Asset Management Plan

1 April 2018 to 31 March 2028

Marlborough Lines

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Summary

This Asset Management Plan (AMP) documents Marlborough Lines Limited's (ML's) processes, strategy and plans for achieving its asset management objectives. It sets out ML's Network and system assets, their condition, service levels, achieved performance, network development planning, lifecycle planning, fleet management and forecast expenditure.

The AMP commences by describing the means by which ML aligns its objectives and performance levels to the interests of its stakeholders. It then sets out the strategy and actions ML will undertake in delivering the objectives and service levels it has set. It covers the planning period from FY2019 to FY2028 (10 years). It is axiomatic that the works planned at the commencement of this AMP will be better known and costed than those at the end of the ten year period.

1.1 Highlights of this AMP

Seven key areas are highlighted in this AMP:

- works to enhance the business's duty of care in matters of public safety (including fire mitigation);
- an ongoing need to maximise energy efficiency throughout ML's operations;
- a shift in capital expenditure towards the renewal of the network - older poles and conductor;
- unchanging service targets for reliability set at current levels requiring continuation of the businesses focus on vegetation management;
- The need to address the progressive aging of assets in the remote parts of the network including the Marlborough Sounds relative to safety, reliability and continuity of supply;
- works to improve the resilience of the network to extreme events, largely arising out of its experience of the recent Kaikoura earthquake; and
- that the network is not expected to be challenged by load growth over this planning period due to its existing installed capacity levels including the potential for new loads from electric vehicles over the medium term.

1.2 Conductor Renewal

Condition and risk assessments undertaken on ML's HV conductor together with the detected commencement of conductor failure faults, has to develop through this Plan, a 15 year renewal programme of approximately 425km of ML's older galvanised steel and light copper conductor. This strategy is supported by comparative age profile analysis and represents an annual replacement rate of approximately 1.4% of the total HV overhead conductor installed length.

The aged galvanised steel and light copper conductor is generally supported on original reinforced concrete or iron rail poles. This leads to full line rebuilds when conductor replacement occurs due to changed conductor weight and the line design code requirements. This increases renewal costs but will also address replacement of older poles – iron rails in particular.

1.3 Duty of care

ML has always recognised a duty of care in its network operations. Accordingly ML has again reviewed its risk profile and this AMP includes works which further mitigate public safety risks, including fire ignition risks. In many cases planned works, such as lines renewal, address multiple drivers including network continuance, reliability, and safety and fire liability risk through reducing ML's exposure to defective equipment faults.

1.4 Consumer expectations

Through planned periodic consultation with key consumer groups and through its annual consumer satisfaction survey, ML has set unchanged reliability targets for the planning period in recognition of the consumer satisfaction reported against the present level of service reliability.

Service targets for planned and unplanned SAIDI are therefore set at 65 minutes and 80 minutes respectively. Further detail is provided within this AMP on this and other service level targets and objectives. The current level of reliability represents near frontier performance on a comparative basis given ML's network characteristics, line lengths and environmental exposure, however, continuing to perform at this level requires ML to continue with its aggressive vegetation management programme and undertake renewals to prevent an increase in the number of component faults that inevitably arise through network ageing, particularly in the remote parts of the network. This expenditure will be targeted through condition monitoring and focussed lines renewal.

1.5 Uneconomic reticulation issues

The network in the Marlborough Sounds area is extensive and problematic from a business perspective. The network in this area was originally developed to meet the regulatory requirement with the assistance to the Rural Electrification Development Council, but no assistance is available for its renewal. Under current legislation this must now be borne by ML's total consumer base effectively creating a cross subsidy between consumers.

Given the potential magnitude of this issue relative to the requirements of the network it is considered that this is a matter which should be revisited further by Government and the regulatory agencies. Due to the legal obligation for supply continuance, inability to differentially price rural and remote consumers and the practical difficulties of creating and managing, perhaps in perpetuity, alternative off-network solutions with the same level of availability, the business must now consider commencement of renewal of some of these uneconomic lines.

Allowing its remote network to deteriorate as a means of deferring expenditure is not an option as ML has the higher priority objective of operating a safe network and this may drive renewal regardless of any other service or cost objectives.

1.6 Resilience to extreme events

ML has developed plans to improve its network resilience to extreme events driven by both the 2017 re-evaluation of its network and business risks and the lessons learnt from the recent Kaikoura earthquake. This includes the relocation of Renwick zone substation away from the Wairau fault line fault trace, re-assessment of some of its assets for seismic design at the higher importance level 4 category and emphasis on the ability to share load between zone substations.

1.7 Load growth and distributed generation

Load growth within the network has been assessed within 4 planning areas determined on their load characteristics. Load changes within these areas are largely forecast to trend at constant rates driven by the steady GDP growth of the region, population trends and the observed shift toward more efficient lighting and appliances.

Whilst the installation of distributed generation within the network, wind and solar in particular, has increased significantly from levels in 2012, the levels are still small in total and a gathering rate of increase is not yet evident.

The current level of secure capacity enjoyed by the network will allow the business time to assess the effects of electric vehicle load as and when it arises. A close watch will be maintained on these new technologies to continuously assess their effects. Overall, load growth within the network is not expected to challenge the network capacity within this planning period, as further detailed in the network development section of this plan.

1.8 Energy efficiency

Energy efficiency for a lines business is mostly dictated by the degree of its network losses. ML's network losses are shown by comparative analysis to be completely consistent with other New Zealand lines businesses after consideration of its network characteristics of total line length, installed transformer capacity per consumer, and energy delivered. Other aspects of energy efficiency are managed through ML's various policies that require consideration of energy efficiency in design, purchase of equipment and plant, and operation of the network together with ancillary operations.

1.9 Cost efficiency

Cost efficiency is achieved through:

- Prudent and timely investment in both maintenance and capital expenditure.
- Ensuring that all such expenditure is incurred at minimum cost consistent with the overall requirements for the expenditure.
- Tenders are sought for all major capital purchases.
- All costs are benchmarked against alternatives.
- Internal costs are benchmarked against the same services provided externally.

Overall comparative assessment of ML's rate of return, direct operating expenditure and total cost do not indicate concern particularly given ML's circumstances of owning and operating a network with a large proportion being low density in remote locations. Irrespective ML has a programme of continuous improvement and will continue to seek betterment in its operations.

1.10 Disclosure of this AMP

This AMP is required to be publically disclosed and to provide particular information to comply with the requirements of Section 2.6 and Attachment A of the Commerce Commission's Electricity Distribution Information Disclosure Amendments Determination 2017. Regulatory disclosure schedules are included in Appendices to this plan which also includes a regulatory disclosure requirements map between the regulatory disclosure requirements and this AMP.

2. Introduction

2.1 Purpose of this AMP

The delivery of a safe, reliable electricity supply of adequate capacity to meet consumer requirements commensurate with reasonable cost is essential for their lives, their homes and businesses. Concurrent in meeting its obligations in the delivery of electricity ML recognises its responsibilities not only to consumers but to its staff, contractors and the public to ensure that all practicable steps are taken to ensure all components of the network are safe and all parties are kept free from harm.

It is a requirement of the Energy Companies Act 1993 that ML has regard to energy efficiency and this aspect is considered fundamental in all aspects of ML's operations and is integral to the considerations within this AMP.

ML recognises that it has an obligation to not only have regard to energy efficiency but the overall efficiency of its operations.

Accordingly, within ML there is a commitment to continuous improvement.

ML has achieved certification of internationally recognised standards which are an integral part of its operations including management (ISO 9001), environment (ISO 14001), health and safety (ISO 18001) and public safety (NZS 7901).

Achievement of these international standards is indicative of ML's commitment towards achieving excellence but it is considered the ultimate means of maximising performance within ML is through a culture of seeking quality in all that is undertaken.

This AMP provides an overall strategy which will enable ML to meet its identified objectives over the next ten years and beyond.

2.2 Basis of AMP

This AMP documents ML's asset management strategy and objectives for its asset management processes. It sets out the assets, their condition, service levels, achieved performance, network development planning, lifecycle planning, fleet management and forecast expenditure. More specifically, this AMP provides detail on how ML:

- maintains and operates all assets in a safe manner to safeguard the health and welfare of staff, consumers, contractors, landowners and the general public consistent with legislative requirements and best industry practice;
- optimises energy efficiency relative to costs and practical considerations;
- sets service levels for its network that will meet consumer, community, other stakeholder and regulatory requirements;
- understands the levels of network capacity, reliability and security of supply required now and in the future, as well as the issues that drive these requirements;
- have robust and transparent processes in place for managing all phases of the network life cycle from initial concept to disposal;
- adequately considers the classes of risk relative to its network business, and ensures there are processes in place to mitigate identified risks;

- makes adequate provision for funding and resourcing all phases of the life cycle of its network assets;
- makes decisions within structured frameworks at each level within the asset management process; and
- increases its knowledge of its assets in terms of location, age, condition and the likely future behaviour of the overall network as it ages.

This AMP is the key strategic document used by ML as part of the asset management system. Disclosure of this AMP also assists ML in complying with the requirements of Section 2.6 and Attachment A of the Commerce Commission's Electricity Distribution Information Disclosure Amendments Determination 2017.

This AMP is limited to ML's network business only, not the wider ML group which also includes the following entities:

- a 50% stake in Nelson Electricity, which has its own AMP and is independently disclosed; and
- an 86% stake in Yealands Wine Group Holdings Limited, which is independently managed and audited.

The interrelationship of these entities along with the various holding companies and other investments by ML, details of shareholders, together with ML's financial accounts is provided on ML's website and within its Annual Report.

2.3 Key stakeholders and objectives

ML's key stakeholders are:

- Its Trust owner;
- the public within its region;
- in excess of 25,000 [1] individual connection points (ICPs, or consumers) to whom ML delivers electricity some of whom receive supply at 11kV;
- generators who are directly connected and embedded within the network and produce electricity for use by others;
- the (currently) 19[1] electricity retailers who operate over our network;
- the territorial authorities, the NZTA and other government agencies who ML engage with; and
- the ML staff and contractors who work in or on our network.

The interests of these and other stakeholders is assessed through stakeholder engagement that forms the driving objectives for the strategy, plans and actions set out in this AMP. These objectives are generally expressed through compliance achievement and measurable service level targets set within this plan.

This publically disclosed AMP also serves as a means of communicating ML's intentions to its stakeholders.

[1] The ICP and retailer numbers are based on data from 28 February 2018.

2.4 Link to other documents

Other documents related to this AMP include:

- ML's Statement of Corporate Intent (SCI), published annually and available on ML's website. This document sets ML's key strategic objectives each year including network reliability targets, consumer engagement objectives, business development goals (accreditations etc.), consumer discounts, and rate of return to shareholders. Asset related objectives in the SCI are encapsulated within this AMP to ensure achievement.
- ML's annual report, which discloses the accounting position and reports on the business performance against budget and on SCI objectives achievement.
- The regulatory disclosures (schedules 1 to 10) to the Commerce Commission.
- The ML annual works plan aligned to the first year forecast of this Plan and subsequently updated for each successive year.
- The various internal standards, policies and procedures that ensure works are undertaken safely and to appropriate quality standards and in consideration of our stakeholders' wider interests.

2.5 Period covered

This AMP covers the period 1 April 2018 to 31 March 2028. This plan was adopted by the ML Board of Directors on 27 March 2018 and a statutory declaration has been made to the Commerce Commission on behalf of the ML Directorate.

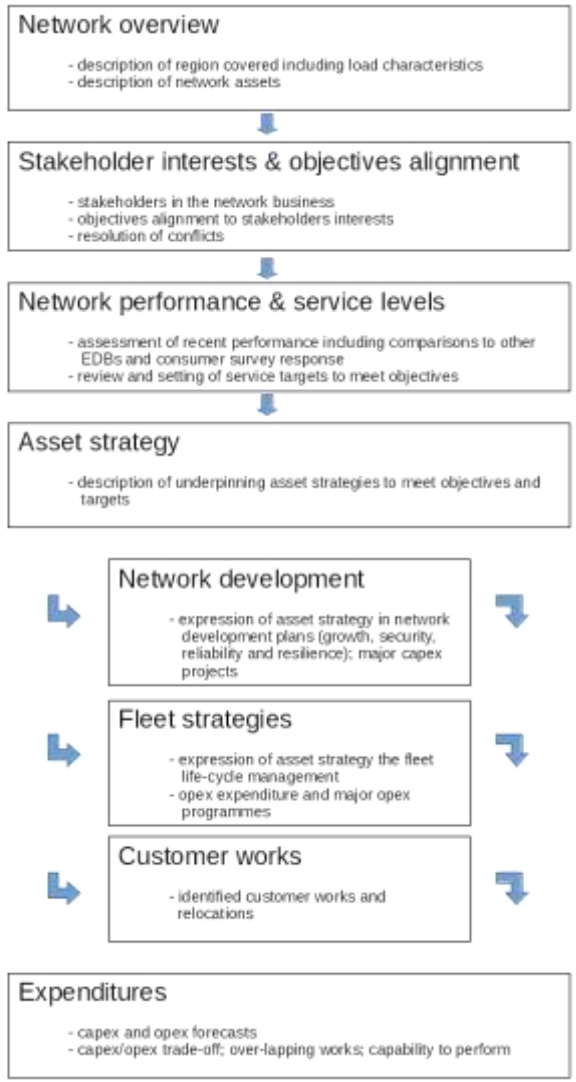


Figure 1: Overview of the structure of this AMP

2.6 Structure of this AMP

Asset management is a process of setting objectives driven by stakeholder requirements then entering a repeating cycle of measure, plan and act. This plan is therefore structured around this process. Measurable and corrective or enduring service level targets over the planning period are set through measurement of the business performance, stakeholder input and comparative assessment against other electricity distribution businesses. Planning for the achievement of the service level targets is underpinned through ML's asset strategy, with its expression in the network development plan and the life cycle fleet strategies.

Implementation of capital expenditure projects is undertaken through the annual works plan with the work guided by ML's policies and standards.

The illustration of Figure 1 sets out the structure of this plan and summarises the included content of each section together with the structural relationship between the document sections.

3. Network overview

This section provides a summary of ML's network, the region it serves and the wider context of their engagement. Specific details about the composition of ML's assets, and the work undertaken (and forecast to be undertaken) on the network itself, are presented in section 1 network development and section 9 Fleet management.

3.1 Region and context

ML's electricity network currently distributes electricity to in excess of 25,000 consumer connections with an after-diversity maximum demand (at FY2017) of 71MW. ML's consumers are predominantly domestic and small-to-medium commercial consumers with the largest consumer representing approximately 3% [of total energy delivered (374GWh).

ML's network covers the Marlborough region in the north-eastern corner of the South Island as illustrated in the map of Figure 2. The red lines show ML's 11kV distribution network.

3.1.1 Supply area characteristics

ML distributes electricity across a diverse area. This can be broken down into the main urban areas of Blenheim and Picton, Marlborough's East Coast, the Marlborough Sounds and the region's major inland valleys (Awatere, Waihopai, and Wairau).

Major consumers are typically located external to Blenheim and are located within various parts of the network, and include food processing, wineries, timber processing and manufacturing.

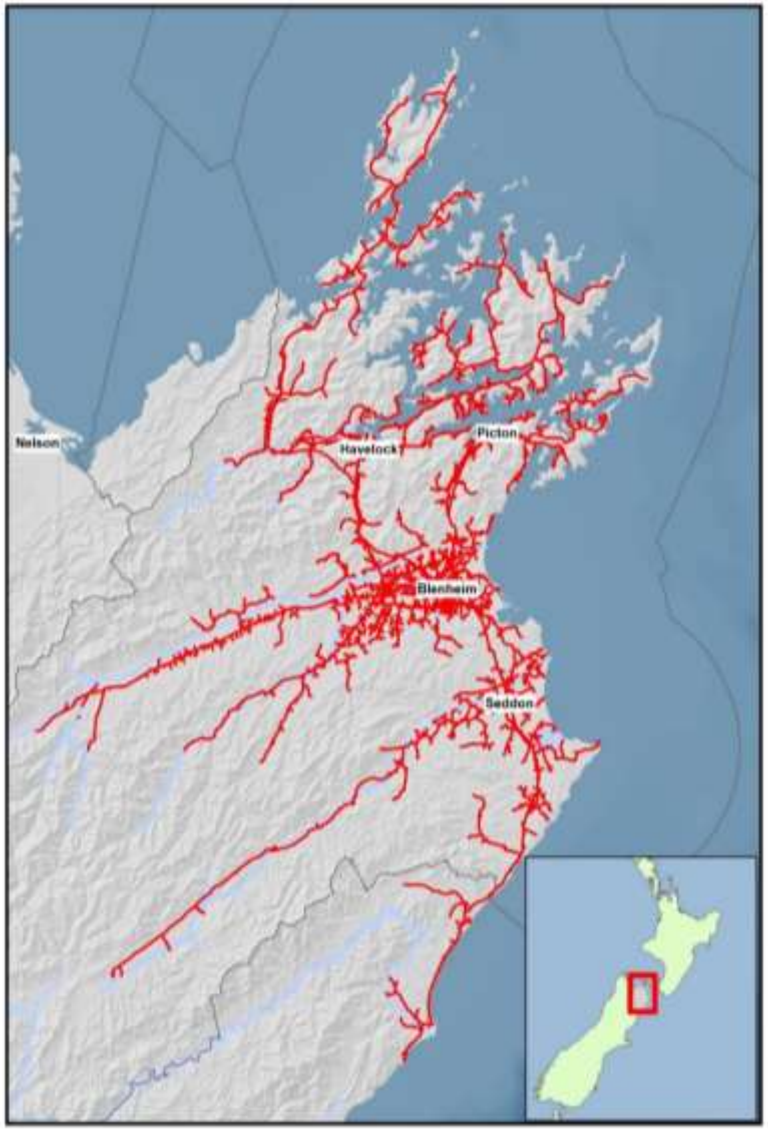


Figure 2: Extent of ML network

Most of the load is related to wineries and in recent years the processing of grapes at the time of vintage coupled with other loads has for particular years resulted in a shift of the maximum system demand from the winter months to April.

3.1.1.1 Urban Areas

Blenheim and Picton contain a mix of residential, commercial and small industrial consumers. The maximum demands are predominately a result of winter heating in homes and typically occur between 7am to 11am and 4am to 8pm on cold and/or wet days. In total, the towns of Blenheim and Picton represent approximately 60% of the total ICPs and 45% of the load. Note that the reason for a lower percentage of the load compared to consumer numbers is that there is a concentration of industrial and larger commercial consumers located in the Riverlands industrial estate east of Blenheim and other large consumers are dispersed over the network.

Residential load growth is currently static due to a range of factors including increased use of energy efficient lighting and other appliances and the use of heat pumps rather than conventional heaters etc. But this general reduction in individual consumption is to an extent offset by an increase in consumer ICP's. Typically growth in residential ICP's has been constrained by availability of residential sections.

3.1.1.2 Wairau Plains

Significant features of this area include Woodbourne airbase and airport, the Riverlands industrial estate and a substantial horticultural/agricultural area with extensive vineyards. The load tends to be driven by wine processing (late March to early May) and the need for irrigation in the vineyards (December to March). Vineyards cover a substantial area of the Wairau Plains as well as significant areas of the lower Awatere Valley.

3.1.1.3 Inland Valleys

While vineyards (and, to a much lesser degree, dairy farms) have expanded into these areas, these areas are still of low connection density and relatively low connection loadings. The inland valleys tend to be sheltered from storms and this, combined with their topography, pastoral land use and ML's lines being relatively clear of vegetation, makes supply in these valleys relatively reliable, especially given the long lengths of the radial feeders in these valleys.

Dry summer conditions and forested areas sometimes give rise to extreme fire risks in summer. ML recognise these risks in both its network design and operation as further detailed in other sections of this plan.

3.1.1.4 Marlborough Sounds

Supply in the Marlborough Sounds poses many unique operational challenges. Significant parts of the network in this area are constructed over rugged terrain with difficult access (many areas can only be reached by foot, tracked vehicle, helicopter and/or boat).

Often line spans are relatively longer in length where valleys need to be traversed and are frequently over significant vegetation. Some areas do not have any road access and can only be accessed by helicopter or boat. There are also significant spans across waterways (the largest being over 2km in length) utilised by shipping and these spans are subject to annual surveillance.

The Marlborough Sounds has a relatively high rainfall and a climate that encourages rapid vegetation growth, leading to the need for tree trimming and vegetation control on a short return basis.

Lines located near the coastal margins are subject to salt spray. These lines require higher levels of surveillance and maintenance, with special provisions required to minimise corrosion damage to conductors, to transformers, salt build-up on insulators, and spalling on concrete poles. This is particularly evident in the north western parts of the sounds where high winds are common.

The winds in the Marlborough Sounds can be extreme and accordingly the lines have to be designed, constructed and maintained properly to ensure their mechanical integrity.

ML has approximately 750km of 11kV distribution lines (in the order of 20% of the network) in the Marlborough Sounds, supplying approximately 2,500 consumers by way of 15,000kVA of distribution transformer capacity. There are on average around three consumers per km of HV line compared with close to nine consumers per km for the remainder of the network. Many of the installations in the Marlborough Sounds are holiday homes with intermittent occupation - approximately 50% of consumers in the Marlborough Sounds use less than 2,000kWh per annum and this compares to an average residential/domestic household consumption of approximately 7,500kWh per annum.

Because of the physics of electricity and supply within the Marlborough Sounds and the low consumer load factors there is an inherent low utilisation of distribution capacity. The maximum demands on the various lines supplying the Marlborough Sounds typically occur over long weekends or public holiday periods – Easter, Christmas, Queens Birthday or Labour Weekend. This holiday occupation also leads to an overall much lower diversity of demand at times of maximum load within the Marlborough Sounds.

Many parts of the Marlborough Sounds are very remote – some sites involve drive times from ML's base of up to three hours to reach. Typically the most cost effective first line of response is to utilise a helicopter.

These various factors increase both the cost of construction and operation/maintenance of the network. They also reduce the overall operating efficiency of the network relative to installed capacity. The situation is exacerbated by the fact that revenue from these consumers does not meet the costs incurred and cross subsidies are required from consumers in economic areas.

Significant issues facing ML regarding reticulation in this area are load growth and supply enhancement. Many of the existing lines are built on private or Government-owned land and constructed in the 1960s and 1970s, with access protected by wayleaves and the "existing works" provisions of the Electricity Act. ML has limited easements over line routes. Therefore, upgrades which necessitate changes to the existing layout or create an injurious effect on the land require new easements to be created. This is a difficult and time-consuming process. Any future major developments in the Marlborough Sounds area will require very careful analysis and design of both asset and non-asset (e.g. demand control) alternatives to ensure the optimal solutions are found.

In addition, environmental regulations and changes in line construction code requirements are now more stringent than when the lines were constructed. This is likely to affect the establishment (or in some cases, re-establishment) of tracks and access to lines as they are reconstructed, thereby likely increasing the time to plan and undertake works, as well as increasing cost.

A further issue with respect to lines in the Marlborough Sounds is that of supply reliability. The various lines supplying sections of the Marlborough Sounds are all radial/spur lines with no interconnection to other parts of the network. The longest has a length of some 326km.

All of these factors together with the poor economics of the Sounds reticulation will ensure that the reticulation of the Sounds will always be radial in nature.

ML has installed automatic switching devices (sectionalisers, reclosers etc) at various points along each of the radial spurs to minimise the areas affected by faults to the network. There is, however, a practical limit to the number of switching devices which can be installed. Over recent years the dedicated SCADA radio system linked to the devices has been expanded and will be further developed to enable increased remote control of switching devices within the network.

ML has installed a ground fault neutraliser at its Havelock substation in an endeavour to further reduce loss of supply during an earth fault and has plans for similar resonant earthing systems at Linkwater zone substation, which, together with the Havelock zone substation, supply a significant portion of the Marlborough Sounds.

Many areas in the Marlborough Sounds are subject to prolonged and/or intense rain and/or extreme wind events. ML has an on-going programme of vegetation control in an attempt to minimise interruptions caused by debris such as tree branches being blown across the lines. There are, however, practical limits to the amount of vegetation control which can be undertaken, particularly given the sensitive environment in which these lines are constructed and the distances that branches can be blown. In some areas the lines have been constructed in environmentally sensitive areas and in others the lines have been surrounded by forestry planted subsequent to the construction of the lines.

The Company has experienced significant disruption to the network by forestry, especially during harvesting operations or during severe storms when trees are not only blown over but in a number of cases have slid down hillsides. The current tree legislation restricts the ability of ML to proactively remove potential hazards to the lines services it provides as it only allows trimming of trees in very close proximity to the lines.

In light of the challenges in supplying the Marlborough Sounds it is not realistic to expect that reliability to consumers in this area will be the same (or similar) to that of urban areas. Lines in the Marlborough Sounds are in a remote location, cannot be duplicated, and are subject to greater economic and environmental challenges.

Supply in the Marlborough Sounds includes the aerial crossings of four navigable waterways[2] with significant spans. Each of these spans has been in service for over 30 years. Because of the arduous environment in which they operate and the frequency of shipping, it was decided to replace the existing conductors and associated hardware of the Tory

[2] Crossings of French Pass to D'Urville Island, Greville Harbour (D'Urville Island), and to Forsyth and Arapawa Islands from the South Island.

Channel (Arapawa Island) and French Pass crossings in 2013 to ensure their mechanical integrity.

The supply in the Marlborough Sounds has been constructed primarily using treated pine poles, principally because of their relatively light weight (ease to transport) and resilience to handling.

At the time of installation, these poles were anticipated to have a useful life of 35 years to 40 years. Over the years, the treated pine poles have been routinely tested and found to be in good condition. Accordingly ML now considers their useful lifespan to be in the order of 55 to 60 years although the poles are now approaching this age with much of the reticulation undertaken in the 1970s. Difficult access and the remote location mean that the cost of replacing poles in the Marlborough Sounds is markedly higher than in other areas.

The network in the Marlborough Sounds was constructed to meet the requirements of consumers and satisfy government regulation of the day but overall it is uneconomic and has to be subsidised by ML’s other consumers. It is salient that for safety reasons ML cannot allow progressive failure of lines due to loss of mechanical integrity as they age regardless of location.

3.1.1.5 East Coast

The East Coast consists of a relatively narrow strip of land running sub-parallel to the coast down to Marlborough’s southern boundary with some sparsely populated inland river valleys running typically west towards the centre of the South Island. Much of the network in this area was constructed in the late 1950s using reinforced concrete poles and copper conductors. The long radial nature of the area means there are no alternative supplies available during faults or planned outages. The low population density makes it difficult to justify the high levels of expenditure required to provide alternative supplies. Accordingly focus must be on ensuring the lines are of quality through timely maintenance together with utilisation of mobile generation. However, the sheltered nature of the land and predominantly pastoral land use, together with relatively small areas of trees and vegetation, leads to relatively high reliability of supply in this area.

3.1.1.6 Demographics and GDP

At the time of the last published Census (2013), ML’s network area had a resident population of about 43,500 people, which was a 2.0% increase from the 2006 Census. Of this population, about 23,000 live within the urban Blenheim area. Key demographic features of the resident population within ML's network area is that they are older than the national average, with a median age seven years greater than the national median, and about 21% of the population is aged over 65 years (for NZ as a whole only 14% of the population is aged over 65 years);

- significantly lower unemployment than the national average, with the most common occupational class being labouring, typically within the viticulture industry, which is almost twice the national average by percentage;
- median income slightly lower than the national median across all age groups; and
- less people involved in manufacturing with more people involved in agriculture, forestry and fishing.

The key demographic implications for ML are therefore: low population growth, lower levels of discretionary spending in the community at large, and an increasing proportion of connected consumers shifting to retirement-level incomes.

At the time of writing, the Statistics NZ GDP figures published for the Marlborough region were up to FY2016 (March year) and show a small variation around a linear 3.9% growth trend as illustrated in Figure 3. From this, ML anticipate that constant consumer connection growth at the historic average levels will continue over the planning period.

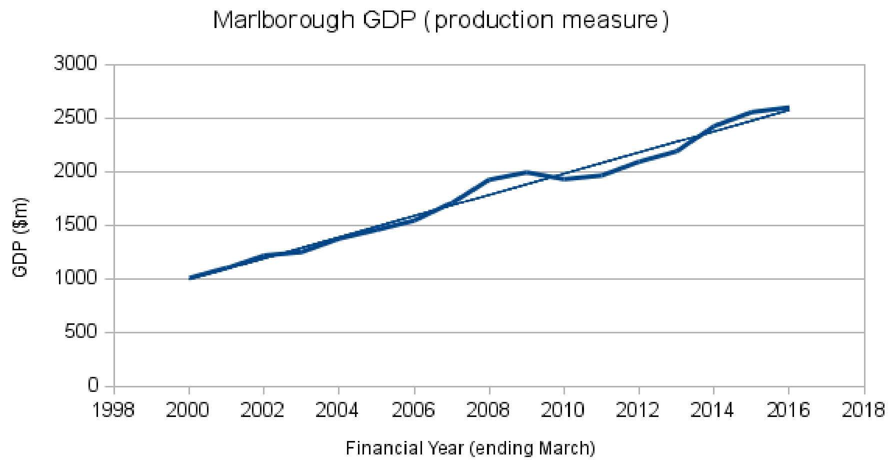


Figure 3: Marlborough GDP

3.1.1.7 Key Economic Activities

Marlborough's key economic activities include:

- viticulture and winemaking;
- aquaculture, including greenshell mussels and salmon farming;
- forestry;
- timber processing;
- food (particularly vegetable) processing;
- tourism;
- aviation (Woodbourne Air Force base and Marlborough Airport) ;
- pastoral farming;
- engineering manufacturing; and
- dairying.

The area's economy is therefore strongly influenced by:

- success of the viticulture industry and international markets for wine;
- world demand for aquaculture products, greenshell mussels and salmon;
- any sustained climate change which impacts on the viticulture or agriculture industries;
- demand for logs and processed timber;
- markets for dairy products;
- government policies on land use, particularly in relation to forestry and climate change;
- government policies on major defence installations;
- access to water for crop and stock irrigation;
- algae bloom, rough seas or sea temperature warming within shellfish farming areas; and
- the incidence and severity of frosts when grapes are flowering and the extent of rain when grapes are ready for harvest.

The impact of these issues on ML's electricity distribution business is broadly set out in Table 1:

Table 1: Economic influences and impacts on the network

Issue	Impact
Shifts in market demand for wine	Currently there is strong demand for Marlborough wine with over 80% of New Zealand's wine produced in Marlborough. All major wineries are planting more grapes. This will result in more electricity used for irrigation and processing of grapes.
Shifts in market demand for aquaculture	Currently there is strong demand for aquaculture products both greenshell mussels and salmon. The growth of these industries is constrained by the difficulties in obtaining further consents for increased areas for aquaculture. Aquaculture is a long established industry in Marlborough with considerable diversity of location of farm sites and processors. Accordingly this industry is likely to be sustainable long term with the greatest threat being the introduction of disease or adverse effects from climate change.
Shifts in market demand for timber	As with any international market demand for timber can vary but in recent years the demand for logs/timber has increased and prices are currently much higher than in earlier years. Any short term downturn within log/timber markets will result in a delay of harvesting until prices increase. Log/timber production has increased markedly in Marlborough in recent years and it is known that it is the intent of Marlborough's saw millers to increase production.
Government policy on nitrogen-based farming	May lead to contraction of dairy shed demand. May lead to contraction of dairy processing demand.
Milk prices	A return to higher prices may lead to further conversion of pastoral land to dairying and subsequent increases in demand. Current levels or reduction of prices are unlikely to have much effect unless prices fell to a level where production was uneconomic.
Climate change increases frequency of droughts	May lead to increased irrigation demand.
Government policy on defence installations	Could lead to a significant contraction of demand at a single site, followed by a knock-on decline in disposable income in the community.
Lack of generation and/or electricity supply nationally	Very unlikely in the current environment.
Increase in distributed generation including photovoltaic installation on consumer premises	This trend can be expected to continue especially as the costs reduce. This has the potential to diminish electricity distributed over the network and ultimately may necessitate changes to ML's pricing structure to ensure equity and fairness by greater recovery of costs on a fixed or capacity basis.
Major earthquake/tsunami	The likelihood of future catastrophic events are unknown but it is salient Marlborough is in an area deemed a 'high seismic zone' and is accordingly subject to earthquake risk. Depending upon the extent of an earthquake it has the potential to cause significant disruption to both Marlborough's economy particularly in relation to production and ML itself. Within practical limits ML has sought to insulate its network and operations from the effects of major disaster and has emergency preparedness plans.

Low probability outcomes are considered and addressed within ML's risk management framework. Other outcomes would be managed on a case-by-case basis as the effects arise.

3.1.1.8 Other drivers of electricity use

Other drivers of electricity use include:

- low temperatures during winter where -5°C frosts can occur in significant areas of Marlborough;
- the use of heat pumps as air conditioners in the summer time;
- increased utilisation of electricity, as polluting sources of energy, such as coal and wood are phased out; and
- charging of electric vehicles as such vehicles become more prevalent.

This AMP anticipates regional climate and appliance utilisation to exhibit similar trends to the past. ML's planning response to higher electric vehicle up-take is discussed under asset strategy but is not expected to impact the network to any significance within this planning period, largely due to existing network capacity levels, expected gradual take-up, efficient load management and electric vehicle journey efficiency.

3.1.2 Large Consumers

The nature of ML's five largest electricity consumers is summarised in Table 2:

Table 2: Our five largest consumers

Ranking by size	Nature of business	Nature of demand
1	Primary processing	Constant all year round
2	Government agency	Constant all year round
3	Winery	Cyclic with harvest season
4	Primary processing	Constant year round
5	Winery	Cyclic with harvest season

Generally the load on the network consists of a large number of smaller consumers and while the loss of any large load would affect operation of the network, the affect would be relatively minor compared to the overall effect of changes to the economy, or a decline in one of the significant regional industries. For example an overall sustained downturn in the wine industry would have a much greater effect on the operation and development of ML, than the loss or gain of two or three of the largest consumers.

Interestingly some years ago Marlborough's largest electricity consumer was a meat processing plant which had to close because of a sustained downturn in lamb production in Marlborough. But the electrical load of the ICP's which have become established on this site has far surpassed the demand of the previous meat processing plant.

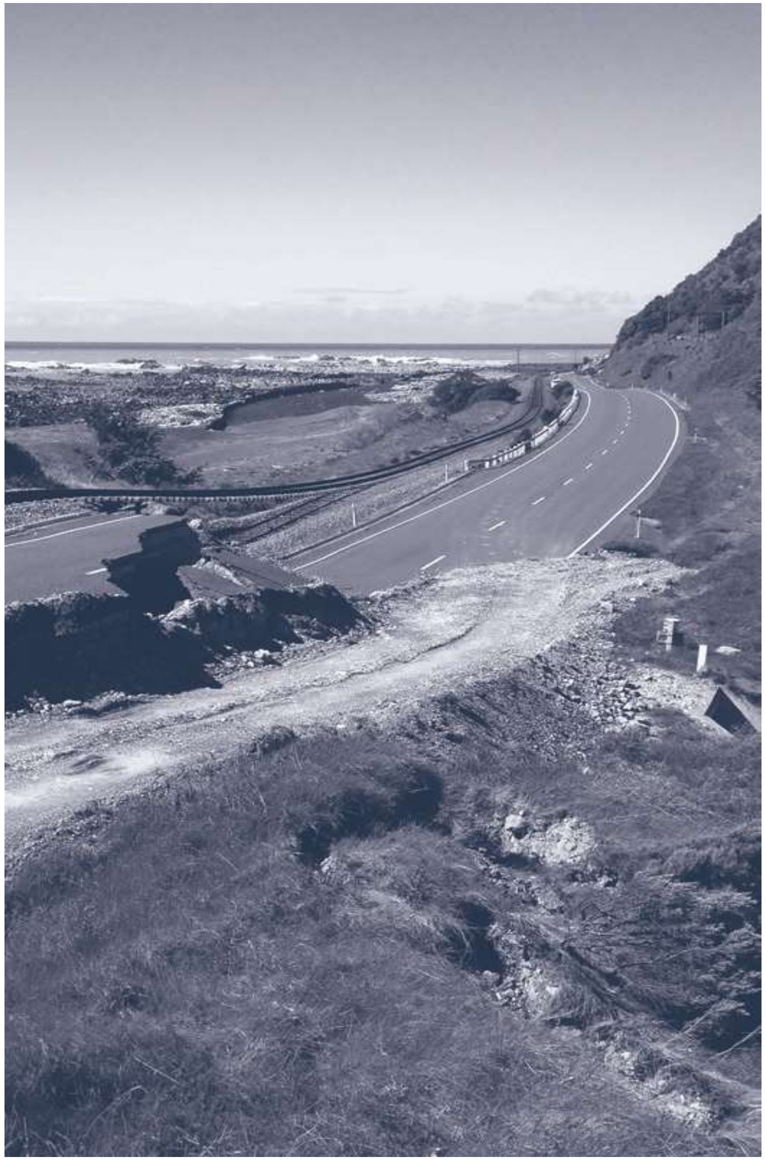
3.1.3 Regional Risks

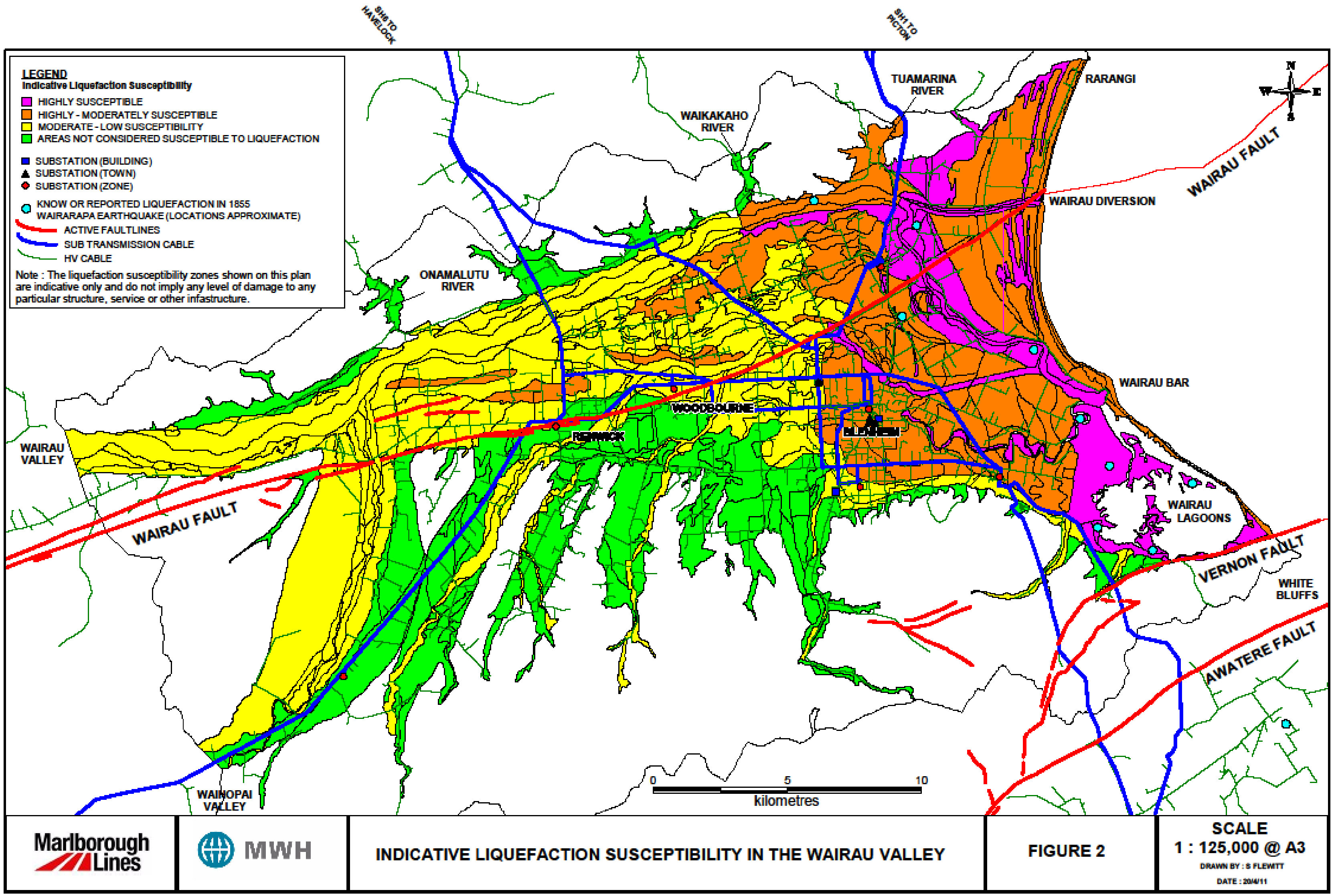
3.1.3.1 Earthquake (including liquefaction and tsunami)

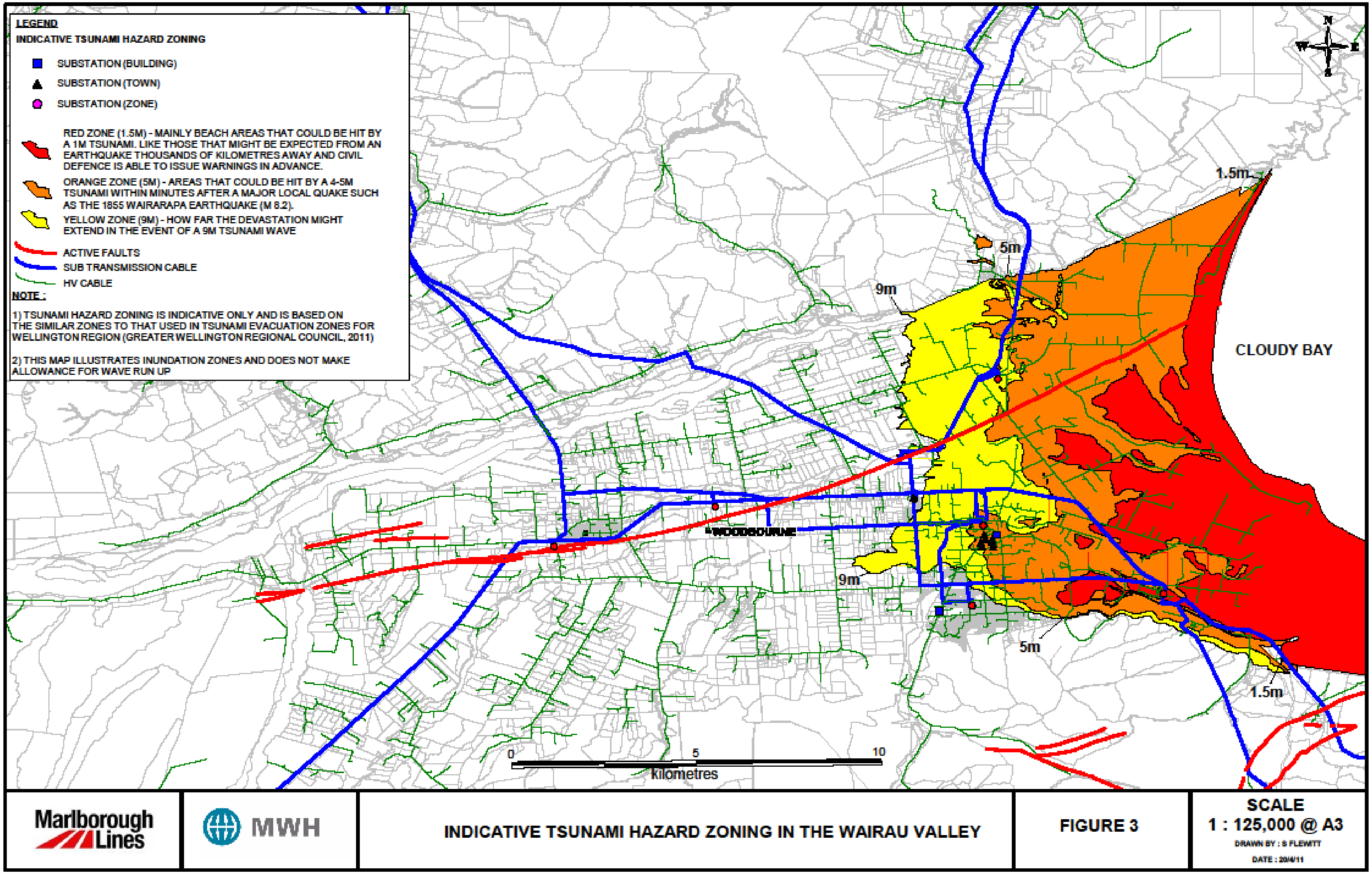
Two major fault lines cross the Marlborough region; the Wairau fault line (an extension of the Alpine Fault) and the Awatere Fault. A third relatively significant fault line, the Vernon fault line, is located south east of Blenheim. The following maps (prepared by MWH in a 2011 report) show these fault lines and the higher populated areas subject to liquefaction and to tsunami risk arising from an earthquake event(s) (noting that the latter is more likely to be triggered from an offshore earthquake).

Subsequent to the November 2016 Kaikoura earthquake, further work undertaken by GNS and other experts has identified that Marlborough could be at risk from the Hikurangi subduction zone which runs under the sea out from the east coast of the North Island to Marlborough. This subduction zone has the potential to generate a significant earthquake and/or tsunami.

The blue lines on the maps mark ML's 33kV sub-transmission lines.




SH6 TO HAVELOCK
SH1 TO PICTON
LEGEND
Indicative Liquefaction Susceptibility
HIGHLY SUSCEPTIBLE
HIGHLY - MODERATELY SUSCEPTIBLE
MODERATE - LOW SUSCEPTIBILITY
AREAS NOT CONSIDERED SUSCEPTIBLE TO LIQUEFACTION
SUBSTATION (BUILDING)
SUBSTATION (TOWN)
SUBSTATION (ZONE)
KNOW OR REPORTED LIQUEFACTION IN 1855 WAIRARAPA EARTHQUAKE (LOCATIONS APPROXIMATE)
ACTIVE FAULTLINES
SUB TRANSMISSION CABLE
HV CABLE
Note : The liquefaction susceptibility zones shown on this plan are indicative only and do not imply any level of damage to any particular structure, service or other infastructure.
TUAMARINA RIVER
RARANGI
WAIKAKAHO RIVER
WAIRAU FAULT
WAIRAU DIVERSION
ONAMALUTU RIVER
WAIRAU BAR
WOODBOURNE
RENWICK
BLENHEIM
WAIRAU VALLEY
WAIRAU FAULT
WAIRAU LAGOONS
VERNON FAULT
WHITE BLUFFS
AWATERE FAULT
0
5
10
kilometres
WAIHOPAI VALLEY
Marlborough Lines
MWH
INDICATIVE LIQUEFACTION SUSCEPTIBILITY IN THE WAIRAU VALLEY
FIGURE 2
SCALE
1 : 125,000 @ A3
DRAWN BY : S FLEWITT
DATE : 20/4/11


LEGEND
INDICATIVE TSUNAMI HAZARD ZONING
SUBSTATION (BUILDING)
SUBSTATION (TOWN)
SUBSTATION (ZONE)
RED ZONE (1.5M) - MAINLY BEACH AREAS THAT COULD BE HIT BY A 1M TSUNAMI. LIKE THOSE THAT MIGHT BE EXPECTED FROM AN EARTHQUAKE THOUSANDS OF KILOMETRES AWAY AND CIVIL DEFENCE IS ABLE TO ISSUE WARNINGS IN ADVANCE.
ORANGE ZONE (5M) - AREAS THAT COULD BE HIT BY A 4-5M TSUNAMI WITHIN MINUTES AFTER A MAJOR LOCAL QUAKE SUCH AS THE 1855 WAIRARAPA EARTHQUAKE (M 8.2).
YELLOW ZONE (9M) - HOW FAR THE DEVASTATION MIGHT EXTEND IN THE EVENT OF A 9M TSUNAMI WAVE
ACTIVE FAULTS
SUB TRANSMISSION CABLE
HV CABLE
NOTE :
1) TSUNAMI HAZARD ZONING IS INDICATIVE ONLY AND IS BASED ON THE SIMILAR ZONES TO THAT USED IN TSUNAMI EVACUATION ZONES FOR WELLINGTON REGION (GREATER WELLINGTON REGIONAL COUNCIL, 2011)
2) THIS MAP ILLUSTRATES INUNDATION ZONES AND DOES NOT MAKE ALLOWANCE FOR WAVE RUN UP
N
W
E
S
1.5m
5m
9m
CLOUDY BAY
WOODBOURNE
9m
5m
1.5m
0
5
10
Kilometres
Marlborough Lines
MWH
INDICATIVE TSUNAMI HAZARD ZONING IN THE WAIRAU VALLEY
FIGURE 3
SCALE
1 : 125,000 @ A3
DRAWN BY : S FLEWITT
DATE : 20/4/11

Earthquake risk in the Marlborough region is high and ML's recent experience of the November 2016 Kaikoura earthquake has provided ML with useful lessons and reinforced its thinking on ways to enhance its network resilience to the high likelihood of future earthquake events.

3.1.3.2 Kaikoura earthquake 2016

The earthquake which occurred at 12.02am on 14 November 2016 had a magnitude of 7.8 on the Richter scale. Substantial damage occurred, especially along the East Coast. A number of houses were destroyed and many severely damaged. Horizontal displacement of up to 7m and vertical displacement of 5m was recorded in areas of the East Coast.

The severity of the earthquake caused substantial damage to State Highway 1 and other roads to the extent that vehicular access south of Blenheim was closed to the general public and indeed until temporary road repairs were undertaken, even emergency response vehicles (including ML vehicles) were not able to access the Ward and East Coast areas. The earthquake not only illustrated the necessity of access and the importance of a resilient network, but also reinforced the need to be prepared for such events.

The Ward and Seddon zone substations were situated in the area of highest ground accelerations within ML's network. These largely sustained only superficial damage including minor step cracking in block walls and minor rotation of poles.

The damage to the network as a whole was mostly minimal and typically comprised a relatively large number of small isolated faults. In some instances, however, the severity of land movement including landslips and a change in the direction of the Clarence River necessitated poles to be realigned or in a few cases lines to be re-routed. Consistent with the parameters of the protective equipment at Transpower's Blenheim substation and that within ML's 33/11kV substations, supply was temporarily lost in whole or in part at 11 zone substations. Overall some 13,300 consumers lost supply when the earthquake struck.

The work relative to the earthquake did not conclude with the restoration of supply. As a consequence of the severe earth movements that occurred, pole-to-pole inspections had to be undertaken for every line, especially along the East Coast. Similarly all river crossings and major waterway crossings throughout Marlborough had to be checked to ensure their integrity. In some instances the effects of the earthquake took time to manifest themselves as a potential or actual network fault.

The situation was exacerbated by the ongoing series of aftershocks. This further necessitated the lines being inspected on a number of occasions. ML needed to ensure the lines were safe and sought to identify and eliminate potential faults before they had the opportunity to disrupt supply. Overall the earthquake had a major impact on ML's planned capital and maintenance programme which resulted in a number of items being deferred to the 2018 financial year.

Key lessons taken from this earthquake were:

- the need for a resilient network and the importance of preparatory planning;
- that, in general, the new line construction stood up well;
- lines suffering most damage were older, often with weaker copper conductor and running transverse to the fault movement;
- that having overhead network is an advantage when it comes to both inspection and rapid repair;
- the importance of adequate civil and mechanical design and appropriate location of zone substations; and
- that the continuance of communications and control systems is vital.

- Having trained and well-resourced staff within ML was the key determinant in the restoration of supply.
- The availability of ML's mobile generation for use within the network was reinforced.
- The ready availability of spares within ML enable rapid restoration of supply

As a result of further information becoming available subsequent to the earthquake ML elected to establish a new replacement zone substation at Renwick further away from the known Wairau fault line trace; placed greater emphasis on network resilience with ability to off-load zone substations; and initiated review of two-pole distribution substations, particularly those in public places, all as further detailed in this plan.

3.1.3.3 Summer fire danger

Marlborough enjoys high sunshine hours but this also often leads to very dry summer conditions, both in the inland regions and the Marlborough Sounds. Consequently a high fire risk frequently results. In response to this, ML works with the rural fire authority to obtain information on a real time basis. This amongst other things includes the disablement of circuit breaker auto-reclose in areas designated as fire danger, not relivening lines in at risk areas within undertaking inspection along the entire length of the line[3], removal of equipment identified as a fire ignition source (such as drop-out fuses with cardboard cartridges) and ML has commenced a program of installation of ground fault neutralisers onto zone substations serving feeders traversing high fire risk areas.

3.1.3.4 Significant adverse weather events

While infrequent, Marlborough is not immune to extreme weather events. By way of example, in June 2013, an intense weather system from the south east caused relatively significant damage to parts of Marlborough’s East Coast – hundreds of trees were blown over. The network suffered numerous outages during this storm with significant damage caused by trees well outside the regulatory growth limit zone being blown over the lines and restoration works were substantial. Snowstorms, while rare, can potentially impact ML’s assets which are located at higher altitudes.

[3] Safety is always given priority over restoration of supply and reliability targets.

3.2 Network and demand

3.2.1 Consumers and load serviced

In FY2017, the network delivered 375GWh of electricity to 25,465 consumers. The peak load was 71MW with a load factor of 64%.

Overall ML's load factor has only changed marginally over a period of some 40 years.

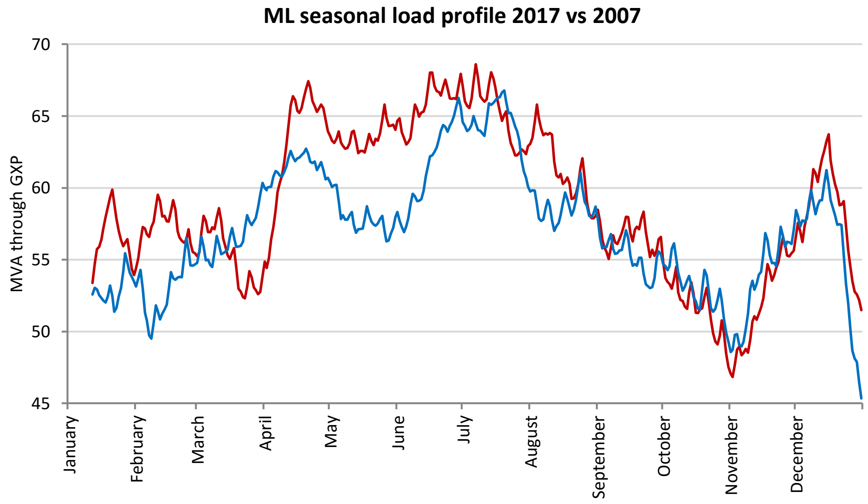


Figure 4: ML's seasonal load profile 2017

ML's seasonal load profile is largely driven by winter load and the wine harvesting season in April. Maximum demand in summer months is typically subject to the vagaries of weather with prolonged hot spells resulting in a marked increase in irrigation consumption for both crops and viticulture. This is reflected in Figure 5, which also shows (generally) the increase in the wine harvesting peak load, winter peak, and summer irrigation peaks from 2007 to 2017.

ML's daily load profile, especially in winter, consists of twin peaks; one in the morning and then again at night. Load management utilising ripple control is utilised when appropriate. Generally, apart from parts of the Marlborough Sounds, the ML network is not capacity constrained. The summer's day profile follows this pattern with much less exacerbated peaks in part due to the constancy of the irrigation load.

Figure 5: Daily GXP load profile

3.2.2 Network servicing consumers

ML distributes electricity throughout Marlborough to in excess of 25,500 consumers (ICPs) on behalf of a number of energy retailers. Figure 6 indicates ML's position in the electricity supply industry.

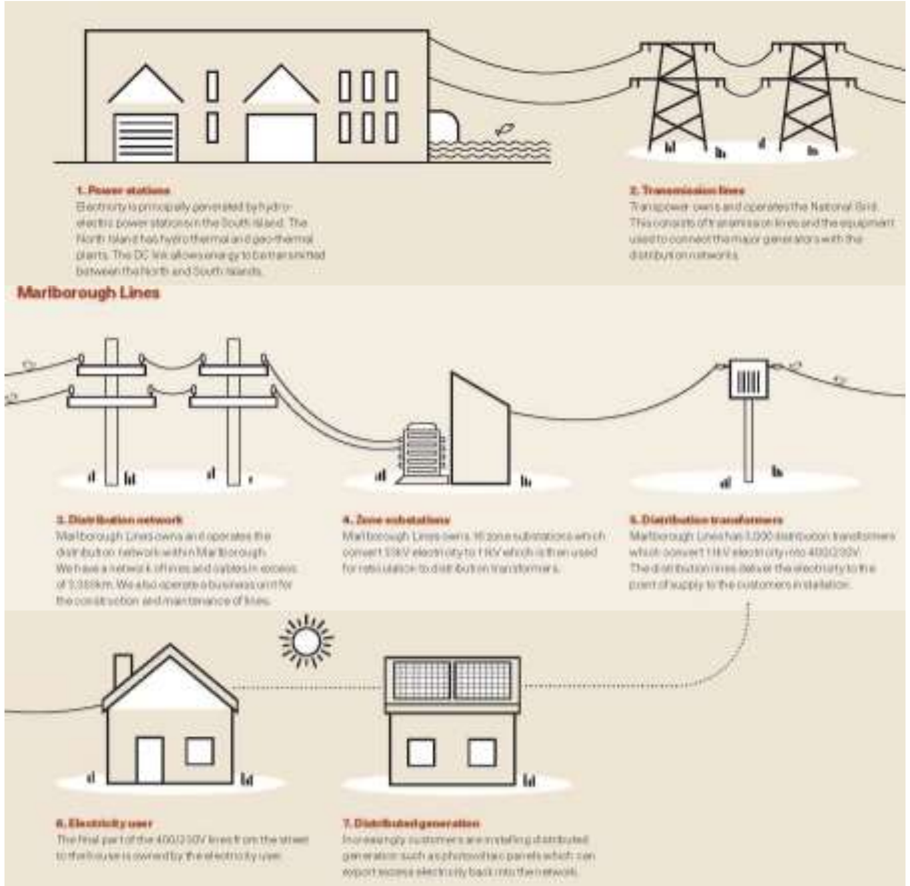


Figure 6: Illustration of the New Zealand electricity supply industry

3.2.2.1 Background to ML network

ML's network originally began as three historically distinct networks:

- The Marlborough Electric Power Board (M.E.P.B.), which was established in 1927 and began to supply the region from its own 1MW Waihopai River scheme.
- The Havelock Town Board electricity department, which commenced in 1917 with a 9kW Pelton Wheel, and was merged into M.E.P.B. in 1927.
- The Picton Borough Council electricity department, which commenced in 1917 with a 10kW Pelton Wheel, and was merged into M.E.P.B. in 1947.

Subsequent to 1947 these networks have operated as a single integrated system. The only surviving generation from the three above individual networks is the Waihopai hydro station now owned by TrustPower Limited.

In 1993 the MEPB was corporatised and became a company trading as Marlborough Electric with the shares held by the Marlborough Electric Power Trust. The beneficiaries of the Trust are the ICP's connected to the Marlborough network.

In 1999 the Electricity Industry Reform Act (Bradford reforms) required the separation of generation and retailing from distribution. Marlborough Electric's generation and retailing businesses were sold and Marlborough Electric became Marlborough Lines with responsibility for electricity distribution in Marlborough.

3.3 Supply within Marlborough

Supply to the region is transmitted by three 110kV lines owned by Transpower New Zealand Limited to the Blenheim Grid Exit Point (GXP). As there is only a single GXP, ML has an extensive and interconnected 33kV sub-transmission network to provide supply reliability and security for the bulk transfer of electricity to the 16 within the region.

The 33/11kV zone substations transform the voltage level down to 11kV. Each of the 16 zone substations has between two and six 11kV feeders radiating outwards, with some meshing possible in urban areas. These feeders collectively supply close to 4,000 distribution transformers that range from pole-mounted 5kVA units to ground-mounted 1,000kVA units. In turn, each distribution transformer has a number of 400V feeders radiating outwards, again with some meshing possible in urban areas.

The majority of consumers take supply at 230/400V, with nine of ML's larger consumers taking supply at 11kV.

3.3.1.1 Transpower point of supply/transmission lines

ML has a single Transpower GXP in Blenheim (on the corner of Murphys and Old Renwick Roads) where supply from the national grid enters ML's network. Blenheim's GXP is currently supplied by three separate Transpower-owned 110kV circuits, one from Kikiwa and two from Stoke. The Kikiwa line is an "H" structure hardwood pole line, although a number of structures have been replaced with pre-stressed concrete (PSC) poles. This line has a summer rating of 56MVA and winter rating of 68MVA.

The two Stoke-Blenheim 110kV circuits are installed on the same towers. These circuits are rated at 76MVA for the original circuit and 105MVA for the second circuit added in 2005.

The 110/33kV transformer capacity at Blenheim GXP consists of two banks of three single phase 50MVA units and a third 60MVA three phase unit. The 60MVA unit was commissioned in January 2011. The three 110kV/33kV transformers supply three 33kV bus bars (buses). This gives an n-1 capacity of 100MVA.

From the Transpower 33kV circuit breakers, the 33kV sub-transmission network distributes supply to ML's 16 separate 33/11kV zone substations.

The bulk supply characteristics are summarised in Table 3:

Table 3: Bulk supply characteristics

GXP	Demand	Voltage	GXP rating		Line rating	
			(n) rating	(n-1) rating	(n) rating	(n-1) rating
Blenheim	71MVA controllable to about 64MVA	110/ 33kV	160/ 172MVA	100/ 112MVA	189/ 202MVA	110/ 136MVA

Transpower's charging scheme mean that ML's peak charges are based on its contribution to the 100 highest upper South Island Coincident Peaks. ML works constructively with other lines companies in the upper South Island to manage the Upper South Island Peak. Changes were made to ML's load control system and those of other upper South Island lines companies to allow control based on upper South Load. This system has been successfully used since 2010 and is an example of how Transpower and network companies work together.

3.3.1.2 Embedded generation

TrustPower Limited operates a 2.4MW ‘run-of-river’ generator at Waihopai which is embedded into ML’s 33kV network.

Energy3 Limited owns two wind farms in Marlborough. One is located at Weld Cone, near ML’s Ward substation, where there are three 250kW turbines. The other is located at Lulworth, just north of the Ure River, where there are four 260kW turbines installed.

Because of the location of the Energy3 windfarms and their consumption of reactive power it has been necessary for ML to install a Static Var Compensator (SVC) at the Ward 33/11kV substation.

Dominion Salt Limited has installed a 600kW wind turbine, which is embedded into its own 11kV installation.

The potential wind resource in the Marlborough Sounds and on the East Coast is significant, however, the development of substantial wind farms would require construction of new lines to convey the output to load centres.

Further detail on embedded generation is described in Section 7.4.

3.3.1.3 Further Marlborough generation

TrustPower operates the Branch Power Scheme and was granted resource consent in 2008 to extend this scheme. Six new power stations were proposed with one connecting to the existing Branch scheme infrastructure, four connecting to a new substation on the 110kV Kikiwa to Blenheim line and one connecting to ML’s existing network in the Wairau Valley. ML understands that TrustPower does not intend to proceed with construction of this scheme.

3.3.1.4 Generation on consumer premises

Figure 7: Wind turbine

The Wairau Hospital and a number of wineries and local businesses have small diesel generators, which are used for load management and emergency power supply. These generators are of insufficient capacity/capability to be able to supply the ML network.

The current low cost of photovoltaic cells has seen an increase in interest in small scale solar distributed generation. At the time of compiling this AMP[4] ML has received 101 applications for distributed generation. Currently embedded in the network are:

- 348 small (<10kW) solar installations;
- Two small scale solar installations with energy storage (combined <10kW);
- A single solar installation of 425kVA at Yealands Winery, with the output being totally consumed on the premises;
- Two installations with both solar and wind;
- One wind only installation;
- 20 larger (>10kW) solar;
- Three large scale solar with energy storage (combined >10kW); and
- Six large scale diesel generators with the ability to synchronise to the grid.

To indicate the growth in this area of small distributed generation, in 2012 there were 12 small solar installations.

To date for the last 12 months ML has processed 104 applications for DG totalling 1,924.5kVA of generation capacity.

Embedded generation external to consumer premises produced 17GWh in the FY2017 year, representing approximately 4.3% of energy entering the network. This is mainly from the Waihopai scheme (10.9GWh). Yearly variations in embedded generation output are mainly due to changes in river flow and the vagaries of the wind.

Figure 8 shows the electricity supplied by embedded generation per year with forecast values for future years. These forecasts will be reviewed regularly and updated to reflect additional data as it becomes available.

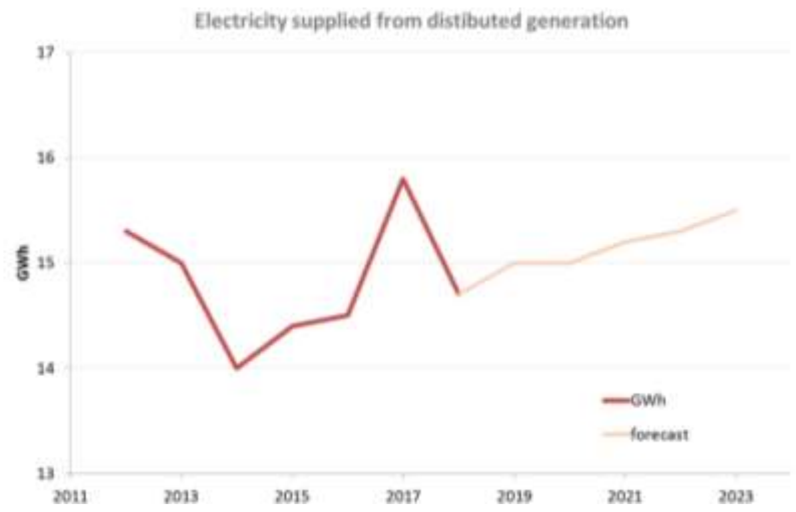


Figure 8: Electricity supplied from distributed generation in GWh

Figure 9 shows a steady number of small scale solar installations over the last five years following a jump after 2012. It is expected this will continue in the short term but it is anticipated, given the vagaries of photovoltaic outputs, the cost of battery storage and consumer demand for reliability, that the actual consumer network demand requirement is unlikely to diminish, especially if the significant utilisation of electric vehicles was to occur.

[4] Data as at 1 March 2018.

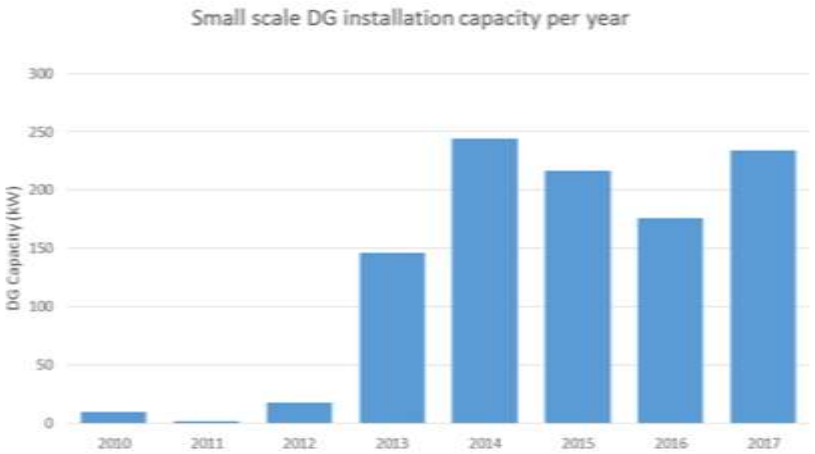


Figure 9: Solar distributed generation installed capacity per year (small scale (<10kW))

3.3.1.5 Sub-transmission system

From the Transpower substation ML's 33kV sub-transmission network distributes supply to ML's sixteen 33/11kV zone substations. The 33kV sub-transmission network uses radial duplicated feeders and provides n-1 security of supply to the 33kV bus at all zone substations, except Rai Valley, Linkwater, Leefield and Ward. About 7% (by length) of the 33kV network is underground. ML has 16 zone substations throughout its network, with four of these zone substations supplying Blenheim.

Of a total 300km of 33kV line, 278km is overhead, most of which has been constructed since 1960. Lines constructed earlier than 1960 include a galvanised tower line constructed in 1926 between Waihopai Power Station and Leefield (noting that much of this from Blenheim to Leefield zone substation has been renewed in the last five or so years) and part of the line between Riverlands and Seddon (where some

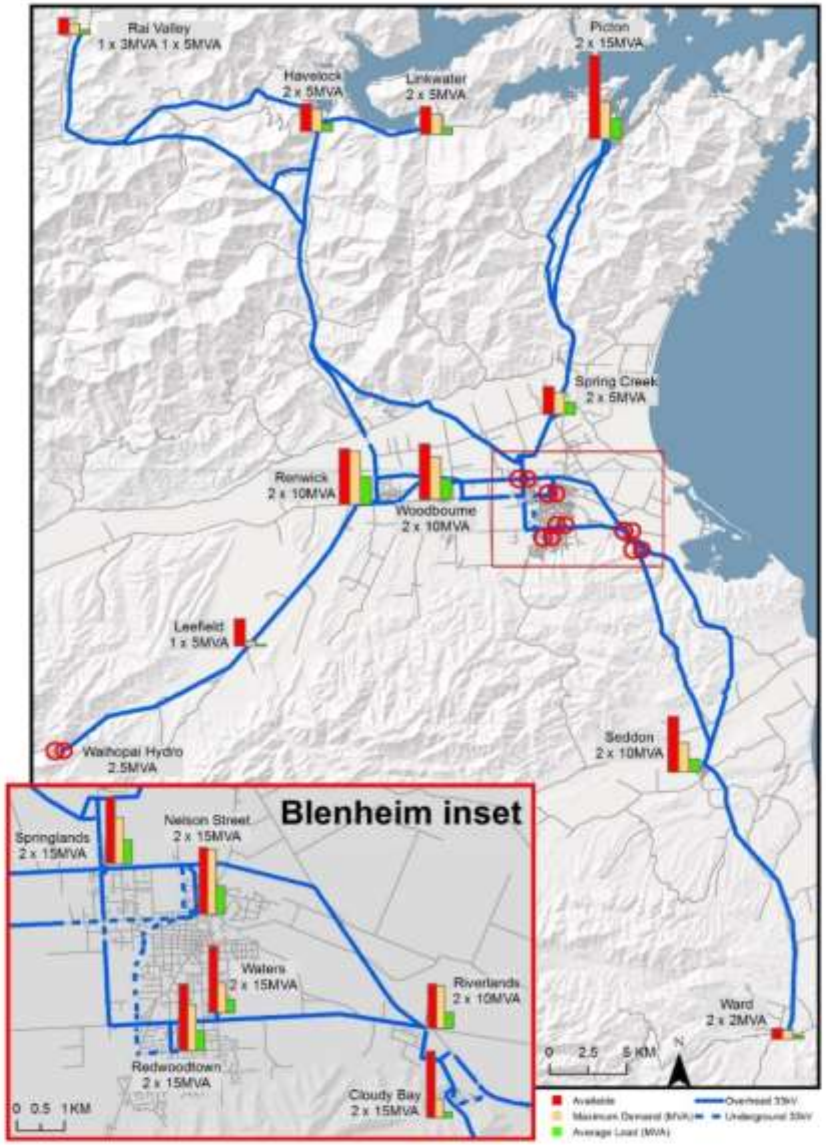


Figure 10: Overview of ML's 33kV network, with zone substation capacity

sections of this have also recently been renewed with others planned for renewal within the planning period).

In the early 1970s, a 33kV and 11kV line utilising the same poles was constructed between Okiwi Bay and Elaine Bay in the Marlborough Sounds. The 33kV line was operated at 11kV to provide two circuits. This line contained a high proportion of larch poles treated with creosote. These poles have since been replaced.

Further poles between Elaine Bay and French Pass also need to be replaced.

Figure 10 shows the overall 33kV sub transmission system (blue lines) together with zone substations (red circles with a red centre) and embedded generation (Waihopai Hydro). The graphs at each zone sub highlight ML's secure availability relative to maximum and average substation loading.

A single line diagram is included in Appendix 10.3. All new 33kV line construction in rural areas is currently being insulated at 66kV or 110kV.

3.3.1.6 Zone substations

Zone substations transform the 33kV down to 11kV for reticulation to 11kV/400V transformers. All of the zone substations transformers are equipped with on-load tap changers and automatic voltage regulators to regulate the 11kV supply and maintain voltage within a controlled band. The major components of the substations are transformers and switchgear and the buildings within which they are housed.

Table 4 sets out the zone substation capacities, security level and 2017 loading.

Figure 11: Photograph of ML's 33kV Waters zone substation

Table 4: Zone substation capacities and security levels

Substation	T1 capacity (MVA)	T2 capacity (MVA)	Maximum demand (MVA)	Average load (MVA)	Security level
Leefield	5	N/A	1.3	0.6	n
Linkwater	5	5	3.6	1.1	n
Havelock	5	5	2.5	1.5	n-1
Nelson Street	15	15	14.6	7.2	n-1
Picton	15	15	6.9	3.8	n-1
Rai Valley	3	5	2	0.9	n
Redwoodtown	15	15	9.9	4.5	n-1
Renwick	10	10	9.4	5.1	n-1
Riverlands	10	10	9.2	3.2	n-1
Seddon	10	10	6.2	2.2	n-1
Spring Creek	5	5	4.1	2.2	n-1
Springlands	15	15	10.3	5.4	n-1
Ward	2	2	1.5	0.4	n
Cloudy Bay	15	15	6.3	1.7	n-1
Waters	15	15	6.8	2.9	n-1
Woodbourne	10	10	8.6	4.2	n-1

All of ML's zone substations other than Leefield have (n-1) security for the 33/11kV transformers, e.g. for a zone substation to have a firm (n-1) 16.5MVA rating it must have two transformers of 16.5MVA. Note Linkwater, Rai Valley, Leefield and Ward substations only have a single 33kV line supplying them, and consequently have an overall security of supply of (n).

Consistent with its planning horizon, ML has recognised the potential need for new zone substation sites and that opportunities to purchase substation sites are limited. At present, three new zone substation sites are proposed within the current planning period being at Fairhall, Budge Street and Kaituna subject to the expected load eventuating and other engineering and value reviews as further detailed in the network development section of this plan. As always new consumer requirements can change in a short timeframe and ML will accordingly move to respond, as and if such load eventuates.

It is salient that not only is it necessary to consider the usual loading of a substation and its N-1 capability, but also the ability of the network to maintain supply if a complete substation has to be removed from service. This could be from a cause on the ML network or an external event such as a major earthquake. Hence where practicable ideally zone substations should be able to be removed from service without the longer term disruption of consumer supply. For this reason the capacity of the major zone substations typically provides for flexibility in network operation.

3.3.1.7 Distribution system

ML operates an 11kV distribution network which is largely radial with some meshing in urban and higher density rural areas. Approximately 8% of the 11kV (by line length) is underground. The total length of cable and conductor operating at 11kV is in the order of 2,300km.

Generally speaking, underground cable is considerably more expensive to purchase and install than overhead line. The decision on whether underground cable is more appropriate than overhead conductor involves several factors, for example surrounding land use, safety, civic amenity, risk avoidance and available budget.

Some other key features of the 11kV system include:

- Lightning protection is generally installed on all under-ground to overhead transitions and in areas prone to lightning.
- All new/replacement 11kV lines in rural areas are being insulated at 22kV to allow for possible future increases in supply voltage and to increase reliability.
- Distribution substations are installed to step down the voltage from 11kV to 400V/230V in locations appropriate to service consumers' needs.
- Protection devices are installed across the network. The selection of locations for protection devices involves consideration of a number of factors such as downstream consumers, location and cost.
- ML's distribution network includes approximately 540 km of Single Wire Earth Return (SWER) lines. SWER lines are cheaper to construct when reticulating low density rural and remote areas having low demand requirements but requires special attention to the transformer earthing arrangements given the ground itself is being utilised as the return conductor.

3.3.1.8 Distribution substations

ML owns close to 4,000 distribution substations. Of these, approximately 460 are ground mounted and the remainder are pole mounted. All transformers greater than 300kVA are ground mounted and in general smaller transformers are pole mounted. Going forward all transformers from 200kVA upwards will be ground mounted.

Key features of ML's distribution substations include:

- typically 200kVA or 300kVA in urban areas;
- fused on the HV side;
- LV cables with HRC fuses;
- LV typically runs along both sides of the street i.e. no multiple service lines crossing the street; and
- LV runs are typically limited to a maximum of 350m to reduce incidences of low voltage.

In rural areas the distance between consumers and voltage considerations typically limit the utilisation of low voltage lines, 11kV lines are generally built with 80m to 100m pole spacing's on the flat and greater distances depending on terrain. These distances also inhibit the installation of LV in some situations and, combined with a low density of consumers, necessitate many rural consumers having their own transformers. This results in a lower coefficient of transformer utilisation than urban areas but such is purely a function of the physics of electricity supply.

3.3.1.9 Low voltage network

ML operates a 400V (LV) reticulation network totalling approximately 830km[5]. There is significant meshing in urban areas. About 45% (by length) of the LV is underground. As noted above, in many rural areas, pole spacing and consumer locations result in consumers having individual transformers with less use of LV conductor.

The LV network supplies the bulk of the ICPs, the majority of which are domestic consumers (i.e. residential properties) in urban areas. Typically LV supply to ICP's in most cases is single phase, but can be two or three phase depending on the supply for the area and the needs of the consumer.

3.3.1.10 Ripple control, SCADA and communications

ML's ripple control system is utilised for the management of loads such as water heating, irrigation, industrial heating and the control of street lights.

Whilst ML's network is generally not constrained the ripple control system is used to minimise the cost of Transpower peaks. Going forward it is expected the ripple control system will continue to make a valuable contribution within the network and may well be utilised to provide an option in the charging of electric vehicles.

[5] Includes street lighting circuits.

ML operates 217Hz and 1050Hz ripple injection systems. These both inject at 33kV with the injection equipment installed at the Springlands substation site. All ripple relays are owned by the energy retailers. The 1050Hz equipment was originally installed in 1967. All new ripple relays are at 217Hz.

3.3.1.11 SCADA

SCADA covers all of the zone substations, voltage regulators and 33kV reclosers. This system allows staff to monitor and control the network remotely.

Communication for SCADA consists of dedicated radio equipment, as well as use of internet and cell phones and including voice radio. The SCADA radio network is being progressively extended to ensure greater reliability in the event of major civil emergencies or wide spread power outages and to extend the reach for remote control of network switches.

Further detail on ML's SCADA is included in Section 9.10.

3.3.1.12 Major asset groups

Table 5 presents a summary of the major asset groups which comprise ML's network.

Further breakdown of the assets (poles, conductor etc.) including age profiles is provided within the Fleet Strategies set out later in this plan.

Table 5: MLL major asset classes

Type	Unit	Number	Average Age (years) FY2017	Regulated asset base $000
Sub-transmission lines	km	278	43.6	19,475
Sub-transmission cables	km	22	9.0	8,120
Zone substations	-	-	-	38,070
Buildings	each	16	16.5	
Switchgear	each	284	11.0	
Transformers	each	31	16.6	
Distribution and LV lines	km	2566	39.3	49,077
Distribution and LV cables	km	569	18.0	44,624
Distribution substations (transformers)	each	3919	21.0	22,789
Distribution switchgear	each	3179	12.1	16,643
Other network assets	-	-	-	6,885
Non network assets	-	-	-	16,379
				222,062

Note – RAB values are from ML's 2017 information disclosure.

4. Stakeholder interests and objectives alignment

This section of the AMP sets out the various stakeholder interests and the alignment of those interests with ML's asset management objectives as further articulated within this plan.

4.1 Stakeholder interests

ML defines its stakeholders as any person or class of persons that:

- has a financial interest in ML (be it equity or debt) and/or;
- pays money to ML (either directly or through an intermediary) for delivering service levels and/or;
- is physically connected to the network and/or;
- uses the network for conveying electricity and/or;
- has an interest in land where ML assets are located on the land; or has an interest in land that provides access to ML assets and/or;
- supplies ML with goods or services and/or;
- is affected by the existence, nature or condition of the network (especially if it is in an unsafe condition) and/or;
- has a statutory obligation to perform an activity in relation to the network's existence or operation such as: request disclosure data, regulate prices, investigate accidents, include in a District Plan, protect archaeological sites, Wahi Tapu sites etc. and/or;
- has an interest in the safety of the network and/or;
- is employed by ML.

Figure 12 highlights ML's key internal and external stakeholder groups as well as the nature of their relationships with ML.

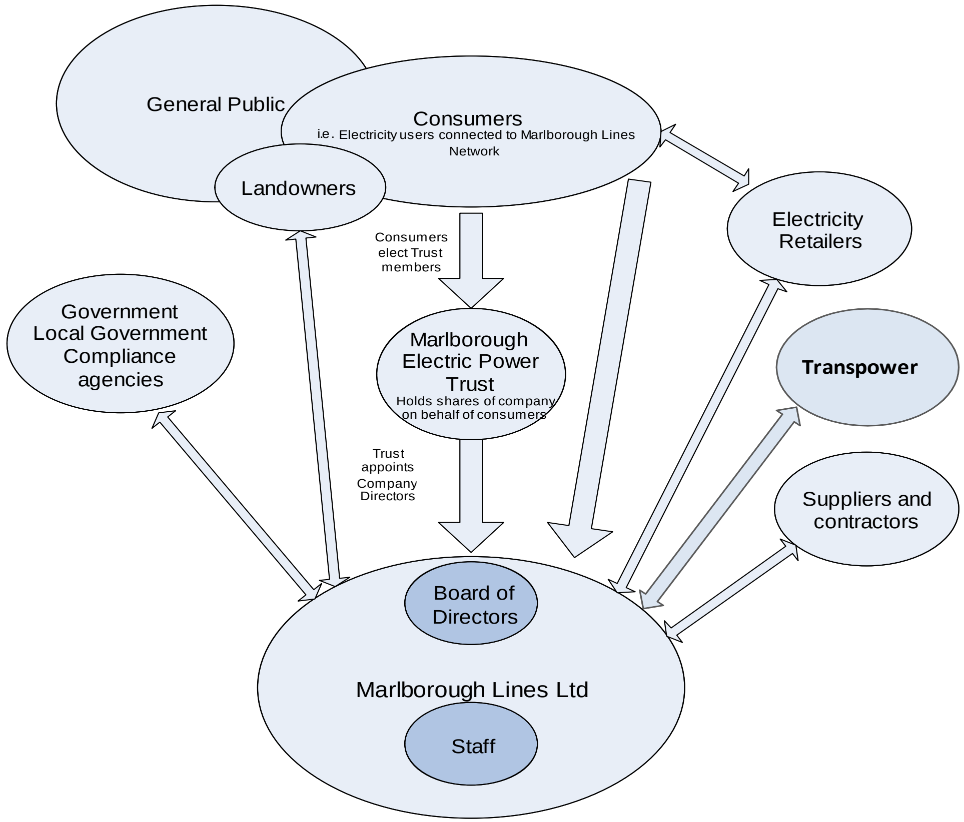


Figure 12: Our key internal and external stakeholders

Figure 12 also gives a general indication of the most significant interests of various stakeholders. It is recognised that most stakeholders will generally have an interest in all aspects of the business.

Table 6: Summary of ML's stakeholders and their interests

Stakeholder	Interests					
	Viability	Price	Supply Quality	Safety	Compliance	Energy Efficiency
Marlborough Electric Power Trust (sole shareholder)	✓	✓	✓	✓	✓	✓
Bankers	✓	✓		✓	✓	
Connected Consumers	✓	✓	✓	✓	✓	✓
Energy Retailers	✓	✓	✓	✓	✓	✓
Mass-market Representative Groups	✓	✓	✓	✓	✓	✓
Industry Representative Groups	✓	✓	✓	✓	✓	
Staff and Contractors	✓	✓	✓	✓	✓	✓
Suppliers of Goods and Services	✓	✓	✓	✓	✓	✓
Public (as distinct from consumers)				✓	✓	
Landowners				✓	✓	
Councils (as regulators)				✓	✓	✓
NZTA (Marlborough Roads)				✓	✓	
Ministry of Business, Innovation and Employment (MBIE)	✓	✓	✓	✓	✓	✓
Energy Safety/ WorkSafe				✓	✓	
EECA					✓	✓
Commerce Commission	✓	✓	✓	✓	✓	✓
Electricity Authority		✓	✓		✓	✓
Utilities Disputes		✓	✓		✓	

4.2 Stakeholder engagement

Table 7 sets out the ways in which ML engages with its stakeholders to then formulate business objectives that meet these varied and numerous requirements.

Table 7: Summary of ML's stakeholder engagement

Stakeholder	How Expectations are Identified
Marlborough Electric Power Trust	• By its approval or amendment of the SCI. • Regular meetings between the ML directors and the MEPT trustees.
Bankers	• Regular meetings between the bankers and ML staff (Note: within ML itself there is no debt). • By adhering to ML Treasury procedure.
Connected Consumers	• Regular discussions with large industrial consumers as part of their ongoing development need assessment. • Regular consumer satisfaction surveys. • Public disclosure documents including this AMP. • Quarterly newsletters. • Website.
Energy Retailers	• Annual consultation with retailers, regular contact and discussion.
Mass-market Representative Groups	• Informal contact with group representatives.
Industry Representative Groups	• Informal contact with group representatives. • WorkSafe website. • Safety bulletins from EEA. • Exchange and contribution towards industry best practice.
Staff and Contractors	• Regular staff briefings. • Regular contractor meetings.
Suppliers of Goods and Services	• Regular supply meetings. • Letters.
Public (as distinct from consumers)	• Informal talk and contact. • Feedback from public meetings. • Information made available on ML's website (including how to stay safe and how to report network damage).
Landowners	• Individual discussions as required.

Table 7: Summary of ML's stakeholder engagement

Stakeholder	How Expectations are Identified
Councils (as regulators)	• Formally, as necessary, to discuss issues such as assets on Council land.
Iwi	• Formally, informally and as required.
NZTA	• Formally, and as required.
MBIE	• Regular bulletins on various matters. • Release of discussion papers. • Analysis of submissions on discussion papers.
Energy Safety/ WorkSafe	• Promulgated regulations and codes of practice. • WorkSafe website. • Audits of ML's activities. • Audit reports from other Lines Companies.
Commerce Commission	• Regular bulletins on various matters. • Release of discussion papers and direct communications. • Analysis of submissions on discussion papers. • Conferences following submission process.
Electricity Authority	• Weekly update. • Release of discussion papers. • Briefing sessions. • Analysis of submissions on discussion papers. • Conferences following submission process. • Information on Electricity Authority's website.
Utilities Disputes	• Reviewing their decisions in regard to other Lines Companies. • Assistance with any complaint investigations.

This stakeholder engagement, both formal and informal, underpins ML's response in setting its goals and objectives as discussed next. It is also important not to lose sight of the fact that ML is a Trust owned business and the consumers directly elect the Trustees. In turn the Trustees appoint the Directors and approve the annual Statement of Corporate Intent and receive ML's Annual Report and accounts.

4.3 Business and planning response

ML's AMP is the key document that translates ML's data, analysis, procedures, policies and strategic aims into planned actions and defines performance criteria and timeframes. It is also used as a means of communicating ML's intentions to stakeholders.

ML, as a supplier of electricity lines services, is included within Part 4 of the Commerce Act 1986. The Commerce Commission has regulatory oversight of the ML network through the Company being subject to information disclosure regulation, including monitoring levels of return on investment. However, as a Trust owned business, ML is exempt from the price/quality path requirements as set down by the Commerce Commission.

The ML Statement of Corporate Intent (SCI) also provides information relevant to the AMP. This AMP deals solely with the electricity assets in the Marlborough area and, along with ML's other plans and policies, combines to demonstrate that ML is responsibly managing its electricity network assets consistent with regulatory requirements and best industry practice. The ML SCI, along with other key Company documentation, is available on ML's website.

4.3.1 Strategic Planning Documents

ML's key strategic planning documents are constructed around its vision and mission statements:

4.3.1.1 Vision

"Our Vision is to be a leader in all that we do in the distribution of electricity and related businesses for the benefit of our consumers, shareholder and community".

4.3.1.2 Mission

To exceed our consumer's expectations in all aspects of our operations and furnish our shareholder with a commercial return.

ML's primary objectives are to:

- operate as a successful business in the distribution of electricity and other related activities; and
- pursue the most efficient use of energy.

In achieving its objectives, ML will:

- develop and maintain customer-responsive transmission, reticulation and distribution systems;
- ensure that all resources – financial, physical and human – are utilised efficiently and economically;
- meet commercial and productivity targets;
- fulfil market requirements in terms of quality and price on a competitive, commercial basis;
- ensure the safety of all systems, plant and equipment under ML control and promote electrical safety within Marlborough;
- care for the environment and ensure that any impact of ML activities is minimised or, where possible, eliminated;
- use all legislative powers fairly and in accord with the principles of natural justice; and
- be a good employer by observing and applying best practice in all areas relating to employment.

4.3.1.3 Statement of Corporate Intent

ML's SCI is a requirement under Section 39 of the Energy Companies Act 1992, and forms the principal accountability mechanism between ML's board and the shareholder. The SCI includes, *inter alia*, revenue and performance targets, which form the heart of the asset management activity. The SCI is available on ML's website and will be updated in September 2018.

Section 36 of the Energy Companies Act 1992 establishes that the principal objective of an energy company is to operate as a successful business and have regard to the efficient use of energy. The directors and the shareholder of the Company believe that a "successful" electricity business is one which earns a commercially realistic rate of return, while providing a safe and reliable service that meets consumer expectations.

4.3.1.4 Interaction between Planning Documents

The interaction between ML's major planning documents and processes is depicted in Figure 13. These plans are compiled annually (with the exception of the AMP) and are subject to regular review during the financial year.

The vision statement guides ML's mission statement. These documents provide an overall direction to the ML's key planning documents, the SCI and this AMP. Business plans and annual budgets are then developed from this AMP.

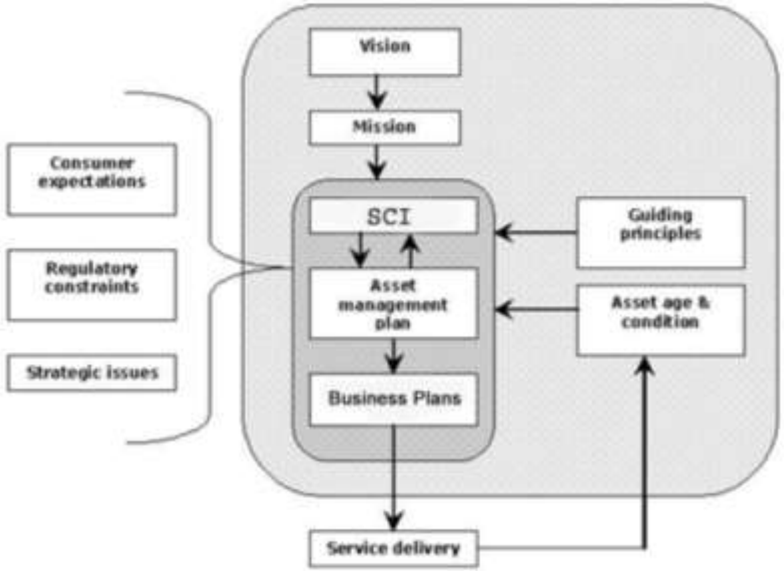


Figure 13: Overview of the key documents and the interaction between them

4.3.1.4.1 Guiding principles

The guiding principles within which the stakeholder interests are accommodated are broadly set out in Table 8.

Table 8: Further detail on stakeholders' interests

Interest	Description	How Interests are Accommodated	Asset Management Actions
Viability	Viability is necessary to ensure that shareholders and other providers of finance, such the bank, have sufficient reason to keep investing in, or provide funding for ML and for shareholders to retain ownership.	ML will accommodate the stakeholders' need for long-term viability by delivering earnings that are sustainable and reflect an appropriate commercial return on employed capital.	Ensure expenditure is appropriate to maintain or enhance the viability of network, subject to consumer requirements.
Price	Pricing is a means of gathering the revenue required to operate the business and signal underlying costs. Setting prices correctly is important for both the consumers and ML. The pricing methodology adopted by ML sets appropriate total target revenue and then tariff structures for different categories of consumers. As only a portion of network assets are dedicated to individual ICPs, this process involves elements of cost sharing between consumer groups, an approach commonly taken by most electricity network companies. Regulations currently require that any increase in cost of supply in rural area should not exceed that of urban areas. This limits the ability of the tariff to be cost reflective in some areas. The low fixed charge regulations also require tariffs to be set at a level for some consumers that means that their service is effectively subsidised by other consumers on the network.	Target revenue is set at a level which ensures ML is sustainable in the long term and ensures there are sufficient funds to provide reliable assets. ML takes a medium term view of revenue requirements so as to avoid price shocks from year to year. The pricing methodology is expected to be cost reflective and pricing signals reflect the cost of services and supply where possible (The low fixed charge regulations and the cross subsidy of uneconomic areas cause significant distortions between consumer graphs and inhibit cost reflective pricing). ML has an exemption from applying the Low Fixed charge regulations across some areas on its network (those classified as "Remote") which reduces the level of cross subsidisation required.	Although not subject to the Price Control mechanism in the DPQ Path, ML revenue is quite consistent from year to year. ML aims to fund its work through its annual revenues and therefore plans relatively smooth expenditure from one year to the next.

Interest	Description	How Interests are Accommodated	Asset Management Actions
Supply Quality	Emphasis on continuity of supply of regulatory voltage, restoration and preventing voltage flicker is essential to minimising interruptions to consumer's businesses. Ensure that ICP supply is not subject to interference by other network users.	ML will accommodate stakeholder's needs for supply quality by focusing resources on continuity and the capacity of supply and restoration through ensuring the assets are of a quality and standard to meet consumer requirements. Require all ICP's to meet appropriate standards relative to power factor, harmonics and utilisation of supply.	ML has a strong community mandate to maintain/improve reliability and to reduce flicker. ML adheres to regulatory requirements in the provision of electricity supply and has connection criteria which must be met by all ICP's. ML also undertakes monitoring of the quality of supply to ICP's.
Health and Safety	Staff and contractors must be able to work on the network in total safety. The general public must be able to move safely around network assets.	ML will ensure that the public is kept safe by ensuring that all assets are structurally sound, live conductors comply with regulatory clearances, all enclosures are kept locked, all exposed metal is securely earthed and assets are built and maintained in accordance with legislative requirements and best practice. ML will ensure the safety of staff and contractors by providing all necessary equipment, training, improving safe working practices, and ensuring that workers are stood down in unsafe conditions. ML will work to and in accordance with applicable industry standards and codes of practice.	All work is subject to rigorous safety standards with safety given the highest priority for expenditure. The Public Safety Management System (PSMS) will document ML's procedures for ensuring safety of the public. ML has circulated its own safety booklet to all staff. All staff are empowered to stop any work if it is considered unsafe.
Compliance	ML must comply with many statutory requirements ranging from safety to disclosing information.	ML will ensure that all safety issues are adequately documented and available for inspection by authorised agencies. ML will disclose performance information in a timely and compliant fashion.	Undertake sufficient monitoring and inspection to ensure compliance is maintained and that proper records are maintained.
Energy Efficiency	Consistent with the provisions of the Energy Companies Act 1993 and as a good corporate citizen, ML will maximise energy efficiency within its own operations and promote energy efficiency to its consumers and public.	ML will consider losses within its system and ensure that these are minimised where practical. ML will assist consumers by providing advice and assistance on energy efficiency.	Comparative assessment of network losses and setting of appropriate loss targets. Energy efficiency will be an integral component in the consideration of the purchase and design of network assets and operations of the network.

4.3.2 Translation into objective and performance targets

As the higher document, the SCI sets the top level objectives. The latest SCI was published in August 2017 for the financial year ending June 2018. The performance targets set for the next 3 financial years are:

Table 9: Performance targets for the next three years

Type	Objective
Financial	To achieve an overall post-tax rate of return on shareholders' funds of 5.0%, measured by taking net operating surplus after interest and tax, and adding back discounts paid to consumers.
Financial	Cash flow return from investments greater than 6.0% post-tax.
Financial	Pay a dividend to MEPT of $4.285m.
Financial	Pay discounts to consumers of $8.2m (excluding GST).
Network reliability	Planned SAIDI (average duration of consumer outages) not to exceed 65 minutes.
Network reliability	Unplanned SAIDI (average duration of consumer outages) not to exceed 80 minutes.
Health & safety	Achieve zero serious harm incidents.
Health & safety	Achieve certification in ISO 45001: Occupational Health and Safety and NZS 7901:2014 Safety Management Systems for Public Safety.
Consumer	Maintain overall consumer satisfaction at above 85%.
Consumer	Provide at least four newsletters to consumers providing financial, energy efficiency and health and safety information.
Environment	Achieve certification in ISO 14001:2004 Environmental management System.

These SCI business targets are integral to this Plan which accordingly sets strategies to achieve them. The performance targets are further detailed and expanded in the performance evaluation and service levels section of this Plan. Hence it reflects the original Statement of Corporate Intent objectives.

4.3.3 Conflicting interests

Most activities result in a need to balance a number of different issues, e.g. quality, cost, time. Finding a balance acceptable to all stakeholders requires that various solutions are carefully considered and priorities evaluated according to the specific circumstances and environment of each instance. The general priorities, in order of highest to lowest, for managing conflicting stakeholder expectations and interests are given below:

1. **Safety**: ML will give top priority to safety. Even if budgets are exceeded or non-compliance arises relative to interruption of supply, ML will not compromise the safety of its staff, contractors and/or the public. Safety is fundamental to the way ML will undertake any activity. By way of example at times of extreme fire risk a complete patrol of a line is undertaken after loss of supply and restoration is delayed at the expense of increased SAIDI minutes.
2. **Compliance:** ML will give priority to compliance, noting that compliance which is safety related will be given highest priority.
3. **Viability:** ML will give high priority to viability, because without it ML will cease to exist.
4. **Return:** ML recognises the need to operate as a successful business and provide a commercial rate of return. This ensures that funding will be available for future activities and ongoing supply continues to be available to consumers.

5. **Supply Quality:** This is important to consumers to allow them to utilise electricity in a reliable and safe manner. An unreliable supply may drive consumers to consider alternatives to grid supply.
6. **Environment:** As a socially responsible organisation, ML will diligently respect the environment and ensure that its operations are based on sustainable practices. ML will consider environmental issues in all aspects of its operations and whenever practicable seek to eliminate or mitigate the impact of ML operations on the environment.
7. **Energy Efficiency:** Consideration will be given to maximising Energy Efficiency in all aspects of ML's operations.
8. **Other:** All other considerations will be given lower priority than those listed above.

Aside from safety, the priority given to these issues may vary slightly from that outlined, according to the issue or issues, their respective magnitudes and the affected stakeholders. In practical terms, the criteria of importance are not mutually exclusive and all will factor in the decision process.

4.3.3.1 Consumer service lines

ML's assets extend to the point of supply, which (in most cases) is the property boundary line crossed by a consumer's service line. This means that the majority of a consumer's service line is owned by the property owner, not ML.

ML has observed some very poor condition privately owned assets with associated safety risks and have advised owners accordingly. Management of these assets is outside ML's jurisdiction and has therefore been excluded from this AMP. However, any changes in future regarding ownership transfer would impact on ML's forecast expenditure amounts with respect to inspections and renewal programmes.

4.3.4 Accountabilities and responsibilities for asset management

ML's accountabilities and accountability mechanisms related to asset management are described in Appendix 10.5.

5. Network performance and service levels

This section of the AMP sets out and discusses the relative performance of the network and business against a number of measures including quality of supply, cost performance, network continuance (essentially the adequacy of replacement levels), and losses and utilisation.

In concert with this assessment of relative performance, this section also measures performance against ML’s internal network and consumer satisfaction targets as notified through its annual SCI, specifically quality of supply, consumer engagement and satisfaction, and performance against objective targets.

This analysis provides the framework for setting the consumer-oriented asset management performance targets that, together with the wider business goals, this plan then sets out to achieve.

Detail on the comparative assessments and reliability performance analysis is extended and discussed in Appendix 11.7.

In overview we show that ML:

- has exemplary network reliability given the length of its network and its low consumer density;
- is achieving its targets in consumer engagement and consumer satisfaction;
- has total costs in keeping with the network services it provides;
- has relatively high opex costs driven by high vegetation management cost - which ideally should decrease slightly over this planning period as the second-cut costs pass over to the tree owners;
- is performing at expectation levels for network losses and transformer utilisation;
- has set capital replacement levels in keeping with good industry practice relative to ML's asset quantities and age profiles;
- does not have an over-aged network and it will not become so over this planning period provided ML execute its replacement and renewal plans;
- is operating as a profitable business; and
- has elected to retain the current internal performance targets across the current planning period, which remain stretch targets for the business.

The comparative performance discussed in the following sections sets ML’s performance against the 28 other Electricity Distribution Businesses (EDBs) within New Zealand using the FY2017 public information disclosure data as provided to the New Zealand Commerce Commission.

The comparative SAIDI statistics for all New Zealand networks for the year ended 31 March 2017 reflects the very significant impact of the 2016 Kaikoura earthquake and the distortions it caused in relation to ML's reliability.

Conversely the comparative SAIDI statistics for all networks to 31 March 2016 illustrate that the ML network was the sixth most reliable in New Zealand (refer to Figure 14). This is testimony to the quality of the asset management programme of ML particularly given the extent and remoteness of its network.

5.1 Quality of supply

5.1.1 SAIFI/CAIDI comparative performance

The average duration of non-supply per consumer per annum (SAIDI) [6] is the key measure of the "average" consumer's experience of supply reliability. SAIDI is derived from the multiplication of the average number of interruptions per consumer (SAIFI) and the average duration of an interruption (CAIDI). Comparative performances of both measures are examined separately within this section although emphasis is placed on SAIFI as a more informative measure for asset management purposes.

5.1.1.1 Comparative SAIFI

For comparison purposes SAIFI has been further divided between planned and un-planned (fault) SAIFI in the comparative analysis presented in Appendix 11.7.

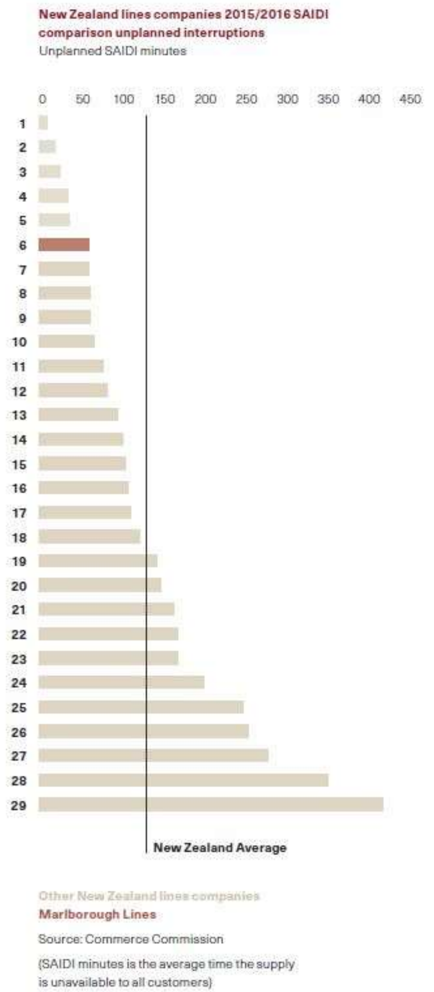


Figure 14: NZ lines companies 2015/2016 SAIDI comparison

[6] SAIDI = System Averaged Interruption Duration Index expressed in minutes per consumer; SAIFI = System Averaged Interruption Frequency Index measured in interruptions per consumer; CAIDI = Customer Averaged Interruption Duration Index measured in minutes per interruption. SAIDI = SAIFI x CAIDI.

This shows that ML's plan plots close to the mean expectation indicating its comparative performance in both number and impact of planned outages is, on the face of it, not unreasonable.

Unplanned (fault) SAIFI is also analysed through regression analysis in this appendix on the basis of the scale of network exposure. This shows ML fault SAIFI plotting under the expectation line even for FY2014 and FY2017, which were particularly onerous years for storms and unavoidable events (viz the Seddon and Kaikoura earthquakes).

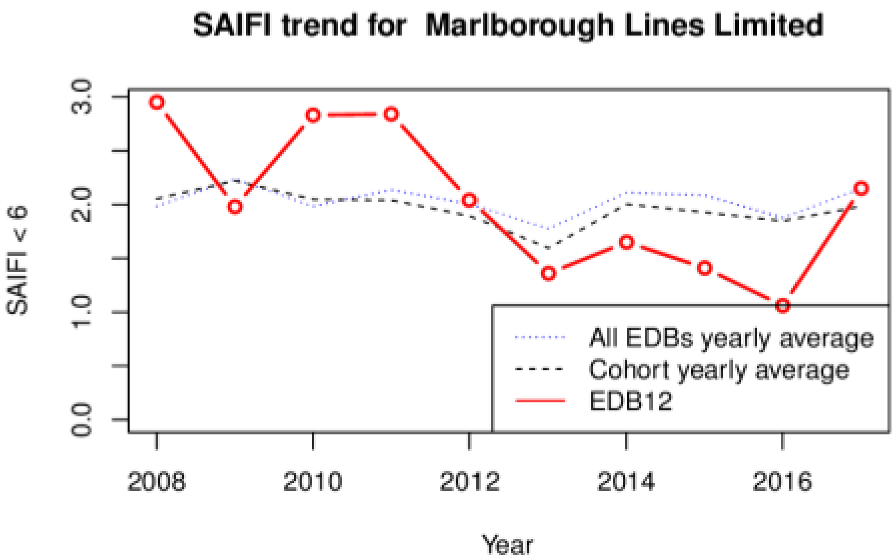


Figure 15: ML's SAIFI trend

Taking FY2016 as a more representative year for unplanned SAIFI ML shows at near frontier performance being approximately 0.5 average interruptions per consumer below expectation. This would translate to a community value of approximately $0.9m per annum in avoided power losses.[7]

The ML target for unplanned SAIFI is <0.67 to yield 80 SAIDI minutes at a target CAIDI of 120 minutes. As this level of unplanned SAIFI represents better than expectation performance on a comparative basis and remains a stretch target for the business (given the effect of irregular storm and other events), this target is retained for the duration of this planning period.

The trend in overall (planned + unplanned) SAIFI is also downward for ML compared to a relatively flat trend for all distribution businesses combined, as illustrated in Figure 15 (ML=red line; includes the effect of the 2017 Kaikoura earthquake). This, together with the comparatively low unplanned interruption frequency, shows the ML network is responding to the reliability improvement strategies being applied.

5.1.1.2 Comparative CAIDI

CAIDI measures the average duration of the interruptions and is generally highly variable between years, particularly when the total number of interruptions is not large, as is the case for smaller distribution businesses like ML. CAIDI is also affected by the types of faults occurring as some faults are more difficult to locate and repair i.e.

[7] This calculation assumes average CAIDI of 120 minutes per interruption; a loss per connection of 1.5 kW; 24,500 network consumers; and a value of lost load of $24/kWh as used in the Electricity Authority modelling after adjusting for shifts in CPI.

underground cable faults, and the difficulty of getting to the fault location i.e. remote faults in the Marlborough Sounds. Multiple faults occurring simultaneously also impact CAIDI as fault restoration has to then be prioritised over the available fault crews.

The comparative analysis described in Appendix 11.7 simply shows that ML's CAIDI fits within the typical distribution of CAIDI times experienced by other distribution businesses. ML's CAIDI might also be expected to be larger on average than other businesses that do not also have a significant proportion of remote lines within their networks.

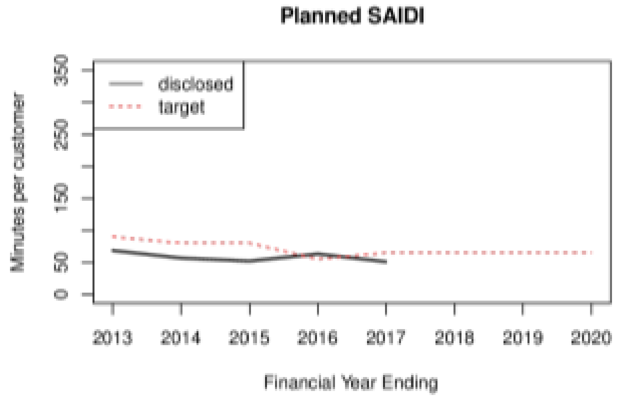
ML set a fault CAIDI target of 120 minutes, which is generally achieved in years without major storms or system events (e.g. earthquakes). This target is therefore retained for this planning period given it remains a stretch target for the business and is at a reasonable level for a network with MLs characteristics.

5.1.1.3 SAIDI performance vs. internal targets

As ML is a Trust owned lines business, it does not fall under the Commerce Commission's quality path requirements for supply reliability. However, to meet its consumers' expectations for reliability and to drive the business based on measured performance, ML sets internal business targets including for network SAIDI (which then define the internal SAIFI and CAIDI targets to meet this). The charts of Figure 16 show the planned and fault SAIDI recorded against the internal business targets from FY2013, with targets extending out to FY2020.

As shown, targets in both planned and fault SAIDI have been lowering over time to reflect both the consumer's expectations and the desire to lock-in the performance improvements achieved to date. Further reductions in the reliability targets will be dependent on identifying and implementing improvement projects that meet economic tests of prudence and efficiency or that ML have clear signals from the community identifying higher service level requirements.

As shown, ML is achieving the current targets in average across the years (omitting extreme events and noting FY2017 included a number of storm events as well as the 14 November 2016 Kaikoura earthquake) and as such these remain stretch targets for the business. These targets also represent better than expectation performance on a comparative



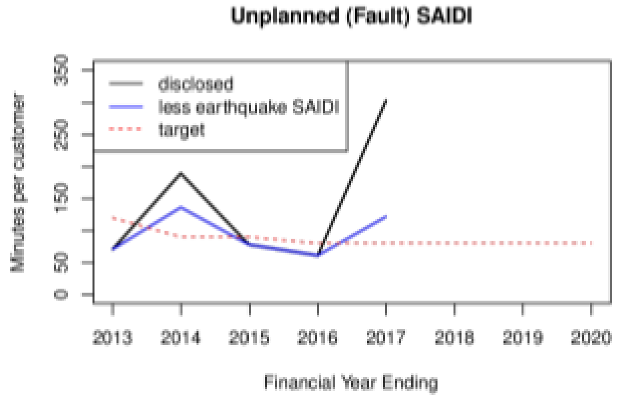


Figure 16: ML's planned and unplanned SAIDI vs target values

basis and so these network SAIDI targets are being retained across the next planning period.

ML's FY2017 targets, FY2017 performance and forward SAIDI targets are set out in Table 10:

Table 10: ML's SAIDI targets

Measure	FY2017 target	FY2017 Performance (includes earthquake)	Target FY2019 to FY2028
Plan SAIDI	<=65	50.9	<=65
Unplanned SAIDI	<=80	303.2	<=80
Total SAIDI	<=145	354.1	<=145

5.1.2 Outage durations compared to service level targets

ML set internal targets for supply restoration differentially based on four fault location types within the network. This is due to a combination of both the importance of fast restoration when large numbers of consumers are involved (viz higher density areas) and the practicality of restoring service across the different parts of the network away from its base in Blenheim. ML therefore internally define four areas for its network with fault restoration target times as follows:

- Blenheim Urban 1.0 hours
- Urban Other 1.5 hours
- Rural 4.0 hours
- Rural/Remote 8.0 hours

The "box-and-whisker" chart of Figure 17 illustrates ML's performance in fault restoration times against these internal targets for the FY2017 year (excluding earthquake faults). The fault restoration times for each fault plot on the x-axis. Rather than plot each fault restoration time, in this chart the boxes represent the bounds for 50% of the restoration times spanning from the 25th to the 75th percentile points and the whiskers are a measure of the spread beyond that. The box centre bar represents the median restoration time and the red bars identify the ML restoration time targets. Faults plotting outside the whiskers (outliers) are shown as individual circles. The number of faults in each area is also noted on the chart.

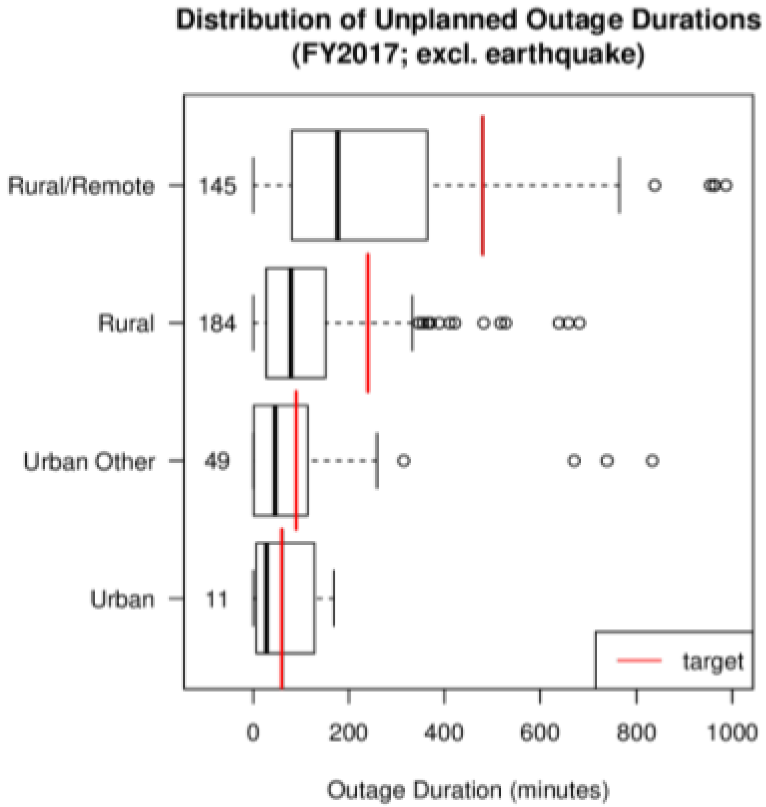


Figure 17: ML's fault restoration times vs target values

Whilst the majority of faults are restored within the target times, these targets remain stretch targets for the business. Also, whilst the worst performance against target is recorded against the Blenheim Urban area, this is also the most aggressive target and the total number of faults in this urban area is low compared to the other groups.

As the restoration time targets remain stretch targets for the business, these targets are retained for the current planning period.

5.1.2.1 Long-duration and repeated outages

Targets for monitoring consumers who experience more or longer outages than most consumers are:

- **CELID-8** (Consumers experiencing long interruption durations) is the number of consumers who receive at least one outage of more than eight hours in the year.
- **CEMI-8** (Consumers experiencing multiple interruptions) is the number of consumers experiencing nine or more interruptions in the year.

ML sets targets and records performance against these reliability measures as set out in Table 11, which shows the FY2017 target was exceeded, but this mainly relates to the impact of the FY2017 Kaikoura earthquake. These CLEID-8 and CEMI-8 performance targets are being retained over the current planning horizon.

Table 11: ML's CLEID and CEMI targets

Measure	FY2017 target	FY2017 Performance	Target FY2019 to FY2028
CLEID-8	<2,500	8,319	<2,500
CEMI-8	<900	2,295	<900

5.1.3 Fault causes and response

Appendix 11.7 examines the total consumer minutes lost to 11kV faults by fault cause over the period FY2015 to FY2017 (three years) together with the average number of incidents per annum. This directs attention to the following:

- The major fault cause on the network is now failure of line components from a variety of causes followed by the effects of extreme wind and weather.
- Pleasingly, most vegetation related faults occur from vegetation outside the legal growth limit cutting zones indicating that ML's vegetation management on the network is working. However, the fact that tree faults occur from trees outside the legal cutting zones indicates deficiency in these regulations from the perspective of achieving reliable supply to consumers.
- Whilst conductor failure is rare and the reliability impact small, it is never-the-less an issue requiring active management due to the potential for public hazard and liability risk from such failures.

Further detail on the performance of the network in both planned and unplanned reliability is provided in Appendix 11.7, which shows:

- marked improvement in performance over the last 8 years (comparing FY2009 to FY2017);

- that this improvement has largely been in the Urban and Rural areas; and
- that SAIFI is now trending up (deteriorating) in the remote sections of ML's network.

From this analysis, this AMP takes the following instruction:

- ML needs to continue its aggressive vegetation management if it is to retain its reliability performance at or under the current targets;
- there must be continued focus on potential asset deterioration, particularly in the remote parts of the network; and
- conductor replacement needs to be specifically addressed to remove conductor from the network which is showing deterioration or is likely to be in a weakened state in order that ML eliminate the risk of potential conductor failures.

5.1.4 Voltage complaints

ML records approximately six voltage complaints per annum, mostly in the rural network and usually associated to irrigation pumping loads. These are treated on a case-by-case basis, often being rectified through simply increasing the voltage tap of the associated distribution transformer. Few voltage complaints are recorded in the urban parts of the network.

Low voltage and other forms of voltage disturbance (e.g. flicker) are rare on the network and so no specific target or strategy is applied other than the usual consideration of voltage regulation that is routinely applied in network design and upgrade.

5.2 Consumer responsiveness

ML commissions an independent annual consumer satisfaction survey through random sampling of its consumer base in a telephone survey of 200 consumers made up of 170 domestic and 30 commercial connections. The purpose of this survey is to gauge the general consumer's reaction to ML's performance during the year across all facets of the business including network reliability, quality, consumer discounts, community sponsorship, information dissemination and Company management.

ML target an 85% consumer approval rating for weighted overall performance[8].

The FY2017 survey reported an error of +/-3.5% at the 95% confidence level and showed that 88% of consumers were satisfied/very satisfied in the weighted overall performance representing an increase of 3% on the previous year, all as charted in Figure 18.

[8] The survey questions are all on a 5-category scale of satisfaction; a weighted average methodology is applied where a weighting of 0% is applied for very dissatisfied, 25% for somewhat dissatisfied, 50% for neutral, 75% for somewhat satisfied and 100% for very satisfied. Achieving a 90% weighted score requires a large proportion of respondents to score in the very satisfied category.

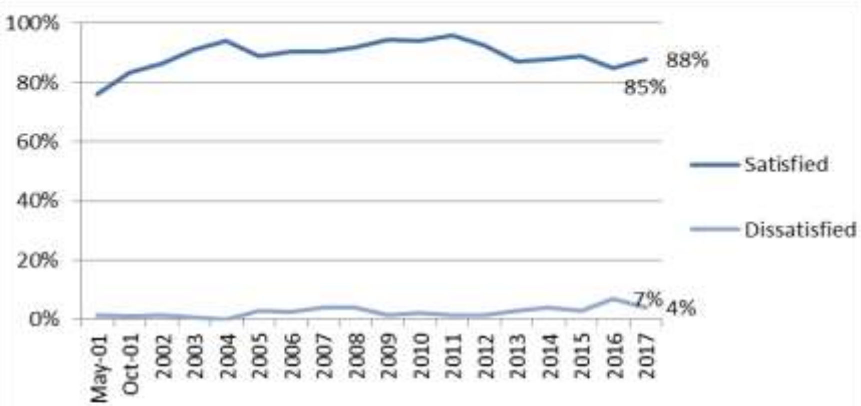


Figure 18: Consumer satisfaction survey results

However, (and conversely) approval ratings dropped in many individual categories and showed satisfaction ratings ranging from 90% (Discounts) to 65% (Directors) with a mean score of 80% across all individual performance measures – down 5% on the previous year.

It can be speculated that a dip in consumer satisfaction would be likely in the same year as the Kaikoura earthquake caused extensive network disruptions with more consumers experiencing extended and multiple outages, as exemplified in the long and multiple service interruption measures discussed earlier. Overall performance satisfaction remains relatively stable, as shown in Figure 18.

In the key network measure of reliability, ML's consumers scored 89% satisfaction over a year which included a major earthquake, a reduction from 96% the previous year. However, 89% satisfaction still provides a clear indicator that ML's consumers approve of ML's current level of reliability, which is driven off the business's reliability targets.

ML will continue to strive to achieve consumer satisfaction at >85% over future years. Although this figure is exposed to the inaccuracies of a relatively small sample size and the imprecision of human judgement, it is ML's belief that a strong focus on maintaining network reliability should continue to drive consumer satisfaction coupled with the standards of ML's service.

5.3 Cost performance

This section looks at the comparative costs of ML, to the extent that networks in different circumstances may be compared, and also examines the expenditure performance against forecast for the current (FY2018) year as promoted in the last AMP (published in March 2017).

5.3.1 Comparative cost performance

Network businesses may be broadly compared on cost as long as the limitations of such comparisons are recognised. In ML's case, it has an extensive remote area to manage in the Marlborough Sounds, sometimes requiring helicopter access and/or long hours of travel for staff thereby increasing its costs.

5.3.1.1 Total cost

The comparison of the relative costs of electricity networks needs careful consideration. By way of example any absolute comparison needs to take into account network age, condition, environment, level of reliability and the reasonableness of capital and maintenance expenditure. It is salient that postponement of prudent capital and maintenance expenditure is not a measure of efficiency, but postponement of a likely greater cost to a future date.

Appendix 11.7 discusses and compares EDBs on the basis of net revenue (income less pass-through costs) against the network services provided (line kms, transformation capacity, number of ICPs managed etc.) Whilst being an approximate measure of relative productivity, this shows ML plotting close to the mean line indicating that ML's total revenue is broadly in keeping, on a comparative basis, with the network services it provides to its consumers.

5.3.1.2 Direct opex

Direct opex is that proportion of operational expenditure spent directly on network assets (as opposed to expenditure operating the network and associated business support costs). Comparative performance of direct opex is discussed Appendix 11.7. This shows ML's direct opex is relatively high, although still within the confidence bounds of the regression model

Closer examination of the direct opex make-up reveals ML's high vegetation management costs largely account for the opex variance in this comparison. High per-km vegetation management costs are an issue for ML with some parts of the Marlborough Sounds network only accessible by boat, helicopter and/or on foot. However, the community value created by the improved reliability, approximately $0.9m as noted earlier, offsets these costs when considered more broadly.

5.3.1.3 Indirect opex

Indirect opex is that portion of operational expenditure accounted to the operation of the network (i.e. switching and system control etc.) and to the business support functions associated with running a network business. Comparison of ML's indirect opex in relation to other New Zealand distribution businesses shows ML plot close to the regression expectation when compared using normalisers of both number of consumers serviced and on regulatory asset base value. This indicates that expenditure in this category is at appropriate levels when assessed on a comparative basis.

5.3.2 Expenditure vs. budget

Projected expenditure (based on extrapolating February regulatory year to date 2018 account actuals) is set out in Table 12 and is compared to the expenditure projected in the last AMP for the FY2018 year.

Table 12: Summary of FY2018 expenditure vs forecast (constant FY18 $)

Item	Projected for FY2018 ($000)	Budget for FY2018 ($000)	% of forecast
Capex: Consumer Connection	230	408	56%
Capex: System Growth	233	0	0%
Capex: Reliability, Safety and Environment	3,793	3,009	126%
Capex: Asset Replacement and Renewal	5,058	6,375	79%
Capex: Asset Relocations	76	612	12%
Subtotal - Capex on network assets	**9,390**	**10,404**	**90%**
Opex: Service interruptions and emergencies	1,057	816	129%
Opex: Vegetation management	2,120	1,836	115%
Opex: Routine and corrective maintenance and inspection	2,473	2,448	101%
Opex: Asset replacement and renewal	785	612	128%
Subtotal - Opex on network assets	**6,435**	**5,712**	**113%**
Total direct expenditure on distribution network	**15,825**	**16,116**	**98%**

This shows an overall outcome of a 2% under-expenditure comprising 10% under-expenditure on network capital and a 13% over-expenditure on direct opex. Key reasons for the expenditure variance against forecast include:

- delays to capital expenditure projects from weather related events restricting site access and the ability to undertake the works;
- a delay to the Redwood Pass renewal project due to the landowner approval process taking longer than expected;
- further deferral of capital expenditure work due to continuation of opex work associated with damage from the November 2016 earthquake (noting that the higher priority work was addressed shortly after the earthquake, with lower priority work being undertaken later;
- introduction of dedicated asset inspection programmes (ring main units, DP boxes for example); and
- Introduction of field mobility solution for field inspections work.

5.4 Network continuance

To provide a safe and reliable electricity lines service the network must be managed such that its condition is not allowed to be run down. General assessments on whether the network is being properly managed in this regard may be seen in:

- the distribution of Asset Health Indicators (AHIs) applicable to each asset category;
- the expected lives and the consumption of those lives in the regulatory accounts;
- the age profiles in relation to the average industry age profiles; and
- the replacement capital forecast in relation to an age-based model forecast.

Asset Health Indicators are measures of asset health based on a set of criteria developed for a number of network asset categories. ML has recently adopted the AHI criteria developed by the NZ Electricity Engineers Association (EEA). AHI charts are provided in the fleet management section of this AMP and in Schedule 12A in Appendix 11.2 and show no issues of concern and with the majority of the network showing health indicators commensurate with the asset ages and their expected lives.

The other measures of network continuance are discussed within this section and demonstrate that, in overview, ML does not have an over-aged network, has an expectation for lives of its network assets in keeping with general industry practice and the level of replacement expenditure is broadly in keeping with the capital that would be spent by an average distribution business given the number, type and ages of ML's assets.

5.4.1 Expected lives and comparative age profiles

The chart of Figure 19 describes the spread of cost-weighted depreciation-based lives (in years) amongst the different EDBs; that is the average accounting based life expected for these asset classes.

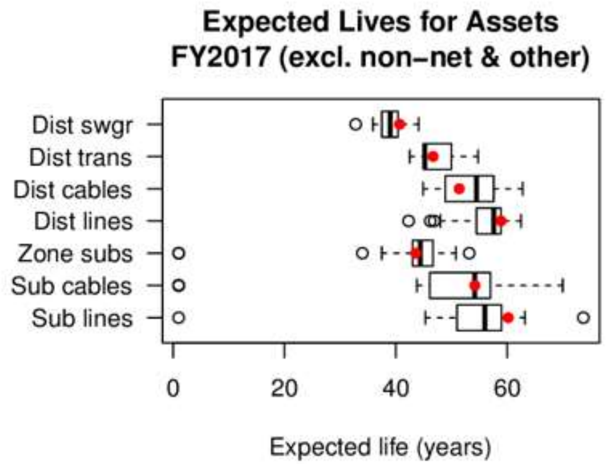


Figure 19: Comparison of expected asset lives

Figure 20 describes the spread of the percentage consumption of those lives.[9] ML's expected life and percentage consumption of that life is represented by the red dot points in the charts. ML show mostly within the +/- 50 percentile boxes for expected lives indicating that ML intend to achieve the asset lives commonly anticipated within the industry. In the comparison of consumption of life, ML show as being at or below 50% consumed life (against its own life expectation) apart from distribution lines, which are becoming marginally over-aged in average but this needs to be considered in the context of ML's environment.

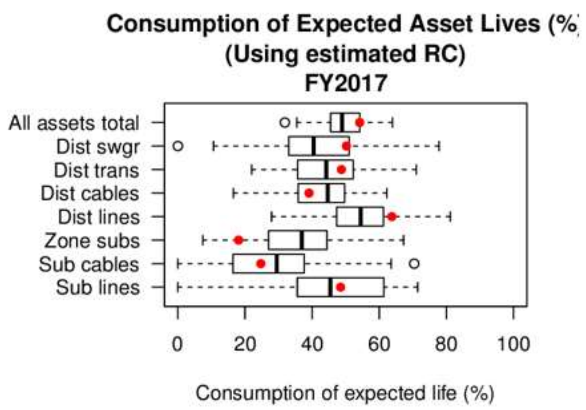


Figure 20: Consumption of asset lives

Further age information is depicted in the charts of Figure 21 (concrete poles) and Figure 22 (wood poles) which show the disclosed age profiles for ML's poles (red lines) in comparison to the New Zealand EDB's combined age profiles (blue dash lines).[10] The vertical yellow dashed line shows the accepted regulatory (ODV) life for each pole type.

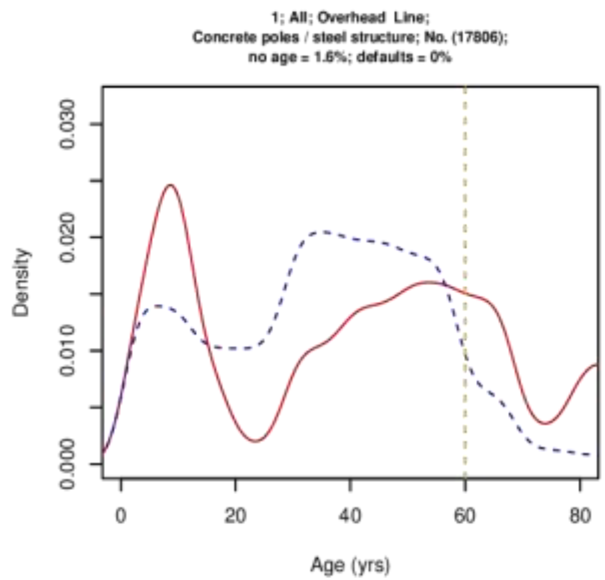


Figure 21: Comparison of ML concrete and steel poles vs New Zealand EDBs average

[9] We have used a calculation of life consumed based on the component depreciation and its depreciated life as there are issues with the regulatory disclosure values in their calculation. These are box-and-whisker charts; the boxes represent the 25th to 75th percentile bounds; the whiskers either the maximum or 1.5 x the inter-quartile length; and the chart circles the outlier points beyond that. Data is from FY2017 Information Disclosure Schedules.

[10] Age in years is on the x-axis and age distribution density on the y-axis. Density is used as the charts show the relative proportionality of asset quantities by age between ML and all NZ EDBs summed together.

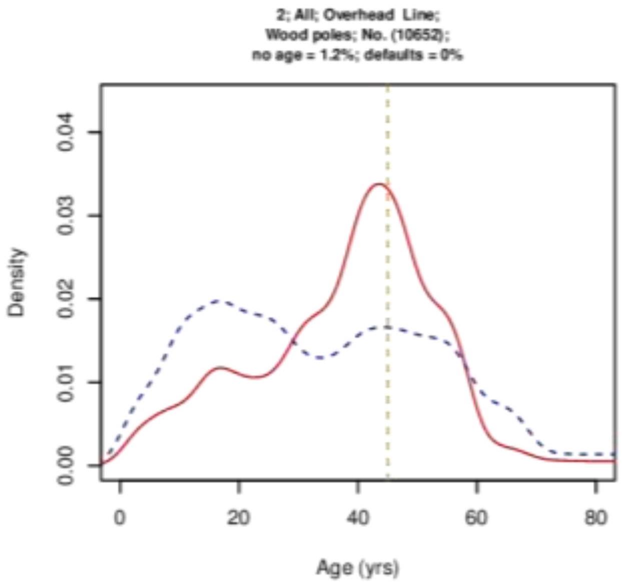


Figure 22: Comparison of ML wood poles vs New Zealand EDBs average

ML's concrete poles show a proportion of the population in excess of the NZ average age profile and indeed ML does have a significant number of reinforced concrete poles approaching 90 years of age. However, these poles are typically in reasonable condition and the final life expectation of concrete poles (pre-stressed pole in particular) is not yet determined as even the NZ average age profile continues to advance (age) almost year-for year. In ML's case, replacement of many of these older concrete poles will be co-incident with conductor replacements due to the increased conductor weight and the reconstructed line design code requirements.

Whilst ML does not have a large population of very old wood poles, its wood pole age profile is becoming weighted above 40 years. Wood poles in particular are considered to have increasing condition deterioration between 40 years and 60 years of age. ML must therefore prepare for increasing wood pole replacements on its network and the strategic enhancement of its condition inspection processes, described later in this plan, is part of that forward thinking together with the budgetary preparation for these works provided within ML's replacement capital forecasts.

Further analysis of the individual asset age profiles for ML's assets in relation to the all-NZ average age profiles for the same asset classes reveals no evidence of a substantive "backlog" of over-age assets on the network, all as further detailed in Appendix 11.8[11].

[11] Note that whilst the LV conductor age profile plotted in the Appendix appears overhung, approximately 65% of this conductor has no allocated age (unknown installation dates), and the model algorithm spreads this group over the older age bins (on the rationale that if it was newer, the ages would be known). This inevitably leads to error where the proportion of the total asset with unknown ages is large. The same applies to assets noted as having default dates but to a lesser extent as the allocated ages are likely to be better approximated. Uncertainty in the ages of LV assets is an issue across the majority of New Zealand EDBs.

Of note, however, is the HV conductor age profile which now exceeds the boundary of the NZ average age profile for HV distribution conductor and where further aging will lead to an age profile "overhang" under this comparative measure. This is illustrated in Figure 23 with the red plotted line being the ML HV conductor age profile and the blue dash line being the all New Zealand age profile for this asset class. In this

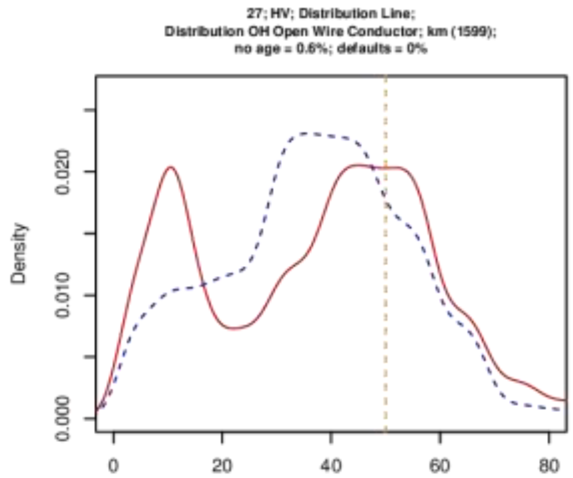


Figure 23: ML vs all NZ EDBs HV conductor age profile

AMP, ML signal the commencement of progressive conductor replacements of its older and at-risk conductor types such as galvanised steel and light copper based mainly on the risk assessments it has undertaken. However, this strategy is also supported in principle by this comparative age assessment as it shows ML's conductor replacement programme commencement is neither too early nor too late in relation to the experiences of other businesses.

Whilst age is a useful proxy, network components needs prudent consideration relative to condition, location and importance, and not age alone.

5.4.2 Replacement levels

ML's replacement capital forecasts are also supported by a "top-down" (repex) modelling based on the Hyland McQueen Ltd comparative benchmarking review of electricity distribution businesses for FY2017 using Disclosure data. The model applied considered the replacement probabilities with age of network assets under 51 categories and is determined using the combined age profiles of asset classes over all distribution businesses in New Zealand and how those age profiles shift in time. When applied to each business separately, the model indicates, in broad terms, the expected renewal and replacement capex forecast of the "average" New Zealand network business in the circumstances of the asset numbers and asset ages of the particular business.

When applied to ML, the model agreement in total is reasonable, as Figure 24, indicating ML's forecasts for replacement expenditure is not unreasonable in comparison to what other businesses might spend in its particular circumstances. The gradually rising model line is indicative that ML should anticipate similar to higher levels of replacement expenditure into the future to arrest its network ageing.

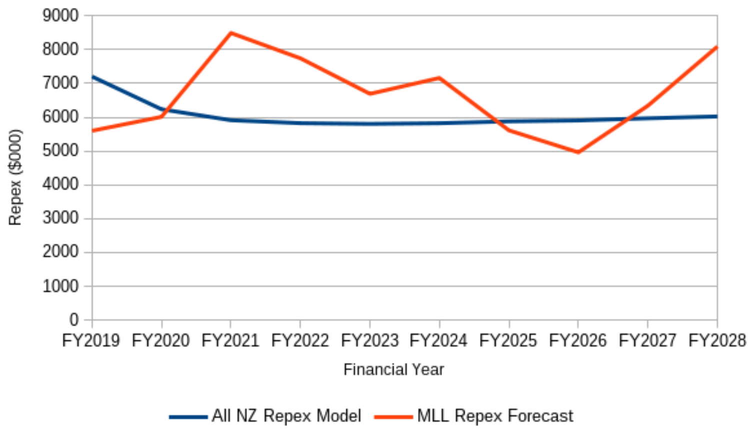


Figure 24: ML replacement expenditure – model and forecast

5.5 Utilisation and losses

5.5.1 Network losses

ML has the objective of pursuing the most efficient use of energy and its delivery over its network. Comparative network losses for all EDBs from FY2013 to FY2017 are examined in Appendix 11.7, section 11.7.4. This shows ML plots slightly below the network losses expectation given its circuit length and energy through-put in this comparative assessment. This analysis reveals no concern in terms of ML's network conductor sizing and circuit loading arrangements as it affects line losses as in general terms, the losses derived for the ML network are consistent with those expected for a network of this kind i.e. a predominantly radial network supplied from a single point of supply and with inherently fewer consumers per transformer than in a purely urban area.

ML's line losses are approximately 5% and this is relatively consistent from year to year. In this plan the target of 5% is set for the current planning period.

5.5.2 Capacity of utilisation

Appendix 11.7, section 11.7.4.2 describes comparative assessment of transformer utilisation (measured as the ratio of system maximum demand to the installed distribution transformer capacity) against a scale measure of energy density for each compared EDB. In this assessment, ML plot close to the regression expectation indicating that, within the limitations of this performance measure, ML's design practices for transformer sizing and loading appear reasonable.

ML's Capacity of Utilisation (CoU) has declined over recent years and is expected to decline further in the coming years. This is likely due to the continued take up of energy efficient appliances, distributed generation and continued growth of electricity connections that do not typically contribute to maximum network demand within the Marlborough region. For example, baches in the Marlborough Sounds and wineries and irrigation all require transformer capacity, but these loads make little or no contribution to maximum demand set during winter months, thereby reducing capacity utilisation. However, as discussed above, the capacity of utilisation plots close to the expectation line in comparison to other distribution companies when scaled against network energy density, particularly after adjustment for non-standard loads. The current target of 21% for transformer utilisation is therefore retained in this plan.

Overall the reality is that the utilisation of transformer capacity cannot be regarded as a primary indicator of network performance given the location and number of transformers on a network are largely a function of ICP location, physics of supply and consumer utilisation of connected capacity.

5.5.3 Load factor

Load factor is a measure of the constancy of the load as it measures the average load in relation to the peak load principally set by consumer demand not ML. Irrespective load factor can be influenced by the manner in which load control, primarily hot water cylinders, is used to limit peak demand. Currently, Transpower charges are based on the maximum demand on the Blenheim GXP at the time of maximum total demand of the upper South Island. This means that at other times, there is no financial incentive to cut hot water supply to houses. The result of this is to not limit maximum demand through load shedding during high load periods within Marlborough that are not coincident with upper South Island maximum demand. This provides benefit to the consumers as service is improved.

In the current circumstances, load factor is largely irrelevant as a performance measure and is no longer targeted or tracked.

5.6 Objective commitments

Through its SCI, ML also set other objective targets for its network business including:

- Consumer engagement
- ISO re-accreditations/audits
- Regulatory disclosures (due 31 March and 31 August)
- Return to shareholders

The performance against these objectives is included in the ML annual reports published against an accounting year ending 30 June and is available on the ML web site.

5.7 Business continuance

ML seeks to provide a commercial return to its shareholder, the Marlborough Electric Power Trust. By operating as a profitable business, ML ensures its continuance in providing an essential electricity service to its consumers and community. Figure 25 identifies the comparative rate of return[12] to New Zealand EDBs where MLs performance is highlighted both as disclosed (ML) and after accounting adjustment (ML adj) where the rebated consumer discount is added back for comparative purposes with investor owned companies and Trust owned companies which have operated with discretionary rather than a discount which is integral to ML's pricing.

As shown, in the more comparative (adjusted) assessment, ML's return on investment is modest but in keeping with other businesses.

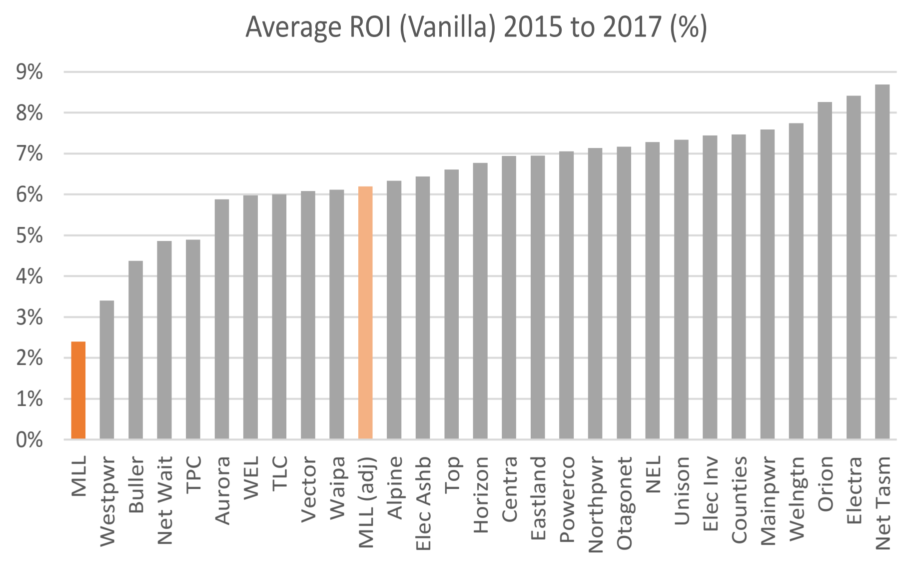


Figure 25: ML's comparative rate of return

[12] The rate of return has been adjusted from the regulatory disclosure to correct differences in the manner in which discounts to consumers are treated such that the rate of return may be compared on an equivalent basis with other businesses.

Clearly in addition to actual return this measure also reflects the level of investment. Hence in any comparison it is important to consider previous levels of expenditure, the condition of the network which will also determine future expenditure and is likely to impact on network performance.

5.8 Performance summary and response

The service level targets that ML has described and set within this Plan have been derived from a combination of consumer engagement, comparative assessment and a commitment to continuous improvement recognising the practical limits of a mostly radial network covering a mix of urban, rural and remote areas.

Consumer engagement arises from planned periodic focus group engagement, particularly with key stakeholders, and through annual satisfaction surveys on the consumer base. Whilst the latter cannot, by its nature, provide specific direction, it does through proxy support the network reliability and faults response that is being achieved through the internal performance targets that have been set.

Comparative assessment shows the network is achieving above expectation reliability while managing costs within expectation levels and that the network is not over-aged and will not become so provided ML manage its asset fleets through condition inspection and targeted replacement and through executing the renewal works set out in this plan.

System losses and the capacity of utilisation are of less interest to consumers than reliability although do ultimately impact on the cost of supply. To a large extent, the performance measures are a direct consequence of design standards and previous decisions on system configuration. Comparative assessment shows these measures to be consistent with expectations given the characteristics of ML's network.

This performance analysis reveals the following key directives:

1. To achieve its reliability targets, ML will need to keep up with its vegetation management programme as this has a significant impact on faults. Vegetation management costs are later forecast to be on a slightly decreasing path as second-cut costs begin to fall to the tree owners. But this expectation needs to be tempered with the consideration that the second-cut provisions of the Tree Regulations only apply to specific trees that have been cut not properties visited. And because of the limitations of the Tree Regulations a network company is only mandated to cut or trim a tree when it is within the prescribed growth limit zone.

2. That ML is entering a period requiring increasing replacement of aging assets, in particular poles and conductor.

3. That whilst reliability has been improving overall, and in urban areas in particular, ML can expect a decreasing reliability trend in the remote parts of the network driven by a potentially increasing fault count if assets were allowed to deteriorate. Aside from the economic issues of being forced to rebuild this uneconomic part of the network, proper targeting of renewal will require a greater focus on inspection and condition assessment as described later in this plan.

4. That no change in strategy is indicated as being necessary to achieve other performance targets such as line losses etc.

6. Asset management strategy

This section sets out the underpinning strategies that ML will employ to realise the asset management objectives it has set and the performance targets it endeavours to meet.

6.1 Overarching asset strategy

6.1.1 Asset management policy

ML will:

- always regard safety as the highest priority;
- define its supply quality targets principally by consulting its respective consumer classes, but also by considering other strategic, comparative, economic and regulatory drivers (as addressed in the preceding sections of this plan);
- achieve supply quality targets by maintaining existing assets and building new assets in accordance with ML's design and construction standards, prevailing engineering standards and best applicable industry practice;
- build and maintain its network and assets to minimise lifecycle costs, recognising that its owners are representative of its consumers; and
- seek to continuously improve its asset management practices to a level that is appropriate, and where priority will be given to strengthening the practices and skills which result in greatest benefit for stakeholders;
- ensure that the capacity of the network is sufficient to meet the expectations of its consumers.

6.1.2 Service levels

ML will:

- provide a safe environment for the public and staff by ensuring that its network is safe;
- continue meeting the service levels described in the performance analysis and service levels section of this plan;
- meet the minimum of statutory levels or agreed terms for supply voltage;
- follow its security of supply standards unless the required investment levels are inconsistent with good engineering practice and/or commercial criteria;
- endeavour to limit flicker to levels specified by AS/NZS 61000.3.7:2001, by educating and encouraging consumers to comply with this standard;
- endeavour to limit harmonics to levels specified in ECP 36:1993 and AS/NZS 61000.3.2:2013 by educating and encouraging consumers to comply with these standard;
- target an overall power factor of greater than or equal to 0.95 lagging at times of high load on the network and require that all ICPs meet this requirement;
- facilitate connection of embedded generation where it doesn't compromise safety, network operation, quality of supply to other consumers, or power factor. ML may require an embedded generator to pay the economic costs of connection, including var compensation, where these costs are consistent with Part 6 of the Electricity Industry Participation Code;

- interrupt supply to domestic consumers in preference to hospitals, industrial and commercial consumers for purposes of emergency demand management; and
- encourage and facilitate energy efficiency.

6.1.3 Asset Configuration

ML will:

- work with Transpower to minimise its fixed asset requirements commensurate with providing a reliable and secure supply to consumers;
- take a long-term view of asset requirements, noting that consumers ultimately benefit from well-planned investments;
- build all future sub-transmission lines insulated to at least 66kV;
- ensure that where possible, land purchases for new zone substations provide sufficient land to allow additional future transformer capacity to be installed;
- build all future rural distribution lines at 22kV;
- consider non-network solutions including demand-side management and distributed generation;
- use fixed generators on long radical feeders such as the those supplying the Marlborough Sounds to improve reliability of supply;
- seek opportunities to improve the network meshing for security and reliability where it is both feasible and economic to do so; and
- use mobile generators where feasible and economic to improve reliability and reduce the effects of faults and planned work on consumer's supply.

6.1.4 Resourcing

ML will:

- identify the required skill sets on a timeframe equal to this AMP and ensure that recruitment and training plans are consistent with its needs and, where appropriate, use relevant contractors;
- endeavour to procure resources locally, where and when appropriate;
- retain its current field services staff for fault restoration, inspections, maintenance and renewal work; and
- use contractors/consultants where its staff do not have the required skill sets, where resources are inadequate for its works programmes or where it is more cost effective to do so, e.g. specialist work such as civil engineering design and radio equipment installation and maintenance.

6.1.5 Materials

ML will:

- make safety the primary consideration in all purchases;
- only use, or allow onto its network, materials and equipment which meet recognised industry standards approved by its own internal standards and policies;
- endeavour to procure materials locally, where and when appropriate relative to cost and other considerations;
- reject offers that do not comply with its internal standards and policies, with relevant national standards, and/or with industry practice;
- consider the total lifecycle costs of network components when assessing offers;

- recycle materials where practical, taking into account the total lifecycle costs and overall risk;
- purchase timber products such as cross-arms and poles from sustainable and renewable resources; and
- consider all environmental impacts in the purchase and utilisation of all items in its operations.

6.1.6 Risk

ML will:

- adopt a risk-averse position, especially with regard to worker and public safety;
- regularly review its risk position using the prevailing standard ISO 31000:2009; and
- err on the side of over-investment in network capacity, recognising that under-investment can lead to supply interruption and that the overall economic cost suffered by consumers can be markedly greater than the cost of prudent investment taken before it is required. Within the network industry, waiting until the demand exists is too late.

6.2 Systems and information management

6.2.1 Business management processes and standards

ML recognises the importance of adopting best practice in its business management practices to undertake its work safely, efficiently and to achieve its objectives. It also recognises it is important to provide confidence and transparency to its stakeholders that its various management practices are consistent with required standards and best practice.

To this end, ML has sought and achieved certification for the following management systems:

- Quality – ISO 9001:2015;
- Environmental – ISO 14001:2015;
- Occupational Health and Safety – OHSAS 18001:2007; and
- Public Safety – NZS 7901:2008 (legislative requirement).

ML is actively working towards achieving Public Safety certification to NZS 7901:2014 (best practice).

The ISO 9001 Quality Management System ensures that ML's procedures and work practices meet with recognised industry best practice. Compliance with the system's procedures is integral to ML's operations and, as such, regular audits (both internal and external) are completed.

Through ISO 14001:2015 Environmental Management System, ML seeks the avoidance or mitigation of any adverse effects of ML's activities upon the natural and built environment as well as the local community. All areas of ML's operation have documented environmental policies and all staff are required to undertake their work in accordance with these policies.

Where appropriate, consultation will be undertaken to assist in obtaining the best possible outcome for all affected parties.

Because ML regards safety as an integral part of its business, it was one of the first New Zealand companies to achieve OHSAS 18001:2007 certification. This is in addition to ML's ACC Tertiary status, which enables ML to gain a 20% reduction in ACC premiums.

NZS 7901:2014 - Safety Management Systems for Public Safety, is designed for organisations to develop a safety management system that operates to safeguard the public (including property) from safety-related risks arising from the presence or operations of ML's assets. Accreditation to this standard also enable ML to be exempt from some prescriptive requirements within the Electricity (Safety) Regulations in favour of its own risk-managed practices.

During the planning period, ML intends to remain certified with the above standards and to obtain certification to the following standards:

- ISO 45001 - Occupational Health and Safety Management Systems. This will effectively replace existing BS OHSAS 18001:2007 and is designed to help organisation improve employee safety, reduce workplace risk and create better and safer working conditions.
- ISO 55001 - Asset Management. This standard is a framework for an asset management system to help organisations proactively manage (including associated risks and costs) the lifecycle of assets from acquisition to decommissioning.

Expenditure associated with obtaining certification to ISO 55001, and ensuring that existing accreditations are maintained is included under the system operations and network support budget.

6.2.2 Information systems

Information systems have become key to the performance of almost all modern organisations and therefore need to be planned and managed. ML has a suite of information systems which have all been configured and developed for its needs. The systems are primarily used to house and manage asset data; that is then used to drive many of the network activities. Table 13 highlights ML's key systems, their roles within the organisations, some of the more significant data that they hold and how these systems integrate together.

Table 13: Overview of Asset Management Information Systems

System Name	Description	Functionality/Usage	Integration
Infor's EAM	Asset and works management system.	Project and work order records including preventative maintenance programmes. ML's primary database for electrical and non-electrical assets, and work management used for analysis and reporting.	Data sharing between ArcGIS and EAM to ensure consistency in asset information. Integration between Estimator and Daybook for project / work order records.
Milsoft Utility Solutions	The Milsoft suite of products primarily allows management of electrical outages (duration, consumers affected etc.).	Electrical connectivity model – capacity and load calculations, electrical network analysis. Outage management – recording and reporting of service interruptions and duration. Ability to log consumer calls.	Integrated with ArcGIS (spatial model and selected assets).
ESRI's ArcGIS	Primary resource for managing spatial information of assets.	Spatial information, e.g. assets in certain areas (geographical or billing areas for example), reporting. ML is currently trialling an Esri mobility application to facilitate asset data capture in the field.	Data sharing between ArcGIS and EAM and ArcGIS and Milsoft to ensure consistency in asset information.
DMS' IntraMaps	Map viewer of electrical assets and other map features.	Used by many staff to confirm location of assets and use other map features (aerial imagery, property information etc).	The information available in Intramaps is based on that which is held in ArcGIS.
Technology One's Financials	Financial record keeping.	Records and reporting of expenditure on projects and works by cost type and category.	EAM to Financials integration – when a work order is created in EAM it integrates to Financials to create a corresponding record which financial information is then recorded against.
Estimator	Bespoke software developed for ML to allow creation of cost estimates for jobs based on material picks lists, labour and plant inputs etc.	Preparation of cost estimates for projects and works for review by ML network.	Integrated with EAM. Estimator receives project/work records for estimating from EAM.
Electronic Daybook	Bespoke software developed for ML to allow the scheduling of human and plant resources to projects and works.	Human and plant resource scheduling.	Bi-directional integration with EAM to create unscheduled job records in Daybook and to update status of work orders in EAM based on scheduling in Daybook.
Gentrack's Velocity	Revenue and billing.	Velocity is used to hold consumer connection information and is used for billing purposes.	No integration.

Table 13: Overview of Asset Management Information Systems

System Name	Description	Functionality/Usage	Integration
Microsoft Excel	Spreadsheet files containing asset information.	Spreadsheets containing asset data not deemed appropriate for inclusion in asset management systems; often project or task based.	No integration.
Mango Live	Repository for key health and safety and other documentation.	Repository for policies, procedures, standards, incidents, forms and staff training register/competencies (some of which relates to asset management at ML).	No integration.
SCADA	Database for equipment which is SCADA enabled.	Allows remote operation of SCADA enabled network equipment.	Integrated with Milsoft – switches opened/closed in SCADA open equivalent equipment in Milsoft for outage recording purposes.

The primary asset management system at ML is EAM, an asset and works management program, which has been available for use from October 2015. EAM consists of a series of modules built around a central asset register of over 110,000 equipment records that make up ML's network assets. The functionality covered by these modules includes:

- asset creation, modification and deletion;
- asset attribution and attribution history;
- management of ML's capex projects (creation and management of project records and information);
- management of ML's opex works (creation and management of opex tasks and information), including preventative maintenance tasks; whereby future works are pre-determined and managed by the system;
- integration with ML's financial system; and
- GIS (map viewer) integration.

Most asset information is contained in EAM with the GIS (ESRI) containing the spatial (location) data. A third system, Milsoft, manages the connectivity of electrical assets, manages outage data and allows for engineering analysis of the network. The three databases are synchronised, i.e. they contain data in common and new data is entered into each system simultaneously through a database interface.

Asset Information, such as cable type and distribution transformer capacity is contained within EAM, as well as asset heirarchical structure details. Information on connected ICPs is contained in Velocity's software 'Gentrack' and ML's electircal connectivity software Milsoft.

Reliability and regulatory reporting uses the asset relationships to determine any ICPs affected by an outage. This module has been configured to suit the information disclosure requirements of MBIE and the Commerce Commission.

For each fault, the time, the consumers affected and the operation of assets is recorded and the network reliability figures (i.e. SAIDI, SAIFI, etc) are calculated based on the connectivity model and consumer connection data. This information is generally tracked within Milsoft.

The network is inspected every five years (annually for assets in public places) and the condition and other asset information updated accordingly.

Vegetation is inspected annually in forestry and in areas such as the Marlborough Sounds where growth is rampant and there is a need to minimise the rise of fire.

6.2.3 Asset data and data quality

Asset management at ML is heavily dependent on accurate asset data. The storage and management of asset records, including various asset attributes, is fundamental in ensuring that appropriate asset management decisions are made. This pertains to the operations of the assets, maintenance regimes for various asset classes, and assessing renewal of assets based on factors such as age, condition and criticality.

6.2.4 Asset data

ML holds records of over 110,000 electrical assets. Along with this, records of non-electrical equipment such as plant, vehicles, office furniture and equipment, and field tools and instruments, are recorded and managed. The assets are separated into distinct classes (for example, poles) and categories (for example, treated pine). The attributes held by assets varies by class.

The information that is recorded and managed by ML is based upon the following requirements and purposes:

- Safety. Having knowledge of asset's location and their condition is imperative in facilitating the safe operation of the network.
- Reliability. Knowing the types of assets (including the manufacturer for example), the location of assets, their condition, how they relate to other assets and are connected to and within the network allows the assets to be managed effectively to assist in minimising failures and resulting outages on the network.
- Regulatory. ML is required to disclose certain information (age and condition for example) under specified asset categories.
- Expenditure. Managing asset records allows for analysis of cost trends and determining internal cost rates and therefore to the effective planning of maintenance and/or renewal activities.

Asset information is largely managed by Engineering, GIS and administrative staff in ML's main office. Changes to assets (and some asset components in the field) are recorded by field staff, and passed back to ML network staff to update the asset management system(s) as appropriate.

ML reviews and updates the information held through adding attributes for various assets when and where it becomes apparent that there would be benefit in holding that information. An example of this is the recent (FY2018) review of pole inspection data. Apart from zone substations, ML manages relatively high volumes of low value assets which are geographically dispersed making invasive inspection techniques uneconomic and, as such, this lessens the scope for data collection to mostly visual inspection records.

Whilst each asset type has unique attributes, ML generally determines the data it collects from a framework of failure modes and consequence assessment. For example, spalling on a reinforced concrete pole generally has to be extensive for the pole strength to be affected, but even a small exposure of the steel cables within a pre-stressed concrete pole are considered grounds for repair or replacement. ML's inspection templates reflect these different asset-specific risk assessments.

ML also utilises information disseminated from organisations such as Electricity Engineers Association (EEA) and Electricity Networks Association (ENA) to identify particular asset types that may exhibit specific failure modes or symptoms, as experienced by other businesses, which may be monitored for.

6.2.4.1 Data locations

The types of data held in the various information systems is set out in Appendix 11.9.

6.2.4.2 Data limitations

While ML endeavours to maintain its asset data as complete and correct as possible, there are general limitations (gaps) to this. These include:

- The occasional challenge in getting accurate and consistent asset information data following fault events. There is the potential for this information to be overlooked when the physical works themselves (including making sites safe and the restoration of supply from outages) takes primary focus. ML has addressed this challenge by drafting a revised as-built standard which specifies what information needs to be captured by field staff when changes to assets (or sometimes asset components) are made. ML is actively communicating the importance of recording changes to assets in the field through the roll out of the new as-built standard.
- Legacy data. ML's network was first established approximately 90 years ago. It is unreasonable to expect that data has always been captured in the manner required by current standards. Records have been lost at times, or during the transfer from one asset system to another, data may have been compromised or lost, meaning that asset records today are not always entirely complete and accurate. Whilst the existence of visible assets is known, for a small proportion of assets, the installation date (for example) may be unknown. ML believe it has a good understanding of the asset information that is not complete or correct, i.e. ML believes that it knows what it doesn't know. ML does not have a programme of retro-populating this data as, in most cases, there is no viable way to determine it or the costs of doing so are prohibitive.

More specifically, known data limitations include the following:

- Aerial conductor condition data. There is no practical means of assessing conductor condition other than visual observations (which do not always provide sufficient information). As such, conductor condition is generally assumed based on type, age (where known), location and operational experience. This limitation may result in the risk-based rather than condition-based renewal of conductor where renewal is based on type, age and location (and hence deterioration risk) along with the condition of the supporting poles. A recent failure in the Wairau Valley of deteriorated conductor, which upon review was deemed to be improperly bound in when installed, highlights the difficulty of determining conductor condition.
  The installation age of ML low voltage (mains) overhead conductor is not detailed in records, although this is a common issue across the whole industry for this particular asset class.
- Underground cable condition. Condition assessment of cable can only be undertaken through cable testing. However, some types of testing cables is known to prematurely age them and results can be uncertain, so for the purposes of assessing condition alone, cable testing of distribution cables is generally not undertaken by ML. As such, other than testing infrared emissions at cable terminations, cable renewal is largely based on age, failure consequence and operating history of the cable sections.
- Underground cable location. ML has a policy to ensure that any new cables installed are accurately plotted on plans using GPS. However, historically there are cables whose plotted location is less accurate.
- Pole condition. Pole condition is assessed during routine inspections/condition assessments. ML in recent years has trialled various pole testing methodologies (including Porta Scan, Pole Scan and the Thor Hammer) with limited success (the results of ML's testing were inconsistent and therefore inconclusive). As such, pole testing is generally undertaken by digging around the pole, sound testing with hammer impact and/or visual observation. This has obvious limitations and results in subjective and usually conservative assessments. Conservatively assessing the condition of poles may result in their risk-based rather than their true condition-based replacement. However, a risk-based approach in assessments is deemed more favourable than the alternative from a public safety perspective and is in keeping with ML's approach to prioritise safety. ML constantly monitors industry practice and pole testing innovations and will review it practice should the situation change.
- Timeliness of inspections. Due to the extent of ML's network, and in particular the remoteness and difficulty in accessing many parts of it, asset condition assessments can be expensive to undertake. While asset data is critical in achieving ML asset management objectives, there is a balance to be met in achieving appropriate quality data against the cost incurred in obtaining and managing such data. ML periodically reviews its data management systems and processes to evaluate where improvements could be made in data quality and data management that are both useful and cost effective.

6.2.5 Communication and participation processes

Asset management practice is communicated internally to staff and externally to other stakeholders through ML's policy and standards and this AMP which is publically disclosed.

ML has a suite of documentation relating to asset management practices which sit within ML's asset management system. Some of the key documentation is summarised in Table 13. Figure 13 in Section 4.3.1.4 highlights the interaction of the asset management system with other key components of ML's business such as the SCI and the annual works plan.

Table 14: Summary of communication asset management processes/documentation

Processes/ systems/ plans within asset management system	Description and Purpose	Stakeholders and communication of processes/systems/ plans	Management of processes/systems/plans
ML Integrated Management System (IMS)	ML has its own comprehensive IMS system. This includes a number of policies and procedures relating to asset management held and available through Mango.	Some policies and procedures contain content about the engagement and management of Consultants and Contractors working on the network. ML's staff attend regular meetings whereby a Policy/Procedure from the IMS system is reviewed. The ISO system is run through as part of new staff induction. Monthly senior management meetings review any issues arising from policies and/or procedures within the IMS system.	Each Policy/Procedure within the IMS system is internally reviewed on an annual basis. Similarly, an external audit is undertaken on the IMS system annually.
ML Network Design Standard	ML has its own network Design Standard which is driven by safety and recognised good industry practice, and is used by ML staff primarily in designing infrastructure (assets) for and on the network.	Internal design team, in-house Contracting department, external Consultants engaged by ML. Network design standard made available to staff through Mango Live.	The standard is reviewed and updated internally on an as needed basis.
ML Maintenance standard	ML has its own Maintenance Standards. These are used to specify processes and procedures relating to the maintenance of assets on ML's network. This includes inspection requirements and frequency.	The document is communicated to relevant staff by the network Engineering Manager.	In-house management of the maintenance standard by ML's Network Engineering Manager.
ML Construction Standard	ML has its own Construction Standard which its own internal contracting company use for constructing (installing) and maintaining equipment on the network. This standard is disseminated to external contracting staff also, as appropriate.	Internal design team, in-house Contracting department, external Contractors engaged by ML. ML will instruct external contractors as part of the procurement process that works are to be undertaken in accordance with applicable elements of ML's standard.	The standard is reviewed and updated internally on an as needed basis.

Table 14: Summary of communication asset management processes/documentation

Processes/ systems/ plans within asset management system	Description and Purpose	Stakeholders and communication of processes/systems/ plans	Management of processes/systems/plans
Other relevant industry Standards	Designs should be undertaken in accordance with relevant industry best practice (i.e. following current applicable standards). Examples of this are the construction of new switch room buildings, or foundations supporting sub-transmission poles in soft ground. Consultant engineers engaged by ML are required to undertake design in accordance with relevant industry standards, one such example would be the AS/NZS 1170.5: 2004 – Structural design actions, Part 5: Earthquake actions. Another would be AS/NZS 7000: 2010 – Overhead line design: Detailed procedures.	ML staff work to applicable standards – the internal standards are formulated on the basis of applicable national/international standards.	ML is a subscriber to Standards New Zealand. ML receives electronic notification when relevant standards are updated.
Asset Management Plan (including AMMAT)	Summary of assets and their management for the next ten year period.	Numerous stakeholders. AMP is publically disclosed.	Regulated by the Commerce Commission. Internally reviewed and updated and signed-off by the Board.

6.3 Compliance

One of the key drivers of ML's asset management strategy is the need to comply with legislative requirements. The following list is a selection of some of the key legislation (Acts and Regulations) relating to ML's asset management activities:

- Health and Safety at Work Act 2015
- Electricity Act 1992 (including subsequent amendments)
- Commerce Act 1986
- Utilities Access Act 2010
- Energy Companies Act 1992
- Companies Act 1993
- Electricity (Safety) Regulations 2010 (and subsequent amendments)
- Electricity (Hazards from Trees) Regulations 2003
- Various Electrical Codes of Practice (tied to the Electricity (Safety) Regulations)
- Resource Management Act 1991

There are many other pieces of legislation and/or regulations pertaining to ML's activities (for example Employment Relations Act 2000), however, they are not included here for the sake of brevity.

MLs procedures and policies are written to comply with legislative requirements and are updated as the legislative requirements and codes are revised.

ML's senior management regularly review ML's legislative compliance and reports are provided to the Managing Director monthly and the ML Board on a quarterly basis. Any legislative breaches will be reported to the ML Board as they occur.

6.4 Risk management

6.4.1 Risk management process

Risks can be highly variable in their nature and scale – the conveyance of electricity (ML's core function) potentially involves significant health and safety hazards the risks of which must be mitigated. But ML is also exposed to considerable business related and other forms of risk. To ensure that risks are managed and exposure remains within acceptable levels, ML has adopted a systemic approach to risk management through following the Australian/New Zealand standards ISO 31000:2009 *Risk Management* and NZS 7901:2014 *Electricity and gas industries – Safety management systems for public safety.*

ML's risk management procedure is expressed in its internal standard IPR61 last revised in August 2017. At the same time, ML also engaged insurance consultants Marsh Limited, to assist it in fully revising its major risks.

Figure 26 shows the risk management process suggested by ISO 31000 and adopted by ML:

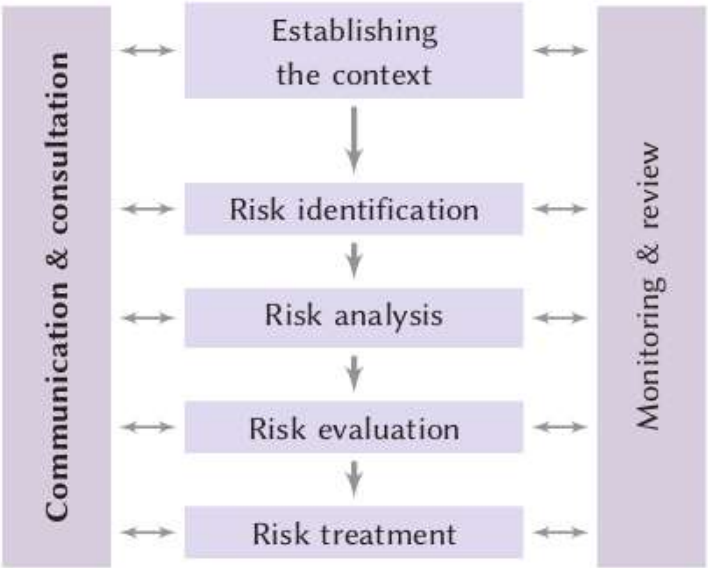


Figure 26: Risk management process overview

This process has five key steps:

1. Establish the risk context
2. Risk identification
3. Risk analysis
4. Risk evaluation
5. Risk treatment

These are supported by a framework for:

- Risk monitoring and review, and
- Communication and consultation with stakeholders.

6.4.1.1 Risk context

The above process allows for the effective management of all risk types affecting ML. The definition of risk based on ISO 31000 is the effect of uncertainty on objectives. So when considering risk and risk management at ML, it is important to place these in relation to the organisation's objectives expressed through its Vision and Mission statements and its Statement of Corporate Intent, all as described in section 4 of this AMP.

The risk management process considers all risks relative to the operations of ML, which are broadly grouped into the following risk category types:

- Health
- Safety
- Public Safety
- Quality
- Environmental
- Financial
- Reputational
- Business Interruption; and
- Regulatory Compliance

6.4.1.2 Risk identification

At ML, risks are identified by a variety of methods including (but not limited to):

- On site checklists, prior to starting work (tailgates);
- Re-assessments during the day as the work environment changes;
- Regular visual hazard inspections of work areas;
- Analysis of accidents/incidents or near misses;

- From internal and external feedback;
- Condition assessment of the network to identify public safety risks;
- External information from specialists;
- Risk workshops;
- External risk reviews; and/or
- Industry information.

Identified risks are reported into MANGO (either directly by employees or from paperwork provided to the Contracting Administration Manager).

6.4.1.3 Risk analysis

Once risks have been identified they are analysed to:

- Identify the source and cause of the risk;
- Assess current controls and their effectiveness, and identify any gaps;
- Consider how likely the risk is of occurring and what the impacts are (likelihood and consequences); and
- Determine the risk rating (Likelihood x Consequence).

ML uses the risk criteria and matrix described in Appendix 11.9 to analyse risks. This categorises likelihood into 5 categories (from rare to almost certain) and consequence also into 5 categories (from insignificant to catastrophic). This analysis is performed on the "raw" (uncontrolled) risk, and then again on the "controlled" (mitigated) risk.

ML's risk profile can then be mapped onto the matrix described in Appendix 11.9, which allows ML to see which risks its needs to focus the most attention on (e.g. risks that fall into the Red and Amber categories – its Priority 1 and 2 Risks).

6.4.1.4 Risk evaluation

Once a risk has been analysed it is then evaluated based on the outcome of the analysis and against the risk assessment criteria to:

- Escalate to the necessary reporting levels;
- Prioritise risks;
- Consider options for managing risks;
- Decide what action is required; and
- Identify resources required to manage the risks.

6.4.1.5 Risk treatment

Risks are treated either through elimination, or the application of controls to reduce the likelihood and/or the consequences of the risk occurring. ML endeavours that the controls put in place will reduce the risk to a tolerable level, and ongoing monitoring and review is undertaken to verify that.

For non-health and safety related risks, treatments may avoid, transfer, reduce, remove or modify (or in rare instances, accept) the likelihood and/or consequence of risk(s). Non health and safety risks may be treated in a variety of ways including combinations of treatments. Some examples of controls include (but are not limited to):

- Changing policies, systems and processes
- Changing plant and equipment
- Redesign
- New or different technology
- Training and education
- Inspections or increased inspection frequency
- Testing
- Insurance

In accord with the Health and Safety at Work Act 2015, when determining the appropriate control to effectively manage a health and safety related risk, a specified sequence of controls must be followed to ensure that all practicable steps are taken to eliminate or minimise the risk. Detail in relation to health and safety risk management is included in ML's separate procedure document CSM6 – Risk/Health and Safety Management.

6.4.1.6 Risk registers

ML maintains an electronic central risk register (in MANGO). The centralised register contains risks in the broad category types as listed in ML's risk context above. Health, Safety, Public Safety, Quality and Environmental risks are held in the MANGO register. Financial, Reputational, Business Interruption and Regulatory Compliance risks are recorded in a separate register held by the Chief Financial Officer with oversight from the Managing Director and the Directorate.

6.4.1.7 Risk monitoring and review

ML has a proactive approach to public safety, safety to its staff, contractors and consumers.

Regular surveillance and monitoring relative to safety is undertaken in respect of all network assets, e.g. ongoing measurement of line heights, inspections of substations, inspections of pillar boxes, and aerial and ground surveillance of lines and vegetation in proximity to the line.

Network Standards prescribe the standards to be followed in respect of network surveillance.

Serious incidents and near misses are investigated in accord with the recognised ICAM procedure to identify the cause and enable the prevention of such events in the future.

The importance of both lead and lag indicators relative to safety is recognised within ML with an emphasis on proactivity.

The performance of the network and the effectiveness of the work programmes relative to health and safety are regularly reviewed by the ML's senior management and where appropriate change affected.

These reviews focus on ensuring that the controls in place are effective and efficient. Notifications of risk reviews are triggered from MANGO, and records relative to reviews are maintained in MANGO. For Business Wide Risks that fall into the Priority 1 and 2 categories, a report is generated from MANGO and circulated with IMS meeting papers for review and discussion.

6.4.1.8 Communication and consultation

Risk evaluation and communication is integrated within all parts of ML's daily operations and processes including Board meetings, Health and Safety Committee meetings, team meetings, training, visitor and employee induction, inspections etc. Where appropriate specific meetings are held with industry groups, e.g. wineries and vineyards relative to the utilisation of grape harvesting equipment in the proximity of power lines. Other avenues for communication are set out in the risk management procedure IPR61.

6.4.2 Key risks

At time of writing ML has on its risk register five Priority 1 risks and 16 Priority 2 risks that it is managing as further detailed in the following tables.

6.4.2.1 Priority 1 risks

Risk source	Risk type	Risk drivers & controls
Products/ services	Damage caused to another party as a result of the goods / services supplied.	Inherently the hazards within an electricity distribution system are ever-present for third parties. ML identifies and takes all practicable steps to reduce the risks emanating from the hazards. In terms of public, the risks are perceived protection from electrocution, fire and ensuring that the mechanical integrity and operation of the network is such that no person is harmed. Fire and subsequent damage to third parties. Controls: - Preventative maintenance (asset inspections, vegetation inspections and subsequent trimming/cutting, possum guards that are twice normal industry height, change in cross arm configuration, increased insulation for transformers and substations); Around 50% of lines do not have trees within falling distance. - Quality line construction, e.g. in exposed areas typically lines are constructed with individual “shackled off” spans rather than simply being installed on pins. - Renewal of identified at risk (weak) conductor. - Approximately 50% of 33kV lines do not have trees falling within distance. - Installation of ground fault neutralisers. - Reclose blocks during periods and in areas of high fire risk.
Staff and Contractors	Potential harm activities (e.g. working at height, live electricity, working in confined spaces etc).	Risk of electrocution and falling from height have been the principal cause of harm within the electricity industry. Controls: - All hazards are identified in the Company’s Hazard Register together with the measures necessary to mitigate risk through taking all practicable steps. - Company Safety Manual. - Company operating procedures including PPE, switching instructions. - Maintenance of an effective safety culture. Helicopter lifting and securing guidelines.
Staff	Employees carrying out work offsite / remotely that put them at significant risk.	Lone working on private property. Working alone in remote areas. Controls: - Smarttrak tracking of employees (GPS location). - Radio and satellite radio communications. Company operating procedures.

Risk source	Risk type	Risk drivers & controls
Public	To/ from trespassers (including children)	Unauthorised access into substations, cable boxes or other electrical equipment. Controls: - Physical security (walls, fences, barbed wire, warning signs, locks, cameras). - Access security (access cards). - Safety by design.
Public	Large crowds at public events	Large crowds such as events, where ML has supplied electrical assets or advice relative to temporary power supplies. Controls: - Appropriately trained staff. Use of appropriate equipment.

The common characteristic of these Priority 1 risks is the breadth of the exposure situations and therefore the difficulty of managing the risk likelihoods.

6.4.2.2 Priority 2 risks

The priority 2 risks relating to asset management are listed in the following table.

Risk source	Risk type	Risk drivers and controls
Technology	Emerging technologies and alternate power sources (e.g. advent and increased use of electric powered vehicles; photovoltaic and large battery storage facilities).	Combination of micro generation (PV, wind) and battery storage may in the future enable consumers to disconnect from MLs distribution network. Controls: - Ensure provision of highly reliable service which provides benefits of consumer load diversity and flexibility in relation to consumer demand. - Ability to modify pricing. Increased utilisation of electric vehicles is likely to enhance the need for efficiently operated electricity networks.
Products / services	Key dependencies on the services of others to ensure on-time supply.	Transpower failure to supply – have three lines supplying ML. Two 110kV lines are on the same tower (from Stoke). Each of the two lines can supply ML 100%. The third line (110kV from Kikiwai via Branch River power scheme), on a separate tower line, can supply 60% to 70% of power. Also, failure could occur in the three Transpower transformers or switchgear or the nine 33kV feeders into ML. Failure to supply has also resulted from problems elsewhere within the National Grid such as at Islington substation. The towers and conductors can be impacted by extreme wind, snow, earthquake, rock fall, landslide, fire and smoke, terrorism. Controls: - Transpower have contingency plans for emergency conditions. - Transpower can helicopter in a spare pole. - Marlborough is supplied over two routes by three 110kV circuits.
Assets	Major accident/incident (e.g. fire, earthquake, tsunami, storm, volcanic).	Earthquake - causing property damage and prevention of access. Controls: - Construction (seismic) standards. - Network layout/configuration. - ML uses earthquake fault line information in planning around critical assets. - ML has an Emergency Preparedness Plan. - ML owns a range of quality vehicles and special plant for utilisation in emergency situations. - ML radios are installed within local helicopters.

Risk source	Risk type	Risk drivers and controls
Assets	Flooding – rivers, flash flood events, embankment failures, bridges etc.	Floods (e.g. embankment failures) - causing property damage and denial of access to ground mounted equipment. Controls: - Network layout/configuration. - Design standards and processes. - Avoid low lying equipment design.
Assets	Malicious damage.	Substations, key poles, earth wires could be a target. Controls: - Secure access to sub-stations, perimeter fencing (electric), buildings alarmed, non-combustible building construction used. - Regular surveillance. - Public awareness.
Financial	Contingent liabilities.	Claims e.g. fire compensation/suppression, loss of continuity of supply. Controls: - Network preventative maintenance established (tree cutting programmes, inspections and monitoring).
Financial	Uninsured loss exposures.	Uninsured Property: Lines and poles, transformers, switch gear, SCADA systems. Uninsured Business Interruption: Revenue. ML's assets are spread over a wide area and it is extremely unlikely that a single event would destroy every asset. Hence the diversity of the location of the network inherently provides some protection. Construction standards and the robustness of equipment used limit damage to key high value assets.
Terrorism, Riots, Insurrection	Uninsured loss exposures.	Measures are taken to prevent unauthorised access to network assets within practical limits. ML will work with law enforcement agencies as appropriate should such unlikely events arise.

6.4.3 Risk mitigation initiatives

Aside from the ongoing surveillance and monitoring of all aspects of ML's network and operations four mitigation projects pertaining to risk are set out in this plan:

- The establishment of Tapp substation as a replacement to Renwick zone substation. Whilst coinciding with Renwick approaching its N-1 rating, and having older equipment, the primary driver for this project is to move this substation further away from the ground rupture fault trace of the Wairau fault and thereby improve network resilience and mitigate the earthquake risk exposure. This work commenced in FY2018 as a consequence of information which became known following the 2016 Kaikoura earthquake and is expected to be completed in FY2019.
- Commencement of the programmed renewal of at-risk conductor (copper and galvanised steel) which is becoming aged. This renewal programme will mitigate public safety and fire ignition risk due to an otherwise anticipated increase in conductor faults if no action is taken.
- Installation of further ground fault neutralisers (GFNs) into substations to minimise fire risk and enhance public safety. Over the period of this Plan it is intended to install such equipment in the 33/11kV substations at Linkwater, Seddon, Renwick, Rai Valley, Spring Creek and Leefield.
- Review of the seismic strength of ML’s 2-pole distribution substations, particularly in urban areas.

6.4.4 Contingency planning

ML’s Emergency Preparedness Plan documents procedures for use in the event of major damage to the network. It contains information on Transpower, the 33kV system, the zone substations, the 11kV lines, supplier’s contact details, staff, consumers including those on medical support and other information which may be useful at times of emergency. Contingency planning is regularly reviewed with consideration given to various “what-if” scenarios. This helps to ensure that the network is prepared and that staff are well trained for any eventuality.

ML operates a 24/7 fault service, with sufficient staff available to ensure appropriate responses to most foreseeable events on the network. As was demonstrated with the 2016 Kaikoura earthquake the culture within ML staff is such that all make themselves available at times of emergency regardless of position. The availability of resources within Marlborough is necessary because invariably at the time of extreme events road access to Marlborough is cut off. For a major event such as a severe earthquake, ML would expect to utilise resources external to Marlborough.

ML is involved in Civil Defence and emergency management activities in conjunction with the Marlborough District Council and other key community groups. Liaison is, in the first instance, through the emergency services groups of each organisation. Regular meetings between ML and the other groups are held to review and assess current plans.

Civil Defence involvement is not restricted to natural disasters, but includes any event – planned or unplanned – which disrupts the Marlborough area.

Following on from the Christchurch Earthquake Sequence, ML reviewed the Emergency preparedness plan and the location of the control room. An emergency control room is available at ML's Springlands site, and another could be quickly setup at the Taylor Pass site. An emergency repeater has been purchased to allow communications to be quickly re-established in the event of loss of the existing repeater.

The radio system is interlinked with backup provisions to maximise its reliability. Over the life of this Plan it is intended to further strengthen the radio infrastructure in recognition it is the backbone of ML's network communications.

ML is part of the group of South Island lines companies that have agreed to a Mutual Aid Cooperative in the event of major disruption to individual or multiple networks.

6.5 Lifecycle management

ML considers its network assets within a lifecycle framework that covers the assets from design and purchase through operation and maintenance and finally to renewal and disposal. The goal of lifecycle management is to maximise the utility of the assets while minimising total cost over the life of the assets. Examples of this include the natural trade-off between cost and quality/capacity and purchase cost and the total operating costs over the assets lifetime.

Practical examples include;

- Ensuring that all distribution transformers in salt prone areas have galvanised tanks and longer insulators; and
- The provisioning of new distribution lines with 22kV insulation which can be achieved at marginal cost on component purchase and installation but yield improved reliability (and hence utility) over the asset lifetime as well as hedging for future load growth that is unlikely to be accommodated though network meshing and would be expensive to undertake later by upgrading to much heavier conductor.

In addition to work undertaken on the assets, it is also necessary to maintain access to the assets and the environment around the assets (for example keep trees clear of overhead power lines and keep open tracks to switches). For ML, a significant part of the maintenance budget is allocated to the maintenance of access tracks and vegetation control.

Network assets are exposed to wind, corrosion and other environmental effects and therefore deteriorate over time, albeit at different rates. Indeed, asset type and age can be a key predictor in assessing the general state of the network although it is often unreliable in predicting the particular state of any single asset. To minimise total lifecycle cost, the cost of condition inspection is balanced against the cost of premature replacement and the costs and risk from asset failure with the latter often being significantly larger for electricity conveyance assets.

6.5.1 Key strategies

6.5.1.1 Condition-based maintenance

ML undertakes a condition-based maintenance programme centred on regular inspection and testing of network equipment. The programme has the following major aims:

- To ensure the safety of staff, consumers and the general public.
- To achieve a reliable, secure system in accordance with service levels and consumer expectations.

- To comply with all aspects of ML's environmental policy.
- To identify required corrective maintenance before failure.
- To minimise the total cost of ownership and maximise the efficiency of ML's operations.
- To satisfy all legislation requirements.

ML endeavours to achieve these aims by undertaking prudent maintenance on a timely basis, while also ensuring that unnecessary maintenance is avoided. It is a process of continuous improvement and one that will become more effective over time. ML endeavours to purchase quality new equipment with minimal maintenance costs to assist with both future reliability and to minimise the total cost of ownership.

By way of example the 12 transformers at the major 33/11kV substations are fully sealed with nitrogen to prevent the ingress of air laden moisture which has the potential to impair the integrity of the insulating oil and the need to maintain the usual breathers is eliminated.

Typical maintenance tasks on critical equipment include the following classes of activities:

- Identification of any abnormalities.
- Maintenance in accord with manufacturer's requirements.
- Checking and/or replenishment of grease and insulation components such as oil, SF6, vacuum.
- Checking and minor repairs or replacement of semi-consumable components e.g. brushes, contacts, gaskets, seals.
- Checking and minor repairs to breakable components e.g. sight glasses.
- Calibration of components such as thermocouples, protection relays etc.

The key criteria for these tasks are that they restore the original service capacity or utility - they do not increase that capacity or utility.

6.5.1.2 Asset replacement and renewal

ML's policy is to obtain maximum value from each asset, without compromising safety and reliability. Allowing assets to run to failure is generally not a viable strategy given the safety considerations incumbent to electricity conveyance. As such, most (but not all) network assets are renewed when condition assessments detects they no longer possess the ability to meet their design requirements. Small pole-mount distribution transformers would be an example of the exception where run-to-failure would be considered as acceptable because the failure and safety consequences are usually minor.

Being mindful of minimising total cost, ML may choose to replace assets early where there is advantage to that through the economies of scale in undertaking whole line section renewal i.e. where most but not all poles and components in the line section are assessed in poor condition. Such a strategy is economically efficient due to the one-off project and site set-up costs especially in rural and remote locations.

Much of the existing network was developed in the 1960s and 1970s and accordingly would, without prudent maintenance, reach the end of its useful life over a short span of time. ML has long recognised this and its policy is to spread renewal expenditure to maximise efficiency and achieve consistency in operations. It is possible to defer this type of expenditure, however that runs the risk of increasing failures (incumbent with safety and liability consequences), attendant increased costs and the possibility of inadequate resources available to correct the problem in a timely manner.

ML must continually and systematically renew its assets if it is to remain a viable business into the future. It should also be noted that replacement of assets is not always straightforward. Consultation with stakeholders is both important and may represent the longest activity in the time scale of executing the works. It can take considerable time to reach agreements with stakeholders such as land owners over access and asset configuration and forward planning is essential.

In general, asset replacement and renewal is prioritised towards areas where parallel renewal drivers exist, for example, low capacity or low strength lines, ties between substations without (n-1) reliability, safety concerns, and/or assets that are expensive or difficult to maintain (e.g. iron rail poles).

Consideration is given to making assets 'smarter' on renewal. Developments in smart grid technologies are making new assets easier to monitor and operate remotely, which is an advantage when assets are difficult to access in a timely way.

6.5.1.3 Routine maintenance and inspection

Where possible, ML prescribes time based condition monitoring over time based servicing. Benefits of condition monitoring are:

- Increased visibility of an asset's health.
- Ability to identify trends across asset groups.
- Maintenance actions become more timely (and therefore efficient) as they are driven by asset condition.
- Ability to identify, plan, prioritise and defer preventative maintenance works.
- Ability to assist in planning future CAPEX work.

Monitoring schedules are prescribed tasks designed to detect potential failure conditions. The schedule is determined by balancing inspection frequencies against potential failure interval and the cost of the monitoring activity against the cost of asset failure.

Most of the preventative maintenance is planned within EAM's Work Order Planning module. Each asset type has a preventative maintenance plan defined for it.

A plan is made up of a list of assets the plan applies to and a series of schedules. A schedule is a set of tasks undertaken on a regular interval. The inspection interval may be based on time between inspections or other units of measure like run hours or number of operations. For efficiency, tasks with similar intervals at the same site are packaged together.

The due date for each task is updated based on one of two methodologies:

1. **Variable:** The task is due in one period from the previous occurrence's completion date. This method is generally used for schedules that have a high cost per task occurrence e.g. out of service tests on a power transformer.

2. **Fixed:** The task is due in one period from the previous occurrence's original due date. This method is preferred for schedules with high task occurrence rates, due to either large asset populations or relatively short task frequency. In this case there is greater efficiency to be gained by grouping tasks in a similar geographical area rather than strict adherence to maintenance frequency.

During routine maintenance, field staff undertake a condition assessment on each asset that then leads to a condition score based off the definitions[13] in Table 15.

Table 15: EEA's AHI scores (with definitions)

AHI category	Meaning
H5	As new condition – no drivers for replacement
H4	Asset serviceable – no drivers for replacement; normal in-service deterioration
H3	End of life drivers for replacement present; increasing asset related risk
H2	End of life drivers for replacement present; high asset related risk
H1	Replacement recommended

These scores are the Asset Health Indicators (AHI) levels promoted by the EEA and which ML has adopted.

6.5.1.4 Corrective maintenance

Asset conditions scored Grade 1 (H1) are reported immediately through to the Control Room. A brief risk assessment is undertaken and appropriate reactive work put in train. This may include emergency shutdowns.

[13] Condition scoring and definitions from Commerce Commission and EEA guide to Asset Health Indicators.

Defects on assets scored Grade 2 (H2) and corrective tasks identified by the field staff are assessed by the maintenance team. Corrective tasks are raised as a "work request" work order in EAM. These tasks are then prioritised based off a risk assessment as follows:

Consequence of functional and/or secondary failure in terms of:

- Risk to public safety;
- Risk to reliability (number consumers affected, restoration time, availability of alternate supply);
- Risk to environment; and/or
- Cost of asset replacement.

Probability of failure is assessed in terms of:

- Known asset health;
- Defect severity;
- Asset environment; and/or
- Predicted "time to fail" based on field experience.

The risk based approach gives priority to serious defects, assets serving large numbers of consumers, specific high-value consumers, or places where public safety is a concern. This system ensures that at all times, corrective maintenance is being performed efficiently and the most critical tasks are the ones being focused on.

The corrective action to be undertaken is determined by:

- Risk to operator safety (during action);
- Risk to service levels (during action);
- Labour and material cost of action; and/or
- Remaining asset life (post-action).

ML uses GIS to plan and schedule maintenance. Outstanding corrective maintenance tasks are plotted within a GIS viewer, on top of the affected asset. This enables corrective maintenance to be grouped geographically and scheduled alongside known planned outages, thereby improving efficiency.

ML is in the process of rolling out a mobile module into EAM. This will allow field assessments to be recorded on electronic tablets rather than the current paper based system. This shift to 'go mobile' will see a decrease in costs associated with data processing and allow for faster communication of asset health through to management.

6.5.1.5 Maintenance levels

Maintenance tasks are categorised by a maintenance level. These levels act as a rough guide to the complexity of the maintenance task. Maintenance levels also provide an indication to the level of access required to complete the task required. Maintenance levels used at ML are described in Table 16.

Table 16: Maintenance level definitions

Maintenance Level	Level Code	Description	Definition
1	SHI	Security and Hazard inspection	Examples include: • Zone Substation Building inspection. • Distribution Transformer visual inspection.
2	ISCA	In Service Condition Assessment	Assessment or testing of an asset based off a predetermined criteria whilst the asset is in service. Examples include: • Earthing System resistance test. • SF_6 switch pressure gauge reading.
3	OSCA	Out-of-Service Condition Assessment	Assessment or testing of an asset based off a predetermined criteria whilst the asset is out of service. Dependent on task, may require an access or test permits. Examples include: • HV cable Tan delta Testing. • Circuit Breaker Functional Test.
4	NIM	In Service / Out of Service Non-intrusive Maintenance	Maintenance activity where access to compartments containing HV conductors is not required. I.E access/test permit not required Operational control or NESS may be required. Examples include: • Substation cleaning. • Ground Mount Switch Operational Test.
5	OSIM	Out of Service Intrusive Maintenance	Maintenance activity where access to compartments containing HV conductors is required. Access or test permits required. • Circuit Breaker Maintenance. • Tap Changer Overhaul.
6	SS	In Service / Out of Service Specialist Survey	Surveys undertaken by specialists generally external to ML. Task is usually non-standard and will require a dedicated health and safety plan approved by the Operations Manager. May require Access or Test Permits. Examples Include: • Partial Discharge Survey. • Earthing System Review.
7	PFM	Post Fault Maintenance	Assessments, testing or maintenance required on an asset after a fault has occurred.
8	OSM	Other Specific Maintenance	Other Items that don't fit into the above categories. Systemic reviews fit in this category. Examples include: • Earthing system classification review.

6.6 Vegetation management

6.6.1 Overview

Vegetation management makes up a significant component of ML's non-network expenditure. It is necessary to maximise public safety including minimising fire risk and maintaining reliability of supply by preventing interference to lines and the provision of access to network assets. ML's network extends through heavily vegetated areas, including many parts of the Marlborough Sounds, where vegetation growth rates are typically high which in dry summers exacerbates the fire risk. Expenditure includes relatively frequent assessment of the network to establish where vegetation is encroaching (or approaching encroachment of) ML's overhead lines. It also includes the liaising with land owners with subsequent first-cut costs borne by ML associated with the physical trimming or felling of vegetation and related network support activities (such as provision of mobile generation to allow continuing operation of the network if large shutdown areas are required to enable the vegetation work to be undertaken).

6.6.2 Legislation

Current legislation[14] specifies minimum distances that vegetation must be clear from overhead power lines 'growth limit zone' with distances varying depending on voltage and conductor span length). The legislation also stipulates that electricity distribution networks shall advertise suitable safety information to vegetation owners in appropriate publications as well as contacting those owners whose vegetation is at approaching, at or exceeding the specified minimum distances.

The current tree regulations are considered to be unduly prescriptive rather than principles based and consequently they are ineffective in remote rural locations where tree growth is rampant and fire risk can be extreme, and it is impracticable to measure growth limit zone many metres above the ground where the vegetation is dense.

Vegetation owners have the option of taking ongoing responsibility for maintaining vegetation outside the minimum distance(s), or granting the line owner (i.e. ML) approval to maintain the vegetation outside the minimum distance by appropriate trimming or removal. ML must cover the costs of the first trim of an individual tree, along with appropriate record keeping, liaison and advertising. The costs associated with subsequent trims are to be borne by the vegetation owner. However the same process of cut and trim notice has to be repeated for every individual tree on a property. And a network owner has no mandate to remove a small tree from under a line but must wait until it encroaches within the growth limit zone before any action can be taken.

6.6.3 Risks with vegetation management

In practice, this legislation is not leading to optimal outcomes. The growth limit zones are not adequate for ensuring safety of the public in relation to trees particularly with trees of high growth in rural and remote environments. In many rural situations the Tree Regulations do not enable a network operator to protect the lines from trees and or eliminate the risk of fire. In addition, the complex formulas require

[14] Electricity (Hazards from Trees) Regulations 2003.

detailed and costly survey work to be undertaken if landowners require strict adherence to the legislation.

Of particular concern to ML are the areas of forestry plantations in the vicinity of ML's network, of which there are many in Marlborough[15]. Forestry plantations naturally involve high volumes of large trees which have the potential to damage ML's network and/or cause fires. The minimum distances specified in the legislation are impractical to measure and manage on such a scale and provide minimal protection to ML's network.

Trees are one of the significant causes of outages on the network. The current tree legislation only permits minimal clearances and removal of vegetation within the prescribed growth limit zone. In areas of high growth, this means that the limits are quickly exceeded after trimming, thereby requiring frequent return visits and high ongoing costs. These costs are further exacerbated in the remote area of ML's network where access is difficult and the work is undertaken at significant height resulting in relatively high costs of mobilising to work sites.

Upon advice from the Rural Fire Authority, ML inhibits the automatic reclosing of supply at times of specified high fire risk, which typically occurs during dry summers. This action has the potential to result in prolonged network outages, however, a fire is deemed to be a much greater threat to the public and so ML will willingly compromise network reliability in the interests of public safety.

Another concern ML has is with vegetation owners who put themselves at risk by carrying out the vegetation trimming or felling work themselves. In some instances when ML notifies vegetation owners of the requirements to maintain minimum distances to overhead lines, against ML's advice, the vegetation owners themselves carry out the work, placing themselves at risk of electrocution or as already occurred in Marlborough at risk of causing a fire which has resulted in loss of homes and property.

6.6.4 Vegetation management strategy

ML proactively undertakes routine inspections of the network to identify areas where vegetation has the potential to (or already is) breaching the minimum specified legislative distances. The inspections are criteria driven – factors such as asset criticality (i.e. 33kV vs 11kV vs low voltage) rural vs urban, topography and land use are considered to determine the frequency of inspections for various areas of the network. The inspections are undertaken by vehicle, boat, foot, or in remote/inaccessible areas by helicopter. Because of the potential for extreme fire risk in the summer months, inspection of these high risk fire areas is undertaken at least annually. Whilst more frequent inspections increases cost, this is balanced by the risk mitigation on this very significant risk to ML.

Records of vegetation that present a risk to ML's network are established and managed within EAM in a similar way to an asset, i.e. a record is created with attribute data and specific location details assigned to it. Liaison with the vegetation owners then occurs as appropriate and where applicable work packs are designed and

[15] Forestry is a significant industry in Marlborough with over 70,000 hectares planted.

compiled to allow either ML or external contractors to undertake the corresponding vegetation control work.

Despite the inadequacies of the tree legislation, ML has directed its efforts to minimising risk of vegetation interference by where possible obtaining greater clearances than those provided by the legislation with the cooperation of vegetation owners. Obtaining greater clearances than the minimum values specified in legislation reduces the potential for network damage, reduces the frequency of inspection required (and subsequent re-trimming of vegetation) and enhances the safety of landowners.

Ideally ML should expect its expenditure on vegetation management to reduce over the planning period because many initial cuts have been undertaken but it is anticipated there will be further trees requiring attention. Further detail on this is provided in Section 9.13.4.

6.7 Surveillance

As noted previously, asset surveillance (inspections, monitoring, testing and condition assessments) is a major input to determining the health of the network assets and provides ML with information that can be used to assess safety risks and reliability issues. There does however, have to be a balance struck between repeated surveillance and condition or time based servicing or replacement. Factors to be considered include:

- expected asset conditions and environment;
- setting the surveillance period in relation to the known defect rate; and
- balancing the cost of the surveillance activity against the cost of life extending maintenance or replacement or the consequences of asset failure.

Where asset defects are identified from surveillance, there are a number of approaches that can be considered depending upon the circumstances. These include:

- planned asset replacement;
- remove asset from service;
- increase frequency of monitoring;
- plan preventative maintenance work, including additional diagnostic testing;
- reprioritise existing works; and
- do nothing and continue to survey at normal frequency.

The approach adopted will principally be governed by risk of failure, public safety and then the criticality of the asset with respect to network reliability, cost of replacement and the cost of more frequent re-inspection in relation to earlier renewal.

6.7.1 Fault recording and analysis

ML records faults within the Milsoft outage management system (OMS). Details, like time of occurrence, the asset that failed, failure type/cause (where known) and external conditions are recorded against each failure event. Each failure recorded can assist with establishing trends for the remaining in-service population and provide drivers for replacement or maintenance campaigns. In depth analysis of faults is prioritised by the impact on network reliability and the potential risks to safety that might be exposed by the fault.

6.7.2 Inspections

The majority of ML's surveillance comes in the form of asset inspections performed by field staff. Due to the spatial sparsity of ML's network - the Marlborough Sounds in particular - the cost per asset of field inspections is high. Time is taken upfront determining what the right data is to collect and how to get the right quality of data out of inspections and to optimise the time (and cost) spent in the field collecting the data.

As part of a wider mobility project, ML is in the process of rolling out electronic inspection forms which will assist in boosting the data quality and turn-around time for inspections. The inspections undertaken are largely based on ML maintenance standards which have recently been revised and are now being implemented.

The data quality of the majority of ML's asset surveillance is affected by the proficiency and consistency of the field staff undertaking the work. We recognise the way to build and maintain proficiency is through education, training and support for ML's asset inspectors and analysts.

ML endeavour to keep clear, open lines of communication between its asset management and field staff to ensure the inspection process is undertaken within a continuous improvement cycle.

6.7.3 Digital mobility

ML has just recently implemented a field mobility platform for asset inspections. This is enabling field staff to capture asset data in the field directly onto tablets and smart phones instead of the traditional approach using pen and paper. The early results are encouraging, with significant work flow savings having removed significant paper work and double handling of data.

Other features that ML is looking to roll out within the scope of the mobility initiative include field access to digital work and policy documentation, to network asset information and to ML's geographic information systems.

The benefits ML expect to see from this approach are:

- better access to information resulting in improved operator safety;
- improved communication channels between project management, engineering and field staff;
- removal of the requirement to double enter inspection data, resulting in faster inspection turnaround time and improved data quality;
- less time spent on preparation of printed documentation for site visits;
- improved confidence in system data;
- better planning decisions based on better data quality;
- reduced revisits to sites to collect missed information;
- ability to assess progress in the field through real time field tracking; and
- increased opportunity to group tasks in the same area.

Going forward ML will give consideration to how this may be utilised elsewhere across field work – capturing of as-built data would be an example of this.

6.7.4 Online monitoring

ML's SCADA system provides measurement and logging of the network utilisation and system events, which can be used to identify unusual operating conditions and indicate accelerated service based aging.

The data provided from online monitoring can reduce the requirements of on-site work and inspections and allows ML's Operations team to respond faster to abnormal conditions on the network.

ML's online monitoring systems currently operate almost exclusively on the sub-transmission and 11kV distribution systems.

Increasing amounts of small scale solar generation is being embedded into ML's LV networks. In order to monitor the effect of this technology on our power quality service levels, ML is likely to want to improve its electrical surveillance of the low voltage reticulation. It may be possible to utilise this monitoring infrastructure as part of a future network congestion management scheme Examples of online monitoring that ML undertakes on its 11kV and 33kV network are in Table 17.

Table 17: Types of online monitoring

Telemetry Type	Measured at	Used for identifying	Relevant Assets
Current	Zone Substations Recloser Sites Switch Rooms	Asset failure (Electrical protection) Thermal Aging Network utilisation and growth	All electrical assets Transformers Cables Overhead Conductors
Voltage	Zone Substations Switch Rooms Recloser Sites	Asset failure (Electrical Protection) Abnormal operations conditions	All electrical assets
Temperature	Power Transformers Generators Plant Rooms	Thermal ageing Abnormal operating conditions	Transformers Generators Power factor correction equipment
Oil/Fuel Pressure and levels	Power Transformers Generators	Abnormal operating conditions Leaks	Power Transformers Generators
Operation counting - Cyclometers	On load tap changers Generators Circuit Breakers	Service wear	Power Transformers Regulator Transformers Circuit Breakers Generators

There is an upfront cost of establishing online monitoring of new assets including the communication systems required to transfer the collected information into Company databases but ML believe the benefits in improved surveillance outweigh these costs.

When procuring new assets for installation on the network, ML has a preference for products that have the ability to be remotely monitored.

6.7.5 Engagement of external parties and external reviews

ML engages external resources for specialist activities. These tasks generally require skillsets and experience that is not available within ML.

Examples include:

- civil and mechanical engineering design;
- technical surveys for zone substation earthing systems;
- thermographic surveys; and
- partial discharge surveys of switchgear and cables.

ML also regularly engages consultants and auditors to independently review and provide quality assurance of its systems.

6.8 Network development strategy

ML undertakes development expenditure in a timely manner to ensure that appropriate levels of network service and reliability are provided in accordance with consumer expectation and in line with organisational strategies.

ML has adopted a range of planning processes and technical and engineering standards to ensure that the assets placed to meet service levels meet the following requirements:

- Meet the load demands of is consumers.
- The safety of its public, consumers, staff and contractors.
- Maximise efficiency of operations.
- Prevent unnecessary investment.
- Be undertaken in an appropriate timeframe.
- Minimise risk of long-term stranding.
- Comply with regulatory requirements.
- Maximise operational flexibility.
- Maximise the fit with organisational capabilities such as engineering and operational expertise and vendor support.
- Comply with environmental requirements.
- Be appropriate to environment, e.g. service in the Sounds fits within the context of low consumer density.

For example, a fundamental criteria considered for 11kV/415V transformers is the maximum demand and delivery of required voltage. Transformers of 200kVA, or greater, are monitored together with other transformers as appropriate and any transformer where the indicated load exceeds the transformer rating is considered for upgrade. Other options such as rebalancing, and or moving load to other transformers are also considered. Other factors taken into account are the load duration, i.e. how often the transformer is close to, or above its ratings, and the time of day and year of the highest loadings.

Increases in load are then reflected in planning upstream through the various classes of ML assets back to the Transpower GXP. The load on all 11kV feeders, zone substations and the 33kV feeders is continuously monitored and the data is used for system modelling and project planning purposes. The planning criteria (“trigger points”) for each asset class are described next.

6.8.1 Trigger points for planning purposes

ML has a broad range of criteria that represent trigger points for action across its varying classes of fixed assets.

These are summarised in Table 18.

Table 18: Summary of planning trigger points

Asset Class	Capacity Criteria	Reliability Criteria	Security of Supply Criteria	Voltage Criteria
400V reticulation network	Conductor or fuse rating.	Blenheim CBD – 50% of load restored within 0.5 hours of fault, 100% within 1 hour. Elsewhere – restored within repair time.	(n) security of supply for standard residential or commercial connection.	Voltage falls below minimum regulatory voltage or 0.94pu at consumer's point of supply based on 1st percentile and 99 percentile.
11kV/400V distribution substation	Transformer rating (kVA).	Blenheim CBD – 50% of load restored within 0.5 hours of fault, 100% within 1 hour. Elsewhere – restored within repair time.	n security for most subs, with rapid transformer replacement, or use of mobile generator.	
11kV distribution network	Current exceeds 90% of thermal rating for more than 15 hours per year.	Meshed Feeder - 50% of load restored within 0.5 hours of fault, 100% within 1 hour. Radial Feeder – repair time.	(n-1) security for most of the urban 11kV network. (n) security for rural 11kV network.	Voltage falls below 0.95pu for more than 100 hours per annum.
11kV distribution hardware	As appropriate to equipment. Not to exceed maximum rating.			
33/11kV zone substation	Firm capacity available 98% of the time, i.e. can exceed firm capacity for 2% of time.	50% of load restored within 2 hours of fault.	(n-1) > 5MVA (n) < 5MVA	Able to cope with 0.85pu to 1.05pu on 33kV network and provide 11.2kV on bus.
33kV sub-transmission network	Current exceeds 66% of thermal rating for more than 1,500 hours per year.		(n-1) > 5MVA (n) < 5MVA	>0.85pu at all zone substations connections with 1.0pu at GXP.

6.8.2 Standardising assets and designs

The Network Standards document the design and construction of network assets. The Network Standards are used for all assets where ownership and/or maintenance responsibility will ultimately rest with ML.

The Standards contain information and drawings to be used in designing network assets and detail the procedures for design approval and construction. These standards and policies help to ensure that public safety is considered at the design stage and assist ML in meeting its obligations under the Electricity (Safety) Regulations 2010. They also assist in providing assets of appropriate quality to ensure that the reliability of supply is maintained or improved, consistent with the requirements of the Commerce Commission.

ML, along with a number of EDBs within New Zealand, has access to, and the use of, the PowerCo Contract Works and Network Operations guide. Where it is suitable, material from these standards is used to develop ML's own standards. This also increases the standardisation across the industry.

ML is also part of a group of South Island network companies buying group for cable, line hardware and store items. This has led to cross-company standardisation and reduction in the number of store items, unit costs and inventory held.

ML is a member of the Collective Network Operations Group, which includes all south island lines companies. The purpose of the group is to work towards common access processes, documentation, competency training and assessment, consistent operational requirements and emergency plans.

Table 19 summarises some of the key strategies for standardising assets and designs at ML.

Table 19: Summary of standard strategies for assets/design

Asset category	Standardised features	Standardising methods
Sub-transmission lines Sub-transmission cables Distribution and LV lines Distribution and LV cables	Conductor – standard suite of conductors/cables to be selected from – generally available conductor/ cables.	ML Design Standard. Any deviation from standard suite of conductors/cables included in standard needs specific Network review and management approval.
Distribution substations and transformers	Size of transformers (if pole mounted) generally dictate size of pole to support them. 'Off the shelf' models selected – nothing bespoke to ensure consistency across network.	ML Design Standard.
Distribution switchgear	Selection generally from preferred suppliers of off the shelf goods – bespoke options avoided unless exceptional circumstances warrant.	ML Design Standard. ML preferred suppliers list.
Poles	All new concrete poles to be pre-stressed type. Any loading changes to iron rail, hard wood, larch or lattice tower poles will result in the pole being replaced. Select from approved pole manufacturers and from limited pole types only.	ML Design Standard. Relevant utility pole standards to apply to all new poles regardless of type.
Other network assets	Generally procure from preferred (i.e. pre-approved) suppliers.	ML preferred supplies list. ML Design Standard.

6.8.3 Strategies for asset efficiency

ML monitors losses and consider losses when looking at the system configuration and network development. In practice, the physical considerations (e.g. conductor size and pole spacing) and the requirement to deliver regulatory voltage tend to take priority at the asset design and construction phases of the lifecycle and this determines the losses.

Demand management also plays a part in energy efficiency. Where trends indicate future increases in demand for example, then this is factored into the capacity of new or replacement transformers.

ML specifies the level of power factor required to be met by users of the network to maximise the efficiency of utilisation. Similarly maximum harmonic levels are specified for consumer installations.

ML considers energy efficiency when purchasing and replacing transformers and the cost of the fixed and variable losses over the life of the transformer are considered.

Lines pricing is designed to incentivise consumers to install transformers of an appropriate rating, however, in many cases, consumers and their consultants prefer to over specify transformer capacity in anticipation of future requirements (thus increasing standing losses).

Energy efficiency initiatives also pertain to electricity users. ML has interposed Use of System Agreements (UoSA) with Energy Retailers. This means that ML does not have direct access to consumers and therefore has less ability to influence end-user behaviour than the energy retailers but as a local Company provides advice to ICP's through newsletters and advice directly to consumers.

6.8.4 Setting asset capacity

The theoretical starting point for quantifying new capacity is to build "just enough, just in time", and then add incrementally over time. However ML recognises the following practical issues:

- The standard size of many components, which makes investment lumpy.
- The ability of ML to obtain a commercial return on investment.
- The one-off costs of construction, consenting, traffic management, access to land and reinstatement of sealed surfaces, which may make it preferable to install additional capacity rather than have to return in the short to medium term. This is especially the case when it is considered that network assets typically have long lives, far in excess of the regulatory period and the 10 year horizon of this Plan.
- The addition of extra capacity can, in some cases, require complete reconstruction, for example where larger conductor requires stronger poles or closer pole spacings, leading to considerable increases in total cost of ownership if an incremental approach is used at the outset.
- The need to avoid over-load risk. Over-load can lead to asset failure, reductions in service and reductions in asset lives.
- In terms of some items, such as power transformers and underground cables, the marginal cost of providing additional capacity for the future is typically small relative to overall project costs.

ML's guiding principle is therefore to minimise the level of investment ahead of demand while minimising the costs associated with doing the work as well as the total cost of the asset over its lifetime. This recognises that the costs of investment in advance of requirements is far more preferable than investment after failure has occurred or consumer supply is lost.

Generically in determining capacity requirements, ML monitors and reviews loading data across the network (and specific areas depending on what is being considered) and assesses trends in data, liaises with other relevant stakeholders in the district (for example the Marlborough District Council around its development plans), whilst reviewing existing infrastructure and any current capacity restraints. Considering these (and other) factors in combination is generally the best approach for determining capacity.

More specifically at the asset level, more detailed criteria are considered in determining asset capacity. Some of these are summarised in Table 20.

Table 20: Summary of criteria used to determine capacity of network assets

Asset category	Criteria to determine capacity*
Sub-transmission Lines	Loading, growth forecasting, health and safety considerations. Surrounding land use (man-made or natural environment), climatic conditions, topography.
Distribution and LV Lines	
Sub-transmission Cables	
Distribution and LV Cables	
Distribution substations and transformers	Expected demand within next 10 years, taking into account diversity.
Distribution Switchgear	Expected future fault and load levels – generally only available in step sizes
Poles	Conductor mechanical loading (i.e. size of conductor and span lengths drive pole size), environment, loading from other sources (i.e. steady state and/or dynamic loads).
Zone Substations - Transformers/ Switchgear/ Buildings	Current loading, expected future growth and demand forecasting.

* Note – not an exhaustive list.

6.8.5 Prioritisation of development projects

In prioritising development work, ML looks at the estimated cost and the benefits that the expenditure will bring. Consideration is given to why the work is required and accordingly, the benefits to stakeholders that undertaking it would provide. Work with the greatest ratio of benefits to costs are undertaken first. In assessing the benefits the various reasons are given a weighting as per Table 21:

Table 21: Considerations in prioritising development projects

Description	Comments	Rating (10=highest)
Safety	ML will not compromise the safety of staff, contractors and the public. Safety is fundamental to the way ML undertakes any activity and accordingly it has top priority on all expenditure.	10
Capacity	Overloading can lead to overheating, reduction in asset life, fire, explosion and cascade tripping (security of supply is implicit within this).	9
Reliability	Consumers want a reliable supply.	8
Voltage	Consumers want all items of their electrical plant and equipment to perform and this requires stable and appropriate voltage levels to be maintained free of harmonic interference.	7
Environmental	Minimising the impact on the environment is a key part of ML's values, especially in highly sensitive areas.	5
Energy Efficiency	Primarily energy efficiency within the network is largely dependent on the network's configuration. The provision of supply at regulatory voltage and at a cost acceptable to consumers means that energy efficiency cannot be the primary determinant of expenditure. Inherent in a low consumer density network are an increased number of transformers, all of which incur losses regardless of consumption. Energy efficiency is taken into account during design and purchase of network components such as transformers. ML also seeks to maximise the efficiency of its network through operations, notwithstanding the limitations imposed by the physical constraints of the network.	5
Renewal (end of useful life)	Lower priority assuming that it is safe, has adequate capacity, good voltage and low maintenance costs.	6

In assessing the potential benefits of the work, consideration is also given to the number of affected consumers, the total kW/kWh and the impact (if any) on revenue/ costs, e.g. reductions in maintenance/ increased line charges.

Potential projects come from a wide range of work including technical studies of the network, e.g. load flow analysis, consumer requests, consideration of load growth, information on proposed load changes, examination of existing constraints and limitations within the network and asset monitoring e.g. large concentrations of maintenance work may result in line renewal and reliability studies.

Projects are developed and budget pricing is undertaken on an annual basis. The benefits are assessed in terms of the criteria above and projects ranked accordingly. This is undertaken by the Engineering Manager in conjunction with engineering staff. From this information a draft plan and budget is developed. This is then discussed with, and approved, by the Managing Director before being submitted to the Board for approval or alteration. Once approved, it is included within ML's annual budget. The programme of projects is then managed on an ongoing basis (both underway and planned projects) to track expenditure and to ensure that any planned projects are still relevant. The programme is then updated accordingly. Monthly reviews are undertaken by engineering and finance staff to manage the status of Capex projects and capitalise or expense costs when and where appropriate.

6.9 Non-network solutions

The electricity distribution model has, until recently, remained relatively unchanged for many decades. However, the industry is now seeing the increasing availability of alternative technologies to the traditional network assets of poles and wires mainly through small scale distributed generation. The use of non-network solutions, where appropriate, can offset investment in standard network assets and has, in time, the potential to challenge the paradigm of a high voltage transmission model for electricity supply. However, it needs to be recognised that an effective electricity network provides significant diversity benefits of electricity utilisation between ICP's and typically has the ability to provide flexibility in meeting consumer demand.

Historically, ML has implemented non-network solutions including ripple control of water heating, night-store heaters, peak demand tariffs and reactive power tariffs. These legacy solutions have become less applicable as the line and energy segments of the electricity supply chain have been vertically disaggregated and line charges have diminished relative to the costs of energy. By way of example the cost difference between delivered day/night energy has been markedly reduced in recent years.

Irrespective the ripple control system remains a valuable tool for load management and has been used to good effect when there have been restrictions in Transpower's capacity to supply.

The widespread introduction of charging of electric vehicles is likely to ensure that the benefits of load management systems are implemented to an increased extent.

With respect to new non-network solutions (technologies) ML is part of a national industry group considering the potential impact of disruptive technologies and the manner in which network assets will be operated and managed in the future as a result. Technologies which are becoming increasingly available are likely to impact the network in the future and include distributed generation (photo-voltaic in particular), to a lesser extent wind and electric vehicles in conjunction with capability improvement and cost reduction in storage batteries.

6.9.1 Distributed generation, photovoltaic/solar and wind

The reduction in the cost of photovoltaic systems and greater consumer interest is resulting in increases in the number of photovoltaic installations into ML's network. Figure 27 plots the distributed generation capacity in solar and wind energy installed into ML's network in kW from year 2010 to year 2017. This shows a lift in solar installations after 2013 but a trend cannot be discerned at this stage (solar capacity installed in years 2014, 2015 and 2017 appear relatively constant). Total distributed generation installed capacity of solar is approximately 4MW with 425kW being associated with a single installation. Given the current relatively low utilisation of photovoltaics the current capacity build is not

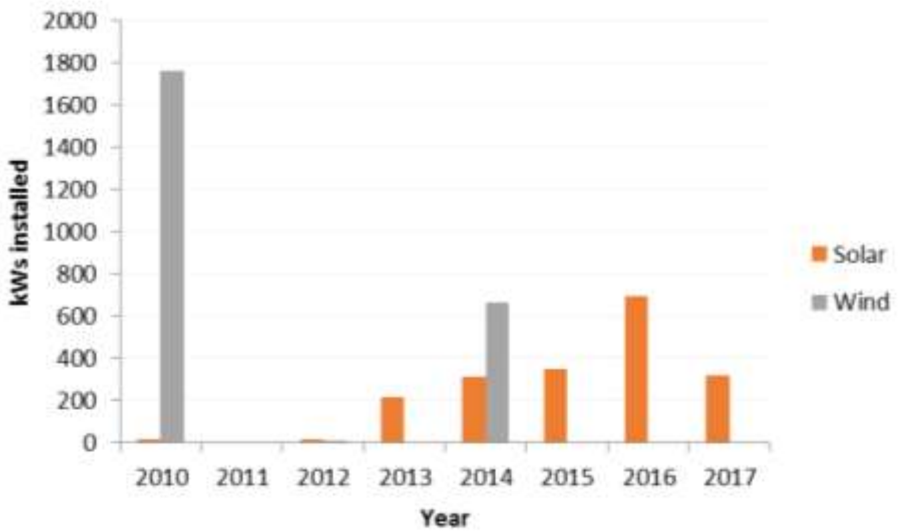


Figure 27: Solar and wind distributed generation into MLL's Network since 2010

expected to markedly alter network requirements over the next five years and perhaps not even over the 10 year planning period.

It is also salient that as cost reflective network pricing is introduced the attractiveness of photovoltaic installation will diminish with the actual saving being specifically related to a reduction in actual energy charges.

To date there have been two ICP wind installations which are located in the relatively windy East Coast area. Both of these installations have the capacity to utilise the entire electricity generated. In both instances these commercial installations have unaltered expectations of capacity from the ML network.

The two other wind generator installations have been installed purely as investments with the objective of supplying electricity to ICP's connected to the ML network. Accordingly were it not for the interconnectivity provided by the ML network these wind generators could not operate. It is salient despite the prevalence of wind on the East Coast wind generation output is subject to significant variation and cannot be predicted with any certainty.

Predicting the future installation of wind generation and large scale photovoltaic installation is uncertain and will be influenced by a number of factors including the impending removal of avoided cost of transmission benefits, falling installation cost, improving solar panel efficiencies, reducing storage battery costs, the degree of marketing undertaken by suppliers, the potential for government subsidies (although this last point is unlikely given the limited scope for carbon reduction in the New Zealand electricity sector compared to overseas where this has been a driving factor). Overall based on currently known parameters distributed generation is unlikely to be substantially increased on the ML network in the near term (next five years).

Because of the lack of diversity and the intermittent nature of solar and wind generation (as well as the inherent requirement for bi-directional power flows caused by the embedded wind generation) the initial effects will likely lead to an increase in the voltage swings in the network requiring capacity reinforcement, particularly in the LV network. Additionally, it is considered likely that there would be little or no reduction in the network peak demand - or at least the potential to strike that peak and to which the network must be designed.

Perversely for ML, the areas where ML might see benefit from consumers disconnecting into home or micro grids is in the Marlborough Sounds area, but consumers here have less incentive to invest in this technology as, generally, the premises they own are not continuously occupied and so the total kWhs consumed is low making the return on investment in off-grid generation less attractive.

The widespread installation of photovoltaics within ICP's particularly in the Marlborough Sounds has the potential to cause voltage problems on the network and study is currently being undertaken to identify the constraints relative to photovoltaic installation on the ML network.

6.9.2 Electric vehicles

The transportation sector utilises a significant amount of energy. Uptake of electric vehicles (EVs) will impact on both the need for generation and the electrical networks which distribute it.

The impact of EVs on the network remains to be determined but due to the present capacity margins in the network, peak demand could increase significantly without triggering growth expenditure. It is also relevant the ripple system could be utilised in accord with user requirements to assist in maximising the efficiency of charging relative to time of use. Additionally, anecdotal evidence suggests the effects on EV charging will be moderated by the short journey distances experienced to date (perhaps due to range anxiety) combined with the relative high efficiencies of these vehicles (in km/kWh).

It is not expected that EV numbers in Marlborough will rise at such a rate that ML will not be able to respond to meet the supply demand as and if it arises. Additionally, while battery powered EVs have been given recent prominence in New Zealand other competing technologies exist; for example the US Department of Energy report significant progress in cost reductions for hydrogen fuel cell infrastructure.[16] ML will continue to monitor the EV technology and uptake in the region but has no plans for network augmentation at this time in relation to it.

6.9.3 Battery technology

This is an important factor in both EVs and in the uptake of PV. Low cost batteries could potentially enable some installations to become independent of the electrical network, if the flexibility of demand capacity provided by the network is not a consideration, and provide others with a means to store the generation and use it at times which produce maximum benefit. But as with the utilisation of photovoltaics the cost of the batteries needs to be balanced against the introduction

[16] Refer https://www.energy.gov/sites/prod/files/2017/10/f37/fcto-progress-fact-sheet-august-2017.pdf

of cost reflective network prices, the requirement for which has been signalled by the Electricity Authority.

Ultimately the reality is the Marlborough network is not capacity constrained and it provides the opportunity for ICP's to share the benefits of diversity of load.

The NZ Smart Grid Forum first report to the Minister (MBIE) in June 2015 included lithium ion battery pack costs in US$/kWh projection to year 2030 (sourced from Nature Climate Change). This chart is reproduced in Figure 28 and shows significantly declining costs. More recent projections placed costs at year 2020 in the range US$130 to US$300 per kWh – that is, in the lower half of the 2015 projections for year 2020.[17] These cost reductions are expected to drive increased take-up of both battery storage for photo-voltaic installations, thereby increasing their utility, and the take-up of EVs assuming these costs pass below price threshold points for consumers. The main issue from a strategy perspective is that the future take-up rates for these technologies is uncertain. ML is mindful of this and will monitor this technology closely noting that ML already has this in its risk register.

It is also salient that if the cost of batteries markedly reduces that it may well lead to the increased utilisation of EVs with potential to result in increased electricity demand.

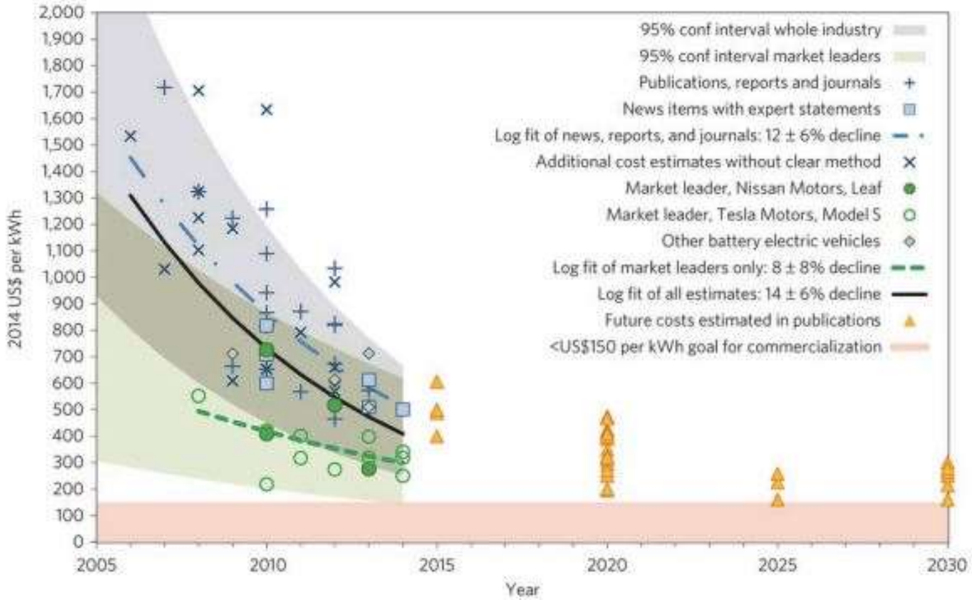


Figure 28: Forecast lithium ion battery costs

[17] Berckmans et al; Cost projection of state of the art lithium-ion batteries for electric vehicles up to 2030; MDPI; Sept 2017.

6.9.4 RAPS

Remote Area Power Supplies (RAPS) are essentially distributed generation installed and maintained by a network business as an alternative to a network connection. ML has examined the application of RAPS to a number of specific locations largely where there are single or a small number of consumers at the end of a significant line section that may require costly maintenance or renewal. To date ML has not applied RAPS schemes due to concerns over:

- the lifecycle economics of the RAPS plant;
- the required availability of the plant;
- the transport and management of backup diesel fuel; and
- the potential for regulatory issues in the future ownership of battery plant.

ML consider RAPS as an alternative to network upgrade or renewal but to date have not found net benefit in any particular scheme. This will continue to be monitored by ML as technology and systems mature.

6.9.5 Network adaption

Ultimately, the role of network services may diversify to range from a traditional full lines service to provisioning firm capacity, fault current and frequency regulation support for micro networks. The greatest risk for ML may not be mastering the technology involved but the ability to properly reflect its long-run and marginal costs for the services it provides.

It is generally believed that the factors driving the uptake of new technologies will not result in need for major change in asset management practices within the period of this AMP or that future plans can be adapted as the technology becomes established and its effects more certain. ML will continue to monitor these technologies and consider how the network can best be managed to give maximum benefit to all stakeholders. ML does not anticipate any difficulty meeting the requirements of electric vehicles when and if their additional demand commences.

6.10 Key assumptions

In preparing this AMP, and undertaking its asset management activities, one of the key assumptions made by ML is that the business will carry on in perpetuity, i.e. the assumption is that ML will own, operate and maintain an electricity distribution network into the future. And there is currently no valid reason to counter this assumption.

Other key assumptions (quantified where possible) are set out in Table 22.

Table 22: Significant assumptions underpinning ML's Asset Management (and AMP)

Assumption	Sources of Uncertainty	Possible Impact of Uncertainty
That no major disasters or widespread systemic problems will occur.	While contingency planning and emergency response plans are in place, it is difficult to predict the timing, extent and location of events with any great degree of certainty.	Extensive damage to significant proportion of ML's network requiring significant expenditure (both opex and capex) in a relatively short timeframe. ML has no debt, a strong balance sheet and is expected to have the capacity to deal with all but the very most serious of disasters.
That there are no significant changes to local authority (i.e. Marlborough District Council's) long term plan.	MDC may alter existing plans. This may allow opportunity for cost sharing with ML – for example if road widening, or renewal of underground services occurs, then there may be opportunity for ML to renew electrical infrastructure (or underground overhead sections) at the same time.	Inclusion of as yet unplanned activities by ML. If works are not included in this planning period, but potentially would be beyond the period – where there is opportunity for costs savings from MDC's work then ML would consider those.
Price inflator assumptions.	Price inflation is manged by the Reserve Bank of New Zealand (RBNZ). While RBNZ aims to keep inflation near the 2% target midpoint, this could vary.	Inaccuracies in forecast expenditure amounts (either over or under depending on actual vs assumed price inflator allowed for). Further detail is presented in the expenditure forecasts section.
There are no significant changes to forecast load demand.	Step change in district population growth, or load demand from industry growth.	Additional or reduction in forecast growth expenditure.
Consumers remain satisfied with current reliability and resulting costs.	Consumers may change preferences – i.e. accept less reliability for lower lines charges. Uncertainty here is knowing consumers future preferences.	Less revenue which in turn would result in less expenditure. Ultimately this would result in a less reliable network.
No significant changes to regulatory regime and requirements.	Change in Government, changes to regulatory nature/requirements of EDBs.	Revision of plan may be required to adhere to any changes in regulatory requirements.

Assumption	Sources of Uncertainty	Possible Impact of Uncertainty
The rate of uptake of new technologies (e.g. electric vehicles, photovoltaic cells).	The rate of uptake of new technologies is largely unknown at this stage.	The widespread charging of electric vehicles on the network has the potential to provide a source of revenue which currently does not exist particularly given the ML network is typically not capacity constrained. The widespread installation of photovoltaics can potentially have two principal affects. A reduction in delivered energy to ICP's where all of the output is consumed within the premises and if large numbers of consumers sought to inject into the network the level of photovoltaics would need to be limited to prevent voltage problems. In event of injection from ICP photovoltaics the network will be required to deliver to other ICP's. The introduction of cost reflective line charges will likely damper enthusiasm for photovoltaics given line charges should relate to installed network capacity not delivered energy. If the cost of battery storage were to significantly be reduced, the benefits of photovoltaics would be further enhanced but again it is advocated if network charges related to the provision of capacity and ICP's required for security of the network capacity the utilisation of photovoltaics and batteries would be constrained.
That no major new loads or new sources of generation connect to the network.	Inability to accurately predict future growth which is controlled by others, change in economic opportunities for various industries.	May require upgrade and/or modification(s) to network depending on nature and scale of new load(s) or generation. Addition to growth expenditure above forecast.

There are also factors which may lead to material differences between the information disclosed in this AMP, and the actual information reported in future disclosures. Examples of these factors include international or national and/or regional economic volatility (leading to changes in demand and/or growth), changes to regulatory requirements, significant natural hazard events (e.g. large magnitude earthquake) and/or technological developments.

6.11 Asset management improvement

As outlined in Section 6.2.1, ML, during the planning period, is intending to become certified to the ISO 55001 Asset Management Standard within the first two years of the planning period. This will provide ML and its stakeholders with a further level of confidence that the asset management practices being undertaken are done so in accordance with international best practice.

To become accredited ML has arranged an external consultant to undertake a 'gap' analysis to identify any shortfalls with existing asset management practices relative to those of the framework of ISO 55001. The findings of the gap analysis will enable ML to target areas required to become aligned to the framework and become accredited.

Completion of the AMMAT has identified areas of improvement in ML's asset management. A selection of improvements (those deemed as having the greatest importance/benefit) based upon the AMMAT assessment are summarised in Table 23.

Table 23: Asset Management Improvements for ML

Improvement Area	Details	Improvement Action
Asset Management Policy	Asset management policy not specifically drafted other than what is included in AMP. At present there is possibly a degree of disconnect between important documents such as SCI, AMP and specific asset management policy/procedures (mostly non-existent as standalone documents) at ML.	Consider drafting policy for the organisation outside of AMP. ML's asset management documentation (SCI and AMP) should be based on the policy.
Asset Management Framework	Compare existing asset management practices to assess whether they fit with industry standard asset management framework.	Modify and align existing asset management to fit with ISO 55001 framework.
Certification	Work towards becoming ISO accredited in asset management systems.	Become certified to ISO 55001.
Personnel/Resourcing (i.e. structuring)	Effective asset management requires adequate resourcing (staffing) to develop, implement and manage asset management policy, processes and procedures.	Review staffing structure and determine whether any changes in roles may benefit existing asset management at ML. Asset management could be improved with staff solely dedicated to asset management. ML acknowledges that this is challenging given the relatively small size of the organisation and breadth of work.
Asset Data	Certain assets and/or their attributes data is less accurate than desired by ML. Greater focus should be placed on asset data to ensure data integrity.	Review asset data and if requirements are meeting ML needs and where improvements can be made. Then formulate action plan to address.
Asset data	As-built process currently under review. Review success and continually improve as-built standard as required.	Implement new as built process and review effectiveness.
Information Systems	A number of information systems are in use.	Review information systems to ensure appropriateness and that correct asset data is held.
Information systems	Mobility.	Move to mobility solution to capture asset information in the field.

7. Network development

7.1 Overview

ML's network has been developed over time in response to the demand of its consumers and this development will continue into the future. This section provides details on the anticipated forecast growth in demand and changes that are expected to the network to accommodate that.

7.2 Growth/demand projections

7.2.1 Demand trends

The network has continued a small but sustained growth trend over the last ten years and it is forecast to continue. The growth rate is projected to be approximately 0.5% per annum across the planning period, based primarily on previous years' data and projected regional growth. Changing consumer trends (i.e. uptake of more energy efficient lighting and appliances) has also been considered. Figure 29 shows both the historical and forecast demand for the whole network. A higher and lower forecast growth rates (0.25% and 0.75% respectively) are also included in the figure to illustrate potential longer term effects of variability to the growth rate forecast. Note that the forecast growth rate will be regularly reviewed and updated subject to relevant information becoming available.

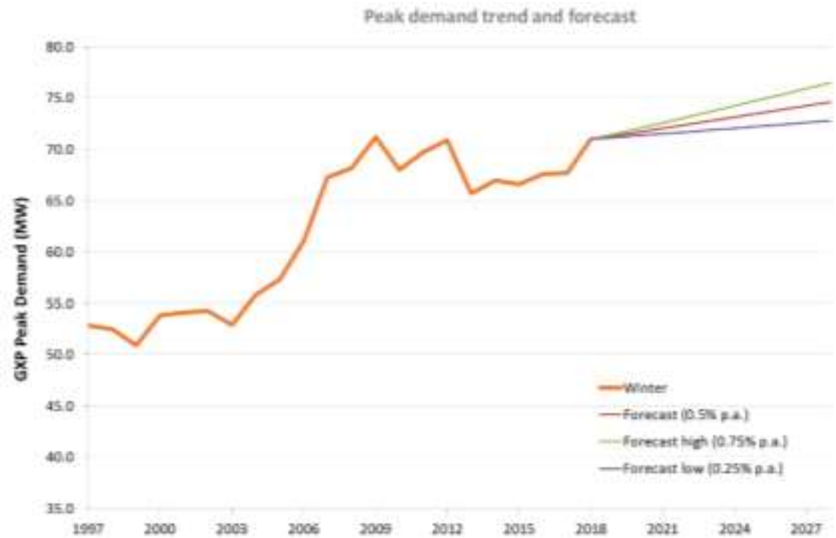


Figure 29: Network peak demand trend and forecast

Table 24 presents a summary of the maximum forecast Blenheim GXP demand (the single GXP supplying all ML's load).

Table 24: Blenheim maximum demand forecast

Substation	Security Rating	Secure Capacity (MVA)	2017	2020	2025	2030
Blenheim GXP	N-3	100	67.7	70.4	74.0	77.8

The steady growth exhibited is mainly a result of:

- Steady residential subdivision activity, especially in key areas such as Taylor Pass and Omaka (i.e. largely driven by steady population growth); and
- Changes in the demand of some larger industrial consumers, especially within the viticulture industry and largely driven by economic growth which is also relatively constant as noted in section 3.1.1.6.

Growth in each area of the network varies according to load type and economic activity. The map in Figure 30 indicates annual forecast growth rates by planning Area as forecast by ML.

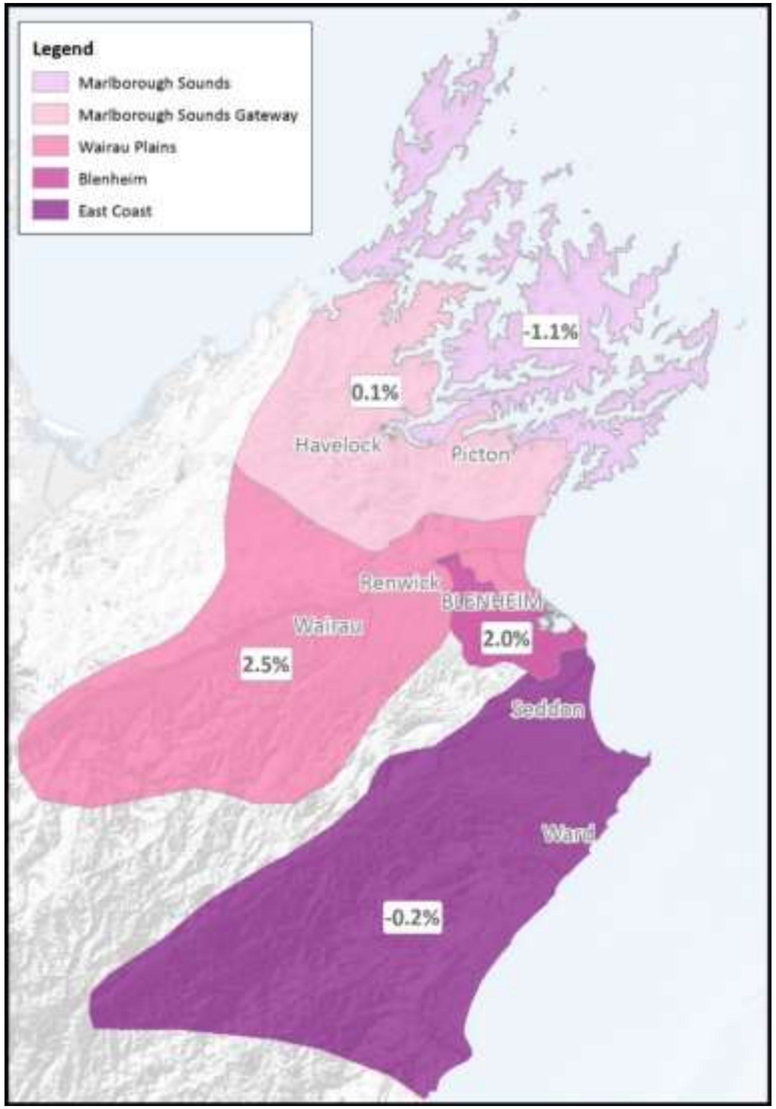


Figure 30: Forecast demand growth by planning area

7.3 Area plans

The network is split into five planning areas to better segment demand forecast and associated planning. The areas are based on both geographical and load type features. These area plans are summarised in the following sections.

7.3.1 Blenheim planning area

Stable residential and commercial growth in the Blenheim area is forecast to result in the N-1 rating being triggered at one zone substation (Nelson St) within the planning period. This, together with other drivers such as improving network resilience to major contingent events, will be the main drivers of investment in this area.

Security in the area is generally satisfactory with all substations supplied by at least two separate 33kV circuits.

Security and growth project spend over the 10 year planning period is set out in the Expenditures section of this plan

7.3.1.1 Area overview

The Blenheim area terminates roughly at the town boundaries but also includes the industrial zones at Riverlands. Six of the 16 zone substations are within this area: Springlands, Nelson St, Waters, Redwoodtown, Riverlands and Cloudy Bay. All these substations are supplied by the only Blenheim GXP located near Springlands.

Blenheim contains a mix of residential, commercial and small industrial consumers. The maximum demands are predominately a result of winter heating and tend to occur at 7am to 11am and 4pm to 8pm during cold and/or wet times. In total the Blenheim area represents approximately 60% of the total ICPs and 45% of the load.

Residential load growth is static or falling slightly due to a range of factors including increased use of energy efficient lighting, use of heat pumps rather than conventional heaters etc.

The industrial type load tends to be driven by wine processing (late March to early May) and can be when Marlborough reaches its peak demand. Load growth generally follows the viticulture industry growth.

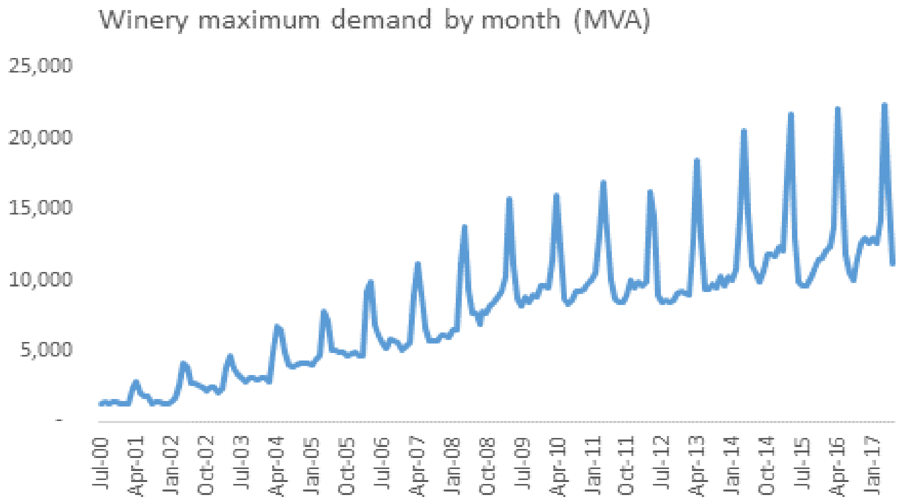


Figure 31: Winery maximum demand by month (MVA)

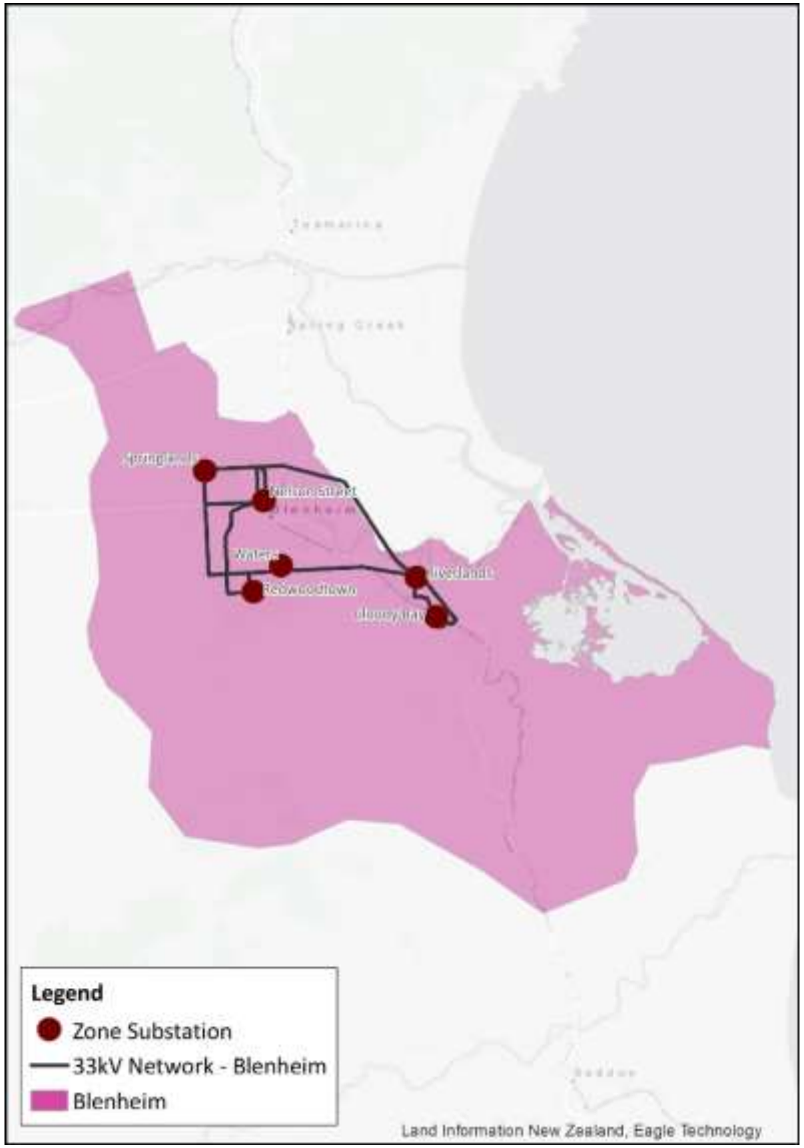


Figure 32: Blenheim urban area

7.3.1.2 Demand forecasts

Demand forecasts for the Blenheim zone substations are shown in Table 25.

Table 25: Blenheim area zone substation maximum demand forecasts

Substation	Security Rating	Secure Capacity (MVA)	2017	2020	2025	2030
Cloudy Bay	N-1	16.5	6.3	8.8	11.3	12.9
Nelson St	N-1	16.5	14.6	15.4	16.9	18.4
Redwoodtown	N-1	16.5	9.9	10.1	10.4	10.8
Riverlands	N-1	10	9.2	8	8.9	9.7
Springlands	N-1	16.5	10.3	10.3	10.4	10.7
Waters	N-1	16.5	6.8	6.8	6.9	7.2

The Blenheim area has the highest rate of growth with much of that coming from the industrial area. Considerable investment has recently taken place in this area with two of the six zone substations less than seven years old.

Cloudy Bay is forecast to grow considerably but a large part of that is planned load transfer from the nearby Riverlands Zone Substation. This growth is largely based on a continued and stable viticulture industry.

Nelson Street is predicted to exceed its secure capacity by 2025, if increases in demand in Blenheim's commercial CBD occur. But this can be addressed by the transfer of load to other zone substations.

Aside from the normal capacity utilisation of a particular substation it is also necessary to consider flexibility of operation within the network should circumstances preclude the utilisation of a zone substation requiring its load to be transferred to those adjacent.

7.3.1.3 Area constraints

Growth constraints affecting the Blenheim area are the zone substation capacities. As noted above, secure capacity is forecast to be exceeded at Nelson Street zone sub in 2024.

7.3.1.4 Growth and security projects

Growth or security (reliability) related projects for the area are set out in Section 7.5.Wairau Plains planning area

Steady growth in this area is not forecast to trigger any security constraints, however, many long radial feeders are located in this area which pose their own security implications. Concerns around the Wairau fault will also drive investment to enhance network resilience in this area. Projects planned include a new zone substation to replace Renwick (due to a combination of growth, aged equipment and proximity to the Wairau fault line), 22kV conversions and the possibility of an additional power transformer at the Leefield zone substation which is currently operating at N security level.

Figure 33: Wairau Plains area

7.3.2 Wairau Plains planning area

Steady growth in this area is not forecast to trigger any security constraints, however, many long radial feeders are located in this area which pose their own security implications. Concerns around the Wairau fault will also drive investment to enhance Network resilience in this area. Projects planned include a new zone substation to replace Renwick (due to a combination of growth, aged equipment and proximity to the Wairau fault line), 22kV conversions and alternate supply to the Leefield sub currently operating at N security level.

7.3.2.1 Area overview

The Wairau Plains area surrounds the Blenheim planning area and covers the more rural parts of Marlborough. Four of the 16 zone substations are located in the Wairau Plains planning area and include: Woodbourne, Renwick, Spring Creek and Leefield.

Significant features of this area include Woodbourne airbase, Renwick Township and airport and a substantial horticultural/agricultural area with extensive vineyards. The load tends to be driven by wine processing (late March to early May) and the need for irrigation in the vineyards (December to March).

7.3.2.2 Demand forecasts

Demand forecasts for the Wairau Plains zone substations are shown in Table 26.

Table 26: Wairau Plains area zone substation maximum demand forecasts

Substation	Security Rating	Secure Capacity (MVA)	2017	2020	2025	2030
Leefield	N	5	1.3	1.4	1.8	2.2
Renwick	N-1	10	9.4	Being replaced by Tapp substation in FY2019		
Spring Creek	N-1	10	4.1	4.5	5	5.5
Woodbourne	N-1	10	8	8.1	8.3	8.6

The growth in this area is forecast to be steady at 2.5% based largely on previous data and anticipated growth in the area (primarily residential and vineyard related (irrigation and/or processing) developments.

Renwick substation is due for replacement with a new green field site in late 2018 and will have a secure rating of 16.5MVA, alleviating the forecast capacity issues in that area and improving network resilience to earthquake events.

7.3.2.3 Area constraints

Major constraints affecting the Wairau Plains area are:

- Kaituna Valley load capacity constraint.
- Leefield substation at only N security (but loaded below the 5MVA security trigger level).
- Spring creek substation supplied by dual circuit strung on the same towers such that one event could impact both circuits and supply to the substation.

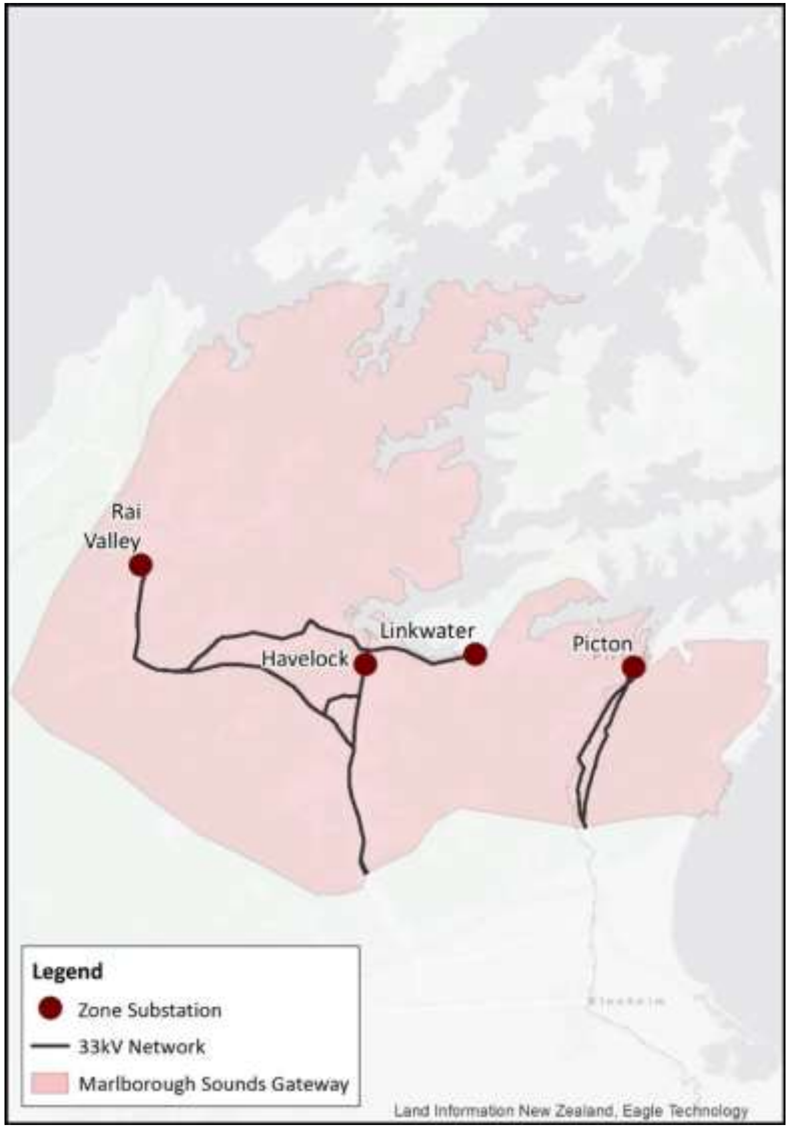


Figure 34: Marlborough Sounds gateway area

7.3.2.4 Growth and security projects

Projects planned for the Wairau Plains area are Kaituna Substation, subject to the expected sawmill load expanding (combined with inability to supply this load from adjacent substations) and completion of Tapp substation to replace Renwick substation. These, and other less substantial projects in the area are set out in Section 7.5.

7.3.3 Marlborough Sounds gateway planning area

Forecast load growth is low in the Sounds Gateway area at only 0.1% with the residential sector converting to more efficient appliances and lighting. Irrigation load in the Rai Valley area is steady and there is limited industrial growth.

As a result there are few planned projects other than renewals in this area.

7.3.3.1 Area overview

The Marlborough Sounds Gateway area includes the townships of Rai Valley, Havelock and Picton. Four substations supply this and the Sounds area and include: Rai Valley, Havelock, Linkwater and Picton. All of these substations are supplied by the Blenheim GXP, with Picton being supplied by dedicated 33kV dual circuits.

Parts of the planning area are largely pastoral (beef/sheep) with a low ICP density. The inland valleys tend to be sheltered from storms. Pastoral land use combined with some irrigation means that the load tends to peak in the winter months.

The planning area also includes the small townships of Picton, Waikawa and Havelock.

7.3.3.2 Demand forecasts

Demand forecasts for the Sounds Gateway zone substations are set out in Table 27:

Table 27: Sounds gateway area zone substation maximum demand forecasts

Substation	Security Rating	Secure Capacity (MVA)	2017	2020	2025	2030
Havelock	N-1	5	2.4	2.4	2.4	2.6
Linkwater	N	5	3.6	3.5	3.2	3.1
Picton	N-1	16.5	6.9	6.6	6.4	6.2
Rai Valley	N	3	2	2.2	2.3	2.5

The forecast load in this area is very low with a flat or declining load at Linkwater and Picton substations based on previous years' data. However, there is potential for further commercial and/or light industrial development at the Havelock marina area. Should this development materialise, then the figures forecast for Havelock may be exceeded.

7.3.3.3 Area constraints

Constraints affecting this area are:

- Rai Valley and Linkwater substations at N security.
- All four substations are supplied by a dual 33kV circuit strung on the same towers (over some sections of the line) where one event could affect both circuits and supply to these substations (Picton is separate to Rai Valley, Linkwater and Havelock but suffers the same problem over some section of the line).

7.3.3.4 Growth and security projects

Growth or security (reliability) related projects for the area are set out in Section 7.5.

7.3.4 Marlborough Sounds planning area

ML has approximately 750km of 11kV distribution lines (in the order of 20% of the network) in the Marlborough Sounds, supplying approximately 2,500 consumers by way of 15,000kVA of distribution transformer capacity. There are on average around three consumers/km of HV line compared with over 10 consumers/km for the entire network. Many of the installations are holiday homes with intermittent occupation - approximately 50% of consumers in the Marlborough Sounds use less than 2,000kWh per annum (note, this compares to an average residential/domestic household consumption of approximately 7,500kWh per annum).

The maximum demands on the various lines supplying the Marlborough Sounds generally occur over long weekends or public holiday periods – Easter, Christmas, Queens Birthday or Labour Weekend. This holiday occupation also leads to much lower diversity of demand than would usually be expected from most areas. These various factors increase both the cost of construction and operation/maintenance of the distribution system. They also reduce the overall operating efficiency of the network relative to installed capacity. The situation is exacerbated by the fact that revenue from these consumers does not meet the costs incurred and cross-subsidies are required from other consumers.

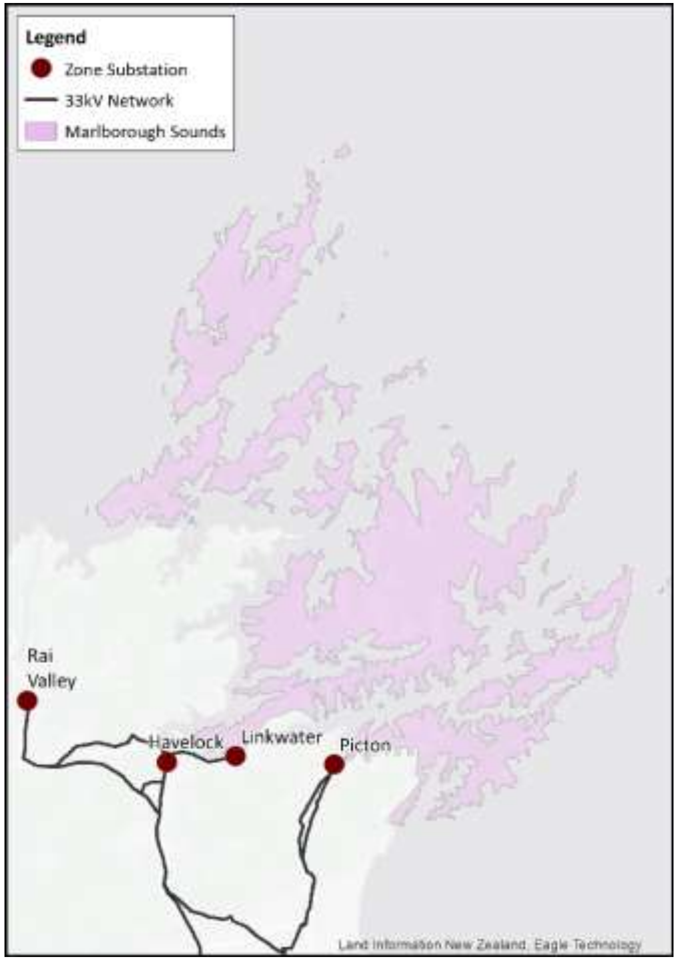


Figure 35: Marlborough Sounds planning area

7.3.4.1 Area overview

Reticulation in the Marlborough Sounds poses many construction and operational challenges. Most of the lines are constructed over rugged terrain, with access to many areas for construction and maintenance limited to foot, tracked vehicles or helicopter. Often spans are relatively large in length where valleys need to be traversed. Some areas do not have any road access and can only be accessed by boat and/or on foot. The Marlborough Sounds has a relatively high rainfall and a climate that encourages rapid vegetation growth, leading to the need for tree trimming and vegetation control on a short return basis.

A significant issue facing ML regarding reticulation in this area is associated with load growth or supply enhancement.[18] . Many of the existing lines are built on private or Government-owned land and constructed in the 1960s and 1970s, with access protected by the "existing works" provisions of the Electricity Act. ML has limited easements over line routes. Therefore, upgrades which necessitate changes to the existing layout or create an injurious effect on the land require new easements to be created. Any future major developments in the Marlborough Sounds area would require very careful analysis and design of both asset and non-asset (e.g. demand control) alternatives to ensure the optimal solutions are found.

In many instances the access utilised to construct the lines has long since gone. The lines which were constructed over rugged bush-clad terrain by

[18] Whilst load is decreasing in average across the area, there remain instances of load increase or supply enhancement at some points.

helicopter pose particular problems, especially in relation to line access and vegetation maintenance.

A further issue with respect to lines in the Marlborough Sounds is that of supply reliability. The various lines supplying sections of the Marlborough Sounds are all radial/spur lines, with no interconnection to other parts of the network.

7.3.4.2 Demand forecasts

Demand forecasts for the Marlborough Sounds main 11kV feeders are shown in Table 28.

Table 28: Demand forecasts for main 11kV feeders in Marlborough Sounds

Feeder (zone sub)	Zone substation Security Rating	Zone Substation Secure Capacity (MVA)	2017	2020	2025	2030
French Pass (Rai Valley)	N	3	0.9	0.8	0.7	0.6
Sounds (Linkwater)	N	5	2.2	2	1.9	1.8
Waikawa (Picton)	N	16.5	3.5	3.5	3.5	3.4

The load in this area is forecast to be static or slightly declining rate based on load trends from the last five years. However, it is important to note that these trends are based on past data. Recent evidence suggests that visitor numbers to D'Urville Island are increasing, if this continues, then further development may occur and maximum demands may trend upwards as a result.

7.3.4.3 Area Constraints

Constraints affecting the Marlborough Sounds area are:

- Radial feeders, although ML does have emergency generation installed at Kenepuru Heads and Elaine Bay.
- All three substations which supply the above main 11kV feeders are they themselves supplied by a dual circuit strung on the same poles (over certain sections) where one event could affect both circuits and supply to these substations (Picton is separate to Rai Valley and Linkwater but suffers the same problem over some of the line sections).
- There are very limited opportunities to transfer 11kV load between substations purely because of the distance involved and the radial nature of the feeders.
- Backup substation supply is best provided by mobile generators owned by ML.

7.3.4.4 Growth and security projects

Growth or security (reliability) related projects for the Marlborough Sounds planning area are set out in Section 7.5.

7.3.5 East Coast planning area

Forecast load growth in the East Coast area is low. The terrain and environment leads itself to mainly pastoral farming. The viticulture industry has been expanding in the Seddon area but water is limited further south constraining expansion into these areas. But a significant irrigation project in the Ure River area is expected to result in intensified land use including viticulture and dairying. The pumping station proposed at Ure River may ultimately necessitate an upgrade of the capacity of the existing line.

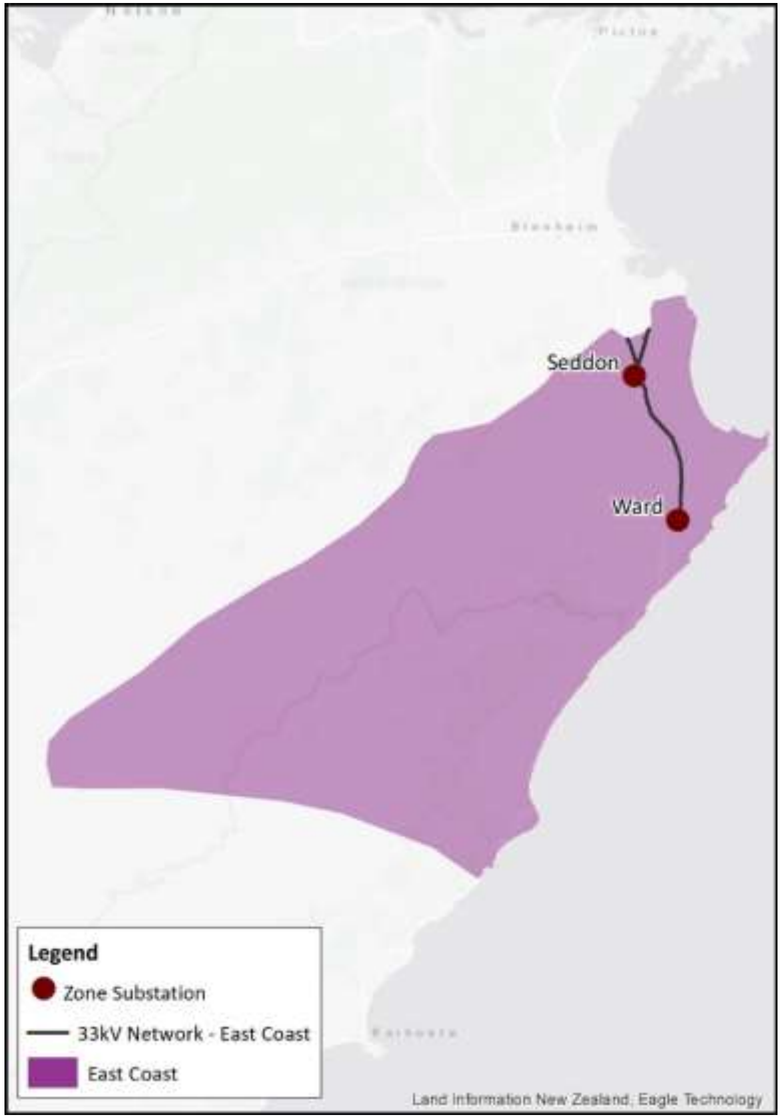


Figure 36: East Coast area

7.3.5.1 Area overview

The East Coast area includes the townships of Seddon and Ward. Two substations supply this area: Seddon and Ward.

The East Coast consists of a narrow strip of coastal land running down to Marlborough's southern boundary, with some sparsely populated river valleys running into the centre of the South Island. Much of the network in the coastal area was constructed in the late 1950s using concrete poles and copper conductors. The long radial nature of the area means there are no alternative supplies available during faults or planned outages. The low population density makes it difficult to justify the high levels of expenditure required to provide alternative supplies through feeder interconnections.

The sheltered nature of the land and pastoral land use, with relatively small areas of trees and vegetation, leads to high reliability of supply in these valleys, unless impacted by snow.

7.3.5.2 Demand forecasts

Demand forecasts for the East Coast zone substations are set out in Table 29.

Table 29: East Coast area zone substation maximum demand forecasts

Substation	Security Rating	Secure Capacity (MVA)	2017	2020	2025	2030
Seddon	N-1	10	6.2	7	7.1	7.2
Ward	N	5	1.5	1.6	1.3	1

The forecast load for both Seddon and Ward are relatively flat based on loading data from recent years. However, ML is aware of current investigations into an irrigation scheme at Ure River. If this proceeds, then maximum demand at Ward is likely to increase. If this materialises, then ML will need to facilitate this growth by upgrading its existing 11kV East Coast feeder from Ward.

7.3.5.3 Area constraints

Constraints affecting this area are:

- Radial feeders
- Wind generation consumes line capacity.

7.3.5.4 Growth and security projects

No growth or security projects are noted for this area within the planning period.

7.4 Grid Exit Point and embedded generation

7.4.1 Grid Exit Point

ML receives electricity at 33kV from the transmission grid, owned by Transpower at the single GXP at Springlands. Forecast load growth over this planning period does not see the load exceed the 100 MVA firm capacity of this GXP. No growth or security projects are therefore planned.

7.4.2 Embedded generation

Aside from the need to meet increased consumer demand, it also may be necessary for ML to extend or increase the capacity of its network to provide for new sources of generation from larger single sites, but at the time of this report no proposals for additional sources of generation are known.

ML has extended its network to enable the connection of wind generation and discussions with further potential generators occur from time to time but currently ML is not aware of further generator installations.

7.4.2.1 Policy

ML is committed to facilitating the connection of new generation to its network subject to generators meeting appropriate technical and commercial criteria. ML's policies are on the website under "Get Connected". Guidance for embedded/distributed generation is set out in separate categories – generation of 10kVA or less, and generation of greater than 10kVA.

7.4.2.2 Distributed generation

Embedded or distributed generation with solar and or wind as the primary energy source is not considered to be sufficiently diverse or reliable enough to reduce or defer capital expenditure for meeting peak demand. Solar has limited production during the winter months where ML's peak loads and highest energy flows occur, while the production from wind is highly variable.

Dark (no sun) and windless days occur despite Marlborough being one the sunniest regions of NZ and, accordingly, it is necessary to have sufficient capacity within the network to cope with days where solar and wind generation is limited.

TrustPower Limited operates a 2.4MW 'run-of-river' generator at Waihopai which is embedded into ML's 33kV network. This plant was originally built in 1927 by the Marlborough Electric Power Board and upgraded by ML's predecessor, Marlborough Electric in 1999. Output of this generator is dependent on rainfall in the catchment area.

Energy 3 Limited has two wind farms: at Weld Cone, near ML's Ward substation, there are three 250kW turbines, while at Lulworth just north of the Ure River, four 260kW turbines are installed. The units at Weld Cone began generation in February 2010 and the Lulworth units commenced in January 2011. Both schemes are embedded into ML's 11kV network.

Dominion Salt Limited has installed a 600kW wind turbine which is embedded into their 11kV installation.

The potential wind resource in the Marlborough Sounds and on the East Coast is significant, however the development of substantial wind farms will require construction of new lines to convey the output to load centres and careful consideration of the need for VAR compensation.

TrustPower operates the Branch Power Scheme and has been granted resource consent to extend this scheme. Six new power stations are proposed with one connecting to the existing Branch scheme infrastructure, four connecting to a new substation on the 110kV Kikiwa to Blenheim line and one connecting to ML's existing network in the Wairau Valley. ML understands that TrustPower does not currently intend to proceed with construction of this scheme.

The Wairau Hospital and a number of wineries and local businesses have small diesel generators which are used for load management and emergency power supply. Some of these units are capable of embedded operation.

The current low cost of photovoltaic cells has seen an increase in interest in small scale solar distributed generation. Details on the installations on the network are set out in Section 3.3.1.2.

There has been anecdotal public discussion concerning tidal power generators at the entrance to Tory Channel, however no resource consent has yet been applied for, and this type of generation is relatively unproven. The cost, efficiency and environmental impacts to the seabed and marine environment have yet to be accurately determined. Utilisation of this resource would require the construction of a new transmission line from Tory Channel to a load centre. In practical terms the current possibility of significant tidal generation in Tory Channel is considered low.

7.5 Major projects

The following subsections provide a summary of the major projects identified under network development. In most cases, the alternative option is to 'do nothing' and not realise the reliability benefits or facilitate potential future growth. Where other alternative options to 'doing nothing' are available and have been considered, these are noted.

7.5.1 Growth and security

7.5.1.1 Year 1 (2019)

There are no projects proposed for the first year of the planning period where the primary driver is system growth but a new 16.5MVA substation is planned for Renwick to provide greater security of supply in the event of an earthquake.

7.5.1.2 Years 2 to 5 (2020 to 2023)

7.5.1.2.1 Kaituna zone substation

ML's Renwick zone substation (the existing zone substation, as well as the new zone substation currently underway) supplies the township of Renwick, the greater Wairau Valley area and the Kaituna Valley area north of the Wairau River.

There are relatively large industrial consumers in the Kaituna area, including a major sawmill which has indicated its intention to expand production significantly over the next few years. As it stands currently, the electricity supply in the Kaituna area is limited due to the voltage restrictions that arise from supplying large loads through radial sections of the 11kV network from Renwick. As well as this, security of supply to the sawmill would be reduced due to the impractical nature of supplying load of this magnitude from other alternate supplies.

To remedy this, ML is intending to construct a small zone substation near the existing 33kV sub-transmission network in the Kaituna area, which will supply the sawmill directly allowing for the proposed load growth, as well as other consumers in the area. This will increase the quality of supply to the area by removing voltage constraints, increase reliability and provide improved security of supply to the area.

To facilitate the construction and commissioning of the proposed zone substation, an extension of the 33kV and 11kV network will be required and the land to construct the substation secured, along with installation of an outdoor transformer and switchgear undertaken.

7.5.1.2.2 Other growth projects

To facilitate the installation of a proposed significant new irrigation pumping station at Ure River the capacity of the line from Ward to Ure River will need to increase. Actual timing is dependent upon RMA consents and project implementation, if indeed it proceeds.

7.5.1.3 Years 6 to 10 (2024 to 2028)

System growth is difficult to anticipate for years 6 to 10 due to a number of uncertainties (local economic conditions, market demand for example) and a paucity of information. The following provides a summary of what ML consider could be possible growth related projects over this time.

- ML owns a small land parcel on Hammerichs Road, Rapaura over which the 33kV line traverses. Should growth in that area occur as previously proposed by a major winery, then consideration would be given to establishing a zone substation at that site to help meet the growth in consumer demand.
- Dependent on future growth, a zone substation may be required to supplement growth in the southern parts of Blenheim. The relatively recently developed Taylor Pass subdivision area, for example, is currently supplied by the Redwoodtown zone substation. Should future growth continue further towards Taylor Pass, then additional zone substation capacity may be required. ML does not anticipate this need to become apparent, if indeed it becomes apparent, until later in the planning period.

7.5.2 Reliability and safety

7.5.2.1 Year 1 (2019)

The reliability and/or safety related projects forecast for year 1 of the planning period are set out in the following sub sections.

7.5.2.1.1 New Renwick zone substation

The existing zone substation at Renwick comprises two power transformers, an overhead switching structure as well as indoor circuit breakers housed in a single level concrete block building.

During the November 2016 earthquake, the building experienced minor damage. This, combined with the aged infrastructure, close to capacity loading and the positon of the site in relation to the known Wairau Fault trace (which when extrapolated, more or less traverses the substation site), as well as the building having structural components which were deemed earthquake prone (when assessed at Importance Level 4) led to the decision to develop a new zone substation at a site acquired on the corner of State Highway 6 and Boyce Street, Renwick.

The new zone substation will include two new 16.5MVA power transformers, new indoor 11kV and 33kV switchgear and other electrical infrastructure. New cable routes are planned for connecting to the existing 11kV and 33kV network. The transformers and switchgear will be housed inside a purpose built building (designed to Importance Level 4) designed to look residential to fit in to the surrounding environment (the adjacent site is being subdivided for residential development).

The new substation provides greater resilience (from potential ground rupture of the Wairau Fault and ground shaking from earthquake(s)), increased capacity, and improved reliability of power supply to Renwick (and the Wairau and Waihopai Valleys which are fed from Renwick). Work has already commenced and it is expected that the substation will be constructed and commissioned by the end of the 2019 calendar year.

7.5.2.1.2 Other less substantial projects

A number of less substantial projects will also be included under the year 1 reliability and safety projects. These include:

- Reconstruction of an 11kV tieline near Hawkesbury to ‘swan’ construction. This is an area of line that is adjacent to water bodies and where outages occur from birds striking the lines. The reconstruction will include the replacement of aged poles and pole components.
- Tie line (11kV) between Cloudy Bay and Riverlands Industrial Estates. This project involves an underground cable between the Cloudy Bay Zone Substation and Riverlands Industrial Estate. This would provide increased reliability to the Riverlands Industrial Estate area. In the event that the Riverlands Zone Substation was not in service, then the Riverlands Industrial Estate could be fed from Cloudy Bay zone substation once the tie cable is commissioned.
- ‘T-Joint’ removals programme. A number of earlier subdivisions constructed prior to 1980 were supplied by underground low voltage cable T-jointed with ICP service cables such that there was no ability to isolate or sectionalise cables to individual households from the main feed supplying multiple consumers. In the event of faults, instead of only the property where the fault occurred being affected, all properties supplied and connected to this design type typically are affected by the fault back to the nearest isolation point. There are several streets around Blenheim where this design was utilised. Year 1 will intend to remove T-Joints from one street.

- Remote device installations. Where appropriate, ML intends to install remote controlled switches on the network to improve operation of the network remotely, thereby potentially reducing outage times. ML is planning to install five remote controlled switches in Year 1 of the planning period.
- Seddon zone substation earth fault protection enhancement. ML intends to install a Peterson Coil at the Seddon zone substation to limit the earth fault current with the aim of preventing bush fires. The Peterson coil is installed in between the neutral bushing of the supply 33kV/11kV transformer and ground. The coil “tunes” its inductive reactance to match the networks capacitive reactance to earth. This results in a steady state earth-fault current approaching zero so that arcing faults become self-extinguishing. It also has the advantage that transient faults (birds or tree debris) will not require the circuit breaker to operate to clear the fault, avoiding unnecessary intermittent outages to consumers.
- Pelorus to Rai Valley 33kV cross arm replacement. The 33kV cross arms between Pelorus and Rai Valley zone substation have previously been identified as being in poor condition. The project will see new steel cross arms attached to the poles and the existing insulators replaced as well with 66kV insulators.
- Ward and Seddon zone substation transformer improvements. Following the November 2016 earthquakes, some damage to the transformer foundations led to a review of the hold down arrangements with recommendations to improve the foundations made. ML intends to act on those recommendations as well as carry out other work to improve clearances in accordance with AS 2067:2016.

7.5.2.2 Years 2 to 5 (2020 to 2023)

7.5.2.2.1 SCADA system upgrade

ML plans to upgrade its SCADA master station software within the next five years to provide more functionality and add additional support for managing the much greater quantity of data being generated. Any such system would need to support a more flexible implementation processes and live replications of operations for redundancy. The current system is constrained and a new system is required to allow future SCADA enabled equipment to be managed, as well as providing increased functionality.

7.5.2.2.2 Fairhall zone substation

To provide greater reliability and resilience to the network, a small zone substation is proposed to be constructed at Fairhall, west of Blenheim. The site was purchased several years ago and is serviced by 33kV capacity cables. The project would initially involve a single power transformer and associated switchgear, house indoors. This would also provide additional capacity which could facilitate further growth in the area.

7.5.2.2.3 Other non-material projects

The following non-material projects are proposed to be undertaken within the 2 to 5 year period of this AMP.

- Continuation of the ‘T-Joint’ removal programme detailed in Year 1. Each year of the programme intends to remove T-Joints from a single street.
- Francis Street tie line. This project would involve installing an underground cable to tie the 11kV network. This would provide

greater operational flexibility, greater capacity, greater reliability, and removed aged overhead infrastructure which is in the vicinity of childcare centres and a secondary school.

- 33kV 'T' removals. In areas of the 33kV network, T connections exist. These can be problematic in that faults on the 33kV line can affect large areas where T's exist. Removing the T's allows greater operational flexibility and reduces the size (area) of any 33kV fault providing greater network reliability. Three sites earmarked for this are the 33kV T near the new Renwick zone substation, the 33kV T affecting the Picton No. 2 line near Spring Creek zone substation and the 33kV T near Woodbourne zone substation.
- Continuation of the remote device installations. This work was summarised under the Year 1 programme. For Years 2 to 5 ML is intending to install 7 devices per year which will allow remote operation using SCADA.
- Wairau River crossing cable. Subject to investigations, the option of installing a cable on the SH 1 Wairau Bridge to provide a secondary alternative supply to the old overhead crossing. This will provide greater security of supply to Picton, which is reliant on the existing overhead crossing for supply.
- Backup ripple control plant. ML currently has two ripple plants at System Control in Springlands, a 217Hz and 1050Hz plant. The 1050Hz plant is being phased out. Due to its criticality, ML is considering the need for a backup 217Hz plant so that there is redundancy in the event of a fault.
- Commencement of a zone substation protection upgrade programme. The protection relays at a number of zone substations are nearing end of life. The current technology allows for greater functionality and will be adopted to renew the older suite of relays.
- Replacement of pole mounted substations programme. A number of pole mounted substations, particularly in Blenheim, are nearing end of life. They were constructed to designs which were based on loadings relevant at the time, but which were less stringent than those currently in place. As a number of these pole mounted substations are near areas of public interest, ML is intending to replace these with ground mounted substations. ML is intending to replace between 5 and 10 pole mounted substations each year.
- Maxwell Road/Alabama Road 33kV RMU. Installing an RMU at this location would allow greater flexibility in operating the network and reduce the area affected during outages.

7.5.2.3 Years 6 to 10 (2024 to 2028)

7.5.2.3.1 Budge Street zone substation

Nelson Street zone substation is currently nearing capacity. ML will consider options to increase the capacity – at this stage it is anticipated that this could be achieved through a number of means such as shedding load to other zone substations or by building a zone substation at Budge Street where ML currently owns a small residential property. Building a new substation would have the additional benefits of providing greater network resilience and greater network flexibility. All of these (and possibly other) options will be evaluated before deciding on the most appropriate option.

7.5.2.3.2 Other non-material system reliability or safety projects

For years 6 to 10 of the planning period, the following reliability or safety related projects are proposed. Note that due to these projects being forecast at least five years from now there is greater uncertainty of time of occurrence.

- Continuation of the T joint, pole mounted substation replacement and remote device installation programmes.

- Park Terrace 11kV tie line. ML is considering replacing the aged overhead lines down Park Terrace with an underground cable. This would replace existing end of life assets and increase reliability in the area by providing an alternative 11kV feed into the area.
- Waikawa Road alternative 11kV supply. Approximately 2,000 consumers along Waikawa road and beyond are largely supplied by a single 11kV feed. In the event of an outage on the 11kV feeder, there is no alternative to supply these consumers (other than bringing in mobile generation although the loading is significantly more than the capacity of any one of ML's mobile generators). ML is intending to investigate options to provide an alternative supply to increase network resilience and reliability in this area. Options may include an underground supply along Waikawa Road, or a second 11kV overhead circuit on other poles than those that the existing circuit is located on.
- DeCastro subdivision tie line. This area is also supplied by a single 11kV feed. ML will evaluate options to provide an alternative supply to this area to increase resilience and reliability.
- Replacement of 33kV and 11kV lines in Old Renwick Road next to racecourse.

7.5.3 Non-system growth projects

There are no non-system growth related projects forecast for the planning period at the time of writing.

8. Customer works

8.1 New connections

This chapter outlines ML's approach to connecting new consumers and how expenditure is forecast relating to the connection of new consumers. The process used to connect new consumers is tailored to ensure the fast, efficient and cost effective connection of new electricity consumers to the ML network.

8.1.1 Overview of consumer connections

Every year, ML connects hundreds of new residential, commercial and industrial electricity consumers to the distribution network. Depending on the size or number of the new connections, the ability to supply the new connections may demand investment to extend the distribution network to the desired point of supply, or upgrade assets to meet the required capacity.

On occasions the new consumer connection may require the upgrade of near end of life ML assets to accommodate new equipment and/or an upgrade in capacity. When this occurs, ML gives consideration to the assets being replaced, and may cover the costs of the new equipment.

8.1.2 Connection process

Residential consumers requiring a new connection in developed areas, such as new builds or subdivision development, will often contact an electrician who will make an application to ML on their behalf. The electrician will submit the proposed connection specifications and design and notify ML of any special requirements, such as the need for an easement. This will then be reviewed and approved provided the distribution assets have sufficient capacity. Upon approval, the installation will be planned and performed by ML's contracting division or one of ML's approved contractors.

Larger commercial consumers, subdivision developers, and local council will often contact ML directly to discuss connection requirements or work with engineering consultancies to develop suitably sized distribution systems for their proposed works. Installations of this size will often involve relatively significant infrastructure development, network extension or asset renewal. Across this process ML works with these larger entities to facilitate the connection of large loads in a standardised and efficient manner.

Where asset replacement is required, ML will review on a case by case basis to determine the level of contribution, if any, that ML will provide. It is beneficial for ML to work with developers during the connection process as it provides an opportunity to upgrade assets that may be approaching end of life or its capacity rating.

ML's consumer connection process and capital contributions policy is set out in further detail on the ML website.

8.1.3 Expenditure forecast

The ability to forecast works relating to new consumer connections is relatively limited. Currently forecasting strategy is reliant on trending expenditure information from recent years, residential development forecasting from major developers and local council, an understanding of the current economy driving local commercial development, local intelligence and other environmental factors.

Over the planning period capital expenditure forecasting will be based on the following assumptions:

- Residential development in the Blenheim and Renwick areas will continue at an approximate rate as seen over recent years. Approx. 1% per annum ICP growth
- Commercial development, especially in the viticulture industry, to continue at or around current rates.
- A general steadying in load through the installation of energy efficient lighting and heating in residential applications should slow the need to increase capacity of distribution assets.

8.2 Asset relocations

This section reviews ML's approach to the relocation of distribution assets when required by other parties. It includes an overview of typical drivers for asset relocation, managing the relocation works and how they are funded.

8.2.1 Overview of asset relocations

Electricity distribution assets often require relocation due to the development of the surrounding environment or infrastructure where they are installed. This is typically due to the activities of other utilities operating in the region such as the replacement of water pipes, telecommunications circuits, roading activities, or through the development of land for farming activities such as the installation of new vineyard blocks.

Working with the stakeholder undertaking the project that has requested asset relocations provides an opportunity to upgrade segments of the network, or replace aged assets, at reduced cost. ML is typically willing to undertake asset relocations during major works because of this, and will regularly schedule meetings with local council and other utilities to discuss upcoming works that may require asset relocations.

In most circumstances ML receive contribution from the third party requesting the relocation of assets, reducing the amount of ML investment in these projects. In most instances pertaining to asset relocations, ML may bear costs, often in the form of materials for the execution of the project. For major infrastructure projects, the level of investment is governed by legislation which requires funding of the materials portion of the project. ML's capital contributions policy is set out in further detail on the ML website.

Expenditure is capitalised where assets are in poor condition or approaching end of life and are able to be renewed or upgraded during the performance of the asset relocation process. Otherwise, relocations of the same asset, or replacement of like-for-like is considered as operational expenditure. Where major works are required for asset relocation, such as major roading and other infrastructure projects, ML will build this into the capital expenditure plan to resource the project. Asset relocation projects proposed for the planning period are set out in the following sub section.

8.2.2 Asset relocation projects

Asset relocation projects are typically driven by third party (typically Marlborough District Council and Marlborough Roads) requirements. As ML is not always aware of third parties' capital expenditure plans, particularly further into the planning period, this makes it difficult for ML to forecast projects where asset relocation is the primary driver. ML regularly meets with representatives from MDC and Marlborough Roads to discuss the more certain upcoming capital expenditure plans, and where possible, seeks to optimise opportunities as and when they arise.

ML are aware of the following asset relocation projects at the time of writing:

- Ōpaoa Bridge replacement and State Highway 1 northern 'gateway' to Blenheim undergrounding (FY2019). ML is proposing to underground the section of line immediately north of the Ōpaoa Bridge running alongside to SH1. This section of line (both HV and LV) is at the north 'entrance' to Blenheim and is adjacent to a number of large trees which require regular trimming. The overhead poles and conductor have been in service for almost 60 years.
- Horton Park, Redwood Street undergrounding. HV and LV lines constructed in the late 1950s run adjacent to the western side of Horton Park along Redwood Street. Regular trimming of the adjacent large mature trees is required to prevent interference with the lines. The timing of this project is subject to MDC requirements.
- New Renwick Road widening. Recently, Marlborough Roads again proposed to widen the section of New Renwick Road from Bells Road to west of Fairhall School. ML, to accommodate the widening, would need to move its overhead lines (and at the same time replace the existing aged equipment with new equipment). ML would contribute the cost of materials to the project, if it proceeds in the future (subject to Marlborough Roads project plans).

As ML is made aware of third party plans which may impact on assets ML will consider options to relocate, and possibly renew, its equipment to meet the third parties' requirements.

9. Fleet management

9.1 Fleet management overview

Our fleet management section provides a summary of key ML asset classes, their populations, condition and specifics of their preventive maintenance regimes and renewal. Good fleet management enables prudent and efficient outcomes in the management of the network assets through early identification of trends and allows the drawing out of specific capex and opex programmes for more focused resourcing and cost control.

The fleet strategies developed are implemented in the field through ML's policies and procedures which are documented and disseminated in its IMS system

Many of ML's asset management objectives are common across the different fleets. These include public safety as the top priority, maximising asset utility while minimising total cost (life cycle strategy), and meeting the network service level targets that have been set.

9.2 Overhead structures (poles)

9.2.1 Asset management objectives

Apart from the fleet-wide asset management objectives (safety, lifecycle, reliability etc.), co-incident project co-ordination has been identified as a specific objective for the overhead structures fleet.

9.2.2 Fleet overview

9.2.2.1 Sub-Transmission

Based on condition assessments, ML's sub-transmission network is in very good condition. Due to the criticality of the sub transmission network for bulk power transfer around the network, more regular monitoring is undertaken and therefore defects are more promptly identified (and corrected). Over 75% of the sub transmission network is built upon concrete poles using hardwood crossarms. New builds are predominantly built on steel poles with steel cross arms as standard.

There are a number of steel lattice towers in service which date back to the late 1920s when the network was first being established. These original steel lattice towers are located alongside Waihopai Valley Rd and adjacent or near to Redwood Pass Road. Many of these have been recently replaced, with the balance to be replaced in the planning period.

9.2.2.2 Distribution

The distribution network is generally in good condition. Nearly half of the distribution lines are supported by concrete poles (a mixture of reinforced and pre stressed), and most of the balance on treated pine (TP) poles. New builds are typically constructed using pre-stressed concrete or treated pine poles are used in areas where the installation of concrete poles is precluded by technical factors.

A large amount of the Marlborough Sounds reticulation was constructed on TP poles between 1968 and 1975. Age based AHI indicate that this population will likely move into a period requiring increased replacements.

There are also approximately 1,700 iron rail poles on the network. The condition assessment of these poles is typically difficult for field staff. ML has a no-climb policy in place on iron rail poles because of the difficulty of assessing their structural integrity. ML has not experienced unassisted failure of steel rails but given their age and former use their mechanical strength is uncertain. Planned replacements are concrete poles together with new pole top hardware.

The population of reinforced concrete pole within the network is relatively unaffected by age. Evidence of spalling is beginning to appear in some areas of the network. For the most part, trends do not seem to have a significant age component.

Most of the network uses flat construction hardwood cross-arms, although some limited areas have been altered to delta construction where faults have occurred from bird strikes to improve network reliability.

9.2.3 Populations and ages

The AHI's presented for overhead structures are based on the pole type and the age. ML is currently in the process of implementing a more robust condition based AHI system for overhead structures that encapsulates the returned surveillance data. Note that the "Do Nothing" forecasts presented in the following charts have been provided by extrapolating ML's existing population and do not take into account any new build or replacement activities.

The age and condition profiles of ML's poles (separated into sub-transmission and distribution) are presented in the following sub sections.

9.2.3.1 Sub-transmission

Figure 37 presents a summary of ML's sub-transmission poles by age and type (note that for illustrative purposes, the x axis is not linear). The majority of these poles are steel and pre-stressed concrete, with the

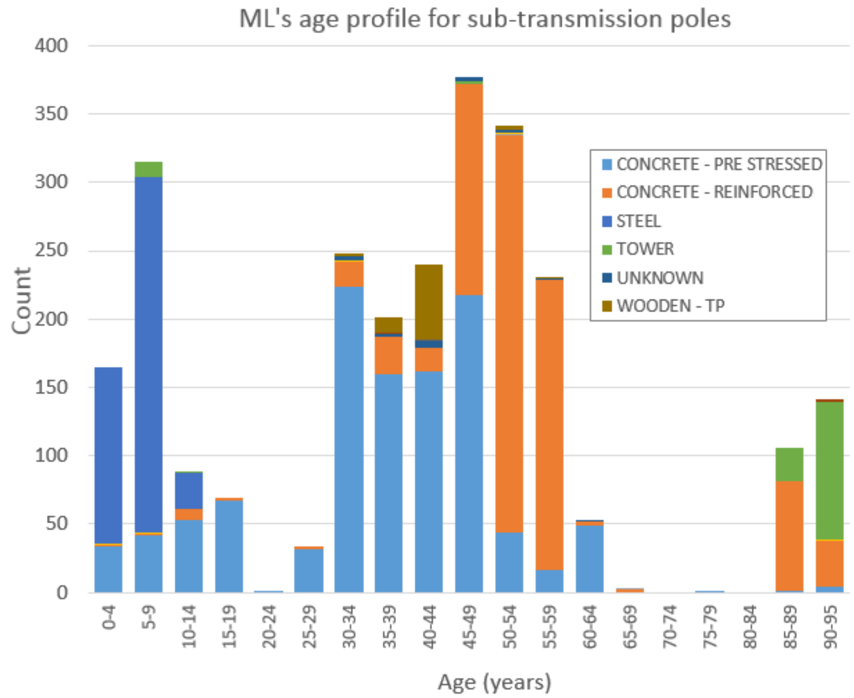


Figure 37: Sub-transmission overhead structures by age and type

older poles typically being reinforced concrete type. As shown, there are still a number of older 33kV poles remaining on the network (earmarked for renewal during the planning period – refer to Section 1.1 for more detail). Figure 38 presents a summary of the AHI condition values derived for the sub-transmission pole fleet, based on the pole type and age profile. The figure clearly illustrates the increase in pole quantities that would be classified in the H1 category, should no renewal projects be undertaken during the planning period. Likewise, there is a significant increase in pole quantities in the H3 category if the 'do nothing' option were to be taken.

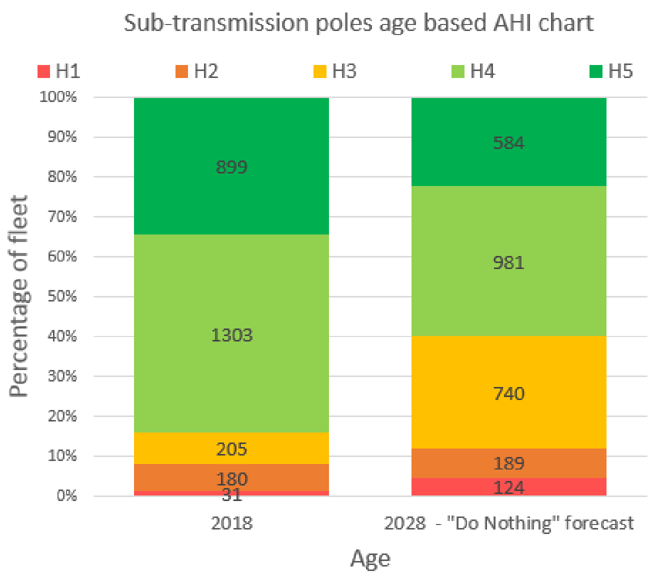


Figure 38: Sub-transmission poles aged base AHI

9.2.3.2 Distribution

Figure 39 presents a summary of ML's distribution (including LV) poles by age and type. The figure clearly illustrates the more even spread across the pole types for this fleet compared with that of sub-transmission poles (along with the relatively vast quantities of distribution and LV poles).

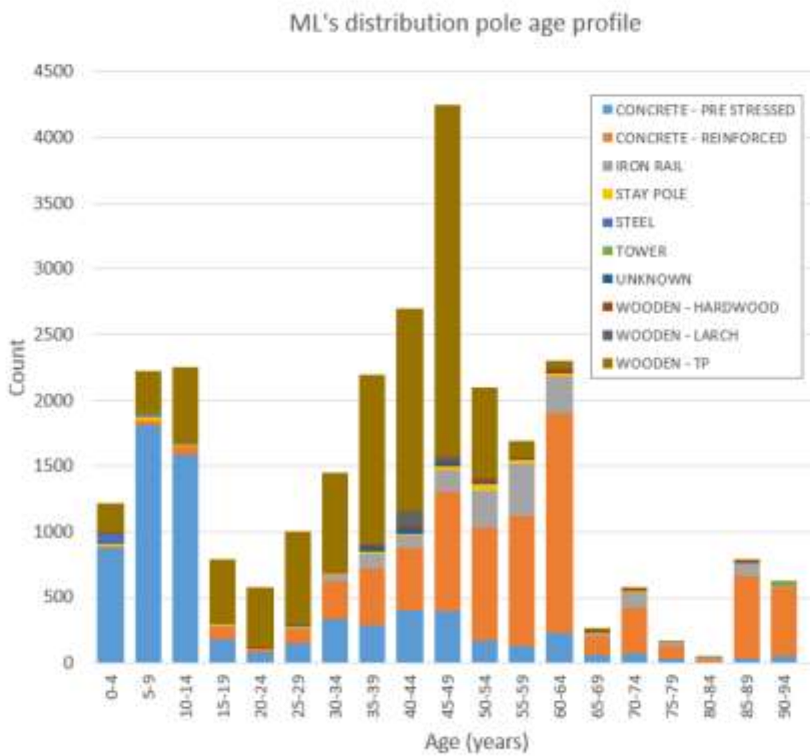


Figure 39: Distribution overhead structures by age and type

The AHI condition values derived for the distribution pole fleet, based on the pole type and age profile are presented in Figure 40. This clearly illustrates the major increase in pole quantities that would be classified in the H1 category, should no renewal projects be undertaken during the planning period. The other AHI scores (H2 to H5) remain relatively unchanged.

As noted above, a large amount of the Marlborough Sounds reticulation was constructed on TP poles between 1968 and 1975. Age based AHI indicate that this current population of approximately 7,000 poles will likely have reached an H1 condition within 18 years.

Based on age alone, the required replacement of around 80% of these structures is likely to be just outside on the horizon of the 10 year planning period of this AMP. As this is a significant portion of the population, ML views it as prudent to make inroads into assessing and prioritising replacement programs within this planning period.

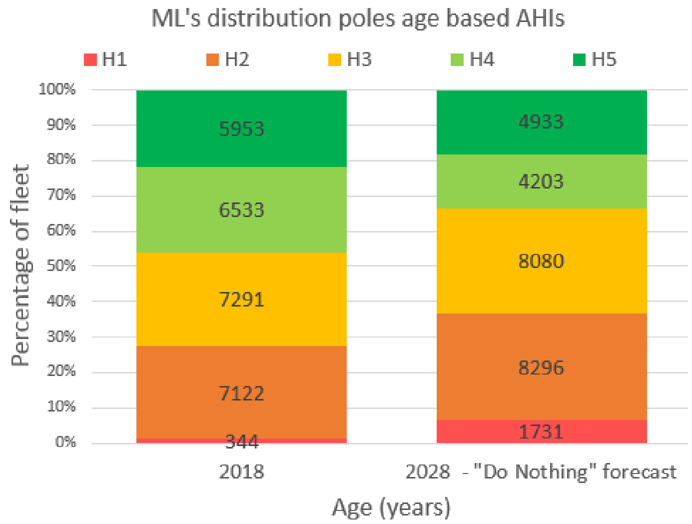


Figure 40: Distribution poles aged base AHI

The recent initiatives to improve the quality of ML's pole AHIs will provide information on how best to prioritise the replacement requirements.

In order to develop AHIs for overhead structures ML is investing in its surveillance program as discussed previously under Asset Strategy.

9.2.4 Condition, performance and risks

Network surveillance has identified end of life indicators for some of the older hardwood cross arms –primarily through evidence of 'flogging' or splitting. Where possible, cross arms in these areas are flagged for block replacement, with the insulators renewed at the same time.

The heightened risks of SWER lines, particularly for faults leading to low conductor or conductor on the ground, is considered in the prioritisation of renewal works despite the generally low consumer density associated to these lines and the lessened reliability impacts.

9.2.5 Design and construct

The 11kV line projects within the ML network have the following main drivers:

- New connections - growth
- The block replacement of poles that are reaching end of life - i.e. complete line rebuild.
- Conductor upgrade for capacity increase - growth
- Conductor upgrade for capacity increase - supply security
- Reliability hot-spotting

The general scope of a new line is:

- Poles:
  - Primarily pre-stressed concrete poles.
  - Steel for sub-transmission structures or when required for structural loading.
  - Tanalised pine where access and transport prevents the use of pre-stressed concrete.

- Pole top hardware:
  - Sub Transmission
    - Constructed at 66kV for both reliability and future capacity hedging
    - Use of steel Cross arms
  - Distribution:
    - Constructed to 22kV outside of the townships of Blenheim, Picton, Havelock and Seddon.
    - Hardwood cross arms or steel if on a steel structure.

9.2.6 Operate and maintain

Poles are inspected and condition assessed on a routine basis. Other than the possible recoating of steel structures which has not been necessary to date, poles are durable and do not require any electrical or mechanical preventative maintenance work for the duration of their lives. Structures are inspected every five years to assess their condition and to check external influences or foundation movement have not affected their integrity.

Cross arms are considered a component of the structure. A hardwood cross arm is likely to have a shorter life than the pre-stressed concrete pole to which it is attached. Cross arm replacements are preferred to be undertaken as block replacement projects due to the economies of scale when working in often remote areas. Replacement of associated pole structures at the same time is subject to condition assessment of each structure or on asset type policy as is the case with iron rails.

Table 30: Overhead structure maintenance schedule

Item	Action	Period	Maintenance level
33kV Poles	Visual inspection	1 Year	SHI
11kV Poles	Visual inspection	5 Years	SHI

9.2.7 Renew or dispose

9.2.7.1 Line rebuilds

There are often economies of scale in replacing entire sections of line at the same time particularly in remote areas where crew transport and set-up costs are significant. ML has a preference for block replacing an entire section of line when end of life indicators begin appearing across multiple assets along the section. Generally the structures within the sections will be of similar age and construction. The scope of block replacement projects usually includes new conductor. Drivers for overhead structure replacement are assessed alongside conductor replacement.

These replacement projects are considered capex where insulators are upgraded to 22kV or 66kV or whole line sections are being renewed.

Renewal of individual structures is subject to condition assessment. Replacements of single structures are expensed.

9.2.7.2 Off the grid supply as an alternative solution to renewal

With significant investment required to renew the reticulation in ML's least economical parts of the network, ML has kept abreast of alternative methodologies of electricity supply to these remote areas.

Remote Area Power Supplies (RAPS) provide one potential alternative to a conventional grid supply. A RAPS typically utilises on a combination of solar generation, battery storage and diesel backup to maintain supply.

ML does not have any firm plans for any significant investment in RAPS within the next five years. This is predominantly due to:

- Significant renewal of the assets where RAPS may be most suitable as a replacement alternative is not likely to be required within the next 5 years.
- Battery technology does not yet offer the financial return.
- Uncertainty around the safety risks and maintenance costs associated with a RAPS scheme.
- Costs and risks associated to the transport of back-up diesel fuel (particularly over water ways in the Marlborough Sounds), and the storage, maintenance and security of managing diesel fuel in remote areas.
- Uncertainty in the regulatory environment particularly in regard to battery and generation ownership.

ML intends to keep abreast of advances in RAPS and battery technologies and review its position as the technology and markets mature.

There are a very small number of instances where RAPS may provide immediate benefit. ML assesses these on a case by case. Criteria for these instances are likely to include:

- Extreme remoteness resulting in increased line and vegetation maintenance costs.
- Extremely low consumer count per km of line requiring renewal.
- Poor asset health driving a case for short term renewal.

ML believes that a coordinated approach with Government and its regulators would be beneficial to EDBs and consumers alike. It is very relevant that ML has a relatively significant proportion of ICP's in areas which are uneconomic and have always been uneconomic. Continuance of supply to these ICP's will add a significant burden of cost for consumers in economic areas.

The progressive replacement of lines which have always been uneconomic will result in an increased burden to ICP's in economic areas and is contrary to the principles of cost reflective pricing espoused by the Electricity Authority.

9.2.8 Overhead structures renewal forecast

The renewal forecast is based on a combination of those poles identified in poor condition for FY2019 renewal, an expectation of how pole condition will deteriorate over the planning period for subsequent years, and policy based replacement due to known type defects or safety concerns.

As noted above, the iron rail poles will be progressively replaced due to concerns around the inability to determine their strength. However, many of these poles support either copper of galvanised steel (GZ) conductor and will be replace co-incident with the replacement of that conductor as further detailed in the conductor fleet strategy This situation also applies to a number of the older reinforced concrete poles.

ML has a small population of larch poles, mainly on D'Urville Island where condition assessment has identified in poor condition. Programmed replacement of these poles is scheduled from FY2019 to FY2021 (next three years)

MLs' expectation for the manner in which the remaining pole population will deteriorate is based on survival analysis from past replacements applied to the current pole population by type.[19] An example of the calculation is illustrated in Figure 41 for tanalised pine poles where the red line fits a probability distribution to the observed survival. The fitted distribution is then used as a prediction tool when applied to the pole age profile.

Based on this analysis, ML expects the TP pole replacements to rise to approximately 100 p.a. which represents approximately 1% p.a. of the roughly 10,000 TP pole installed.

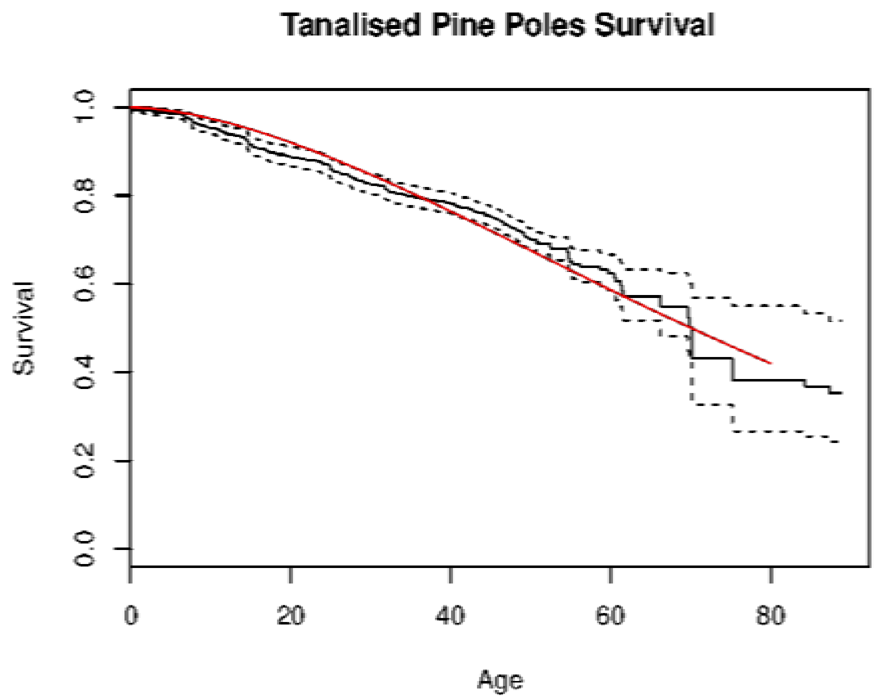


Figure 41: TP pole survival profile

[19] Survival analysis is a statistical method for determining the likelihood an asset will fail (in this sense deteriorate to a state requiring renewal), given characteristics such as type, location, age etc. but where age and type are the main drivers.

The lives of concrete poles are more difficult to forecast forward as they are more affected by environment than age. The expected life of pre-stressed concrete poles is not yet known as any acceleration in the deterioration of the older poles has yet to be detected. Renewal is forecast at the historic rate being carried forward.

Forecast renewal costs for this fleet are provided in the Expenditure section of this plan.

9.3 Overhead conductor

9.3.1 Asset management objectives

Apart from the fleet-wide asset management objectives (safety, lifecycle, reliability etc.), co-incident project co-ordination has been identified as a specific objective for the overhead conductor fleet.

9.3.2 Fleet overview

Overhead conductors have been summarised by voltage in the following subsections. The disclosure schedule on asset data presents a summary of the conductors by AHI grade for high level pole types. The AHI grading that ML has applied is largely based on asset age.

9.3.2.1 Sub-Transmission

ML's sub-transmission overhead conductor was built using aluminium conductor steel reinforced (ACSR) conductor, with all aluminium alloy conductor (AAAC) becoming the preference over the last 12 years. ACSR is still used on occasion when additional strength is required (e.g. long spans).

New sub transmission is constructed at 66kV but will continue to be operated at 33kV. There is a section of line that runs from Leefield Zone Substation to the Waihopai power scheme which is over 90 years old. However, this is principally a dedicated line for the Waihopai power scheme and is subject to ongoing assessment.

9.3.2.2 Distribution

The backbone of the distribution system is constructed at three phase 11kV with some spur lines and lines at the extremities of the network being two 11kV phase together with 33 separate areas of single wire earth return (SWER). All of the distribution system currently operates at 11kV. New rural construction is generally insulated at 22kV and, within the period of this plan, it is considered possible that some areas may be operated at 22kV.

Most of the central area of the 11kV network is capable of being ring-fed with supply available from at least two zone substations. This arrangement provides flexibility in the operation of the system, and enables supply to be maintained to most consumers in these urban areas at times of emergencies or planned outages. However a significant portion of ML's network is supplied by way of long radial spur lines, which have no alternative supply options (other than mobile generation that may be brought in in some cases).

Most conductors are aluminium, although some copper, copper weld and galvanised steel conductors remain in use on older lines and spur lines. These are generally in parts of the network where demand is relatively low and static. Replacement is generally driven by asset health and line-down safety issues (including fire ignition) and is subject to condition and risk assessment.

9.3.2.3 11kV SWER

SWER lines have been used extensively throughout the more remote sections of ML's network, with a total of approximately 540km of 11kV SWER lines currently in place. These lines were constructed at significantly lower cost than the more traditional two and three wire systems, due to the ability to span longer distances without the possibility of mid-span wire clashing. This type of construction is ideally suited to areas of low population density, such as parts of the Marlborough Sounds and the upper Awatere Valley and especially where the terrain is undulating where pole numbers can be minimised.

The trade-off for the reduced construction costs is that the earthing systems at each transformer must be constructed as an operating rather than just a safety earth and require more rigid monitoring than with standard construction.

9.3.3 Populations and ages

For this AMP, the AHI's presented for overhead conductor are summarised by voltage and have been built on the conductor type and age criteria. The "Do nothing" forecasts have been provided by extrapolating ML's existing population and do not take into account any new build or replacement activities.

In sub-transmission the older conductor is the earlier ACSR which remains in reasonable condition despite its age. In distribution, the older conductor is the weaker copper and galvanised steel types, which is now subject to programmed replacement.

9.3.3.1 Sub-transmission

ML's sub-transmission conductor age by length is plotted in Figure 42. The uptake and move to AAAC conductor is clearly demonstrated. Figure 42 presents a summary of the sub-transmission conductors AHI values. This indicates that the sub-transmission conductor population is generally in good condition.

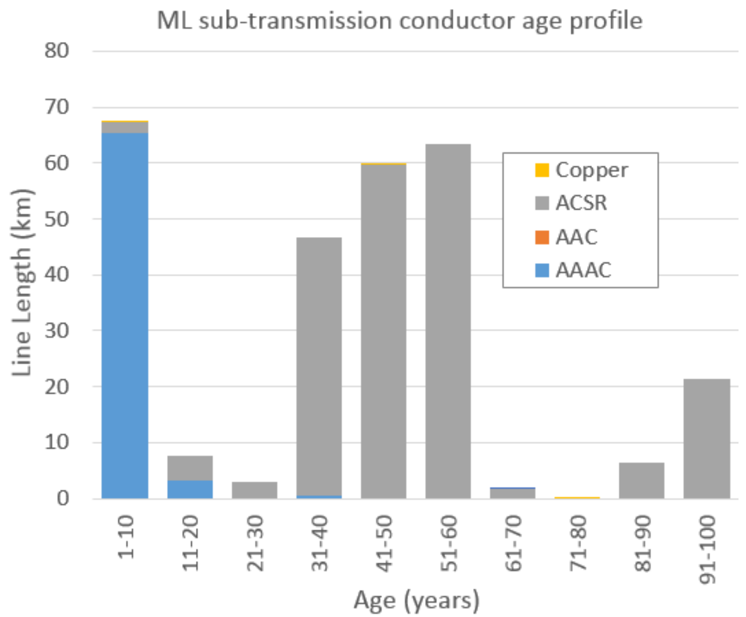


Figure 42: Sub-transmission conductor age profile by conductor type

9.3.3.2 Distribution

ML's distribution conductor age profile is presented in Figure 43. This shows the bulk of the fleet to be made up of ACSR, with significant quantities of copper and galvanised steel conductor making up the bulk of the aged fleet. Much of the newer conductor fleet is comprised of AAAC.

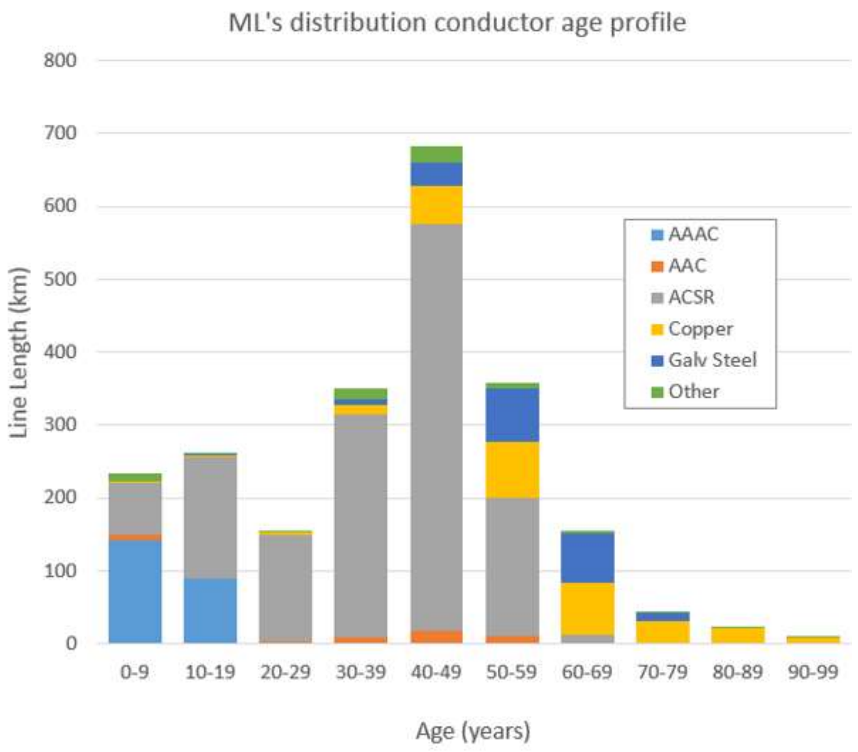


Figure 43: Sub-transmission conductor age based AHI

Figure 44 presents a summary of the distribution conductor fleets AHI values today, and projected out 10 years from now if no renewals are undertaken across the planning period. It clearly shows the significant portion of conductor that would be placed in the H1 and H2 AHI categories.

9.3.4 Condition, performance and risks

The condition of the network's aluminium and ACSR conductor is generally good. The older part of our distribution conductors are predominantly copper and galvanised steel. In both cases the types of conductors are lower capacity which can provide further justification for replacement. Conductor failures are predominantly caused by contact from foreign objects like trees or birds and from corrosion and fatigue.

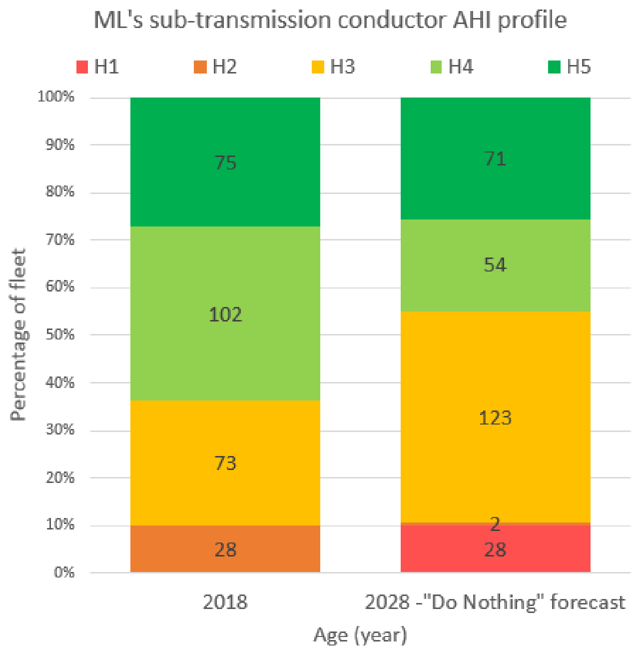


Figure 44: Distribution conductor age profile

ML's vegetation program, discussed elsewhere has dramatically decreased (but not eliminated) the occurrences of these faults, however, any historic weakening that has occurred will remain. While inland Marlborough is generally benign for steel corrosion, corrosion still progresses albeit at a slower rate than where the conductor is exposed to coastal wind. Conductor vibration and wind also contribute to metal fatigue and the effects of this are cumulative over time.

ML has begun to notice an accelerated ageing on some older copper and galvanised steel conductors. A programme has commenced to inspect areas of similar age and construction using high resolution cameras mounted on telescopic sticks and drones to get a better understanding of the conductor condition at and around the insulators. At this stage it is anticipated that a large part of our pole and overhead line replacement budget will be focused on the renewal of lines that fit into this category. There is approximately 430km of this older style line within the network that provides candidacy for replacement.

ML takes a precautionary approach to line replacement in consideration of:

- the public safety issues of line faults where conductors have the potential to fail;
- the difficulty of testing conductor strength necessitating a precautionary approach;
- it is more cost effective to take a proactive approach rather than react to failure; and
- fire ignition risk from fallen conductor.

SWER lines present an increased operational risk as spans are typically greater than two or three phase and line faults on SWER lines have been traditionally harder to detect because of the limits of protection equipment relative to an earth return system. As mitigation, and with advances in technology ML is:

- installing smarter, remote controllable reclosers at the beginning of SWER networks
- retrofitting SWER lines with a new insulator bracket.

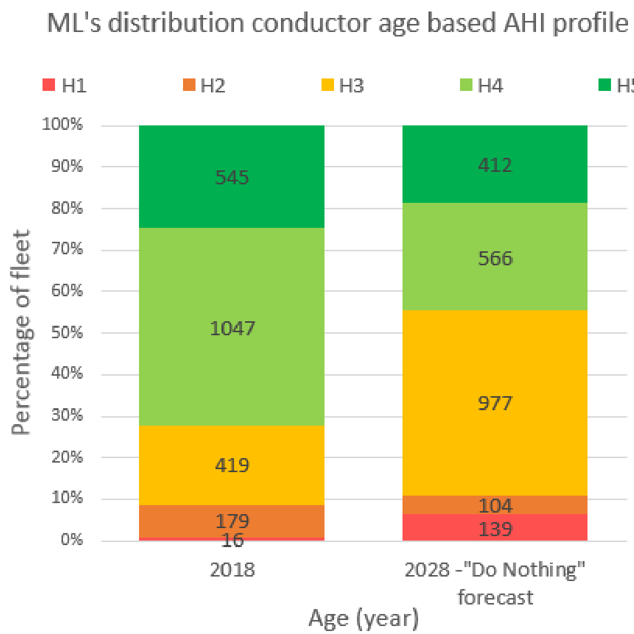


Figure 45: Distribution conductor age based AHI

9.3.5 Design and construct

As a general guide, ML's standard line conductor specifications are:

- Primarily AAAC conductor – some AAC used on LV; and

- ACSR where required (typically based on mechanical loading).
- Special consideration is given to unique circumstances such as the crossing of Tory Channel which has a span of 2,029 metres.

Periodic review identifies those areas where changes in demand may require upgrades to the capacity of the network, generally by way of increases in the conductor size.

9.3.6 Operate and maintain

Conductors are generally long life assets, with little maintenance required. As previously detailed issues like corrosion from sea spray or fatigue from wind driven vibration or earthquake forces can age the conductor.

Visual inspections are undertaken on the conductor heights at the same time as pole structure inspections. Intrusive testing on conductors is only used on a case by case basis generally to support major replacement decisions.

Where foreign object damage is a common failure mode, the conductor configuration may be redesigned or modified to mitigate the consequence of further contacts. Examples of this include utilisation of delta configurations, the application of bark guards, and insulated conductor systems.

Table 31: Overhead conductor maintenance schedule

Item	Action	Period	Maintenance Level
33kV Lines	Visual inspection	1 Year	SHI
11kV Lines	Visual inspection	5 Years	SHI

9.3.7 Renew or dispose

ML uses a condition and risk based strategy to determine the priority for conductor replacements. Conductor age and type of conductors focus ML's detailed condition assessment activities.

Drivers for conductor renewal are analysed alongside structure (pole and crossarm) renewal as these will often be actioned at the same time. However, conductor renewal usually requires a full line rebuild as:

- older conductor is generally strung on older poles;
- the replacement conductor is invariably heavier necessitating a line redesign to current code requirements; and
- remnant pole strengths of older poles are often unknown so cannot be reutilised under the new line construction codes regardless of their condition.

9.3.7.1 Load Control as an alternative to capacity upgrade

Generally speaking, ML has very few areas that are constrained due to line capacity. Should there be demand growth above line capacity, there are a number of tools that ML could apply other than capacity upgrade including:

- utilising the ripple control system to remove participating hot water load during peak periods;
- establishing a generation participant program to utilise backup generators embedded within consumer installations based on ripple control signalling; and
- pricing signalling that encourages consumers to reduce load during peak times.

However, these means are more likely to be used for investment deferral as they are of limited effect.

9.3.7.2 Battery storage and demand side management as an alternative to capacity upgrade

At this stage, ML does not plan any investment in battery storage within the next five years. This is predominantly due to not having a requirement for such storage. Aside from not having a need for batteries other factors to be considered would be:

- the current market pricing and payment structures, systems and tools are not currently available to allow for ML or its consumers to realise the value in demand side management;
- the uncertainty around the safety risks and maintenance costs associated with battery systems;
- current battery costs; and
- uncertainty in the regulatory environment as to ownership of these assets.

ML will keep abreast of this rapidly developing area and review its position on battery storage, demand side management and associated infrastructure during this planning period.

9.3.7.3 Off the grid power supplies as an alternative to line renewal

This is discussed in section 1.1.1.

9.3.8 Overhead conductor renewals forecast

ML's renewal forecast is based on the replacement of 15km of line in FY2019 building to 30km p.a. by FY2021. This rate of renewal will replace all at-risk conductor (old copper and galvanised steel) over a 15 year period and, at 30km per year represents a replacement rate of approximately 1.4% per annum against the total high voltage distribution conductor.

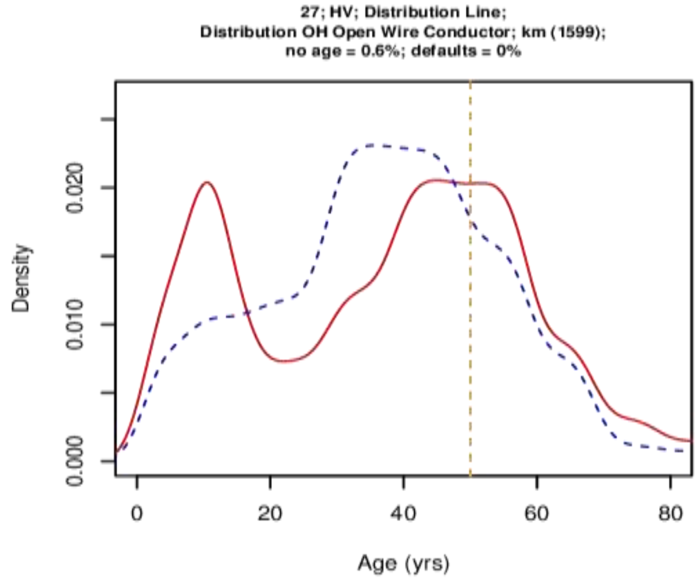


Figure 46: ML's distribution conductor age profile

ML's distribution conductor age profile in relation to the all NZ EDB combined profile is illustrated in Figure 46 where the red line is the ML distribution overhead conductor age profile; the blue dotted line is the all NZ EDB combined age profile and the yellow vertical line is the regulatory life for overhead conductor (based on FY2017 Disclosure data).

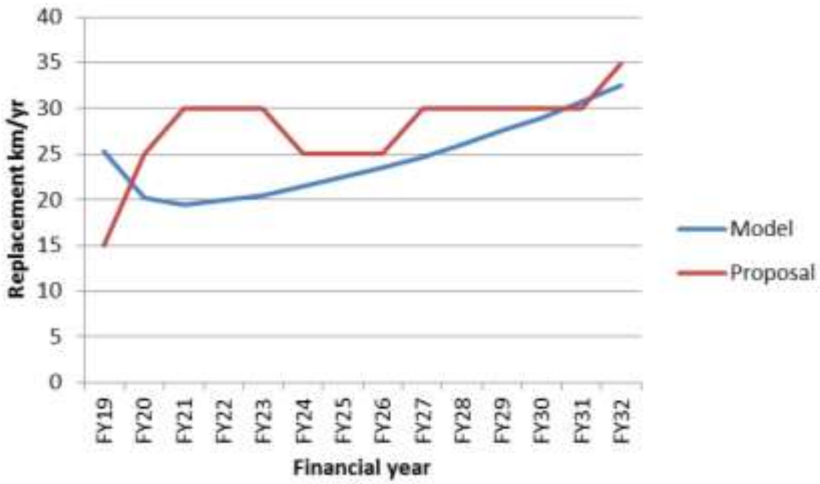


Figure 47: Proposed distribution conductor renewal rate

As shown, the ML conductor age profile is now advanced past the all NZ profile indicating that an increase in renewal should be anticipated. However it also needs to be recognised the inland Marlborough area provides a more benign environment than other parts of New Zealand and over the life of the assets they have been properly maintained. Further, analysis of the manner in which the all NZ age profile advances leads to a gross expectation on the rate at which conductor will be renewed as it ages. Figure 47 applies this rate expectation to the ML copper and GZ conductor and compares it with the planned renewal rate. This shows the conductor renewal proposed in this plan is in keeping with that indicated by the all NZ conductor ageing model.

The renewal projects will be directed to replace conductor using a priority scoring system that includes conductor age, condition, and avoided risk (i.e. lines crossing vineyards, fire risk areas, public places etc.).

The forecast replacement will coincidently renew most of the approximately 1,700 iron rail structures on the network as well as a number of the older reinforced concrete poles, which generally support the copper and GZ conductor targeted in this project. ML have adjusted its replacement forecasts for these pole types to ensure these over-lapping works are not double counted.

Forecast expenditure in this category is provided in the Expenditures section of this plan

9.4 Cables

9.4.1 Asset management objectives

Being an underground asset, public safety is less of an issue with the main focus being on achieving lifecycle and reliability objectives.

9.4.2 Sub-transmission cables

9.4.2.1 Fleet overview

The ML sub transmission cable network consists of approximately 22km of paper insulated lead alloy sheathed (PILC) and cross-linked polyethylene (XLPE) cables energised at 33kV, including all ancillary components including joints and cable termination structures.

9.4.2.2 Populations and ages

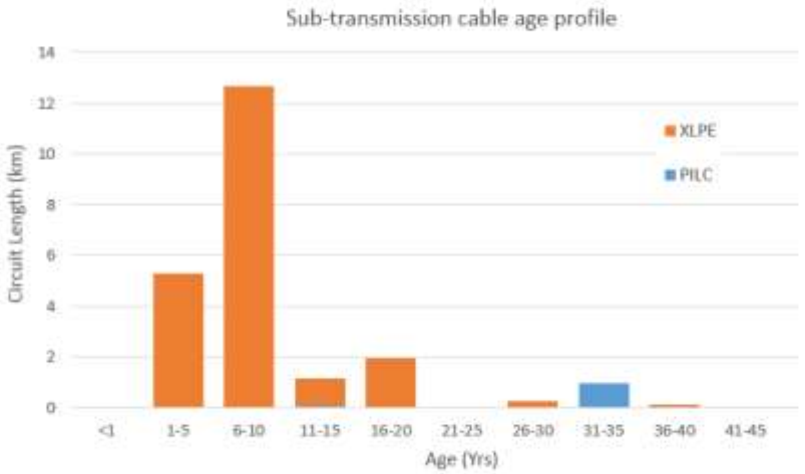


Figure 48: Sub-transmission cable age profile

Of the 22km of sub-transmission cable installed within the network, the majority of the cables have been installed within the last 20 years, and by in large these are XLPE type cables. The use of XLPE has been the preferred cable insulation technology over the last 30 years, over that of wax impregnated paper due to its ease of use, superior performance and reduced cost.

9.4.2.3 Condition, performance and risks

Given the age, and the manner in which it has been installed, the sub transmission cable network is in good condition. Furthermore, the sub transmission cables typically have a greater capacity than what is required from their load, reducing the aging effects due to heating etc. that would otherwise be experienced.

The Wairau River Bridge 33kV crossing, built in 1985, is a bridge suspended PILC cable that is a component of the sub-transmission network which supplies Havelock and Linkwater Zone substations. Although alternate supplies to these substations is available, a failure on this cable would result in a short duration outage for more than 2000 consumers.

An issue has been identified with certain types of 33kV heat shrink terminations due to the environmental conditions when installing the terminations possibly resulting in future premature failure of the termination. To counter this, ML has moved to a cold-applied alternative installation method.

9.4.2.4 Design and construct

All new sub-transmission cable circuits that ML install are constructed to 33kV, utilise the most recent XLPE insulating materials, and are standardised on size either being single core 300mm^2 or 630mm^2. Standardisation of size assists in ongoing cable management by reducing spares holdings, reducing cost and simplifying installation and repair practices. The capacity of cables of this size is expected to be sufficient for the foreseeable future.

9.4.2.5 Operate and maintain

Generally PILC and XLPE cables are maintenance free. Oil filled or gas filled cables do require regular maintenance due to pressurised components, but ML does not own or operate any oil filled or gas filled cables. On occasion inspections and diagnostic testing is performed, especially when cables are being removed from service for other works, however this is typically performed on an infrequent basis but as the opportunity arises.

9.4.2.6 Renew or dispose

ML has no plans to renew any of its sub-transmission cables during the period covered by this AMP.

9.4.3 Distribution cables

9.4.3.1 Fleet overview

The ML fleet of distribution cables operates at 11kV, including some examples of 11kV SWER cabling that is installed within the distribution system. The distribution cable system is comprised of approximately 185m, installed within the major townships of the Blenheim CBD, Renwick, Picton and Havelock.

9.4.3.2 Populations and ages

As with the sub transmission components, the underground distribution network is relatively young, with the bulk of this type of asset being installed within the last 20 years. The key driver for installation of significant amounts of distribution cable in urban areas over this period of time has been to increase in network reliability and aesthetics over that of overhead alternatives particularly, as exiting overhead circuits approached end of life demanding replacement.

As work is performed on the urban distribution network within the Blenheim CBD area, such as planned cable renewals, circuit capacity upgrades, or ring main unit replacements, replacement of older generation distribution cable is performed simultaneously, where achievable. This has gradually seen a decline in first generation XLPE cables and PILC cables within the Blenheim CBD, however there are still sections of cable that are approaching end of life that will demand replacement over the planning period to avoid unreliability.

9.4.3.3 Condition, performance and risks

Cable degradation is impacted by the combination of a number of factors including:

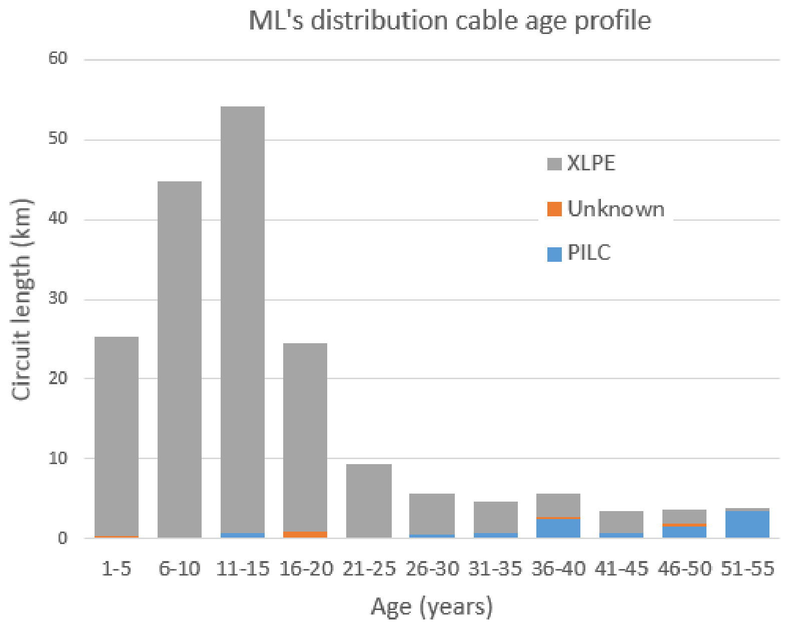


Figure 49: Distribution cable age profile

- Design and manufacture including insulation material;
- Installation type and environment;
- Electrical loading;
- Cable exposure;
- Cable age; and

- External factors (third party damage, ground movement etc.)

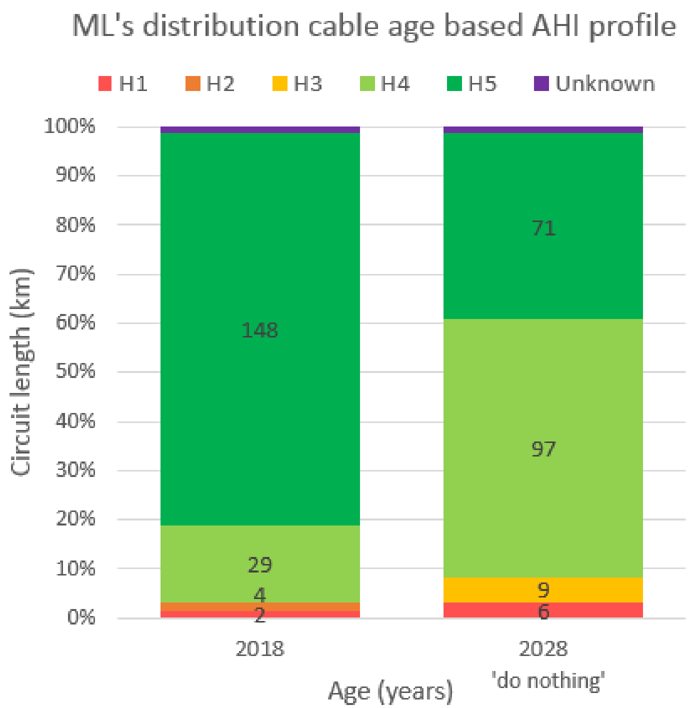


Figure 50: Distribution cable AHI summary

Given the relatively new age of the cable fleet, the majority of the distribution cable fleet is in sound condition and utilise modern XLPE plastic insulation technologies including water blocking and water-tree retardant properties. It is anticipated that this newer cable imposes minimal risk to network reliability until beyond the current planning period.

As mentioned above there remains a number of sections of cable, typically PILC, that theoretically maybe approaching or beyond their estimated onset of unreliability although this has yet to be experienced. ML has a continuous program in action to replace aged underground distribution assets at risk where no alternatives exist.

9.4.3.4 Design and construct

When installing new sections of underground distribution network during new-builds or cable replacement, ML has standardised on a set of cable sizes. ML will utilise 50mm², 95mm² or 300mm² multicore aluminium cables with XLPE insulation. Single core cables and other conductor sizes may be utilised for specific applications, such as when increased current ratings are demanded. Standardisation of cable size allows for the reduction in the requires critical spares, such as jointing kits etc., as well as ensuring staff are competent in handling and working with regular sizes.

Where cable installation is required in rural areas of the distribution network, ML installs 22kV cable to be energised at 11kV, in preparation for the eventual voltage upgrade to 22kV distribution. These are standardised to the same sizes mentioned above, although single score cables are utilised for larger sized 22kV cables. The marginal cost difference in doing so is minimal, higher voltage cables have a greater life expectancy when energised below their rated voltage, and in conjunction with overhead reconstruction projects, places the distribution network in a position where voltage upgrade is feasible.

9.4.3.5 Operate and maintain

Cables are generally maintenance free as they are typically buried, with the only exposed sections being at the overhead to underground transitions, or at termination onto switchgear and other plant.

ML regularly performs asset inspections, which includes the visual inspection of cable termination poles and ground mounted switchgear for obvious signs of wear or damage, including condition degradation due to exposure to UV. Thermovision diagnostic testing on cables and switchgear terminations is also performed regularly. Inspections and testing regimes are summarised in Table 32.

Table 32: Maintenance/Inspection task summary for distribution cables

Maintenance/Inspection Task	Frequency
Visual inspection of cable termination poles.	5 yearly
Switchgear cable termination box partial discharge testing.	6 yearly
Thermographic imaging of cable terminations. Tan Delta diagnostic testing and VLF testing of cables.	Irregular when need arises

Cable faults most commonly occur due to interference from third parties during activities such as excavation or underground thrusting. Where distribution cables have been damaged resulting in increased risk of failure, corrective action is immediately taken by ML to avoid a fault developing. Actions will include:

- Replacement of mechanical protection on cable termination pole
- Replacement of the cable termination due to degradation
- Removal of failed/damaged section and cable replaced or jointed.

9.4.3.6 Renew or dispose

ML's renewal approach for distribution cables is to replace on condition (when and where known) and/or age. As mentioned previously, there are some distribution cables that will require replacement over the planning period, subject to condition assessments. Assessing cables' condition through testing can be difficult (largely due to the time and cost involved, and one of nature of the testing – noting that some tests can 'age' cables). The AHI guide provides end of life drivers for cables based on known issues, loading history, partial discharge and failure history which can be used to deduce condition. Another of the key determinants of the life of a cable can be the manner of installation and the ground conditions within which it is installed.

ML will consider renewal of cables based on the condition values deduced based on the AHI guide.

9.4.4 Low voltage cables

9.4.4.1 Fleet overview

This fleet includes LV link boxes, cabinets and pillars

The LV distribution network provides the typical interface between the distribution system and consumer installations. The typical consumer installation is supplied from either an overhead service line or from a service cable connected to an LV underground distribution box.

The ML LV cable fleet operates at 230V/400V. The main assets within this class are cables and LV boxes which include link boxes, LV cabinets, service boxes and pillar boxes.

9.4.4.2 Populations and ages

ML’s LV underground cable network consists of nearly 400km of circuit length, including street light circuits. The bulk of the LV cable population has been installed within the last 20 years, during new subdivision installations or overhead to underground conversions. There are portions of the LV cable network that employ early types of XLPE or PILC insulated cables that are approaching end of life.

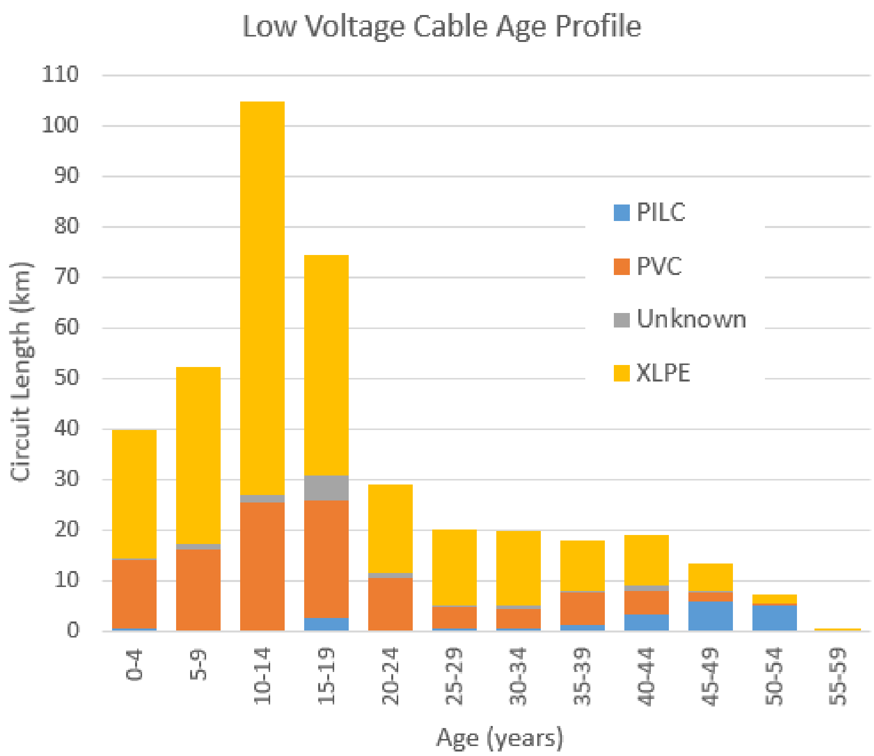


Figure 51: Low voltage cable age profile

9.4.4.3 Condition, performance and risks

Consumer service lines connect to the LV cable network from an LV service fuse box usually located on the property boundary or on the street frontage near the property. ML is aware of a design flaw of an older type of link box where there are uncovered energised terminals within the box, and the exterior and lid of the box, made of galvanised steel and where this is not earthed. This could pose a potential health and safety risk to members of the public as well as staff working on these link boxes. A replacement programme is currently underway to address this issue.

When a portion of the LV network is approaching the end of its useful life and is supplying numerous consumers of high importance, such as in the CBD area, ML will replace it as a result of condition assessment based on the AHI guide.

LV cables are typically buried or surrounded by mechanical protection where the cable transitions above ground to overhead connections on a cable termination pole. As a result, excluding damages from third parties, LV cable failures are relatively rare. A large number of LV outages might typically be caused by failure at the transformer LV box from causes such as external interference including vehicle contact and vandalism, or failure of terminations and joints. To overcome this, LV boxes are typically installed in protected areas, sheltered from external influences, and regular inspections are performed.

9.4.4.4 Design and construct

ML carries stock of numerous sizes of aluminium and copper cables for use on the LV cable network or to perform consumer work. Due to the simplicity of performing cable terminations on LV cables over that of distribution or sub-transmission, there is reduced need to standardise on a reduced selection of cable sizes. Irrespective it is necessary to utilise the right size cable for the application required, considering voltage drop, continuous loading, fault current capacity and mechanical performance when selecting LV cable sizes.

LV box types are thoroughly scrutinised before being approved for use on the ML LV network. Considerations include the ability to cover metallic bus sections, ability to accept approved fuse carriers, mechanical performance, locking ability etc.

9.4.4.5 Operate and maintain

Maintenance of the LV cable network focuses on the inspection of LV boxes. The frequency of inspections is based on safety factors and the criticality of the asset, with boxes in public areas or high risk exercises being inspected annually.

The occurrences of detailed visual inspections and the thermal imaging of LV boxes is summarised in Table 33.

Table 33: Maintenance inspections for LV boxes

Area	Frequency
CBD and Public Places	1 yearly
Other Locations	3 yearly

9.4.4.6 Renew or dispose

As mentioned above, renewal of LV cables is generally managed using a run to failure strategy, unless the cable supplies critical consumers where alternative supply options are limited or non-existent. LV cable renewal is expected to remain relatively minor and constant given the age and quantity of the existing LV cable population.

The issues identified with older style LV boxes have identified the possibility of a potential safety risk albeit low to the public and ML staff. This issue is currently being addressed.

9.5 Zone substations

Zone substations are the link between the sub-transmission and the distributions system by transforming the voltage, generally from 33kV to 11kV and allowing for bulk supply of electricity to end users over a number of distribution feeders radiating out from the zone substation. The supply of electricity to thousands of consumers sometimes depends on a few critical assets within the zone substation.

This chapter describes ML’s portfolio of assets comprising its zone substations. The portfolio includes:

- Power Transformers
- Switchgear
- Impedance Support
- Site & Buildings

Across the Marlborough region, ML operates 16 zone substations set in both urban and rural environments. ML’s zone substations take a supply of electricity at 33kV sub-transmission voltage and step this down for regulated distribution at 11kV.

9.5.1 Asset management objectives

The primary objectives are supply security, voltage quality and lifecycle outcomes. Safety objectives generally derive from ensuring adequate site security and electrical clearances, particularly from the fence lines, and in maintaining an adequate earth to control earth potential rise on internal faults.

9.5.2 33/11kV transformers

9.5.2.1 Fleet overview

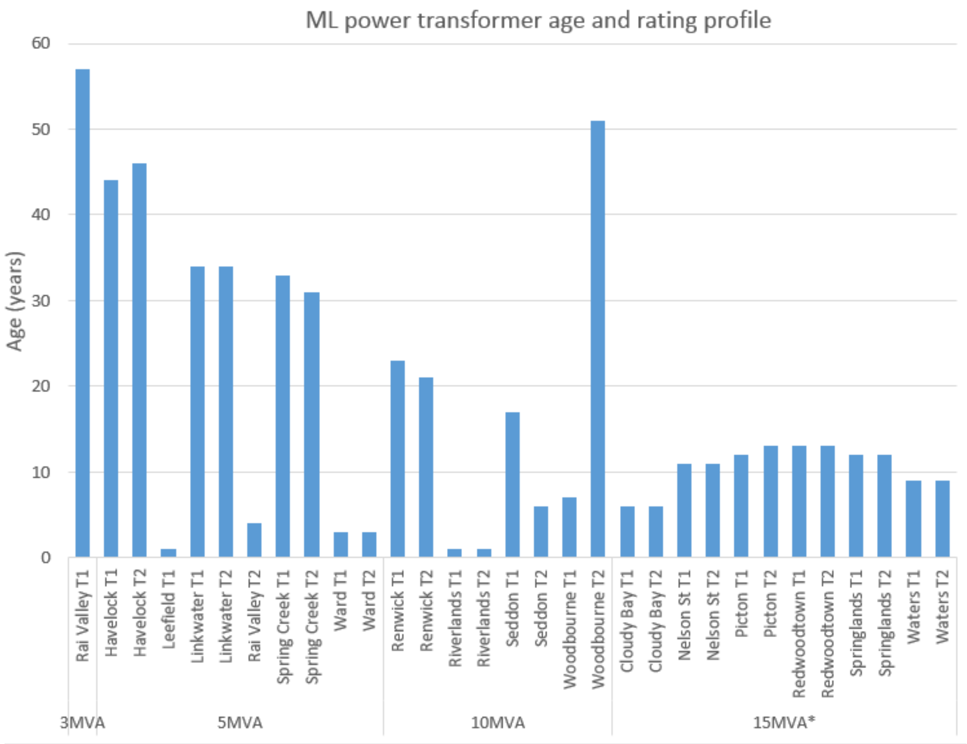


Figure 52: ML zone substation power transformer age and rating profile

Within ML's 16 zone substations, 31 power transformers are in operation, ranging in capacity from 3MVA to 16.5MVA capacity. All excluding one of ML's zone substations have N-1 security at the transformer level, allowing for the removal from service of any one transformer without impacting end users.

9.5.2.2 Populations and ages

The age and ONAN (natural cooling) rating details of the zone substation power transformer fleet under ML's stewardship are shown Figure 52 The majority of the transformer fleet is relatively new due to a number of recent out-door to in-door upgrades within the urban areas of the network over the last 10 years. However there are a number of transformers approaching their anticipated 65-year life span and will likely require replacement within the period covered by this AMP. But the transformers have been properly maintained, have not been heavily loaded and are not considered to be at the point of imminent failure. Irrespective they are subject to regular surveillance.

The average age of the ML power transformer fleet is approximately 17 years.

9.5.2.3 Condition, performance and risks

Power transformer failures are rare, with the main causes generally arising from wear on moving parts within on-load tap changers, or defects related to lack of maintenance or age and loading or insulation failures of the bushings. However, failures can have a major impact in major outages, result in fire or oil discharge or reduced levels of security until repair or replacement is completed.

Given that ML have achieved N-1 at nearly all zone substations, transformers almost never operate above half their ONAN rating, which means that the transformer fleet is in good condition, in spite of age.

Using the EEA Guide to Asset Health Indicators, ML has ranked the condition of its fleet, and this is shown in Figure 53. From this four transformers at Havelock, Woodbourne and Rai Valley zone substations are budgeted for replacement within the planning period, but actual timing will be dependent on their assessed condition.

To minimise installation costs both transformers will be ordered and purchased at the same time within the FY2019 year.

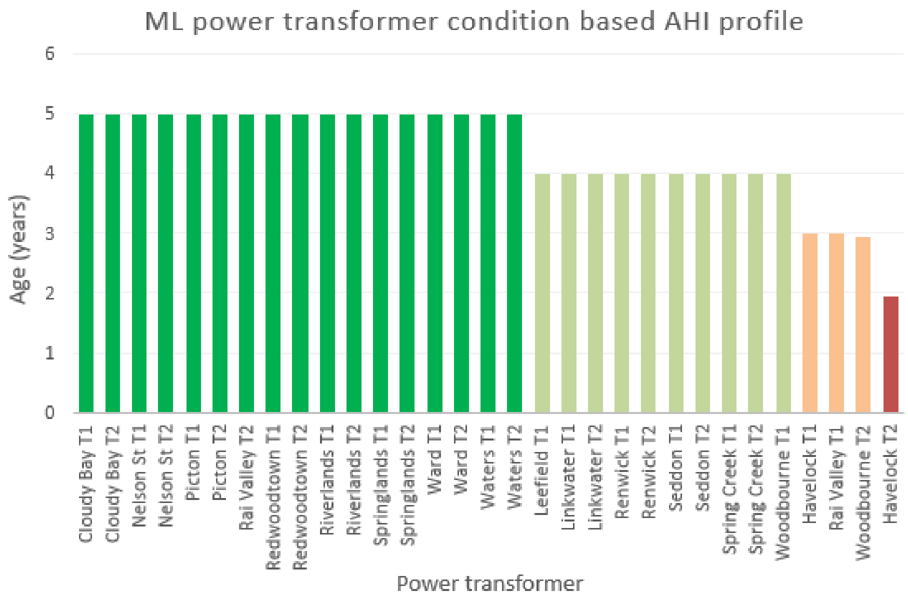


Figure 53: Summary of power transformer AHI profile

A small number of our zone substations have transformers either sharing a common transformer bund, or have been installed with minimal separation between transformers. In the event of catastrophic failure of one transformer and subsequent fire, oil leak, or explosion, potentially there is a very low risk, this could result in damage to the remaining transformer with the risk of rendering it inoperable. An ongoing project is currently underway to rectify these issues, as well as increasing seismic performance of transformer bund/foundations given the recent seismic activity across the Marlborough Region.

9.5.2.4 Design and construct

Where practicable, ML has standardised on its transformer size and configuration across the fleet, allowing for flexibility, interchangeability and reduction of spares inventory. This includes transformer components as well as tap changing hardware.

The indoor 16.5MVA transformer fleet which are installed at the major zone substations can be further uprated by 5MVA with the provision of cooling fans but such will be an unlikely requirement given the practicalities in delivering additional capacity to the network.

Where new zone substation transformers are purchased for upgrade of existing substations, or construction of new substations, ML takes advantage of technological improvements for the transformer and ancillary components to ensure continual improvement across the ML transformer fleet. These improvements include:

- Nitrogen sealed
- Reduced Losses
- Seismic performance
- Reduced noise emissions
- Improved condition and performance monitoring

All transformers are purchased in accord with recognised industry standards.

9.5.2.5 Operate and maintain

The ML power transformer fleet undergo regular routine inspections and maintenance to ensure continued reliable and safe operation. The details and frequency of routine maintenance tasks are summarised in Table 34.

Table 34: Maintenance/inspection tasks for power transformer fleet

Maintenance/Inspection Task	Frequency
Visual inspection of foundations, main tank, OLTC and cooling system. Recording of operational temperatures and oil levels, and tap changer activity.	1 monthly
Transformer and OLTC dissolved gas analysis. OLTC operational checks.	1 yearly
Transformer condition assessment. In depth visual inspection, insulation and winding resistance tests.	3 yearly
Power Transformer Major Service and Tap changer service.	6 yearly

Given the ability to remove transformers from service at any of ML's zone substations without the need for planned consumer outages, the ability to maintain the existing transformer fleet is straightforward.

9.5.2.6 Renew or dispose

Due to the majority of the ML zone substation transformer fleet being rarely operated above half their ONAN rating, they are not exposed to significant long term stresses and as such, over their useful life, transformers rarely need to be removed from service for major refurbishment activities.

When transformers approach end-of-life, it is ML philosophy to typically initiate a transformer replacement project rather than to refurbish the existing transformer. This is due to the cost of refurbishment relative to that of replacement given the relatively small transformer sizes that make up the power transformer fleet. This also allows ML to sustain a modern transformer fleet.

Over the planning period, ML has budgeted for replacement of four transformers being Havelock T1 and T2, Rai Valley T1 and Woodbourne T2 subject to condition assessments. Further detail is provided in Section 9.12.

9.5.3 Zone substation switchgear

9.5.3.1 Fleet overview

Zone substation switchgear provides for the connection/disconnection of the sub-transmission and distribution network. Depending on the locality and criticality of the zone substation, the 33kV and/or 11kV switchgear may be individually pole mounted, or contained within indoor switchboards.

9.5.3.2 Populations and ages

ML currently has 194 zone substation circuit breakers in service across the network, excluding field reclosing devices installed within the distribution network. Of this total 133 can be remotely controlled. The majority of these are 11kV, due to the multiple radial 11kV feeders emanating from each of ML's zone substations. As with the transformer fleet, MLs zone substation switchgear fleet is relatively new due to the conversions from outdoor to indoor of urban based zone substations undertaken in the last ten years.

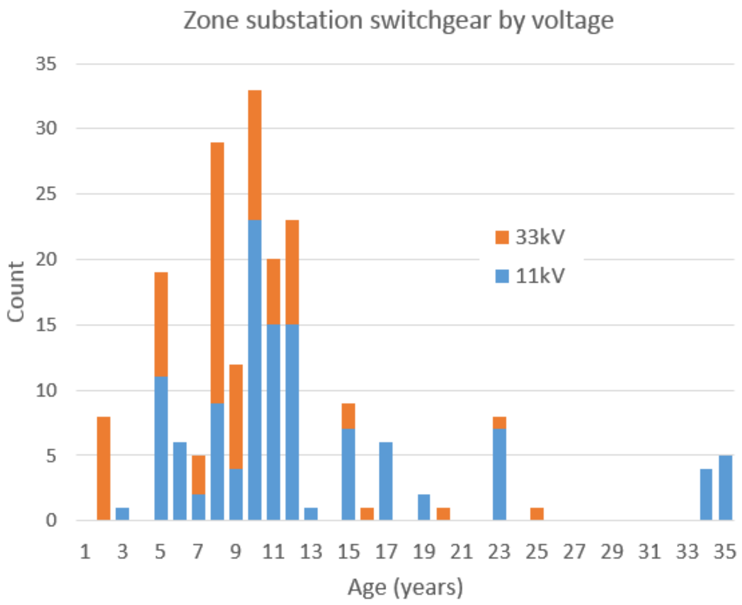


Figure 54: Zone substation switchgear by voltage

There are two sites where the 11kV indoor switchboards are approaching the end of their useful life and pose a risk to reliability. These are proposed for replacement in the coming two years.

Switchgear technology has changed dramatically over time. Prior to the 1990s, switchgear typically used mineral oil as the insulation and arc-extinguishing medium, however in modern designs this has been replaced by insulating gasses (for example sulphur-hexafluoride, or SF_6) or vacuum systems. Where practical ML utilises vacuum based switchgear, due to its environmental benefits over SF_6, however the majority of recent replacements at sub-transmission (33kV) level have often required the implementation of SF_6 due to its compact design, demanding less floor space in indoor applications.

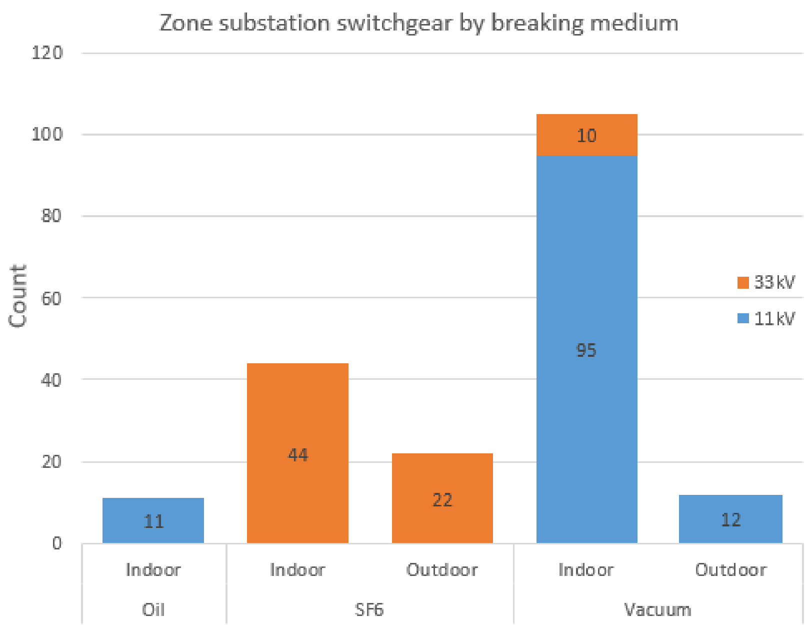


Figure 55: Zone substation switchgear by insulation type and voltage

9.5.3.3 Condition, performance and risks

Given recent investment into urban zone substations, including the replacement of switchgear, the bulk of the ML zone substation switchgear fleet is in sound condition.

The older switchgear is typically pole mounted reclosers or 11kV indoor switchboards. Pole mounted reclosers can pose an operational risk due to the fact that they are exposed to the elements over their lifetime, and are more difficult to maintain. ML has standardised on the type of pole mounted switchgear across the outdoor zone substation fleet, and carry sufficient spares to replace switchgear and/or control cubicles readily in the event of component failure.

Arc flash risk is a serious safety concern which must be considered relative to the indoor fleet. Modern switchgear is rated to contain arc flash or to deflect gas into external venting in the event of an electrical explosion to prevent or limit harm to the operator during such switchgear failures. However older styles of switchgear do not provide the same levels of arc flash protection to that of modern types. Older indoor switchgear, especially oil filled switchgear can also be more challenging to maintain. It is ML's preference to replace this type of switchgear with new arc-flash rated equipment as part of its commitment to continuous improvement. Over the coming planning period ML intends to replace 11kV switchboards at four rural zone substations to remove aged switchgear. Refer to section 8.12 for further details.

Over the past years ML has implemented a programme to remotely control zone substation switchgear which has improved network reliability especially where significant travel time is eliminated. All 11kV switchgear, and approximately 80% of the 33kV switchgear across the ML zone substation fleet is automated enabled. The remaining 20% of the 33kV fleet is automation ready and there are programs in place to implement automation at these sites over the next year.

9.5.3.4 Design and construct

Given the importance of zone substation switchgear, reliability and safety considerations are paramount when it is purchased. Accordingly all switchgear has been reviewed to ensure adequate arc fault containment ratings, mechanical longevity and other safety considerations.

ML currently has both withdrawable and non-withdrawable type circuit switchgear installed within the network. Withdrawable type circuit breakers allow for critical parts to be maintained, allowing for a typically longer useful life. This is especially important for oil-filled circuit breakers, where regular maintenance of moving components is required.

Medium voltage breakers utilising vacuum or SF_6 often do not require servicing over their useful life and thus can be made in a non-withdrawable arrangement, removing the risk of failures from connecting or disconnecting as with withdrawable types. However, in the event of failure of non-withdrawable type switchgear an outage on the complete enclosure or board may be required.

Another function that is desirable with new switchgear is the ability to operate the disconnector and earthing mechanism remotely. Most switchboards now allow for the remote operation of the circuit breaking mechanism to isolate supply together with the ability to remote earth. This provides an immediate safety measure and reduces the need for manual switching in the field when isolating the network to perform works.

9.5.3.5 Operate and maintain

Zone substation switchgear undergoes routine inspections and maintenance to ensure its continued safe and reliable operation. These preventative tasks are summarised in Table 35.

Table 35: Summary of preventative maintenance tasks for zone substation switchgear

Maintenance/Inspection Task	Frequency
Visual inspection of foundations, main compartments, rear covers, cyclometer reading, oil levels (where applicable).	1 monthly
Functional Test.	1 yearly
Partial discharge survey of board and cable compartments.	3 yearly
General Service. Removal of trucks (where applicable), and overhaul.	5 yearly

ML typically performs all routine maintenance tasks, including major overhauls, of all zone substation switchgear with its own trained in-house staff.

9.5.3.6 Renew or dispose

As mentioned above, decisions regarding switchgear renewal are based on the age and condition of the switchgear, as well as reliability and safety metrics relating to the current switchgear relative to that of what could be achieved through renewal. These factors include:

- General condition (including number of operations)
- Insulating Medium
- Current make/break capacity
- Arc Flash Risk
- Reliability issues (parts, type, etc)

Over the planning period, ML has budgeted to replace four 11kV switchboards in the existing zone substation switchgear fleet due to their age and condition. These will be at Rai Valley, Spring Creek, Riverlands and Woodbourne. Please refer to the section 1.1 for further detail.

9.5.4 Ground fault neutralisers & neutral earthing resistors

9.5.4.1 Fleet overview

Zone substation impedance support is the general term for electrical devices used to alter the power system impedance at the zone substation for benefits such as fault reduction or voltage control. This includes items such as ground fault limiters, neutral earthing resistors, capacitors and other reactive compensation schemes. The fleet of impedance support hardware on the ML network is relatively minimal, with all alternate grounding systems other than direct earthing only being installed within the last four years.

Due to the relatively recent adoption and commissioning of these assets, no renewals are anticipated within the planning period.

9.5.4.2 Populations and ages

9.5.4.2.1 Neutral Earthing Resistors

ML generally has a low fault level due to the nature of operating a radial network, supplied from a single Transpower GXP. However, a low fault level can be troublesome at the farthest reaches of the network where high impedance faults may not allow sufficient fault current to flow to operate upstream protection devices.

Alternatively within the ML network in some locations due to the proximity to Transpower's GXP, or the capacity of the sub transmission network between the GXP, fault levels need to be reduced.

Accordingly ML has installed neutral earthing resistors on the two paralleled zone substation transformers at Springlands zone substation, and plans to do the same at Nelson Street zone substation in FY2019.

Fault levels are reviewed as part of ML's design and review when considering changes to the network.

9.5.4.2.2 Inductive Ground Fault Limiters

In recent years devices have become available to reduce the impact of earth faults both in terms of network reliability and reduction of fire risk.

Following the successful performance of the first ground fault neutraliser installed at Havelock zone substation further similar equipment is scheduled to be installed at Linkwater and Seddon in FY2019 together with the new 33/11kV Tapp Substation at Renwick. Further installations will occur at Rai Valley, Spring Creek, Woodbourne and Leefield during this planning period principally for enhancement of public safety.

9.5.4.2.3 Reactive Compensation

ML has an obligation to minimize its reactive power demands at the single GXP to maintain a near unity power factor. This is such that transmission assets are utilised to their full capacity for the conveyance of real power, and to reduce voltage disturbances on the transmission network.

At Ward zone substation, there are two wind farms that are connected to the 11kV distribution system and due to their construction, demand significant amounts of reactive power from the distribution network. Given the above requirements, ML has opted to install reactive compensation at Ward to meet the reactive power demands of the wind farm instead of supplying this from the GXP. This static compensation Var consists of two 500kVAr low voltage STATCOMs connected to the 11kV via a ground mounted 1MVA transformer.

9.5.5 Zone substation buildings & earth grids

9.5.5.1 Fleet overview

ML's 16 zone substations comprise both outdoor and indoor zone substations. Typically this is a reflection of the environment they are in (i.e. urban vs rural). The zone substations comprise critical electrical assets, which are often located inside buildings. Earthing systems (grids) are also installed at zone substations. These earthing systems are an essential part of the network and ensure the grounding of the voltage source to enhance supply, facilitate operation of protection and provide a safe environment within the Substation and its vicinity.

9.5.5.2 Populations and ages

ML's zone substation fleet varies in age, from the early days of ML's network (circa 1920s) through to more recently commissioned zone substations such as Cloudy Bay in 2012. Irrespective the oldest substation at Renwick has been rebuilt over the years including the earthing system so minimal parts of the substation structure are of this vintage. Currently, a new zone substation, Tapp substation, is under development at Renwick.

9.5.5.3 Condition, performance and risks

The primary risk of buildings is from their failure in a significant seismic event, which could damage the critical infrastructure housed within them. To address this risk, ML recently undertook a programme of seismic strengthening (outlined in the following subsection).

Another risk which needs to be addressed at zone substations is electrical hazards which result from the return of earth fault current to the zone substation in the event of faults on the distribution network. This includes a possible rise of earth potential, or possible risks to personnel through step and touch potential. ML undertook a review of its zone substation earth grids in 2015 to reassess where such issues may be present. This report proposed a small number of improvements, such as the installation of insulators on nearby fence sections or the augmentation of existing earth grids around substation assets, all of which ML subsequently carried out.

9.5.5.4 Design and construct

New zone substations, such as the Tapp zone substation at Renwick which is nearing completion, are designed and constructed to integrate with their surrounding environments. As the Tapp Substation will be located in a residential area the building will be designed to look like a residential dwelling. Other, relatively recent examples of this nature are the Springlands and Waters zone substations. Over the past three years, ML has undertaken a seismic strengthening programme of works involving structural assessments of the zone substation buildings, and strengthening works to the buildings that were deemed earthquake prone (i.e. <34% of the New Building Standard).

9.5.5.5 Operate and maintain

ML undertakes monthly inspections of its zone substations' grounds and buildings. This is a reflection of the critical nature of the assets at these locations. Inspections are undertaken on the assets at the zone substations, as well as the security of the sites.

9.5.5.6 Renew or dispose

ML is not forecasting any renewal of zone substation buildings or zone substation earth grids during the planning period.

9.6 Distribution transformers

9.6.1 Asset management objectives

Distribution transformers convert electrical energy from the reticulated voltage of 11kV to low voltage 400/230V. Their effective performance is essential for maintaining a safe and reliable network at an appropriate voltage.

Transformers come in a variety of sizes, single or three phase, and ground or pole mounted. ML's transformers, like the vast majority throughout the world, are oil filled which have inherent environmental and fire risks. Managing the lifecycle and risks of the distribution transformers assets, including correctly disposing of these assets when they are retired, is the key objective of this asset management strategy.

9.6.2 Pole mount transformers

9.6.2.1 Fleet overview

There are approximately 3,500 pole mounted transformers on the network. These are located in rural or suburban areas where the distribution network is overhead. The pole mount transformer fleet ranges in sizes from 1kVA up to 300kVA (being the largest pole mount transformer).

Recent changes to ML's standards have set the maximum allowable capacity for a new single pole mounted transformer at 200kVA. This means any pole mounted transformers greater than 200kVA that require replacement will be converted to a ground mounted equivalent.

Larger pole-mount transformers, particularly those serving urban areas, may be mounted in a 2-pole or pole-and-a half configuration. Risk evaluations following on from the Kaikoura earthquake have initiated an external engineering study to ascertain any public safety risk.

In rural areas, 11kV lines are generally built with 80m to 100m pole spacing's on the flat and greater distances depending on terrain. These distances make the installation of LV impractical in many situations and, combined with a low density of consumers, necessitate many rural consumers to being supplied from dedicated transformers. This results in a lower coefficient of utilisation than would be achieved in an urban area with greater ICP density, with fewer transformers, closer pole spacing and more LV conductor run, however it is the most cost effective solution to supply voltage at regulatory levels.

There are approximately 320 distribution transformers operating on the SWER network.

Reactive replacement of pole mounted transformers can usually be undertaken quickly, affecting a relatively low number of consumers. Suitable spare transformers are held in stock at our depot. This ensures a fast response time to return the supply service.

In remote areas the most practical method of transformer installation can be by helicopter.

9.6.2.2 Populations and ages

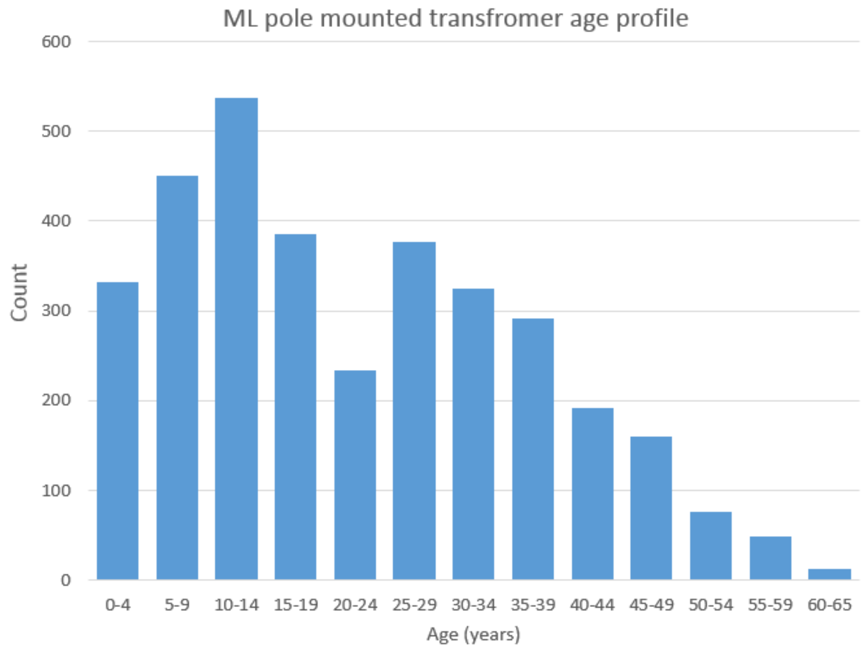


Figure 56: Pole mounted distribution transformer asset health indicators

Table 36 summarises our population of pole mounted distribution transformers by kVA rating. Many are very small, around 40% are 15kVA or smaller. A transformer of this size typically supplies one or two houses in a rural area.

Table 36: Pole mounted distribution transformer population by kVA rating

Rating	Numbers of Transformers	% of Total
≤ 15kVA	1378	40%
> 15 and ≤ 30kVA	991	29%
>30 and ≤ 100kVA	819	24%
>100kVA	248	7%
Total	3436	

The data in Table 37 shows our pole mounted distribution transformer age profile. The expected life of these units ranges from 45 to 60 years. Approximately 8% of our fleet within this age group and is due for replacement.

Table 37: Pole mounted distribution transformer population by age

Age	Numbers of Transformers	% of Total
≤ 10 years	839	24%
> 10 and ≤ 20 years	863	25%
> 20 and ≤ 45 years	1393	41%
> 45 and ≤ 70 years	266	8%
> 70 years	0	0%
Unknown age	75	2%
Total	3436	

9.6.2.3 Condition, performance and risks

The main reasons for replacing pole mounted transformers are equipment degradation and unexpected failures, usually caused by third parties (e.g. vehicle accidents) or lightning strikes. The predominant causes of equipment degradation are:

- Deterioration of the insulation, windings and/or bushings
- Moisture and contaminant concentrations in insulating oil
- Thermal failure because of overloads
- Mechanical loosening of internal components, including winding and core
- Oil leaks through faulty seals

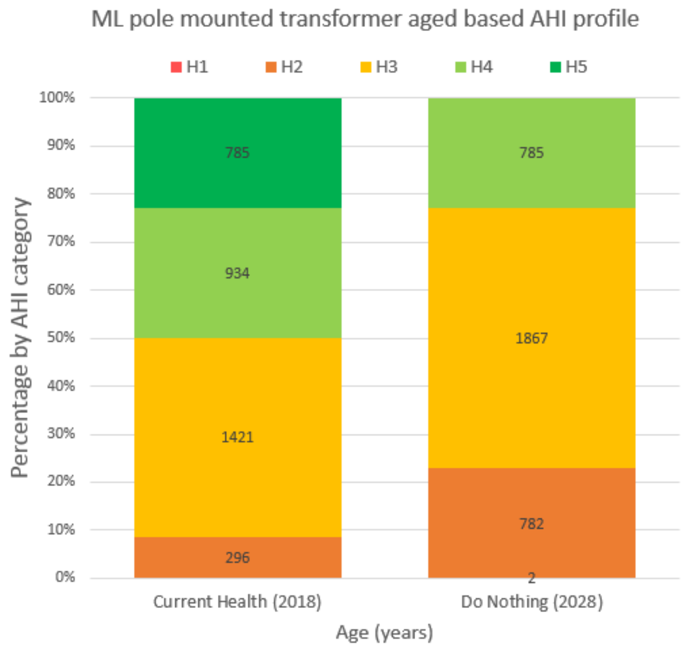


Figure 57: Pole mounted distribution transformer age profile

- External tank/enclosure damage and corrosion
- Lightning strikes
- Overall transformers are very reliable items and although the risks of oil fires and oil leakage are ever present the incidence of such events is low especially with properly installed quality transformers
- ML has oil spillage mitigations and ML staff are trained in their use

The larger pole mounted transformer structures are currently being reviewed to confirm or otherwise they meet modern seismic standards and satisfy public safety criteria and reliability of supply. These larger units also generally supply a larger number of consumers compared with smaller pole mounted transformers.

9.6.2.4 Design and construct

To improve seismic compliance, pole mounted transformers above 200kVA are, where practical, replaced with a ground mounted transformer of equivalent or greater size (see condition, performance and risks section). Smaller pole mounted transformers are replaced like-for-like.

9.6.2.5 Operate and maintain

Pole mounted transformers are reasonably robust and do not require intrusive maintenance. Maintenance is generally limited to visual inspections. Small pole mounted distribution transformers are less critical than ground mounted equivalents. It is often cost effective to replace them when they are close to failure, rather than carry out rigorous maintenance to extend their life particularly if they have to be removed and taken to a workshop.

Our preventive inspections are summarised in Table 38.

Table 38: Ground mounted distribution transformer population by kVA rating

Item	Action	Period	Maintenance Level
Distribution transformers in public places	Distribution Transformer Visual Inspection	1 Year	SHI
All other distribution transformers	Distribution Transformer Visual Inspection	6 Year	SHI

9.6.2.6 Renew or dispose

Pole mounted transformer renewal is primarily based on condition. The renewal need is often only identified when the transformer is close to failure and sometimes after they fail. Some in-service failure of smaller units is accepted because the consumer impact is limited, the cost of obtaining better condition information is high, and their maximum asset life is typically realised. Renewals are often combined with pole replacements or increases in consumer capacity.

9.6.3 Ground mount transformers

9.6.3.1 Fleet overview

There are approximately 460 ground mounted distribution transformers on our network. These are usually located in suburban areas and CBDs with underground networks. Ground mounted transformers are generally more expensive and invariably serve larger and more critical loads compared with pole mounted transformers.

Ground mounted transformers may be enclosed in a consumer’s building, housed in a concrete block town substation, or berm mounted in a variety of enclosures. Ground mounted transformers require seismically designed separate foundations (if not housed in a building), along with earthing and a LV panel.

Their capacity depends on load density but is generally 50 or 100kVA in lifestyle areas, 200 or 300kVA in newer suburban areas, and 500kVA to 1MVA in CBD areas. The most important substations within the CBD have dual 1MVA transformers for reliability.

This fleet includes the kiosks and LV distribution panel (ie ground-mount substation).

9.6.3.2 Populations and ages

Table 39 summarises the population of ground mounted distribution transformers by kVA rating. The smallest units have a size of approximately 50kVA, with larger units used for higher capacity installations.

Table 39: Ground mounted distribution transformer population by capacity

Rating	Numbers of Transformers	% of Total
≤ 50kVA	57	12%
> 50 and ≤ 100kVA	76	16%
>100 and ≤ 200kVA	85	18%
>200 and ≤ 500kVA	155	33%
>500kVA	92	20%
Total	**465**	

The data below shows our ground mounted distribution transformer age profile. The expected life of these units ranges from 45 to 60 years. Only 1% of the fleet is within this age group and candidates for replacement.

Table 40: Ground mounted distribution transformer population by age

Rating	Numbers of Transformers	% of Total
≤ 10 years	190	41%
> 10 and ≤ 20 years	172	37%
> 20 and ≤ 45 years	79	17%
> 45 and ≤ 70 years	6	1%
> 70 years	0	0%
Unknown	18	4%
Total	**465**	

9.6.3.3 Condition, performance and risks

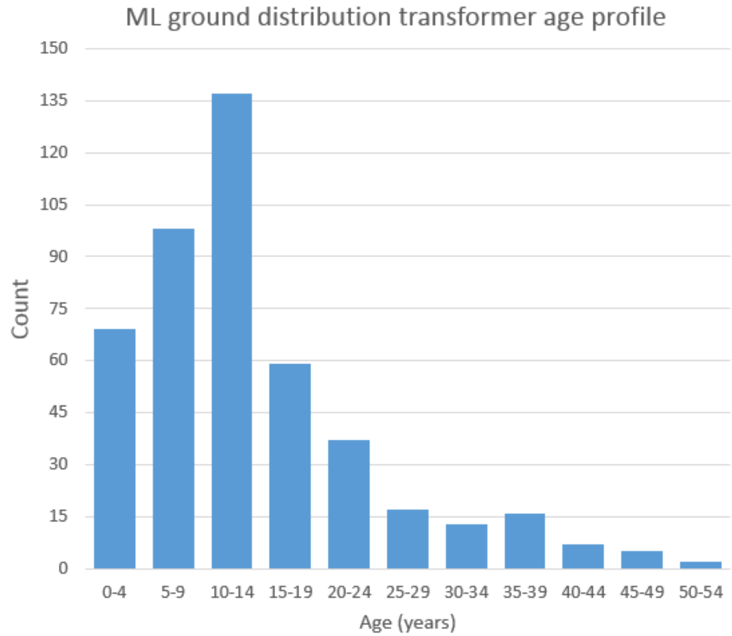


Figure 58: Ground mounted distribution transformer age profile

The main reasons for replacing ground mounted transformers are equipment degradation and unexpected failures, sometimes caused by third parties (e.g. vehicle accidents) or through faults. The predominant causes of equipment degradation are:

- Deterioration of the insulation, windings and/or bushings.
- Moisture and contaminant concentrations in insulating oil.

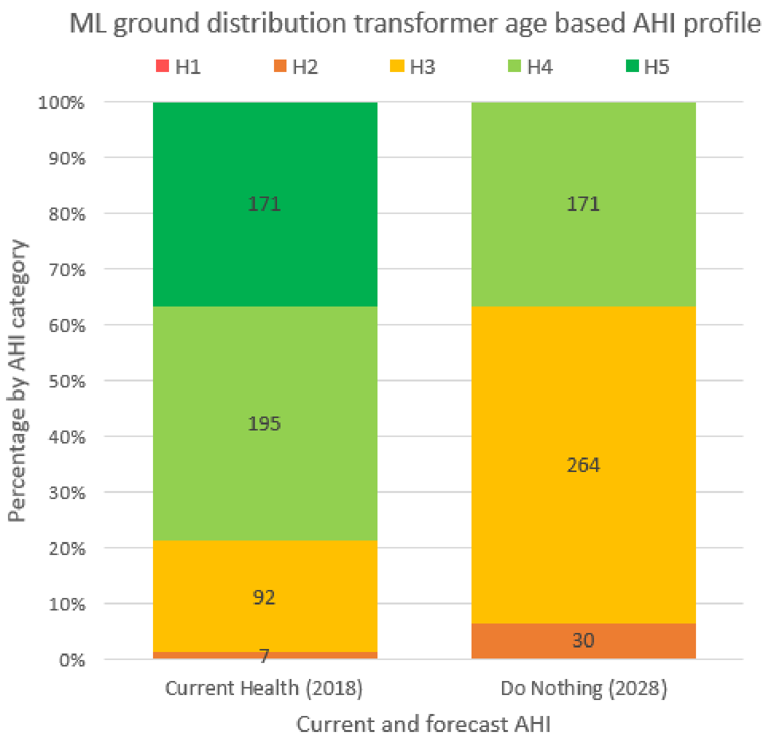


Figure 59: Ground mounted distribution transformer asset health indicators

- Thermal failure because of overloads
- Mechanical loosening of internal components, including winding and core
- Oil leaks through faulty seals
- External tank/enclosure damage and corrosion
- Lightning strike

9.6.3.4 Design and Construct

Maximum Demand Indicator (MDI) readings are performed on all large distribution transformers to assess capacity usage. The frequency of the readings increases as the transformer capacity margin decreases. ML utilises electronic loggers which provide load profile data together with maximum demand indicators which just record peaks only. MDIs are gradually being replaced by these new loggers.

9.6.3.5 Operate and maintain

Transformers used for large industrial loads can be exposed to more onerous load conditions than residential transformers, making it even more critical that they are regularly visited and tested.

ML's routine inspections involve visual checks and data capture, as well as oil testing for transformers greater than 500kVA. This combined information assists in determining the internal health of the transformer enabling any remedial action required.

9.6.3.6 Renew or dispose

Inspections have revealed the population of large transformers to be in relatively good condition. The oil within a few transformers has failed crackle tests indicating the ingress of water, and some have had oil leaks which ultimately (if left) could have had significant consequences. These transformers have either been replaced or subject to corrective maintenance.

9.6.4 SWER isolation transformers & voltage regulators

9.6.4.1 Fleet overview

Other types of distribution transformers include three phase isolation and single wire earth return (SWER) isolation transformers, capacitors and voltage regulators. The population of this sub-fleet is a small part of the distribution transformer portfolio and is quite varied.

The three phase isolation transformer provides isolation of supply between two earthing systems, preventing transferred EPR between the sites and has specific use within a substation.

SWER isolating transformers are only installed in rural areas and convert from 11kV phase to phase, to a single wire earth return system at 11kV phase to ground. SWER is a cost effective form of reticulation in remote rural areas to supply light loads over long distances. SWER transformers are generally mounted on a two pole structure with a recloser.

There are two pole mounted capacitors in the network providing voltage support in very specific circumstances.

Voltage regulators are typically a pair of single phase 11kV transformers fitted with controls that are used to lower or increase the voltage in response to load conditions. There are several three phase configured units which are used where the reticulation suffers from excessive voltage fluctuation, particularly on long lines where voltage rises with light load and drops with heavier load. Voltage regulators are generally pole mounted.

9.6.4.2 Populations and ages

Table 41 summarises the population of other distribution transformers by type. SWER isolation transformers make up the largest portion of the fleet installed over a number of small SWER networks within the region.

Table 41: SWER isolation transformers and voltage regulators by age

Type	Number of Assets	% of total
Voltage Regulator	28	44%
Capacitor	2	3%
SWER Isolation Transformer	33	52%
Isolation transformer	1	2%
Total	**64**	

Figure 60 shows ‘other’ distribution transformers age profile. The voltage regulator population is young, with an average age of 14 years. Over the past years a number of SWER isolation transformers have been replaced, leading to a wide variation in age. Approximately 8% of the fleet within this age group are candidates for replacement. SWER transformers are typically installed in remote areas and the cost of accessing and replacing a transformer can be greater than the cost of the transformer itself.

Table 42: SWER isolation transformers and voltage regulators population by type

Rating	Numbers of Assets	% of Total
≤ 10 years	20	31%
> 10 and ≤ 20 years	21	33%
> 20 and ≤ 45 years	16	25%
> 45 and ≤ 70 years	5	8%
> 70 years	0	0%
Unknown	2	3%
Total	**64**	

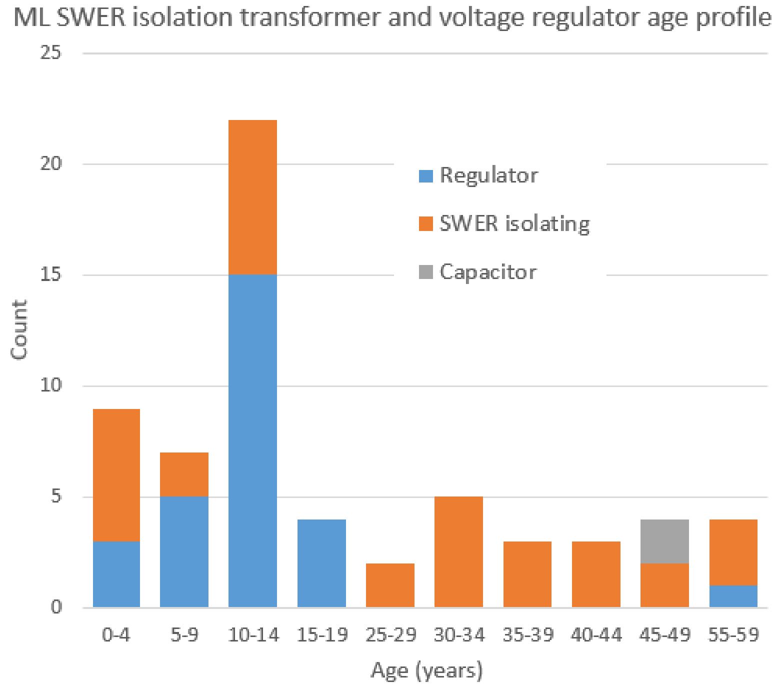


Figure 60: SWER isolation transformer and voltage regulators age profile

9.6.4.3 Condition, performance and risks

These transformers are of similar construction as pole mounted distribution transformers and so their failure modes are similar. It is salient that because a number of SWER transformers are installed in lightning prone areas they are at increased risk relative to transformers installed in Blenheim.

Both of our in service capacitors are nearing their end of life and will need replacement (or removal) within this AMP period.

The condition of the regulator fleet is relatively good with no known type issues. ML does not anticipate a need for a significant renewals programme for the transformers. It may be necessary, however, to replace the controllers to simplify SCADA connectivity.

9.6.4.4 Design and construct

ML has a replacement programme in place for all SWER isolation transformers supplying more than eight consumers. This involves a new structure and electronic circuit breaker for improved reliability.

9.6.4.5 Operate and maintain

SWER isolation transformer maintenance is similar to ground mounted or pole mounted transformers. They share the same physical attributes and failure modes.

Voltage regulators require more frequent inspections and maintenance. Currently each site is visited once a month for visual inspection.

9.6.4.6 Renew or dispose

Our renewal strategy for this fleet is condition-based replacement. Units are generally replaced as part of the defect management process when a significant defect is identified. Some units fail and they are immediately replaced to minimise the impact on consumers.

It is expected renewals for this fleet will remain fairly constant over the planning period and in line with historical quantities.

9.6.5 Distribution transformers renewal forecast

Aside from the inspection and maintenance regime transformers are generally run to failure unless potential problems or poor condition are detected from network surveillance. Failure rates are also monitored to look for any systemic problems with the transformer stock.

Renewal forecasts are based on:

- historic renewal rates;
- Weibull survival analysis (using rates reported from other networks) with pole mount and ground mound considered separately; and
- an age-based replacement model derived from observed shifts in the all-NZ reported age profile for this asset class.

These three models report similar outcomes being 30 to 35 pole mount transformers p.a. and approximately 5 ground mount transformers p.a. This represents a renewal rate of approximately 1% p.a. on the installed base. The age-based models indicate that a slowly increasing replacement rate should be anticipated.

During the planning period, commencing in year 1, ML may instigate a renewal programme of two-pole mounted transformers. This will be subject to a review of the older pole mounted transformers designs against current design code requirements. Further detail on this is set out in section 1.1.1.

9.7 Distribution switchgear

9.7.1 Asset management objectives

The key asset management objectives for this fleet are safety and lifecycle.

9.7.2 Ground mount switchgear

9.7.2.1 Fleet overview

ML's fleet of ring main unit (RMU) switches is deployed within the cable distribution network. Almost all the RMUs are located in the urban, newer residential and the industrial areas and as such they have significant public exposure.

ML primarily operates two types of ring main units, the ABB SD style oil switch and the ABB Safelink2 SF_6 gas switches. A program to remove orphaned models from the network is now mostly completed with only two remaining.

ML also has a small population of station style switchgear banks installed predominantly at the larger distribution substations in Blenheim's CBD. Due to being installed within a secure substation buildings, public exposure to these assets is less of an issue.

9.7.3 Populations and ages

Figure 61 summarises the RMUs condition based on AHI grades (deduced from age).

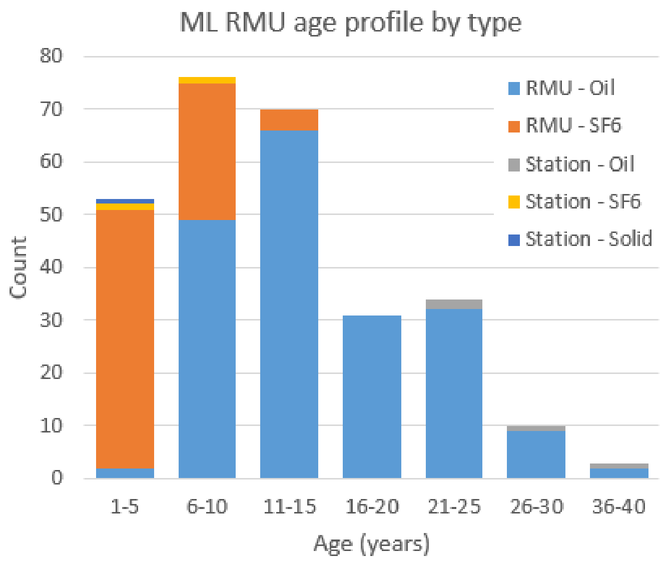


Figure 61: RMU aged based AHI

9.7.3.1 Condition, performance and risks

As part of its commitment to continuous improvement ML has lifted its benchmark for operator and public safety for new RMUs to require an internal arc classification (IAC) of AB (operator and public). For this reason, very few of ML's existing fleet achieve an AHI score of H5 as seen in Figure 62.

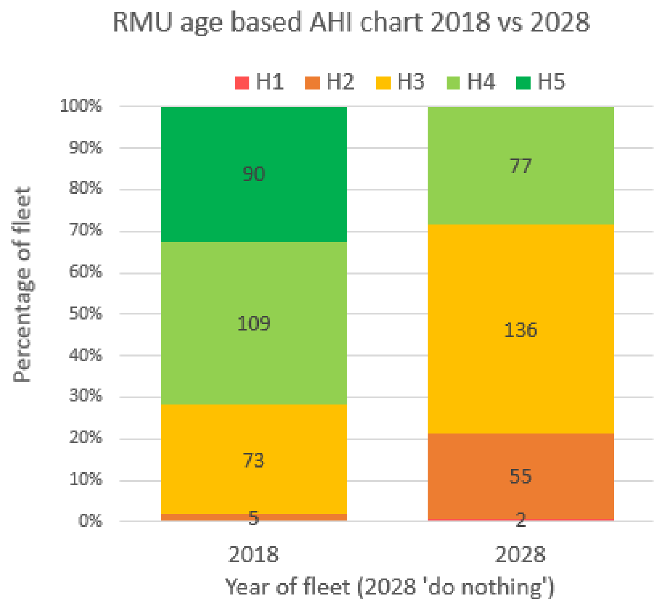


Figure 62: Ring main unit age profile by insulation type

ML has noted from both national and international safety bulletins that, there have been a small number of recent failures of oil ring main units. As a result the industry as a whole is trending towards a more cautious approach to oil RMU operation. While ML have not had any related failures within its own population, ML is changing its switching procedures for its oil RMU fleet to include remotely operated motorised actuators. This change will further enhance staff safety during switching operations.

9.7.3.2 Design and Construct

In keeping with rising public safety standards, ML has recently updated its purchase specification for ring main units to require an internal arc classification for both operator and public safety.

ML also orders all new RMUs with switching motors installed, ready to be made for remote control when a suitable communications link to the RMU is available.

9.7.3.3 Operate and Maintain

Visual inspections of RMUs are undertaken on either a three yearly basis or annual inspections if the asset is in a designated public place. For efficiency these inspections are combined with the inspection of any associated transformer and testing of earth grids at the same site.

ML also undertakes partial discharge testing, with particularly focus on discharge in the cable compartments. ML actively responds to any identified partial discharge issues.

Table 43: Ring main unit maintenance schedule

Item	Action	Period	Maintenance Level
Oil Switches	Oil Switch Visual Inspection	3 Years / 1 Year*	SHI
Gas Switches	Gas Switch Visual Inspection	3 Years / 1 Year*	SHI
Switches with Batteries	Battery Test	3 Years	OSCA
All Switches	Partial Discharge Survey	6 Years	SS

*Visual Inspections undertaken annually at sites designated as a public place.

9.7.3.4 Renew or dispose

ML has a programmed budget for the gradual replacement of its oil RMU fleet with, automatable gas switches.

ML prioritises replacement of RMUs based on a combination of the AHI calculation, public exposure, criticality and the operational configuration of the RMU.

This plan calls for the replacement of the two remaining orphan RMUs in FY2019 plus the gradual replacement of one oil RMU per annum over the planning period.

Where possible, ML looks to remove single switch units with bus connected cables. These are generally replaced with a three switch unit, with consideration given to a four switch unit for either future extension or generator connection.

9.7.4 Pole mount switches

9.7.4.1 Fleet overview

ML has a population of just over 1,000 pole mounted air break switches (ABS's) within its network.

On the sub-transmission network, ABS's have been historically utilised for circuit isolation and circuit changeover points between feeders. The latter application has been superseded by smaller 33kV RMU based switching stations which offer remote controllability, more precise protection and enable the creation of "self-healing" restoration schemes.

Within the distribution network, ABS's are used for circuit isolation and reducing the impact of outages.

ML does not yet use vacuum or SF_6 based pole mounted switches on the network but is now considering these as an alternative to the traditional air break switch.

9.7.4.2 Populations and ages

Figure 63 illustrates the pole-mount switch age profile by network voltage.

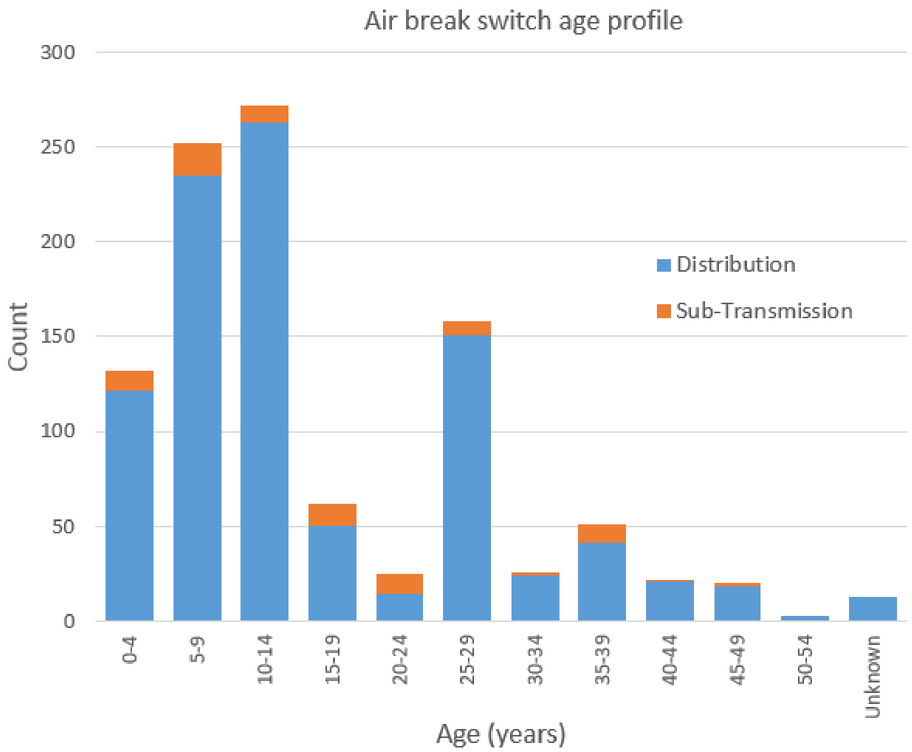


Figure 63: Pole mount switch age profile by network type

9.7.4.3 Condition, performance and risks

The failure rate of air break switches has increased over the last couple of years, particularly in an older vintage of sub-transmission ABS. This is typically due to failure of the porcelain insulators.

Some of the ABS fleet have an alignment issue with the flickers, which can require the operator to reset the flicker after a closing operation. These issues are relatively low risk and rectified when other maintenance is undertaken in the same area.

9.7.4.4 Design and construct

ML will generally use air break switches on distribution lines for:

- Sectionalising feeders to reduce outage impacts for construction, maintenance and fault work.
- Preventing ferroresonance when installed at the overhead to underground interface.
- Normally open tie points within or between feeders.
- Bypass connections to facilitate maintenance of reclosers.

Like other standard pole top equipment, new ABSs in rural areas are specified as 22kV for distribution and 66kV for Sub-transmission.

When in public places, operating handles are mounted above standing reach to reduce the exposure of touch potential to the public and minimise opportunities for vandalism.

9.7.4.5 Operate and maintain

ML does not undertake regular maintenance on the air break switches themselves. The associated earthing systems are tested on a periodic basis.

Maintenance on air break switches occurs on condition when reported by field staff. Maintenance work may include greasing or component replacement – typically insulators. Depending on the work required, complete renewal is considered as an alternative.

9.7.4.6 Renew or dispose

Air break switches are generally disposed of during the process of a line rebuild. The new line will generally be specified with new ABS's located in positions appropriate to the new route configuration.

Some ABS are renewed reactively. When a switch fails, it is replaced immediately.

9.7.5 Reclosers and sectionalisers

9.7.5.1 Fleet overview

As part of ML's programme to increase the reliability of the distribution network, ML has made substantial investment in remote controllable reclosers over the last 15 years. The distribution fleet consists of predominantly vacuum type reclosers. There are a small number of older mechanical oil reclosers and sectionalisers located in the extremities of the network.

There are a number of SF6 33kV reclosers utilised on our sub-transmission network used as line reclosers and are occasionally utilised in auto changeover between lines.

Reclosers also feature as protection for power transformers and feeders at outdoor substations – refer to section 8.5.3 for details on these units.

9.7.5.2 Populations and ages

Figure 64 presents a summary of ML's recloser and sectionaliser population.

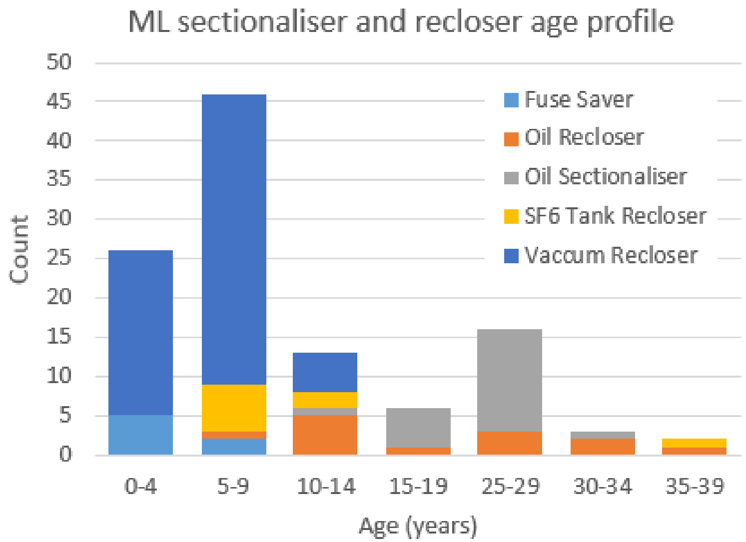


Figure 64: Recloser and sectionaliser age profile

9.7.5.3 Condition, performance and risks

Most of ther recloser fleet is is good condition with few known design or maintainability issues. The oil breakers are beginning to age and this can be reflected in minor leaks around seals which will result in higher maintenance costs or replacement to eliminate the risk of failure. A summary of the age based condition profile for sectionalisers and reclosers is summarised in Figure 65.

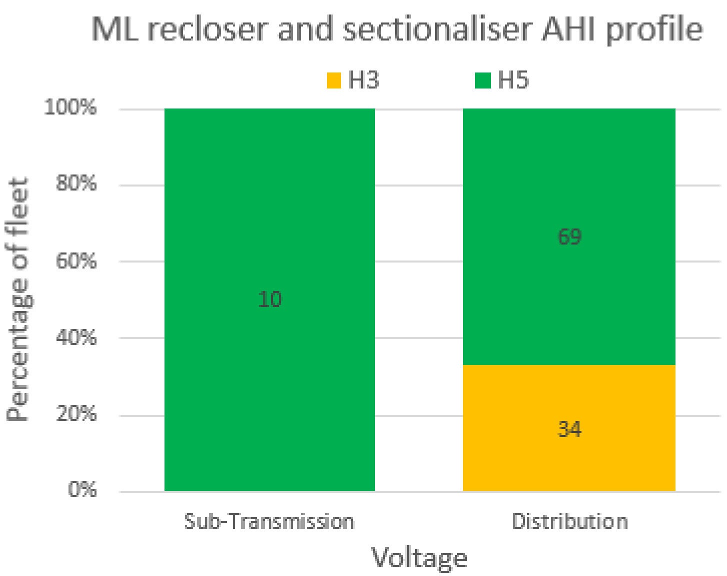


Figure 65: Recloser and sectionaliser condition based AHI

9.7.5.4 Design and construct

The reclosers ML has installed operate primarily with overcurrent and earth fault protection. Due to the high penetration of reclosers installed within the distribution network, there are very few remaining locations where new reclosers can be installed and still achieve effective protection discrimination with upstream devices. Continuation of distribution automation will therefore shift to the installation of remote controlled line sectionalisers (switches).

Communications connectivity is a critical feature for new recloser and sectionalsier sites because remote monitoring and control are important benefits gained from the installation of the recloser or sectionaliser.

Reclosers are also fitted with a backup battery system designed to provide eight hours of operability after loss of mains supply.

Reclosers are installed with isolating links and bypass switches to facilitate maintenance.

9.7.5.5 Operate and maintain

Modern reclosers have online monitoring systems which reduces the requirement for site visits. Visual inspections are undertaken with testing of the associated earth.

Table 44: Preventative maintenance for reclosers

Item	Action	Period	Maintenance Level
SWER Reclosers	Recloser Visual Inspection	3 Years	SHI
General Reclosers	Recloser Visual Inspection	6 Years	SHI
Reclosers with Batteries	Battery Test	3 Years	ISCA

9.7.5.6 Renew or dispose

ML is gradually replacing the oil recloser fleet with newer vacuum reclosers. Replacement with a new recloser with all the benefits of better protection functionality, monitoring and remote controllability is preferred to the mechanical maintenance and overhaul required on the older oil reclosers.

Other replacement is done on condition, with consideration given to asset refurbishment and other relevant criteria.

The ability to remotely alter protection settings of reclosers is of particular benefit at times of high fire risk.

Many of the existing oil reclosers are utilised protecting SWER networks and are prioritised over those protecting more remote standard construction.

Occasionally vacuum and SF6 reclosers are removed from service as part of overhead to underground conversions. These units are returned to stock for use in other projects.

9.7.6 Distribution switchgear renewal forecast

The forecast amount for distribution switchgear included in the overall system renewal budget forecasts are largely based on the following renewal programmes:

- Oil insulated RMUs;
- 11kV switchgear at zone substations; and
- Pole mounted reclosers;

These renewal programmes are further described in section 1.1.

9.8 Earthing Systems

9.8.1 Fleet overview

Earthing Systems provide three main functions:

1. Provide a voltage reference to earth for the power system.
2. Provide an effective fault return path, enabling protection to trip quickly.
3. Reduce Earth Potential Rise (EPR)[20];
    a. in the event of an earth fault on conventional circuits and
    b. during normal operation of a SWER network.

Every metal clad piece of network equipment that is installed at ground level or designed to be operated from the ground using uninsulated

[20] EPR occurs when current returns via the earth rather than through a conductor. On conventional networks this only occurs as intended through the earthing system at times of fault or when a conductor's insulation has failed. However, in a SWER network, conductors for the return circuit run from the transformer down the pole and into the ground where there is extensive bare conductor which makes contact with the earth. All current flows through the earthing system as part of normal operation. This means that while loaded, EPR of some magnitude is always present on a SWER earthing system.

tools has to be bonded to earth to protect both the public and ML staff from the risk of EPR.

As earthing systems may be shared between different assets at the same site and assets like transformers and switches may be replaced without affecting the earthing system, ML treats the earthing systems as a separate asset class.

ML operates one of the largest SWER networks in New Zealand by combined length. A significant amount of this network was constructed with subsidy from the Rural Electric Reticulation Council and located in remote rural areas and largely through the Marlborough Sounds. Because EPR is ever present at SWER transformer sites, the integrity of the earthing systems must always be such that EPR across the ground is kept to a level which is not injurious to human life or stock.

9.8.2 Populations and Ages

The ages of the ML earthing systems population is summarised in Figure 66.

9.8.3 Condition, Performance and Risks

Historically, ML has taken a conservative approach to the electrical requirements of earth grids and has always ensured the minimum regulatory requirements were met. Earthing systems are regularly checked and overall it can be said ML's earthing systems are in a very good condition.

From a materials perspective, the soils around Marlborough are benign, and corrosion of earth grids is not an issue that has been observed to date. This also indicates that age based renewal is not an effective strategy for this asset class.

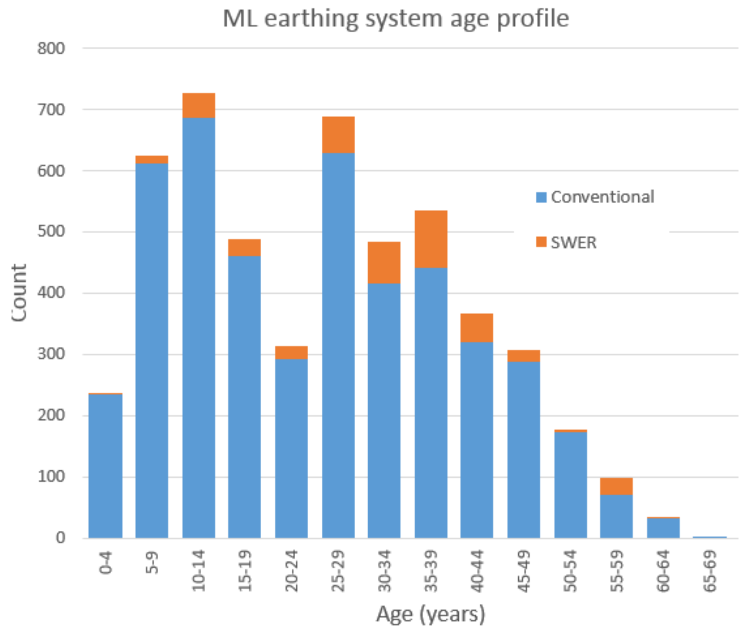


Figure 66: Distribution earthing system age profile

The most common cause of earthing system defects is from civil or horticultural conversion works on the land causing damage where the earthing system is located.

The risk associated with an earthing system's EPR is assessed with a probabilistic methodology based off the EEA's Guide to Power System Earthing. This takes into account:

- the probability of human exposure to an EPR hazard at the site; and
- the probability of an EPR event occurring.

9.8.3.1 SWER Earth Grids Risks

The EEA probabilistic method presents SWER earthing systems as a higher risk because the probability of EPR occurring is virtually constant for SWER sites. A more deterministic method must be used to either ensure the EPR at the site does not reach harmful levels or reduce the public (and livestock) exposure to the site.

The trade-off is that due to their configuration, SWER networks are only be used in low loaded and usually remote areas, meaning that they are generally installed in areas with very low public exposure.

Design and installation practices of SWER earthing has changed significantly since the original installation of the SWER network. Original earthing conductors were often mole-ploughed into the ground at relatively low depths where there was optimum conductivity within the ground. As a consequence if there were to be earthworks in the vicinity there is potential for buried earthing systems to be at risk. ML is mitigating this risk by:

- improving the data on where the SWER earthing systems run;
- running an education campaign targeting the owners of the land where SWER earthing systems are present; and
- prioritising the rebuild of high risk SWER sites.

9.8.4 Design and Construct

ML has a series of standard earthing designs for various asset classes which have recently been externally reviewed with some changes arising from the review. These changes include improved control of the EPR contours as a mitigation strategy. There are areas in Marlborough where the soil resistivity is not ideal for the construction of earthing systems. ML mitigates these areas by:

- increasing the size of the earthing system installed;
- installing conductivity enhancers around the earthing conductors; and/or
- utilising soil of greater conductivity around the conductors.

Consideration is also given to where an HV earthing system may potentially transfer EPR onto a LV multiple earthed neutral system (the standard LV system in New Zealand utilised for the provision of ICP supply) and mitigating measures are effected as required.

Due to their configuration, SWER networks can only be safely used in low load scenarios. Supply via SWER imposes limitations for any future growth. ML avoids the construction of new SWER networks where possible due to the lack of future capacity as well as the operational risks and maintenance costs associated with SWER installations.

9.8.5 Operate and Maintain

The resistance of earthing systems are periodically tested at frequencies based on the risk profile of the site as further described in 8.8.3 above. The inspection periods applied are summarised in Table 45. For efficiency, earth tests are also combined with visual inspections of the transformers or switches at the same site.

Table 45: Distribution earthing system maintenance schedule

Item	Action	Period	Maintenance Level
Earthing systems in public places	Inspection/ Earth Test	1 Year	ISCA
Earthing systems in public places	Classification review	3 years	OSM
SWER earthing systems	Inspection/Earth Test	3 Years	ISCA
Other earthing Systems	Inspection/Earth Test	6 Years	ISCA

The need for corrective maintenance is driven by the earth test results and is evaluated recognising the risks described in section 9.8.3.1.

Emergency repairs are also made after damage by external parties.

9.8.6 Renew or Dispose

Earthing systems are not generally renewed on condition of age but improved or added to if the performance of the earth were to be subject to deterioration. The latter is determined by testing or effecting reinstatement after damage has occurred. In some cases (SWER in particular) there may be a safety driver to rebuild the earthing system to improve the EPR exposure at the site.

Disposal of an earthing system may occur when an entire site is decommissioned – generally due to asset relocation.

9.8.7 Distribution Earthing Systems Renewal Forecast

Earthing systems are incrementally maintained rather than renewed so no capital is allocated against this fleet strategy.

9.9 Mobile generators

9.9.1 Fleet overview

Diesel generators are used within ML's network to:

- provide supply to areas when planned or unplanned works would require an area to have no mains supply;
- reinforce supply lines where an alternate temporary feed does not have the capacity to maintain voltage;
- provide security of supply during network maintenance; and
- reduce ML's contribution to regional power consumption peaks.

ML has several generators used for operational support, split into a mixture of mobile units and fixed sites, with a cumulative capacity of over 3.7MW.

The mobile units are used to reduce outages when work is required on radial lines and/or during emergencies such as earthquakes when supply from upstream lines is not available. ML has installed generation connection points at strategic locations across the 11kV network to provide safe and efficient deployment of the mobile generators into the network.

There are two remotely controlled generation sites in the Marlborough Sounds at Elaine Bay and Kenepuru Heads. These sites are embedded midway along two of ML's longest and most remote feeders. In fault situations, these sites often enable supply to be restored to the remote ends of their respective feeders long before fault response staff can be deployed into the area.

ML has a range of generator sizes to enable the generator capacity to be matched to that of the required load. A summary of ML's fleet is provided in Table 46.

Table 46: Diesel generator summary

Generator	Standby Rating @ 0.8 pf (kW)	Output Voltages	Mounting type
Gen 1	832	11kV, 400V	Flatbed Trailer
Gen 2	440	11kV, 400V	Curtain Sider Truck
Gen 3	440	11kV, 400V	Fixed (Elaine Bay)
Gen 4	440	11kV, 400V	Fixed (Kenepuru Heads)
Gen 5	440	11kV, 400V	Fixed (Kenepuru Heads)
Gen 6	440	11kV, 400V	Fixed (Kenepuru Heads)
Gen 7	180	400V	Skid
Gen 8	165	400V	Fixed (Taylor Pass)
Gen 9	300	11kV, 400V	Curtain Sider Truck
Gen 10	88	11kV, 400V	Folding Sided Truck

The capabilities of the current fleet meets requirements and there are no plans to expand this fleet further.

9.9.2 Populations and Ages

The age profile of ML's generator fleet, including both fixed and mobile, is summarised in Figure 67.

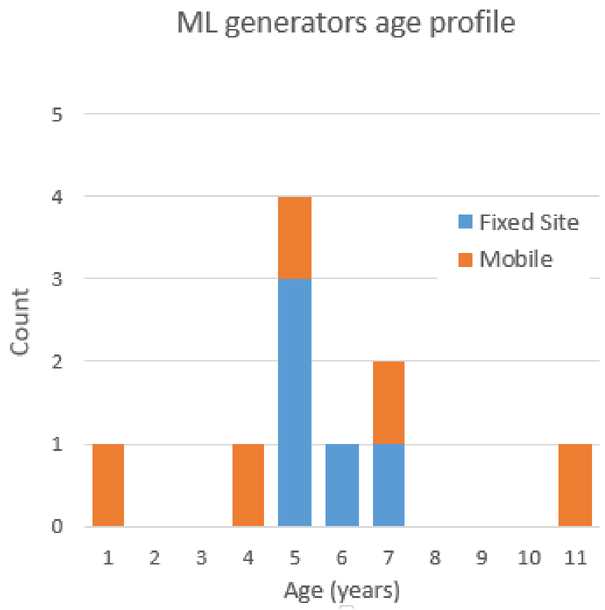


Figure 67: Diesel generator age profile

9.9.3 Condition, Performance and Risks

Due to the small, relatively young, age and scheduled maintenance, ML has a good understanding of the health of the generator fleet and considers the fleet to be in good condition.

It is planned that the generator/engine controller be standardised amongst the fleet to facilitate ease of operation. The cost of this work is relatively small and will be undertaken in the FY2019 year.

The electrical protection configured with a diesel generator is typically more sensitive than what would be installed within the standard line recloser or feeder protection due to the need to protect the generators themselves. This makes the generators inherently less robust than the mains supply so the mains supply is restored as soon as this is viable. At all times diesel generators are operated in a manner to minimise fuel costs.

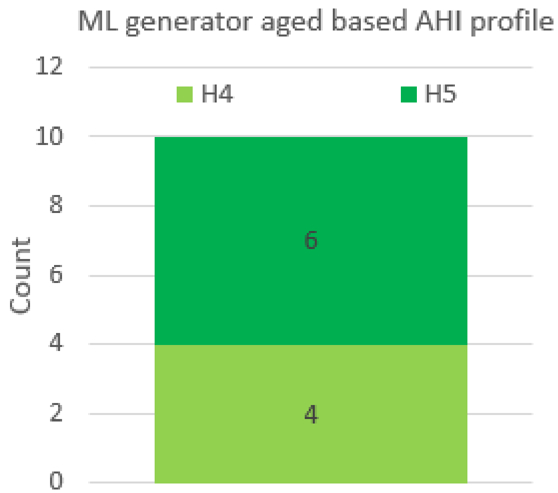


Figure 68: Diesel generator condition based AHI

9.9.4 Design and Construct

Demand for generators has been driven by reliability improvement to provide enhanced service and improve network reliability. The key performance indicator is the amount of recovered SAIDI minutes saved.

ML's mobile generators are typically mounted on the back of a 'curtain sided' or folding side style truck, along with a step-up transformer, isolating switches and protection and control modules. The mobile generators are relatively easy to use and operate, and have proven to be of significant benefit to the network.

9.9.5 Operate and Maintain

The diesel engines associated with the generators are regularly serviced in accord with manufacturer requirements which relate to both hours run or periods between service.

The vehicle mounted generators have flexible 11kV cables used to connect to the network. These cables are regularly moved as part of connection and disconnected activities and will suffer wear as part of these procedures. The cables are electrically tested every three months and visually inspected before each use.

Table 47: Summary of periodic maintenance for ML's generator fleet

Item	Action	Period	Maintenance
All Generators	Visual Inspection and run loaded.	1 Month	ISCA
Mobile Generators	Cable test	3 Months	OSCA
All Applicable Generators	250 Hour Service	6 Months or 250 Running Hours	NIM
All Generators	Electrical Inspection	1 Year	OSCA
All Generators	500 Hour Service	1 Year or 500 Running hours	NIM
All Generators	2,000 Hour Service	2 Year or 2,000 Running hours	NIM
All Generators	3,000 Hour Service	3 Years or 3,000 Running hours	NIM
All Generators	4,500 Hour Service	4,500 Running Hours	NIM
All Generators	12,000 Hour Service	6 Years or 12,000 Running Hours	NIM
All Generators	Overhaul	Based off condition assessment	OSIM

9.9.6 Renew or Dispose

The diesel generator life expectancy is placed at 20 to 30 years. Due to good maintenance practices, ML is not expecting to have to renew or dispose of any of its fleet during this planning period due to asset health, although changes in operational requirements may affect these plans.

9.9.7 Diesel Generator Systems Renewal Forecast

No capital renewal within this plan. Inspection and routine maintenance is relatively minor and is included in the routine opex budget.

9.10 Secondary systems

9.10.1 Asset management objectives

Secondary systems such as protection systems are a critical part of operating a safe and reliable electricity network. Their useful lives can be shorter than assets in other areas due to ongoing improvements in technology and a commitment to continually improve the performance of the network to meet ICP requirements. Assets in this class are growing in complexity due to the uptake in "smart grid" applications and typically have to be considered in conjunction with the operation of a number of network components.

Protection assets ensure the safe and correct operation of the electrical network. They detect network faults and operate circuit breakers to prevent harm to the public and staff, or damage within consumer installations or to network assets. The SCADA and communications assets provide network visibility and remote control, allowing ML's operators to operate the network with a greater level of efficiency.

9.10.2 SCADA and communications

9.10.2.1 Fleet overview

ML operates the iFix Open Database Connectivity (ODBC) based SCADA system. The system has been designed to allow monitoring and remote control of devices in the network, including circuit breakers, transformer tap changers, line reclosers, voltage regulators and the load management system.

Figure 69: Communications mast at Takorika with varying antenna

A central server communicates with remote terminal units (RTUs) over a wide range of communications mediums. The RTUs then interface with network equipment such as transformer control units and circuit breaker control systems. DNP3.0 is ML's standard communications protocol for RTU's.

The communications network carries ML's SCADA system traffic as well as protection and voice (DMR) systems. ML's communications network consists of different data systems and physical infrastructure, including fibre optic circuits, UHF point-to-point digital radios, microwave point-to-point digital radios, point-to-multipoint UHF repeaters and cellular/ADSL circuits. Protection circuits are typically direct inter-relay fibre circuits between substations. All communication operates over TCP/IP Ethernet protocol.

The communications fleet also covers the infrastructure that houses communication systems, including masts, huts, cabinets and RF equipment.

The SCADA system has been operating for approximately 15 years. During this time it has had new servers and software upgrades to ensure stability and reliable operation.

Over the past seven years there has been significant expansion of the SCADA communications network to provide coverage to the remote parts of our network in the Marlborough Sounds and the East coast. Consequently the majority of communications equipment is at a very young age and not due for replacement within this planning period.

The expansion of the SCADA coverage area has enabled the connection of a number of 3 phase and SWER reclosers to our SCADA system. Table 48 depicts the devices connected and the methodology.

Table 48: SCADA equipment population by communication method

Type	Fibre Optic	Licensed Radio	Unlicensed Radio (WiFi)	Cellular/ ADSL	Not Connected (but capable)
33/11kV Circuit Breakers	92	12	22	7	44
33kV Reclosers	2	11	10	4	-
11kV Reclosers	1	40	4	13	-
SWER Reclosers	-	13	2	1	1
Voltage Regulators	-	-	3	18	6

9.10.2.2 Condition, performance and risks

Some aspects of the SCADA system are becoming limited in terms of compatibility with the latest available technology and potentially could inhibit further development of the network unless it is upgraded.

The majority of our communications network is in new condition and is at little risk of failure due to old components. During the recent earthquakes some damage to an analogue voice repeater site was sustained but the rest of the network performed well.

The key perceived risk from the SCADA system is the loss of network visibility and control. It is preferred to operate equipment remotely for a number of reasons, including safety, speed of operation and improved operator feedback. Enhanced status information from the field through the use of SCADA minimises outage durations and requires less staff on the ground and achieve faster response times.

A significant risk is a cyber-attack on the SCADA system where a party gains control of devices or blocks ML from controlling them. The increasing risk of a cyber-attack on our network requires ongoing vigilance and improvement to the security levels of our SCADA system. The potential safety, reliability and cost consequences from an attack on the system become increasingly serious.

9.10.2.3 Design and construct

All new SCADA connected equipment must be capable of TCP/IP communications with DNP3.0 protocol.

The latest standard RTU and protection relays that are being installed provide remote engineering access. This allows technicians and engineers to access information remotely removing the need to download the data at the site. This reduces the time required to understand and react to a fault.

Communications systems are now all Ethernet IP based technology, often layer 3 capable, allowing for smart routing of packets such that any device or site can fail and not impact a wide area.

9.10.2.4 Operate and maintain

The SCADA system is continuously monitored through self-checking systems and a third party monitoring system. The communications network is part of this monitoring system and alerts operators to communication failures or overloaded networks. Further staff resource will be required to monitor the network as it develops.

Our preventive maintenance schedule is outlined in Table 49.

Table 49: Preventive maintenance schedule for SCADA and comms equipment

Asset type	Maintenance Description	Frequency
Communications equipment	Visual inspection of radios, switches, antennas at zone substations and radio sites.	Yearly
SCADA Master Station	Software upgrades, database checks	3 monthly
SCADA Master Station	Hardware upgrades follows I.T. sever replacements	5 Yearly

9.10.2.5 Renew or dispose

It is planned to upgrade the SCADA master station software within the next five years to provide more functionality and add additional support for managing the much greater quantity of data being generated.

Other communications assets, such as radio links and their associated hardware, are typically replaced due to obsolescence. The opportunity is taken to replace legacy communication assets with modern more functional assets.

9.10.3 Protection relays

9.10.3.1 Fleet overview

Protection assets ensure the safe and correct operation of our electrical network. They detect network faults and operate circuit breakers to prevent harm to the public and staff, or damage to network assets, or ICP installations.

Protection relays or integrated controllers are installed to detect and measure faults on the HV electricity network. They directly trip circuit breakers or operate switches to clear and isolate faults. They provide significant benefit to the network reliability through auto reclosing features for transient faults.

Protection systems include all associated parts such as CT's and VT's, communication interfaces, auxiliary relays and interconnecting wiring.

The ML network has predominately numerical relays installed. There are now less than five remaining electromechanical relays installed, which are all scheduled for replacement within the next year.

The expected life of a numerical relay is approximately 20 years. Obsolescence is the main driver for replacement and this is typically dictated by functions available, network standardisation and communication protocols. In all cases relays are purchased from suppliers of quality equipment to recognised standards.

9.10.3.2 Populations and ages

Simple phase over current and earth fault relays are generally used on zone substation feeders. 21 of the 31 zone substation transformers have dedicated differential protection. Figure 70 shows the relay population age profile, with the Table 50 providing the population breakdown by relay type.

Table 50: Quantities of protection relays by type

Relay Type	Quantity
Bus Differentials	9
Cable/Line Differential	11
OC/EF with Directional	18
OC/EF	65
Transformer Differential	21
Total	124

ML installed its first numerical relay in 2002. These first generation relays will require renewal during the next five years as they near end of life. Figure 70 shows the protection relay age profile by type.

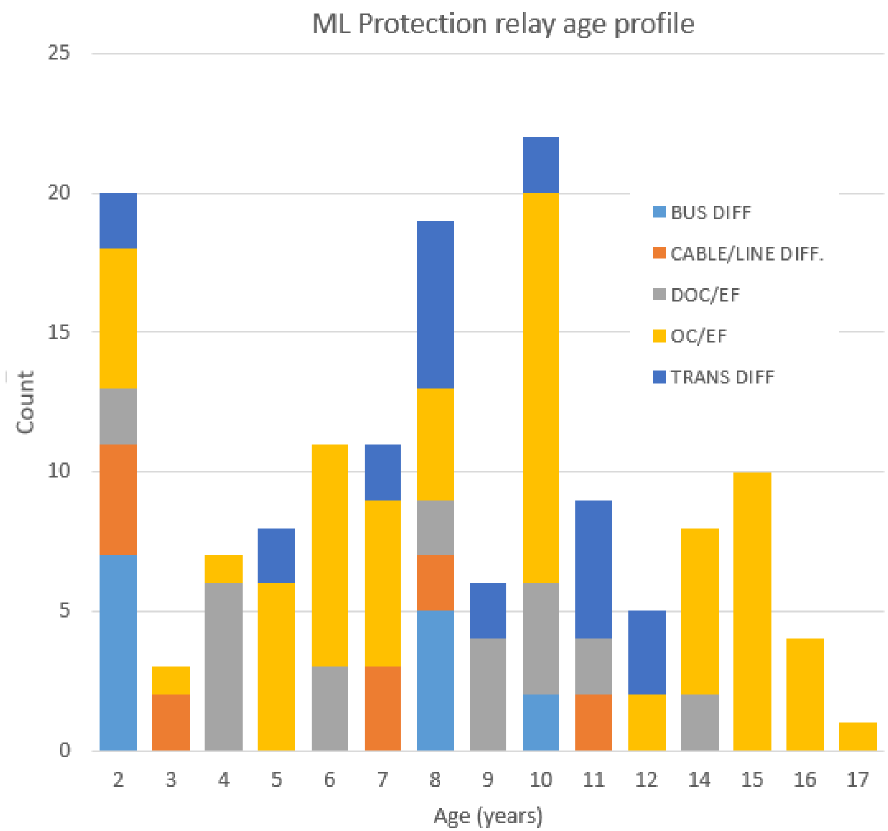


Figure 70: Protection relay age profile

9.10.3.3 Condition, performance and risks

Numerical relays have an expected life of 20 years due to their microprocessor-based technology. Excessive heat and vibrations may cause them to fail. They can also be subject to internal firmware faults which can cause undesired trippings.

The primary safety risk for a protection device is that it fails to clear a fault. This can put the public or staff in danger, impact on ICP installations, cause network equipment failure, overload, high or low voltage etc.

Backup protection is a requirement for all circuits but these inherently take longer to clear a fault to ensure protection discrimination. Longer fault clearance times are a considerable risk to the network.

9.10.3.4 Design and construct

Protection system design must balance many competing requirements to ensure the overall system is effective.

The protection equipment must operate correctly when required, despite sometimes not operating for long periods. It must operate with speed and precision as part of an overall protection system. It must provide safety to the public and staff, as well as minimise damage to the network equipment. Correct operation is fundamental to providing reliable supply.

ML has recently undertaken a review of all protection relays and has selected the Schweitzer Engineering (SEL) relays as the standard.

9.10.3.5 Operate and maintain

Numerical relays require less detailed and less frequent checks. They are also able to provide alerts regarding their condition, prompting a maintenance callout if necessary.

The preventive maintenance schedule for protection relays is outlined in Table 51.

Table 51: Preventive maintenance schedule for protection relays

Maintenance Description	Frequency
Visual inspection of protection relays at zone substations, checking any alarm flags and resetting them.	Monthly
Detailed secondary testing and operational checks for numerical relays. Perform diagnostic tests relevant to relay function (e.g. overcurrent, distance).	6 yearly
Relay battery replacement (storage battery)	10 yearly

9.10.3.6 Renew or dispose

The strategy is to replace relays on the basis of functionality and age. Concerns of higher maintenance costs and having odd spares increase with age. First generation numerical relays can increasingly be expected to diminish in functionality and will require replacement.

9.10.4 Load control relays

9.10.4.1 Fleet overview

Metering in consumer installations is owned by Energy Retailers. ML operates a successful ripple control system for peak lopping of system load at certain periods of the year.

ML operates both 217Hz and 1050Hz ripple injection systems. These inject at 33kV with the injection equipment installed at the Springlands substation site. All ripple relays are owned by the energy retailers. The first 1050Hz relays were originally installed in 1967. All new ripple relays are 217Hz phasing and the 1050Hz relays are being phased out.

9.10.4.2 Populations and ages

The 1050Hz plant was commissioned in 1967 although the rotary generator has been changed to solid state, while the 217Hz plant was commissioned in late 2009 – the ages of the plants are 51 years and 9 years respectively.

9.10.4.3 Condition, performance and risks

There is currently only one 217Hz ripple controller available for service. Should this fail control signals could not be provided and may put ML at risk of exceeding the load target during shedding periods. Conversely there is a second 217Hz system out of service that can be used for parts. The maintenance contract with the supplier should enable major faults to be rectified within 48 hours provided the failure was not catastrophic.

9.10.4.4 Design and construct

It is planned to replace the ageing 1050Hz plant with a second 217Hz plant to operate as backup or compliment the other system within the planning period.

9.10.4.5 Operate and maintain

Regular inspection and testing of the ripple injection system assets is undertaken to ensure their continued and reliable operation. The controllers have a number of check alarms programmed to provide the early identification of any problems. The preventive maintenance schedule is outlined in Table 52.

Table 52: Preventive maintenance schedule for load control relays

Maintenance Description	Frequency
Visual inspection of ripple plant, checking any alarm flags and resetting them.	Monthly
Onsite testing and physical inspection of ripple plant.	Yearly

9.10.4.6 Renew or dispose

ML plan to dispose of the 1050Hz system within the next two to five years. This needs to be coordinated with the retailers to ensure all consumers have been transferred to 217Hz relays. ML will continue to renew the existing 217Hz plant and plans to install a second 217Hz system to allow more invasive maintenance and fault backup going forward.

9.10.5 Secondary systems renewal forecast

No renewal is forecast for the SCADA communications network.

Protection relay replacement work is, as far as practical, coordinated with zone substation works – typically power transformer or switchboard replacements. At these times the protection systems may also be replaced depending on the technology and condition of the existing relay assets.

A new 217Hz Ripple Control system is forecast to be installed within five years. Refer to the network development section for project details.

9.11 Non-Network assets

9.11.1 Information systems

ML has extensive IT systems which are critical to supporting our everyday business needs. IT systems cover all aspects of the business - payroll for staff, asset data management, billing, GIS viewers, financial information, purchasing and stock, scheduling and estimating of work, storage of electronic files, and running engineering analysis of capacities and loads on the network for example – all related directly or indirectly to achieving our asset management objectives.

ML's IT infrastructure is generally managed by the ICT team which comprises three full time staff members. External consultants are engaged at times to assist the IT team as and when specific advice and input is required.

IT related assets such as computer hardware and software have relatively short lifespans as new and improved technologies become readily available.

ML's forecast IT related capital expenditure is summarised in the regulatory schedule (11a) which can be found in Appendix 11.2. The amounts forecast are relatively constant across the planning period. The more substantial capital expenditure projects for IT are outlined in Section 9.12.2.

9.11.2 Vehicle fleet

9.11.2.1 Description

ML owns and manages a significant vehicle fleet across the network and Contracting divisions. Vehicles are an essential asset to enable and facilitate ML's activities and to meet our asset management objectives. The current vehicle fleet at the beginning of 2018, across both the corporate, engineering, field workers and contracting business comprises the following:

- 50 utility vehicles (utes);
- 23 trucks (including crane and bucket trucks, mobile generators;
- 26 light vehicles (cars and SUV);
- 3 forklifts;
- 53 other (ATVs/quad bikes, chippers, trailers etc).

When procuring vehicles ML considers safety (largely based on the Australasian New Car Assessment Programme (ANCAP) rating), environmental impacts (including fuel efficiency) and operational requirements (i.e. suitability for intended use).

Recently, ML purchased a fully electric vehicle, a Nissan Leaf. The purchase of this vehicle is in line with ML's policy to procure vehicles which minimise environmental impacts. ML's vehicle procurement policy is reviewed and updated when deemed necessary. It is envisaged that upon the next update, the policy will include greater focus on procuring vehicles in future where appropriate that are fully electric, or electric hybrid.

9.11.2.2 Management

Records of ML's vehicles are maintained in the asset management system, Infor's EAM. Vehicles are split into various classes and categories, and relevant attributes are recorded against each vehicle. The records allow easy visibility and tracking of when maintenance activities are required against each vehicle.

ML's vehicles are regularly maintained to ensure operational effectiveness and to minimise the potential for componentry failure which could contribute to an accident or lessen reliability.

ML's utility vehicles travel the greatest distances often on gravel or rough roads. These vehicles are typically replaced between three to six years depending on the make and models, distance travelled and performance. Other vehicles are replaced on a case by case basis.

9.11.2.3 Forecast costs

ML's capital expenditure on vehicles has averaged approximately $500,000 over the past two years. The expenditure on vehicles is forecast to remain at around this level for the planning period. The annual expenditure on vehicles will be reviewed and any adjustments to forward forecasts will be made as appropriate, i.e. reflecting any changes in ML's vehicle requirements to support asset management objectives.

9.11.3 Buildings and land

9.11.3.1 Description

ML owns and maintains a number of non-network properties and buildings, including:

- The main office building/property at 1 Alfred Street, Blenheim.
- The Taylor Pass depot which comprises land and a series of buildings – offices, workshops and sheds/warehouses to store electrical and non-electrical goods.
- Residential property (including dwelling) at 34 Budge Street, Blenheim. This was purchased several years ago for a possible future zone substation development site.
- The D'Urville Island depot building/property at Kapowai Bay. This is used to store materials and equipment to assist work that is undertaken on D'Urville Island and provides limited accommodation for staff.
- A 60 hectare eucalypt plantation in the Wakamarina Valley, Marlborough.
- Vacant lot at 287 Hammerichs Road, Rapaura. Site of a potential future zone substation development.
- The property/building on the corner of Old Renwick and Thomsons Ford Road housing the historic (out of service) diesel generators.
- The System Control building adjacent to the Springlands Zone Substation on Murphys Road. The System Control building currently houses ML's ripple plant (i.e. is a system asset). The building has historically served as a backup network Control Room and it is planned that it be strengthened within the next few months to meet new seismic standards so that can be a backup control room in the event of a severe seismic event.
- The Picton depot building/property at 15 Market Street, Picton. In past years this was utilised by field staff based in Picton to respond to faults and carry out work in the Picton area. It is now mostly unused and available for emergency purposes.
- The Havelock depot building/property at 24 Lawrence Street, Havelock. This was also used as the base for field staff carrying out work in the Havelock area. It is now mostly unused and is available for emergency purposes.

ML's main office building is located on Alfred Street, Blenheim. The main office houses engineering, network, financial, commercial and corporate services staff. The property also includes an adjacent building housing Company vehicles as well as the network Control Room in which four network Controllers work. Adjoined to this building is the former workshop which is currently leased out. At an appropriate time over the planning period it is likely the Company will vacate its Alfred Street site and relocate its administration and network operations to its Depot in Maxwell Road to be adjacent to its field staff.

ML's contracting business is located at Taylor Pass Road, Blenheim, and comprises an office building, electrical workshop, stores warehouse, plant and vehicle sheds and other buildings housing materials and/or equipment. The Taylor Pass office houses contracting staff, including management, supervisors, design estimators, fault men and administrative support staff.

9.11.3.2 Management

ML aims to provide staff with secure, safe and functional office environments that facilitate efficient work and allow for future growth. Security of critical non-network services and infrastructure, such as IT servers and the Network Control Room are also considered, including contingency (i.e. backup) in the (unlikely) event of failure.

Maintenance of the properties outlined is undertaken as and when required with painting occurring at appropriate intervals. The grounds of all properties are maintained and care taken to ensure they integrate with the environment.

9.11.3.3 Forecast costs

During the planning period, it is anticipated that a review of the current office location and layout will occur to ensure that it is fit for purpose, both currently and into the future. Until the review is undertaken, ML is unable to forecast costs. The review may recommend, for example, that due to capacity constraints a new office building is required to meet ML's aims or a reconfiguration/refurbishment of the existing office.

A review will be undertaken of the existing back up Network Control and IT server rooms at System Control. The building's structural integrity was recently assessed and deemed to be inadequate if the building is to be classified as Importance Level 4. The main Network Control Room is also deemed to be structurally inadequate (earthquake prone) if assessed at Importance Level 4. ML's strategy for the Network Control Room is to have a facility rated at 100% New Building Standard (NBS). This will be provided by upgrading the Springlands building adjacent to the ripple control plant.

ML incurs expenditure as required for maintenance of non-network buildings but overall this is not material relative to other expenditure.

9.11.4 Other Non-Network renewal forecast

Other non-network asset capital expenditure will cover plant, tools and equipment, and office and IT equipment. Expenditure for these assets is expected to be relatively constant over the planning period and is presented within the regulatory schedules in Appendix 11.2.

9.12 Major renewal projects

9.12.1 Network (system) renewal projects

The following sub sections provide a breakdown of the more significant planned renewal projects identified at the time of preparing this AMP.

9.12.1.1 Year 1 (2019) – Detailed descriptions

9.12.1.1.1 Distribution Pillar (DP) replacement programme.

This programme intends to replace a number of aged (some over 50 years) DP boxes, many of which are in the urban environment.

The DP boxes will be replaced on a risk criteria basis. Criteria to consider will include age, number of consumers, type and location. The works to replace any one DP box broadly comprises isolating the site, civil works (potentially) to open up the footpath/ground immediately surrounding the site, removing the old box and switchgear and installing new switchgear and box and connecting to existing cables.

9.12.1.1.2 Distribution transformer replacement programme

As detailed in the fleet management section, ML has a number of distribution transformers which are at or nearing end of life. This programme will involve replacing those transformers. A prioritised list will be developed (based on factors such as environment, number of consumers supplied, size and loading). In the first year, ML intends to replace 15 of the oldest distribution transformers in the fleet.

9.12.1.1.3 33kV rebuild Casey's Road to Marfell's Beach Road section

The 33kV power poles between Seddon and Ward were installed over 55 years ago (based on asset data) and are showing signs of deterioration.

The section between Casey's Road and Marfell's Beach Road is adjacent to Dominion Salt Works salt ponds and is in relatively poor condition. Spalling is evident on a number of the power poles, and pole components are in relatively poor condition (a number of defects have been recorded from recent condition assessments).

The work will include replacing the reinforced concrete poles with new pre-stressed concrete poles, new pole components (i.e. primarily cross arms and insulators) and new conductor. Consideration still needs to be given to whether or not pre-stressed concrete poles are best suited to the environmental conditions at this location, typically characterised by unconsolidated saturated (potentially brackish water) soils and salty air.

9.12.1.1.4 Oil RMU replacement programme

ML has a number of older oil insulated RMUs in our Network. While these are not necessarily at end of life (in terms of the asset lifecycle), they cannot be operated remotely unlike their modern day SF_6 insulated equivalents.

Some of the oil insulated RMUs have an enclosed bus extension which have a possible susceptibility to moisture ingress. An inspection programme is in the progress of being undertaken to identify the RMUs' condition. From these findings, ML will determine whether renewal is appropriate or whether retrospectively filling the bus extensions with resin for insulation purposes is appropriate. As part of the findings review, consideration will be given to the required isolation of the RMUs which can impact in some instances hundreds of consumers.

9.12.1.1.5 Hutcheson Street 33kV pole replacement

The reinforced concrete poles along Hutcheson Street are approximately 60 years old and some have significant spalling evident. 22 poles, which support a 33kV circuit (to Nelson Street Zone Substation), an 11kV circuit and sections of LV conductor, will be replaced. Pole components (primarily crossarms and insulators) will also be replaced. As part of this work the pole mounted transformers will be replaced with ground mounted transformers.

The Marlborough District Council were offered the opportunity to convert the overhead reticulation along Hutchison Street on a joint basis with ML but declined the opportunity.

The majority of the poles are located within sealed footpath and in close proximity to the Hutcheson Street carriageway. As such, there will likely be a need for traffic management to be included under this project as the works are undertaken.

9.12.1.1.6 Kinross Street Substation renewal

The Kinross Street Substation is one of several indoor town substations that ML have, and comprises 11kV switchgear and a single 1MVA 11kV/400V transformer. The substation and its assets are approximately 50 years old. It supplies 46 consumers on the southern side of the Blenheim CBD, including several bars, restaurants, and numerous businesses. It also houses HV switches for transformers at the post office and central developments which cover a large part of the Blenheim CBD.

The loading at the sub for 2016 peaked at 550kVA. This shows the transformer is not overloaded but it is an old piece of equipment which could have reliability issues in future.

ML intends to rebuild the substation to include new HV and LV switchgear and dual transformers. Doing so will increase safety through including arc fault contained switchgear (the existing switchgear has exposed live terminals). The addition of a second transformer will increase security of supply for the area. It is also proposed to utilise the SCADA system to provide monitoring and control with faster restoration times in the event of faults.

9.12.1.1.7 Havelock Zone Substation Power Transformer renewal

The T1 and T2 power transformers at Havelock are both 5MVA capacity, and are 44 and 46 years old respectively. Recent dissolved gas analysis (DGA) testing of T2 has revealed that the paper insulation has deteriorated to less than 40% of its original tensile strength. Maintenance is required on both of the tap changers, both are showing signs of partial discharge within the OLTCs, and the manufacturer of the OLTCs in these transformers (Fuller) have recommended retrofitting components of the transformer tap changer.

ML intends to replace the two power transformers in FY2019.

9.12.1.1.8 Copper and steel conductor replacement

There is approximately 420km of 11kV and LV copper and steel conductor throughout the network. Much of this conductor is aged (some is over 60 to 70 years old), has capacity limits, and is in many cases supported by old iron rail poles which are due for replacement. Accordingly it is intended to phase much of the 420km out over the course of the planning period.

During the first year replacement of approximately 15km of this conductor will be undertaken. Sections for replacement will be determined by criteria such as age, condition, consumers affected, access, land use etc. For the 2019 regulatory year $2.1m has been provided for this work.

9.12.1.1.9 Spring Creek 11kV switchgear upgrade

The Spring Creek Substation 11kV bus currently consists of a combination of Reyrolle and AEI/GEC switchgear that has been migrated from other sites. This is getting to the stage where increased maintenance will be required over the next few year. Spare parts for the AEI/GEC model in particular are becoming hard to procure.

Replacement of the existing switchgear will:

- Improve network safety
- Increase reliability
- Reduce maintenance requirements

9.12.1.1.10 Redwood Pass 33kV (No 1 circuit to Seddon)

The No 1 circuit between Riverlands and Seddon was constructed over 80 years ago, largely supported on steel lattice tower poles. A number of sections of this circuit have been replaced in recent years. It is intended to replace two further sections of lattice towers in 2019. The first is a section alongside Redwood Pass road on the northern side of the pass (i.e. the Wairau Valley side). This is a section of line that has been on hold for approximately two years following protracted discussions with a landowner who has claimed part of the road reserve as private property. The second section includes approximately 30 poles (many of which are original reinforced concrete, not lattice tower) which are primarily from the hills on the Awatere Valley side of Redwood Pass, down onto the plains which are predominantly developed in vineyards.

The lattice towers and reinforced concrete poles will be replaced with new 16.3m steel poles, with new pole hardware/components and AAAC conductor.

9.12.1.2 Years 2 to 5 (2020 to 2023) – Summary descriptions

9.12.1.2.1 Distribution Pillar replacement programme.

This will be a follow on from the programme described under Year 1 projects. ML intends to replace up to 25 DP boxes each year of the programme from Year 2 on through to Year 10 of the planning period.

9.12.1.2.2 Redwood Pass 33kV (No 1 circuit to Seddon)

This project will see the remaining section of the original reinforced concrete poles replaced with 16.3m steel tower poles. This is a continuation of the works outlined in Year 1 (2019) and will result in the complete rebuilding of the Redwood Pass 33kV feeder to the Awatere River.

9.12.1.2.3 Arthur Street substation upgrade

Arthur Street substation will be, along with Wynen Street substation, the last town substation to be renewed. Arthur Street substation has transformers nearing the end of their serviceable life, aged switchgear which is difficult to maintain and operate, and no arc flash rating on the switchgear. The project will involve the replacement of this equipment with new and modern equivalents connected to the SCADA system. Benefits will include greater network resilience, increased reliability (less likelihood of equipment faults), and easier and safer maintenance and operation of the equipment.

9.12.1.2.4 Riverlands 11kV switchgear replacement

The 11kV switchgear at Riverlands zone substation is aged and has limitations including an inability to be operated remotely. ML intends to replace the switchgear with new and modern equivalents.

9.12.1.2.5 Woodbourne zone substation upgrade (T2 and 11kV switchgear)

Woodbourne T1 is over 50 years old and is programmed for replacement (like for like) in this planning period. This will be subject to condition assessment and testing. Additionally, like Riverlands zone substation, Woodbourne zone substation has aged 11kV switchgear which has operational constraints. ML intends to replace the 11kV switchgear with new equivalents which will enable remote operation (via SCADA).

9.12.1.2.6 33kV renewals

Generally speaking, the 33kV overhead lines are high criticality assets, distributing electricity between ML's zone substations. Many sections of the 33kV network are aged, some are original late 1920s and 1940s reinforced concrete poles, with original components and conductor. Naturally, these assets are showing the signs of ageing and some deterioration, with some concrete spalling evident on poles. During the planning period, between years 2 to 5 and 6 to 10, the following sections of line will be considered for renewal, and prioritised on the basis of condition and network criticality: Seddon to Ward, Alabama Road to Riverlands, Murphy's Road and Old Renwick Road. Where appropriate, the sections will be split out into smaller sub-sections which may be split over multiple years. The Seddon to Ward and Alabama Road to Riverlands sections are examples of this.

9.12.1.2.7 Treated pine pole replacement programme

As detailed in the fleet management section, there are significant volumes of treated pine poles, primarily in the Marlborough Sounds, that are approaching 50 years of age. ML recognises a systematic programme of renewal of these poles will be required over a number of years.

9.12.1.2.8 Larch pole replacement

ML still has a number of larch poles (approximately 180) on its network, many of these are on D'Urville Island. ML intends to replace all remaining larch poles on the network within the first five years of the planning period due to the variability in their condition (some have been found to been internally rotten) and it is difficult to assess their condition (pole testing technologies trialled by ML in the past have proven to be inconclusive).

9.12.1.2.9 Casey's Road to Marfell's Beach Road 11kV renewal

The 11kV Grassmere feeder has mostly been replaced over recent years. One remaining section is between Casey's Road and Marfell's Beach Road. ML intends to renew this section of line, upgrading the conductor to higher capacity Iodine type. This will result in the entire feeder being constructed with Iodine. This will facilitate parts of Ward typically fed from Ward zone substation to be able to be fed by this feeder in the event of an outage at Ward zone substation.

9.12.1.2.10 Rai Valley T1 power transformer renewal.

Rai Valley T1 is nearing end of life (almost 60 years in age). Subject to condition assessment and testing, ML is proposing to replace the 3MVA Rai Valley T1 power transformer with a new 3MVA or 5MVA power transformer (the benefits of any capacity increase will also be assessed as part of the project evaluation).

9.12.1.2.11 11kV recloser renewal programme

The aged 11kV reclosers on the network are beginning to show signs of deterioration. This programme will see a gradual replacement of the fleet, with one to two reclosers targeted for replacement each year.

9.12.1.2.1 Copper and galvanised steel replacement continuation

Continuation of the renewal of the old copper and galvanised steel conductor as described for year 1 earlier. A target of 20 km rising to 30 km per annum is budgeted for.

9.12.1.3 Years 6 to 10 (2024 to 2028) – An overview

Years 6 to 10 of the planning period are more difficult to forecast with certainty. At this time, the following projects are forecast:

- A continuation of the DP box replacement (up to 25 DP boxes per year), copper and steel conductor replacement (up to 40km per year), oil RMU replacement (one RMU per year), 33kV renewal programme, 11kV recloser renewal programme (one to two per year) and the treated pine pole (Marlborough Sounds) and iron rail pole replacement programmes.
- Wynen Street substation upgrade (2024). Similar to Arthur Street zone substation (refer to 9.12.1.2.3), the equipment at Wynen Street is nearing end of life and is difficult to maintain and operate. This equipment will be renewed with modern equivalents.
- Renewal of the Picton 11kV and LV network programme. Much of the Picton HV and LV overhead assets are showing signs of deteriorated condition (based on recent asset inspections) and a number of defects (such as split cross arms). Subject to further inspections in future, ML propose to systematically renew these assets to improve network reliability and resilience. The work will be split across multiple years.
- 11kV town cable replacement programme. Many of Blenheim's 11kV cables will be approximately 60 years in age during years 6 to 10 of the planning period. ML intends to phase out the older cables (subject to testing results) and replace them with new equivalents. This work will be complex due to the confined and developed nature of many parts of town

9.12.2 Non-Network (non-system) renewal projects

There is no significant non-network capital expenditure planned within the next five years for vehicles and land and buildings.

9.12.2.1.1 Buildings

In the next two years, ML intends to review its existing office facilities against future needs. Depending on the outcome of the review, the following options are considered possibilities:

- do nothing;
- upgrade existing Alfred Street office building and facilities; or
- construct new office building at a to be determined location.

9.12.2.1.2 IT systems

The following IT projects are forecast over the course of the planning period:

- ML will review the effectiveness of its primary asset management system within five years of this Plan, Infor's EAM. ML implemented EAM in 2015, with the production environment available for use in October that year. Depending on the outcome of the review ML may elect to purchase a new asset management system within the first five years of the planning period.
- The ML server and storage hardware platform is coming towards the end of a five year refresh cycle. The current platform is due for replacement in 2018, to ensure ongoing mainstream functionality, support and servicing for all of ML's server-based IT services. The

next full refresh in 2023 will be influenced by the evolution and adoption of IT "cloud" services within the electricity industry, which may result in a "hybrid" environment for ML, with some services hosted in-house and some services delivered from the cloud.

- ML have uninterruptible power supply (UPS) systems to provide clean and reliable power to all of the server, storage, and communications IT infrastructure at Alfred Street, Taylor Pass, and System Control. The current UPS equipment is due for replacement in 2020. This equipment is designed for approximately 5 years of continuous operation, which will mean a further replacement of this equipment will be required in approximately 2025.
- The ML IT networking infrastructure provides internal wired and wireless system connectivity, external internet protection and secure connectivity, and segregation and protection of the SCADA environment. A recent refresh of this equipment ensures that another full replacement will not be required until approximately 2021. It is anticipated that further significant investment in networking infrastructure will be required in another five years. Rapid changes are taking place within the communications and security industry that will determine the shape and form of the communications infrastructure investment that ML will require in 2021 and beyond.
- The existing Gentrak billing system is both old and expensive to maintain, and is becoming less relevant to recent changes within the electricity industry. It is likely that investment in a replacement billing system will be required within the next five to seven years

While strictly not renewal, ML is currently trialling a mobility application, Esri's Survey123. This application is being hosted on mobile devices (iPads) for the trial, and is being used to capture asset data in the field. It is expected that this, if successful, will be expanded and further functionalities implemented for use by field staff.

9.13 Operational expenditure (opex)

9.13.1 Overview

Operational expenditure is essential in meeting asset management objectives. Opex is a very broad category – it includes work on the network such restoration of network outages, inspections of assets, and vegetation management as well as non-network support activities, corporate and administrative costs, vehicle operation costs etc.

Generally, opex activities on the network are more broadly termed as 'maintenance'. Maintenance work on the network is split into maintenance portfolios. These are reactive (reacting to network outages and incidents, repair to assets, or to make sites safe) and scheduled maintenance (preventative and corrective).

ML's opex is outlined in the following subsections. Further detail on the maintenance regimes can be found in Sections 6.5 to 6.7.

9.13.2 Routine and corrective maintenance and inspection (Network)

This section of expenditure covers asset patrols, inspections and testing, rectification work from faults (excluding initial fault restoration work undertaken), maintenance of zone and distribution substation sites and maintenance (such as vegetation clearance) of access tracks. Within ML this is referred to as preventive maintenance – inspections of equipment to identify defects and the rectification of defects identified when and where appropriate (differentiated from faults which result in power outages).

When defects are identified, they are recorded in the asset and works management system. Each defect is assigned a priority, urgent, high, medium or low. The priority assigned is based on the nature of the defect, the criticality of the asset, and the safety implications (potential consequences) which may arise from the defect worsening or resulting in a more substantial failure.

The inspection of the assets to identify any defects are undertaken on a scheduled basis or as a result of changed circumstances. The regularity of inspections varies across different asset classes, and for different voltages. For example, a pole carrying dual sub-transmission circuits would be subject to more regular inspections than a pole carrying low voltage conductor only.

The amount forecast for the planning period is $2.6m per annum (escalated by inflation). This has been based on analysis of the trend of the last four years of actual expenditure. No drivers have been identified that would cause a variation from the historical trend with inspection, maintenance and testing cycles well established, however, ML will work towards identifying areas where improvements and efficiencies can be made.

9.13.3 Service interruptions and emergencies (Network)

This section of expenditure covers works undertaken during or immediately following unplanned events which interrupt the normal operation of network assets (i.e. fault work). The drivers of this expenditure include earthquakes, weather events, human interaction (car v pole, cable strike, machinery), animal interaction (possums, swans, geese) and asset failure.

The amount forecast for the planning period is $900k per annum (escalated by inflation). This has been based on historic levels of expenditure after removing non-routine expenditure such as from the November 2016 earthquake. ML has seen improving levels of underlying network reliability over the last ten years through a number of initiatives including remote system control, introduction of long run possum guards and bird spikes, vegetation management, relocating at risk assets, and general asset upgrades.

There will always be the potential for events such as weather, human and animal interaction with the network and asset failure. ML is cognisant that while consumers want a reliable network they also want it to be cost effective. Accordingly any improvements to network reliability need to be measured against the cost of achieving them.

ML intends to maintain or ideally improve current target levels of network reliability and it is inevitable the need for fault expenditure will continue and is forecast to remain flat.

9.13.4 Vegetation management (Network)

This section of expenditure covers the felling, removal or trimming of vegetation (and associated costs) in the proximity of electrical assets. This includes:

- the inspection of electrical assets for the purposes of identifying vegetation in the vicinity of the assets
- Liaising with landowners;
- Physical work involved with felling or trimming vegetation including operational support (such as mobile generation).
- Use of helicopters for spraying.

Details on ML's vegetation management strategy is presented in Section 6.6.

ML faces high costs in relation to vegetation management largely because of the extent of indigenous and native forested areas coupled with difficult to access terrain that exists in the Marlborough Sounds.

The amount forecast for the planning period is $1.95m for 2019 and trending down to $1.65m over the forecast period. This has been based on two criteria.

The first is that ML is now moving into the second trim phase of tree management under the Electricity (Hazards from Trees) Regulations 2003. This requires that the tree owners pay for the second trim rather than the network owner.

The second reason for decreased spend is that ML works with tree owners to, where possible, remove trees under the line before they encroach within the growth limit zone and create clearance zones wider than the statutory limits. Once these clearances have been created there will be less ongoing cost to maintain them.

There will always be cyclical tree inspections and costs to manage the trees outside the statutory clearance zones.

9.13.5 Asset replacement and renewal (Network)

This section of expenditure covers mainly cross arm replacement, single structure replacements and replacement of network consumables such as recloser batteries.

The amount forecast for the planning period is $700k per annum (escalated by inflation) based upon an average level of historic expenditure and information gained from surveillance.

There are no drivers to suggest that the replacement and renewal OPEX activities on MLs network will step away from historic trends as assets continue to age.

9.13.6 Systems operation and network support (Non-Network)

This section of expenditure covers a range of management activities of the network. Some of the more significant activities falling under this section include:

- Policy, standard and manuals development and management;
- Outage recording and data management;
- Data recording and management, support (administration) and management of IT asset management systems (including GIS, Milsoft, EAM and other systems);
- Asset management planning, load forecasting, network modelling, engineering design, technical advice, procurement and inventory management, contract management, (excluding those that can be capitalised on projects);
- Training;
- Easements (establishing/acquiring and management of new and existing);
- Vehicle operation and management (maintenance);
- Consumer enquiries, records and other consumer management activities;
- Other office based and control room system operations.

The amount forecast for the planning period is $4.0m per annum (escalated by inflation). This has been based on recent levels of historical expenditure and forecast requirements. All expenditure is subject to regular review to maximise benefits relative to costs in all aspects of ML's operations.

9.13.7 Business support (Non-Network)

This section of expenditure covers corporate activities including:

- CEO and director costs, legal services, non-engineering/technical consulting services
- Commercial activities including pricing, billing, revenue collection and marketing
- Compliance related activities (finance and regulation)
- HR and training (non-operational);
- Property management
- Support services such as IT, secretarial etc.

The amount forecast for the planning period is $4m per annum (escalated by inflation). This has been based on the historical level of expenditure and forecast requirements. No structural changes to this support function are forecast.

10. Expenditure forecasts

10.1 Overview

This section collects together the forecast costs of the network development, fleet strategy actions and other business related costs required to meet the asset management objectives, risk mitigations and Network performance targets as set out in this plan.

10.1.1 Assumptions on cost inflators

ML faces cost pressures from a number of sources, including labour, fuel, construction costs, and international commodities such as copper and aluminium. Exchange rates will also impact on the final prices ML pays for many inputs that are utilised into its business. Escalation in these cost drivers affect ML's estimation of the nominal values of its cost forecasts over the planning period. Rather than taking an overly complex approach to escalate expenditure forecasts from constant to nominal dollars given there are large inherent uncertainties, ML has instead applied an index based upon the Consumer Price Index (CPI) forecast publicly available from the Reserve Bank Of New Zealand's (RBNZ) Monetary Policy Statement. It has therefore assumed a long run CPI rate of 2% consistent with the RBNZs mid-point target. This approach is simple and not likely to be materially different from an approach using a combination of Labour Cost, Producer Price and Capital Goods Price indices.

10.2 Capex

ML's capex is charted in Figure 71 over the period FY2013 to FY2018 (actual) and FY2019 to FY2028 (forecast). Values are expressed in FY2018 constant prices. This shows the capex forecast continuing at a level of approximately $10m per annum; a level slightly higher than the average of the last six years. The low capex outcome evident in FY2017 arose due to the Kaikoura earthquake interrupting planned works.

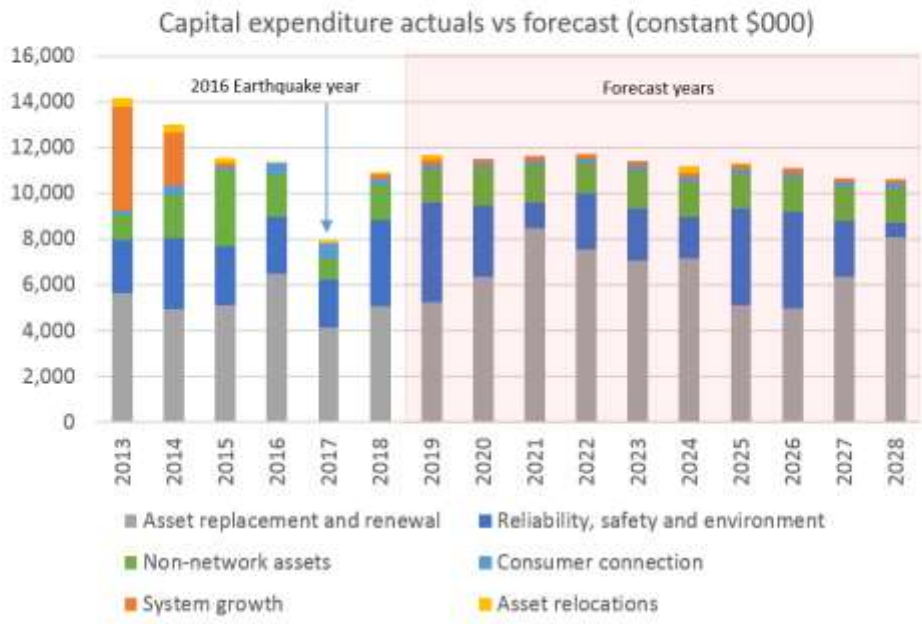


Figure 71: Summary of actual and forecast capex

The largest component of the historic and forecast capex expenditure is for asset replacement and renewal. This component of capex expenditure is forecast to trend up in average over the forecast period as further illustrated in Figure 72 where it is also compared to total capex expenditure.

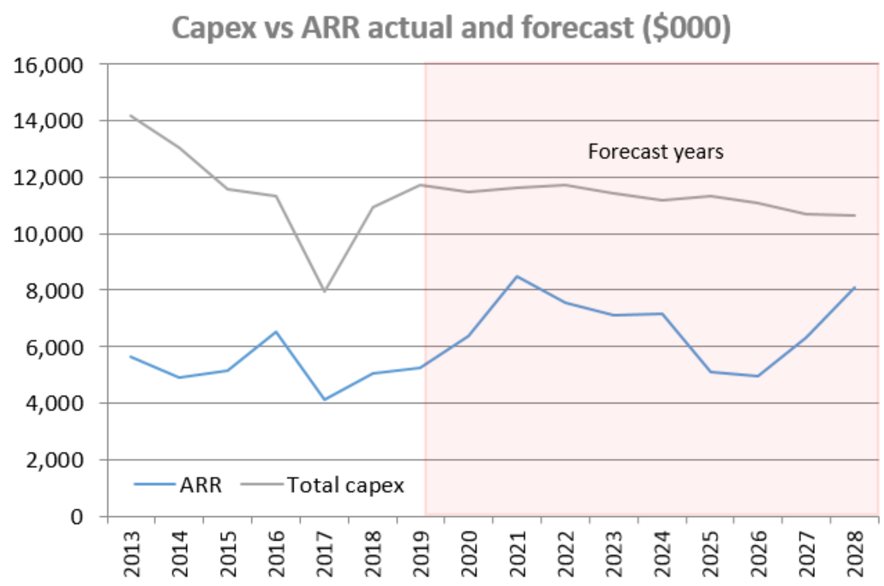


Figure 72: Comparison of total capex vs ARR actuals and forecast

10.2.1 Contribution to drivers

For accounting and regulatory disclosure, system capex projects and programmes are allocated over the eight categories of:

- growth & security;
- replacement & renewal;
- asset relocations;
- quality of supply;
- legislative and regulatory;
- reliability, safety & other;
- overhead to underground conversion; and
- consumer connections

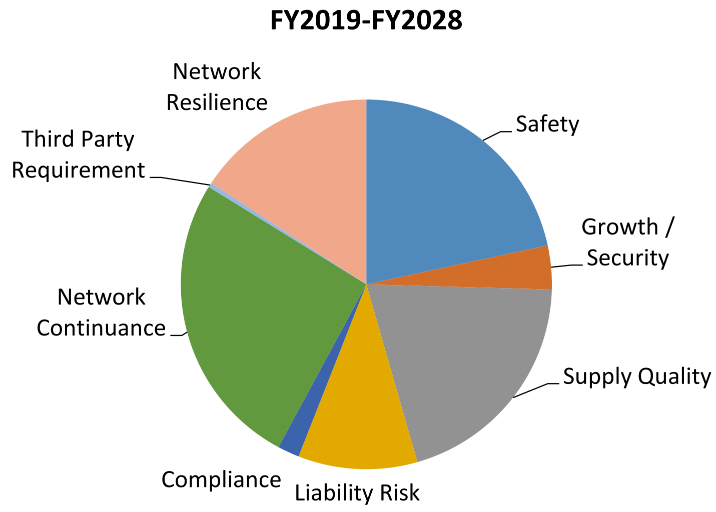


Figure 73: Breakdown of forecast capex amounts by drivers

Accounting allocation is against the category most applicable to the works expenditure, however, in most cases any particular project will impact across multiple objective drivers. For example, a line renewal may be driven by the age and condition of the line and therefore be allocated to replacement and renewal, but renewal will also impact the line reliability and safety implications from avoided faults. In order to show the effect of the forecast expenditure against its asset management objectives, ML have also allocated to the works costs against multiple asset management driver categories in proportion to their assessed benefit. The chart of Figure 73 illustrates this assessed benefit return to ML in proportion to the total expenditure over the forecast period.

This benefit return to ML and its stakeholders is reflective of the general themes in this plan; that network capacity is adequate and not expected to be challenged by growth over the forecast period; that the expenditure focus is shifting towards renewal with it benefits in ensuring network continuance, improved supply quality and safety; and the addressing of ML's risk evaluations for liability from fire risk and the network's resilience to major events like earthquakes.

Line breakdowns of the capital expenditure are provided in the regulatory schedules included in Appendix 11.2.

10.3 Opex

ML's opex forecast is discussed in section 9.13 and charted in Figure 74 for the period FY2013 to FY2018 (actual and estimated) and FY2019 to FY2028 (forecast).

ML's opex forecast slightly declines over the forecast period. It is also at lower levels than what was achieved in 2017 and forecast to be achieved in 2018.

The basis for the expenditure categories in this forecast are discussed in section 9.13 where forward forecasts are based off historic averages where there is an expectation of continuance at the past levels and after adjustment for any one-off factors. The step rise in systems operations cost from FY2016 to FY2017 and subsequent step down for our forecast over the next planning period arose from several increased costs, including higher IT operational support costs associated with the early implementation (training and support) for EAM, increasing salary costs during a significant period of overlap for new senior staff overlapping with departing senior staff and increased legal costs.

At a high level ML is seeking to hold non-network expenditure flat in real terms. Making do with existing resources and looking to offset any cost pressures by making efficiency improvements. ML will be seeking to advance its asset management capability to make the best use of existing systems and processes.

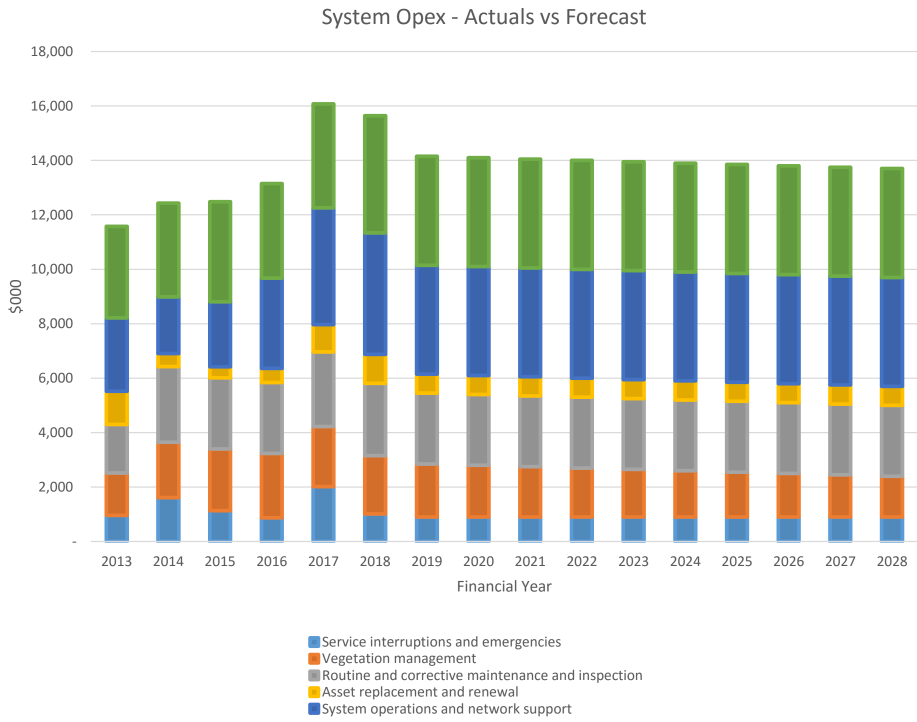


Figure 74: Summary of actual and forecast opex

ML is forecasting a small reduction in vegetation management expenditure (for reasons discussed previously), but forecasting the other maintenance expenditure categories to be held constant in real terms. Unforeseen events such as storms or seismic events and individual projects arising from circumstances as yet unknown will cause actual results to vary. However, ML believe this to be a reasonable long term view.

10.4 Capex/opex trade-off and overlapping works

MLs' capital investment is directed at network restoration, load growth, utility enhancement or improvement or holding of the service reliability. While some works, such as remote controlled network switches, will reduce the need for manual switching, by and large, the capital programme set out in this plan does not encompass productivity improvement projects of any significance that would see an offset in opex costs. ML will always seek opportunities for productivity improvement but in this current round it has not identified projects that net benefits above costs in this area.

In preparing its budget forecasts ML has been cognisant not to "double count" activity costs from programmes with overlapping works. The main area where this is a possibility is with pole and crossarm replacements coincident with the planned conductor renewals – that is, the same poles are not represented in different renewal programmes. ML has placed the majority of the required iron rail pole replacements within the conductor renewal programme as the conductor targeted for replacement is associated to this pole type. The replacement of tanalised pine poles is treated separately as these poles are generally located with the Marlborough Sounds area and not associated to the target conductor types.

10.5 Capacity to deliver

The expenditure levels forecast in this plan, while representing a change in emphasis towards renewal works, do not represent a significant change from historic levels of capital or operational expenditure and, as such, ML foresee no issue in managing and achieving the outcome expenditures set out in this plan. Additionally, the nature of the works planned does not represent any significant change from the business's skills base for their execution. Again, ML do not hold any reservation about its ability to achieve the works it has planned.

ML has its own in-house contracting division that completes most of the maintenance, vegetation management and replacement upgrades on our network on a cost basis, although we utilise external resources as necessary to manage the peak workload. Examples of the use of external resources recently include:

- Following the November 2016 earthquake ML brought in a number of crews from neighbouring electricity distribution businesses to assist with earthquake repairs;
- In May 2017 ML had a major line re-build project between Tuamarina and Picton. We contracted resources from neighbouring distribution businesses to assist with general work;
- In February 2018 we have utilised external resources to backfill to enable our employees to complete a major streetlight upgrade project; and
- On a regular basis we contract vegetation companies to complete work on our network to take the peak off heavy workload.

MLL believes maintaining its own Contracting division enables it to maintain the resources it requires to manage and retain key staff and maintain standards and quality of workmanship. This approach also means it has control of the size of the workforce available to it and ensures the work plan can be delivered.

11. Appendices

11.1 Glossary

Term	Meaning
AAAC	All aluminium alloy conductor.
AAC	All aluminium conductor.
ABS	Air Break Switch – used in the 33kV and 11kV networks.
ACR	Asset Critically, a measure of important of asset for providing service.
ACSR	Aluminium conductor steel reinforced
AHI	Asset Health Index – a measure of an assets remaining life. Defined in the EEA guide to this measure.
ALARP	As Low As Reasonably Practicable – a principle of risk management.
AMMAT	Asset Management Maturity Assessment Tool.
AMP	Asset Management Plan.
ArcGIS	Geographic Information System from ESRI used by ML.
CAIDI	For the Total of All Interruptions (Consumer Average Interruption Duration Index). CAIDI is the average duration of an interruption of supply for consumers who experienced an interruption of supply in the period. The CAIDI for the total of all interruptions is the sum obtained by adding together the interruption duration factors for all interruptions *divided by* the sum obtained by adding together the number of electricity consumers affected by each of those interruptions.
Capex	Capital expenditure.
CBD	Central Business District.
CDMA	Data system provided by Telecom, uses Cell network, ML uses this for some SCADA communications.
CPI	Consumer Price Index.
DGA	Dissolved Gas Analysis.
DNP3	Distributed Network Protocol (version 3) – a communications protocol.
DOC	Department of Conservation.
DP	Degrees of Polymerisation.

EAM	Info's enterprise asset management software for managing assets and works.
EDB	Electricity Distribution Business.
EEA	Electricity Engineers Association.
ENA	Electricity Networks Association.
EPV	Elevating Platform Vehicle – Used in Live Line work and for ease of maintenance on various assets.
GAAP	Generally Accepted Accounting Principles.
GFC	Global Financial Crisis.
GIS	Geographic Information System – a way of storing information in a computer such that the location of the equipment is also stored and various maps/views can be produced.
GPS	Global Positioning System. Receivers utilise satellites to accurately locate themselves on the earth's surface. This information is then used to locate items such as power poles.
GXP	Grid Exit Point, connection between Distribution Network and National Grid.
Hiab	Trade Name for truck mounted hydraulic crane.
HV	High Voltage – voltage equal or above 1,000 volts.
ICP	Installation Control Point – point of connection of a consumer to the network.
IntraMaps	Map viewer of electrical assets and other map features.
kVA	10^3 VA. Measure of apparent power.
kWh	10^3 Wh measure of energy.
Live Line	Various techniques for working on the network with the power on. Procedures range from connection of transformers to complete pole replacement.
LV	Low Voltage – voltage below 1,000 volts.
Mango.	Document repository and control software that holds ML's policies and procedures.
MangoLive	Web access into Mango documents.
MDC	Marlborough District Council.
Milsoft	Network analysis software; records and manages network outage data.
ML	Marlborough Lines Limited.
MVA	10^6 VA. Measure of apparent power. N level security, any one failure causes loss of supply. N-1 level security, two failures required before loss of supply.

N-1	A security level whereby the loss of any 1 device or circuit will not lose supply
Number of Faults per 100km of Prescribed Voltage Line	This is a measure of the number of faults in relation to the total length of the network 6.6kV and above
NZTA	New Zealand Transport Agency.
ODV	Optimised Deprival Value, a method of valuing assets laid down in regulations.
PILC	Paper Insulated Lead Covered – a type of cable
PSTN	Public Switched Telephone Network, i.e. standard telephone system.
RAPS	Remote Area Power Supply
Ripple Control	System which uses frequencies >50Hz to transmit information across power system. Mainly used to control water heating/night store loads and street lighting.
RTU	Remote Terminal Unit.
SAIDI	For Total of Interruptions (System Average Interruption Duration Index). SAIDI is the average total duration of interruptions of supply that a consumer experiences in the period. The SAIDI for the total of interruptions is the sum obtained by adding together the interruption duration factors for all interruptions *divided by* the total consumers.
SAIFI	For the Total Number of Interruptions (System Average Interruption Frequency Index). SAIFI is the average number of interruptions of supply that a consumer experiences in the period. The SAIFI for the total number of interruptions is the sum obtained by adding together the number of electricity consumers affected by each of those interruptions *divided by* the total consumers.
SCADA	Supervisory Control and Data Acquisition**,** computer and communications system to monitor and control equipment in the network, e.g. circuit breakers.
SCI	Statement of Corporate Intent. Standard NZ Voltages, 230V/400V. Transformers output 240V/415V to allow for voltage reduction along lines/cables.
SF6	Sulphur hexafluoride – and electrical insulating gas
SWER	Single Wire Earth Return. A system which uses a single wire (compared with two for convectional single phase or three for three phase) to transmit power. ML uses this system at 11kV.
TCR	Task Critically, a measure how urgently maintenance or repair is required.
Thermovision	Using infra-red technologies to locate hot spots/faults in network Assets.
VHF	Very High Frequency, radio frequency used by ML primarily for voice communications.
XLPE	Cross-Linked Poly Ethylene – a type of cable insulation

11.2 Regulatory schedules

Regulatory schedules have been completed to compliment this AMP. The regulatory schedules have been disclosed as a separate document and include:

- S11a. Capex Forecast;
- S11b. Opex Forecast;
- S12a. Asset Condition;
- S12b. Capacity Forecast;
- S12c. Demand Forecast;
- S12d. Reliability Forecast;
- S13. AMMAT; and
- S14a Mandatory Explanatory Notes on Forecast Information.

11.3 Regulatory requirements look-up

Regulatory Requirement (Attachment A)	Corresponding AMP Section(s)
3.1 A summary that provides a brief overview of the contents and highlights information that the EDB considers significant;	1. Summary
3.2 Details of the background and objectives of the EDB's asset management and planning processes;	6 Asset management strategy
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; 3.3.2 states the corporate mission or vision as it relates to asset management; 3.3.3 identifies the documented plans produced as outputs of the annual business planning process adopted by the EDB; 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 3.3.5 includes a description of the interaction between the objectives of the AMP and other corporate goals, business planning processes, and plans;	2.1 Purpose of this AMP 4.3.1 Strategic Planning Documents 4.3.1.4 Interaction between Planning Documents
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;	2.5 Period covered
3.5 The date that it was approved by the directors;	2.5 Period covered
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 3.6.2 what these interests are; 3.6.3 how these interests are accommodated in asset management practices; and 3.6.4 how conflicting interests are managed;	4 Stakeholder interests and objectives alignment
3.7 A description of the accountabilities and responsibilities for asset management on at least 3 levels, including- 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; 3.7.2 executive—an indication of how the in-house asset management and planning organisation is structured; and 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;	11.6 Business organisation and role responsibilities
3.8 All significant assumptions- 3.8.1 quantified where possible; 3.8.2 clearly identified in a manner that makes their significance understandable to interested persons, including- 3.8.3 a description of changes proposed where the information is not based on the EDB's existing business; 3.8.4 the sources of uncertainty and the potential effect of the uncertainty on the prospective information; and	6.10 Key assumptions

Regulatory Requirement (Attachment A)	Corresponding AMP Section(s)
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;	
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;	6.10 Key assumptions
3.10 An overview of asset management strategy and delivery; To support the Report on Asset Management Maturity disclosure and assist interested persons to assess the maturity of asset management strategy and delivery, the AMP should identify- • how the asset management strategy is consistent with the EDB's other strategy and policies; • how the asset strategy takes into account the life cycle of the assets; • the link between the asset management strategy and the AMP; and • processes that ensure costs, risks and system performance will be effectively controlled when the AMP is implemented.	6 Asset management strategy
3.11 An overview of systems and information management data; To support the Report on Asset Management Maturity disclosure and assist interested persons to assess the maturity of systems and information management, the AMP should describe- • the processes used to identify asset management data requirements that cover the whole of life cycle of the assets; • the systems used to manage asset data and where the data is used, including an overview of the systems to record asset conditions and operation capacity and to monitor the performance of assets; • the systems and controls to ensure the quality and accuracy of asset management information; and • the extent to which these systems, processes and controls are integrated.	6.2 Systems and information management
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;	6.2.4.2 Data limitations
3.13 A description of the processes used within the EDB for- 3.13.1 managing routine asset inspections and network maintenance; 3.13.2 planning and implementing network development projects; and 3.13.3 measuring network performance;	6 Asset management strategy and 7 Network development
3.14 An overview of asset management documentation, controls and review processes.	6 Asset management strategy and 11.6 Business organisation and role responsibilities
3.15 An overview of communication and participation processes;	6 Asset management strategy and 11.6 Business organisation and role responsibilities

Regulatory Requirement (Attachment A)	**Corresponding AMP Section(s)**
3.16 The **AMP** must present all financial values in **constant price** New Zealand dollars except where specified otherwise; and 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.	10 Expenditure forecasts and throughout
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- 4.1.1 the region(s) covered; 4.1.2 identification of large **consumers** that have a significant impact on **network** operations or asset management priorities; 4.1.3 description of the load characteristics for different parts of the **network**; 4.1.4 peak demand and total energy delivered in the previous year, broken down by **sub-network**, if any.	3 Network overview
4.2 a description of the **network** configuration, including- 4.2.1 identifying bulk electricity supply points and any **distributed generation** with a capacity greater than 1 MW. State the existing firm supply capacity and current peak load of each bulk electricity supply point; 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; 4.2.3 a description of the distribution system, including the extent to which it is underground; 4.2.4 a brief description of the **network**’s distribution substation arrangements; 4.2.5 a description of the **low voltage network** including the extent to which it is underground; and 4.2.6 an overview of **secondary assets** such as protection relays, ripple injection systems, SCADA and telecommunications systems. *To help clarify the **network** descriptions, **network** maps and a single line diagram of the **subtransmission network** should be made available to interested **persons**. These may be provided in the **AMP** or, alternatively, made available upon request with a statement to this effect made in the **AMP**.*	3.3 Supply within Marlborough
4.3 If **sub-networks** exist, the **network** configuration information referred to in clause 4.2 must be disclosed for each **sub-network**.	N/A
Network assets by category 4.4 The **AMP** must describe the **network** assets by providing the following information for each asset category- 4.4.1 voltage levels; 4.4.2 description and quantity of assets; 4.4.3 age profiles; and 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.	9 Fleet management

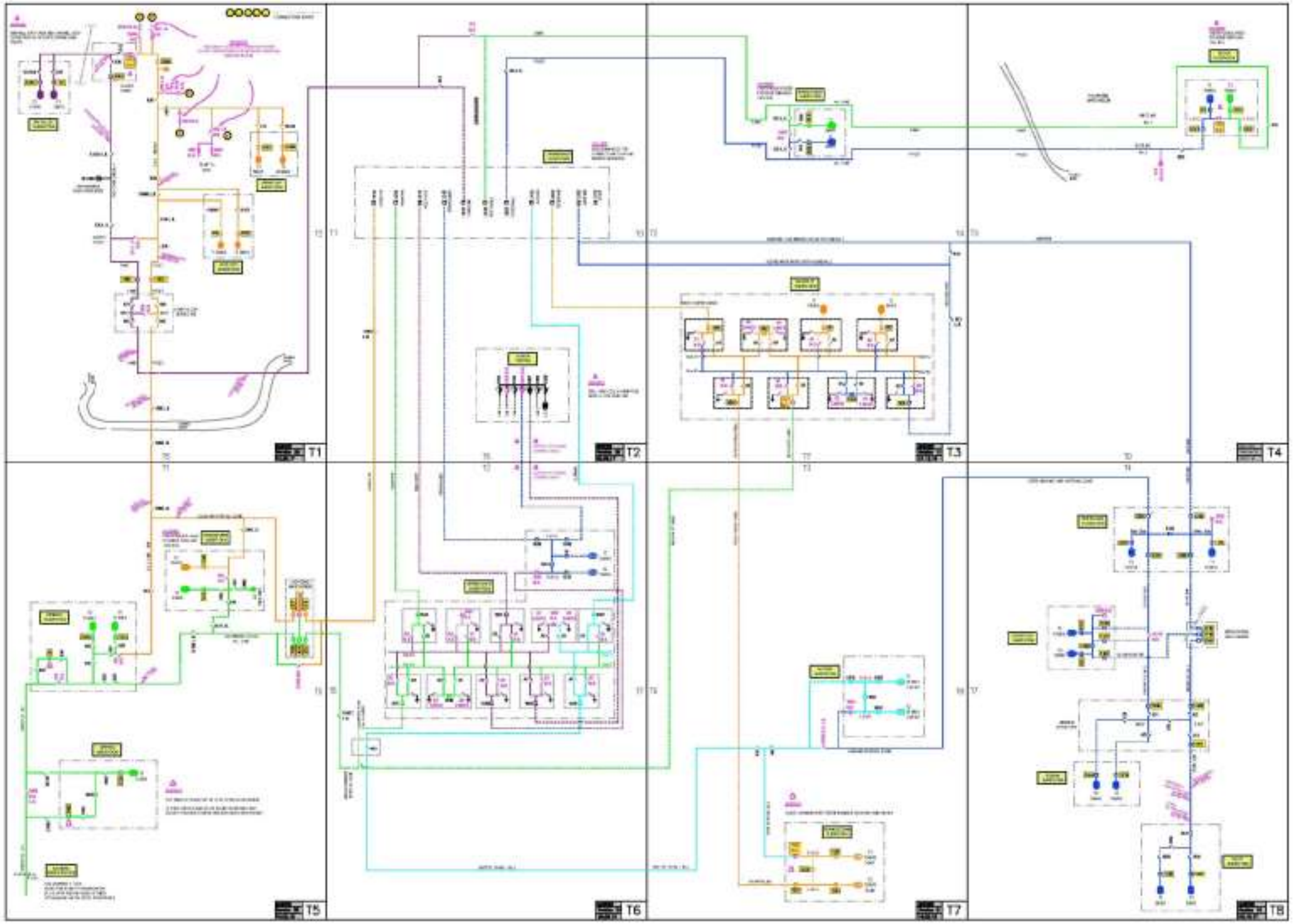
Regulatory Requirement (Attachment A)	Corresponding AMP Section(s)
4.5 The asset categories discussed in clause 4.4 should include at least the following- 4.5.1 the categories listed in the Report on Forecast Capital Expenditure in Schedule 11a(iii); 4.5.2 assets owned by the **EDB** but installed at bulk electricity supply points owned by others; 4.5.3 **EDB** owned mobile substations and generators whose function is to increase supply reliability or reduce peak demand; and 4.5.4 other generation plant owned by the **EDB**.	9 Fleet management
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**.	5 Network performance and service levels
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**.	5 Network performance and service levels
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 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.	5 Network performance and service levels
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. 9. Targets should be compared to historic values where available to provide context and scale to the reader. 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.	5 Network performance and service levels and 4 Stakeholder interests and objectives alignment
Network Development Planning 11. **AMP**s must provide a detailed description of **network** development plans, including— 11.1 A description of the planning criteria and assumptions for **network** development; 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;	7 Network development
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; 11.4 The use of standardised designs may lead to improved cost efficiencies. This section should discuss- 11.4.1 the categories of assets and designs that are standardised; and	6.8.2 Standardising assets and designs

Regulatory Requirement (Attachment A)	Corresponding AMP Section(s)
11.4.2 the approach used to identify standard designs;	
11.5 A description of strategies or processes (if any) used by the **EDB** that promote the energy efficient operation of the **network**;	6.8.3 Strategies for asset efficiency
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**.	5.5 Utilisation and losses
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;	7 Network development
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; 11.8.1 explain the load forecasting methodology and indicate all the factors used in preparing the load estimates; 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; 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 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;	7.2 Growth/demand projections
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- 11.9.1 the reasons for choosing a selected option for projects where decisions have been made; 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 11.9.3 consideration of planned innovations that improve efficiencies within the **network**, such as improved utilisation, extended asset lives, and deferred investment;	7 Network development
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- 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; 11.10.2 a summary description of the programmes and projects planned for the following four years (where known); and 11.10.3 an overview of the material projects being considered for the remainder of the **AMP planning period**;	6.4 Major Projects

Regulatory Requirement (Attachment A)	Corresponding AMP Section(s)
*For projects included in the **AMP** where decisions have been made, the reasons for choosing the selected option should be stated which should include how target levels of service will be impacted. For other projects planned to start in the next five years, alternative options should be discussed, including the potential for non-network approaches to be more cost effective than **network** augmentations.*	
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	
11.12 A description of the **EDB**'s policies on non-network solutions, including- 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 11.12.2 the potential for non-network solutions to address **network** problems or constraints.	7.4.2 Embedded generation
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;	6.5 Lifecycle management
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- 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; 12.2.2 any systemic problems identified with any particular asset types and the proposed actions to address these problems; and 12.2.3 budgets for maintenance activities broken down by asset category for the **AMP planning period**;	6.5 Lifecycle management and 9.13.2 Routine and corrective maintenance and inspection (Network)
12.3 Identification of **asset replacement and renewal** policies and programmes and actions to be taken for each asset category, including associated expenditure projections. This must include- 12.3.1 the processes used to decide when and whether an asset is replaced or refurbished, including a description of the factors on which decisions are based, and consideration of future demands on the **network** and the optimum use of existing **network** assets; 12.3.2 a description of innovations that have deferred asset replacements; 12.3.3 a description of the projects currently underway or planned for the next 12 months; 12.3.4 a summary of the projects planned for the following four years (where known); and 12.3.5 an overview of other work being considered for the remainder of the **AMP planning period**; and 12.4 The asset categories discussed in clauses 12.2 and 12.3 should include at least the categories in clause 4.5.	6.5 Lifecycle management throughout 9 Fleet management and 9.12 Major renewal projects
Non-Network Development, Maintenance and Renewal 13. **AMP**s must provide a summary description of material non-network development, maintenance and renewal plans, including— 13.1 a description of **non-network assets**;	9.11 Non-network assets

Regulatory Requirement (Attachment A)	**Corresponding AMP Section(s)**
13.2 development, maintenance and renewal policies that cover them; 13.3 a description of material **capital expenditure** projects (where known) planned for the next five years; and 13.4 a description of material maintenance and renewal projects (where known) planned for the next five years.	9.11 Non-network assets and 9.12.2 Non-Network (non-system) renewal projects
Risk Management 14. **AMP**s must provide details of risk policies, assessment, and mitigation, including— 14.1 Methods, details and conclusions of risk analysis; 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; 14.3 A description of the policies to mitigate or manage the risks of events identified in clause 14.2; and 14.4 Details of emergency response and contingency plans.	6.4 Risk management 11.10 Risk matrix
Evaluation of performance 15. **AMP**s must provide details of performance measurement, evaluation, and improvement, including— 15.1 A review of progress against plan, both physical and financial; 15.2 An evaluation and comparison of actual service level performance against targeted performance; 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; 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.	5 Network performance and service levels and 11.7 Performance analysis of reliability and cost
Capability to deliver 16. **AMPs** must describe the processes used by the **EDB** to ensure that-	10.5 Capacity to deliver
16.1 The **AMP** is realistic and the objectives set out in the plan can be achieved; and	10.5 Capacity to deliver
16.2 The organisation structure and the processes for authorisation and business capabilities will support the implementation of the **AMP** plans.	10.5 Capacity to deliver

11.4 Single line diagram of 33kV Network



11.5 SCADA coverage map

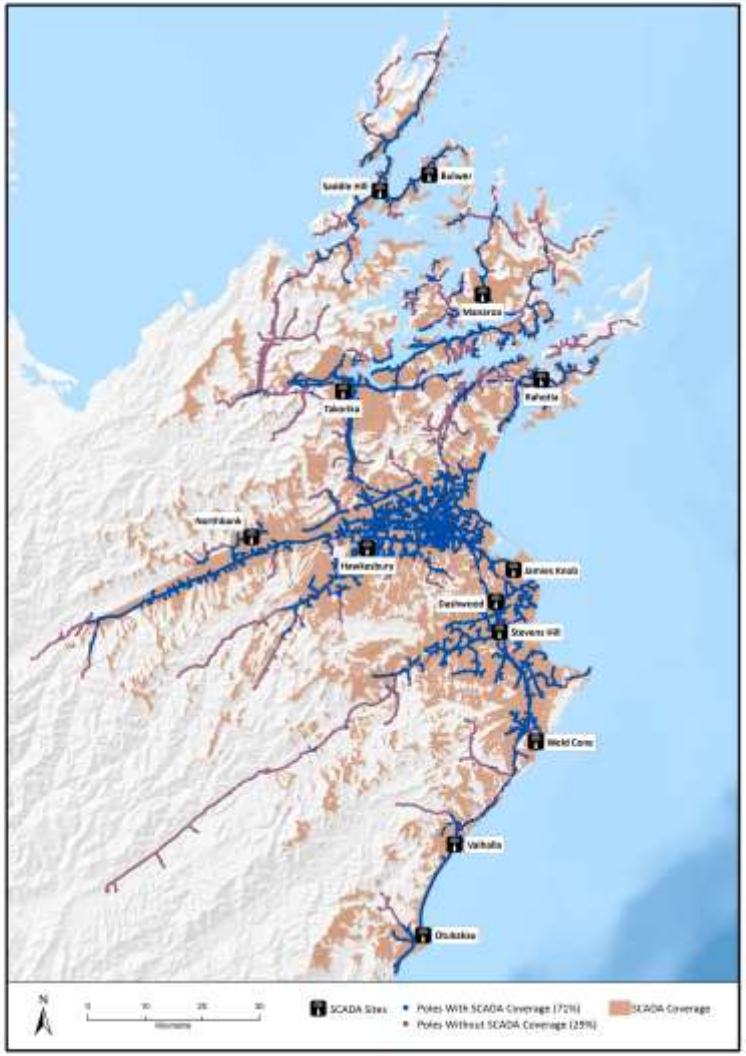


Figure 75: SCADA coverage map

11.6 Business organisation and role responsibilities

ML's accountabilities and accountability mechanisms are shown in Figure 75 and are discussed in detail in the following sections.

The ultimate accountability is to connected consumers. The Commerce Amendment Act recognises this accountability and accordingly the price path threshold does not apply to beneficially owned Lines Companies such as ML. ML undertakes independent surveys of consumers annually and the overall satisfaction levels have been at or about 90 % for a number of years.

11.6.1 Accountability at Ownership Level

ML has a single Shareholder – the Marlborough Electric Power Trust. The Trust currently has six trustees, each of whom holds 4,666,650 shares (with the exception of the Chair who holds 4,666,750 shares) in ML on behalf of the Trust.

The Trust is subject to the following three accountability mechanisms:

- an election process;
- the Trust Deed which holds all Trustees collectively accountable to the New Zealand judiciary for compliance with the Trust Deed; and
- the provisions of the Trustee Act 1956.

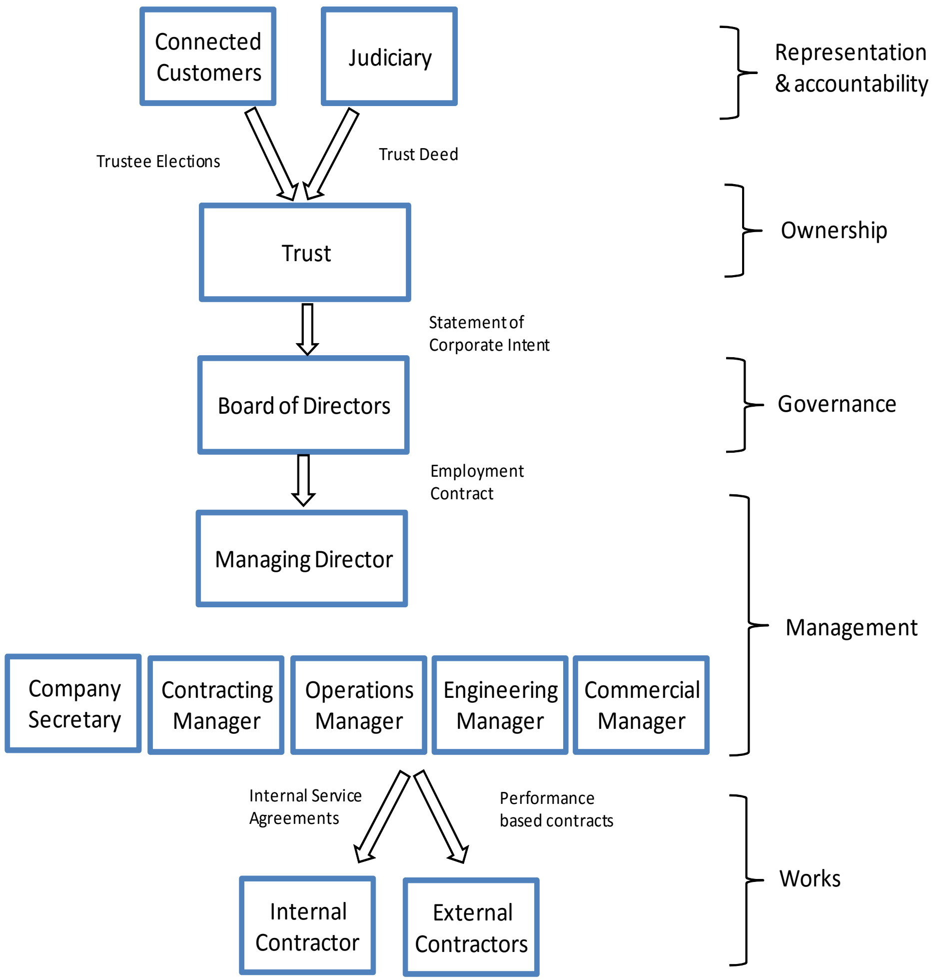


Figure 76: Summary of key ML organisational responsibilities and accountabilities

11.6.2 Accountability at Governance Level

ML currently has eight directors who are collectively accountable to the Trust through the SCI. The current directors are:

- David Dew (Chair);
- Ken Forrest (Managing Director);
- Peter Forrest;
- Phil Robinson;
- Jonathan Ross;
- Tim Smit;
- Ivan Sutherland; and
- Steven Grant.

The Board approves the annual budgets, SCI and this AMP. Each month it receives reports on the overall performance of ML and the key activities undertaken.

11.6.3 Board Reporting

ML's regular board reports include the following:

- the capital expenditure program (progress and spend against budget);
- the maintenance program (progress and spend against budget);
- incidents and major outages; and
- any major changes to asset management processes or practices.

On a quarterly basis the Board receives a report on Legislative Compliance and Risk Management, which includes:

- all health and safety accidents and near-misses;
- all incidents of third party contact with the network; and
- details of major consumer works.

11.6.4 Accountability at Managing Director Level

The Managing Director, Ken Forrest, is accountable for all aspects of ML's operations to the directors primarily through his employment contract and the required objectives of the Board.

11.6.5 Accountability at Management Level

The second tier of management reports to the Managing Director. Accountability for asset management at the second tier is:

- Accountability for managing the existing assets and planning new assets lies with the Engineering Manager. This role addresses long-term planning issues such as capacity, security and asset configuration. At time of writing, this position is currently vacant
- Responsibility for minute by minute continuity and restoration of supply lies with the Operations Manager, Warner Nichol, principally through control and dispatch, switching and fault restoration. The Operations Manager also has responsibility for asset maintenance.
- Accountability for the key area of line pricing lies with the Commercial Manager, Katherine Hume-Pike.
- Accountability for all administrative and financial activities lies with ML's Chief Financial Officer, Gareth Jones.

The key accountabilities of the four second tier managers are to the Managing Director through their respective employment contracts and required performance criteria.

11.6.6 Accountability at Works Implementation Level

ML has an in-house contracting department. This operates as a separate division of the Company/business. With the implementation of the Electricity Industry Reform Act 1998, many Lines Companies sold their contracting operations. ML recognised it was very unlikely that active competition would be present in the Marlborough market and therefore chose to retain its contracting staff, rather than being subject to limited competition and consequent price gouging.

ML Contracting undertakes the majority of the work on the ML network. Broadly this is:

- Construction of new assets.
- Maintenance of existing assets.
- Operation of existing assets.

It also undertakes work such as the construction of line extensions for external consumers and the operation of hydroelectric schemes for Trustpower.

ML retains relativity with prevailing market rates and undertakes testing from time to time to compare the commercial performance of ML's Contracting division with other similar businesses in the area and throughout New Zealand.

The Contracting Manager, Stephen McLauchlan, is accountable both to the Operations Manager and Engineering Manager for the quality of work done, and to the Managing Director for the overall performance of the Contracting business unit.

11.7 Performance analysis of reliability and cost

This appendix extends the comparative assessments or reliability and cost and the Network reliability performance analysis presented in section 5 of this AMP.

Comparative charts provided in this section generally plot ML's FY2017 performance as a red dot point; FY2016 performance as a dark blue dot point; and prior years back to FY2013 as light blue dot points. Regression lines are plotted as dark blue dash lines and their 95 percentile confidence bounds as yellow dash lines. Outlier data may be highlighted as orange points.

11.7.1 Comparative SAIFI

For comparison purposes, SAIFI is further divided between planned and un-planned (fault) SAIFI, both of which have been regressed against network size and type and plotted in Figure 77 and Figure 78 respectively.

The charts plot the expected SAIFI on the x-axis and the actual SAIFI on the y-axis. The expected SAIFI is derived through statistical deduction (multi-factor regression) but invariably comes back to practical explanations. In urban networks, there is greater meshing allowing for greater ability to isolate sections of the network for maintenance without dropping service to large numbers of consumers. For this reason, comparison between networks for plan SAIFI normalises based on the length of the rural and remote sections of each network. A similar normalisation applies to fault SAIFI but in this case an additional parameter also becomes significant being the length of urban underground network.

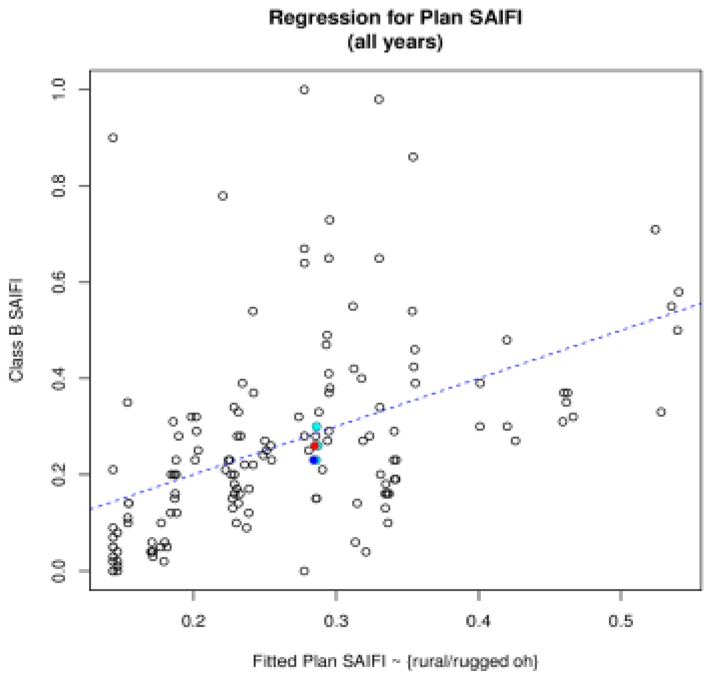


Figure 77: Regression of plan SAIFI

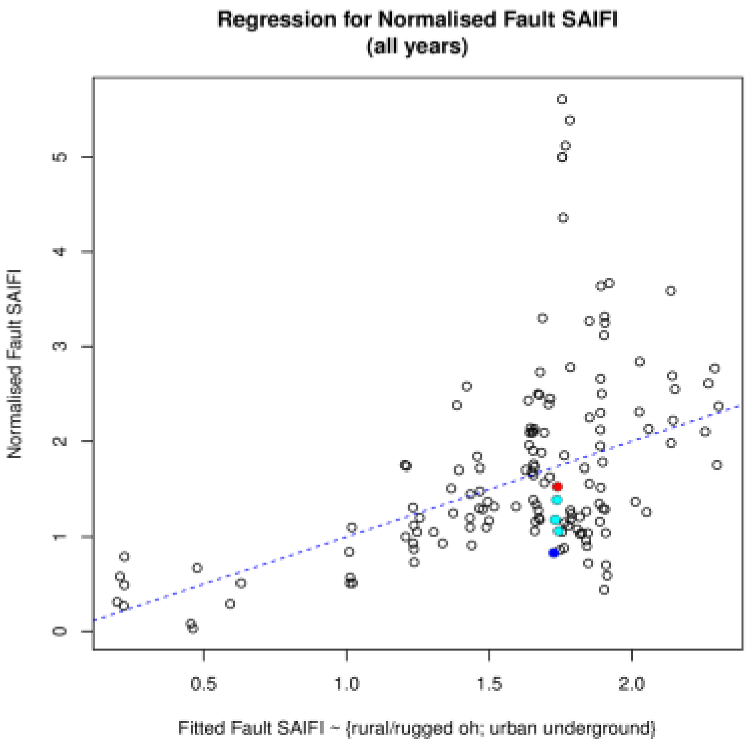


Figure 78: Regression of unplanned (fault) SAIFI

For plan SAIFI (Figure 77) the explanatory power of the regression is low – as the point scatter is very large – and so meaningful comparisons should be avoided. However, it is at least noteworthy that ML plots close to the mean expectation line indicating its comparative performance in both number and impact of planned outages is, on the face of it, not unreasonable for would be expected based on its Network characteristics.

Unplanned (fault) SAIFI is also regressed on the basis of the scale of Network exposure and plotted in Figure 78. The explanatory power of the regression is mildly better and shows ML plotting below the expectation line for frequency of fault outages, even for FY2014 and FY2017, which were particularly onerous years for storms and unavoidable events (viz the Seddon and Kaikoura earthquakes).

Taking FY2016 as a more representative year for unplanned SAIFI (the dark blue dot point), ML shows at near frontier performance being approximately 0.5 average interruptions per consumer below expectation. This would translate to a community value of approximately $0.9m per annum in avoided power losses.[21]

The ML target for unplanned SAIFI is <0.67 to yield 80 SAIDI minutes at a target CAIDI of 120 minutes. As this level of unplanned SAIFI represents better than expectation performance on a comparative basis and remains a stretch target for the business (given the effect of irregular storm and other events), this target is retained for the duration of this planning period.

[21] This calculation assumes average CAIDI of 120 minutes per interruption; a loss per connection of 1.5 kW; 24,500 network consumers; and a value of lost load of $24/kWh as used in the Electricity Authority modelling after adjusting for shifts in CPI.

The trend in overall (planned + unplanned) SAIFI is also downward for ML compared to a relatively flat trend for all distribution businesses combined, as illustrated in Figure 79 (ML=red line; includes the effect of the 2017 Kaikoura earthquake; cohort is for medium sized EDBs with mixed urban and rural networks). This, together with the comparatively low unplanned interruption frequency, shows the ML network is responding to the reliability improvement strategies being applied.

11.7.2 Comparative CAIDI

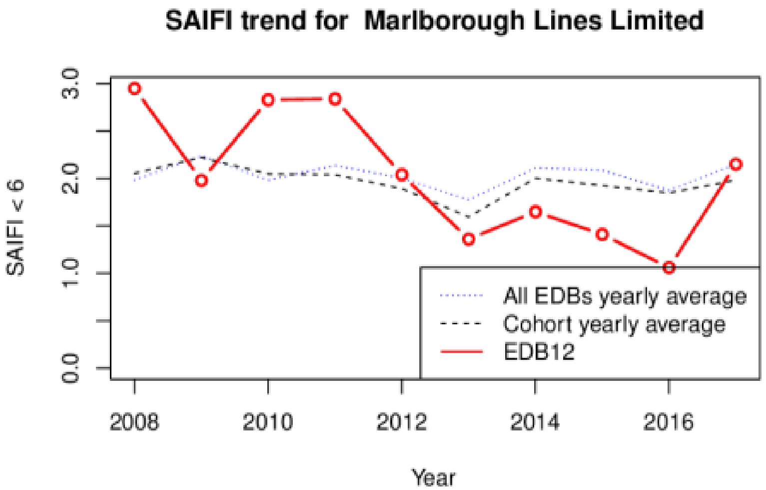


Figure 79: ML's SAIFI trend (red line)

CAIDI measures the average duration of the interruptions and is generally highly variable between years, particularly when the total number of interruptions is not large, as is the case for smaller distribution businesses like ML. CAIDI is also affected by the types of faults occurring as some faults are more difficult to locate and repair i.e. underground cable faults, and the difficulty of getting to the fault location i.e. remote faults in the Marlborough Sounds. Multiple faults occurring simultaneously also impact CAIDI as fault restoration has to then be prioritised over the available fault crews.

Comparative analysis simply shows that ML's CAIDI fits within the typical distribution of CAIDI times experienced by other distribution businesses as illustrated in Figure 80 where ML is represented by the red points, (which include the earthquake years), and each row plots the disclosed CAIDI (on the x-axis) for each New Zealand EDB from FY2008 to FY2017. ML's CAIDI might also be expected to be larger in average than other businesses that do not also have a significant proportion of remote lines within their networks.

ML set a fault CAIDI target of 120 minutes, which is generally achieved in years without major storms or system events (e.g earthquakes). This target is therefore retained for this planning period given it remains a stretch target for the business and is at a reasonable level for a Network with MLs characteristics.

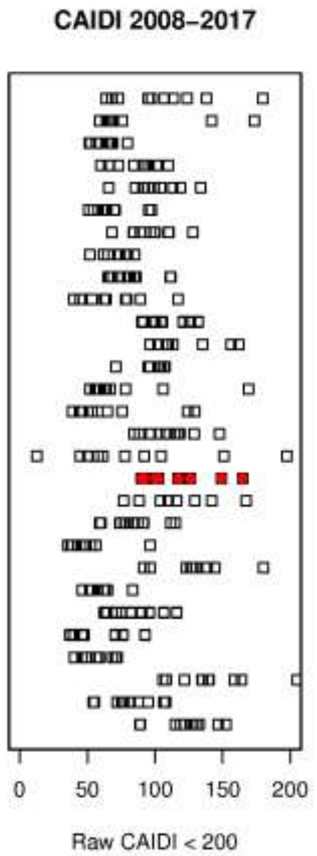


Figure 80: ML's CAIDI

11.7.3 Comparative cost performance

Network businesses may be broadly compared on cost as long as the limitations of such comparisons are recognised. In ML's case, it has an extensive remote area to manage in the Marlborough Sounds, sometimes requiring helicopter access and/or long hours of travel for staff thereby increasing its costs.

The comparative assessments provided here are based on the public disclosure data up to FY2017.

11.7.3.1 Total cost

The comparison of the relative costs of electricity networks needs careful consideration. By way of example any absolute comparison needs to take into account network age, condition, environment, level of reliability and the reasonableness of capital and maintenance expenditure. It is salient that postponement of prudent capital and maintenance expenditure is not a measure of efficiency, but postponement of a likely greater cost to a future date.

Businesses are structured differently; for example some, like ML, have an internal contracting arm while others may fully contract out this service. Determining if a business is relatively efficient requires comparing the different businesses total inputs against the output products and services they provide. This is the economic concept of total factor productivity.

Figure 81 approximates the productivity of the different electricity distribution businesses by comparing the retained revenue (income less pass-through costs) against the network services provided (line kms,

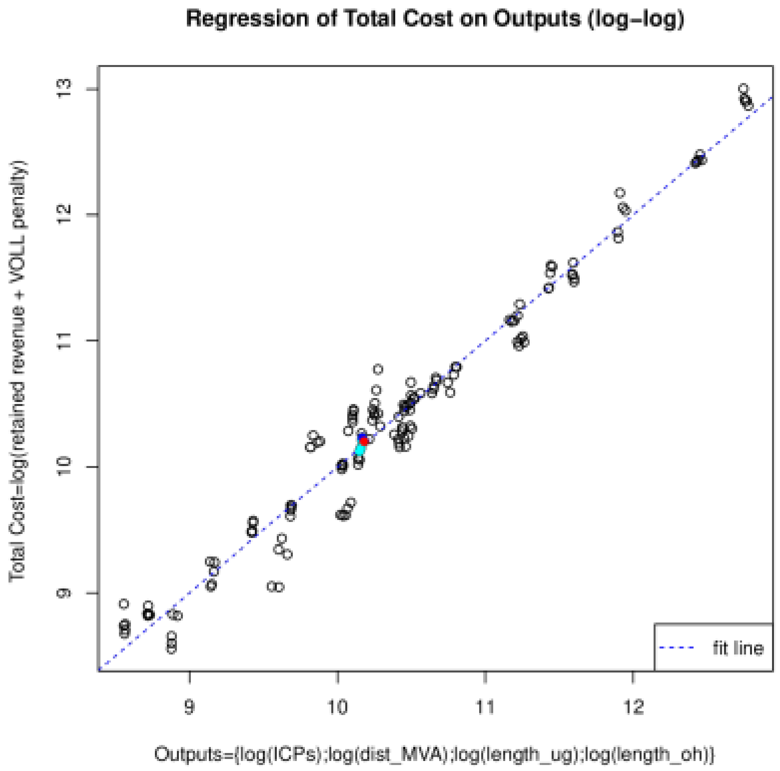


Figure 81: Comparison of total costs vs services provided

transformation capacity, number of ICPs managed etc.)[22]. Whilst being an approximate measure of productivity, this shows ML (coloured points) plotting close to the mean line indicating that ML's total revenue is broadly in keeping, on a comparative basis, with the extent and capacity of the Network services it provides.

11.7.3.2 Direct Opex

Direct opex is that proportion of operational expenditure spent directly on network assets (as opposed to expenditure operating the network and associated business support costs). The chart of Figure 82 shows a regression of direct opex in relation to the size of the assets being serviced – expressed in terms of a combination of the total circuit length and the transformation capacity.

This shows ML's direct opex is relatively high, although still within the confidence bounds of the regression model. Of note is the high direct opex cost in FY2014 and FY2017 compared to other years which arose from wind storms and the Seddon and Kaikoura earthquakes occurring within those financial years.

Closer examination of the direct opex make-up reveals ML's high vegetation management costs largely account for the opex variance in this comparison. High per km vegetation management costs are an issue for ML with some parts of the Marlborough Sounds network only accessible by boat, helicopter and/or on foot. However, the community

[22] Based on the Hyland McQueen Ltd EDB comparative performance assessments for FY2017. Here inputs to the businesses (capital materials and labour) are approximated using net revenue, an assumption which usually requires prices to be struck in a competitive market, so is a source of error in this comparison. Outputs are based on the found regression relationship between the log values of the main components of the Network services provided (consumers managed, line length serviced, transformer capacity employed etc.). Point values are for each EDB from FY2013 to FY2017 and where dollar values have been corrected to FY2017 using CPI adjustment. Whilst reliability is an output, it has been included as a penalty or benefit on the revenue side being the assessed community value of reliability, where just meeting expectation reliability would incur a zero addition.

value created by the improved reliability, approximately $0.9m as noted earlier, offsets these costs when considered more broadly.

11.7.3.3 Indirect opex

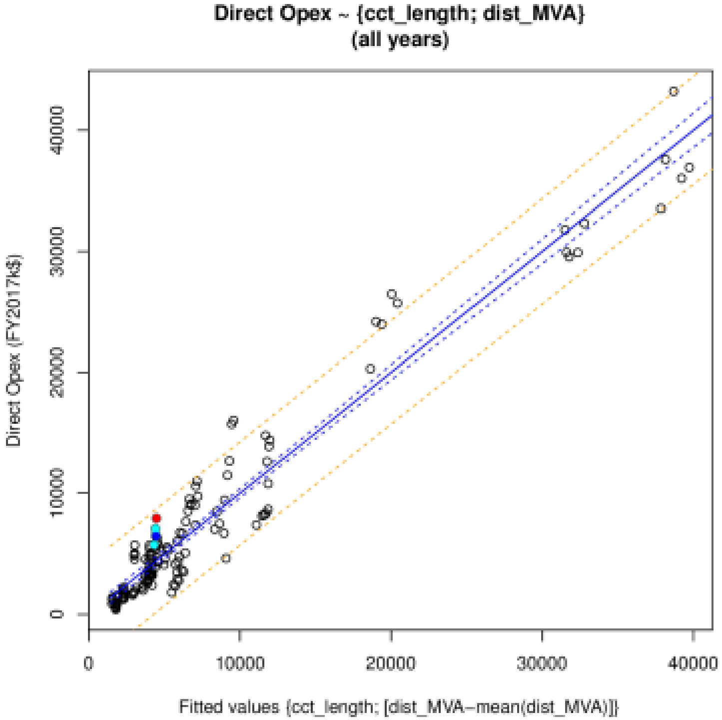


Figure 82: Direct Opex – actual vs expected

Indirect opex is that portion of operational expenditure accounted to the operation of the network (i.e. switching and system control etc.) and to the business support functions associated with running a network business. Comparison of ML's indirect opex in relation to other New Zealand distribution businesses shows ML plot close to the regression expectation when compared using normalisers of both number of consumers serviced and on regulatory asset base value. This indicates that expenditure in this category is at appropriate levels when assessed on a comparative basis.

11.7.4 Utilisation and losses

11.7.4.1 Network losses

ML has the objective of pursuing the most efficient use of energy and its delivery over its network. Figure 83 regresses the disclosed Network

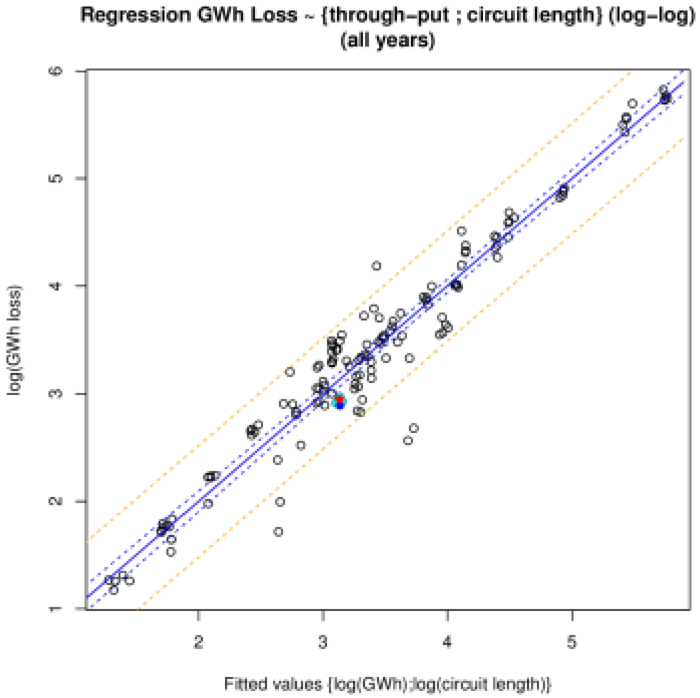


Figure 83: Regressed network losses

losses for all EDBs from FY2013 to FY2017 (with ML being the coloured dot points) against the energy through-put and circuit length (on a log-log scale given that losses go a square of current - and hence energy through-put - and the length of the lines that carry that current). This shows ML plots slightly below the Network losses expectation given its circuit length and energy through-put in this comparative assessment. This reveals no concern in terms of ML's Network conductor sizing and circuit loading arrangements as it affects line losses as in general terms, the losses derived for the ML Network are consistent with those expected for a Network of this kind i.e. a predominantly radial network supplied from a single point of supply and with inherently fewer consumers per transformer than in a purely urban area. ML's line losses are approximately 5% and this is relatively consistent from year to year. In this plan a target of 5% is retained across this planning period but may be reviewed in future plans.

11.7.4.2 Capacity of utilisation

Figure 84 regresses the disclosed distribution transformer utilisation (measured as the ratio of system maximum demand to the installed distribution transformer capacity) against a scale measure of energy density for each compared EDB. [23] In this measure, ML plot close to the regression expectation indicating that, within the limitations of this performance measure, ML's design practices for transformer sizing and loading appear reasonable.

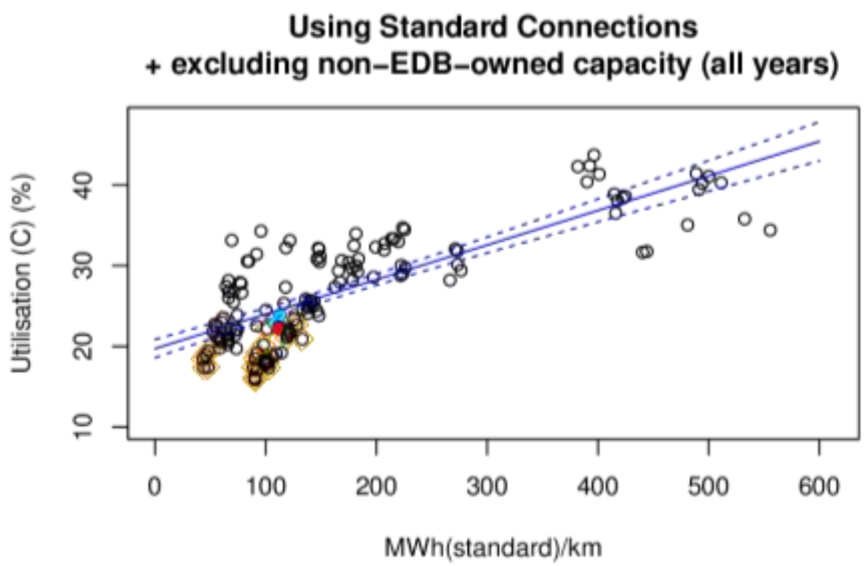


Figure 84: Regressed distribution transformer utilisation

ML's Capacity of Utilisation (CoU) has declined over recent years and is expected to decline further in the coming years. This is likely due to the continued take up of energy efficient appliances, distributed generation and continued growth of electricity connections that do not typically contribute to maximum network demand within the Marlborough region. For example, baches in the Marlborough Sounds and wineries and irrigation all require transformer capacity, but these loads make little or no contribution to maximum demand set during winter months, thereby reducing capacity utilisation. However, as discussed above, the

[23] Energy density is used as a normalising factor as in dense networks it is easier to leverage the diversity of individual demands in reducing the transformer capacity required. The points marked with orange squares are EDBs where the ratio of non-standard energy delivered is greater than 25% as this degree of non-standard load may lead to misinterpretation under this measure.

capacity of utilisation plots close to the expectation line in comparison to other distribution companies when scaled against network energy density, particularly after adjustment for non-standard loads. The current target of 21% for transformer utilisation is therefore retained in this plan.

Overall the reality is that the utilisation of transformer capacity cannot be regarded as a primary indicator of network performance given the location and number of transformers on a network are largely a function of ICP location, physics of supply and consumer utilisation of connected capacity.

11.7.5 Fault causes and response

Figure 85 shows the total consumer minutes lost to 11kV faults by fault cause over the period FY2015 to FY2017 (3 years) together with the average number of incidents per annum. This directs attention to the following:

- The major fault cause on the Network is now failure of line components from a variety of causes followed by the effects of extreme wind and weather.
- Pleasingly, most vegetation related faults occur from vegetation outside the legal growth limit cutting zones indicating that ML's vegetation management on the Network is working. However, the fact that tree faults occur from trees outside the legal cutting zones indicates deficiency in these regulations from the perspective of achieving reliable supply to consumers.

Whilst conductor failure is rare and the reliability impact small, it is never-the-less an issue requiring active management due to the potential for public hazard and liability risk from such failures.

11.7.6 Network performance: planned outages

For the FY2017 year, ML set a service target of planned outages being less than 65 SAIDI minutes with less than 260 planned interruptions over the network. The recent performance for planned outages (FY2009 to FY2017) is illustrated in the six charts of Figure 86.

The top left chart shows the performance and trend in planned SAIDI and shows ML outperformed its target in this area. It also shows a consistent downward trend on this measure, particularly in the rural and urban areas. The increase in planned outages in the remote areas (i.e. the Marlborough Sounds area) reflects the difficulty of supporting load while sections of the network are taken out for service and the increasing need to do so in these areas.

The top middle chart plots the distribution of planned outage times and compares year FY2009 to year FY2017 and shows improvement to almost zero planned outage minutes in urban areas achieved mainly through both improved switching ability. Other area show improvement largely through reduction in the average outage time.

The top right chart demonstrates the improvement from FY2009 to FY2017 where a greater proportion of the outages are of shorter duration achieved through better work planning. The bottom left chart shows the distribution of consumers affected per outage and indicates that most outages affect relatively small numbers of consumers. This arises from ML's policy of supporting planned outage load through network re-configuration and placing mobile generation for outages affecting large numbers of consumers where it is economically viable to do so.

The bottom middle chart shows the performance and trend in number of planned outages per year and compares the total number of outages to the service target of less than 260 outages. ML's performance oscillates about this target indicating it remains a stretch target for ML. The bottom right chart plots the number of planned outages per ICP (viz plan SAIFI) and shows a decreasing trend much like the plan SAIDI trends of the top left chart. This indicates the gains made in planned outage performance have arisen largely through reducing the average number of consumers affected per planned outage; again a result of the asset management policies employing mobile generation and network re-configuration supporting consumer load.

Given the comparative assessment of cost, further improvements in planned outage performance will only come from initiatives that show a strong cost benefit. In this context, seeking further reductions in planned outage SAIDI is more likely through innovation in planning and work processes that reduce the average outage duration.

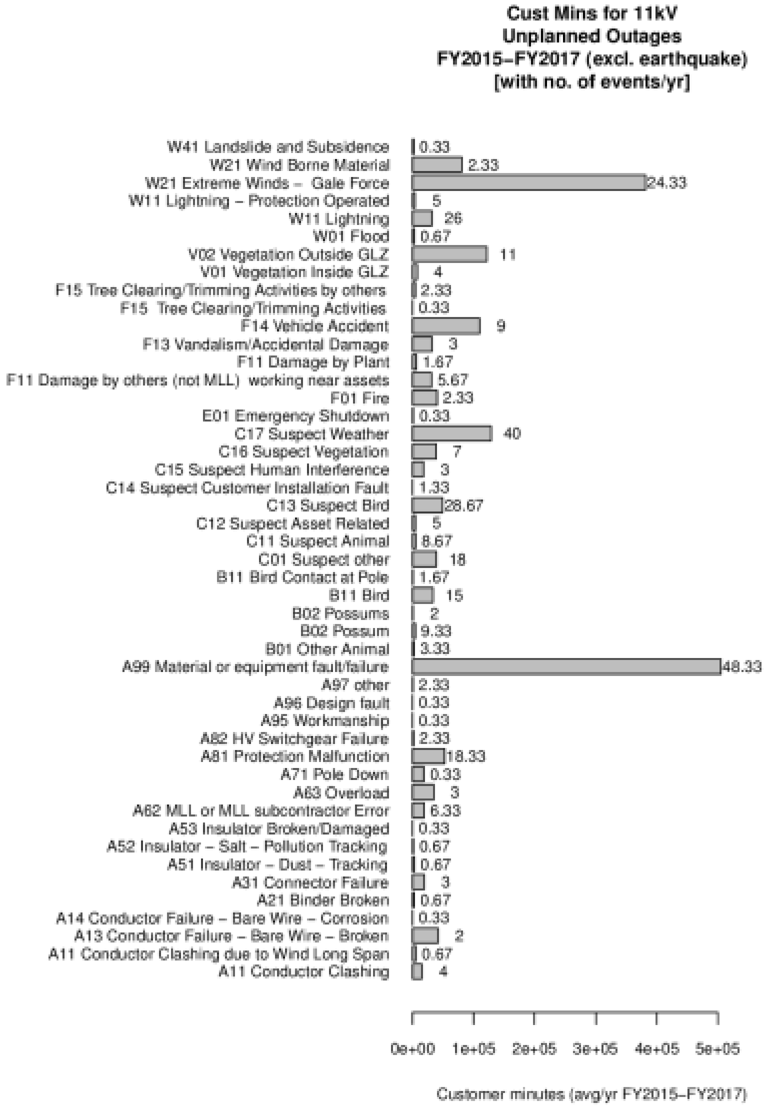


Figure 85: ML's 11kV cumulative outage minutes vs cause

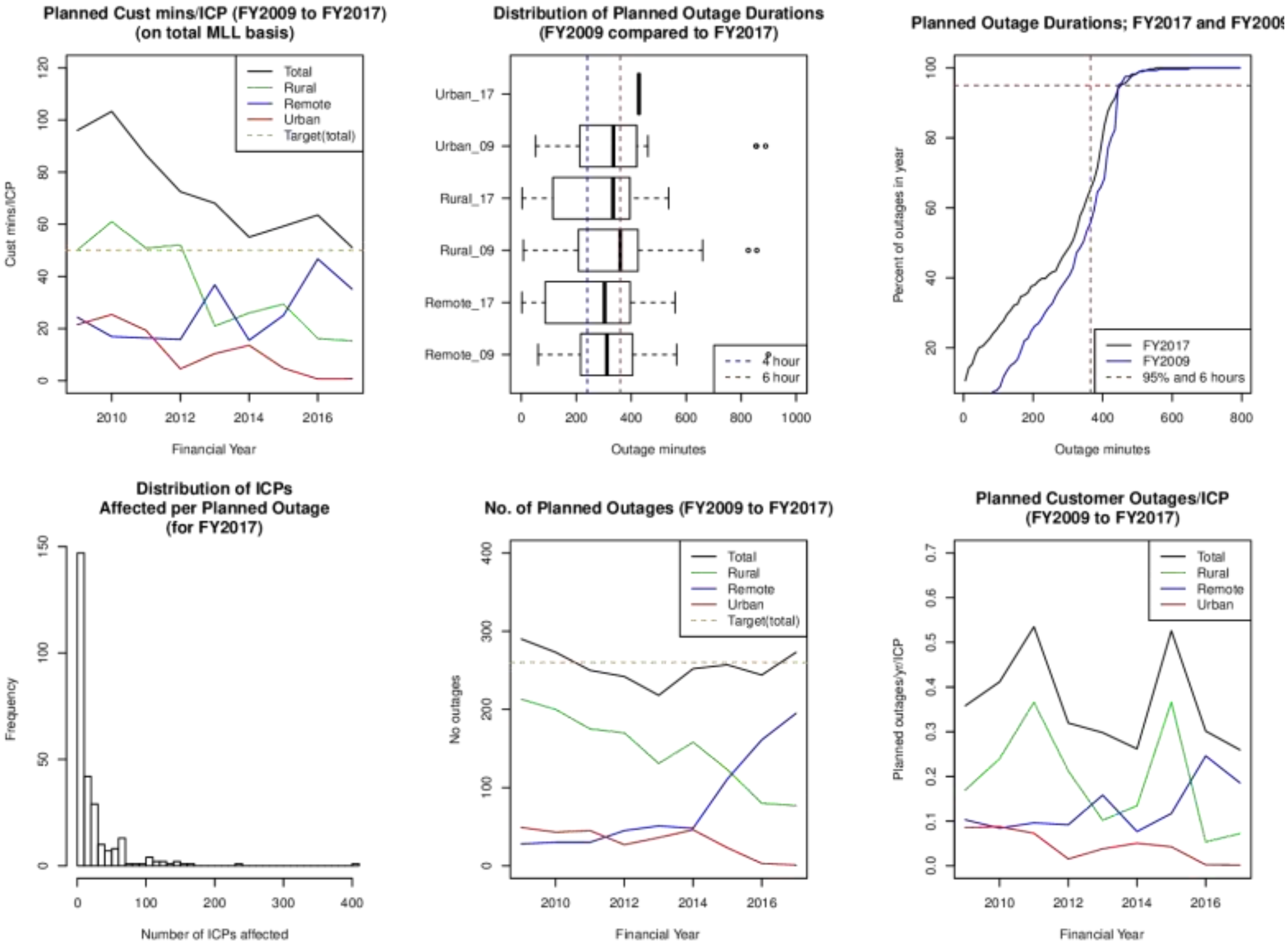


Figure 86: Planned outage analysis charts

11.7.7 Network performance – forced outages

For the FY2018 year, ML set service targets for unplanned (forced) outages of:

1. Unplanned SAIDI <=80 comprised of SAIFI <=0.67 and CAIDI <=120 minutes
2. Fault response times of less than or equal to:
   a. Blenheim Urban 1.0 hours
   b. Urban Other 1.5 hours
   c. Rural 4.0 hours
   d. Remote Rural 8.0 hours
2. Total number of fault interruptions < 340

The performance and trend in forced outages is set out in the 6 charts of Figure 87 that also identifies the relevant targets. Note that these charts exclude the earthquake events but include any storm events.

The top left chart illustrates the unplanned SAIDI over time and reveals a falling trend in total although the internal SAIDI target has not been met largely due to the lift in remote area. The top middle chart shows the distribution of outage duration times (the boxes represent the 50 percentile bounds) and compares year FY2017 performance to year FY2009 and shows improving performance, especially in urban areas and generally in the average outage duration. As shown, the outage times are most varied for the Remote (viz Sounds) consumers as might be expected due to the time and difficulty of getting work crews to the sites. It is also noted that the internal maximum response times remain stretch targets for ML as they are not met in all cases.

The top right chart shows the distribution of all outage times and compares year FY2009 to year FY2017 noting marginal improvement and that approximately 95% of all unplanned outages are restored within 6 hours. The bottom left chart shows the distribution in number of consumers affected per outage and shows the majority are small consumer numbers. This reveals the benefit being returned from the automatic sectionalisers and re-closers that have been installed.

The bottom middle hand chart shows the number of unplanned outages per annum and where ML's internal targets are met only in average – that is, the targets for numbers of forced outages remain as stretch targets for ML. Faults in the Remote/Sounds areas are increasing and the management of this is becoming a key focus for ML. However, analysis of the fault categorisations shows that many faults are caused by weather and/or wind-blown materials, which is a result of the "natural" environment that the overhead network exists within. These types of faults are difficult to deal with without resorting to expensive network re-design, which is not economically viable in these low density areas.

The bottom right hand chart illustrates the trend in the average number of outages per consumer, which shows a downward trend much like the unplanned SAIDI trend of the top left chart. Taken together with the essentially flat trend seen in the total number of outages, this reveals that the effect of the reliability measures implemented has been to reduce the numbers of consumers affected by the outages that are occurring rather than the number of outages that are occurring. This is largely due to the operation of the automatic re-closing switches that have been strategically placed within the network.

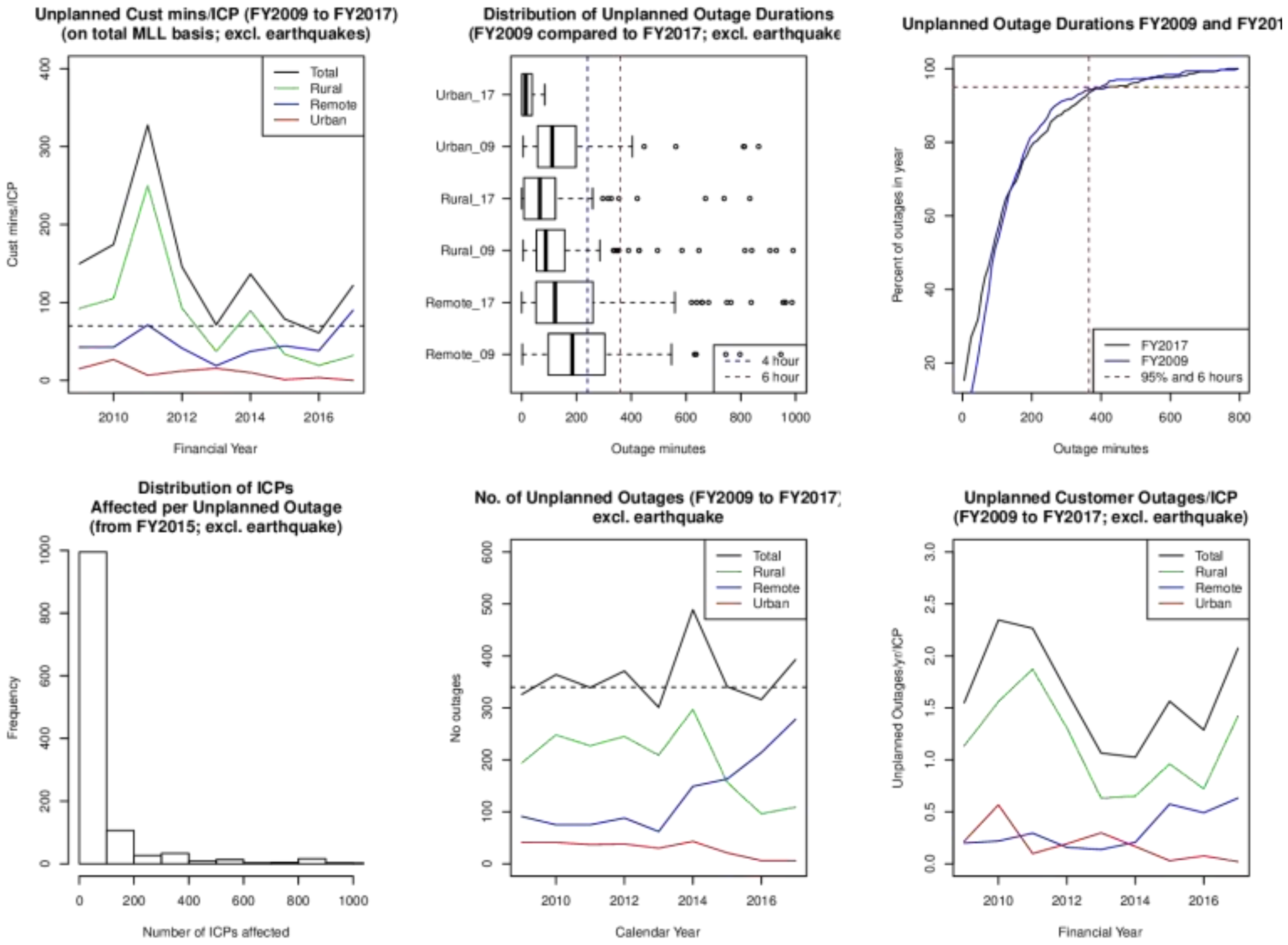


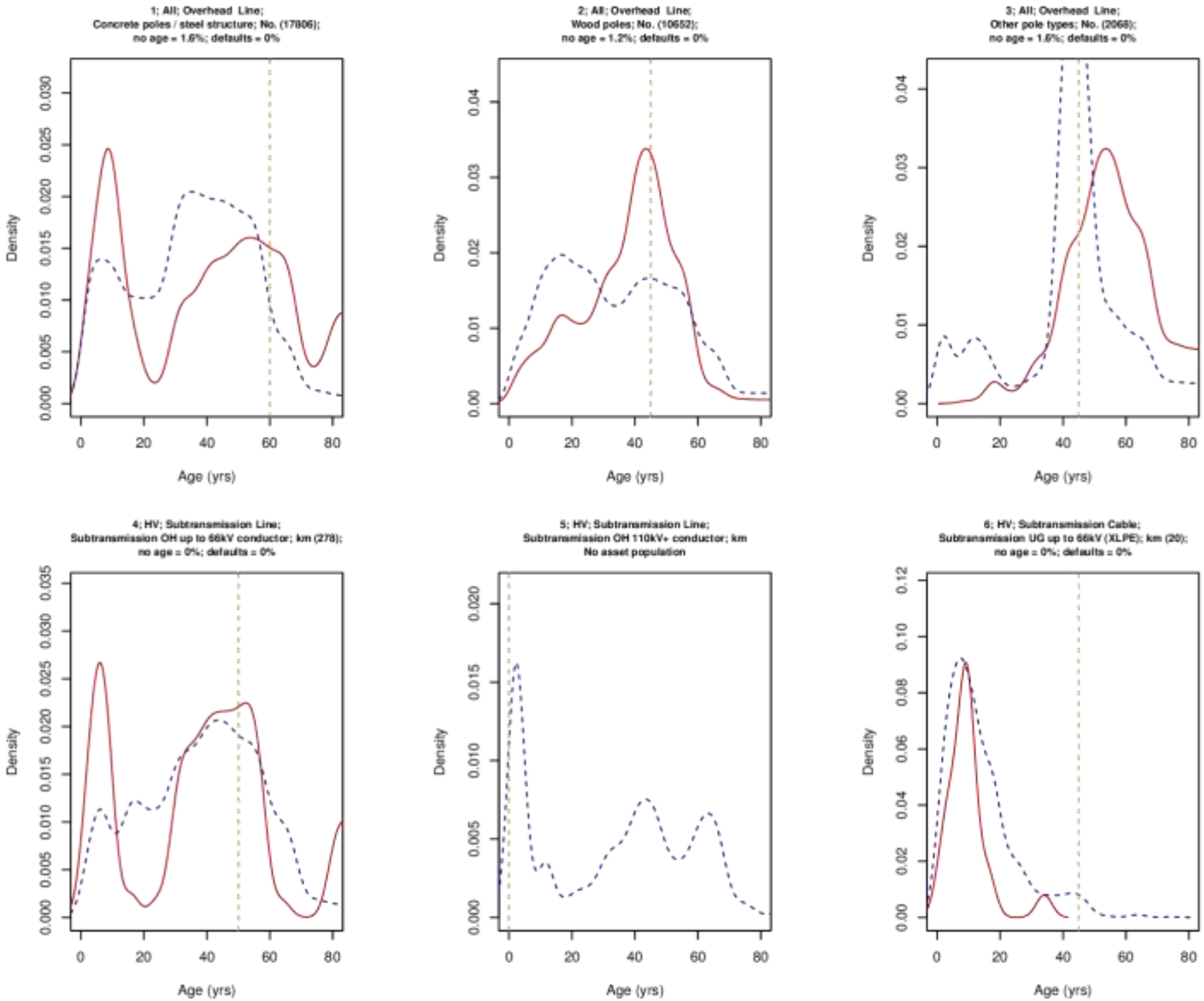
Figure 87: Unplanned outage analysis charts

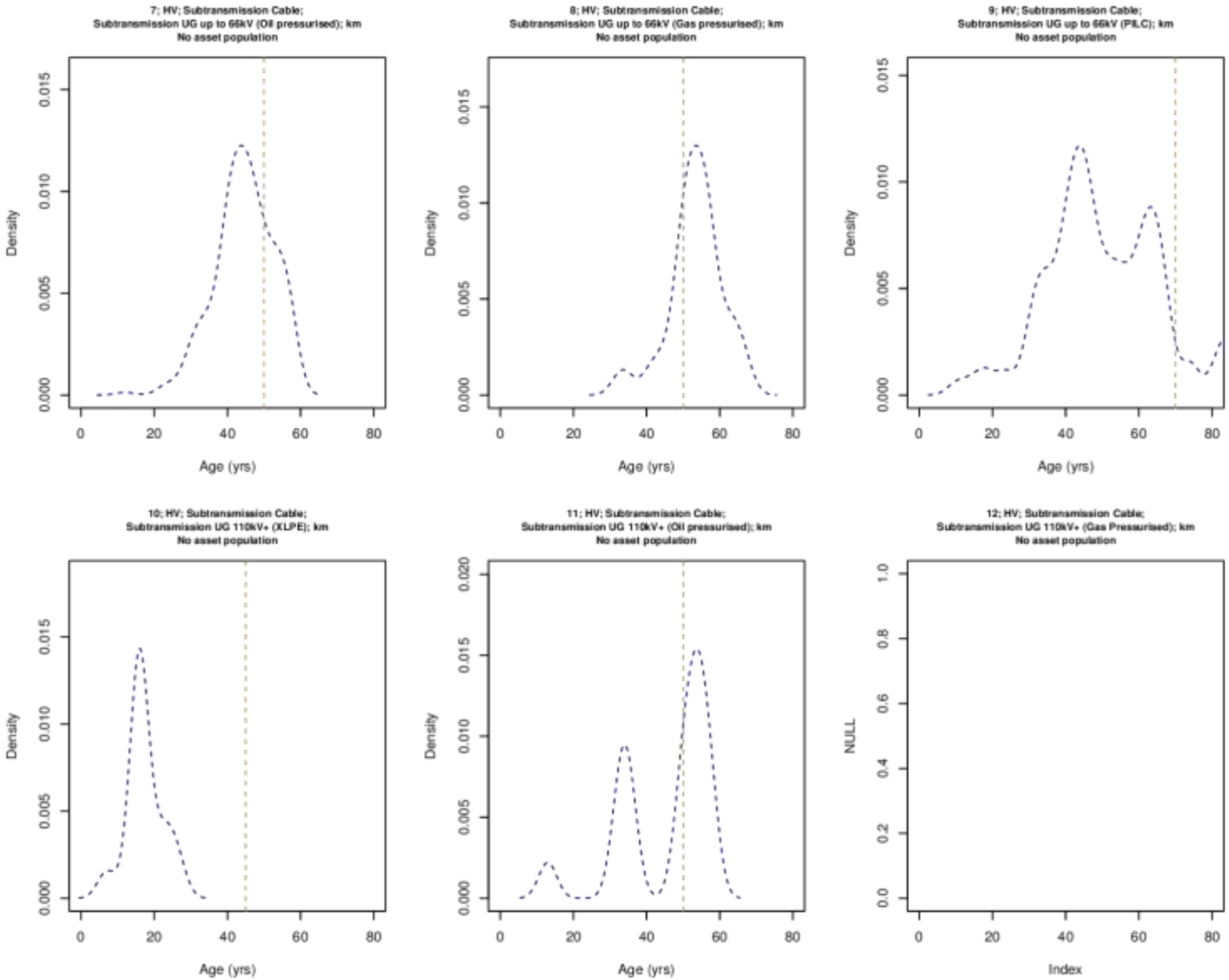
11.8 Comparative age profiles

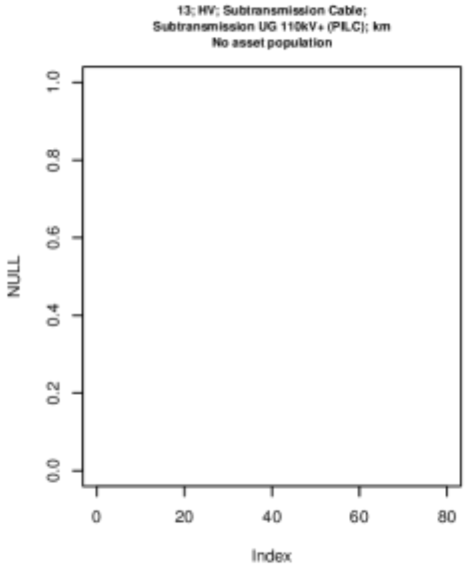
This appendix sets out charts that compare the ML asset age profiles against age profiles for comparable assets when averaged over all New Zealand distribution businesses. The asset classes used are the 51 asset types listed in the Commerce Commission Disclosure reports for FY2017. Where charts are blank, ML reports no assets of this type on its network.

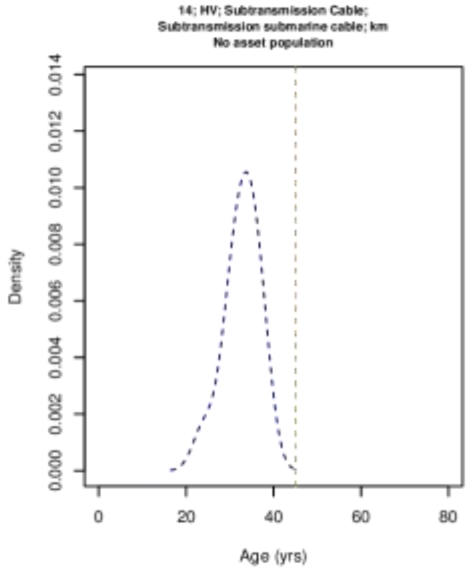
The charts are arranged 6 per page and the chart titles record the asset class, the total quantity (on the ML network) and percentages of the total noted as having no age or having been assigned a default age. ML advise caution in making age distribution comparisons where the percentage of the totals with no age or default ages are large as the algorithms used in creating the age profiles make assumptions in how these assets ages are spread (being generally spread over the top quartile of the available age bins).

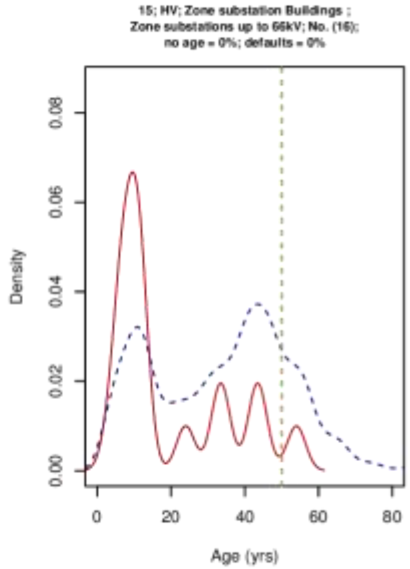
The lines on the chart are red for the ML age profile and blue dash line for the all NZ average age profile. The yellow dash vertical line marks the regulatory expected lift for that asset class as used in ODV calculations.

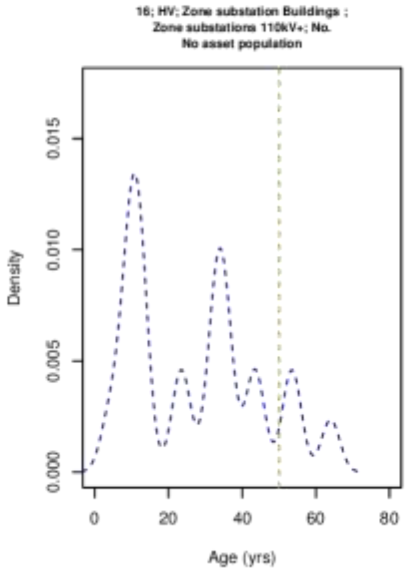

1; All; Overhead Line;
Concrete poles / steel structure; No. (17806);
no age = 1.6%; defaults = 0%
2; All; Overhead Line;
Wood poles; No. (10652);
no age = 1.2%; defaults = 0%
3; All; Overhead Line;
Other pole types; No. (2068);
no age = 1.6%; defaults = 0%
4; HV; Subtransmission Line;
Subtransmission OH up to 66kV conductor; km (278);
no age = 0%; defaults = 0%
5; HV; Subtransmission Line;
Subtransmission OH 110kV+ conductor; km
No asset population
6; HV; Subtransmission Cable;
Subtransmission UG up to 66kV (XLPE); km (20);
no age = 0%; defaults = 0%
Density
Age (yrs)

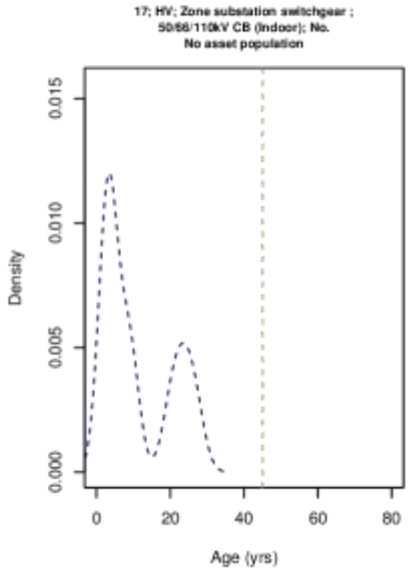

7; HV; Subtransmission Cable;
Subtransmission UG up to 66kV (Oil pressurised); km
No asset population
Density
Age (yrs)
8; HV; Subtransmission Cable;
Subtransmission UG up to 66kV (Gas pressurised); km
No asset population
Density
Age (yrs)
9; HV; Subtransmission Cable;
Subtransmission UG up to 66kV (PILC); km
No asset population
Density
Age (yrs)
10; HV; Subtransmission Cable;
Subtransmission UG 110kV+ (XLPE); km
No asset population
Density
Age (yrs)
11; HV; Subtransmission Cable;
Subtransmission UG 110kV+ (Oil pressurised); km
No asset population
Density
Age (yrs)
12; HV; Subtransmission Cable;
Subtransmission UG 110kV+ (Gas Pressurised); km
No asset population
NULL
Index

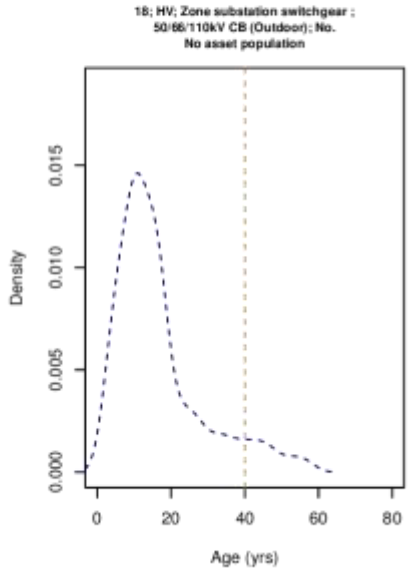

13; HV; Subtransmission Cable;
Subtransmission UG 110kV+ (PILC); km
No asset population
NULL
Index
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80

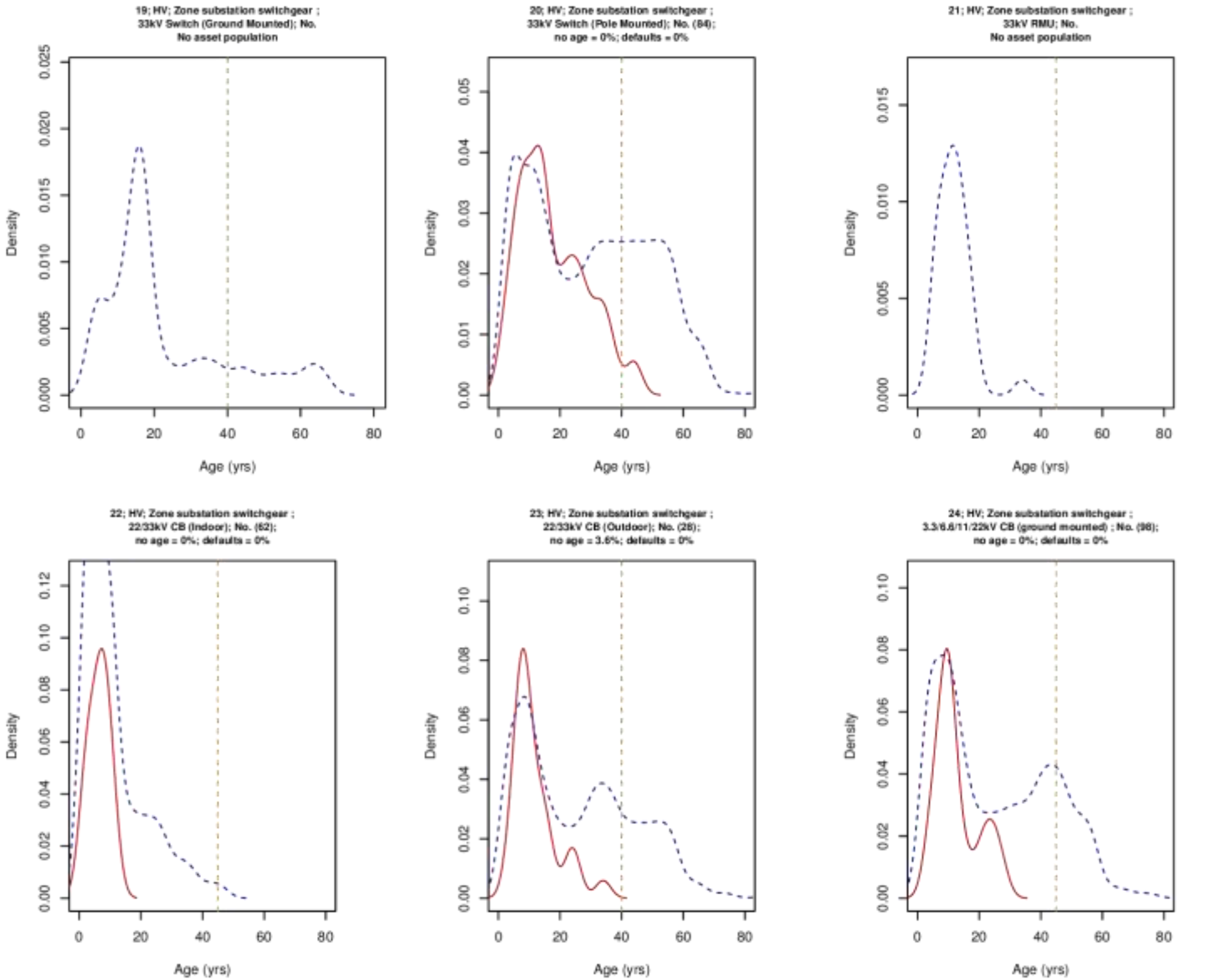

14; HV; Subtransmission Cable;
Subtransmission submarine cable; km
No asset population
Density
Age (yrs)
0.000
0.002
0.004
0.006
0.008
0.010
0.012
0.014
0
20
40
60
80


15; HV; Zone substation Buildings ;
Zone substations up to 66kV; No. (16);
no age = 0%; defaults = 0%
Density
Age (yrs)
0.00
0.02
0.04
0.06
0.08
0
20
40
60
80

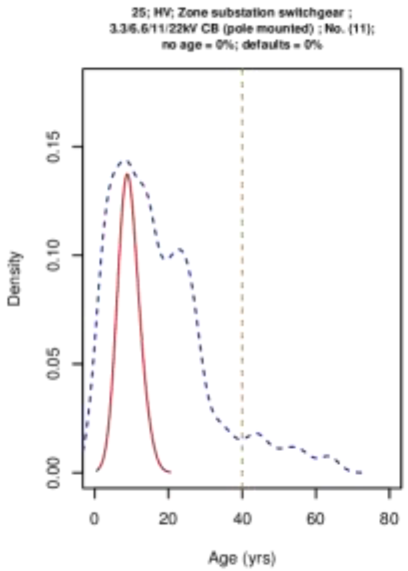

16; HV; Zone substation Buildings ;
Zone substations 110kV+; No.
No asset population
Density
Age (yrs)
0.000
0.005
0.010
0.015
0
20
40
60
80

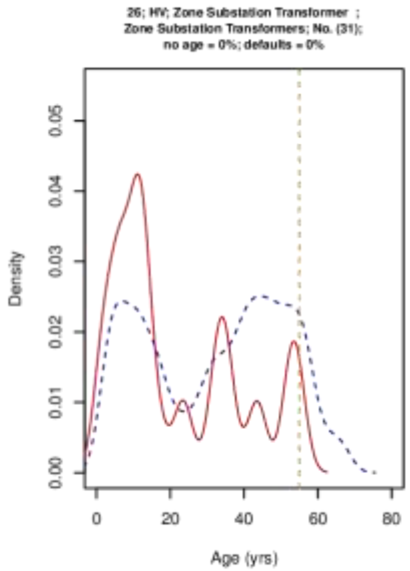

17; HV; Zone substation switchgear ;
50/66/110kV CB (Indoor); No.
No asset population
Density
Age (yrs)
0.000
0.005
0.010
0.015
0
20
40
60
80

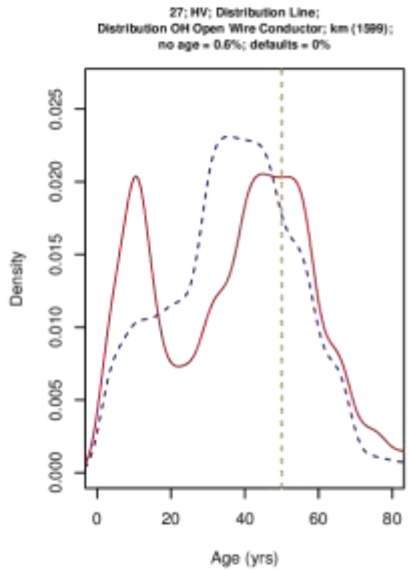

18; HV; Zone substation switchgear ;
50/66/110kV CB (Outdoor); No.
No asset population
Density
Age (yrs)
0.000
0.005
0.010
0.015
0
20
40
60
80

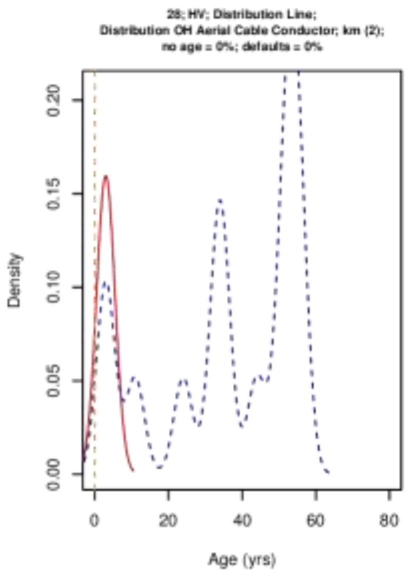


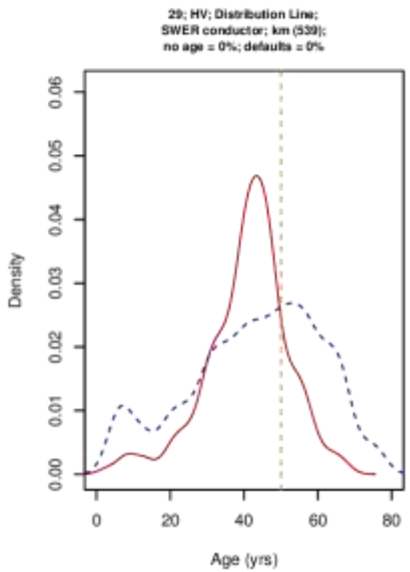
19; HV; Zone substation switchgear ;
33kV Switch (Ground Mounted); No.
No asset population
20; HV; Zone substation switchgear ;
33kV Switch (Pole Mounted); No. (84);
no age = 0%; defaults = 0%
21; HV; Zone substation switchgear ;
33kV RMU; No.
No asset population
22; HV; Zone substation switchgear ;
22/33kV CB (Indoor); No. (62);
no age = 0%; defaults = 0%
23; HV; Zone substation switchgear ;
22/33kV CB (Outdoor); No. (28);
no age = 3.6%; defaults = 0%
24; HV; Zone substation switchgear ;
3.3/6.6/11/22kV CB (ground mounted) ; No. (98);
no age = 0%; defaults = 0%
Density
Age (yrs)

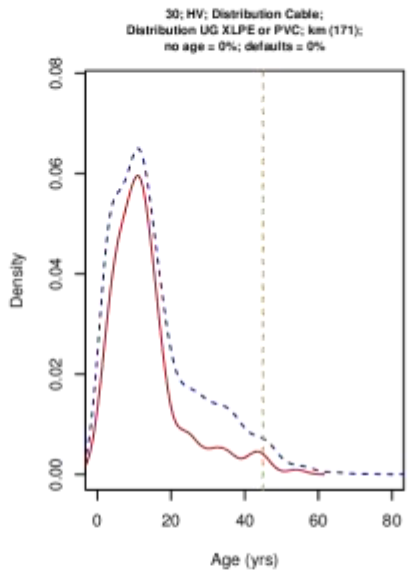

25; HV; Zone substation switchgear ;
3.3/6.6/11/22kV CB (pole mounted) ; No. (11);
no age = 0%; defaults = 0%
Density
Age (yrs)

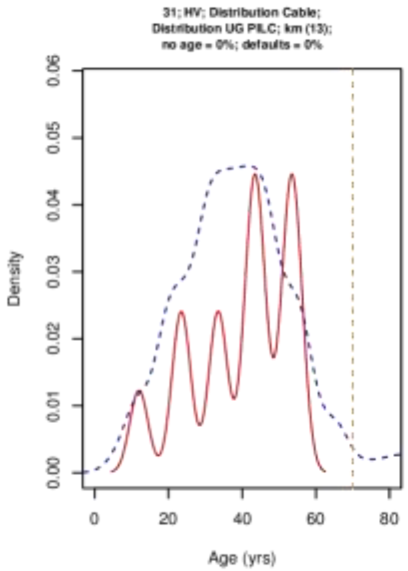

26; HV; Zone Substation Transformer ;
Zone Substation Transformers; No. (31);
no age = 0%; defaults = 0%
Density
Age (yrs)

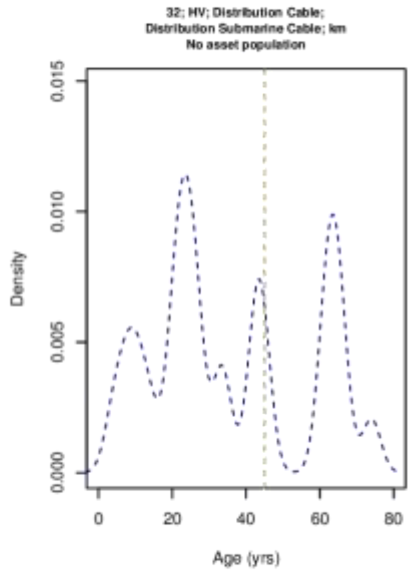

27; HV; Distribution Line;
Distribution OH Open Wire Conductor; km (1599);
no age = 0.6%; defaults = 0%
Density
Age (yrs)

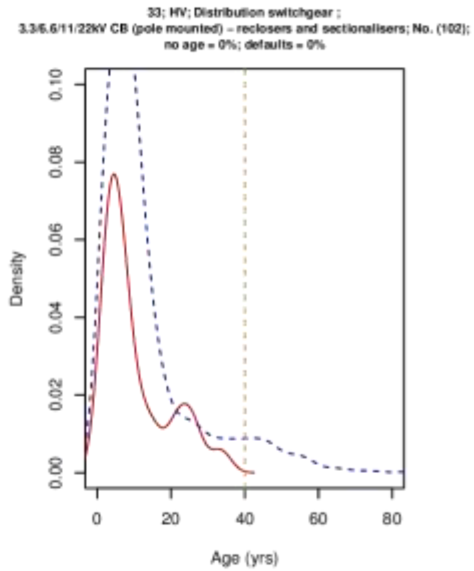

28; HV; Distribution Line;
Distribution OH Aerial Cable Conductor; km (2);
no age = 0%; defaults = 0%
Density
Age (yrs)

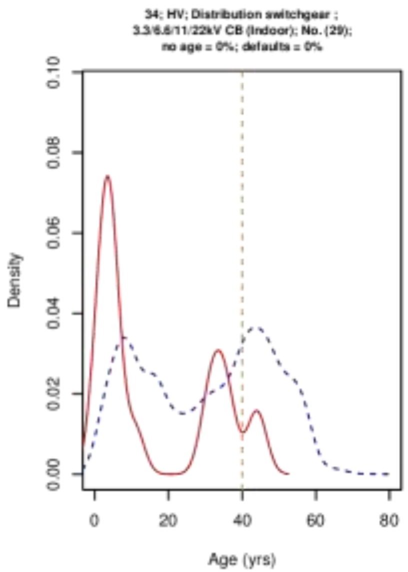

29; HV; Distribution Line;
SWER conductor; km (539);
no age = 0%; defaults = 0%
Density
Age (yrs)

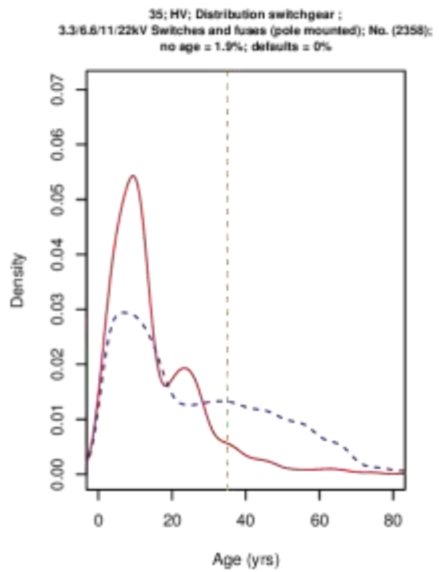

30; HV; Distribution Cable;
Distribution UG XLPE or PVC; km (171);
no age = 0%; defaults = 0%
Density
Age (yrs)

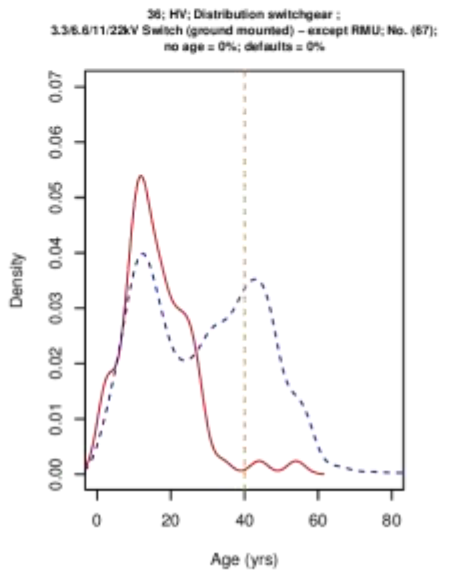

31; HV; Distribution Cable;
Distribution UG PILC; km (13);
no age = 0%; defaults = 0%
Density
Age (yrs)

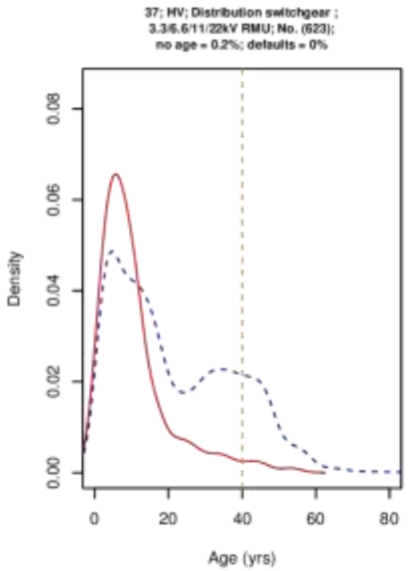

32; HV; Distribution Cable;
Distribution Submarine Cable; km
No asset population
Density
Age (yrs)

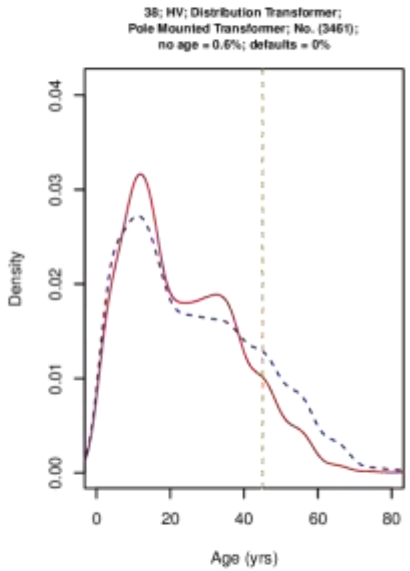

33; HV; Distribution switchgear ;
3.3/6.6/11/22kV CB (pole mounted) – reclosers and sectionalisers; No. (102);
no age = 0%; defaults = 0%
Density
Age (yrs)

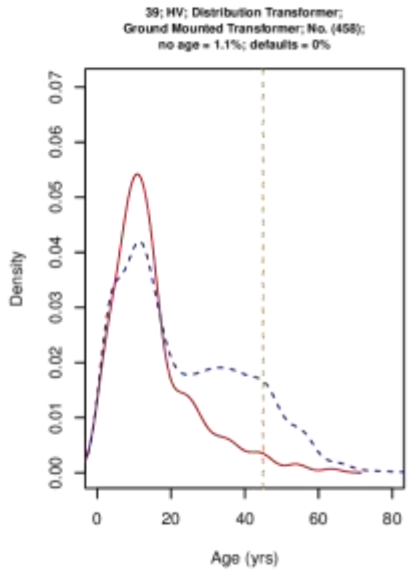

34; HV; Distribution switchgear ;
3.3/6.6/11/22kV CB (Indoor); No. (29);
no age = 0%; defaults = 0%
Density
Age (yrs)

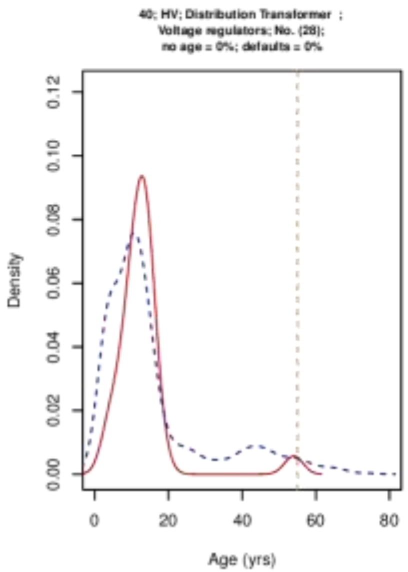

35; HV; Distribution switchgear ;
3.3/6.6/11/22kV Switches and fuses (pole mounted); No. (2358);
no age = 1.9%; defaults = 0%
Density
Age (yrs)

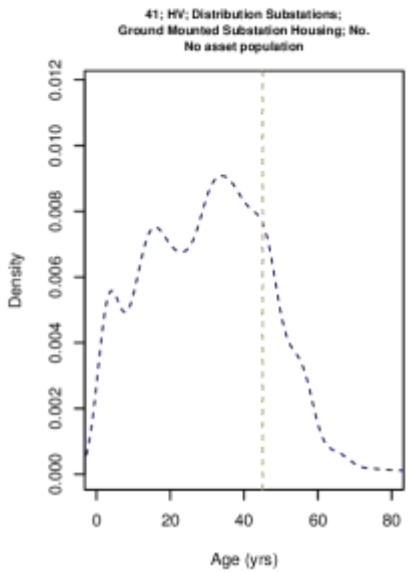

36; HV; Distribution switchgear ;
3.3/6.6/11/22kV Switch (ground mounted) – except RMU; No. (67);
no age = 0%; defaults = 0%
Density
Age (yrs)

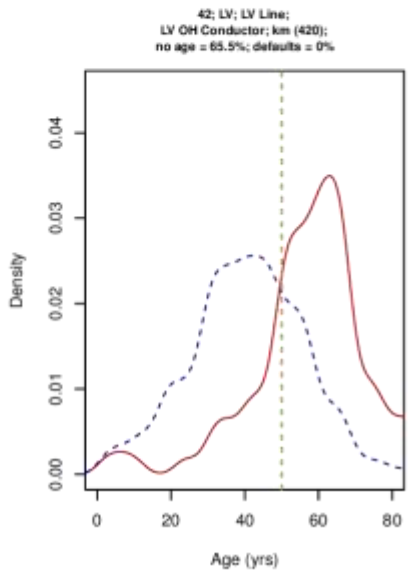

37; HV; Distribution switchgear ;
3.3/6.6/11/22kV RMU; No. (623);
no age = 0.2%; defaults = 0%
Density
Age (yrs)

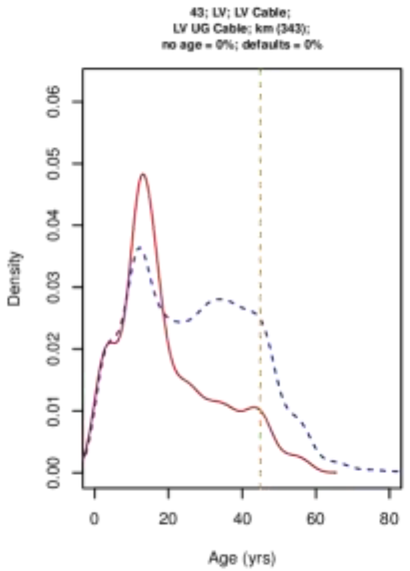

38; HV; Distribution Transformer;
Pole Mounted Transformer; No. (3461);
no age = 0.6%; defaults = 0%
Density
Age (yrs)

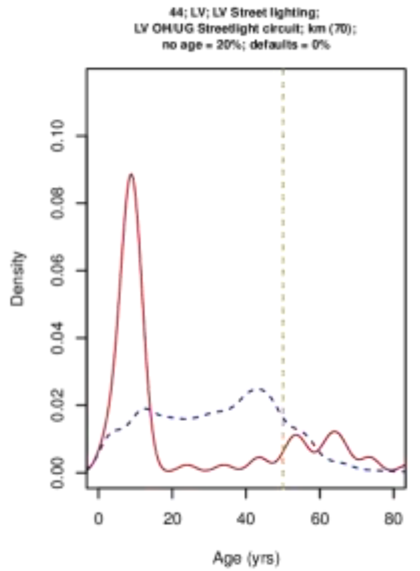

39; HV; Distribution Transformer;
Ground Mounted Transformer; No. (458);
no age = 1.1%; defaults = 0%
Density
Age (yrs)

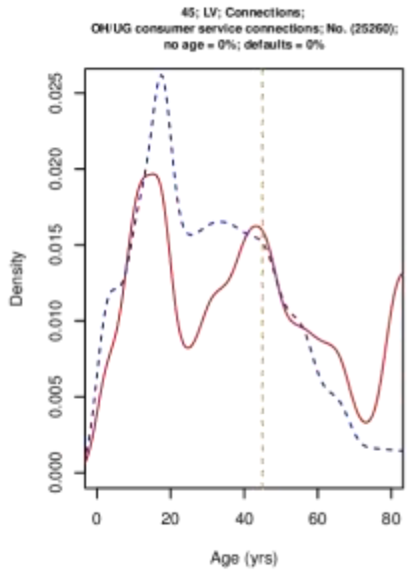

40; HV; Distribution Transformer ;
Voltage regulators; No. (28);
no age = 0%; defaults = 0%
Density
Age (yrs)

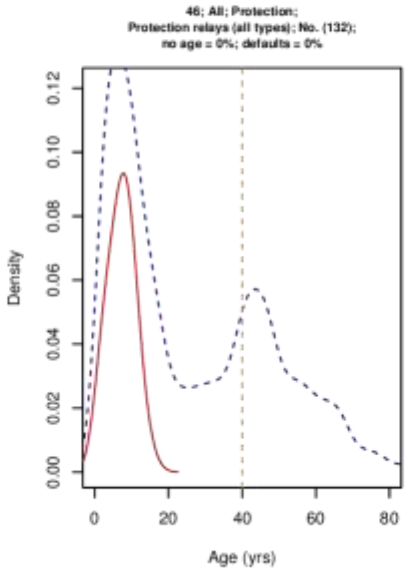

41; HV; Distribution Substations;
Ground Mounted Substation Housing; No.
No asset population
Density
Age (yrs)

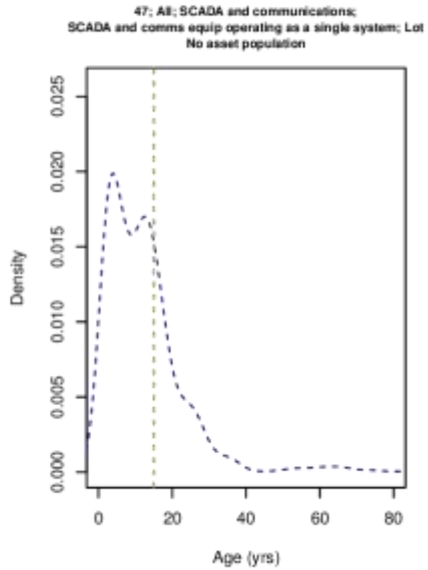

42; LV; LV Line;
LV OH Conductor; km (420);
no age = 65.5%; defaults = 0%
Density
Age (yrs)

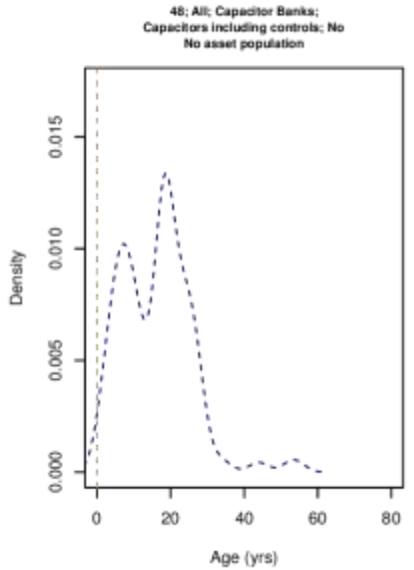

43; LV; LV Cable;
LV UG Cable; km (343);
no age = 0%; defaults = 0%
Density
Age (yrs)

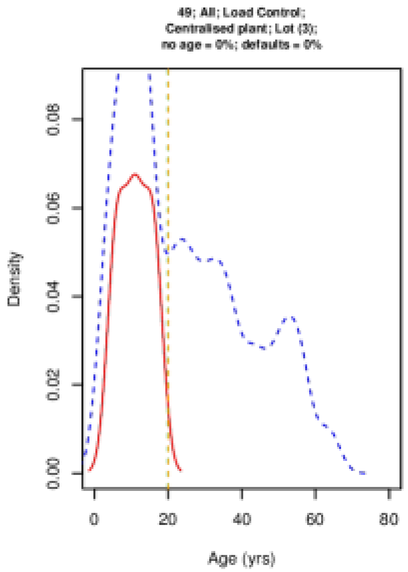

44; LV; LV Street lighting;
LV OH/UG Streetlight circuit; km (70);
no age = 20%; defaults = 0%
Density
Age (yrs)

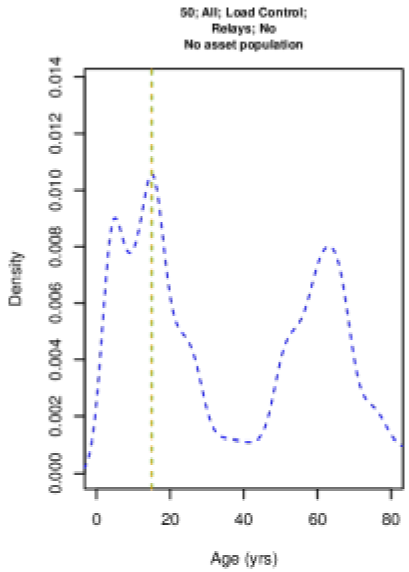

45; LV; Connections;
OH/UG consumer service connections; No. (25260);
no age = 0%; defaults = 0%
Density
Age (yrs)

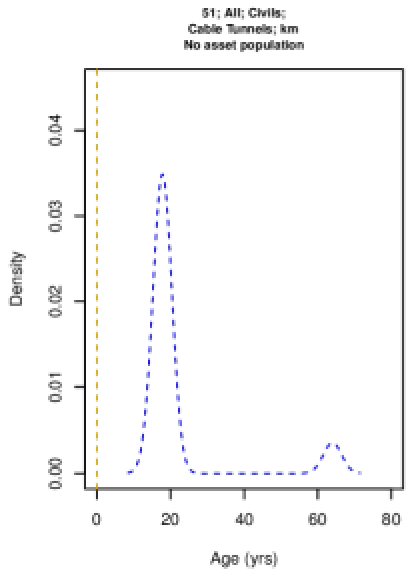

46; All; Protection;
Protection relays (all types); No. (132);
no age = 0%; defaults = 0%
Density
Age (yrs)


47; All; SCADA and communications;
SCADA and comms equip operating as a single system; Lot
No asset population
Density
Age (yrs)


48; All; Capacitor Banks;
Capacitors including controls; No
No asset population
Density
Age (yrs)


49; All; Load Control;
Centralised plant; Lot (3);
no age = 0%; defaults = 0%
Density
Age (yrs)


50; All; Load Control;
Relays; No
No asset population
Density
Age (yrs)


51; All; Civils;
Cable Tunnels; km
No asset population
Density
Age (yrs)

11.9 Data locations

The following table provides a summary of the key information held at ML and where it is held.

Table 53: Information repositories

Repository	Information	Key users	Notes
Infor's EAM	• Network and non-Network equipment records (i.e. assets) • Location • Technical specifications • History • Test records • Network outages • Financial data • Asset Condition • Structural dependencies • Project and works records, including corrective and preventative maintenance regimes • Easement records	Most staff	Main asset data repository, also used for maintenance and capital works programs. Displays on the GIS and electrical equipment records also mostly replicated in Milsoft for connectivity and engineering analysis purposes.
GIS (ESRI)	• Line asset type • Line connectivity • Survey 123 (asset inspection data)	Most staff, especially GIS and Engineering	A map-based view of electrical asset data, as well as views of maps, and data relating to the environment such as roads, archaeological sites, DoC sites etc
Network folders	• Design records and project files Calculations, analysis of options, protection reviews. Includes drawings and drawing register.	Engineering, Project Management and Operations staff	
SCADA	• Network status e.g. loads, switch positions, tapchanger positions • Faults and outages	Engineering, operations and development staff	Current status as well as historical logs and graphs of loading etc.

The following table provides a summary of the key information held at ML and where it is held.

Table 53: Information repositories

Repository	Information	Key users	Notes
	• Inspection data		
Milsoft	• Outage management system • Engineering Analysis	Operations, engineering and administration staff	Network status/electrical connectivity. Hold outage performance data.
Fault record sheets	• Description and duration • Likely cause	Operations manager, network management and staff	Reviewed regularly to look for systemic issues and ways to improve service.
Technology One's Financials	• Financial data • Inventory • Payroll	Administration, Stores, Finance and Project Management staff	Keeps financial records.
Velocity (Gentrack)	• Connection data • Billing data • ICP management • Load control relays not owned by ML	Operations and administration staff Commercial Manager and billing team	ICP based data, Milsoft also displays some of this data.
Mango	Policies and procedures (Integrated Management System documentation)	All staff	Procedures, policies and guidelines related to design, operation, health and safety, public safety and environmental practice.
Network Standards	Design and policy information for design and construction of network assets	Contractors, ML design staff, operators	
Emergency Response Plan	Information for use in civil emergencies, e.g. earthquake, major storms	Engineering, contracting and administration staff during severe events	

11.10 Risk matrix

The risk matrix used for risk categorisation and ranking is set out following together with the consequence assessment table and likelihood assessment table used to map risks onto the risk matrix.

Consequence Severity

Likelihood	Insignfiant	Minor	Moderate	Major	Catastrophic
Almost Certain	Priority 2	Priority 2	Priority 1	Priority 1	Priority 1
Likely	Priority 3	Priority 2	Priority 2	Priority 1	Priority 1
Possible	Priority 4	Priority 3	Priority 2	Priority 1	Priority 1
Unlikely	Priority 4	Priority 4	Priority 3	Priority 2	Priority 1
Rare	Priority 4	Priority 4	Priority 3	Priority 2	Priority 2

Priority 1	Immediate action required to actively manage risk and limit exposure.
Priority 2	Attention required to ensure risk exposure is managed effectively, disruptions minimised and outcomes monitored.
Priority 3	Cost/benefit analysis to assess extent to which risk should be mitigated. Monitor to ensure risk does not increase over time.
Priority 4	Effectively manage through routine procedures and appropriate internal controls.

	Consequence				
Risk Theme	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Health	*No illness or disease*	*Illness only*	*Illness with a possibility of leading to a disease*	*A disease, manageable*	*A disease, leading to fatality (terminal)*
Safety (incl. Public)	*No injury*	*First aid required*	*External medical treatment required*	*Extensive injuries, possibility of a fatality*	*Multiple fatalities*
Quality	*No quality incident*	*Less than $10,000*	*Less than $100,000*	*Less than $1m*	*Above $1m Extensive reputational damage*
Environmental	*Minor transient environmental harm*	*Transient environmental harm*	*Significant release of pollutants with midterm recovery*	*Significant long term envrionmental harm*	*Catatstrophic, long term environmental harm*
Financial	*Loss of assets or unbedgeted revenue loss or increased costs to NZ$2m*	*Loss of assets or unbudgeted revenue or loss or increased costs NZ$2m to NZ $5m.*	*Loss of assets or unbudgeted revenue loss or increased costs NZ$5m to NZ$50m.*	*Loss of assets or unbudgeted revenue loss or increased costs NZ$50m to NZ$100m.*	*Loss of assets or unbudgeted revenue loss or increased costs exceeding NZ$100m.*
Reputational	*Limited media attention - no impact on public memory*	*Local media attention - short-term impact on public memory.*	*Local media attention (not front page) and / or regular inquiry.*	*Local / national media news and / or regular investigation - medium term impact on public memory.*	*International media news headlines and / or government investigation / enquiry - long term impact on public memory.*
Business interruption	*Minor service disruption for up to 2 hours for major industrial/commercial customers; up to 3 hours for residential; up to 12 hours for rural.*	*Business interruption/service delivery failure between 2 and 6 hours fo rmajor industrial/ commercial customers; between 3 hours and 24 hours for residential; between 12 hours and 2 days for rural.*	*Total service cessation between 6 hours and 1 day for major industrial / commercial clients; between 1 to 2 days for residential; between 2 to 7 days for rural.*	*Total service cessation between 1 to 2 days for major industrial / commercial clients; between 2 and 7 days for residential; between 1 and 2 weeks for rural.*	*Disruption to supply (point of supply outage) exceeding 2 days for major industrial / commercial customers; exceeding a week for residential; exceeding 2 weeks for rural.*
Regulatory	*Verbal written concern.*	*Prosecution / improvement notice.*	*Prosecution of business / prohibition notice.*	*Prosecution and fines for Director and employee.*	*Imprisonment of Director or employee.*

Likelihood	Description	Likelihood Criteria
Almost Certain	Is expected to Occur in most circumstances	Likely to occur more than once per year
Likely	The event will probably occur in most circumstances	Likely to occur once per year
Possible	The event might occur at some time (would not be surprised either way: whether it happens or not)	Likely to occur once in 5 years
Unlikely	The event could occur at some time (would be surprised if it happens)	Likely to occur once in 10 years
Rare	The event may occur only in exceptional circumstances	Will occur less than once in 30 years

11.11 Director certificate

CERTIFICATION FOR YEAR-BEGINNING DISCLOSURES

Pursuant to Schedule 17
Clause 2.9.1

We, David William Richard Dew and Kenneth John Forrest, being directors of Marlborough Lines Limited, certify that, having made all reasonable enquiry, to the best of our knowledge:

a) The following attached information of Marlborough Lines Limited prepared for the purposes of clauses 2.4.1, 2.6.1, 2.6.3, 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 measured on a basis consistent with regulatory requirements or recognised industry standards.

c) The forecasts in Schedules 11a, 11b, 12a, 12b, 12c and 12d are based on objective and reasonable assumptions which both align with Marlborough Lines Limited's corporate vision and strategy and are documented in retained records.

Signed by:

DWR Dew — Date: 29/3/2018

KJ Forrest — Date: 29/3/18