the network, and the digital capabilities required to support achievement of this. The network planning 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 enhancing Vector's symphony modelling capability to better understand the impact of DER's on the network. 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 increased introduction of disruptive technology (e.g. Solar PV, V2G) enables the injection of energy into the LV network from non-traditional sources and establishes two-way power flows, a situation that was not envisaged when the LV network was designed. The challenge is to encourage the connection of these devices without writing off value in existing network assets, and to deliver economic solutions to the problems raised. To meet this challenge, we need to improve our understanding of LV network performance (LV visibility), including anticipating issues so we can proactively address them. To achieve this outcome, 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. This is 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).
- 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.
- Development of self-service congestion maps. These would enable relevant and selected customers to calculate spare capacity on the network for the connection of new load or new generation (e.g. additional solar/PV).

The Network Planning 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Network Planning | 3.8 | 1.5 | 0.8 | 0.6 | 2.5 | 2.5 | 1.95 | 1.95 | 1.8 | 2.4 | **19.8** |

TABLE 14-19: NETWORK PLANNING INVESTMENT FORECAST

## 14.6 Value stream needs statements – core digital

### 14.6.1 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.

Investment in the upcoming years are to replace some core systems focused on file and contract management, payroll and communication tools.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Corporate | 4.25 | 2.96 | 2.99 | 4.42 | 7.20 | 3.32 | 2.14 | 1.78 | 2.92 | 1.93 | **33.91** |

TABLE 14-20: CORPORATE INVESTMENT FORECAST

### 14.6.2 EMPLOYEE EXPERIENCE

The Employee Experience Value Stream focuses on ensuring that Vector employees are equipped and mobilised to fully engage and perform their roles effectively. 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 due to COVID-19, there is increased investment in Digital tools to support collaboration and dispersed workforces.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Employee Experience | 4.53 | 3.00 | 2.72 | 2.95 | 3.16 | 3.15 | 3.33 | 3.35 | 3.01 | 3.02 | **32.22** |

TABLE 14-21: EMPLOYEE EXPERIENCE INVESTMENT FORECAST

### 14.6.3 DIGITAL SERVICES AND COMMON BUSINESS TOOLS

The focus for this Value Stream 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 core areas within this Value Stream;

- 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Digital Services and Common Business Tools | 4.15 | 5.10 | 4.39 | 3.67 | 4.51 | 4.15 | 4 | 3.51 | 3.79 | 4.51 | **41.78** |

TABLE 14-22: DIGITAL SERVICES AND COMMON BUSINESS TOOLS INVESTMENT FORECAST

## 14.7 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 | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-network Property and Leases | 11.3 | 2.6 | 10.4 | 2.4 | 3.3 | 13.5 | 2.5 | 11.3 | 1.1 | 4.7 | **63.1** |

TABLE 14-23: NON-NETWORK PROPERTY INVESTMENT FORECAST

## 14.8 Non-network OPEX

Total non-network opex is projected to be $837 million over the 10-year AMP planning period.

- Expenditure on System Operations and Network support is forecasted to be $438 million for the period FY22-FY31. 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 $399 million over the AMP21 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.

| DESCRIPTION | FY22 $M | FY23 $M | FY24 $M | FY25 $M | FY26 $M | FY27 $M | FY28 $M | FY29 $M | FY30 $M | FY31 $M | TOTAL $M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| System operations and network support | 41.4 | 43.7 | 43.9 | 44.2 | 44.4 | 44.2 | 44.0 | 44.1 | 44.1 | 44.2 | **438.2** |
| Business Support | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | 39.9 | **398.6** |

TABLE 14-24: NON-NETWORK OPEX

## 14.9 Expenditure forecast – non-network CAPEX

Figure 14-1 presents the total non-network CAPEX forecast expenditure for the 10-year planning period.

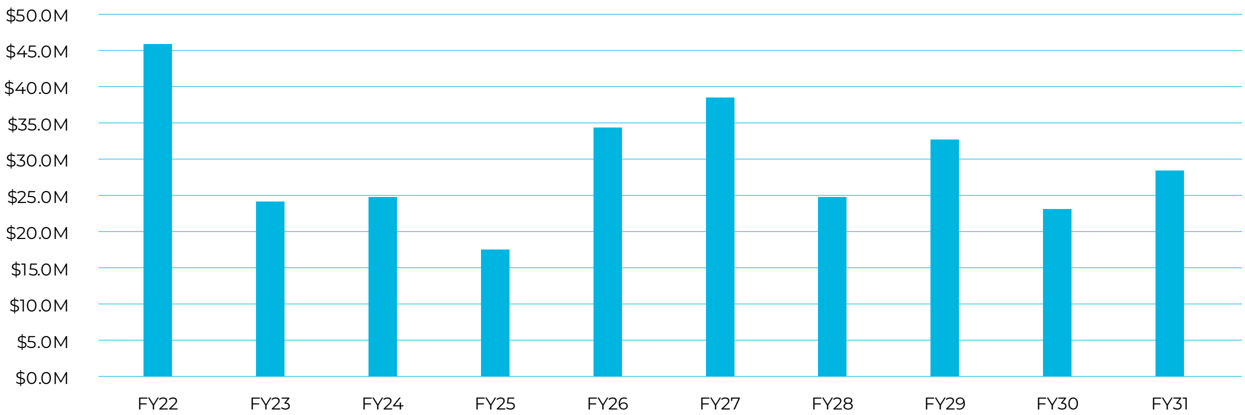



FIGURE 14-1: NON-NETWORK CAPEX

**SECTION 15**

# Expenditure forecasts

# 15 – Expenditure forecasts

## 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 Section 8 to 14. It includes context for key assumptions and provides a high-level comparison with the forecast included in the 2020 AMP (disclosed in March 2020), highlighting how our investment plan has evolved over the last year to both grow and improve the network to meet Auckland's needs. Implications from the 2021 Climate Change Commission report are yet to be worked through in detail and has not been accounted for in this AMP.

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 2021 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.

### 15.2.1 TOTAL CAPEX

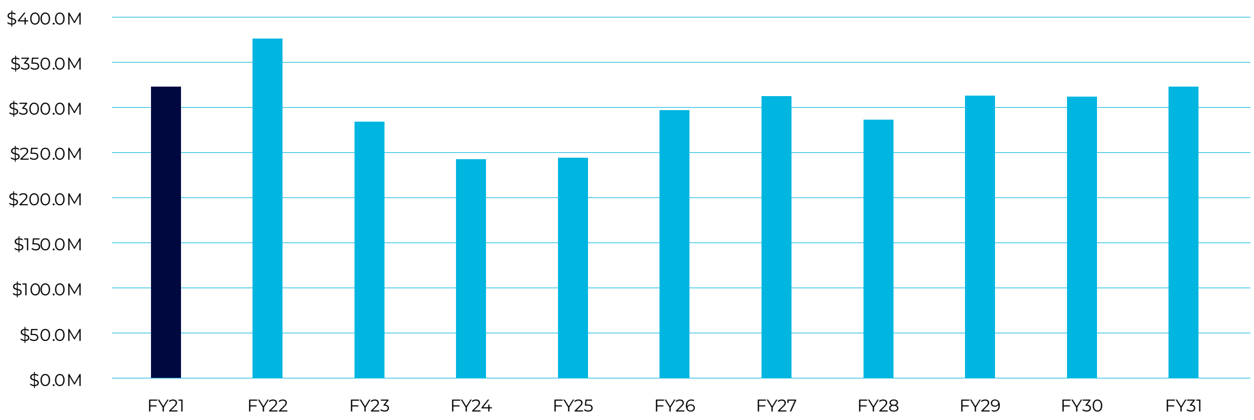



FIGURE 15-1: TOTAL CAPEX

FY22 comes off a period of historically high spend in FY20 and FY21, with a surge of expenditure to address reliability bringing forward programmes of work such as network automation. The higher expenditure profile in FY22 also reflects the growth and integrity expenditure profile (see detail in the following sections), which are punctuated by large significant projects for which there is more certainty in the short term. The expenditure profile also aligns with network technology initiatives including ADMS deployment and a GIS upgrade that is planned for FY22 and FY23.

### 15.2.2 GROWTH CAPEX

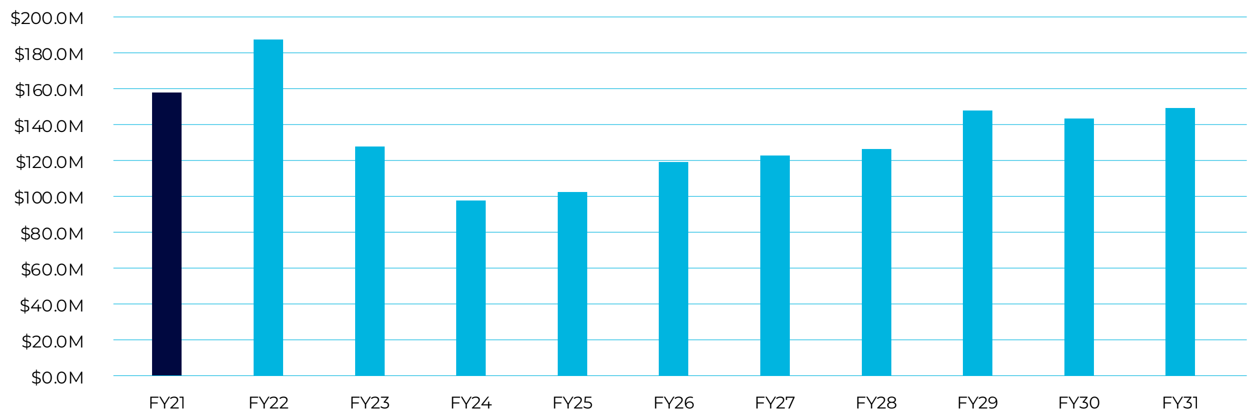



FIGURE 15-2: GROWTH CAPEX

Growth CAPEX is higher in FY22 reflecting significant projects including two customer-driven data centres, two new zone substations, Wellsford-Warkworth future-proofing duct, and large relocation projects such as the SH16 Safe roads initiative. Some of the expenditure has been brought forward compared to the previous forecast due to changes in demand profile and customer requirements.

The higher spend in the outer years from FY29 to FY31 is dominated by the provision for three new zone substations to meet the modelled growth demand. However, the forecast expenditure beyond the first years of the period remains uncertain due to the unpredictability of the timing of large customer projects and ongoing uncertainty around the rate of our customers' adoption of climate change and carbon emission mitigation technologies.

### 15.2.3 INTEGRITY CAPEX

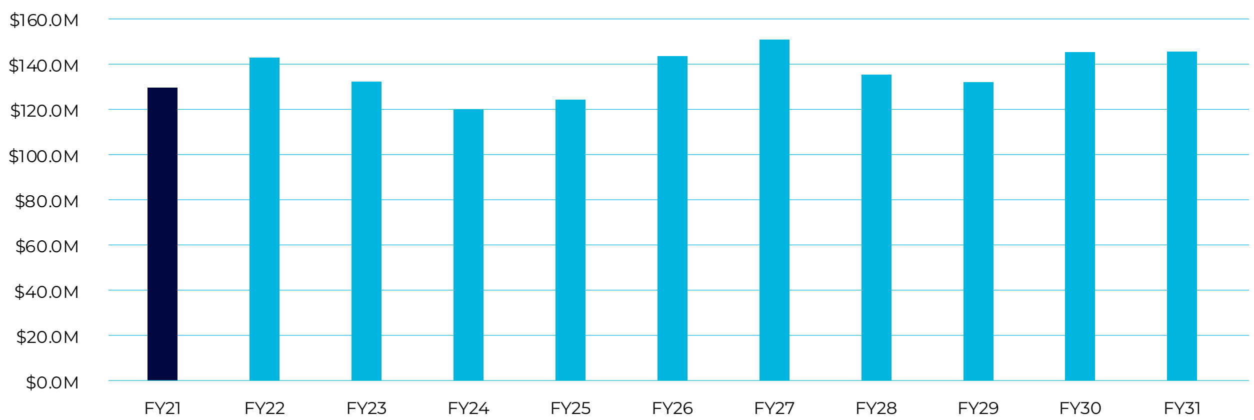



FIGURE 15-3: INTEGRITY CAPEX

Integrity expenditure has increased from the historical level, and is forecasted to be significantly above DPP3 allowance levels, to allow for increased investment in our proactive replacement and reliability programmes, as well as allowing for the increasing cost of projects with relatively large civil components such as zone substation transformer and switchgear replacement.

FY22 expenditure is higher partly due to provision for a one-off increase in stock of $9m to mitigate supply chain risk. The timing of the large subtransmission cable replacement and the future proof ducting project has a material impact on the integrity expenditure profile. This is currently staggered to occur in FY22, FY23 and FY26 to FY31 based on our risk profile.

### 15.2.4 NON-NETWORK DIGITAL CAPEX

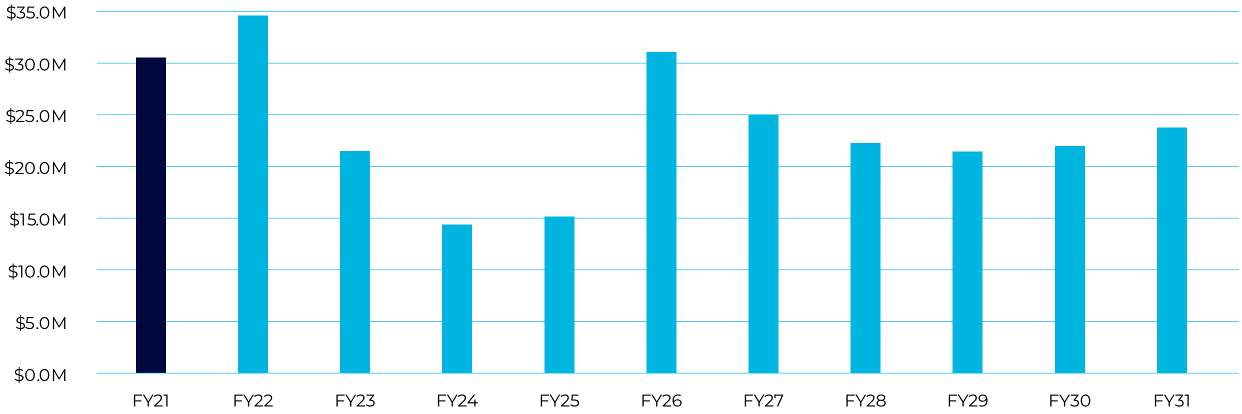



FIGURE 15-4: NON-NETWORK DIGITAL CAPEX

To respond to the fast-changing landscape and the uncertainty in the upcoming years, Digital investments have been brought forward to support the Symphony strategy. Examples of some of the key investments in FY21-FY22 are ADMS and GIS that are focused on core network operations. FY23-FY25 has reduced expenditure as we leverage the capabilities of the platforms that will have been deployed. With Digital investments, lifecycles are typically in the 3-5 year range hence from FY26 investments increase once more as Vector will replace, upgrade platforms or leverage new technologies.

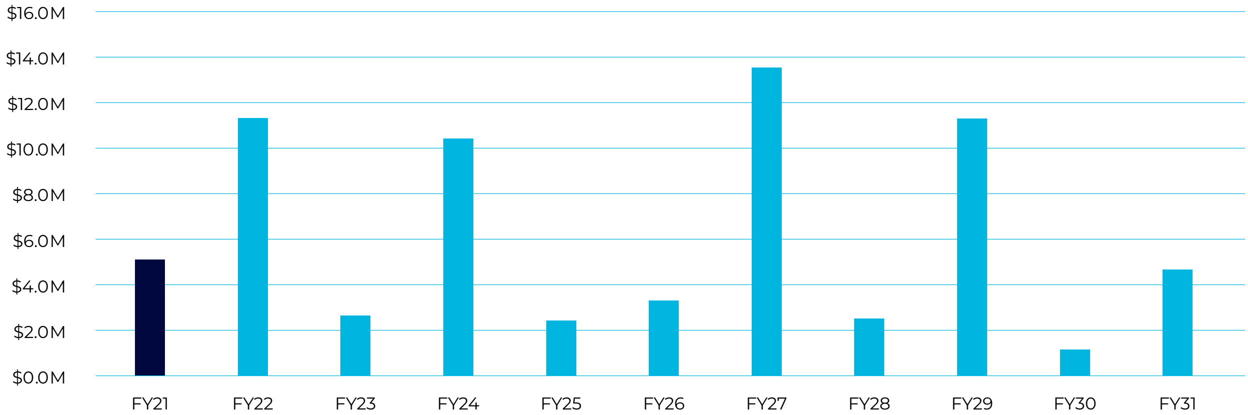



FIGURE 15-5: NON-NETWORK PROPERTY AND LEASES

Property and leases reflect risk strategies to mitigate the impact of COVID-19 with:

- construction of a modernised electricity control room (EOC) in FY22 at our Newmarket premise and the establishment of a permanent second EOC at a remote location to provide increased resilience
- increased longer term warehousing arrangements in FY24 and FY29 to mitigate supply chain risk

Further changes to the Head Office lease drive the increase in Capex in FY27.

## 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 and shown in Table 15-1.

A limited re-categorisation of projects ($6m) has occurred where programmes previously categorized as Asset replacement and renewal have been moved to the Reliability, safety and environment category. These programmes such as overhead 11 kV switch renewal have been identified as more directly addressing network reliability and safety and the new categorisation is considered more appropriate as the key driver of the expenditure.

Figure 15-6 shows the difference between the 2021 and 2020 AMP expenditure forecasts year on year, with Table 15-2 breaking down the variance by expenditure categories.

| KEY CAPEX CATEGORIES | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 | FY31 | TOTAL (FY22-31) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Customer Connection | 85,244 | 64,071 | 58,124 | 58,918 | 51,404 | 56,404 | 60,904 | 60,904 | 60,904 | 60,904 | **617,781** |
| System growth | 59,638 | 26,642 | 8,985 | 12,538 | 36,901 | 35,502 | 34,530 | 55,961 | 51,502 | 57,194 | **379,392** |
| Asset relocation | 41,987 | 36,548 | 30,318 | 30,618 | 30,566 | 30,566 | 30,566 | 30,566 | 30,566 | 30,566 | **322,864** |
| Asset replacement and renewal | 114,348 | 102,493 | 89,781 | 95,127 | 103,962 | 112,326 | 97,862 | 91,179 | 106,284 | 106,194 | **1,019,557** |
| Reliability, safety and environment | 28,221 | 29,413 | 30,052 | 28,861 | 39,219 | 38,165 | 37,161 | 40,616 | 38,583 | 39,013 | **349,303** |
| Non-network asset | 45,794 | 24,071 | 24,719 | 17,485 | 34,259 | 38,441 | 24,709 | 32,645 | 23,043 | 28,344 | **293,510** |
| **Total CAPEX** | **375,232** | **283,239** | **241,978** | **243,547** | **296,310** | **311,403** | **285,731** | **311,870** | **310,881** | **322,214** | **2,982,407** |

TABLE 15-1: AMP 2021 CAPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY21)

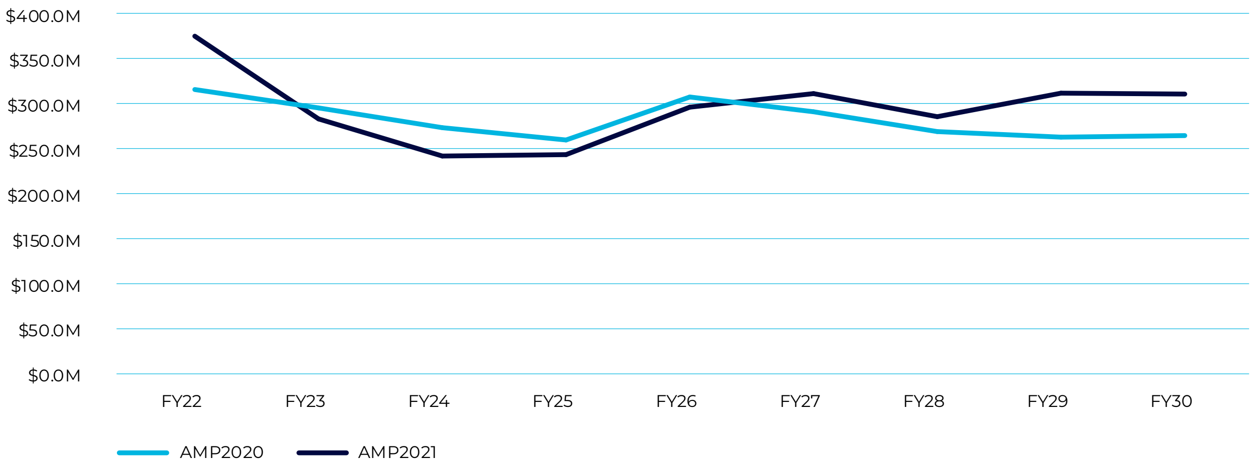



FIGURE 15-6: AMP 2021 VARIANCE TO AMP2020 CAPEX FORECAST (FINANCIAL YEAR, $M CONSTANT FY21)

| KEY CAPEX CATEGORIES | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 | TOTAL (FY22-30) |
|---|---|---|---|---|---|---|---|---|---|---|
| Customer Connection | 9,139 | (1,257) | (1,288) | (4,053) | (10,527) | (2,487) | 2,013 | 1,866 | 1,866 | **(4,728)** |
| System growth | 16,562 | (4,875) | (7,349) | (1,408) | (8,661) | (12,704) | (7,205) | 25,976 | 14,172 | **14,508** |
| Asset relocation | 7,220 | 2,215 | (14,472) | (12,039) | (15,212) | (1,687) | 6,636 | 6,636 | 6,636 | **(14,065)** |
| Asset replacement and renewal | 12,106 | (1,801) | (13,568) | 3,919 | 3,245 | 10,877 | 4,390 | 37 | 13,194 | **32,397** |
| Reliability, safety and environment | 3,811 | (912) | 724 | (1,207) | 2,909 | 2,318 | 1,314 | 1,996 | 2,216 | **13,170** |
| Non-network asset | 10,483 | (5,605) | 4,435 | (1,475) | 16,956 | 23,890 | 9,420 | 12,381 | 8,093 | **78,577** |
| **Total CAPEX** | **59,321** | **(12,236)** | **(31,518)** | **(16,264)** | **(11,291)** | **20,208** | **16,568** | **48,892** | **46,176** | **119,858** |

TABLE 15-2: AMP 2021 VARIANCE TO AMP2020 CAPEX FORECAST TABLE (FINANCIAL YEAR, $'000 CONSTANT FY21)

### 15.3.1 EXPLANATION OF MAJOR NETWORK CAPEX VARIANCES

Key changes in Network CAPEX over the 9 years for which the 2020 AMP and 2021 AMP overlap are as follows:

- Overall customer connection gross expenditure is in line with the previous AMP ($5m lower), with an increase in large commercial customer connection expenditures, in particular data centres, in the earlier years of the forecast that is offset by a lower residential subdivision and service connection numbers.
- An increase of $15m in system growth expenditure forecast is largely driven by provision for three new zone substations and one significant zone substation upgrade in the period FY28 to FY31. The expenditure also reflects changes in the timing of the project such as the Millwater zone substation that was brought forward from FY28 to FY22 to align with customer projects.
- Asset relocation has reduced by $14m. The Auckland Light Rail project ($86m) that was part of last year's AMP is not included in this year's forecast due to the uncertainty of the project and is partially offset by full expenditure provision for relocation projects including SH16 Safe Roads ($13m) and Mill and Redoubt Rd corridor ($14m), as well as a new provision for projects such as Penlink Dairy Flat to Whangaparaoa ($4m). The longer-term forecast expenditure level has also been revised to reflect the increase in infrastructure construction activity in recent years, which is anticipated to continue in Auckland.
- An increase of $32m in asset replacement and renewal expenditure is attributed to higher cost estimates for large primary asset replacements including zone substation transformer and switchgear, as well as new provisions to replace capacitor banks and low overhead lines. Provision is also made to allow for a $9m increase in stock level to mitigate a potential supply chain risk resulted from COVID disruptions.
- The Reliability, safety and environment is forecast to be $13m higher largely due to the re-categorisation of overhead 11 kV switch proactive replacement programme and new provision for safety initiatives to replace 11 kV and 33 kV cable terminations.

### 15.3.2 EXPLANATION OF MAJOR NON-NETWORK CAPEX VARIANCES

- Key changes in Non-network CAPEX over the 9 years for which the 2020 AMP and 2021 AMP overlap are as follows:
- An increase in network digital expenditure of $41.2m, is largely attributed to:
  - Cyber Security and Modernising IT/OT Network infrastructure: With the increasing number of threats and their severity, Vector is forecasting an increased expenditure of $15m to ensure investments in platforms in both the IT and OT networks are protected.
  - Increased projected costs of $7m for key system upgrades such as SAP, Siebel, and GIS. More detailed discovery on each of these upgrades has provided better certainty of the effort required and has resulted in increased forecast costs.
  - Collaboration (Meeting Rooms and Tools) forecasted to increase by $1.3m: Due to COVID and an increasingly distributed workforce, investment in meeting rooms and tools to allow for in-person and remote people to collaborate has become more important.
  - As the lifecycle of many digital platforms is 3-5 years, 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 $18m.
- Property and leasing costs have increased by $37.4m compared to the previous AMP due to:
  - Reduction in FY23 and subsequent increases in FY24 and FY29 is due to the new assumption for the warehousing lease. Due to COVID-19, a new lease arrangement planned for FY24 will accommodate an increase in stock holding and renew in 5 years.
  - The assumption for the Head Office lease arrangements has reverted from entering into a new lease in FY22 back to keeping the existing lease, which is due to expire in FY27. The prior year AMP assumed the impact of entering a new lease in FY22 to replace the existing lease.
  - Investment in a modernised electricity control room (EOC) and the establishment of a permanent second EOC. Associated head office refurbishment costs have also been revised downwards.

## 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

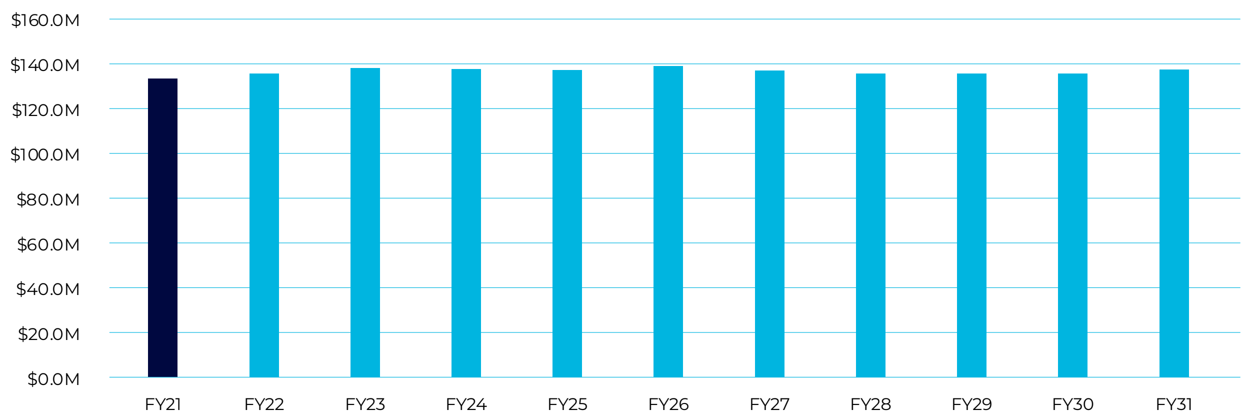



FIGURE 15-7: TOTAL OPEX

The total OPEX expenditure profile is consistent over the AMP horizon with a small increase in the system operation and network support that is partially offset by the expected efficiency in corrective maintenance over the 10-year planning period.

### 15.4.2 NETWORK OPEX

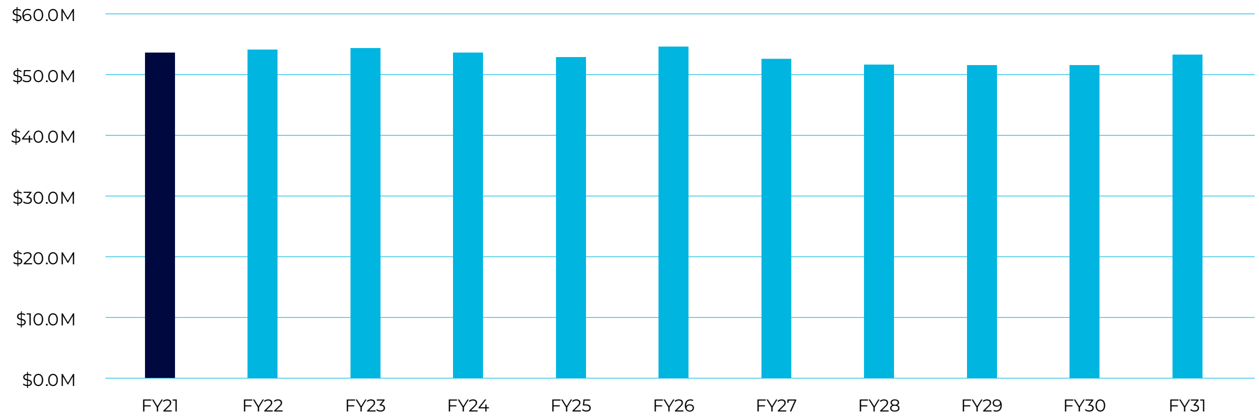



FIGURE 15-8: NETWORK OPEX

The network OPEX forecast expenditure is consistent with FY21 expenditure and is underpinned by the latest asset maintenance standards. Over the 10 year planning period the expenditure profile is slightly reduced reflecting the forecast efficiencies in corrective maintenance as a result of the Risk Based Approach (RBA) introduced as part of the SAP PM system changes.

### 15.4.3 NON-NETWORK OPEX


FIGURE 15-9: NON-NETWORK OPEX

Non-network OPEX forecast expenditure is slightly higher than historical levels attributed to higher digital services expenditure and expected higher customer-driven value-added services.

## 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 2021 and 2020 AMP expenditure forecasts year on year, with Table 15-4 breaking down the variance by expenditure categories.

#### 15.5.1.1 AMP 2021 OPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY21)

| AMP21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 | FY31 |
|---|---|---|---|---|---|---|---|---|---|---|
| Service Interruptions and emergencies | 15,046 | 15,120 | 15,193 | 15,265 | 15,337 | 15,410 | 15,484 | 15,560 | 15,638 | 15,716 |
| Vegetation management | 5,398 | 5,317 | 5,225 | 5,129 | 5,028 | 4,930 | 4,833 | 4,738 | 4,645 | 4,554 |
| Routine and corrective maintenance and inspection | 19,520 | 19,497 | 19,484 | 19,460 | 21,212 | 19,415 | 19,401 | 19,386 | 19,367 | 21,103 |
| Asset Replacement and renewal | 13,999 | 14,278 | 13,587 | 12,895 | 12,895 | 12,726 | 11,756 | 11,756 | 11,756 | 11,756 |
| System operations and network support | 41,374 | 43,669 | 43,954 | 44,182 | 44,377 | 44,207 | 44,038 | 44,092 | 44,146 | 44,202 |
| Business Support | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 |
| **Total OPEX** | **135,195** | **137,739** | **137,300** | **136,790** | **138,708** | **136,545** | **135,370** | **135,391** | **135,410** | **137,190** |

TABLE 15-3: OPEX FORECAST

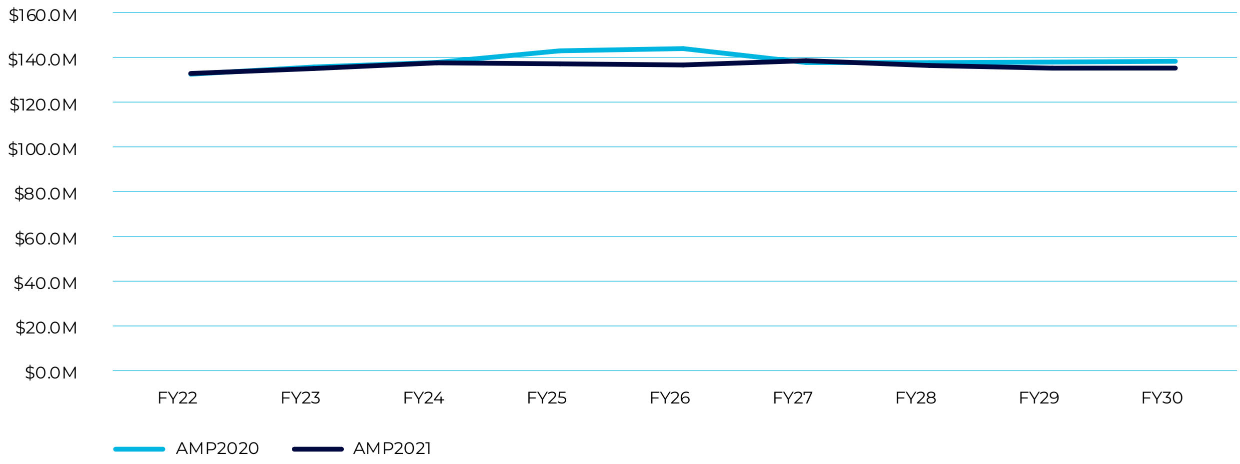



FIGURE 15-10: AMP 2021 VARIANCE TO AMP2020 OPEX FORECAST CHART (FINANCIAL YEAR, $M CONSTANT FY21)

| AMP21 | FY22 | FY23 | FY24 | FY25 | FY26 | FY27 | FY28 | FY29 | FY30 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| Service Interruptions and emergencies | (470) | (521) | (607) | (651) | (639) | (679) | (723) | (767) | (811) | **(5,868)** |
| Vegetation management | (3,214) | (3,400) | (3,598) | (3,802) | (2,376) | (2,565) | (2,753) | (2,941) | (3,128) | **(27,777)** |
| Routine and corrective maintenance and inspection | 842 | (379) | (4,768) | (4,926) | 1,843 | 35 | (2) | (118) | (260) | **(7,733)** |
| Asset Replacement and renewal | (456) | (321) | (1,158) | (1,973) | (1,939) | (1,923) | (3,039) | (3,187) | (3,336) | **(17,332)** |
| System operations and network support | 435 | 2,250 | 2,132 | 1,838 | 1,769 | 1,674 | 1,622 | 1,797 | 2,116 | **15,633** |
| Business Support | 2,181 | 2,181 | 2,181 | 2,181 | 2,181 | 2,181 | 2,181 | 2,181 | 2,181 | **19,633** |
| **Total OPEX** | **(682)** | **(188)** | **(5,818)** | **(7,332)** | **840** | **(1,276)** | **(2,714)** | **(3,035)** | **(3,237)** | **(23,443)** |

TABLE 15-4: AMP 2021 VARIANCE TO AMP 2020 OPEX FORECAST (FINANCIAL YEAR, $'000 CONSTANT FY21)

### 15.5.2 EXPLANATION OF MAJOR NETWORK OPEX VARIANCES

Key changes in Network OPEX over the 9 years for which the 2020 AMP and 2021 AMP overlap are as follows:

- $6 million decrease in Service interruptions and Emergencies expenditure is largely attributable to a lower allowance for reactive SAIDI initiatives that have already been bought forward and implemented, and a general reduction in the level of exceptional maintenance expenditure provided for major weather-related events.
- $28m reduction in vegetation expenditure is predominately caused by the inclusion of the costs of maintaining only the privately owned trees on the Auckland network. Costs associated with council-owned trees will be funded by a collaborative partnership with Auckland City Council that is not included in this expenditure.
- A decrease of $8 million in Routine and Corrective Maintenance is largely due to the Albany-Wairau 110 kV line decommissioning project ($12m) that is no longer required. This is partly offset by a higher forecast expenditure on planned maintenance driven by the introduction of the new maintenance standards.
- An overall reduction of $17million in Asset Replacement and Renewal as a direct result of the risk-based approach to corrective maintenance and resource allocation supported by insights and efficiencies driven from SAP PM.

### 15.5.3 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 by $16m higher as a result of new expenditure related to DERMS and SOC service charges ($54m), and an increase in third party services of $11 million; partly offset by a reduction in personnel costs associated with operational structure changes and a reduction in support costs as part of a group savings initiative.
- A forecast increase in Business Support expenditure of $20m, due to an increase in personnel costs associated with operational structure changes (costs previously categorised as system operations and network support), and a $4m increase in corporate allocation.

# 15.6 Inputs and assumptions

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

### 15.6.1.1 SPECIFIC PROJECTS

The requirement to invest capital for specific individual projects is either borne out of a risk: i.e. an ageing asset with a poor health risk score, or the need to reinforce the network.

Cost estimation for significant capital projects (greater than $1m) involves site inspections to determine constraints and risks. 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.

### 15.6.1.2 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). As a result of COVID-19, Statistics NZ updated their provisional resident population for 2018 which was significantly lower than the previous estimate. The AFG used this to rebase their growth scenario with a high level of uncertainty around a 'new normal', due to COVID-19, in the short term. The cost estimates for customer connections are based on an average cost using historical data.

For distribution assets, Vector has progressed with the use of Condition Based Asset Risk Management (CBARM) models for asset classes including distribution ring main units, distribution transformers, overhead conductors and overhead 11 kV switchgear to support the forecasted volume of assets to be replaced and/or remedied during the AMP cycle.

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 situation. The models incorporate Vector's input data such as historical failure rates, 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.

## 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 current knowledge. Vector has a standard quarterly planning process that reviews investments, reprioritises as required and follows a business case process to proceed with investments.

Some of the key assumptions in our forecasts are:

- Support for all existing platforms is provisioned thus not requiring unexpected replacement. Specifically, current SAP version support will continue through to 2027.
- Cybersecurity threats will remain at a level where current investment forecasts are sufficient to protect Vector systems and respond to incidents.
- COVID-19 challenges remain manageable for IT hardware supply chains, access to vendor resources, and requirements for additional systems to support contact tracing and staff safety.

## 15.6.3 PROPERTY AND LEASES

The mitigation of risks associated with COVID-19 has been the major impact on the assumptions in the lease and property forecasts. Larger warehousing arrangements for increased stock holding to minimise the impact on the supply chain has been assumed. Also, no significant changes to the location/structure of Head Office have been made compared to plans in the prior year.

## 15.6.4 OPERATING EXPENDITURES

To a large extent, the network operating expenditure relates to a programme of work driven by various maintenance standards with a risk-based approach to asset maintenance. To this end, our 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 Chapter provides an overview of the processes used to manage and deliver 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 resource for delivering our works programme. Finally, we provide an overview of our use of standardised equipment sizes and types on our network to minimise long-term costs and to manage critical spares and inventory.

## 16.2 Capital works delivery

### 16.2.1 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 investment 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 and incorporated in the SAP workflow. The first three gates relate to the dentification of need, options analysis and development of the preferred solution. A Capital Expenditure Justification (CEJ) document is the artefact that is developed to demonstrate prudence and efficiency of expenditure and that the governance process has been followed.


FIGURE 16-1: PROJECT LIFECYCLE

Projects are monitored using an enterprise-wide project management tool and a monthly review cycle. Exception reporting is provided to the Executive and Board monthly, covering; HSE, performance against schedule, financial performance, issues and risks. HSE and risk are also reported through to the Board using Risk and Incident Management System (RIMS) and Active Risk Manager (ARM) and escalated to the Board Risk Committee as required.

Monthly reviews of each project are carried out by the Programme Management Office ensuring the reporting is of the required quality. The performance of projects in delivery is also reviewed through a series of monthly contractor performance meetings attended by the Manager Capital Programme and representatives from the contractor. Escalations are handled by the Project Control Group; which comprises senior management from Networks Delivery and representatives from each electrical contractor. Escalations within construction projects are handled by the Engineer to Contract in line with the NZ3910 contract.

A monthly governance meeting including representatives from all parts of Network Delivery & Planning meets monthly to review any exceptions and manage change.

Approvals are required before any commitment is made. The approvals process follows Vector's Procurement Policy and Delegated Authority Framework.

The capital works delivery process includes five primary stages: 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.

| PHASE | ACTIVITY OVERVIEW |
|---|---|
| Identification | • Requirement and options analysis<br>• Project prioritisation<br>• Establish base cost estimate<br>• Needs statement<br>• Recommendation for inclusion in Asset Management Plan (AMP) |
| Scoping | • Development of initial (preliminary) project scope<br>• Cost estimation<br>• Assessment of alternate project options<br>• Determination of key project risks<br>• Procurement analysis (identification of long lead time items)<br>• Prepare Development Funding Application (CEJ) |
| Feasibility | • Identification and assessment of project-specific risks/issues<br>• Surveying and/or Geotech investigation<br>• Early Contractor Involvement<br>• Design concepts development and review<br>• Safety in Design (SID)<br>• Finalise project scope<br>• Detailed design<br>• Cost estimation<br>• Early procurement (long lead time items only)<br>• Prepare Full Funding Application (CEJ) – Business case |
| Procurement | • Tendering for construction<br>• Procurement tendering<br>• Preparation of contract documentation |
| Delivery | • Cost, Schedule and Quality performance monitoring<br>• Risk and issues management<br>• Construction<br>• Commissioning<br>• Handover / Project close |

TABLE 16-1 PROJECT LIFECYCLE DELIVERABLES

## 16.2.2 CUSTOMER INITIATED PROJECTS

The Customer Delivery team focus on customer-initiated projects like subdivisions and commercial connections. We use an outsourced delivery model where our Field Service Providers (FSPs) 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 projects effectively.

Within Vector we have a team of customer advisors that administer the project delivery and maintain the interface with the customer.

The Multi-Utility Services Agreement (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.

### 16.2.2.1 RESOURCE SCHEDULING

The priority of customer-initiated projects is generally governed by when the client contracts Vector to deliver the works. Resource levelling and outage scheduling will then be used to fine-tune delivery scheduling.

### 16.2.2.2 FEASIBILITY AND DETAILED DESIGN

When a customer approaches Vector with a potential project we engage one of our FSPs to carry out a design. The simple nature of these projects combined with normally tight schedules requires a detailed design to be produced immediately. The design, along with a project cost, is presented to the client as our offer to complete the works.

### 16.2.2.3 PROCUREMENT

Procurement of the works is through our MUSA contract using our FSPs.

Vector manages the procurement of distribution equipment procurement directly. This equipment is then free issued to the FSP. The contractor manages any other equipment procurement.

### 16.2.2.4 DELIVERY

Our two FSPs manage the delivery of all customer-initiated works.

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 generally 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 the maintenance team.

### 16.2.3 MAJOR PROJECTS

Major projects are predominantly works identified in the AMP. However, some larger customer-initiated works are also delivered by the major projects team. The decision to use the major projects team to deliver customer works is based on the project size and delivery risk.

We use a mixture of in-house project managers (PM) and contracted project managers to manage the delivery of projects. This enables us to closely match capability and capacity.

To generate competitive tension while ensuring that we maintain extremely high quality and safety standards, we tender works through two closed contracting groups:

1. **Electrical** – We retain a panel of four specialist electrical contractors. These contractors were pre-approved and signed a five-year umbrella agreement in 2019. 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 that are familiar with our critical risks.
2. **Specialist and civil contractors** – We have a pool of specialist and civil contractors; containing pre-qualified builders, designers, civil works contractors, consultants and specialists. Maintaining this restricted pool of contractors helps us maintain our quality and safety standards and provides the contractors with the confidence to invest in processes and people that will deliver high quality work safely. There is no overarching agreement with these contractors or any workflow 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 Auckland Council's 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.

#### 16.2.3.1 RESOURCING AND SCHEDULING

We use an enterprise version of MS Project to schedule and track our works. The PMO uses the priorities set out in the AMP and our network planning team to provide an outline programme which is then levelled by the delivery team based on outages and resource availability. As the physical works are contracted out the primary limiting factor on delivery is the capacity of the project managers. Having a surge capacity of consultant PMs allows us to manage workflow appropriately.

#### 16.2.3.2 FEASIBILITY AND DETAILED DESIGN

The Major Projects team receive a detailed scope of works from the planning team. For large projects a project manager will assist with the development of this scope of works ensuring constructability and that the pricing estimate allows for the onsite conditions. The detailed design is developed using external engineering design consultants managed by the project manager and Vector's project engineers.

#### 16.2.3.3 PROCUREMENT

Depending on the nature of the work we have the option to tender projects to our panel of electrical contractors or directly to our special pool. A modified NZS 3910 invitation to tender is sent to the contractors. Generally, we allow six weeks for the contractor 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 controlled by the PMO and once the contractor's offer is received a PM leads a team that assess the offer. The non-priced sections of the offer are assessed before the PM being provided with the priced information. 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 a modified NZS 3910 contract.

Vector manage the procurement of major plant directly through our in-house procurement team, using either pre-existing umbrella agreements or a competitive process. Smaller items, expendables and construction materials are purchased directly by our installation or construction contractors.

#### 16.2.3.4 DELIVERY

Our project managers have an active role in every step of the delivery of their projects. Our project delivery model is based around the PMI delivery framework, using an Enterprise-wide portfolio management tool 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 delivery team monthly:

- Project health checks are 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.
- Project schedule performance is tracked and reported monthly. Vector's executive team receive a monthly exception report.
- Financial performance is tracked monthly by the PMO and at any significant commitment change.
- Change control is provided through a formal change board comprising senior members of the delivery team.

#### 16.2.3.5 COMMISSIONING

Commissioning activities are split into two categories:

Our maintenance contractor will carry out checks on the distribution equipment being brought onto the network to ensure it complies with our standards and can be operated and maintained safely.

Substation or sub-transmission equipment is subject to a rigorous commissioning process involving, Vector's operation and maintenance teams, asset specialists, the installation contractor and specialist commissioning contractors.

## 16.3 Maintenance works delivery

### 16.3.1 FIELD SERVICE MODEL

Vector has three main field service providers who undertake maintenance activities on Vector's behalf:

- Electrix 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 maintaining trees encroaching on electricity networks.

Electrix and Northpower operate under the Multi-Utility Services Agreement (MUSA). The scope of the electricity maintenance contracts is to deliver the reactive, preventative, corrective and reactive maintenance works programmes, based on the requirements set by the Vector maintenance standards.

Service providers are performance managed by Vector's Field Services group. The MUSA contract defines the responsibilities, obligations and Key Performance Indicators (KPIs) to complete scheduled works. Vector maintains a library of technical standards which contractors must comply with when performing their duties.

Treescape operates under a separate services contract, again managed by Vector's Field Services 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 work activities.

The delivery of all these maintenance activities is closely monitored and adjusted by Field Services, monthly, 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 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; and
- Progress with risk register actions (the board has a risk committee with a specific focus on risks to the business).

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 transformers, with all new power transformers purchased under two specifications. We also have limited the number of manufacturers and models to reduce the type and number of spare parts required.

**Subtransmission Cables**: Standard cables sizes are procured and modelling is used to ensure target network ratings can be achieved. Cable ratings are calculated using CymCap cable-rating software which uses field-tested ground thermal conductivity results and standard cable installation practices.

**Distribution cables and overhead conductors**: Standard distribution cable sizes are nominated to ensure a relatively small range of cables is held in stock. We apply the same principle for overhead conductors, for which standard conductor sizes are nominated to ensure only a small range of stock need be held.

**Communications**: We standardise our communications equipment as much as possible, including routers and ethernet switch models to reduce the number of spares required.

**Automation systems**: We have a standardised RTU design that uses devices from selective manufacturers.

**Auxiliary systems**: We have standardised secondary systems on switchgear to be powered using 110 V DC systems across all zone substation sites. Some sites still have legacy 24V DC and 30 V DC and are being progressively replaced due to the condition of natural site refurbishment. Vector continues to test the benefits of new technologies such as the use of Nickel-Cadmium batteries modern online monitoring systems.

**Buildings**: Buildings have a template design standard approach to minimise the cost and complication of bespoke engineering 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 |
| ARMS | Active risk management system |
| 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 |
| 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 |
| DSM | Demand Side Management |
| EDB | Electricity distribution business |
| EECA | Energy Efficiency and Conservation Authority |
| EGF | Electricty, gas, and fibre |
| EIM | Enterprise 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 |
| FPI | Fault Passage Indicator |
| FSP | Field Service Provider |
| FY | Vector financial year (year ending 30th June) |
| 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 |
| 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 |
| 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 vlaue |
| 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. |
| RIMS | Risk and Incident Management System |
| 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 |
| 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 |
| 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<br>EAA018 Asset health Modelling Strategy |
| Technical Specifications | ENS0099 General technical requirements |
| Maintenance Standards | ESM001 General Maintenance Requirements |
| Engineering Standards | ESE001 Computer Aided Design (CAD) Drawing Standard<br>ESE003 Electricity Network Drawing Management<br>ESE004 Engineering Management Stan |

| ASSET CLASS | 1XX SUBTRANSMISSION SWITCHGEAR |
|---|---|
| Strategies | EAA100 Sub transmission Switchgear |
| Technical Specifications | ENS-0005 Specification for 11 kV to 33 kV indoor switchboards<br>ENS-0022 Specification for 110 kV GIS indoor switchboards<br>ENS-0106 Specification for 33 kV outdoor circuit breakers |
| Maintenance Standards | ESM101 Maintenance of Primary Switchgear – MV fixed pattern<br>ESM102 Maintenance of Primary Switchgear – 110 kV GIS<br>ESM103 Maintenance of Indoor and Outdoor Conventional Switchgear<br>ESM104 Primary Switchgear -Outdoor |
| Engineering Standards | ESE101 Primary Indoor Switchgear<br>ESE102 Instrument Transformers Indoor<br>ESE103 33 kV Switchyard Renewal and Extension Design Criteria |

| ASSET CLASS | 2XX POWER TRANSFORMERS |
|---|---|
| Strategies | EAA200 Power Transformers |
| Technical Specifications | ENS-0124 Specification for 110 kV-22 kV two-winding power transformers<br>ENS-0149 Specification for neutral earthing resistors |
| 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<br>ENS-0110 Thermal backfill for underground cables<br>ENS-0191 Specification for single core 110 kV cable<br>ENS -028 Testing of High Voltage Cables and Switchgear<br>ENS -0102 Specification FOR Polymetric cable protection covers<br>ENS-127 Specification for 11& 22 kV underground distribution cable |
| Maintenance Standards | ESM-301 Maintenance of cables |
| Engineering Standards | ESE-301 Cable Support Systems-in enclosed basements<br>ESE-302 Design requirements for sub transmission and distribution cables<br>ESE-303 Installation requirements for cables and ducts |

| ASSET CLASS | 4XX OVERHEAD LINES |
|---|---|
| Strategies | EAA400 Overhead Lines |
| Technical Specifications | ENS-0094 Specification for prestressed concrete utility services poles<br>ENS-0091 Specification for treated timber utility services poles<br>ENS-0100 Specification for hardwood crossarms<br>ENS 101 Specifications for Surge Arrestors<br>ENS-0153 Specification for overhead conductors<br>ENS-0159 Specification for galvanised steel fittings for overhead construction<br>ENS-0160 Specification for LV ABC fittings<br>ENS-0163 Specification for overhead line connectors<br>ENS-0109 Specification for helical fittings and accessories<br>ENS-0084 Specification for pole mounted fuse carriers and links<br>ENS-0088 Specification for overhead insulators<br>ENS-0112 Specification for hazard marking for poles |

| | |
|---|---|
| | ENS- 0162 Specification for fault passage indicators |
| Maintenance Standards | ESM401 Maintenance of Overhead Lines |
| Engineering Standards | ESE401 Overhead Line Design Requirements<br>ESE402 Overhead Standard Design Applications<br>ESE406 Overhead Standard Applications Structures with Streetlights<br>ESE413 Aerial Fibre Cables Installation<br>ENS-0057 Pole Inspection and Replacement |

| ASSET CLASS | 500 DISTRIBUTION NETWORK |
|---|---|
| Strategies | EAA500 Distribution Equipment |
| Technical Specifications | ENS-0103 Specification for 11 kV and 22 kV distribution switchgear<br>EN54 Specification for LV distribution service pits<br>0162 Specification for fault passage indicators<br>ENS-0121 Specification for auto-reclosers<br>ENS-0097 Specification for pole mounted $SF_6$ switches<br>ENS-0098 Specification for sectionalisers and remote switches<br>ENS-0101 Specification for surge arrestors<br>ENS-0079 Specification for ducting of insulating material<br>ENS-0078 Specification for 400V underground cable<br>ENS-0090 Specification for oil filled distribution switchgear<br>ENS-0093 Specification for fluid filled distribution transformers<br>ENS-0102 Specification for polymeric cable protection covers<br>ENS-0115 Specification for fibreglass enclosures<br>ENS-0155 Specification for IPPCs for LV distribution Pit<br>ENS-0170 Refurbishment of distribution Transformers and oil filled switchgear<br>ENS-0170 Transformer less than and over 50 kVA refurbishment assessment<br>ENS-0154 |
| Maintenance Standards | ESM501 Maintenance of Overhead Switchgear<br>ESM502 Maintenance of Pole Mounted Distribution Transformers<br>ESM503 Maintenance of Ground Mounted Distribution Equipment and Voltage Regulators<br>ESM505 Maintenance of LV Distribution Systems |
| Engineering Standards | ESE501 Distribution Substations in Buildings<br>ESE502 Outdoor Ground Mounted Distribution Equipment<br>ESE503 Distribution Switchgear<br>ESE504 Low Voltage Underground Distribution<br>ESE505 Ground Mounted Distribution Transformer<br>ESE506 Distribution Earthing<br>ENS-0028 Testing of High Voltage Cables and Switchgear |

| 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<br>ESM602 Maintenance of Capacitor and Reactor Banks<br>ESM603 Maintenance of Building Security, Air and Fire Management Systems<br>ESM607 Maintenance of Earthing System |
| Engineering Standards | ESE601 DC Systems<br>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<br>ESM708 Maintenance of Minor Tunnels<br>ESM709 Maintenance of Penrose-Hobson Tunnel |
| Engineering Standards | ESE701 Zone Substation Buildings<br>ESE702 Zone Substation Grounds<br>ESE703Zone Substation Building Services<br>ESE704 Zone Substation Earthing<br>ESE002 Zone substation signage |

| ASSET CLASS | 800 PROTECTION AND CONTROL |
|---|---|
| Strategies | EAA800 Protection |
| Technical Specifications | ENS-4002 Protection and Control – Protection Settings Management System<br>ENS-4003 Protection and control – Technical documentation |
| Maintenance Standards | ESM801 Maintenance of Protection and Control Systems<br>ESM804 Maintenance of Pilot Cables<br>ESM805 Maintenance of Radio Equipment |
| Engineering Standards | ESE801 Protection Systems<br>ESE802 Automation and Control in Zone Substations<br>ESE803 Protection and Control for Overhead Distribution Feeders<br>ESE805 Secondary Cabling<br>ESE806 Protection distribution Substation<br>ESE807 Protection Philosophy Subtransmission Zone Substations and Distribution<br>ESE810 Testing and Commissioning of Protection Relays |

| ASSET CLASS | 900 NEW ENERGY SOLUTIONS |
|---|---|
| Strategies | EAA900 New Energy Solutions (Being developed – work in progress) |
| Technical Specifications | Being developed – work in progress |
| Maintenance Standards | ESM901 Generation and Energy storage |
| Engineering Standards | Being developed – work in progress |

| HEALTH, SAFETY AND ENVIRONMENT MANAGEMENT STANDARDS |
|---|
| HSEMS01 Management systems framework and HSE policies<br>HSEMS02 Leadership and Accountability<br>HSEMS03 Competence and Behaviour<br>HSEMS04 Engagement, Participation and Consultation<br>HSEMS05 Contractor HSE Management<br>HSEMS06 Emergency Management<br>HSEMS07 Wellness and Fitness to Work<br>HSEMS08 Risk Management<br>HSEMS09 Incident Management<br>HSEMS10 Audits, Reviews and Performance Reporting<br>HSEMS11 Operational Control<br>HSEMS12 HSE in Project Management |

| ELECTRICITY OPERATING STANDARDS |
|---|
| ESH001 Electricity Network Safety and Operating Plan<br>EOS001 Operational Control of the Network<br>EOS002 Release of Network Equipment<br>EOS003 Procedures for Operations on the Vector Network<br>EOS004 Switching Schedules and Permits Preparation Use and Operating Terms<br>EOS006 Live Line Operating Standard<br>EOS007 Zone Substation Access and Security<br>EOS009 Commissioning of Network Equipment<br>EOS010 Operational Numbering of Vector Equipment<br>EOS011 Protocol for Communications with the Electricity Operations Centre<br>EOS012 Operation of Ground Mounted Switchgear up to and including 33 kV<br>EOS013 Standard Operational Terms and Abbreviations<br>EOS014 Operation of Circuit Breakers and associated Equipment<br>EOS015 Procedures for Operation of OH Equipment up to and including 110 kV<br>EOS018d Tunnel Procedures Rail Maintenance Planning<br>EOS019 Contingency Plans (35 documents)<br>EOS020 Procedures for Management and Operations on the Vector Low Voltage Network<br>EOS026 Managing Asset Rating Changes |

| NETWORK INFORMATION STANDARDS |
|---|
| ECD005HV Event Quality Assurance Process<br>ECD010 HVSpec Planned Work Data Capture (DRAFT – work in progress)<br>EGD003 Calculation Guidelines for Electricity Reliability Metrics<br>ENSD001 Asset Data Standards SAP and GIS (Electricity)<br>EOC-009 HV Event Quality Control Procedure<br>ESD002 Reactive Maintenance Data Standard<br>ESD003 HV Event Data Standard<br>ESD005 Asset Data and GIS Data Standard<br>ESD006 Planned and Corrective Maintenance Data Standard<br>ESD007 Vegetation Cut or Trim Data Standard (DRAFT – work in progress)<br>USD003 Data Update Request Data Standard |

## 17.3 Appendix 3 – Typical load profiles

Figure 17-1, Figure 17-2 and Figure 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.

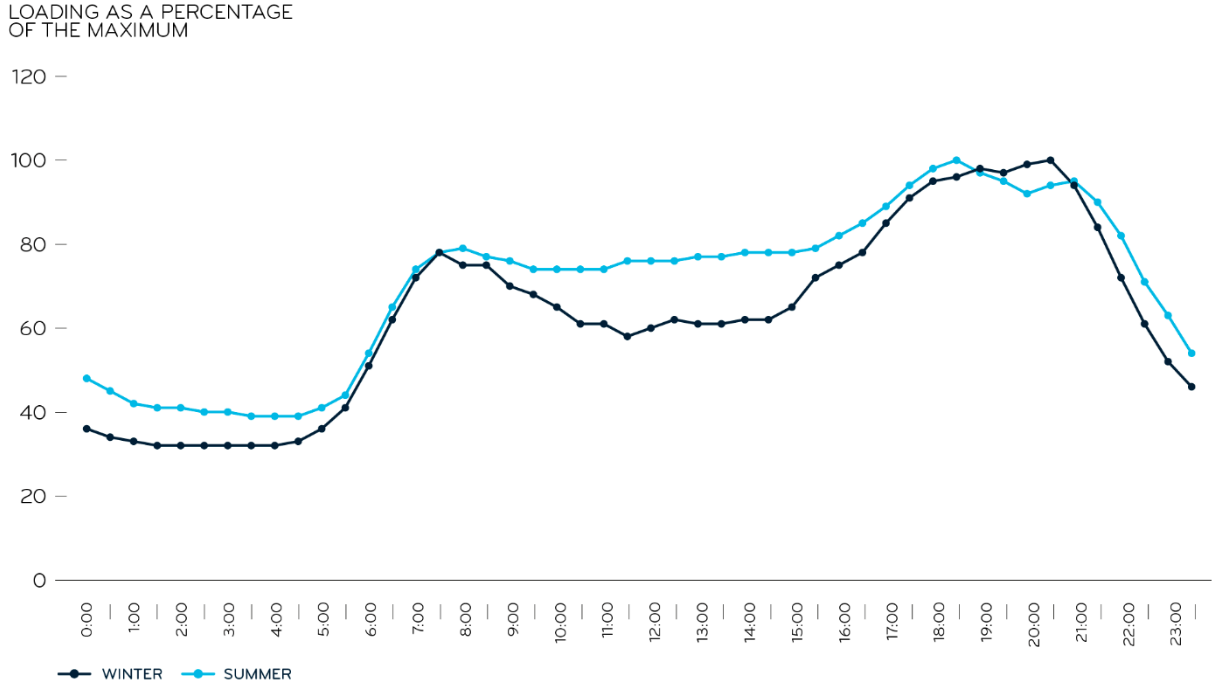



FIGURE 17-1: TYPICAL RESIDENTIAL DEMAND PROFILE (NORMALISED – LOADING AS A PERCENTAGE OF MAXIMUM)

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.

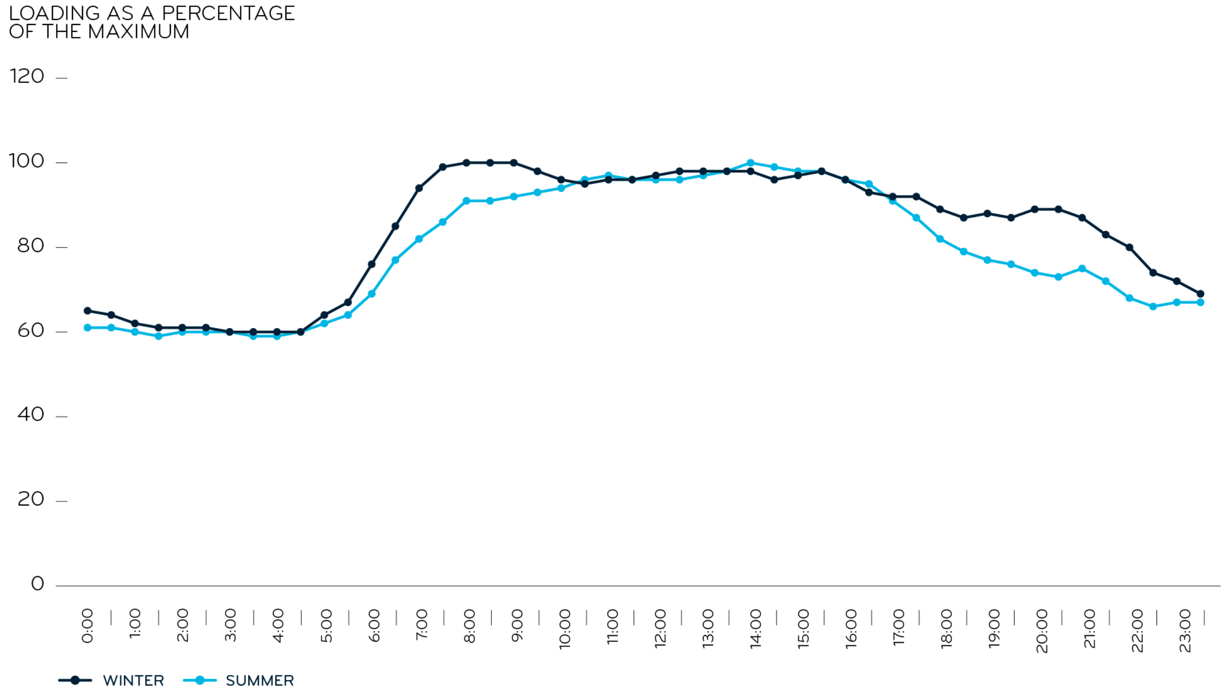



FIGURE 17-2: TYPICAL COMMERCIAL DEMAND PROFILE

Commercial demand follows a similar profile and loading for both winter and summer.

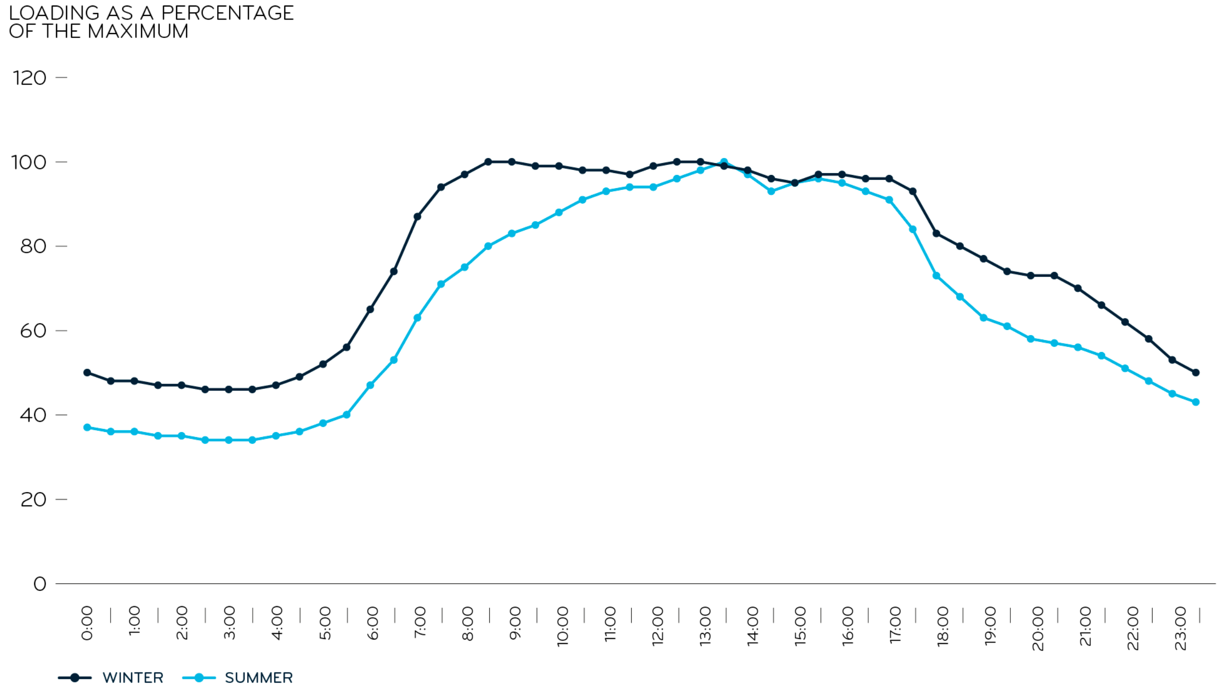



FIGURE 17-3: TYPICAL CBD DEMAND PROFILE

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 7:00 am and a slower ramp-down in the evenings. The peak load in summer is driven mainly by air-conditioning, adding an extra 10% load above the winter demand profile.

### 17.3.1 IMPACT OF COVID-19 LOCKDOWNS ON DEMAND PROFILE

The global pandemic experienced in 2020 caused countrywide lockdowns in New Zealand with Auckland being the most affected. The lockdowns caused a noticeable shift in customer behaviour as many employees worked from home and SME, Commercial and Industrial customers operating at a limited capacity. The lockdowns were divided into four levels with level 4 representing an almost complete shut down in public movement and interaction. Level 1 represents an almost normal scenario. The figures below show a comparison between historical demand profiles and those experienced during the various levels of lockdown.

The data indicate that at level 4, there was a change of shape in the residential demand profile. The morning peak falls away and the midday demand remains at a higher level. This is most likely due to people waking up slightly later and not having to get ready before commuting to work. The higher midday levels can be attributed to heating and cooking occurring in homes where under normal circumstances, there would be nobody at home. At level 2 the residential demand returns to pre-pandemic behaviour.

Unlike residential customers, the SME, Industrial and Commercial customers maintain the same shape but with a greatly reduced maximum demand. This is due to the reduced volume in economic activity which mostly recovers by the time level 1 is reached. It should be noted that SME never fully recovers and although there are many factors, it is likely that many businesses did not survive the lockdowns. We would expect this to return to normal over the next few years as the economy recovers.

The situation will be continuously monitored to see if any customer behavioural changes are permanently altered going forward. An example of this would be more people working from home or retailers moving to online platforms vs operating out of traditional retail spaces.

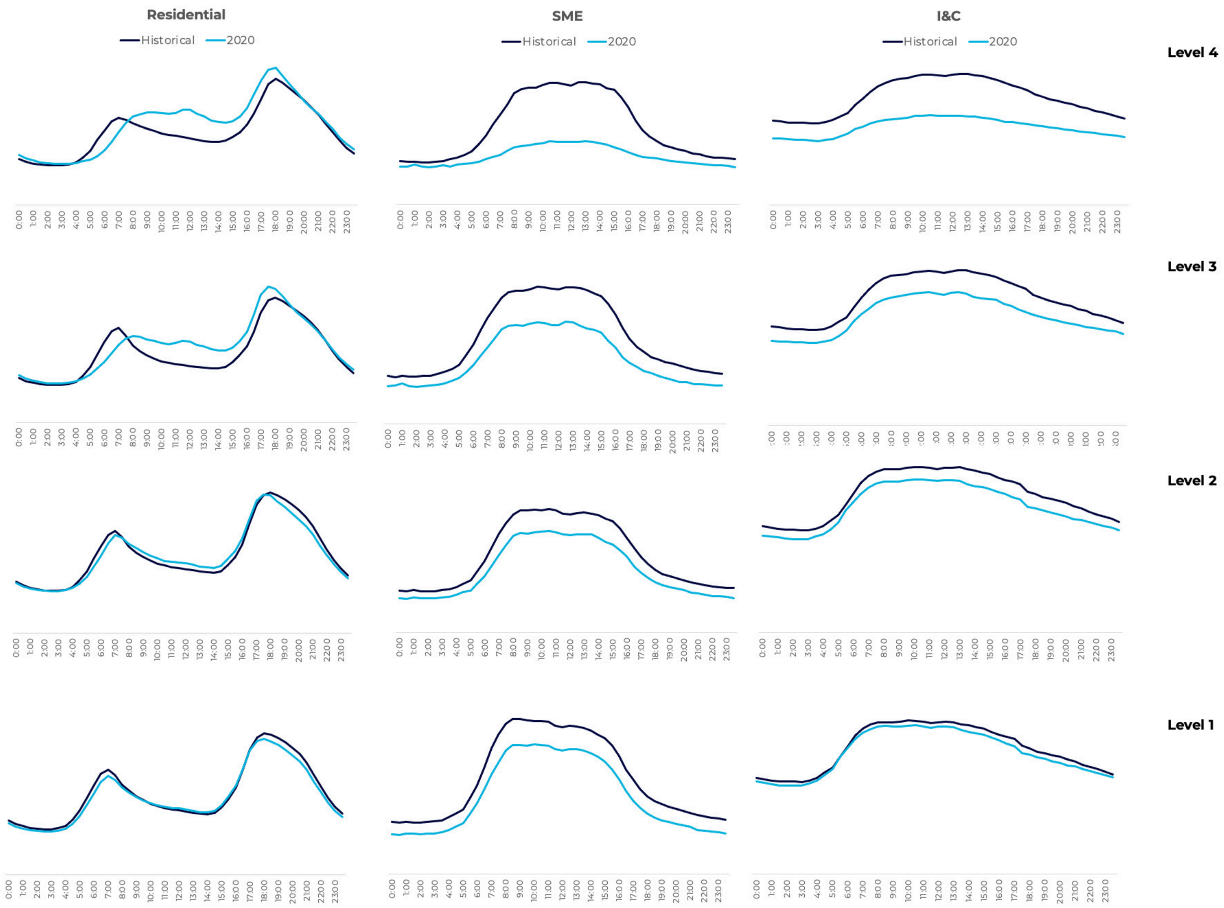



FIGURE 17-4: COMPARISON OF LOCKDOWN DEMAND PROFILES AGAINST HISTORICAL DATA

### 17.3.2 LARGE CUSTOMERS THAT HAVE A SIGNIFICANT IMPACT ON 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

## 17.4 Appendix 4 – AMP information disclosure compliance

### INFORMATION DISCLOSURE DETERMINATION REQUIREMENT

| CONTENTS OF THE AMP | CLAUSE | AMP SECTION |
|---|---|---|
| 3.1. | A summary that provides a brief overview of the contents and highlights information that the EDB considers significant; | Section 1 |
| 3.2. | Details of the background and objectives of the EDB's asset management and planning processes; | Section 5 |
| 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; | Section 1, Section 5 |
| 3.3.2. | states the corporate mission or vision as it relates to asset management; | Section 1, Section 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. | Section 1, Section5 |
| 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 |
| 3.5. | The date that it was approved by the directors; | Section 1 |
| 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 | Section 4, Section 9, Section 13 |
| 3.6.2. | what these interests are; | Section 4, Section 9, Section 13 |
| 3.6.3. | how these interests are accommodated in asset management practices; and | Section 4, Section 9, Section 13 |
| 3.6.4. | how conflicting interests are managed; | Section 4, Section 9, Section 13 |
| 3.7. | A description of the accountabilities and responsibilities for asset management on at least 3 levels, including- | Section 6 |
| 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; | Section 6 |
| 3.7.2. | executive—an indication of how the in-house asset management and planning organisation is structured; and | Section 6 |
| 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; | Section 6 |
| 3.8. | All significant assumptions | |
| 3.8.1. | quantified where possible; | Sections 8 - 15 |
| 3.8.2. | clearly identified in a manner that makes their significance understandable to interested persons, including- | Sections 8 - 15 |
| 3.8.3. | a description of changes proposed where the information is not based on the EDB's existing business; | Sections 8 - 15 |

| 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 | Section 1, Sections 8 - 15 |
| 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; | Section 1 |
| 3.10. | An overview of asset management strategy and delivery; | Section 5 |
| 3.11. | An overview of systems and information management data; | Section 6 |
| 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 |
| 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 | Sections 9 -13 |
| 3.13.3. | measuring network performance; | Section 7 |
| 3.14. | An overview of asset management documentation, controls and review processes. | Section 5, Section 6 |
| 3.15. | An overview of communication and participation processes; | Section 5, Section 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, Section 10 |
| 4.1.1. | the region(s) covered; | Section 3, Section 10 |
| 4.1.2. | identification of large consumers that have a significant impact on network operations or asset management priorities; | Section 10, Appendix 3 |
| 4.1.3. | description of the load characteristics for different parts of the network; | Section 10, Appendix 3 |
| 4.1.4. | peak demand and total energy delivered in the previous year, broken down by sub-network, if any. | Section 10 |
| 4.2. | a description of the network configuration, including- | Section 3, Section 10 |
| 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; | Section 3, Section 10, 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; | Section 3, Section 10, Appendix 9 |
| 4.2.3. | a description of the distribution system, including the extent to which it is underground; | Section 3 |
| 4.2.4. | a brief description of the network's distribution substation arrangements; | Section 3 |

| CONTENTS OF THE AMP | CLAUSE | AMP SECTION |
|---|---|---|
| 4.2.5. | a description of the low voltage network including the extent to which it is underground; and | Section 3 |
| 4.2.6. | an overview of secondary assets such as protection relays, ripple injection systems, SCADA and telecommunications systems. | Section 3 |
| 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 |
| 4.4. | Network assets by category | Section 12 |
| | The AMP must describe the network assets by providing the following information for each asset category- | |
| 4.4.1. | voltage levels; | Section 12 |
| 4.4.2. | description and quantity of assets; | Section 12 |
| 4.4.3. | age profiles; and | Section 12 |
| 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. | Section 12 |
| 4.5. | The asset categories discussed in clause 4.4 should include at least the following- | Section 12 |
| 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 |
| 4.5.4. | other generation plant owned by the EDB. | Section 12 |
| | **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 |
| 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 | Section 7 |
| 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. | Section 7 |

| CONTENTS OF THE AMP | CLAUSE | AMP SECTION |
|---|---|---|
| | **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; | Section 10 |
| 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; | Section 10 |
| 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; | Section 9, Section 10, Section 16 |
| 11.4. | The use of standardised designs may lead to improved cost efficiencies. This section should discuss- | Section 9, Section 10, Section 16 |
| 11.4.1. | the categories of assets and designs that are standardised; and | Section 9, Section 10, Section 16 |
| 11.4.2. | the approach used to identify standard designs; | Section 9, Section 10, Section 16 |
| 11.5. | A description of strategies or processes (if any) used by the EDB that promote the energy efficient operation of the network; | Sections 8 - 13 |
| 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 |
| 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; | Section 10 |
| 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 |
| 11.8.1. | explain the load forecasting methodology and indicate all the factors used in preparing the load estimates; | Section 10 |
| 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 |
| 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 | Section 10 |
| 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; | Section 10 |
| 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 - 12, Section 14, Section 10a, Section 12a |
| 11.9.1. | the reasons for choosing a selected option for projects where decisions have been made; | Sections 10 - 12, Section 14, Section 10a, Section 12a |
| 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 - 12, Section 14, , Section 10a, Section 12a |
| 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 - 12, Section 14, , Section 10a, Section 12a |
| 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 - 12, Section 14, Section 10a, Section 12a |
| 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 - 12, Section 14, Section 10a, Section 12a |

| CONTENTS OF THE AMP | CLAUSE | AMP SECTION |
|---|---|---|
| 11.10.2. | a summary description of the programmes and projects planned for the following four years (where known); and | Sections 10 - 12, Section 14, Section 10a, Section 12a |
| 11.10.3. | an overview of the material projects being considered for the remainder of the AMP planning period; | Sections 10 - 12, Section 14, Section 10a, Section 12a |
| 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 | Section 9 |
| 11.12. | A description of the EDB's policies on non-network solutions, including- | Section 10 |
| 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 | Section 10 |
| 11.12.2. | the potential for non-network solutions to address network problems or constraints. | Section 10 |
| | **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; | Section 8, Section 12 |
| 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- | Section 8, Section 12 |
| 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; | Section 8, Section 12 |
| 12.2.2. | any systemic problems identified with any particular asset types and the proposed actions to address these problems; and | Section 8, Section 12 |
| 12.2.3. | budgets for maintenance activities broken down by asset category for the AMP planning period; | Section 8, Section 12 |
| 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- | Section 12 |
| 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; | Section 12 |
| 12.3.2. | a description of innovations that have deferred asset replacements; | Section 12 |
| 12.3.3. | a description of the projects currently underway or planned for the next 12 months; | Section 12 |
| 12.3.4. | a summary of the projects planned for the following four years (where known); and | Section 12 |
| 12.3.5. | an overview of other work being considered for the remainder of the AMP planning period; and | Section 12 |
| 12.4. | The asset categories discussed in clauses 12.2 and 12.3 should include at least the categories in clause 4.5. | Section 12 |
| | **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 |
| 13.2. | development, maintenance and renewal policies that cover them; | Section 14 |
| 13.3. | a description of material capital expenditure projects (where known) planned for the next five years; and | Section 14 |
| 13.4. | a description of material maintenance and renewal projects (where known) planned for the next five years. | Section 14 |

| CONTENTS OF THE AMP | CLAUSE | AMP SECTION |
|---|---|---|
| | **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 |
| 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 |
| 14.3. | A description of the policies to mitigate or manage the risks of events identified in clause 14.2; and | Section 6 |
| 14.4. | Details of emergency response and contingency plans. | Section 6 |
| 15. | AMPs must provide details of performance measurement, evaluation, and improvement, including— | |
| 15.1. | A review of progress against plan, both physical and financial; | Section 15 |
| 15.2. | An evaluation and comparison of actual service level performance against targeted performance; | Section 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. | Section 5, 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. | Section 5, 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 | Section 1, Section 16 |
| 16.2. | The organisation structure and the processes for authorisation and business capabilities will support the implementation of the AMP plans. | Section 6, Section 16 |

## 17.5 Appendix 5 – Significant change from AMP2020

| 2021 AMP SCHEDULE DATE | SUBSTATION | PROJECT AND PROGRAMME DESCRITPION | 2020 AMP SCHEDULE DATE | REASON FOR CHANGE |
|---|---|---|---|---|
| FY22 | Millwater | Millwater Zone Substation | FY28 | Brought forward in keeping with customer project |
| FY22 | Silverdale | Data centre Silverdale stage 2 | - | New Project |
| FY22 | Bush road | Piermark Drive 11 kV reinforcement | - | New Project |
| FY22 | Various | Strategic TX stock | - | New Project |
| FY22 | Various | General stock | - | New Project |
| FY23 | Westgate | SH16 Safe Roads stage 1 Huapai to Waimauku | FY22 | Change in timing based on NZTA work |
| FY23 | Mt Albert | Mt Albert 33/11 kV TX Replace T1 | On-hold | Project brought forward due to deteriorating condition monitored |
| FY23 | Waimauku | SH16 to Waimauku future proofing ducts | FY24 | Change in timing based on NZTA work |
| FY23 | Onehunga | Onehunga SUBT cable future proofing ducts | FY21 | Change in timing to align with third party civil work |
| FY23 | Westgate | Data centre Westgate stage 1 | - | New Project |
| FY23 | Manly | Penlink Dairy Flat to Whangaparaoa | - | New Project |
| FY23 | CBD | CBD 22 kV extension Albert Wellesley St | - | New Project |
| FY23 | South Howick | South Howick 33/11 kV Replace T2 | - | New Project |
| FY24 | McNab | McNab 33/11 kV TX Replace T1 | FY21 | Revised asset risk assessment and prioritisation |
| FY24 | Manukau | Mill and Redoubt road | FY22 | Initial forecast for prelim design only |
| FY24 | Westgate | SH16 Safe Roads stage 2 Brigham Creek to Kumeu | FY21 | Change in timing based on NZTA work |
| FY24 | Manurewa | Manurewa 33/11 kV TX Replace T3 | FY22 | Revised asset risk assessment and prioritisation |
| FY25 | McNab | McNab 33/11 kV TX Replace T2 | FY22 | Revised asset risk assessment and prioritisation |
| FY25 | Rosebank | Rosebank 11 kV vacuum CBs retrofit | FY22 | Revised asset risk assessment and prioritisation |
| FY25 | Wiri | Wiri 11 kV vacuum CBs retrofit and upgrade protection | FY22 | Revised asset risk assessment and prioritisation |
| FY25 | Newton | Newton 33/11 kV TX Replace T1 | FY23 | Revised asset risk assessment and prioritisation |
| FY25 | Various | Auckland ZSSs capacitor banks | - | New Project |
| FY26 | CBD | NDG Centre 22 kV Supply | FY22 | Change in customer project timing |
| FY26 | Pakuranga | Pakuranga 11 kV SWBD Replace | FY23 | Revised to allow for better project design and scheduling |
| FY26 | Rockfield | Rockfield 11 kV vacuum CBs retrofit | FY23 | Revised asset risk assessment and prioritisation |
| FY26 | Sabulite | Sabulite 33 kV SWBD ODID | FY23 | Revised to allow for better project design and scheduling |
| FY26 | Sandringham | Sandringham 11 kV SWBD Replace | FY24 | Revised to allow for better project design and scheduling |
| FY26 | Triangle Rd | Triangle 33/11 kV TX Replace T1 | FY24 | Revised asset risk assessment and prioritisation |
| FY26 | Waiheke | Waiheke SUBT cable Reinforcement | FY23 | Change in risk assessment, close monitoring will continue |

| 2021 AMP SCHEDULE DATE | SUBSTATION | PROJECT AND PROGRAMME DESCRITPION | 2020 AMP SCHEDULE DATE | REASON FOR CHANGE |
|---|---|---|---|---|
| FY26 | Ngataringa Bay | Ngataringa Bay Direct Supply Belmont ZSS | FY22 | Change in risk assessment with project split into two stages |
| FY26 | Mt Eden | Mt Eden land purchase for ZSS | - | New Project |
| FY27 | New Lynn | New Lynn 33 kV SWBD ODID | FY23 | Revised to allow for better project design and scheduling |
| FY27 | St Heliers | St Heliers 11 kV vacuum CBs retrofit | FY24 | Revised asset risk assessment and prioritisation |
| FY27 | Triangle Rd | Triangle 33/11 kV TX Replace T2 | FY25 | Revised asset risk assessment and prioritisation |
| FY27 | Waikaukau | Waikaukau 33 kV SWBD ODID | FY24 | Revised to allow for better project design and scheduling |
| FY27 | Auckland Airport | Auckland airport third supply | FY22 | Change in customer project timing |
| FY28 | Te Papapa | Te Papapa 11 kV SWBD Replace | FY25 | Revised to allow for better project design and scheduling |
| FY28 | Henderson valley | Henderson Valley 11 kV SWBD replace | FY25 | Revised to allow for better project design and scheduling |
| FY28 | Waikaukau | Waikaukau 11 kV SWBD replace | FY24 | Revised to allow for better project design and scheduling |
| FY28 | South Howick | South Howick 33/11 kV Replace T1 | - | New Project |
| FY28 | Various | Northern ZSSs capacitor banks | - | New Project |
| FY28 | CBD | CBD 22 kV Hobson St Bradnor Lane | - | New Project |
| FY29 | McNab | McNab 33/11 kV TX Replace T3 | FY23 | Revised asset risk assessment and prioritisation |
| FY29 | Otara | Otara 33/11 kV TX Replace T2 | FY27 | Revised asset risk assessment and prioritisation |
| FY29 | Quay | Quay 11 kV SWBD Replace | FY26 | Revised to allow for better project design and scheduling |
| FY29 | Warkworth | Wellsford-Warkworth 33 kV upgrade stage 1 | FY26 | Revised load forecast and constraint modelling |
| FY29 | Warkworth | Warkworth Matakana Rd ducts | FY26 | Revised load forecast and constraint modelling |
| FY29 | CBD | CBD 22 kV conversion to off load Quay 11 kV | - | New Project |
| FY30 | Henderson valley | Henderson Valley 33 kV SWBD ODID | FY23 | Revised asset risk assessment and prioritisation |
| FY30 | Waimauku | Waimauku 33 kV TX Replace T1 | FY28 | Revised asset risk assessment and prioritisation |
| FY30 | Whenuapai | Whenuapai Zone Substation | FY28 | Brought forward in keeping with customer project |
| FY30 | Newton | Newton 11 kV SWBD replace | FY27 | Revised to allow for better project design and scheduling |
| FY30 | Sunset Road | Sunset Rd 11 kV SWBD replace | FY27 | Revised to allow for better project design and scheduling |
| FY30 | Sunset Road | Sunset Rd 33 kV SWBD ODID | FY28 | Revised to allow for better project design and scheduling |
| FY30 | CBD | CBD 22 kV conversion to off load Victoria | - | New Project |
| FY30 | Mt Eden | Mt Eden New Zone Substation | - | New Project |
| FY30 | Mt Albert | Mt Albert SUBT Cable replace | - | New Project |
| FY31 | Onehunga | Onehunga SUBT Cable replace | FY24 | Revised risk assessment |
| FY31 | Newmarket | Newmarket substation development | FY27 | Revised load forecast and constraint modelling |

| 2021 AMP SCHEDULE DATE | SUBSTATION | PROJECT AND PROGRAMME DESCRITPION | 2020 AMP SCHEDULE DATE | REASON FOR CHANGE |
|---|---|---|---|---|
| FY31 | Hobsonville | Hobsonville 33 kV SWBD ODID | FY28 | Revised to allow for better project design and scheduling |
| FY31 | Manly | Manly 11 kV SWBD replace | FY28 | Revised to allow for better project design and scheduling |
| FY31 | Woodford | Woodford 11 kV SBWD replace | FY27 | Revised asset risk assessment and prioritisation |
| FY31 | Takanini | Brookby 11 kV Feeder Upgrade Reconductoring | FY26 | Improved voltage due to other project implemented |
| FY31 | Sandringham | Sandringham new 11 kV feeders to Mt Albert Rd | - | New Project |
| FY31 | Mt Albert | Mt Albert Zone Substation Upgrade | - | New Project |
| Beyond AMP horizon | Highbury | Highbury 2nd 33/11 kV TX and cables | FY23 | Revised load forecast and constraint modelling |
| Beyond AMP horizon | Greenhithe | Greenhithe 2nd 33/11 kV TX | FY22 | Revised load forecast and constraint modelling |
| Beyond AMP horizon | Freemans Bay | Freemans Bay 11 kV reinforcement for security | FY24 | Revised load forecast and constraint modelling |
| Beyond AMP horizon | Waiheke | Waiheke East 11 kV feeder new | FY23 | Revised load forecast and constraint modelling |
| Beyond AMP horizon | Victoria | Victoria 11 kV SWBD replace | FY27 | Revised to allow for better project design and scheduling |
| Beyond AMP horizon | Clevedon | Kawakawa bay Reconductoring | FY30 | Project timing based on pending agreement with a third party |
| On-hold | McKinnon | Westfield Albany Expansion | FY22 | Project on hold based on customer project timing |
| Deleted | Various | Auckland Light Rail Transit station supply | FY25 | Project not included due to uncertainty in timing |
| Deleted | Various | Auckland Light Rail Project | FY27 | Not included due to high uncertainty of the project |
| Deleted | Henderson valley | Piha 11 kV reinforcement | FY30 | Project replaced by alternative solution |

# 17.6 Appendix 6 – Forecast Capital Expenditure (Schedule 11a)

*Company Name* **Vector Electricity**
*AMP Planning Period* **1 April 2021 to 31 March 2031**

## SCHEDULE 11a: REPORT ON FORECAST CAPITAL EXPENDITURE

This schedule requires a breakdown of forecast expenditure on assets for the current disclosure year and a 10 year planning period. The forecasts should be consistent with the supporting information set out in the AMP. The forecast is to be expressed in both constant price and nominal dollar terms. Also required is a forecast of the value of commissioned assets (i.e., the value of RAB additions)
EDBs must provide explanatory comment on the difference between constant price and nominal dollar forecasts of expenditure on assets in Schedule 14a (Mandatory Explanatory Notes).
This information is not part of audited disclosure information.

| *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 | | | **RY21** | **RY22** | **RY23** | **RY24** | **RY25** | **RY26** | **RY27** | **RY28** | **RY29** | **RY30** | **RY31** |
| 9 | | **11a(i): Expenditure on Assets Forecast** | **$000 (in nominal dollars)** | | | | | | | | | | |
| 10 | | Consumer connection | 66,990 | 88,828 | 71,080 | 62,305 | 62,600 | 57,940 | 61,175 | 67,631 | 70,282 | 71,688 | 64,117 |
| 11 | | System growth | 45,828 | 53,330 | 35,083 | 13,742 | 12,186 | 32,875 | 39,020 | 38,603 | 57,301 | 60,772 | 65,703 |
| 12 | | Asset replacement and renewal | 104,373 | 106,865 | 108,615 | 97,656 | 100,501 | 111,215 | 122,894 | 115,394 | 107,694 | 121,274 | 128,175 |
| 13 | | Asset relocations | 33,144 | 39,672 | 38,764 | 33,248 | 32,495 | 33,183 | 33,832 | 34,509 | 35,199 | 35,903 | 36,621 |
| 14 | | Reliability, safety and environment: | | | | | | | | | | | |
| 15 | | Quality of supply | 329 | - | - | - | - | - | - | - | - | - | - |
| 16 | | Legislative and regulatory | 97 | 40 | - | - | - | - | - | - | - | - | - |
| 17 | | Other reliability, safety and environment | 29,363 | 28,644 | 29,302 | 30,686 | 30,532 | 39,121 | 41,864 | 41,571 | 45,055 | 45,192 | 45,877 |
| 18 | | **Total reliability, safety and environment** | 29,789 | 28,684 | 29,302 | 30,686 | 30,532 | 39,121 | 41,864 | 41,571 | 45,055 | 45,192 | 45,877 |
| 19 | | **Expenditure on network assets** | 280,124 | 317,379 | 282,844 | 237,637 | 238,314 | 274,334 | 298,785 | 297,708 | 315,531 | 334,829 | 340,493 |
| 20 | | Expenditure on non-network assets | 30,528 | 46,614 | 30,271 | 25,701 | 20,598 | 32,739 | 41,535 | 31,883 | 35,431 | 29,990 | 32,483 |
| 21 | | **Expenditure on assets** | 310,652 | 363,993 | 313,115 | 263,338 | 258,912 | 307,073 | 340,320 | 329,591 | 350,962 | 364,819 | 372,976 |
| 22 | | | | | | | | | | | | | |
| 23 | *plus* | Cost of financing | 5,674 | 6,606 | 5,496 | 4,397 | 4,287 | 5,514 | 6,122 | 5,997 | 6,788 | 7,009 | 7,204 |
| 24 | *less* | Value of capital contributions | 86,352 | 114,930 | 96,680 | 81,983 | 80,598 | 76,105 | 79,727 | 86,634 | 89,685 | 91,479 | 84,166 |
| 25 | *plus* | Value of vested assets | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | |
| 27 | | **Capital expenditure forecast** | 229,974 | 255,669 | 221,931 | 185,752 | 182,601 | 236,482 | 266,715 | 248,954 | 268,065 | 280,349 | 296,014 |
| 28 | | | | | | | | | | | | | |
| 29 | | Assets commissioned | 208,035 | 267,352 | 225,236 | 176,685 | 175,416 | 232,881 | 254,042 | 243,498 | 243,358 | 278,713 | 291,879 |
| 30 | | | *Current Year CY* | *CY+1* | *CY+2* | *CY+3* | *CY+4* | *CY+5* | *CY+6* | *CY+7* | *CY+8* | *CY+9* | *CY+10* |
| 32 | | | **$000 (in constant prices)** | | | | | | | | | | |
| 33 | | Consumer connection | 66,990 | 87,086 | 68,320 | 58,711 | 57,833 | 52,478 | 54,322 | 58,877 | 59,985 | 59,985 | 52,598 |
| 34 | | System growth | 45,828 | 52,284 | 33,721 | 12,949 | 11,258 | 29,776 | 34,649 | 33,606 | 48,906 | 50,851 | 53,899 |
| 35 | | Asset replacement and renewal | 104,373 | 104,770 | 104,397 | 92,023 | 92,847 | 100,731 | 109,126 | 100,457 | 91,916 | 101,477 | 105,148 |
| 36 | | Asset relocations | 33,144 | 38,894 | 37,259 | 31,330 | 30,020 | 30,055 | 30,042 | 30,042 | 30,042 | 30,042 | 30,042 |
| 37 | | Reliability, safety and environment: | | | | | | | | | | | |
| 38 | | Quality of supply | 329 | - | - | - | - | - | - | - | - | - | - |
| 39 | | Legislative and regulatory | 97 | 39 | - | - | - | - | - | - | - | - | - |
| 40 | | Other reliability, safety and environment | 29,363 | 28,082 | 28,164 | 28,916 | 28,207 | 35,433 | 37,174 | 36,190 | 38,454 | 37,815 | 37,635 |
| 41 | | **Total reliability, safety and environment** | 29,789 | 28,121 | 28,164 | 28,916 | 28,207 | 35,433 | 37,174 | 36,190 | 38,454 | 37,815 | 37,635 |
| 42 | | **Expenditure on network assets** | 280,124 | 311,155 | 271,861 | 223,929 | 220,165 | 248,473 | 265,313 | 259,172 | 269,303 | 280,170 | 279,322 |
| 43 | | Expenditure on non-network assets | 30,528 | 45,700 | 29,096 | 24,219 | 19,029 | 29,653 | 36,882 | 27,756 | 30,240 | 25,094 | 26,647 |
| 44 | | **Expenditure on assets** | 310,652 | 356,855 | 300,957 | 248,148 | 239,194 | 278,126 | 302,195 | 286,928 | 299,543 | 305,264 | 305,969 |
| 45 | | | | | | | | | | | | | |
| 46 | | **Subcomponents of expenditure on assets (where known)** | | | | | | | | | | | |
| 47 | | Energy efficiency and demand side management, reduction of energy losses | | | | | | | | | | | |
| 48 | | Overhead to underground conversion | 12,978 | 8,053 | 10,737 | 10,737 | 10,737 | 10,737 | 10,737 | 10,737 | 10,737 | 10,737 | 10,737 |
| 49 | | Research and development | - | - | - | - | - | - | - | - | - | - | - |

| Row | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 | CY+6 | CY+7 | CY+8 | CY+9 | CY+10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 58 | | | | | | | | | | | | |
| 59 | **Difference between nominal and constant price forecasts** | $000 | | | | | | | | | | |
| 60 | Consumer connection | - | 1,742 | 2,760 | 3,594 | 4,767 | 5,462 | 6,853 | 8,754 | 10,297 | 11,703 | 11,519 |
| 61 | System growth | - | 1,046 | 1,362 | 793 | 928 | 3,099 | 4,371 | 4,997 | 8,395 | 9,921 | 11,804 |
| 62 | Asset replacement and renewal | - | 2,095 | 4,218 | 5,633 | 7,654 | 10,484 | 13,768 | 14,937 | 15,778 | 19,797 | 23,027 |
| 63 | Asset relocations | - | 778 | 1,505 | 1,918 | 2,475 | 3,128 | 3,790 | 4,467 | 5,157 | 5,861 | 6,579 |
| 64 | Reliability, safety and environment: | | | | | | | | | | | |
| 65 | Quality of supply | - | - | - | - | - | - | - | - | - | - | - |
| 66 | Legislative and regulatory | - | 1 | - | - | - | - | - | - | - | - | - |
| 67 | Other reliability, safety and environment | - | 562 | 1,138 | 1,770 | 2,325 | 3,688 | 4,690 | 5,381 | 6,601 | 7,377 | 8,242 |
| 68 | **Total reliability, safety and environment** | - | 563 | 1,138 | 1,770 | 2,325 | 3,688 | 4,690 | 5,381 | 6,601 | 7,377 | 8,242 |
| 69 | **Expenditure on network assets** | - | 6,224 | 10,983 | 13,708 | 18,149 | 25,861 | 33,472 | 38,536 | 46,228 | 54,659 | 61,171 |
| 70 | Expenditure on non-network assets | - | 914 | 1,175 | 1,482 | 1,569 | 3,086 | 4,653 | 4,127 | 5,191 | 4,896 | 5,836 |
| 71 | **Expenditure on assets** | - | 7,138 | 12,158 | 15,190 | 19,718 | 28,947 | 38,125 | 42,663 | 51,419 | 59,555 | 67,007 |

## 11a(ii): Consumer Connection

| Row | | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|---|---|
| 75 | | *Consumer types defined by EDB** | **$000 (in constant prices)** | | | | | |
| 76 | | Service Connection | 15,650 | 14,491 | 13,354 | 12,862 | 12,862 | 12,862 |
| | | Customer Substations | 15,641 | 36,350 | 22,213 | 14,737 | 13,970 | 8,625 |
| 77 | | Business subdivisions | 2,962 | 1,137 | 1,208 | 1,208 | 1,208 | 1,208 |
| 78 | | Residential Subdivisions | 27,338 | 27,537 | 24,788 | 23,690 | 23,690 | 23,680 |
| | | Capacity Changes | 3,631 | 5,082 | 5,327 | 5,105 | 4,994 | 4,994 |
| 79 | | Street Lighting | 1,765 | 2,489 | 1,430 | 1,109 | 1,109 | 1,109 |
| | | Easements | 3 | - | - | - | - | - |
| 80 | | | | | | | | |
| 81 | | **include additional rows if needed* | | | | | | |
| 82 | | **Consumer connection expenditure** | 66,990 | 87,086 | 68,320 | 58,711 | 57,833 | 52,478 |
| 83 | *less* | Capital contributions funding consumer connection | 68,013 | 88,358 | 69,365 | 59,672 | 58,719 | 53,282 |
| 84 | | **Consumer connection less capital contributions** | (1,023) | (1,272) | (1,045) | (961) | (886) | (804) |

## 11a(iii): System Growth

| Row | | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|---|---|
| 86 | | Subtransmission | 15,990 | 11,415 | 3,520 | 326 | - | 5,219 |
| 87 | | Zone substations | 13,914 | 25,107 | 11,565 | 2,099 | 1,267 | 8,484 |
| 88 | | Distribution and LV lines | 4,732 | 1,994 | 2,458 | 3,198 | 3,927 | 4,745 |
| 89 | | Distribution and LV cables | 6,935 | 11,707 | 13,001 | 6,053 | 5,581 | 10,482 |
| 90 | | Distribution substations and transformers | 38 | - | - | - | - | - |
| 91 | | Distribution switchgear | 868 | 184 | 48 | - | - | - |
| 92 | | Other network assets | 3,351 | 1,877 | 3,129 | 1,273 | 483 | 846 |
| 93 | | **System growth expenditure** | 45,828 | 52,284 | 33,721 | 12,949 | 11,258 | 29,776 |
| 94 | *less* | Capital contributions funding system growth | | | | | | |
| 95 | | **System growth less capital contributions** | 45,828 | 52,284 | 33,721 | 12,949 | 11,258 | 29,776 |

| Row | | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|---|---|
| 104 | | | | | | | | |
| 105 | **11a(iv): Asset Replacement and Renewal** | | **$000 (in constant prices)** | | | | | |
| 106 | | Subtransmission | 1,047 | 6,102 | 1,810 | 121 | 23 | 1,210 |
| 107 | | Zone substations | 30,481 | 28,905 | 31,350 | 24,189 | 27,225 | 29,697 |
| 108 | | Distribution and LV lines | 35,784 | 14,836 | 12,934 | 12,844 | 12,722 | 12,699 |
| 109 | | Distribution and LV cables | 16,151 | 25,857 | 29,842 | 29,092 | 28,139 | 30,312 |
| 110 | | Distribution substations and transformers | 4,907 | 5,703 | 6,164 | 6,015 | 5,518 | 5,373 |
| 111 | | Distribution switchgear | 12,755 | 12,251 | 15,552 | 15,387 | 15,164 | 17,564 |
| 112 | | Other network assets | 3,248 | 11,116 | 6,745 | 4,375 | 4,056 | 3,876 |
| 113 | | **Asset replacement and renewal expenditure** | 104,373 | 104,770 | 104,397 | 92,023 | 92,847 | 100,731 |
| 114 | *less* | Capital contributions funding asset replacement and renewal | | | | | | |
| 115 | | **Asset replacement and renewal less capital contributions** | 104,373 | 104,770 | 104,397 | 92,023 | 92,847 | 100,731 |
| 116 | **11a(v):Asset Relocations** | | | | | | | |
| 117 | | *Project or programme** | | | | | | |
| 118 | | Overground to underground conversions | 12,978 | 8,053 | 10,737 | 10,737 | 10,737 | 10,737 |
| 119 | | | | | | | | |
| 120 | | | | | | | | |
| 121 | | | | | | | | |
| 123 | | **include additional rows if needed* | | | | | | |
| 124 | | All other asset relocations projects or programmes | 20,166 | 30,841 | 26,522 | 20,593 | 19,283 | 19,318 |
| 125 | | **Asset relocations expenditure** | 33,144 | 38,894 | 37,259 | 31,330 | 30,020 | 30,055 |
| 126 | *less* | Capital contributions funding asset relocations | 18,340 | 24,318 | 23,561 | 17,583 | 15,741 | 15,648 |
| 127 | | **Asset relocations less capital contributions** | 14,804 | 14,576 | 13,698 | 13,747 | 14,279 | 14,407 |
| 128 | | | | | | | | |
| 129 | **11a(vi):Quality of Supply** | | | | | | | |
| 130 | | *Project or programme** | | | | | | |
| 131 | | | | | | | | |
| 132 | | | | | | | | |
| 133 | | | | | | | | |
| 134 | | | | | | | | |
| 135 | | | | | | | | |
| 136 | | **include additional rows if needed* | | | | | | |
| 137 | | All other quality of supply projects or programmes | 329 | - | - | - | - | - |
| 138 | | **Quality of supply expenditure** | 329 | - | - | - | - | - |
| 139 | *less* | Capital contributions funding quality of supply | | | | | | |
| 140 | | **Quality of supply less capital contributions** | 329 | - | - | - | - | - |
| 141 | | | | | | | | |
| 142 | **11a(vii): Legislative and Regulatory** | | | | | | | |
| 143 | | *Project or programme** | | | | | | |
| 144 | | | | | | | | |
| 145 | | | | | | | | |
| 146 | | | | | | | | |
| 147 | | | | | | | | |
| 148 | | | | | | | | |
| 149 | | **include additional rows if needed* | | | | | | |
| 150 | | All other legislative and regulatory projects or programmes | 97 | 39 | - | - | - | - |
| 151 | | **Legislative and regulatory expenditure** | 97 | 39 | - | - | - | - |
| 152 | *less* | Capital contributions funding legislative and regulatory | | | | | | |
| 153 | | **Legislative and regulatory less capital contributions** | 97 | 39 | - | - | - | - |

## 11a(viii): Other Reliability, Safety and Environment

| | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|
| *Project or programme** | $000 (in constant prices) | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **include additional rows if needed* | | | | | | |
| All other reliability, safety and environment projects or programmes | 29,363 | 28,082 | 28,164 | 28,916 | 28,207 | 35,433 |
| **Other reliability, safety and environment expenditure** | 29,363 | 28,082 | 28,164 | 28,916 | 28,207 | 35,433 |
| *less* Capital contributions funding other reliability, safety and environment | | | | | | |
| **Other reliability, safety and environment less capital contributions** | 29,363 | 28,082 | 28,164 | 28,916 | 28,207 | 35,433 |

## 11a(ix): Non-Network Assets

| | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|
| **Routine expenditure** | | | | | | |
| *Project or programme** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **include additional rows if needed* | | | | | | |
| All other routine expenditure projects or programmes | 10,464 | 13,425 | 9,525 | 15,045 | 11,980 | 13,841 |
| **Routine expenditure** | 10,464 | 13,425 | 9,525 | 15,045 | 11,980 | 13,841 |
| **Atypical expenditure** | | | | | | |
| *Project or programme** | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| **include additional rows if needed* | | | | | | |
| All other atypical projects or programmes | 20,064 | 32,275 | 19,571 | 9,174 | 7,049 | 15,812 |
| **Atypical expenditure** | 20,064 | 32,275 | 19,571 | 9,174 | 7,049 | 15,812 |
| | | | | | | |
| **Expenditure on non-network assets** | 30,528 | 45,700 | 29,096 | 24,219 | 19,029 | 29,653 |

# 17.7 Appendix 7 – Forecast Operational Expenditure (Schedule 11b)

Company Name: Vector Electricity
AMP Planning Period: 1 April 2021- 31 March 2031

## SCHEDULE 11b: REPORT ON FORECAST OPERATIONAL EXPENDITURE

This schedule requires a breakdown of forecast operational expenditure for the disclosure year and a 10 year planning period. The forecasts should be consistent with the supporting information set out in the AMP. The forecast is to be expressed in both constant price and nominal dollar terms.
EDBs must provide explanatory comment on the difference between constant price and nominal dollar operational expenditure forecasts in Schedule 14a (Mandatory Explanatory Notes).
This information is not part of audited disclosure information.

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 21 | 31 Mar 22 | 31 Mar 23 | 31 Mar 24 | 31 Mar 25 | 31 Mar 26 | 31 Mar 27 | 31 Mar 28 | 31 Mar 29 | 31 Mar 30 | 31 Mar 31 |
| 9 | **Operational Expenditure Forecast** | $000 (in nominal dollars) | | | | | | | | | | |
| 10 | Service interruptions and emergencies | 14,192 | 15,043 | 15,563 | 15,903 | 16,275 | 16,674 | 17,088 | 17,514 | 17,952 | 18,401 | 18,864 |
| 11 | Vegetation management | 9,211 | 6,590 | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 |
| 12 | Routine and corrective maintenance and inspection | 16,252 | 19,166 | 20,098 | 20,422 | 20,778 | 22,619 | 22,046 | 21,974 | 22,397 | 22,823 | 24,846 |
| 13 | Asset replacement and renewal | 12,871 | 13,806 | 14,643 | 14,417 | 13,946 | 14,035 | 14,175 | 13,583 | 13,578 | 13,850 | 14,127 |
| 14 | **Network Opex** | 52,526 | 54,605 | 55,803 | 56,243 | 56,499 | 58,828 | 58,809 | 58,570 | 59,427 | 60,574 | 63,337 |
| 15 | System operations and network support | 41,825 | 41,669 | 44,417 | 45,989 | 47,100 | 48,249 | 49,125 | 49,916 | 50,913 | 51,996 | 53,102 |
| 16 | Business support | 37,235 | 40,289 | 41,075 | 41,771 | 42,545 | 43,383 | 44,251 | 45,136 | 46,039 | 46,960 | 47,899 |
| 17 | **Non-network opex** | 79,060 | 81,958 | 85,492 | 87,761 | 89,645 | 91,633 | 93,376 | 95,052 | 96,952 | 98,955 | 101,001 |
| 18 | **Operational expenditure** | 131,586 | 136,563 | 141,295 | 144,004 | 146,144 | 150,461 | 152,185 | 153,623 | 156,379 | 159,529 | 164,338 |
| 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 21 | 31 Mar 22 | 31 Mar 23 | 31 Mar 24 | 31 Mar 25 | 31 Mar 26 | 31 Mar 27 | 31 Mar 28 | 31 Mar 29 | 31 Mar 30 | 31 Mar 31 |
| 21 | | $000 (in constant prices) | | | | | | | | | | |
| 22 | Service interruptions and emergencies | 14,192 | 14,829 | 15,102 | 15,175 | 15,247 | 15,319 | 15,392 | 15,466 | 15,541 | 15,618 | 15,697 |
| 23 | Vegetation management | 9,211 | 6,513 | 5,337 | 5,248 | 5,153 | 5,053 | 4,954 | 4,857 | 4,762 | 4,669 | 4,577 |
| 24 | Routine and corrective maintenance and inspection | 16,252 | 18,888 | 19,503 | 19,487 | 19,466 | 20,774 | 19,864 | 19,404 | 19,390 | 19,372 | 20,669 |
| 25 | Asset replacement and renewal | 12,871 | 13,607 | 14,208 | 13,759 | 13,068 | 12,895 | 12,768 | 11,998 | 11,756 | 11,756 | 11,756 |
| 26 | **Network Opex** | 52,526 | 53,838 | 54,150 | 53,669 | 52,934 | 54,042 | 52,978 | 51,725 | 51,449 | 51,414 | 52,698 |
| 27 | System operations and network support | 41,825 | 41,081 | 43,095 | 43,882 | 44,125 | 44,328 | 44,249 | 44,080 | 44,078 | 44,133 | 44,188 |
| 28 | Business support | 37,235 | 39,722 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 | 39,858 |
| 29 | **Non-network opex** | 79,060 | 80,803 | 82,953 | 83,741 | 83,983 | 84,186 | 84,108 | 83,938 | 83,937 | 83,991 | 84,047 |
| 30 | **Operational expenditure** | 131,586 | 134,641 | 137,103 | 137,410 | 136,917 | 138,228 | 137,086 | 135,664 | 135,385 | 135,405 | 136,745 |
| 31 | **Subcomponents of operational expenditure (where known)** | | | | | | | | | | | |
| 32 | | | | | | | | | | | | |
| 33 | Energy efficiency and demand side management, reduction of energy losses | | | | | | | | | | | |
| 34 | Direct billing* | | | | | | | | | | | |
| 35 | Research and Development | | | | | | | | | | | |
| 36 | Insurance | 3,203 | 3,554 | 3,716 | 3,779 | 3,849 | 3,925 | 4,004 | 4,084 | 4,166 | 4,249 | 4,334 |
| 37 | ** Direct billing expenditure by suppliers that direct bill the majority of their consumers* | | | | | | | | | | | |
| 38 | | | | | | | | | | | | |
| 39 | | *Current Year CY* | *CY+1* | *CY+2* | *CY+3* | *CY+4* | *CY+5* | *CY+6* | *CY+7* | *CY+8* | *CY+9* | *CY+10* |
| 40 | | | | | | | | | | | | |
| 41 | **Difference between nominal and real forecasts** | $000 | | | | | | | | | | |
| 42 | Service interruptions and emergencies | - | 214 | 461 | 729 | 1,028 | 1,355 | 1,697 | 2,048 | 2,410 | 2,783 | 3,167 |
| 43 | Vegetation management | - | 77 | 163 | 252 | 347 | 447 | 546 | 643 | 738 | 831 | 923 |
| 44 | Routine and corrective maintenance and inspection | - | 278 | 595 | 935 | 1,312 | 1,844 | 2,182 | 2,569 | 3,007 | 3,451 | 4,177 |
| 45 | Asset replacement and renewal | - | 199 | 434 | 658 | 878 | 1,140 | 1,406 | 1,585 | 1,823 | 2,094 | 2,371 |
| 46 | **Network Opex** | - | 767 | 1,653 | 2,573 | 3,565 | 4,786 | 5,831 | 6,845 | 7,978 | 9,160 | 10,638 |
| 47 | System operations and network support | - | 588 | 1,322 | 2,107 | 2,975 | 3,921 | 4,876 | 5,836 | 6,835 | 7,863 | 8,914 |
| 48 | Business support | - | 567 | 1,217 | 1,913 | 2,686 | 3,525 | 4,393 | 5,278 | 6,181 | 7,101 | 8,040 |
| 49 | **Non-network opex** | - | 1,155 | 2,538 | 4,020 | 5,661 | 7,446 | 9,269 | 11,114 | 13,016 | 14,964 | 16,955 |
| 50 | **Operational expenditure** | - | 1,922 | 4,192 | 6,594 | 9,226 | 12,233 | 15,099 | 17,959 | 20,993 | 24,124 | 27,593 |

## 17.8 Appendix 8 – Asset Condition (Schedule 12a)

*Company Name* **Vector Limited**
*AMP Planning Period* **1 April 2021 – 31 March 2031**

### SCHEDULE 12a: REPORT ON ASSET CONDITION

This schedule requires a breakdown of asset condition by asset class as at the start of the forecast year. The data accuracy assessment relates to the percentage values disclosed in the asset condition columns. Also required is a forecast of the percentage of units to be replaced in the next 5 years. All information should be consistent with the information provided in the AMP and the expenditure on assets forecast in Schedule 11a. All units relating to cable and line assets, that are expressed in km, refer to circuit lengths.

| *sch ref* | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *7* | | | | | **Asset condition at start of planning period (percentage of units by grade)** | | | | | | | |
| *8* | | | | | | | | | | | | |
| *9* | | | | | | | | | | | | |
| *10* | All | Overhead Line | Concrete poles / steel structure | No. | - | 0.13% | 21.15% | 36.53% | 42.18% | | 4 | 6.33% |
| *11* | All | Overhead Line | Wood poles | No. | 0.05% | 3.49% | 81.25% | 11.29% | 3.92% | | 4 | 33.28% |
| *12* | All | Overhead Line | Other pole types | No. | - | - | 0.31% | 0.10% | 99.59% | | 4 | - |
| *13* | HV | Subtransmission Line | Subtransmission OH up to 66kV conductor | km | - | - | 90.94% | 2.29% | 6.78% | | 3 | - |
| *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 | - | 0.56% | 5.32% | 38.54% | 55.57% | | 2 | 0.56% |
| *16* | HV | Subtransmission Cable | Subtransmission UG up to 66kV (Oil pressurised) | km | - | - | - | 95.50% | 4.50% | | 2 | - |
| *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 | - | 38.59% | 27.21% | 32.25% | 1.95% | | 2 | 78.67% |
| *19* | HV | Subtransmission Cable | Subtransmission UG 110kV+ (XLPE) | km | - | - | - | 85.80% | 14.20% | | 2 | - |
| *20* | HV | Subtransmission Cable | Subtransmission UG 110kV+ (Oil pressurised) | km | - | - | - | 92.09% | 7.91% | | 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 | - | - | 4.98% | 95.02% | - | | 2 | - |
| *24* | HV | Zone substation Buildings | Zone substations up to 66kV | No. | - | - | 7.63% | 71.19% | 21.19% | | 4 | 5.93% |
| *25* | HV | Zone substation Buildings | Zone substations 110kV+ | No. | - | - | - | 33.33% | 66.67% | | 4 | - |
| *26* | HV | Zone substation switchgear | 22/33kV CB (Indoor) | No. | - | - | 6.83% | 15.66% | 77.51% | | 3 | 0.40% |
| *27* | HV | Zone substation switchgear | 22/33kV CB (Outdoor) | No. | - | 7.38% | 51.64% | 10.66% | 30.33% | | 3 | 12.30% |
| *28* | HV | Zone substation switchgear | 33kV Switch (Ground Mounted) | No. | | | | | | | N/A | |
| *29* | HV | Zone substation switchgear | 33kV Switch (Pole Mounted) | No. | - | 12.09% | 80.77% | 4.40% | 2.75% | | 3 | 17.03% |
| *30* | HV | Zone substation switchgear | 33kV RMU | No. | - | 30.77% | - | 69.23% | - | | 3 | 30.77% |
| *31* | HV | Zone substation switchgear | 50/66/110kV CB (Indoor) | No. | - | - | - | 45.00% | 55.00% | | 3 | - |
| *32* | HV | Zone substation switchgear | 50/66/110kV CB (Outdoor) | No. | - | - | 100.00% | - | - | | 3 | - |
| *33* | HV | Zone substation switchgear | 3.3/6.6/11/22kV CB (ground mounted) | No. | - | 7.83% | 21.03% | 21.34% | 49.81% | | 3 | 13.51% |
| *34* | HV | Zone substation switchgear | 3.3/6.6/11/22kV CB (pole mounted) | No. | | | | | | | N/A | |
| *35* | | | | | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | | | | | Asset condition at start of planning period (percentage of units by grade) | | | | | | | |
| 37 | | | | | | | | | | | | |
| 38 | **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** |
| 39 | HV | Zone Substation Transformer | Zone Substation Transformers | No. | - | 7.27% | 47.73% | 20.45% | 24.55% | | 4 | 5.91% |
| 40 | HV | Distribution Line | Distribution OH Open Wire Conductor | km | - | - | 83.90% | 11.35% | 4.75% | | 3 | 1.61% |
| 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 | 0.46% | 0.05% | 1.74% | 17.72% | 80.03% | | 2 | 0.84% |
| 44 | HV | Distribution Cable | Distribution UG PILC | km | 0.30% | 1.20% | 3.15% | 74.65% | 20.71% | | 2 | 1.50% |
| 45 | HV | Distribution Cable | Distribution Submarine Cable | km | - | - | 86.11% | 13.89% | - | | 2 | - |
| 46 | HV | Distribution switchgear | 3.3/6.6/11/22kV CB (pole mounted) - reclosers and sectionalisers | No. | - | 0.30% | 5.92% | 48.52% | 45.27% | | 4 | 11.36% |
| 47 | HV | Distribution switchgear | 3.3/6.6/11/22kV CB (Indoor) | No. | - | - | 13.59% | 8.09% | 78.32% | | 4 | - |
| 48 | HV | Distribution switchgear | 3.3/6.6/11/22kV Switches and fuses (pole mounted) | No. | 2.44% | 1.73% | 42.10% | 19.98% | 33.76% | | 4 | 9.13% |
| 49 | HV | Distribution switchgear | 3.3/6.6/11/22kV Switch (ground mounted) - except RMU | No. | 6.35% | 1.08% | 73.48% | 17.25% | 1.84% | | 3 | 8.02% |
| 50 | HV | Distribution switchgear | 3.3/6.6/11/22kV RMU | No. | 0.48% | 1.21% | 47.23% | 19.07% | 32.00% | | 3 | 7.98% |
| 51 | HV | Distribution Transformer | Pole Mounted Transformer | No. | 2.20% | 3.00% | 45.24% | 25.51% | 24.05% | | 3 | 5.20% |
| 52 | HV | Distribution Transformer | Ground Mounted Transformer | No. | 5.23% | 1.21% | 33.99% | 27.72% | 31.85% | | 3 | 6.44% |
| 53 | HV | Distribution Transformer | Voltage regulators | No. | - | - | - | 33.33% | 66.67% | | 4 | - |
| 54 | HV | Distribution Substations | Ground Mounted Substation Housing | No. | 1.16% | 0.74% | 77.23% | 8.45% | 12.41% | | 4 | 1.90% |
| 55 | LV | LV Line | LV OH Conductor | km | - | - | 85.78% | 7.78% | 6.44% | | 3 | 0.23% |
| 56 | LV | LV Cable | LV UG Cable | km | 0.50% | 4.23% | 20.76% | 39.47% | 35.05% | | 2 | 4.73% |
| 57 | LV | LV Streetlighting | LV OH/UG Streetlight circuit | km | | | | | | 100.00% | 1 | 0.08% |
| 58 | LV | Connections | OH/UG consumer service connections | No. | | | | | | 100.00% | 1 | - |
| 59 | All | Protection | Protection relays (electromechanical, solid state and numeric) | No. | - | 1.26% | 60.55% | 21.55% | 16.65% | | 3 | 1.26% |
| 60 | All | SCADA and communications | SCADA and communications equipment operating as a single system | Lot | - | 5.15% | 36.31% | 36.86% | 21.68% | | 4 | 5.15% |
| 61 | All | Capacitor Banks | Capacitors including controls | No. | - | - | 76.81% | 23.19% | - | | 3 | 15.94% |
| 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 2021 - 31 March 2031**

## SCHEDULE 12b: REPORT ON FORECAST CAPACITY

This schedule requires a breakdown of current and forecast capacity and utilisation for each zone substation and current distribution transformer capacity. The data provided should be consistent with the information provided in the AMP. Information provided in this table should relate to the operation of the network in its normal steady state configuration.

*sch ref*

7 **12b(i): System Growth - Zone Substations**

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | | | | | | | | | | |
| 9 | [1] *Extend forecast capacity table as necessary to disclose all capacity by each zone substation* | | | | | | | | | |
| 10 | Atkinson Road | 18.6 | 21 | N-1 | 19.4 | 87% | 24 | 78% | No constraint within +5 years | Meets Vector security criteria |
| 11 | Auckland Airport | 18.0 | 25 | N-1 | 0.0 | 72% | 25 | 112% | Other | Reinforcement to be agreed with the customer |
| 12 | Avondale | 29.2 | 24 | N-1 switched | 16.1 | 122% | 24 | 134% | No constraint within +5 years | Meets Vector security criteria |
| 13 | Bairds | 23.2 | 24 | N-1 | 21.4 | 97% | 24 | 103% | No constraint within +5 years | Meets Vector security criteria |
| 14 | Balmain | 8.5 | - | N-1 switched | 14.1 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 15 | Balmoral | 15.7 | 24 | N-1 | 15.1 | 65% | 24 | 72% | No constraint within +5 years | Meets Vector security criteria |
| 16 | Belmont | 13.1 | 14 | N-1 | 11.5 | 94% | 14 | 92% | No constraint within +5 years | Meets Vector security criteria |
| 17 | Birkdale | 22.9 | 24 | N-1 | 16.2 | 95% | 24 | 93% | No constraint within +5 years | Meets Vector security criteria |
| 18 | Brickworks | 9.1 | - | N-1 switched | 11.9 | - | - | | No constraint within +5 years | Constraint relieved by new 11kV feeder |
| 19 | Browns Bay | 16.5 | 16 | N-1 switched | 15.6 | 103% | 18 | 88% | No constraint within +5 years | Meets Vector security criteria |
| 20 | Bush Road | 23.6 | 23 | N-1 switched | 12.3 | 104% | 23 | 105% | No constraint within +5 years | Meets Vector security criteria |
| 21 | Carbine | 15.2 | 22 | N-1 | 8.9 | 71% | 22 | 69% | No constraint within +5 years | Meets Vector security criteria |
| 22 | Chevalier | 22.0 | 19 | N-1 switched | 15.4 | 116% | 24 | 91% | No constraint within +5 years | Meets Vector security criteria due to sufficient 11kV backup. Capacity to increase due to planned subtran cable replacement |
| 23 | Clendon | 19.0 | 24 | N-1 | 14.7 | 79% | 24 | 106% | No constraint within +5 years | Meets Vector security criteria |
| 24 | Clevedon | 2.5 | - | N-1 switched | 3.2 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 25 | Coatesville | 10.9 | - | N | 10.4 | - | 12 | 88% | No constraint within +5 years | Constraint relieved by the installation of a second transformer |
| 26 | Drive | 28.3 | 24 | N-1 switched | 23.2 | 118% | 24 | 128% | No constraint within +5 years | Meets Vector security criteria |
| 27 | East Coast Road | 15.6 | - | N-1 switched | 15.6 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 28 | East Tamaki | 14.8 | 24 | N-1 | 7.3 | 62% | 24 | 65% | No constraint within +5 years | Meets Vector security criteria |
| 29 | Flatbush | 11.6 | 24 | N-1 | 10.6 | 48% | 24 | 75% | No constraint within +5 years | Meets Vector security criteria |
| | Forrest Hill | 17.1 | 16 | N-1 switched | 15.6 | 107% | 16 | 103% | No constraint within +5 years | Meets Vector security criteria |
| 30 | Freemans Bay | 18.5 | 22 | N-1 | 13.4 | 86% | 22 | 94% | No constraint within +5 years | Meets Vector security criteria |
| 31 | Glen Innes | 12.2 | 24 | N-1 | 33.9 | 51% | 24 | 63% | No constraint within +5 years | Meets Vector security criteria |
| 32 | Greenhithe | 11.0 | - | N-1 switched | 11.0 | - | 24 | 50% | No constraint within +5 years | Meets Vector security criteria |
| 33 | Greenmount | 36.0 | 48 | N-1 | 29.1 | 75% | 48 | 83% | No constraint within +5 years | Meets Vector security criteria |
| 34 | Gulf Harbour | 9.1 | - | N-1 switched | 9.1 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 35 | Hans | 23.5 | 24 | N-1 | 12.7 | 99% | 24 | 118% | No constraint within +5 years | Meets Vector security criteria |
| 36 | Hauraki | 9.4 | - | N-1 switched | 10.0 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 37 | Helensville | 15.5 | 9 | N-1 switched | 8.5 | 172% | 9 | 105% | No constraint within +5 years | Meets Vector security criteria |
| 38 | Henderson Valley | 16.1 | 16 | N-1 switched | 21.0 | 101% | 16 | 106% | No constraint within +5 years | Meets Vector security criteria |
| 39 | Highbrook | 8.8 | 23 | N-1 | 0.0 | 38% | 23 | 53% | No constraint within +5 years | Meets Vector security criteria |
| 40 | Highbury | 12.8 | - | N-1 switched | 14.7 | - | - | | No constraint within +5 years | Meets Vector security criteria |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | | Hillcrest | 21.0 | 24 | N-1 | 17.5 | 88% | 24 | 96% | No constraint within +5 years | Meets Vector security criteria |
| 42 | | Hillsborough | 16.7 | 24 | N-1 | 12.4 | 71% | 24 | 74% | No constraint within +5 years | Meets Vector security criteria |
| 43 | | Hobson 110/11kV | 15.3 | 25 | N-1 | 13.1 | 61% | 25 | 61% | No constraint within +5 years | Meets Vector security criteria. New load to be connected to 22kV distribution network |
| 44 | | Hobson 22/11kV | 14.4 | 18 | N-1 | 8.9 | 80% | 18 | 91% | No constraint within +5 years | Meets Vector security criteria. New load to be connected to 22kV distribution network |
| 45 | | Hobson 22kV | 48.2 | 80 | N-1 | 45.5 | 60% | 80 | 82% | No constraint within +5 years | Constraint relieved by CBD subtransmission reinforcement and planned load transfer to Liverpool |
| 46 | | Hobsonville | 12.2 | 16 | N-1 | 11.0 | 76% | 16 | 116% | No constraint within +5 years | Meets Vector security criteria |
| 47 | | Hobsonville Point | 12.8 | - | N | 7.5 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 48 | | Howick | 34.0 | 48 | N-1 | 16.3 | 71% | 48 | 87% | No constraint within +5 years | Meets Vector security criteria |
| 49 | | James Street | 12.6 | 16 | N-1 | 19.5 | 79% | 16 | 126% | No constraint within +5 years | Meets Vector security criteria |
| 50 | | Kaukapakapa | 4.4 | - | N-1 switched | 4.4 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 51 | | Keeling Road | 15.0 | - | N-1 switched | 15.6 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 52 | | Kingsland | 25.3 | 24 | N-1 switched | 22.9 | 105% | 24 | 111% | No constraint within +5 years | Meets Vector security criteria |
| 53 | | Laingholm | 9.3 | 9 | N-1 switched | 10.7 | 103% | 9 | 97% | No constraint within +5 years | Meets Vector security criteria |
| 54 | | Lichfield | 16.5 | 20 | N-1 | 0.0 | 88% | 20 | 88% | No constraint within +5 years | Meets Vector security criteria |
| 55 | | Liverpool | 26.3 | 48 | N-1 | 22.5 | 55% | 48 | 73% | No constraint within +5 years | Meets Vector security criteria. New load to be connected to 22kV distribution network |
| 56 | | Liverpool 22kV | 85.7 | 100 | N-1 | 53.8 | 86% | 150 | 69% | No constraint within +5 years | Constraint to be relieved by transformer capacity upgrade |
| 57 | | Mangere Central | 33.4 | 48 | N-1 | 19.3 | 70% | 48 | 68% | No constraint within +5 years | Constraint relieved by the installation of the third transformer |
| 58 | | Mangere East | 25.0 | 24 | N-1 switched | 24.6 | 104% | 24 | 131% | No constraint within +5 years | Constraint relieved by load transfer to Mangere Central substation |
| 59 | | Mangere West | 22.0 | 30 | N-1 | 5.2 | 73% | 30 | 103% | No constraint within +5 years | Constraint relieved by load transfer to Mangere Central substation and planned new Mangere South substation |
| 60 | | Manly | 19.8 | 14 | N-1 switched | 13.1 | 141% | 14 | 137% | No constraint within +5 years | Meets Vector security criteria |
| 61 | | Manukau | 27.0 | 48 | N-1 | 25.8 | 56% | 48 | 68% | No constraint within +5 years | Meets Vector security criteria |
| 62 | | Manurewa | 45.0 | 48 | N-1 | 34.2 | 94% | 48 | 109% | No constraint within +5 years | Meets Vector security criteria |
| 63 | | Maraetai | 7.8 | 18 | N-1 | 4.3 | 43% | 18 | 54% | No constraint within +5 years | Meets Vector security criteria |
| 64 | | McKinnon | 17.7 | 24 | N-1 | 10.9 | 74% | 24 | 85% | No constraint within +5 years | Meets Vector security criteria |
| 65 | | Mcleod Road | 9.9 | - | N-1 switched | 10.1 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 66 | | McNab | 43.3 | 48 | N-1 | 30.2 | 90% | 48 | 87% | No constraint within +5 years | Meets Vector security criteria |
| 67 | | Milford | 7.2 | - | N-1 switched | 7.7 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 68 | | Mt Albert | 8.1 | - | N-1 switched | 12.6 | - | - | | No constraint within +5 years | Meets Vector security criteria due to sufficient 11kV backup. Transformer to be replaced |
| 69 | | Mt Wellington | 19.2 | 24 | N-1 | 15.2 | 80% | 24 | 88% | No constraint within +5 years | Meets Vector security criteria |
| 70 | | New Lynn | 13.6 | 14 | N-1 | 11.0 | 97% | 14 | 108% | No constraint within +5 years | Meets Vector security criteria |
| 71 | | Newmarket | 39.6 | 46 | N-1 | 30.5 | 86% | 46 | 103% | No constraint within +5 years | Meets Vector security criteria |
| 72 | | Newton | 22.0 | 19 | N-1 switched | 19.7 | 116% | 19 | 137% | No constraint within +5 years | Meets Vector security criteria |
| 73 | | Ngataringa Bay | 7.6 | - | N | 6.1 | - | - | | No constraint within +5 years | Constraint relieved by the installation of cables |
| 74 | | Northcote | 5.9 | - | N-1 switched | 6.1 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 75 | | Onehunga | 16.0 | 15 | N-1 switched | 12.6 | 109% | 24 | 72% | No constraint within +5 years | Meets Vector security criteria due to sufficient 11kV backup. Capacity to increase due to planned subtran cable replacement |
| 76 | | Orakei | 26.3 | 22 | N-1 switched | 16.0 | 122% | 22 | 113% | No constraint within +5 years | Meets Vector security criteria |
| 77 | | Oratia | 5.4 | - | N-1 switched | 6.5 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 78 | | Orewa | 17.6 | 22 | N-1 | 9.0 | 79% | 24 | 87% | No constraint within +5 years | Meets Vector security criteria |
| 79 | | Otara | 29.9 | 36 | N-1 | 26.6 | 83% | 36 | 79% | No constraint within +5 years | Meets Vector security criteria |
| 80 | | Pacific Steel | 23.5 | 42 | N-1 | #N/A | 56% | 42 | 45% | No constraint within +5 years | Meets Vector security criteria |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 81 | Pakuranga | 20.0 | 24 | N-1 | 16.3 | 83% | 24 | 90% | No constraint within +5 years | Meets Vector security criteria |
| 82 | Papakura | 25.0 | 23 | N-1 switched | 10.7 | 107% | 23 | 120% | No constraint within +5 years | Meets Vector security criteria |
| 83 | Parnell | 11.8 | 18 | N-1 | 16.0 | 66% | 18 | 66% | No constraint within +5 years | Meets Vector security criteria |
| 84 | Ponsonby | 15.3 | 14 | N-1 switched | 13.4 | 106% | 14 | 106% | No constraint within +5 years | Meets Vector security criteria |
| 85 | Quay | 20.8 | 24 | N-1 | 17.3 | 87% | 24 | 97% | No constraint within +5 years | Meets Vector security criteria. CBD new load to be connected to 22kV distribution network |
| 86 | Quay 22kV | 41.8 | 60 | N-1 | 27.1 | 70% | 60 | 90% | No constraint within +5 years | Meets Vector security criteria |
| 87 | Ranui | 11.1 | - | N-1 switched | 12.4 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 88 | Red Beach | 21.2 | 23 | N-1 | 12.1 | 93% | 23 | 109% | No constraint within +5 years | Meets Vector security criteria |
| 89 | Remuera | 27.4 | 24 | N-1 switched | 24.1 | 114% | 24 | 117% | No constraint within +5 years | Meets Vector security criteria |
| 90 | Riverhead | 12.0 | 9 | N-1 switched | 8.1 | 133% | 9 | 142% | No constraint within +5 years | Meets Vector security criteria |
| 91 | Rockfield | 21.4 | 24 | N-1 | 19.5 | 89% | 24 | 90% | No constraint within +5 years | Meets Vector security criteria |
| 92 | Rosebank | 21.6 | 22 | N-1 | 9.3 | 100% | 22 | 102% | No constraint within +5 years | Meets Vector security criteria |
| 93 | Rosedale | 13.9 | 24 | N-1 | 12.6 | 58% | 24 | 76% | No constraint within +5 years | Meets Vector security criteria |
| 94 | Sabulite Road | 22.0 | 14 | N-1 switched | 16.6 | 157% | 14 | 156% | No constraint within +5 years | Meets Vector security criteria |
| 95 | Sandringham | 23.6 | 24 | N-1 | 21.1 | 98% | 24 | 116% | No constraint within +5 years | Meets Vector security criteria |
| 96 | Simpson Road | 5.5 | - | N-1 switched | 5.5 | - | - | | No constraint within +5 years | Constraint relieved by the installation of the second transformer at Swanson ZS |
| 97 | Snells Beach | 7.8 | - | N-1 switched | 13.3 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 98 | South Howick | 25.0 | 18 | N-1 switched | 21.7 | 139% | 18 | 116% | No constraint within +5 years | Meets Vector security criteria |
| 99 | Spur Road | 12.7 | - | N-1 switched | 14.8 | - | 24 | 77% | No constraint within +5 years | Constraint relieved by the installation of the second transformer |
| 100 | St Heliers | 21.8 | 21 | N-1 switched | 18.6 | 104% | 21 | 105% | No constraint within +5 years | Meets Vector security criteria |
| 101 | St Johns | 17.8 | 24 | N-1 | 33.7 | 74% | 24 | 85% | No constraint within +5 years | Meets Vector security criteria |
| 102 | Sunset Road | 15.5 | 14 | N-1 switched | 12.0 | 111% | 14 | 111% | No constraint within +5 years | Meets Vector security criteria |
| 103 | Swanson | 11.7 | - | N-1 switched | 11.7 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 104 | Sylvia Park | 18.1 | 24 | N-1 | 9.1 | 75% | 24 | 78% | No constraint within +5 years | Meets Vector security criteria |
| 105 | Takanini | 18.0 | 18 | N-1 | 13.5 | 100% | 18 | 110% | No constraint within +5 years | Constraint relieved by transformer capacity upgrade |
| 106 | Takapuna | 8.2 | - | N | 7.7 | - | 24 | 44% | No constraint within +5 years | Constraint relieved by the installation of the second transformer |
| 107 | Te Atatu | 22.4 | 14 | N-1 switched | 11.3 | 160% | 24 | 91% | No constraint within +5 years | Meets Vector security criteria |
| 108 | Te Papapa | 23.9 | 23 | N-1 switched | 14.7 | 106% | 23 | 96% | No constraint within +5 years | Meets Vector security criteria |
| 109 | Torbay | 10.3 | - | N-1 switched | 10.3 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 110 | Triangle Road | 16.1 | 12 | N-1 switched | 14.7 | 134% | 18 | 110% | No constraint within +5 years | Meets Vector security criteria |
| 111 | Victoria | 23.0 | 22 | N-1 switched | 15.2 | 105% | 22 | 100% | No constraint within +5 years | Meets Vector security criteria due to sufficient 11kV backup. New load to be connected to 22kV distribution network |
| 112 | Waiake | 8.6 | - | N-1 switched | 10.1 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 113 | Waiheke | 10.0 | 15 | N-1 | 2.1 | 67% | 15 | 77% | No constraint within +5 years | Meets Vector security criteria |
| 114 | Waikaukau | 7.4 | - | N-1 switched | 7.7 | - | - | | No constraint within +5 years | Meets Vector security criteria |
| 115 | Waimauku | 11.9 | - | N | 10.8 | - | 18 | 71% | No constraint within +5 years | Constraint relieved initially by the installation of 2 voltage regulators; long-term solutions include the Whenuapai zone substation or a 2nd 33kV circuit to Waimauku |
| 116 | Wairau Road | 17.1 | 16 | N-1 switched | 16.4 | 107% | 16 | 109% | No constraint within +5 years | Meets Vector security criteria |
| 117 | Warkworth | 21.7 | 18 | N-1 switched | 14.1 | 121% | 18 | 134% | No constraint within +5 years | Meets Vector security criteria |
| 118 | Wellsford | 8.1 | 9 | N-1 | 5.1 | 90% | 9 | 98% | No constraint within +5 years | Meets Vector security criteria |
| 119 | Westfield | 27.2 | 24 | N-1 switched | 21.0 | 113% | 24 | 125% | No constraint within +5 years | Meets Vector security criteria |
| 120 | Westgate | 9.8 | 24 | N-1 | 6.7 | 41% | 24 | 73% | No constraint within +5 years | Meets Vector security criteria |
| 121 | White Swan | 29.2 | 32 | N-1 | 17.1 | 91% | 32 | 93% | No constraint within +5 years | Meets Vector security criteria |
| 122 | Wiri | 42.0 | 48 | N-1 | 20.2 | 88% | 48 | 100% | No constraint within +5 years | 11kV constraint and future Wiri zone substation consraint relieved by new Wiri West substation |
| 123 | Woodford | 8.4 | - | N-1 switched | 10.7 | - | - | | No constraint within +5 years | Meets Vector security criteria |

124 **12b(ii): Transformer Capacity**

| | | |
|---|---|---|
| 125 | | (MVA) |
| 126 | Distribution transformer capacity (EDB owned) | |
| 127 | Distribution transformer capacity (Non-EDB owned) | |
| 128 | **Total distribution transformer capacity** | |
| 129 | | |
| 130 | **Zone substation transformer capacity** | |

# 17.10 Appendix 10 – Forecast Network Demand (Schedule 12c)

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |

## SCHEDULE 12C: REPORT ON FORECAST NETWORK DEMAND

This schedule requires a forecast of new connections (by consumer type), peak demand and energy volumes for the disclosure year and a 5 year planning period. The forecasts should be consistent with the supporting information set out in the AMP as well as the assumptions used in developing the expenditure forecasts in Schedule 11a and Schedule 11b and the capacity and utilisation forecasts in Schedule 12b.

| *sch ref* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *7* | **12c(i): Consumer Connections** | | | | | | | |
| *8* | *Number of ICPs connected in 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 21** | **31 Mar 22** | **31 Mar 23** | **31 Mar 24** | **31 Mar 25** | **31 Mar 26** |
| *11* | *Consumer types defined by EDB** | | | | | | | |
| *12* | Residential & Small Medium Enterprise (SME) | | 13,279 | 11,461 | 9,796 | 9,796 | 9,796 | 9,917 |
| *13* | Industrial & Commercial | | 131 | 86 | 86 | 86 | 86 | 99 |
| *14* | [EDB consumer type] | | | | | | | |
| *15* | [EDB consumer type] | | | | | | | |
| *16* | [EDB consumer type] | | | | | | | |
| *17* | **Connections total** | | 13,410 | 11,547 | 9,882 | 9,882 | 9,882 | 10,016 |
| *18* | **include additional rows if needed* | | | | | | | |
| *19* | **Distributed generation** | | | | | | | |
| *20* | Number of connections | | | | | | | |
| *21* | Installed connection capacity of distributed generation (MVA) | | | | | | | |
| *22* | **12c(ii) System Demand** | | | | | | | |
| *23* | | | *Current Year CY* | *CY+1* | *CY+2* | *CY+3* | *CY+4* | *CY+5* |
| *24* | **Maximum coincident system demand (MW)** | for year ended | **31 Mar 21** | **31 Mar 22** | **31 Mar 23** | **31 Mar 24** | **31 Mar 25** | **31 Mar 26** |
| *25* | GXP demand | | 1,739 | 1,770 | 1,800 | 1,826 | 1,881 | 1,916 |
| *26* | *plus* Distributed generation output at HV and above | | 16 | 16 | 16 | 16 | 16 | 16 |
| *27* | **Maximum coincident system demand** | | 1,755 | 1,786 | 1,816 | 1,842 | 1,897 | 1,932 |
| *28* | *less* Net transfers to (from) other EDBs at HV and above | | - | - | - | - | - | - |
| *29* | **Demand on system for supply to consumers' connection points** | | 1,755 | 1,786 | 1,816 | 1,842 | 1,897 | 1,932 |
| *30* | **Electricity volumes carried (GWh)** | | | | | | | |
| *31* | Electricity supplied from GXPs | | 8,447 | 8,894 | 8,578 | 8,535 | 8,491 | 8,517 |
| *32* | *less* Electricity exports to GXPs | | | | | | | |
| *33* | *plus* Electricity supplied from distributed generation | | 136 | 136 | 136 | 136 | 136 | 136 |
| *34* | *less* Net electricity supplied to (from) other EDBs | | | | | | | |
| *35* | **Electricity entering system for supply to ICPs** | | 8,583 | 9,030 | 8,714 | 8,671 | 8,627 | 8,653 |
| *36* | *less* Total energy delivered to ICPs | | 8,261 | 8,691 | 8,387 | 8,346 | 8,303 | 8,328 |
| *37* | **Losses** | | 322 | 339 | 327 | 325 | 324 | 325 |
| *38* | | | | | | | | |
| *39* | **Load factor** | | 56% | 58% | 55% | 54% | 52% | 51% |
| *40* | **Loss ratio** | | 3.8% | 3.8% | 3.8% | 3.7% | 3.8% | 3.8% |

# 17.11 Appendix 11 – Forecast Interruptions and Duration (Schedule 12d)

*Company Name* **Vector Limited**
*AMP Planning Period* **1 April 2021 – 31 March 2031**
*Network / Sub-network Name* **Vector Limited**

## SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

This schedule requires a forecast of SAIFI and SAIDI for disclosure and a 5 year planning period. The forecasts should be consistent with the supporting information set out in the AMP as well as the assumed impact of planned and unplanned SAIFI and SAIDI on the expenditures forecast provided in Schedule 11a and Schedule 11b.

| *sch ref* | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|---|
| 9 | for year ended | 30 Jun 21 | 30 Jun 22 | 30 Jun 23 | 30 Jun 24 | 30 Jun 25 | 30 Jun 26 |
| 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 2021 – 31 March 2031**
*Network / Sub-network Name* **Southern Network**

## SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

This schedule requires a forecast of SAIFI and SAIDI for disclosure and a 5 year planning period. The forecasts should be consistent with the supporting information set out in the AMP as well as the assumed impact of planned and

| *sch ref* | | Current Year CY | CY+1 | CY+2 | CY+3 | CY+4 | CY+5 |
|---|---|---|---|---|---|---|---|
| 9 | for year ended | 30 Jun 21 | 30 Jun 22 | 30 Jun 23 | 30 Jun 24 | 30 Jun 25 | 30 Jun 26 |
| 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 2021 – 31 March 2031** |
| *Network / Sub-network Name* | **Northern Network** |

## SCHEDULE 12d: REPORT FORECAST INTERRUPTIONS AND DURATION

This schedule requires a forecast of SAIFI and SAIDI for disclosure and a 5 year planning period. The forecasts should be consistent with the supporting information set out in the AMP as well as the assumed impact of planned and

| *sch ref* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *8* | | | *Current Year CY* | *CY+1* | *CY+2* | *CY+3* | *CY+4* | *CY+5* |
| *9* | | for year ended | **30 Jun 21** | **30 Jun 22** | **30 Jun 23** | **30 Jun 24** | **30 Jun 25** | **30 Jun 26** |
| *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 2021 – 31 March 2031** |
| *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 January 2021, 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 | 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 | 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. | | 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 | 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | Asset management plans (AMP) are 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). |
| 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. | | 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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)?<br><br>(Note this is about resources and enabling support) | 3 | Vector has a process to optimise proposed projects to improve cost effective delivery. Regular meetings with FSPs are held to identify any potential resource constraints for capital and maintenance programmes. Specialised resources are employed as required such as the RMA specialist. | | 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 | Event management processes and contingency plans are in place for emergency events, business continuity, supply restoration, response to natural disasters, health, safety and environmental events. Regular reviews of events are conducted weekly, in addition to an annual emergency exercise that is performed to test response preparedness. | | 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. |
| 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 | As defined in the AMP, the COO - Electricity Gas & Fibre has overall responsibility for Vector's Network Asset Management. The Heads of Network Performance, Chief Engineer, Field Services, Capital Programme Delivery, Customer Excellence and Commercial Strategy all report to the COO and with appropriate authorities for delivering various parts of the asset management policy and plan. External Field Services Providers have a good understanding of their roles in the delivery of asset management strategy, 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | Vector utilises external FSP's and consultants to supplement internal resources to help deliver on its AMP. Specialist consultants provide advice on project management, engineering and asset management. The latest development in the contracting model allows Vector to more field service resources as needed. | | 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. Latest asset management updates are communicated to the business during fortnightly EGF team meetings | | 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 | Maintenance, design and planning standards have been developed which together, with the controls established in the commercial contracts with the service providers, ensure that the KPI's established are being monitored and deficiencies addressed. Maintenance information is collected and stored in SAP-PM. The requirements and performance expectations are communicated through well-established communications mechanisms. Dedicated field assessors provide assurance against these standards. | | 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | An HR strategy is in place to align competencies and human resources with Vector's AMP and strategy. Core competencies are identified in the job design process and included in our job profiles / position descriptions.<br><br>HR Plans for monitoring development and availability of resources by encouraging on-the-job learning, through financial support for formal learning and the investment of time and energy into the career development framework for our employees, thus solidifying the bond between employee and the organisation. | | 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 | Core competencies are identified in the job design process and included in our job profiles / position descriptions. Competency is regularly reviewed against the requirements of the job profile and training needs identified.<br><br>The competency requirements and associated training requirements (e.g. Worker Type Competency (WTC) are well established for safety critical activities across Vector and Vector's FSP's. Individuals, when recruited, have their competency assessed against the job skill requirements. Training needs are identified and agreed. Training achieved is recorded in Vector's learning management system. | | 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | The competency requirements and associated training requirements are well established for all persons carrying out asset management related activities across both FSP's and Vector. These are assessed regularly and the currency monitored. | | 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. |
| 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 | Effective two-way communication channels are in place for staff and other stakeholders in the form of group presentations / meetings (electricity, gas and fibre), internal comms video updates, dashboards, reporting, standards, meetings and additional information on Vector's web site. In addition, the FSPs have direct access to a suite of controlled technical standards and pertinent systems, such as Infonet, GIS and SAP. The effectiveness of these are reviewed and monitored regularly. Regular operational meetings are held with the FSPs to review the delivery of the annual plans and identify any areas for improvement. | | 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 | The AMP is approved by the Board and widely communicated to internal and external stakeholders, including FSPs. In addition, a comprehensive set of design, maintenance and operating standards have been established.<br><br>Enhancements to Vector's asset management framework and system is underway. | | 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. |

| | |
|---|---|
| *Company Name* | Vector Limited |
| *AMP Planning Period* | 1 April 2021 – 31 March 2031 |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | Asset Management Systems have been developed but are evolving further. This includes further collection and analysis of data and improving the utilisation of SAP for asset lifecycle information. A data analytics team has been established to deliver consistent and relevant information needed for quality decision-making. A data standard has been developed to ensure the data standards align with the business requirements for information. An Enterprise Information Management team has been established to ensure the requirements for data and data quality improvement are | | 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.<br><br>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 | Controls have been developed to manage Asset Master Data (physical asset data) across all systems. These controls are being revised and aligned with the design and construction standards. In addition, data QA and QC processes are being implemented for all maintenance data, across the PM lifecycle. SAP-PM has been developed for integration interfaces to ensure a standardised data model and standardised method of serving and consuming maintenance related data. | | The response to the questions is progressive. A higher scale cannot be awarded without achieving the requirements of the lower scale.<br><br>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. |
| 64 | Information management | How has the organisation's ensured its asset management information system is relevant to its needs? | 3 | A broad range of network operations and asset management data is available through PowerBI dashboards and SAP PM for all staff and stakeholders. A dedicated Operational Information and Insights team has been established to ensure that information and data align with asset management requirements and user needs. | | 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. |

| | | | |
|---|---|---|---|
| | | Company Name | Vector Limited |
| | | AMP Planning Period | 1 April 2021 – 31 March 2031 |
| | | 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 |
|---|---|---|---|---|---|---|---|---|
| 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 | Processes of identification and assessment of asset related risks across the asset lifecycle are defined by the Network Risk Management Process document. Supporting systems such as Active Risk Manager (ARM) and Failure Mode and Effects Analysis (FMEA) are used to assess and document asset related risks throughout the lifecycle as defined by the process. | | 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 | Risk assessments are used to support asset management decisions associated with asset management strategies and plans, and the prioritisation and allocation of resources, budget and activities. The influence of risk management is well documented in Vector's asset strategy documentation. | | 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 | The business has a regulatory and HSQE team that advises the business of its obligations and monitors compliance. Regulatory changes are assessed and corresponding changes are made to business operating procedures and practices. In addition, Vector's asset management is also subject to external audit e.g. asset management system audits. | | 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 |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | A suite of technical standards form the basis of Vector's control and management of its network assets. These are supported by the AMP, a maintenance plan and good project and operations management. The effective management of associated projects, budgets and high level work plans are monitored against the expectations established in the AMP.<br><br>The newly implemented SAP-PM significantly improves the visibility of AM deliverables. This will ensure that activities are completed when required, results recorded consistently and improve the ability to effectively audit, report on and monitor over the lifecycle of the asset. | | 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 | A suite of maintenance standards has been deployed with specific data requirements and standards.<br><br>The newly implemented SAP-PM significantly improves the visibility of AM deliverables. This will ensure that activities are completed when required, results recorded consistently and improve the ability to effectively audit, report on and monitor over the lifecycle of the asset.<br><br>Further improvements are being developed in the form of audits and better continuous improvement processes. These proposed improvements will support alignment with ISO 55000 and industry best practice. | | 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. |

| | |
|---|---|
| *Company Name* | **Vector Limited** |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 95 | Performance and condition monitoring | How does the organisation measure the performance and condition of its assets? | 3 | Service levels, asset condition and performance information are consistently gathered and reviewed. Various BI reports have been created to monitor key performance indicators and actions based on condition and performance information. Vector has also adopted a condition based risk management approach to its asset management with the support of information from SAP PM to form the leading indicators used to improve the asset management strategy and plans. | | 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 | Vector has a Network event management process in place which defines the investigation process and responsibilities. Incidents are reported as defined by Vector's Incident Management Process. Major events are investigated systemically by the dedicated independent investigation team to ensure all risks associated with the incident are assessed and appropriate mitigation plans are developed. Ownership of the actions are defined and followed up and reported on. | | 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. |

| | | |
|---|---|---|
| *Company Name* | **Vector Limited** | |
| *AMP Planning Period* | **1 April 2021 – 31 March 2031** | |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 105 | Audit | What has the organisation done to establish procedure(s) for the audit of its asset management system (process(es))? | 2 | Vector has an established audit procedure. External and internal audits, and reviews on asset management practices are carried out on a regular basis. Field work carried out by contractors is sample audited.<br><br>Improvements to Asset Management Systems are currently being made which contains associated audit requirements.<br><br>Proposed improvements include auditing of maintenance standards to ensure they are being followed effectively by the FSP's; closer monitoring of "as built" information to improve data accuracy and the implementation of new standards and supporting information management system changes. | | 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 | Actions arising from audits, investigations, asset performance reviews, risks and legal compliance are captured in various systems and registers. Formal investigation processes are in place for major events. Root cause analysis and condition and performance reviews are being completed when needed but there is room to improve. | | 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 | Continuous improvement processes exist for the ongoing improvements to Vector's technical standards. Internal action registers are also in place to capture improvements associated risks, audits and asset performance reviews. Optimisation improvements across risk, cost and performance will improve with improved data and SAP reporting, currently underway. In addition, further embedded risk thinking and assurance processes will drive continuous improvement in budgeting, strategic thinking and project optimisation. | | 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. |

| | |
|---|---|
| *Company Name* | Vector Limited |
| *AMP Planning Period* | 1 April 2021 – 31 March 2031 |
| *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 |
|---|---|---|---|---|---|---|---|---|
| 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 | Vector participates in a number of national and international 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. |

## 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)

1. 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.**

**The CGPI forecast is 2%, which is based on the 10-year compound annual growth rate to June 2020 of 2.15%.**

**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)

1. 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) December 2020 PPI (Producer Price Index-inputs) forecast up to March 2025. Thereafter, we have assumed a long-term inflation rate of 2.0%.**

**The LCI forecast is 2%, which is based on the 10-year compound annual growth rate to June 2020 of 1.83%.**

**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

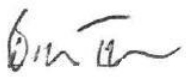
We, _____Bruce Turner_______________________________________, and

___Michael Buczkowski_______________________________________, 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

31 March 2021

_________________________

Date

vector

VECTOR.CO.NZ