AusNet Electricity Services Pty Ltd

Electricity Distribution Price Review 2016–20

Appendix 7A: Network Capital Expenditure Overview 2016-2020

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Electricity Distribution Network – EDPR Network Capital Expenditure Overview 2016 to 2020

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Table of Contents

1 Introduction

The objectives of the AusNet Services network related capital expenditure program for 2016-20 are generally aligned with the key asset management objectives: to meet demand growth; maintain reliability[1]; and improve safety. Changing internal and external factors such as lower forecast demand growth, the new Value of Customer Reliability, improved data and analysis of network asset age and condition, and increased focus on network safety, have influenced the development of capex forecasts and changed the expected profile of capex for 2016-20 compared with that of 2011-15.

The total forecast capex is similar to the 2011-15 expenditure, however the drivers and areas of expenditure have changed. The largest expenditure categories are Asset Replacement (44%), Safety (29%) and Customer Connections (22%) whilst Network Augmentation represents only 4% of the total network capex forecast. The following key points describe some of the changes and their impact on the AusNet Services capex forecast for the 2016-20 period.

1.1 Growth

Growth capex involves augmentation of the network to meet increasing demand and connection of new customers. Traditionally network augmentation has been a driver of significant capex. In the 2011-15 period augmentation expenditure represented approximately 12 % of the total network capex. AusNet Services has forecast a significant reduction in augmentation capex in response to lower forecast demand growth and the successful implementation of demand management techniques such as contracted demand management and critical peak tariffs utilising non network solutions to resolve network constraints.

The proposed augmentation capex for 2016-20 is approximately 4% of the total network capex program, and is focussed on the high growth, residential estate corridors in the Central region of AusNet Services' network. No new zone substations and no additional zone substation transformers are forecast in the 2016-20 period. New customers are forecast to connect to the network at rates similar to long term averages. Capex representing approximately 22% of network capex will continue to be required to extend the network to new customers.

1.2 Asset Replacement

The proportion of capex for replacement of assets is forecast to increase from approximately 28% (2011-15) to 44% (2016-20) of total network capex. The high level drivers of this increase include: deterioration in asset condition associated with increasing asset age; reduced opportunity to replace poor condition assets as part of augmentation related projects; improved condition data; risk analysis and application of more advanced asset management techniques and analysis. The specific asset categories driving increased expenditure include: poles; cross-arms; Overhead lines (conductor); and Zone Substation major rebuild projects.

1.2.1 Poles

The quantity of poles to be replaced has increased from approximately 2,000 per annum (2011-15) to 3,000 per annum (2016-20), more than 50%. The key factor contributing to the increase is condition-based replacements to maintain risk levels of the deteriorated assets. Economic evaluation to determine the economic volume of pole replacements suggests that over 5,000 pole replacements per annum is economic. However, the proposed pole replacement program is limited to around 3,000 per annum and is combined with an aggressive pole reinforcement program to constrain expenditure.

1.2.2 Cross-arms

From 2011 to 2014, a significant cross-arm replacement program was conducted with one of the key drivers focusing on safety risk mitigation. A total of 39,000 timber cross-arms were replaced to address increasing

[1] Reliability associated with zone substations is likely to reduce over time as economic assessment of the optimal timing of plant replacement utilising the new lower Value of Customer Reliability (VCR) results in deteriorated assets remaining in service for longer. This is effectively 'risk maintained' as the consequence of the asset failure is lower due to lower VCR but the probability of failure is higher with deteriorating asset condition.

deterioration rates and reduce limited life cross-arm volumes. This included 10,000 replacements targeted in extreme bushfire risk areas.

Over the 2016-2020 period, a total of 45,645 replacements are required to continue safety risk mitigation efforts. The key drivers for cross-arm replacements are asset condition and risk. The forecast quantity is based on consideration of asset age, asset condition, reliability impact and mitigation of fire ignition risk (based on Fire Loss Consequence models).

1.2.3 Conductor

A conductor replacement program has been undertaken in the 2011-15 period to improve safety by reducing the risk of a failed conductor igniting a bushfire. The safety related conductor replacement program will continue at a reduced level of approximately 270 km per annum over the forecast regulatory period in areas of high fire loss consequence. In addition, analysis of asset condition data supports the replacement of 171 km per annum of conductor with deteriorating condition to mitigate reliability impacts in areas with low or no fire loss consequence.

1.2.4 Zone Substation Major Rebuild Projects

Nine zone substation rebuilds are forecast to commence within the 2016-20 period involving Seymour, Morwell, Myrtleford, Leongatha, Moe, Watsonia, Thomastown, Maffra and Phillip Island zone substations. A further 6 zone substations rebuilds have commenced and will be completed during the 2016-20 period. These projects are mostly partial rebuilds involving replacement of some of the deteriorated switchgear and transformers. At each site, a range of options have been considered to replace deteriorated transformers, circuit breakers and associated assets in whole or in part. The proposed rebuilds include the optimal combination of asset replacement to balance the benefits (reduction of probability of asset failure and associated consequences) with the costs of the replaced assets.

The proposed assets to be replaced as part of the rebuild program include 70 of the oldest 1950's and 1960's 22 kV bulk oil circuit breakers, 12 of the oldest 1950's and 1960's 66 kV oil circuit breakers and 11 of the oldest transformers mostly installed in the 1940's to 1960's.

1.3 Safety

Capex related to Environment, Safety and Legal (ESL) requirements is forecast to remain at a similar level to the 2011-15 period and represents approximately 29% of the total network capex forecast for the 2016-20 period. Approximately 93% of the forecast ESL capex relates to reduction of bushfire risk across the network, with 40% of the Safety capex related to programs of work necessary to meet energy safety obligations.

Programs focussed on reduction of bushfire risk across the network have achieved significant improvements during the current regulatory period. These improvements are illustrated by improved performance on Key Performance Indicators such as the Distribution Bushfire Mitigation index (on time completion of asset replacement and maintenance work in fire declared areas), Number of fire risk incidents, Fire Ignition Risk indicator and F-Factor performance.

Continuation of network safety programs such as Armour rods and vibration dampers, Overhang removals and conductor replacements are required (in some cases necessary to meet obligations) to achieve the long term targets for reduction in bushfire risk and improved safety performance.

Several programs and trials are proposed that utilise developing technology to reduce the risk of bushfire ignition from powerlines. These projects focus on detecting fault conditions and limiting the energy delivered to the fault to reduce the risk of fire ignition.

2 Overview of Distribution Network

AusNet Services' electricity distribution network serves the fringe of the northern and eastern Melbourne metropolitan area and the eastern half of rural Victoria as shown in Figure 2.1[2]

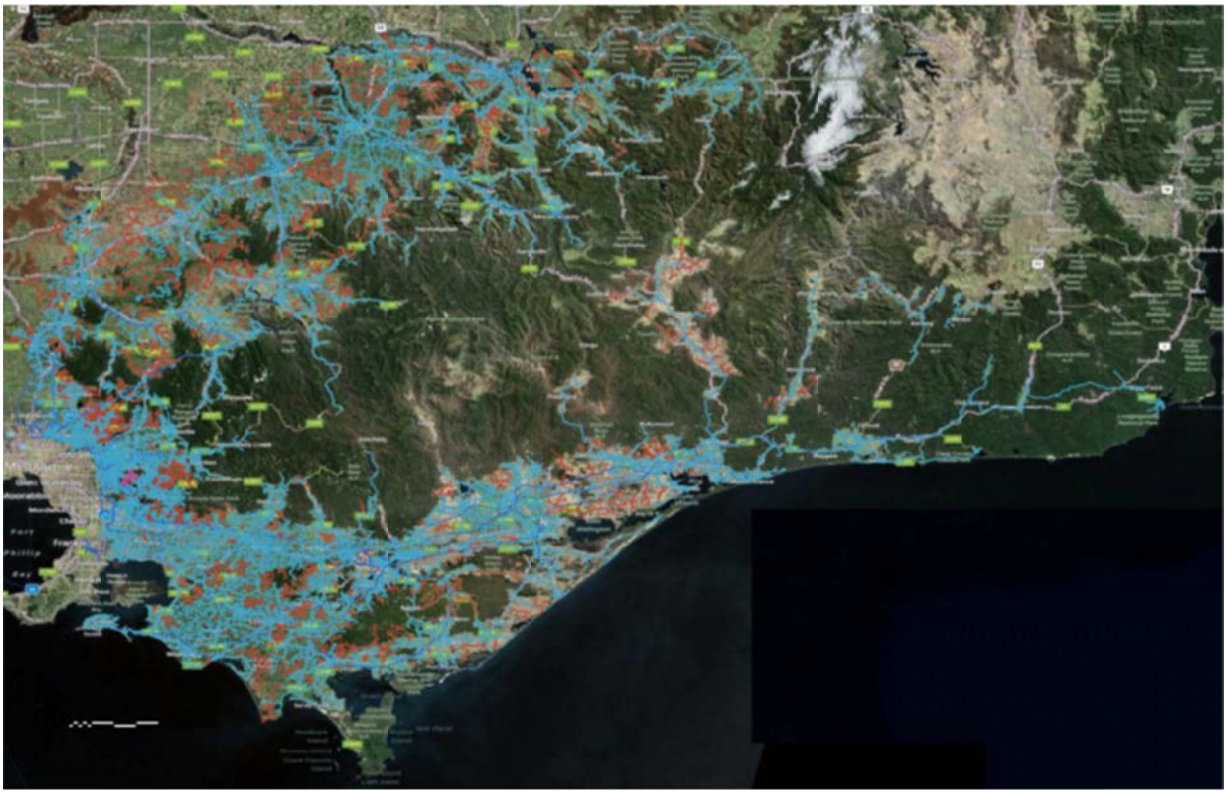

Figure 2.1 – AusNet Services' Supply Area

Whilst approximately one third of the customer base is urban, the majority of network line length is in rural areas. Much of the area is mountainous, and designated as High Bushfire Risk Area by the Department of Sustainability and Environment. A study into bushfire risk completed by Tolhurst and Chong[3] (2011) identified 5% of the HV network is in an "Extreme Risk" range. Approximately 60% of feeders subject to vegetation management are located in High Bushfire Risk Areas. The network area also contains Melbourne's fast developing northern and south eastern urban growth corridors.

The electricity network comprises a 'subtransmission' network constructed as overhead line and operating at 66 kV and a 'distribution' network of overhead lines and underground cables, which includes a range of operating voltages, including 22 kV, 12.7 kV, 11 kV, 6.6 kV and 240/415 and 240/480 Volts. The majority of customers are supplied from the low voltage network at 240/415 Volts.

The subtransmission network is supplied from the transmission network at 11 terminal stations (connection points). The subtransmission network consists of 2,200 km of 66 kV lines made up of 101 individual circuits. These are predominantly configured as loops back to the terminal station to maximise reliability. The subtransmission network supplies electricity to zone substations which transform the voltage for distribution in the surrounding area.

The 22 kV distribution network is currently supplied by over 50 zone substations, which are strategically located close to regional load centres. Additionally, three terminal stations supply 22 kV distribution feeders. Three

[2] The distribution area is portrayed in this map by a blue coloured overlay of the distribution feeders, subtransmission and SWER lines. The green boxes are not network related items.

[3] A Bushfire Risk Assessment for the SP AusNet HV Network in Victoria - Dr Kevin Tolhurst and Derek Chong (2011).

22/6.6 kV zone substations supply the Mount Dandenong area via three 6.6 kV feeders. The Latrobe Valley power stations and mines are supplied via five dedicated zone substations operating at 11 kV and 6.6 kV.

3 Asset Age

AusNet Services does not replace assets due to age. However, asset age and condition are related; assets tend to deteriorate as they age, so old assets are generally in worse condition than new assets. The change in average age over time of a class of assets provides an indication of whether the average condition of assets is likely to be deteriorating or improving.

An increase in average age over time would be expected where a class of assets is in generally good condition and/or relatively young. Conversely, a decrease in average age over time would be expected where a class of assets is in poor condition or experiencing high failure rates and/or is relatively old and requires replacement with new assets, thereby decreasing the average age of the population. The change in average age over time of a class of assets indicates a change in the level of risk being managed, and may also indicate over or under investment in asset replacement is occurring when considered in context of condition data, failure rates and the installation profile.

Figures 3.1-3.7 below show the change in average age over time of the major asset classes with forecast replacement volumes. Each figure also shows the change in average age that would occur if no asset replacements are made.

The average age of the key lines assets (poles, conductor and distribution transformers) continue to increase. The average age continues to increase even with increasing volumes of pole and conductor asset replacements.

In zone substations, the fleet of power transformers is relatively old with an average age at the start of the regulatory period of 39 years. This average age is maintained over the regulatory period. The average age of circuit breakers is forecast to decrease over the period driven by replacement of a group of very old (over 50 years average age) bulk oil circuit breakers.

3.1 Poles

Despite the significant replacement program forecast, the average age of poles continues to increase over the forecast period. The continual increase in average age is a reflection of the heavy investment in overhead lines assets during the 1960's and indicates that proposed replacement rates are not keeping pace with the aging population. This increase is occurring even though pole replacement rates have increased significantly in the past few years and are forecast to continue at rates that are high relative to historical rates.

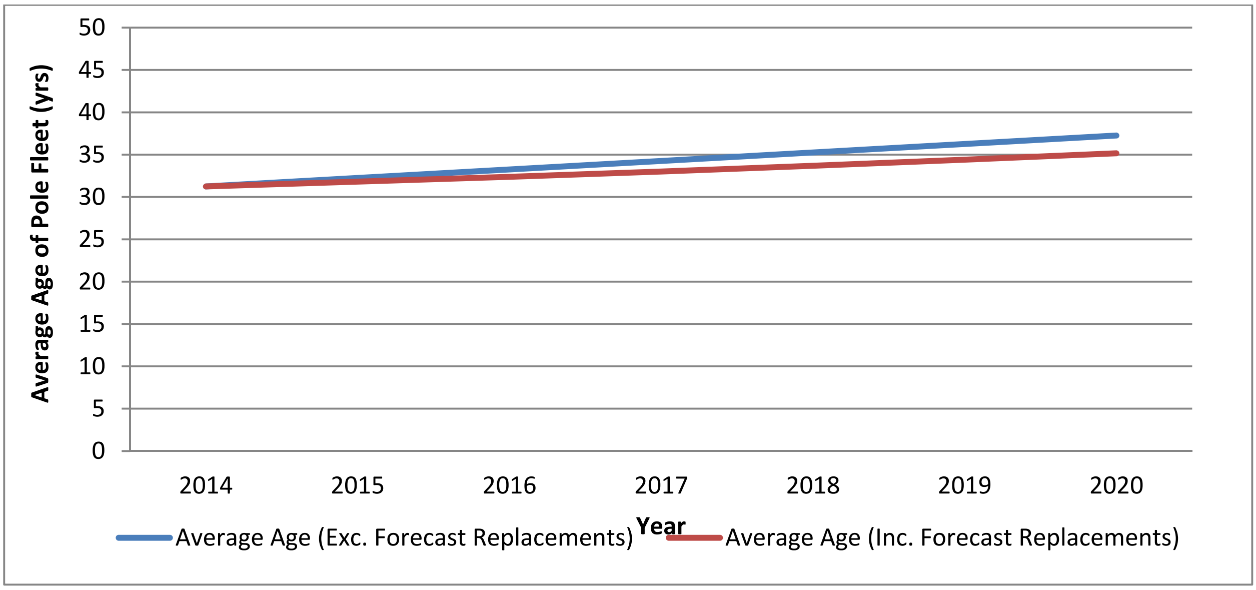

Figure 3.1 – Asset class average age – Poles

3.2 Cross-arms

The average age for cross-arms is expected to decrease slightly over the 2014 to 2017 period and then remain constant for the remainder of the regulatory period. The decrease in average age is driven by high replacement volumes, resulting from deteriorating condition identified by ground and aerial inspections. The forecast replacement volumes are predominantly driven by low voltage timber cross-arms.

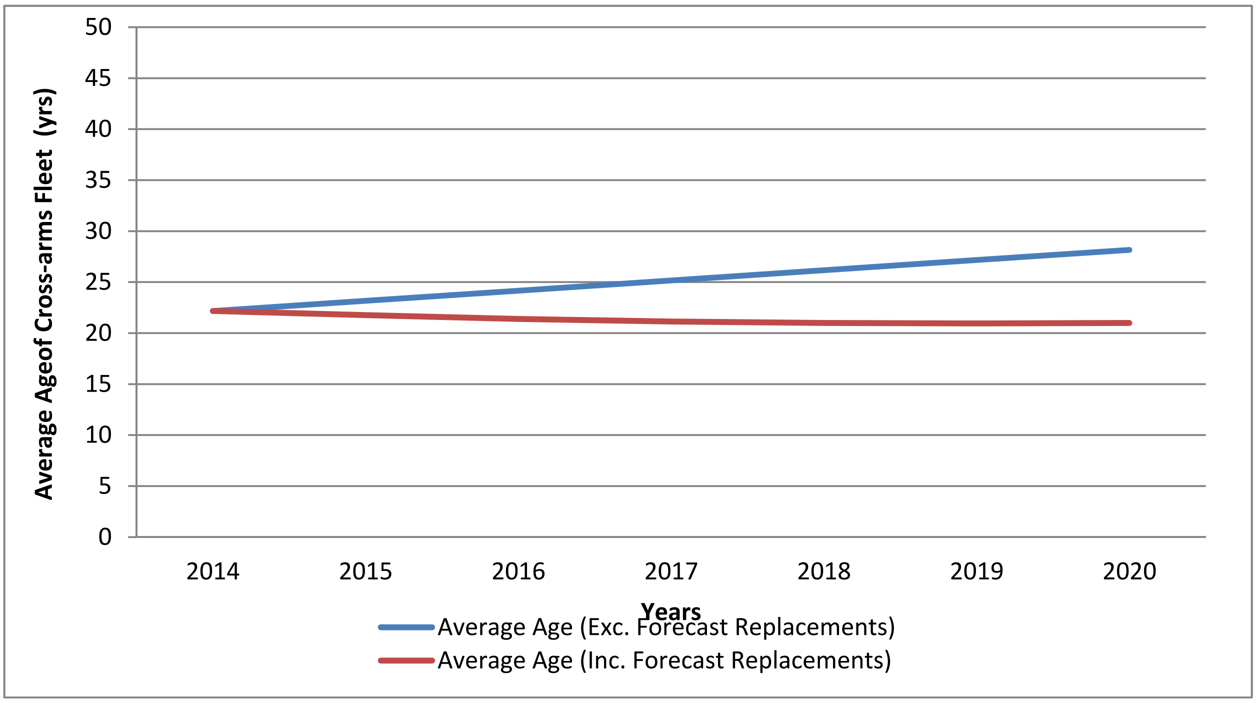

Figure 3.2 – Asset class average age – Cross-arms

3.3 Conductors

The average age of conductors is expected to increase over the regulatory period. The replacement forecast includes programs targeted at deteriorated conductor and programs targeted at reducing the risk of conductor failure in high bushfire risk areas. Combined, these programs do not result in the replacement of sufficient conductor to reduce the average age over the forecast regulatory period.

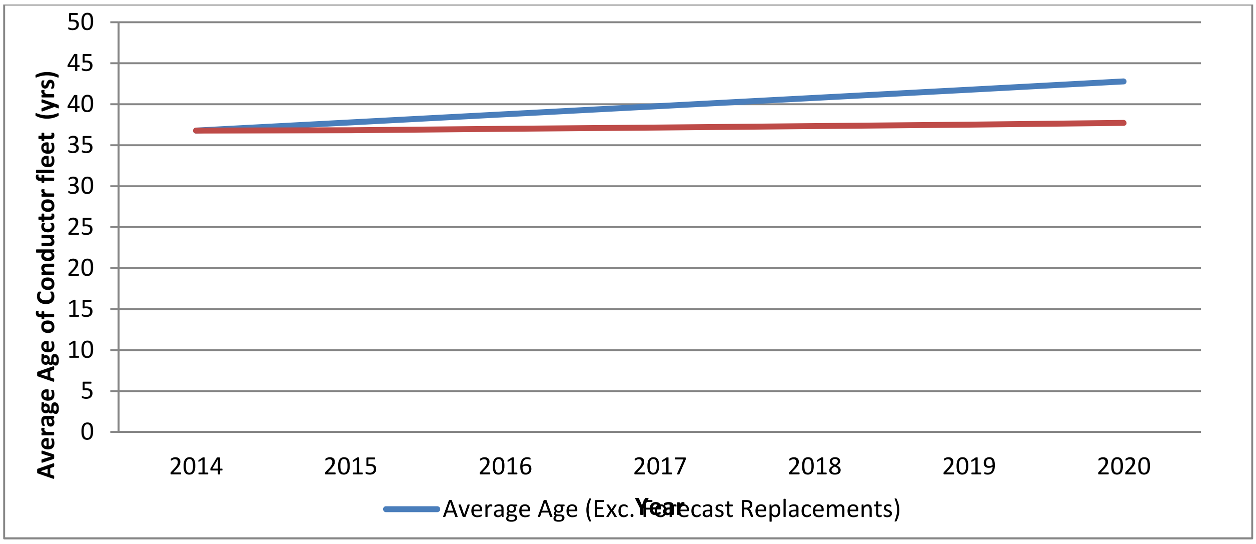

Figure 3.3 – Asset class average age – Conductors

3.4 Power transformers

The average age of the power transformers is forecast to remain relatively constant over the regulatory period. The number of transformers to be replaced in planned zone substation rebuild projects combined with the planned purchase of two new spare units is sufficient to maintain the current average age.

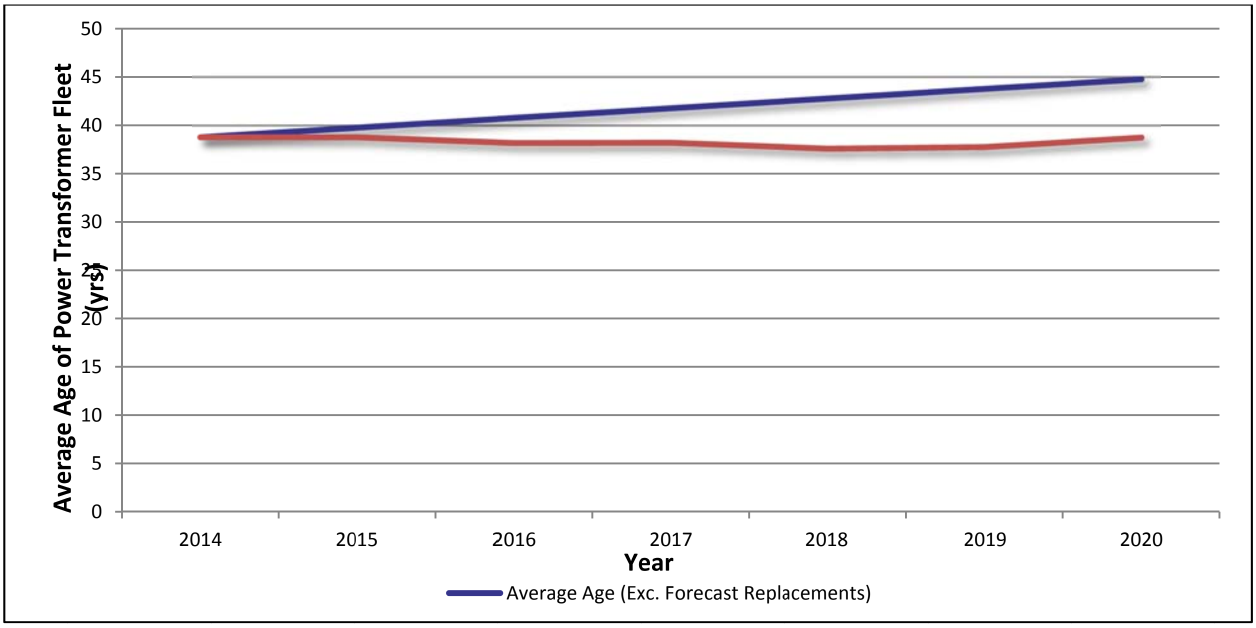

Figure 3.4 – Asset class average age – Power transformers

3.5 Circuit Breakers

The average age for the circuit breakers at Zone substations is around 28 years. By the end of forecast regulatory period, it is expected that the circuit breaker average age will fall slightly to 25 years. This reduction is driven by the replacement of a number of bulk oil circuit breakers. These bulk oil circuit breakers form 28% of the circuit breaker category, many are in very poor condition and the average age exceeds 50 years.

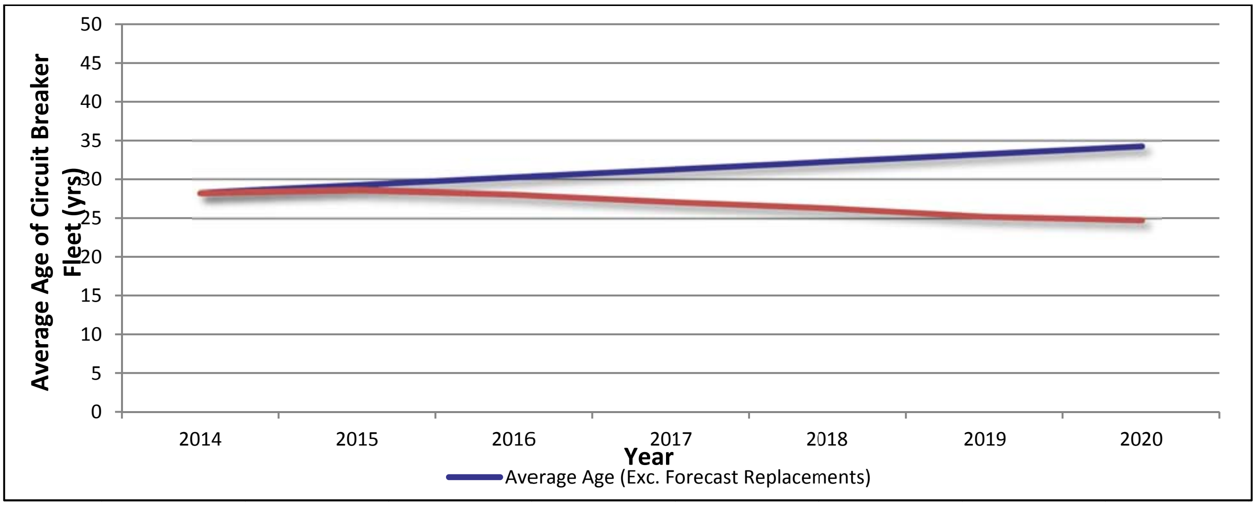

Figure 3.5 – Asset class average age – Circuit breakers

3.6 Service Cables (Overhead)

Programs of proactive and reactive overhead service cable replacement are planned for the forecast regulatory period. Combined these programs lead to maintenance of the current average service cable age.

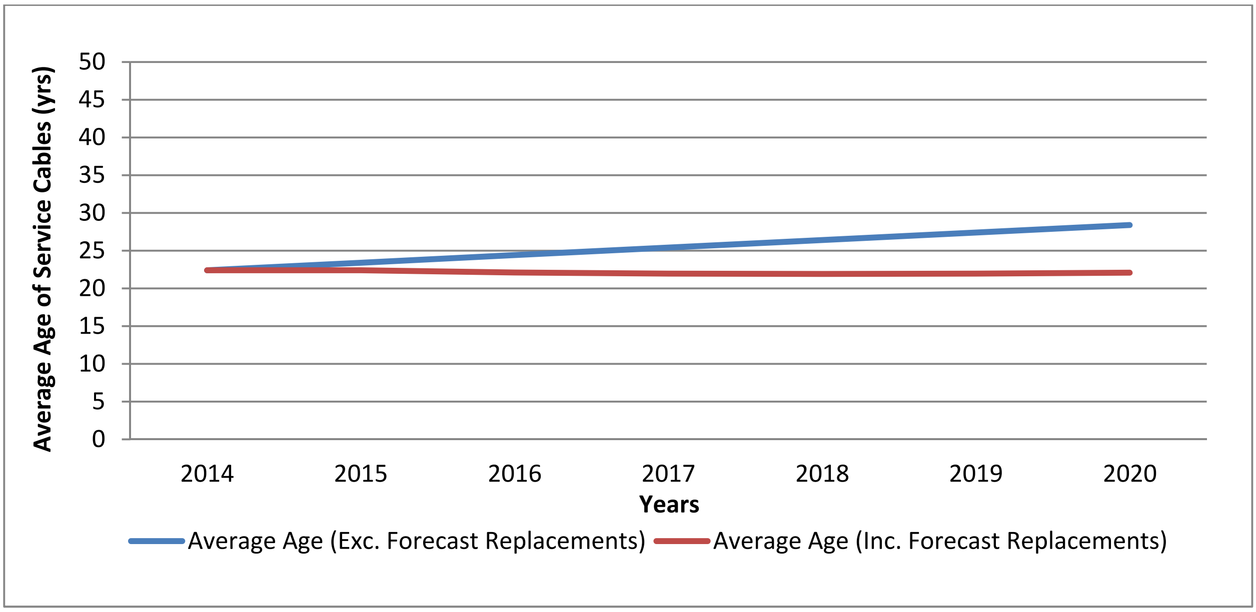

Figure 3.6 – Asset class average age – Service cables

3.7 Distribution Transformers

No proactive program of distribution transformer replacement is planned and consequently the small reactive program results in an increase in the average age of distribution transformers.

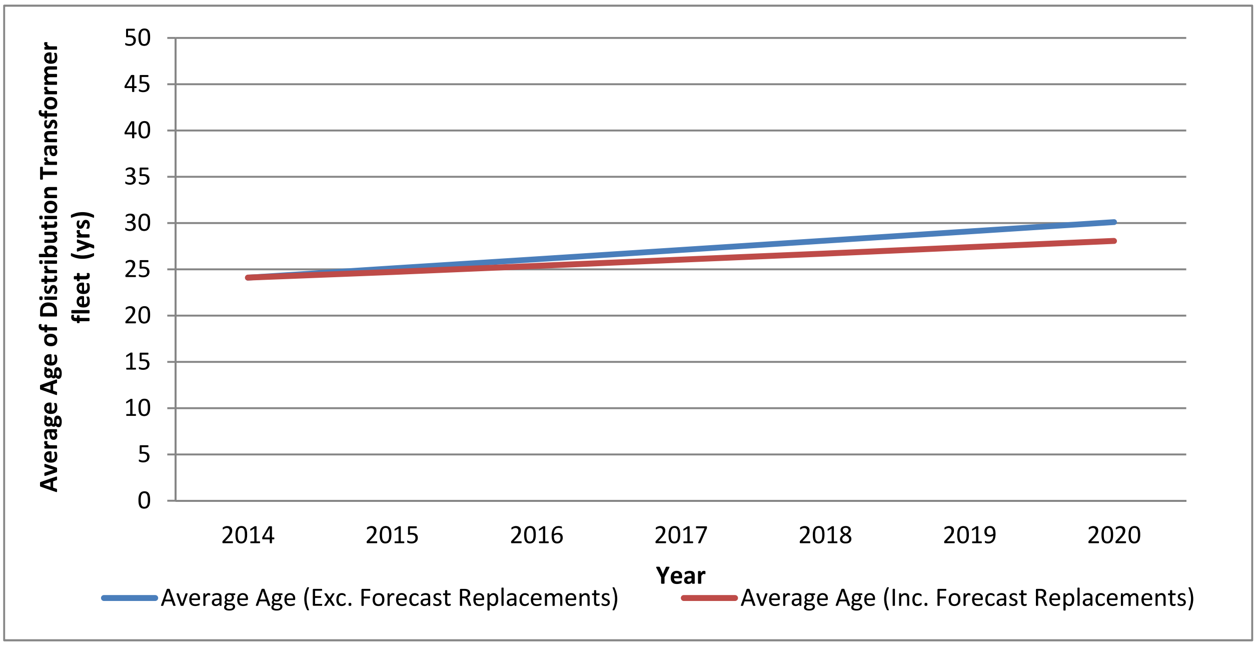

Figure 3.7 – Asset class average age – Distribution transformers

4 Asset Condition

AusNet Services' asset management strategies are driven by asset condition and the consequences of asset failure rather than replacing assets on the basis of service age. The condition assessment is an essential step in analysing the risk of failure and/or planning for replacement before failure.

Asset condition assessment is an input to the asset planning process. This process also includes consideration of the impact of failure, risk mitigation, economic analysis, customer requirements, coordination of projects, and development of efficient projects for asset replacement or refurbishment.

The overall asset condition provides an indication as to when action is required within a period of time to manage the risk exposure of an in-service failure. Adverse factors can accelerate asset deterioration prompting replacement. A high level summary of the condition of the main asset classes is shown in Table 1.

Table 1: Asset Condition Summary

Asset Class	Asset Inspection Methodology	Condition Summary
Poles	In HBRA[4], cyclic ground and aerial inspections at 60 month intervals and a maximum of 37 months between aerial and ground. In LBRA, cyclic ground inspections at 60 month intervals.	Increasing volume of deteriorating White Stringybark and Messmate timber poles. The concrete pole population is in very good condition. Wood and steel pole population is in good to average condition. Condition maintained by ongoing program involving reinforcement or replacement of individual poles when sound wood readings identify a pole as unfit for service.
Cross-arms	In HBRA, cyclic ground and aerial inspections at 60 month intervals and a maximum of 37 months between aerial and ground. In LBRA, cyclic ground inspections at 60 month intervals.	Significant volumes of HV cross-arm replacements in the current EDPR period have resulted in the overall population being in good to average condition. Increasing volume of deteriorating LV wood cross-arms apparent from inspections.
Conductor	In HBRA, cyclic ground and aerial inspections at 60 month intervals and a maximum of 37 months between aerial and ground. In LBRA, cyclic ground inspections at 60 month intervals.	Failures due to conductor breakage are decreasing. Damaged, stranded conductor and tie related failures are increasing. Generally bare conductors are in good to average condition. Insulated conductor (NMS HV ABC) is in poor condition and is currently being replaced due to high failure rates and the potential consequence of failure.
Underground cable	Very limited inspection and testing due to nature of cables.	Low failure rates and limited observable end of life characteristics indicate that cables are generally in good condition.
Switches & fuses	In HBRA, cyclic ground and aerial inspections at 60 month intervals and a maximum of 37 months between aerial and ground. In LBRA, cyclic ground inspections at 60	Low failure rates for gas switches, which are generally in good to average condition. Air break switches and overhead fuses are currently exhibiting low failure rates and are in average condition. Continue targeted EDO fuse replacement programs to mitigate the potential failure consequences.

[4] HBRA – Hazardous Bushfire Risk Area

Asset Class	Asset Inspection Methodology	Condition Summary
	month intervals.	
Distribution transformers	In HBRA, cyclic ground and aerial inspections at 60 month intervals and a maximum of 37 months between aerial and ground. In LBRA, cyclic ground inspections at 60 month intervals.	Low failure rates experienced with overloading and tank corrosion the main driver of replacement. Generally this population is in good to average condition.
Services	Cyclic ground inspection program with 60 month intervals.	Currently, low failure rates and limited observable end of life characteristics indicate that services are generally in good condition with the exception of aluminium neutral screened aerial service cables. These poor condition assets are part of a targeted replacement program
Zone substation transformers	Online and offline cyclic inspection and testing. 12 month visual and oil sampling, 48 month routine overhaul and 72-96 month electrical testing	Transformers have low failure rates due to the ability to observe end of life characteristics through the inspection regime to identify suitable replacement timing. Overall the fleet is in average condition, with an increasing number of aged transformers moving into poor condition. These are managed by refurbishment or replacement of individual units when inspection identifies transformer as unfit for service.
Zone substation switchgear	Online and offline cyclic inspection and testing. 48 month Class 1 overhaul, 96 month Class 2 overhaul and 192 month Class 3 overhaul	Switchgear has low failure rates due to the ability to observe end of life characteristics through the inspection regime to identify suitable replacement timing. Overall the fleet is in average condition, however over 100 bulk oil circuit breakers and 30 minimum oil circuit breakers are in very poor condition.
Zone substation instrument transformers	Visual inspection and 48 month routine overhaul and oil sample where required	Historically, instrument transformers have low failure rates. Overall the fleet is in good condition, managed by refurbishment or replacement of individual units when inspection identifies instrument transformer as unfit for service.
Zone substation civil infrastructure	3-6 month station asset inspection, 12 month thermal, UV, RF, ultrasonic testing, 60 month fire system testing and 120 month earth grid testing.	Currently, zone substation civil infrastructure is in average to poor condition with asbestos being the prominent issue. Half the zone substations have exceeded 40 years of service. Condition can be managed by asbestos removal and economically integrating building and security fence replacement activities in zone substation augmentation or redevelopment projects.

5 Network Performance

The distribution network performance over the current regulatory period is described in this section. Network performance is recognised[5] as one of the main drivers for asset investment decisions. Network performance is reviewed annually against targets for network capacity, network reliability, quality of supply, environment, safety, supply security and regulatory compliance.

This section discusses network performance with respect to these factors;

5.1 Capacity

Network capacity can become constrained at each network level due to demand growth; subtransmission, medium voltage (mostly 22 kV) and low voltage, and any constraints can lead to poor network performance. Subtransmission and medium voltage capacity is reviewed during the annual network planning process. Low voltage capacity is monitored through output measures such as the number of overloaded distribution transformers and fuse operations.

The loading of the 66 kV sub-transmission network under system normal conditions is within ratings. During the current regulatory period, augmentation of the South Gippsland subtransmission network has been completed to provide additional capacity required to prevent voltage collapse of this system.

Zone substation historical and forecast capacity is shown in Figure 2. Sufficient capacity and demand side responses have ensured that zone substations have met peak demand requirements.

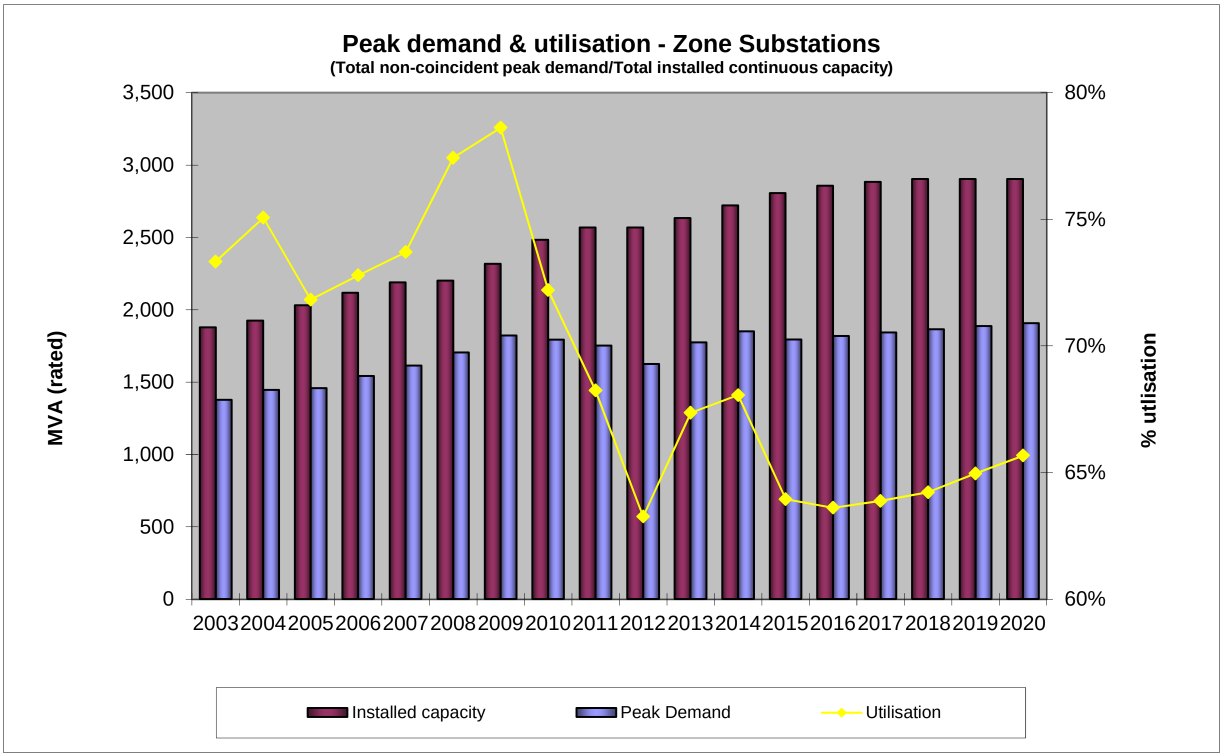

Figure 2: Zone substation capacity & demand

Distribution feeders are carefully monitored to ensure that sufficient capacity is available to meet peak demand. Demand side responses, load transfers to adjacent feeders and augmentation have been utilised to ensure that feeder capacity does not affect network performance.

[5] Electricity Distribution Network Annual Performance Review

An active program of distribution transformer upgrades has been undertaken since 2007 to reduce unacceptable network performance resulting from the failure of overloaded distribution transformers. This program and the associated LV network upgrades have ensured that LV network capacity is sufficient.

5.2 Network Reliability - Unplanned

The majority of electricity distribution network outages are unplanned and result from a variety of factors beyond AusNet Services' control, including storms, interference by animals, vegetation and bushfire.

In the current regulatory period, AusNet Services has responded to the Service Target Performance Incentive Scheme (STPIS) and actively sought to improve network performance. This has been achieved by systematically reviewing poorly performing segments and investing in making the network "smarter". This includes adding technology that automatically reconfigures the affected network in order to minimise the number of customers affected by outages. These smart distribution feeder automation (DFA) schemes have been implemented on over 80% of distribution feeders.

Network performance shown in the following sections reflects the outcome of the 'reliability maintained' and 'reliability improvement' strategies that have been implemented during the current regulatory period.

5.2.1.1. USAIDI

Figure 3 shows the network Unplanned System Average Interruption Duration Index (USAIDI) performance from 2010 to 2014 calendar years against the AER target. Exclusion criteria apply in the STPIS to major event days so that underlying network performance can be assessed. The chart shows performance including and excluding these major event days.

The underlying improvement is driven by an investment program and operational changes undertaken during the previous and current regulatory periods. These include:

- A substantial investment in distribution feeder automation (DFA) – this increases the network's ability to self-heal during outage events.
- Key feeder reviews – Feeders are specifically patrolled to identify reliability risks and works are undertaken to eliminate the risks.
- Targeted vegetation management – Additional tree clearing along the first section of feeders to reduce the number of full feeder faults.

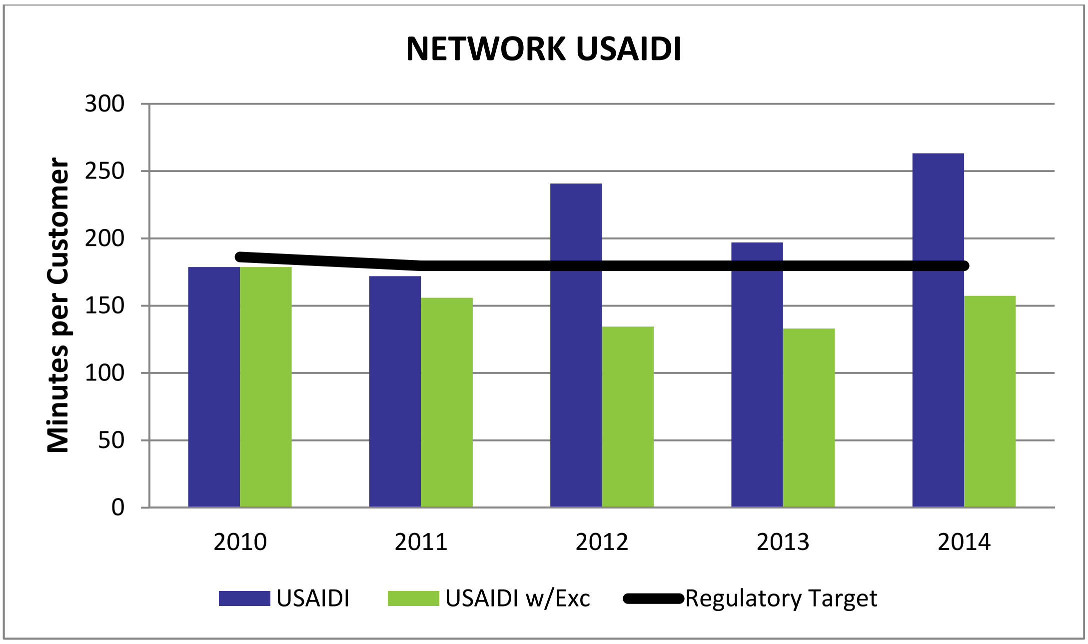

Figure 3: Unplanned SAIDI

The 2010 outcome for average unplanned minutes off supply per customer was lower than target despite significant weather events during the year. Lightning and other impacts of thunderstorms on two occasions had a significant influence on network reliability. Each of these events contributed 12 minutes off supply and neither met the exclusion criteria for the S-Factor Scheme.

The 2011 outcome for average unplanned minutes off supply per customer was lower than the target. A bushfire in East Gippsland early in 2011 and four days of storms and other weather related incidents across the year had a significant impact on electricity distribution network performance across Victoria. The combined effect of these four events, which did not meet the major event day exclusion criteria, contributed 29 minutes USAIDI.

The 2012 overall USAIDI performance exceeded the target. There were three major storm events during the year that exceeded the MED threshold of 10.4 (applicable for 2012) and one transmission-related outage. The worst event occurred over three days in September, affecting customers in suburban Melbourne and the south-east of the state resulting in 83.1 minutes USAIDI of which 71.9 minutes was excluded from the STIPS.

The 2013 overall USAIDI performance also exceeded the target. A severe thunderstorm and two tornadoes cut a path of destruction across Victoria's North-East region in March and three separate major storms occurred including one with the strongest wind recorded in five years at 140 km/h. Trees falling on electrical assets caused a combined total of 47 USAIDI minutes lost all of which met the major event day exclusion criteria.

The 2014 overall USAIDI performance also exceeded the target. Extreme weather that affected network performance was experienced with 12 Total Fire Ban days declared between January and March which resulted in bushfires in some parts of the State. Thirteen USAIDI minutes, which did not meet the STPIS exclusion criteria, were lost in January due to four consecutive days with temperatures above 40 degrees Celsius where extreme loads resulted in many outages. In February, 18 USAIDI minutes were lost due to bushfires. A transmission event at Morwell Terminal Station caused the loss of supply to ~100,000 customers for up to 2 hours and three further storms were experienced during the year resulting in 63 USAIDI minutes which were excluded from the STPIS.

5.2.1.2. USAIFI

Similar to the USAIDI performance, Unplanned System Average Interruption Frequency Index (USAIFI) performance, shown in Figure 4, was below the AER target for the period from 2011-2014 after the MED exclusions were considered. The main reasons for this improvement are the same as those that apply to USAIDI.

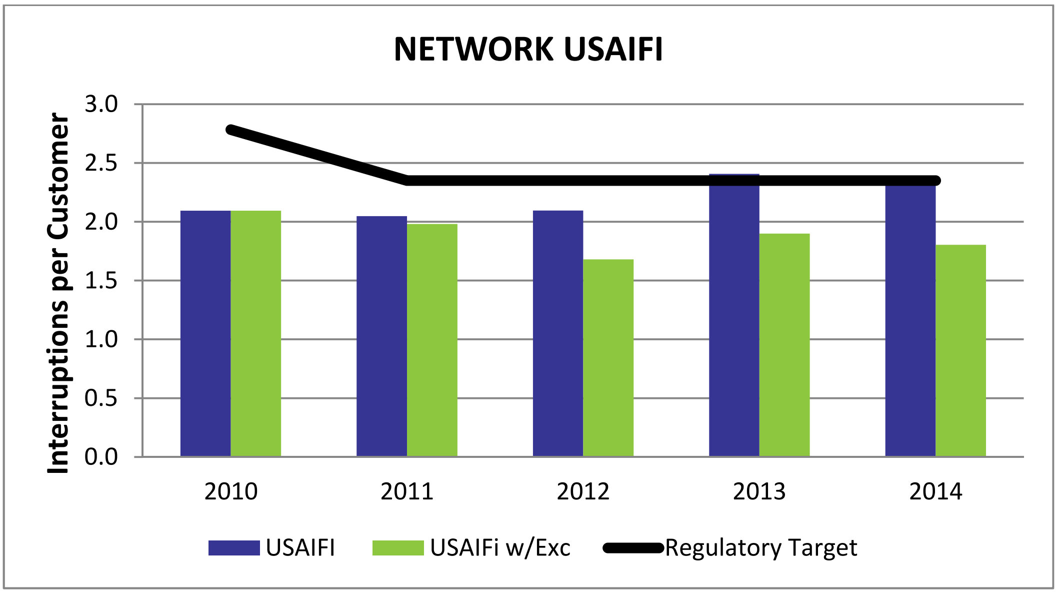

Figure 4: Unplanned SAIFI

5.2.1.3. MAIFI

The Momentary Average Interruption Frequency Index (MAIFI) performance has been above the AER target for every year in the period 2011 to 2014 as shown in Figure 5. A contributing factor is the implementation of distribution feeder automation schemes where feeders are sectionalised to minimise customers affected due to sustained outages. The operation of DFA schemes intentionally transforms what would be a sustained outage into a momentary outage. Whilst MAIFI is above target, the associated reduction in USAIFI (i.e. sustained outages) is less disruptive to most customers.

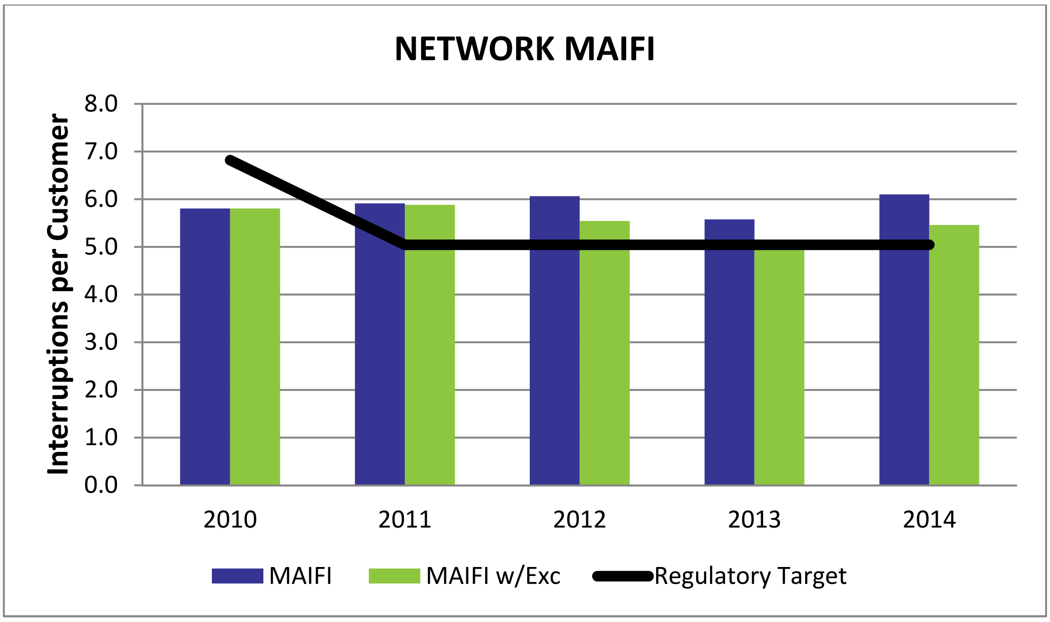

Figure 5: MAIFI

5.3 Network Reliability – Planned

Planned outages result from planned shutdowns which are undertaken for maintenance or upgrades on the network. Affected customers are given notice prior to the interruptions.

The number of planned minutes off supply is recorded by the Planned System Interruption Duration Index (PSAIDI). PSAIDI has increased in the 2011-14 period compared with previous years, as shown in Figure 6, due to the volume of maintenance work carried out during this period, including work that is required to implement the Victorian Bushfire Royal Commission recommendations.

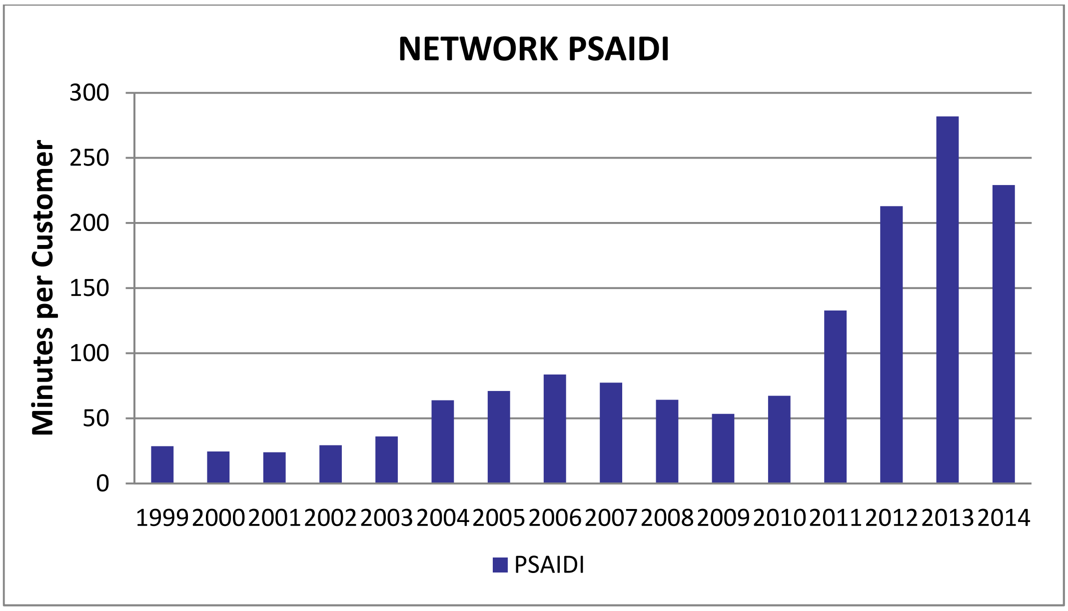

Figure 6: Planned SAIDI

5.4 Quality of Supply

Power quality is monitored and analysed using power quality data obtained from AMI systems and Zone Substation power quality meters to proactively address power quality issues and regulatory compliance.

An ongoing capital investment program is undertaken to address customers' power quality complaints. The majority of this expenditure is spent upgrading or installing new distribution transformers, low voltage lines and LV fuses. A significant capex investment has been made since 2009 to identify the overloaded distribution transformers and upgrade them along with associated low voltage networks to minimise outages and power quality issues.

Smart tools utilising AMI systems have been developed to identify customers who are receiving steady state voltage below the range specified by the Distribution Code and relevant Australian Standards. These tools are used to monitor and allow appropriate actions to be taken to bring the voltages within code limits. For example, secondary bus voltages at zone substations EPG, BWN, NRN, PHM, SMG, WT, LYD and ELM have been adjusted to bring the majority of the customers fed from these substations within code.

Few complaints relating to network harmonics and flicker have been received in the current regulatory period. These complaints are investigated with special attention given to customers' internal disturbing loads and undertaking specific measurements in consultation with the respective customer. Similarly complaints on voltage sags and swells are investigated with due consideration to their internal loads and network performance.

It has been observed through AMI data that the majority of customers are receiving towards the middle to upper margin of the allowable low voltage level. As the penetration of solar PV generation increases resulting in increased voltages, the number of customer complaints for high voltage could increase in future years, unless proactive action is taken to adjust voltage.

5.5 Environment

Asbestos is present in 75% of zone substations with varying levels of volume and risk. The asbestos in buildings presents a potential health risk to on-site personnel. Twenty five buildings at fourteen zone substations contain asbestos in different components including exterior wall cladding, eave linings, doors, windows, floor tiles or roof sheeting or ceiling linings. Building restoration works to remove asbestos are incorporated into zone substation refurbishment or rebuild projects. In addition, older primary plant equipment presents environmental risks especially those power transformers and circuit breakers containing large volumes of insulating oils. Typically, these risks arise from pollution arising from transformer oil leaks.

Sixteen zone substations have been identified to have oil management systems exhibiting high oil escape risk. These stations were not designed to capture and separate oil, and oil spills could result in high environmental impact due to nearby waterways. The existing environmental design for these stations does not comply with current EPA and AS1940 &2067 Australian standards.

Station rebuilds in the asset replacement category have targeted many bulk oil circuit breakers and several deteriorated power transformers for replacement which will benefit the environment through the new design with further reduction of risks of oil spills.

5.6 Safety

AusNet Services has initiated an Enhanced Safety Program targeting high causal factors to improve network safety. These include;

- EDO fuse replacement program
- Hazard tree removal program
- Conductor replacement program
- Bare wire replacement program
- HV ABC replacement program
- Animal/bird proofing.

Most of the Enhanced Safety Program investment is targeted at reducing the risk of bushfire ignition.

5.6.1.1. Fire Starts

The F Factor is a lagging indicator that was introduced by the AER post the Victorian Bushfires Royal Commission recommendations and this now forms part of the STPIS. The target for the current regulatory period was set based upon retrospective review of 2006-2010 network incidents.

Figure 7 shows the F-Factor performance since it was introduced in 2012 and comparison with the previous years. It should be noted that ground fires are heavily influenced by environmental conditions such as annual rainfall.

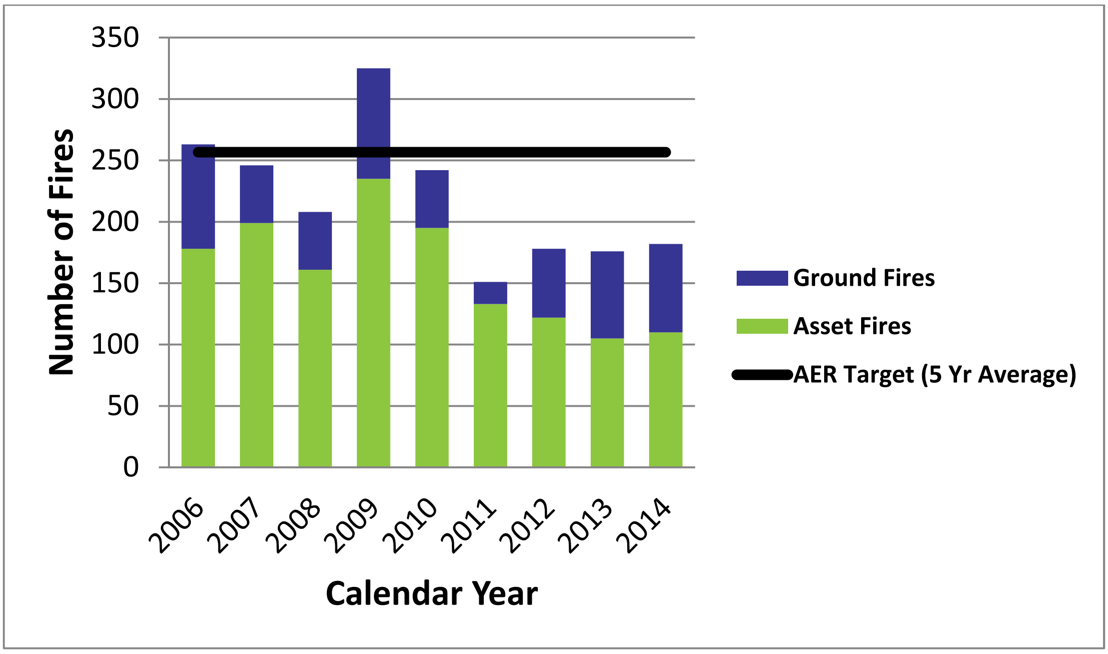

Figure 7: F-Factor – Ground & Asset Fire Incidents

5.7 Supply Security

Supply is secured at the network subtransmission level by network design which provides redundancy and reduces the potential for a single network event (fault) to cause widespread outages. Customers supplied from some zone substations experience less secure supply than others due to radial subtransmission lines and zone substation switching arrangements. Analysis of these arrangements indicates that it is not economic to improve network security at these locations unless this is done in conjunction with other work. Security of some zone substations will be improved in the forecast period as switching arrangements are changed in conjunction with zone substation rebuilds.

5.8 Regulatory Compliance

A well-established compliance regime is applied to electricity network regulatory obligations including a compliance reporting database system. When non-compliances occur the compliance team initiate a process to ensure that future activities are compliant with relevant obligations.

6 Key Drivers of Capex

The key drivers of forecast capital expenditure are:

- **Asset replacement at end of life** – Pole replacement, cross-arm replacement and station rebuild programs form the bulk of asset replacement capital expenditures. In the asset replacement category, objective condition ratings have been used as key inputs into risk based economic assessments to determine the scope of works and the timing of economic asset replacements. Assets that have reached the end of their reliable service lives have an increasing probability of failure. Customer supply reliability is affected by asset failure and the value of this loss of supply forms the primary 'benefit' input into the economic assessment.
- **Network Safety** – The network safety initiatives are driven by increasing community expectations and Victoria's energy safety regime that places emphasis on individual company accountability for safety and targeted risk management. AusNet Services has performed safety assessment for the electricity distribution network and subsequently identified the key mitigating management strategies as described in AMS 20-13, including plant asset strategies such as conductor and overhead cable replacement, government funded conductor replacement, enhanced control and electrical protection schemes to reduce fire risks, operational strategies such as vegetation management, and business strategies such as occupational health & safety.
- **Growth**

  Customer connections – Customer connections comprises both residential and business customer connections. Forecast expenditure is directly related to forecast volumes of new connections. There is no discretion in customer connection capital expenditure as AusNet Services is obliged to offer to connect new customers.

  Demand growth – Demand growth is forecast to be limited to areas where new customers connect to the network. In these areas, new distribution feeders, new or augmented low-voltage network and one new 66 kV sub-transmission line are necessary to meet the increase in demand.

7 Asset Management System

AusNet Services maintains a comprehensive asset management system certified to the ISO 55001 Asset Management standard. The system comprises a suite of processes and documents that enable the distribution assets to be managed in a way which efficiently meets stakeholder requirements. Embedded within this system are continuous improvement processes that result in ongoing refinement and improvement of the systems and processes used to manage assets.

The Asset Management Strategy (AMS) is central to AusNet Services' processes for managing the electricity Distribution assets, determining the delivery of quality services to customers and value to shareholders. It summarises the medium-term strategic actions for achieving regulatory and business performance targets, which are implemented via the programs of work listed in the five-year Asset Management Plan produced each year.

The AMS is underpinned by the regulatory and commercial imperatives of delivering efficient cost and service performance. It recognises that cost and service efficiency does not mean lowest possible cost, nor does it mean guaranteed reliability. Instead, efficiency requires the costs and benefits of all expenditure decisions to be weighed against one another. A key element in this cost benefit analysis is the consideration of risk management in relation to asset performance and network reliability. AusNet Services' ongoing commitment to maintain ISO 55001 Asset Management accreditation ensures an auditable asset management system facilitating customer's expectations to safely maintain the quality, reliability and security of supply in an economic manner.

The efficiency concepts that underpin the AMS are embedded in clauses 6.5.6(a) and 6.5.7(a) of the National Electricity Rules (NER), as these define the operating and capital expenditure objectives.

8 Approach to Capital Expenditure Forecasting

This section describes the methodology used for developing the capex forecast, and the key assumptions that underlie the forecasts.

AusNet Services' method of forecast is based on a bottom up forecast of individual projects or programs of work modified by a top-down adjustment. Cost escalation or de-escalation is then applied across the entire suite of the forecast projects (according to their labour and material profile) to account for expected changes in input costs. The overall forecasting methodology is illustrated in Figure 9.1.

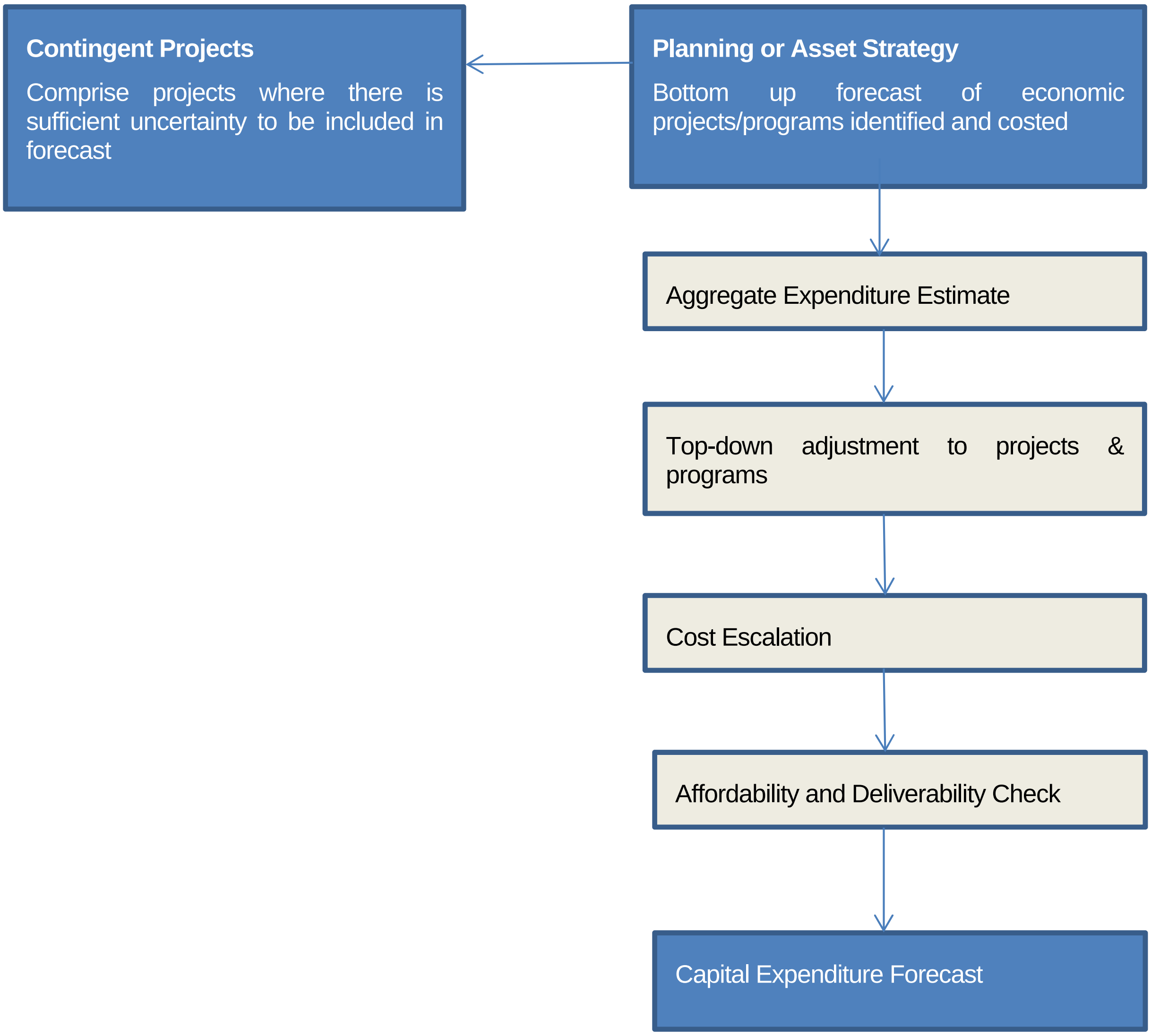

Figure 9.1 – Capital Expenditure Forecasting Process

8.1 Bottom-up forecasting

The bottom up capital expenditure forecast is estimated by summing-up expenditure across all of AusNet Services' programs and projects. This involves identifying, scoping and costing every project and program over the entire regulatory period, conducting a cost benefit analysis of options to determine the preferred option, and then estimating the timing of expenditure on each project and the impact of escalators. This multi-stage process is shown below in Figure 9.2.

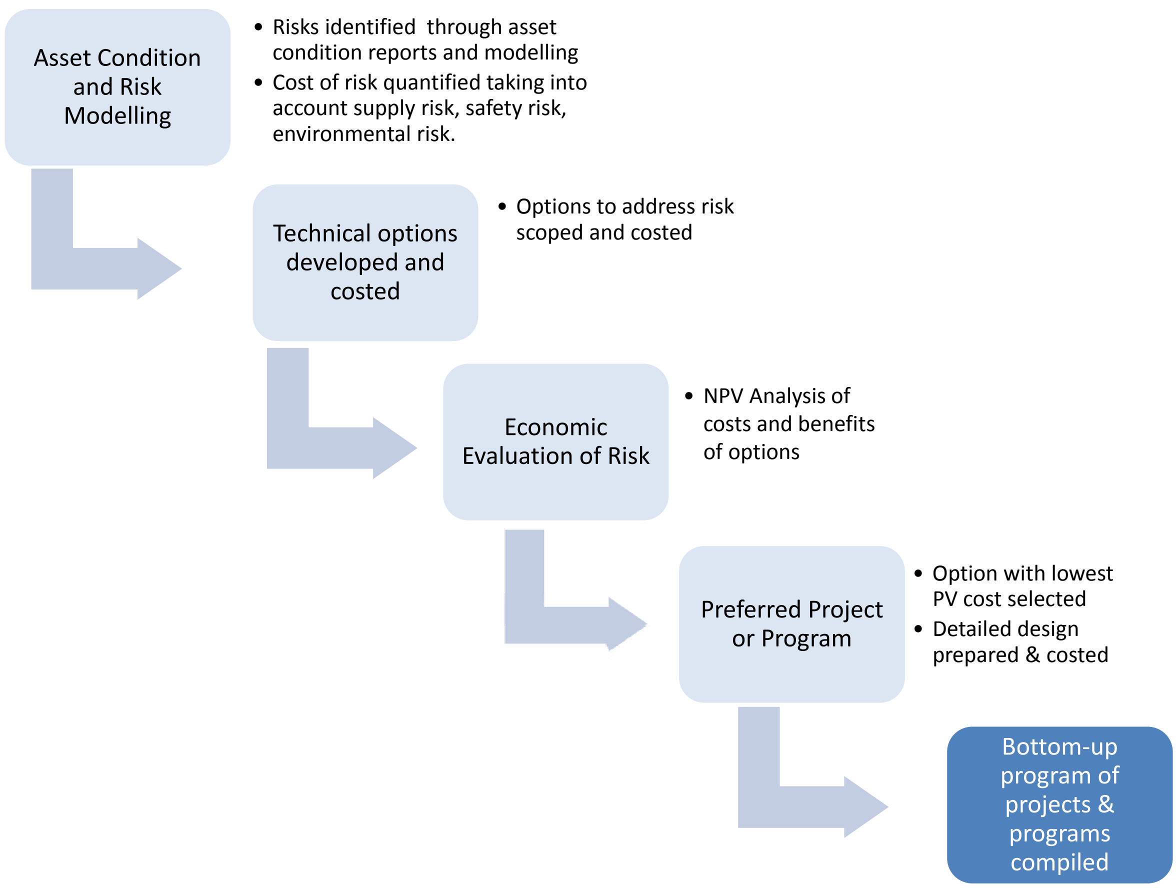

Figure 9.2 – Bottom up Capital expenditure forecasting methodology

8.1.1 Condition Based Risk Modelling

Assets are initially prioritised for economic evaluation using condition based quantitative risk assessments. Risk models are developed using objective asset condition assessments, quantified failure consequences and Reliability Centred Maintenance (RCM) techniques.

A wide range of methods and techniques are used to assess the condition of all major asset categories. Asset condition data informs the definition of remaining service potential (RSP) which is used to establish dynamic time based probability of failures for each asset. Probabilities of failure are validated by comparison against historical failure data for each asset category.

RCM methods involve the assignment of functions and functional failures to individual network assets. Failure Mode Effect Criticality Analysis (FMECA) of historical asset failure data determines typical root causes of functional failures and quantifies the effects and consequences these have on key performance measures including network safety, reliability and availability. Consequences of asset failures are expressed in monetary terms for each performance measure and summed to represent total consequence cost of failure for each asset.

Consequence costs of asset failure are then multiplied by condition based probabilities to quantify the overall cost of failure for each asset as illustrated in Figure 9.3. The probability weighted cost of failure is referred to as the "risk cost".

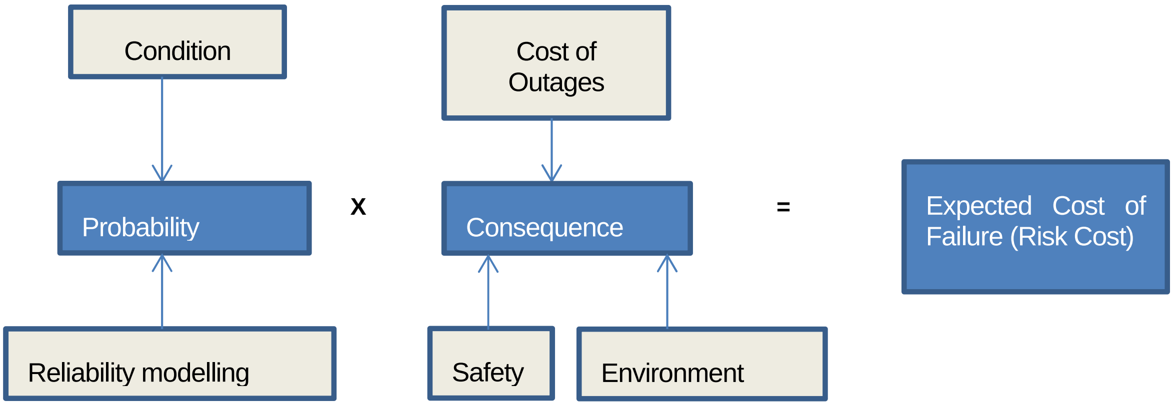

Figure 9.3 – Quantifying cost of asset failure

8.1.2 Fire Loss Consequence Model (FLCM)

The FLCM provides the consequence, measured in houses lost, of a fire start at any location in Victoria on a day of extreme fire risk. The network has been overlayed on the FLCM so that the consequence of an asset failure can be determined.

The FLCM has been used for economic analysis of part of the safety program including conductor replacement, cross-arm replacement, EDO fuse replacement and the installation of animal & bird proofing to determine the volume of activities that should be undertaken. The analysis has been utilised on assets located in bushfire risk areas where the consequence of failure is ignition of a ground fire with the potential to start a bushfire resulting in house and other losses. The cost:benefit ratio used for the economic analysis has been established by quantifying the costs and benefits as follows:

- The cost of replacing assets or installing Animal & Bird proofing is based on the historical cost of these activities.
- The benefit of replacing assets or preventing flashovers is calculated by multiplying the probability of an asset igniting a bushfire by the consequence of a bushfire starting at that location. The benefits are the avoided cost (consequence) of a bushfire which is calculated using the FLCM.
- The probability of an asset failure igniting a bushfire is based on the probability of an asset failing modified by the probability of the failure occurring on a day of extreme fire risk.

8.1.3 Zone Substation Rebuild Projects

A rebuild of a zone substation is considered when most of the assets are in a deteriorated condition and selective asset replacement is not an economic option.

The baseline risk for the zone substation is first established. The baseline risk includes safety risk, supply risk, environmental risk and collateral plant damage risk. Asset renewal options are than developed to address the identified plant failure risks, which includes staged replacement, green field redevelopment and brown field redevelopment.

The most economic asset renewal option is selected based on the present value cost of each option, which includes forecast capital expenditure, risk cost and operation and maintenance cost. The economic timing of the selected option is established by comparing the annualised total cost of the selected option with the annual incremental benefits (that is, reduced risk or avoided cost of failure) it is expected to deliver. Under this evaluation approach, the economic timing is identified as the point in time at which the annual incremental benefits just exceed the annualised cost.

Sensitivity studies around the discount rate, asset failure rate and demand scenarios are conducted to test the robustness of the economic evaluation. This is a crucial step in ensuring replacement investments are economic under a range of reasonable scenarios.

Overall, AusNet Services' approach is consistent with that documented in the Distribution Annual Planning Report[6] and consistent with the principles underpinning the regulatory investment test.

Once the preferred option has been economically selected a detailed project scope and detailed project cost can be estimated. AusNet Services does this, using a detailed technical scope of works (refined from the preferred option) and current unit costs for installing or replacing assets. This resulting cost estimate is the most likely cost (the P50) of the project and assumes the scope of work will not change during the detailed design and construction phases.

An important step in determining project timing is program optimisation. During this step, the capital program, as a whole, is considered and optimised to facilitate timely delivery. As a result, the timing of some individual projects may be adjusted to optimise the overall program. This program optimisation facilitates a smooth demand for capital raising, major equipment procurement, detailed design services and project management and construction services. The smoothing of resource demands produces a lower overall cost of capital investment.

8.1.4 Real cost escalators

The cost of several project inputs are expected to increase over the regulatory period, in excess of CPI. To take these changes into account, project costs are broken down into labour and materials escalators. Broadly these are:

- **Internal labour:** The cost of using AusNet Services' staff on capital projects
- **External labour:** The cost of contractors on capital projects
- **Asset "Materials" escalators:** This includes all other costs and is divided into the following sub-categories: secondary equipment, switchgear, transformers, reactive equipment, lines and towers, establishment, communications, non-network, land and easements.

For the labour categories, AusNet Services has commissioned an expert forecast of real price changes relative to the base year. No real price escalation has been applied to the materials. The escalators are then applied to the appropriate expenditure category for each project to calculate the escalated project cost. Once this is done, costs are simply summed across all projects.

8.1.5 Improvements in capital efficiency

AusNet Services is constantly looking for ways to improve capital efficiency. This includes independent Post Implementation Reviews (PIR) of completed projects and programs and continual improvement in asset management practices and systems. All improvements to date have been included in the capital expenditure forecast.

8.2 Top-down forecasting

The capital expenditure forecast has been prepared to sustainably meet customers' reliability, growth and safety expectations. Customer's input into aspects of capex and trade-offs relating to safety and reliability outcomes were ascertained through customer engagement activities including regional workshops and focus groups. Management directed the team preparing the expenditure forecast to constrain expenditure where possible (especially augmentation expenditure) to address long-term sustainability of investment in network assets. This direction recognises that demand growth is slowing and energy use falling and that past levels of expenditure cannot be maintained.

The following modifications were made to the bottom-up forecast:

- Incorporating the new Value of Customer Reliability (VCR) rate;
- Omitting projects with uncertainty;

[6] The Distribution Annual Planning Report is published annually in December and is publically available on the AusNet Services web site.

- Assuming that an improved technique for pole reinforcement can be implemented to limit the number of pole replacements;
- Utilising conservative assumptions to forecast replacement volumes for some asset categories;
- Excluding minor and incidental programs from the forecast.

The VCR was revised after the initial forecast for augmentation and major asset replacements had been completed. Incorporating the VCR published in November 2014 resulted in deferral of the sub-transmission line augmentation project, deferral of several zone substation rebuild projects and deferral of major zone substation plant replacements. A change in VCR has a material impact on the proposed program as the economic assessment used for both augmentation and replacement programs uses VCR as a key input.

Several projects were included in the bottom-up capex forecast that have not been incorporated in the proposed program. These projects have some uncertainty around timing or need and include IT projects relating to 'Power of Choice' and the roll-out of Ground Fault Neutralisers to reduce the risk of bushfire ignition.

Pole replacement is the largest single asset replacement component. Pole replacement rates have increased as timber poles rot and no longer have sufficient strength to remain in service. Pole reinforcement (staking) provides a means of extending the life of a pole. The pole replacement expenditure forecast assumes that new methods of timber and steel pole reinforcement can be adopted to enable poles that would otherwise require replacement to remain in service.

Limited asset condition data is available for some assets such as underground cables. Age based modelling suggests that large programs of replacement are warranted however there is uncertainty around the size of replacement programs. The expenditure forecast has been based on historical levels of expenditure which are significantly smaller than a forecast based on age based modelling.

A bottom up forecast of replacement expenditure includes a provision for every asset category. A number of categories have not been included in the forecast such as insulators and pole top capacitors.

The risks associated with these top-down adjustments have been considered. The risks associated with the deferral of projects are primarily an increased probability of network outages. The risks associated with other adjustments are that unforeseen expenditure will be necessary requiring a reprioritisation of works or spending in excess of regulatory allowances.

8.3 Estimating and Unit costs

The project cost estimates[7] used to develop the EDPR capital expenditure forecast are on the basis of *P(50) estimate* outcomes. A *P(50) estimate* outcome does not include the *Management Reserve* derived for a project.

A project's *Management Reserve* allowance is used to cover "uncertainty" in the project and is released to the project manager through a change management process.

8.3.1 Estimating principles

AusNet Services' estimates are founded on five key principles, they are:

- All projects are to be project managed in accordance with the AusNet Services project execution procedures & practices;
- for Business Case approval and implementation, P(90)[8] estimates provide confidence in processes of project priority, affordability and strategic fit;
- estimates are subject to reviews and a sign-off process based on consistent clear lines of responsibility and accountability that will ensure costing standards and controls are applied to any budget information that is to be released;
- regular system reviews are conducted to encourage and facilitate continuous improvements; and

[7] Project Coat Estimate Methodology Electricity Distribution Pricing Reset (EDPR) 2015/16-2019/20.

[8] A P(90) estimate is a cost estimate where there is 90% confidence that this cost will not be exceeded at project completion.

- project learnings will be shared to increase corporate knowledge.

8.3.2 Estimating rationale

The projects developed by AusNet Services and information provided in the EDPR submission are based on needs in order to address asset condition, safety, and regulatory obligations in its distribution network. Identifying and funding the highest priority works to meet these needs, and delivering them through an efficient program, is underpinned by sound project cost estimation.

A conservative but realistic view of the project scope is taken together with the associated Project Components and Project External Uncertainties, particularly in the early project stages when detailed design is yet to be produced. Estimators make provision for items that are considered likely to be required, having regard to such inputs as environmental determinants and community input on the final project scope. Such items are included as Provisional Items.

All estimates include a detailed consideration of project costs, including project definition, engineering and management. These costs may be estimated using typical values or estimated on a first principles basis, taking into account the expected personnel required for the project and their costs. Estimates are applicable only to a particular project scope, or range of scopes or program of works, which are defined as part of the estimating process.

8.3.3 Unit costs

The unit rates used to estimate projects and asset replacements relating to zone substations are compiled based on AusNet Services' database. This database is built up using a bottom up approach, with labour and materials itemised individually. The database is reviewed and updated on an annual basis.

Zone substation unit rates are divided into three key categories: line, primary and secondary. Each category will consist of its stand-alone components with various functions. For example - primary unit rates will consist of individual rate for the capacitor bank, reactor, circuit breaker, neutral earthing resistor, isolator, current transformer, voltage transformer, modular switch room including switch gear and its associated secondary equipment, power transformers, etc. Unit rates in this example are inclusive of civil, primary equipment and associated secondary works, unless otherwise specified.

The unit rates used to forecast costs of lines related works, including the majority of the safety related expenditure, are based on the historical rates. These rates are calculated by summing the direct costs incurred for each category of asset replacement over a 12 month period and dividing this by the volume of replacement activities

8.4 Relationship between forecast and RINs

This section describes how the detailed forecast outlined in Section 12 is aligned with the data provided in the RIN.

8.4.1 Forecast categories

The Capex forecast was prepared using categories which align with the categories used by AusNet Services to manage the assets. These categories do not fully align with the categories defined in the RIN templates 2.2 – Repex and 2.3 – Augex. AusNet Services categories were used to develop the forecast because:

- Historical volumes of activities are captured for most of these categories
- Actual unit costs of undertaking replacement or augmentation in these categories were available
- Forecast categories align with organisation structure and are well understood by the team preparing the EDPR forecast.

8.4.2 Forecast methodology

The approach to forecasting is described in Sections 8.1 and 8.2. The approach to estimating and development of unit rates is described in Section 8.3. Section 12 describes the forecast including:

- A brief description of each category
- The main drivers of the expenditure

- Volumes of activities
- Total costs of each category
- The scope of each category
- Benefits of the expenditure

The unit rates used to develop the total category costs shown in Section 12 are provided in the document titled Unit Rates EDPR. The Capex forecast was prepared in 2014 and consequently the unit rates in the document and all the costs in Section 12 are expressed in $2014.

The forecast prepared in the categories described in Section 12 forms the input to the AusNet Services Capex model.

8.4.3 Populating the RIN

The RIN was populated after the Capex forecast (developed in AusNet Services' categories) was prepared. The following approach was used:

- Where the asset categories used by AusNet services fully align with the categories defined in the RIN template, the replacement volumes and respective expenditure were directly allocated to that category.
- If the asset categories used by AusNet Services did not fully align with the categories defined in the RIN template, the following methods were used where appropriate:
  - Apply historic RIN category average weightings of asset cohorts to forecast replacement volumes
  - Apply the weighting of the calculated volumes to determine the asset category's expenditure
  - Convert units from the Capex forecast to appropriate units for the RIN
  - Assign asset volumes to the most relevant category based on subject matter expert knowledge and experience
  - Create new 'Other' asset categories for assets that do not fit into categories defined by the AER
  - For zone substation rebuilds, the indicative estimates were used to allocate expenditure to each voltage type and asset class, then based on the scope of works, expenditure and volumes were applied using appropriate methods mentioned above.
- Escalation was applied to all monetary values.
- If replacement volumes were less than 1 (due to historic average weighting allocation), this volume was allocated to the subsequent year to represent a unit that is whole. Its expenditure was also moved to the subsequent year.
- If replacement volumes had decimal points (due to allocation by historic average weightings), the volumes were rounded to the nearest whole number.

9 Asset Replacement Modelling

The AER has developed a model to forecast asset replacement expenditure – the REPEX Model – and has used this to produce benchmark expenditure levels for the NSW regulatory review process. The AER REPEX Model has been considered by AusNet Services as a point of comparison and reference for the Replacement forecasts generated by AusNet Services using bottom up build with various adjustments and constraints applied. The AER REPEX model has been populated using age profile data prepared for the 2014 RIN, unit rates used in the preparation of the bottom up EDPR forecasts and asset lives derived from a combination of historic asset performance data and risk modelling.

The AER REPEX model replacement capex forecast is significantly higher than (approximately double) the AusNet Services replacement forecast for the 2016 to 2020 period. However, the AER REPEX model appears to include replacement of all assets with zero remaining life at the start of the forecast resulting in very high forecast AER REPEX for the first 2-3 years. The long term average of the AER REPEX model forecast, excluding these initial high forecast years, is approximately $256 million per annum. The total for a 5 year period based on this long run average is approximately $1,280 million. The 5 year AusNet Services replacement capex forecast (approximately $820 million) is comparable although still significantly lower than the AER REPEX model suggests.

10 Risk

Corporate and asset related risks are key to the development of asset management plans for the Electricity Distribution network. AusNet Services operates a corporate Risk Management Framework[4] utilising the principles of ISO 31000 "Risk management – Guidelines on principles and implementation of risk management", 2007 to assess a range of business risks. Corporate risks and control measures are registered using AusNet Services' risk management information system, CURA. Asset risks are quantified through the application of Reliability Centred Maintenance (RCM) techniques.

The capital program will replace selected high-risk assets in the distribution network where economic analysis confirms there is a net benefit.

Network risk arises from a number of causes including:

- Asset failure (pole falls over, conductor breaks, transformer short-circuits, etc);
- External damage (tree falls on line, car hits pole, etc);
- Network overloading (network has insufficient capacity to supply required load);
- Weather (lightning strike, wind blows over pole, etc);
- Malicious damage (theft of copper, vandalism, terrorism, cyber-crime, etc);
- Flooding (kiosk under water, etc).

Management of the electricity distribution network involves mitigating all these risks, however, asset failure, external damage (primarily through trees and branches contacting overhead lines), and network overloading are the key risks that drive expenditure. Asset failure risks are commonly mitigated by ensuring that deteriorated equipment is replaced before it fails in-service (capital expenditure). External damage risk arising from trees and branches is primarily mitigated by operational programs involving vegetation cutting and clearing. Network overloading risk is mitigated through network augmentation or demand-side response to peak loading.

10.1 Capital expenditure program

AusNet Services' proposed network capital expenditure program comprises four major components with different types and levels of risk associated:

Table 2: Network Capex Categories

Capex Category	Proportion of Network Capex
Customer connections	22%
Network augmentation	4%
Asset Replacement	44%
Safety & environmental	29%

Note: The percentages shown in Table 2 are the proportions of Network Capex not Total Capex.

Customer connections expenditure is directed at meeting connecting AusNet Services' obligation to connect new customers to the network as the network grows.

Network augmentation expenditure is directed at providing additional capacity in areas where load grows. Augmentation expenditure can be deferred and the primary consequence of deferral is network overloading. Network overloading can lead to network outages (unserved energy) or damage to network components (such as transformer failure due to overheating).

Asset replacement and Safety & environmental expenditure are the major categories of expenditure and are the categories where trade-offs can effectively be made between risk and expenditure.

10.2 Asset Replacement

Most asset replacement capital expenditure is intended to prevent the consequences of asset failure. The major consequences of asset failure are:

- Failure to supply energy (unserved energy);
- Fire ignition;
- Electric shock (to employees, public and animals);
- Environmental damage (oil leaks); and
- Damage to other network components.

Secondary consequences such as physical damage to a person or property resulting from an asset failure also exist. Examples of these consequences include a pole falling on a car and an exploding transformer bushing injuring a person at a zone substation.

Most asset replacement risk arises from seven asset types and over 80% of forecast asset replacement expenditure is targeted at these assets. These asset types and the consequences of failure relating to each asset type are shown below.

Table 3: Consequences of failure - Major Asset types

Asset Type	Major Consequence	Secondary Consequences
Poles	Failure to supply energy	Fire ignition, electric shock
Pole top structures (cross-arms, insulators, etc)	Failure to supply energy	Fire ignition, electric shock
Conductor	Fire ignition	Failure to supply energy, electric shock
Distribution transformers (pole and ground types)	Failure to supply energy	Fire ignition, environmental damage
Zone substation transformers	Failure to supply energy	Environmental damage, damage to other network components
Zone substation circuit breakers	Failure to supply energy	Environmental damage, damage to other network components
Zone substation instrument transformers	Failure to supply energy	Environmental damage, damage to other network components

The impact of the forecast asset replacement expenditure and an assessment of risk are shown in Table 4.

Table 4: Asset Type Risk Assessment

Asset Type	Program	Risk Assessment
Poles	Replace when measured wood thickness indicates failure is imminent	Maintains risk
Pole top structures (cross-arms, insulators, etc)	Replace when visual assessment indicates failure is imminent	Risk reduction arising from replacement of HV timber cross-arms with steel. , Large volume of replacements resulting from current condition of cross-arms will lead to a better average condition.
Conductors	Replace based on condition assessed by inspectors[9]	Maintains risk
Distribution transformers (pole and ground types)	Visual inspection. Replace either on failure or when external indicators such as oil leaks indicate replacement is necessary.	Maintains risk
Zone substation transformers	Closely monitor transformer condition. Replace some transformers based on risk and condition in rebuild projects. Undertake refurbishment works for other transformers. Repair or replace failed transformers.	Increasing risk. The high cost of transformer replacement coupled with lower Value of Customer Reliability (VCR) makes economic replacement of power transformers difficult. Consequently, transformer failure rates are expected to increase.
Zone substation circuit breakers (CBs)	Replace both in station rebuilds and in CB replacement programs based on risk and condition.	Small reduction in risk as volume of replacements leads to reducing average CB age and failure rate. Also, new technology CBs carry less environmental risk due to less oil.
Zone substation instrument transformers	Replace both in station rebuilds and in instrument transformer replacement programs based on risk and condition.	Maintains risk.

10.3 Safety and Environmental Program

Over 90% of the Safety and Environmental program (29% of total Network Capital expenditure) is targeted at reducing the risk of bushfire ignition.

31% of the proposed Safety and Environmental expenditure involves fitting armour rods and vibration dampers, and eliminating the risk from some overhanging trees by undergrounding or installing insulated conductors. This work will be undertaken to meet obligations arising from the findings of the Victorian Bushfire Royal Commission. 15% of the proposed expenditure is Government funded work involving undergrounding or insulating high bushfire risk lines.

The remaining program of work (approximately 50% of the Safety and Environmental program) is targeted at reducing the risk of bushfire ignition by:

- Replacing deteriorated overhead conductor in high fire-loss areas;

[9] A program of conductor replacement is also included in the Safety & Environmental category.

- Installing enhanced zone substation protection systems which reduce fault current and reduce the risk of bushfire ignition (REFCL or GFN). This expenditure is proposed as a Pass Through;
- Replacing overhead hardware that has the potential to ignite a fire such as EDO fuses;
- Installing enhanced protection systems that can detect downed conductors, sectionalise network segments and reduce fault currents;
- Animal and bird proofing overhead network components to reduce the risk of fire resulting from a flashover due to animal or bird contact.

The risk to the public of electric shock is managed by routine asset replacement programs including:

- Overhead service cable replacements
- Pole, cross-arm and conductor replacements
- Zone substation and regulator fence replacements
- Secondary (protection) replacements.

The planned asset replacement programs should maintain the risk of electric shocks at current levels.

10.4 Risk Summary

The proposed program of work will result in an overall reduction in risk due to the large program of work targeted at reducing the risk of bushfire. The risks[10] arising from asset failure, other than bushfire ignition, should be maintained at approximately their current level. Similarly, the proposed capital program should maintain environmental and network overloading risks at their current level.

[10] The risk associated with ageing power transformers is constant as the consequence of the asset failure is lower due to lower VCR but the probability of failure is higher with deteriorating asset condition.

11 Deliverability

11.1 Deliverability of Proposed Program

The proposed annual program of Capital and Operational works is smaller than the program delivered in 2014 and encompasses similar activities, therefore the proposed program is not expected to present particular delivery challenges.

The following sections describe how AusNet Services is structured and organised to deliver the works program, initiatives undertaken in the current regulatory period to improve delivery, and how the approach results in efficient delivery.

11.1.1 Structure

A simplified version of AusNet Services' structure showing responsibilities for key components of the Capital and Operating program is shown in Figure 8. The Asset Management division is the group responsible for developing the overall program of Capital and Operating works. The Service Delivery division is responsible for delivering the program. Service Delivery is most affected by the size of the works program as the physical resources to deliver the program are retained or engaged by this division.

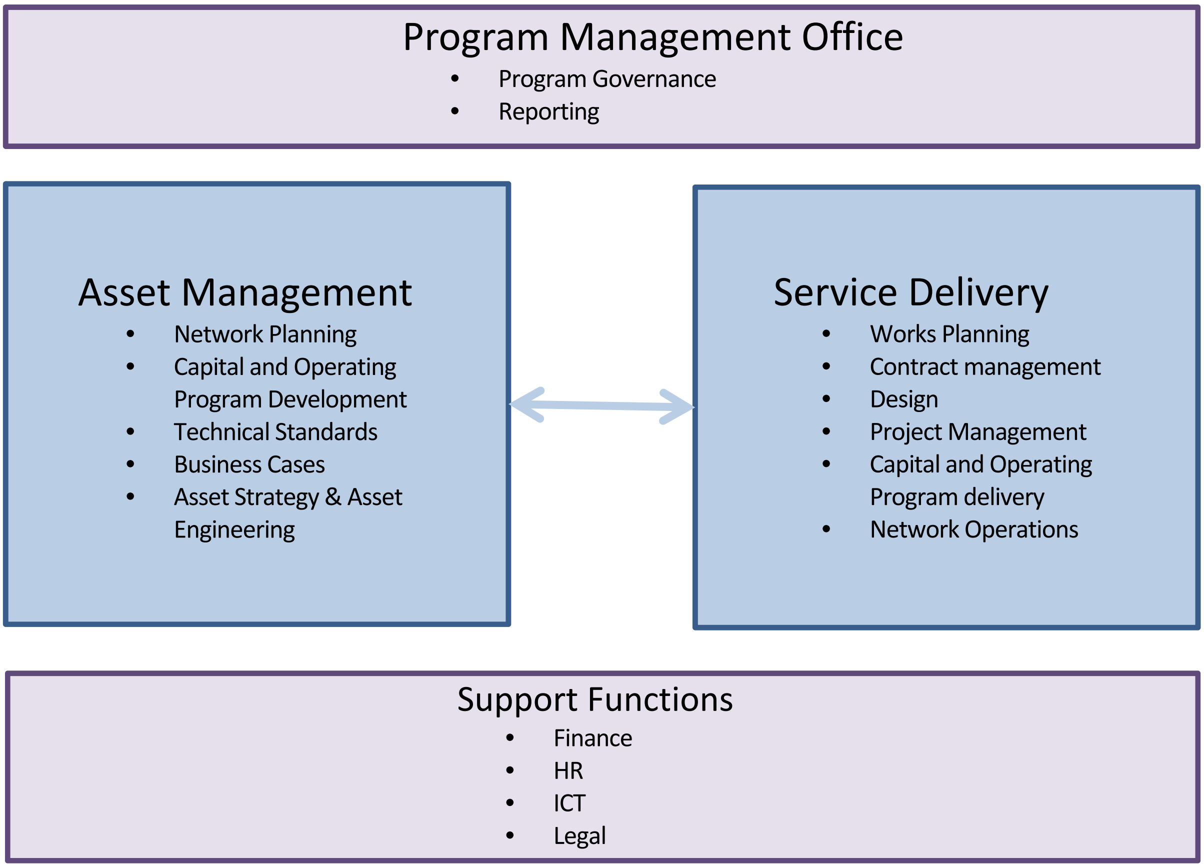

Figure 8: Simplified Organisational Structure

11.1.2Operating Model

Service Delivery utilises a regional based structure with a hybrid operating model to deliver the works program as shown in Figure 9.

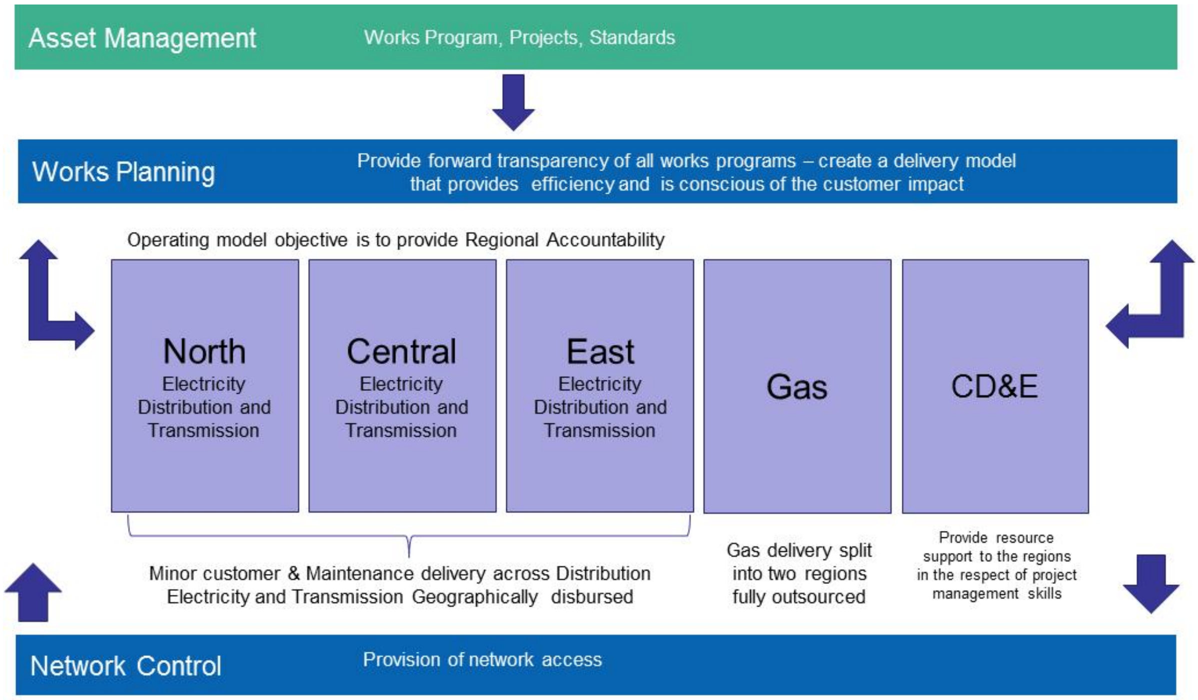

Figure 9: Service Delivery Regional Operating Model

Each of the regions is accountable for delivery of customer connections, maintenance and capital works programs. The regions are supported by:

- Network Control (CEOT);
- Works Planning;
- Capital Delivery and Engineering;
- Corporate functions including ICT, Legal and HR.

CEOT incorporates the control room, outage planning and network operations. Works Planning plans the delivery of the complete program and ensures a balance between work volumes and available resources. Capital Delivery and Engineering undertakes design, manages the delivery of major projects such as zone substation rebuild projects, and provides project management support to the regions.

A hybrid operating model is utilised to deliver the program of works. This hybrid involves a mix of internal and external resources. The main elements of the model are:

- Internal teams dedicated to faults, minor capital and customer works;
- A mix of internal and fully outsourced teams by geographic location delivering comparable works programs;
- Capital Panels established to provide top-up resources for minor capital and capital surplus works in each region;
- Major Capital Panels established to facilitate efficient and safe delivery of major works.

The hybrid operating model is shown diagrammatically in Figure 10.

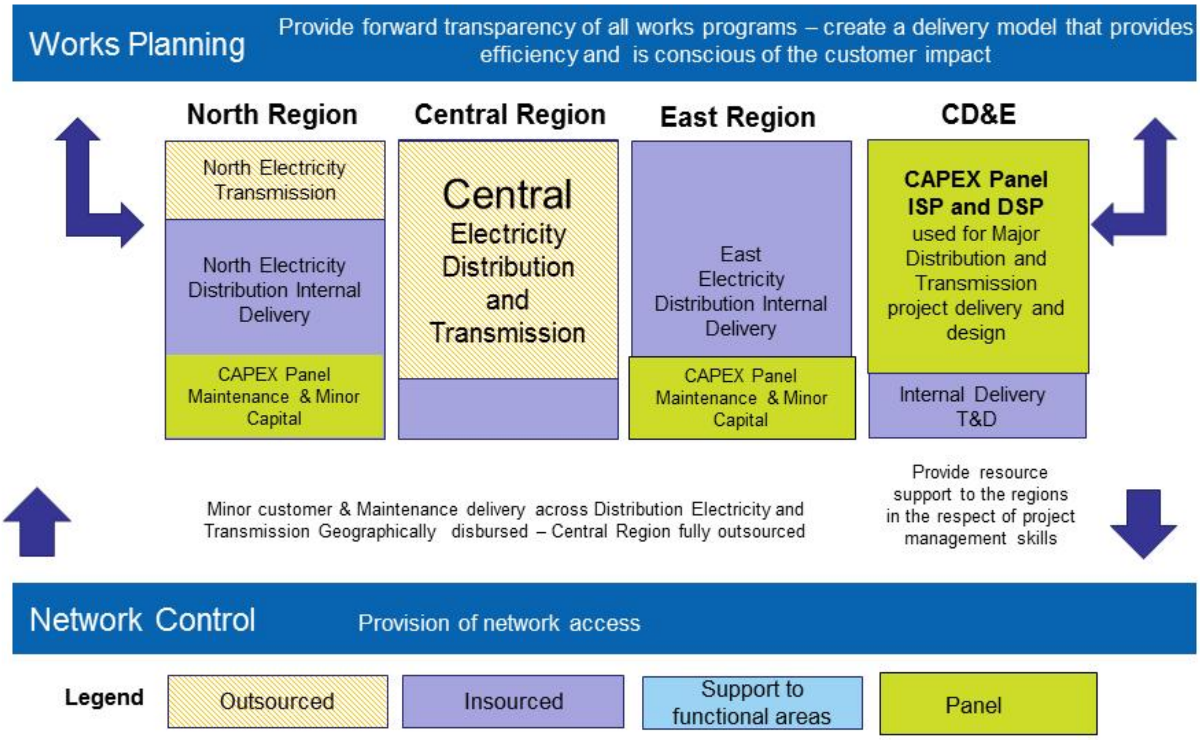

Figure 10: Service Delivery Regional Operating Model

11.1.2.1 Initiatives to improve delivery

Several initiatives have been undertaken to improve the delivery of the works program. These include:

- Establishment of the Enterprise Program Management Office (EPMO);
- Selection of Design and Installation Service Providers to a panel of service providers;
- Project PUMA, involving selection of single supplier under a long-term contract to deliver works in the Central region;
- Works integration to bundle works by distribution feeder.

The EPMO ensures appropriate governance of projects throughout the project lifecycle and provides consistent project reporting which assists in the delivery of the program and ensures that appropriate action is taken to resolve any project and program issues.

Pre-qualified panels of Design Service Providers (DSPs) and Installation Service Providers (ISPs) have been established to undertake design and installation works for major projects such as zone substation rebuilds. These panels were established by competitive tender and ensure that providers have the skills and resources to undertake the required work in a safe and competent manner and can comply with works management processes.

Project PUMA established a long-term contract with a supplier of services in the Central region. The contract contains a number of innovative features including incentives to innovate and a transparent, open-book approach to costs with benefits sharing. The contract rewards the service provider for achieving excellent results by allowing annual extensions up to a full term of ten years.

Works integration involves bundling various types of work by region and feeder. For example, customer works, asset replacements, inspections and defect repairs are bundled together to minimise the impact on customers, reduce the volume of outage applications, and minimising travel time.

11.1.2.2 Efficient Delivery

The combination of insourcing and outsourcing provides a sufficient pool of resources to complete the planned program while ensuring flexibility. When peaks of work arise, additional external resources are engaged to meet the peak workload. These additional resources are not retained when the volume of work reduces, ensuring that internal resources are always fully occupied.

The establishment of pre-qualified panels of service providers using a competitive process ensures efficient costs and appropriate quality of services provided. Further, the cost and time taken to engage resources on a project is reduced.

The engagement of a single contractor to undertake the majority of work in the Central region under an innovative contract ensures that work is undertaken safely and with appropriate quality while providing a reward to drive sustainable cost reductions.

The combination of regions and insourced and outsourced work provide opportunities for comparison and benchmarking of activities including costs, response and quality. This provides a sound basis for improvement of work processes to maximise efficiency.

The integration of both Distribution and Transmission functions provides synergies in areas such as plant procurement, zone substation design, regional management and administrative overheads.

12 Forecasts

All forecasts set out in this section are expressed in $2014 P50 direct costs only. The forecasts do not include overheads or cost escalations. The forecast capital expenditure for each category only includes capital expenditure which is required to meet the capital expenditure objectives as stipulated in section 6.5.7 of National Electricity Rule version 66.

Some asset category forecasts were prepared over a 5-year period and the resulting volume forecast can result in a fraction of an asset replacement in each year. Asset replacement volumes have been rounded down or up to the closest whole number in the tables in this section. However, expenditure forecasts for the same asset categories are based on replacement of a fraction of an asset. In these cases, such as the forecast for Bare Conductor replacement in Table 17 and Table 18, forecast expenditure for each year of the regulatory period is constant but the volume of assets to be replaced is higher in one or two years than the other years.

AusNet Services' total CAPEX forecast (including non-network forecasts incorporated for completeness) for the 2016-2020 regulatory period is shown in Table 5.

	$(000's)					
Categories	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Customer Connections	66,444	65,166	64,553	61,548	61,131	318,842
Network Augmentation	7,823	19,114	16,137	10,205	9,849	63,128
Asset Replacement[11]	137,887	128,694	126,286	126,519	117,714	637,100
Safety, Security and Environment	110,345	77,613	78,107	77,770	76,903	420,739
Non-Network	38,124	37,928	37,780	36,426	21,261	171,519
TOTAL	*360,610*	*335,526*	*329,873*	*312,456*	*290,368*	*1,628,834*

Table 5 – AusNet Services' total CAPEX forecast for the 2016-2020 regulatory period.

12.1 Customer Connections

Customer connection expenditure is directed at connecting new customers to the network as the network grows. These connections account for 19%of the total CAPEX forecast. Forecast expenditure and forecast number of new customer connections are shown in Table 6 and Table 7 respectively.

Customer Connections	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Expenditure (in $000's)	66,444	65,166	64,553	61,548	61,131	318,842

Table 6 – Customer connections expenditure forecast for the 2016-2020 regulatory period.

Customer Connections	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Volumes	14,326	14,101	13,958	13,448	13,365	69,198

Table 7 – Number of forecast customer connections.

Scope of works:

- Connect new customers to the network.

[11] Includes SCADA & Network control

Benefits and Investment drivers:

- Compliance

Related documents:

- AMS 20-30 Demand Forecasting Procedure

12.2 Network Augmentation

Lower forecast demand growth and the successful implementation of demand management techniques is driving a significant reduction in augmentation capex. The proposed augmentation capex for 2016-2020 is approximately 4% of the total network capex program, and is focussed on the high growth, residential estate corridors in the Central region of AusNet Services' network. No new zone substations, no additional zone substation transformers and only one sub-transmission line augmentation are forecast in the 2016-20 period.

12.2.1 Sub-Transmission Augmentation (Zone Substations and 66kV Lines)

A single sub-transmission project is proposed to improve supply security to customers in the growing northern suburbs of Melbourne. The project is the subject of a completed regulatory test but has been deferred as it is not economic to commence the augmentation until 2016. This deferral is due to the reduced VCR.

Sub-Transmission Augmentation	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	779	8,191	2,654	0	0	11,624

Table 8 – Sub-transmission augmentation expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Construct a new 66 kV line between Kalkallo (KLO) and Doreen (DRN) zone substations to reinforce the existing radial 66 kV line from South Morang Terminal Station (SMTS) to KLO zone substation.

Benefits and Investment drivers:

- Improve supply security to the increasing customer demand at KLO.
- Regulatory Investment Test conducted with the outcome favouring network augmentation.

Related documents:

- Network Consultation – Maintain reliability of electricity supply to Kalkallo Zone Substation customers
- Network Conclusions Report KLO-DRN 66kV Line.

12.2.2 Distribution Feeders

New and augmented distribution feeders are required to meet load growth associated with developing suburbs.

Distribution Feeders	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	1,043	4,923	7,482	4,705	4,348	22,503

Table 9 – Distribution feeders expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Establish 5 new high voltage distribution feeders and upgrade the capacity of 11 existing feeders to complete a program of 16 high voltage distribution feeder augmentation projects

Benefits and Investment drivers:

- Meet the supply requirements of customers
- Network reliability

Related documents:

- AMS 20-12 Capacity
- AMS 20-16 Distribution Network Planning Standards & Guidelines
- AMS 20-35 Network Support Services

12.2.3 Distribution Substations and LV

Ongoing investment in distribution substations and low voltage networks is necessary to meet localised load growth including growth in embedded generation. Expenditure in this category is also required to address power quality issues that result from change in load, generation or energy use.

A program of augmenting overloaded distribution transformers will continue over the forecast period and expected to decline in 2019 and 2010. Partially offsetting this forecast reduction in augmentation of distribution transformers is the need to increase investment in correcting power quality. A comparative report of power quality by Power Quality Australia (University of Wollongong) suggests that the power quality of AusNet Services' network is poorer than most other participants in the study. The results of this study combined with increasing volumes of embedded PV generation suggest that additional expenditure may be required to address these issues.

Distribution Substations and LV	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	6,000	6,000	6,000	5,500	5,500	29,000

Table 10 – Distribution substations and LV expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Upgrade distribution transformers (including SWER networks)
- Upgrade low voltage supply circuits
- Upgrade fuses and switches necessary to meet growth
- Power quality related augmentation

Benefits and Investment drivers:

- Network reliability
- Quality supply to consumers by addressing overloads

Related documents:

- AMS 20-12 Capacity
- AMS 20-15 Quality of Supply

12.3 Asset Replacement

The proportion of network capex for replacement of assets is forecast to increase from approximately 28% (2011-2015) to approximately 44% of the network CAPEX forecast in the 2016-2020 regulatory period. The specific asset categories driving increased expenditure include poles, cross arms, conductor and zone substation major rebuild projects.

12.3.1 Poles

Summary:

AusNet Services has over 372,000 poles in the distribution network. Approximately 55% of poles are located in areas classified as hazardous bushfire risk areas (HBRA). Poles are inspected on a cyclic basis and where poles are assessed to be unserviceable they are scheduled for replacement or reinforcement (staked).

Most poles that require replacement are wood poles that have an insufficient cross-sectional area of sound wood to maintain their required structural strength. The pole replacement program is based on asset condition and failure modes including termite rot, pole fires, bush fires and vehicle accidents. The following three variable factors are used to determine the volume of poles replaced each year:

- Volume of poles downgraded by inspectors
- Suitability of downgraded poles for economical remediation by staking
- Deterioration rates of the population of wood poles already supported by stakes

The development and implementation of a new staking system is now a priority to economically and safely extend the service life of a wider range of deteriorating wood poles. The forecast has assumed that a new staking system can be successfully implemented and therefore the forecast rate of staking poles increases each year of the forecast period.

The forecast expenditure and replacement rates per year for pole replacements and poles staked are shown in Table 11 and Table 12 respectively.

Expenditure (in $000's)	2016	2017	2018	2019	2020	Total
Pole Replacements	40,392	35,399	31,824	29,421	26,993	164,030
Poles Staked	1,003	1,452	1,801	1,970	2,139	8,365
Total	*41,395*	*36,851*	*33,625*	*31,391*	*29,132*	*172,394*

Table 11 – Pole replacements and poles staked expenditure forecast for the 2016-2020 regulatory period.

Volumes	2016	2017	2018	2019	2020	Total
Pole Replacements	3,747	3,233	2,835	2,642	2,447	14,904
Poles Staked	1,147	1,661	2,060	2,253	2,447	9,568
Total	*4,894*	*4,894*	*4,895*	*4,895*	*4,894*	*24,472*

Table 12 – Pole replacements and poles staked volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Stake unserviceable poles where practical and economic
- Where staking is not practical or economic, replace unserviceable poles and associated cross-arms, insulators and switchgear.
- Includes timber, steel and concrete pole replacements
- Includes pole replacements driven by deterioration and damage
- Volume of poles to be replaced per year is shown in Table 12.

Benefits and Investment drivers:

- Maintain public safety
- Prevent bushfire ignition
- Network reliability

Related documents:

- AMS 20-70 Electricity Distribution Network – Poles

12.3.2 Cross-arms

Summary:

AusNet Services has over 190,000 steel and 55,000 timber HV cross-arms, and 170,000 timber LV cross-arms supporting 66kV sub-transmission lines, 22/11/6.6 kV and LV circuits. Approximately 55% of cross-arms are mounted on poles located in areas classified as high bushfire risk. Cross-arms are inspected at regular intervals and are assigned as serviceable or having limited life. The majority of cross-arm replacements are timber and approximately 45,000 cross-arms (including in-service failures) are planned to be replaced in the forecast EDPR period.

The cross-arm replacement program is based on asset condition and failure modes including timber rot and termite infestation, mechanical failures, bush fires and vehicle accidents. Factors taken into consideration to determine the volume of cross-arms replaced each year are as follows:

- Fire ignition mitigation
- Incidental failures
- Reliability mitigation – replacement of deteriorated cross-arms on condition in accordance to the criteria in the Asset Inspection Manual (4111).

The forecast expenditure per year for cross-arm replacements is show in Table 13 and their respective replacement rates are shown in Table 14. Note: Sub-transmission cross-arms are included in the category 'HV Cross-arms'.

Expenditure (in $000's)	2016	2017	2018	2019	2020	Total
HV Cross-arms	11,807	11,224	10,641	10,059	9,476	53,207
LV Cross-arms	14,471	13,757	13,042	12,328	11,614	65,212
Total	*26,278*	*24,981*	*23,683*	*22,387*	*21,090*	*118,419*

Table 13 – HV and LV cross-arms expenditure forecast for the 2016-2020 regulatory period.

Volumes	2016	2017	2018	2019	2020	Total
HV Cross-arms	3,748	3,563	3,378	3,193	3,008	16,889
LV Cross-arms	6,381	6,066	5,751	5,436	5,121	28,756
Total	*10,129*	*9,629*	*9,129*	*8,629*	*8,129*	*45,645*

Table 14 – HV and LV cross-arms replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace cross-arms and associated insulators and fittings

- Number of cross-arms to be replaced per year is shown in Table 14

Benefits and Investment drivers:

- Maintain public safety
- Reduce risk of bushfire ignition
- Network reliability

Related documents:

- AMS 20-57 Electricity Distribution Network – Cross-arms

12.3.3 Conductor

Summary:

AusNet Services has over 38,000 km of bare overhead conductor and approximately 143 km of HV ABC in its electricity distribution network. The conductor forms 429,000 spans of low voltage (LV), medium voltage (MV) and high voltage (HV) circuits. There are four types of conductors used; galvanised or aluminised steel strands, aluminium conductor with steel reinforcing strands (ACSR), all aluminium strands (AAC) and copper strands. HV ABC contain 3 different types, including non-metallic screened aerial bundle cable (NMS ABC), light duty metallic screened (LDMS) and insulated unscreened conductor (IUC).

Two conductor replacement programs are proposed. The first program targets the replacement of conductor in bushfire risk areas and the second targets conductor in other areas.

Conductor replacement is included in the Enhanced Network Safety program to reduce the risk of bushfire ignition. The conductor Asset Management Strategy (AMS)[12] identifies the length of conductor that should be replaced to meet "so far as is practicable" (SFAIP) safety obligations. Copper (Cu) and galvanised steel (SC/GZ) are the main conductor cohorts requiring targeted asset replacement to reduce the risk of bushfire ignition. The Fire Loss Consequence Model (FLCM) was used to determine the volume of conductor that should be replaced to meet SFAIP obligations. Replacement volumes of conductor outside bushfire risk areas are forecast based on asset condition. These volumes include a component based on historical replacement volumes where conductor is inspected and badly deteriorated spans are replaced plus a component where deteriorated asset condition makes proactive replacement of longer sections of conductor economic. Forecast expenditure and volumes are shown in Table 15 and Table 16 respectively.

Following an escalation in HV ABC failures, some of which resulted in fire ignitions over the 2013/14 summer, a program was established to accelerate an initially longer term program for replacement of deteriorated HV ABC. The accelerated program is focussed in the Mt Dandenong area. The HV ABC conductor program in the Enhanced Safety Program commenced in 2014 and a large proportion will be completed in the 2011-15 regulatory period. The remaining 10km of conductor will be replaced during 2016. In addition to this program targeting conductor in bushfire risk areas, another program has been established to replace HV ABC cables that are in the poorest condition and are exhibiting high failure rates indicating end-of-life. This program will replace HV ABC that is not located in bushfire risk areas.

Safety Program Expenditure (in $000's)	2016	2017	2018	2019	2020	Total
Bare Conductor	15,067	15,067	15,067	15,067	15,067	75,337
ABC	4,680	-	-	-	-	4,680
Total	*19,747*	*15,067*	*15,067*	*15,067*	*15,067*	*80,017*

Table 15 – Bare conductor and ABC safety program expenditure forecast for the 2016-2020 regulatory period.

[12] AMS 20-52 Conductor.

Safety Program Volumes (in km's)	2016	2017	2018	2019	2020	Total
Bare Conductor	269	269	269	269	269	1,345
ABC	10	-	-	-	-	10
Sub-total	279	269	269	269	269	*1,355*

Table 16 – Bare conductor and ABC safety program replacement volumes forecast for the 2016-2020 regulatory period.

The replacement volumes and costs shown in Table 17 and Table 18 are in addition to the volumes and costs shown in the tables above.

Replacement Expenditure (in $000's)	2016	2017	2018	2019	2020	Total
Bare Conductor	7,153	7,153	7,153	7,153	7,153	35,763
ABC	-	4,530	4,530	4,530	4,530	18,121
Total	*7,153*	*11,683*	*11,683*	*11,683*	*11,683*	*53,885*

Table 17 – Bare conductor and ABC replacement program expenditure forecast for the 2016-2020 regulatory period.

Replacement Volumes (in km's)	2016	2017	2018	2019	2020	Total
Bare Conductor	38	39	38	39	38	192
ABC	-	9.5	9.5	9.5	9.5	38
Total	*38*	*48.5*	*47.5*	*48.5*	*47.5*	*230*

Table 18 – Bare conductor and ABC replacement program replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace 269 km of bare conductor circuits per year in bushfire risk areas with insulated underground cable, HV ABC or covered conductor cable systems.
- Replace 10 km of HV ABC in 2016 to complete the HV ABC conductor replacement program as part of the Enhanced Safety Program.
- Replace approximately 38km of bare conductor per year in planned programs.
- Replace 38km of HV ABC between 2017-2020 in planned programs.

Benefits and Investment drivers:

- Network reliability
- Improve public safety by reducing the risk of bushfire ignition
- Compliance with Electricity Safety Regulations

Related documents:

- AMS 20-52 Electricity Distribution Network – Conductor

- AMS 20-13 Enhanced Network Safety
- AMS 20-65 Insulated Cable System

12.3.4 Zone substation major rebuild projects

Zone substation major rebuild projects target the replacement of deteriorated plant in zone substations. The projects typically include the replacement of major plant such as transformers and/or circuit breakers and often include ancillary equipment such as protection systems or panels containing asbestos. The scope of each project is determined through economic analysis of options.

Six existing major rebuild projects that commenced in the current EDPR period will be completed during the forecast EDPR period. Their scheduled completion dates are between 2016 and 2018. In addition, nine new rebuild projects are included in the zone substation major rebuild projects and four of these nine projects will be completed after 2020.

Detailed forecast expenditures for the Major Rebuild Projects for the forthcoming EDPR period are shown in Table 19.

Project Expenditure ($000's)	2016	2017	2018	2019	2020	Total
BDL Rebuild	3,010	239	0	0	0	3,249
YPS Rebuild	1,170	0	0	0	0	1,170
CLPS Rebuild	567	0	0	0	0	567
PHM Rebuild	9,791	3,110	0	0	0	12,901
MBY Rebuild	5,568	1,810	0	0	0	7,378
WGI Rebuild	3,535	5,376	1,411	0	0	10,322
MWT22 Rebuild	150	3,050	10,000	5,699	900	19,799
MYT Rebuild	0	150	3,050	4,214	1,071	8,485
LGA Rebuild	150	2,059	670	0	0	2,878
MFA Rebuild	0	150	2,300	5,368	1,539	9,357
TT Rebuild	0	150	3,800	4,689	1,146	9,785
SMR Rebuild	0	0	0	150	9,050	9,200
MOE Rebuild	0	0	150	2,300	2,772	5,222
WT Rebuild	0	0	150	3,050	3,735	6,935
PHI Rebuild	0	0	150	1,175	1,963	3,288
Total	*23,941*	*16,093*	*21,680*	*26,645*	*22,177*	*110,536*

Table 19 – Expenditure on Zone Substation Major Rebuild Projects in the 2016-2020 regulatory period

Bairnsdale (BDL) Rebuild

Summary:

This project is one of the six existing refurbishment programs committed from the current EDPR period. It will roll over into the forthcoming EDPR period. The project started in 2013 and is scheduled for completion in 2016/2017.

Scope of works:

- New 66/22kV transformer
- Replace one 66 kV circuit breaker and six 22 kV circuit breakers
- Install new modular 22 kV indoor switchboard

- Install new control room, battery room and amenities building
- One new 22 kV feeder

Benefits and Investment drivers:

- Improve public safety
- Reliability – reduction in USAIFI
- Compliance – Maintaining voltages within required tolerances
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- Bairnsdale Zone Substation New 20/33 MVA transformer and reconfigure 66 kV and 22 kV buses (74338262 Business Case)

Yallourn Power Station (YPS) Rebuild

Summary:

YPS was established in the late 1920's to support the development of the Yallourn Power Station and the infrastructure for the establishment of the associated open-cut coal mine. This project is one of the six existing refurbishment programs committed from the current EDPR period and it will be carried over into the next EDPR period. The project started in 2012 and is scheduled for completion in 2015/2016.

Scope of works:

- Replace 66/11 kV transformer
- One new 66 kV circuit breaker

Benefits and Investment drivers:

- Improve public safety
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- YPS Zone Substation Rebuild (74285767 Business Case)
- AMS 20-120 – Replacement and refurbishment program for power transformers and station voltage regulators
- AMS 20-233 – YPS – Condition Assessment and Rebuild Options

Clover Power Station (CLPS) Rebuild

Summary:

Ownership of the deteriorated generator transformers at CLPS has been transferred to AGL. AGL will replace the transformers with an upgrade to 20/25 MVA units and introduce a 66 kV circuit breaker for switching the much larger transformers. AusNet Services' project is to interface with the AGL asset replacement project and relocate our associated secondary equipment to AusNet Services' owned Clover Flat Zone Substation. This project is one of the six existing refurbishment programs committed from the current EDPR period and it will be carried over into the next EDPR period. The project started in 2014 and is scheduled for completion in 2015/2016.

Scope of works:

- Replace 66 kV circuit breaker
- Install new control room at CF for secondary equipment

Benefits and Investment drivers:

- Improve public safety
- Network Reliability
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- Clover Power Station (CLPS) Transformer Replacement (74327859 Business Case)
- Ownership transfer to AGL – AGL letter 24 October 2013

Pakenham (PHM) Rebuild

Summary:

The condition of assets at PHM continues to deteriorate, increasing the risk of wide-spread supply outages and associated S factor revenue penalties. The asset replacements will significantly reduce supply risks in the Pakenham area and remove health and safety risks at the Zone Substation. This project is one of the six existing refurbishment programs committed from the current EDPR period and it will be carried over into the next EDPR period. The project started in 2014 and is scheduled for completion in 2016/2017.

Scope of works:

- Replace three 66/22 kV transformers with two new 66/22 kV transformers,
- Replace two 66 kV circuit breakers and two new 66kV circuit breakers,
- Install new station service transformers
- Replace nine 22 kV circuit breakers with new modular indoor switchboards
- Install new control room

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- PHM Zone Substation Rebuild and Full Switching (74336963 Business Case)

Mount Beauty (MBY) Rebuild

Summary:

The condition of assets at MBY continues to deteriorate increasing the risk of wide-spread supply outages. The 66/22 kV transformers and 66 kV regulator were installed in the early 1940's. The asset replacements will significantly reduce supply risks in the region and remove explosive failure risks at the Zone Substation. This project is one of the six existing refurbishment programs committed from the current EDPR period and it will be carried over into the next EDPR period. The project started in 2014 and is scheduled for completion in 2016/2017.

Scope of works:

- Replace two 66/22 kV transformers
- Replace station service transformer
- Replace associated secondary equipment

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduced maintenance

Related documents:

- MBY Transformer Replacement (74294706) Business Case
- AMS 20-71 Power transformers and station voltage regulators

Wonthaggi (WGI) Rebuild

Summary:

The condition of assets at WGI continues to deteriorate increasing the risk of wide-spread supply outages. The asset replacements will significantly reduce supply risks in the Wonthaggi area and remove health and safety risks at the Zone Substation. This project is one of the six existing refurbishment programs committed from the current EDPR period and it will be carried over into the next EDPR period. The project started in 2014 and is scheduled for completion in 2017/2018.

Scope of works:

- Replace transformer OLTC
- Two new 66 kV circuit breakers,
- Replace ten 22 kV circuit breakers with new modular indoor switchboards
- Replace capacitor banks
- Install new station service transformers
- Refurbish existing control room

Benefits and Investment drivers:

- Improve safety
- Improve reliability – reduced USAIFI
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- Wonthaggi ZSS Rebuild (74396064 Business Case)
- AMS 20-54 Circuit Breakers

Morwell (MWT22) Rebuild

Summary:

The transformers and circuit breakers at MPS were installed in the 1940's and 1950's. The circuit breakers at MWT were first installed in the 1950's and 1960's. The deteriorated condition of both transformers and bulk oil circuit breakers present a high risk of explosive failures to AusNet Services' personnel on site. The risks associated with plant failure are increasing and assets are becoming more difficult to maintain. The project is planned to commence in 2016 and be completed in 2019/2020.

Scope of works:

- Retire 66/11 kV and 11/22 kV transformers and replace with two new 66/22 kV transformers
- Replace eighteen 22 kV circuit breakers with three new indoor modular switchboards.
- Retire 11 kV switchboard
- Install new control room, battery room and amenities building

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- AMS 20-254 Planning Report MWT ZSS Rebuild

Myrtleford (MYT) Rebuild

Summary:

66 kV and 22 kV circuit breakers were first installed at MYT in the early 1970's. The deteriorated condition of the bulk oil circuit breakers presents a high risk of explosive failures to AusNet Services' personnel on site. The risks associated with plant failure are increasing and assets are becoming more difficult and expensive to maintain. In addition, the station configuration does not provide switching flexibility in case of internal faults i.e. any 66 kV zone or transformer fault will result in zone substation black. The project is planned to commence in 2016 and to be completed in 2019/2020.

Scope of works:

- Replace one 66 kV circuit breaker and five 22 kV circuit breakers and associated current transformers (CTs)and voltage transformers (VTs)
- Install new modular 22 kV indoor switchboard
- Refurbish control room and battery room

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- AMS 20-255 Planning Report MYT ZSS Rebuild
- AMS 10-54 Circuit breakers

Leongatha (LGA) Rebuild

Summary:

66 kV circuit breakers were first installed at LGA in the 1960's. The deteriorated condition of the bushings, CTs and VTs and to a lesser extent the minimum oil circuit breakers present a high risk of explosive failures to

AusNet Services' personnel on site. The risks associated with plant failure are increasing and assets are becoming more difficult and expensive to maintain. The project is planned to commence in 2016 and to be completed in 2017/2018.

Scope of works:

- Replace two 66 kV circuit breakers
- Replace four sets of 66 kV CTs and two VT's

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduced maintenance

Related documents:

- AMS 20-251 Planning Report LGA ZSS Rebuild
- AMS 10-54 Circuit breakers

Maffra (MFA) Rebuild

Summary:

The 66 kV switchyard at MFA was first constructed in the 1960's. Some of the 66 kV circuit breakers have now been in service for more than 50 years. The deteriorated condition of the bushings, CTs and VTs and to a lesser extent the minimum oil circuit breakers, present a high risk of explosive failures to AusNet Services' personnel on site. The risks associated with plant failure are increasing and assets are becoming more difficult and expensive to maintain. The project is planned to commence in 2016 and to be completed in 2019/2020.

Scope of works:

- Replace five 66 kV circuit breakers and associated CTs and VTs
- Upgrade 66 kV busbars
- Install new 22 kV capacitor banks
- Install new battery room and amenities building

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduced maintenance

Related documents:

- AMS 20-250 Planning Report MFA ZSS Rebuild
- AMS 20-63 Instrument Transformers
- AMS 10-54 Circuit breakers

Thomastown (TT) Rebuild

Summary:

The 66 kV and 22 kV bulk oil circuit breakers at TT were installed in the 1950's and 1960's. The deteriorated condition of the bulk oil circuit breakers present a high risk of explosive failure to AusNet Services' personnel on site. The risks associated with plant failure are increasing and assets are becoming more difficult and expensive to maintain. The project is planned to commence in 2016 and be completed in 2019/2020.

Scope of works:

- Replace two 66 kV circuit breakers
- Replace 19 outdoor circuit breakers with three new 22 kV indoor switchboards
- Install new station service transformers

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduced maintenance

Related documents:

- AMS 20-252 Planning Report TT ZSS Rebuild
- AMS 10-54 Circuit breakers

Seymour (SMR) Rebuild

Summary:

SMR zone substation commenced operation in 1955 and the condition of station assets continues to deteriorate increasing the risk of wide-spread supply outages and associated S factor revenue penalties. Bulk oil circuit breakers and transformers were installed in the 1950's. The asset replacements will significantly reduce supply risks in the region and remove explosive failure risks at the Zone Substation. The project is planned to start in 2018 and is scheduled for completion in 2020/2021.

Scope of works:

- Replace three 66/22 kV transformers with two new 66/22 kV transformers
- Replace two 66 kV circuit breakers and install an additional two new 66 kV circuit breakers
- Replace two 22 kV circuit breakers and install an additional three new 22 kV circuit breakers
- Install new control room

Benefits and Investment drivers:

- Improve safety
- Network reliability – reduced USAIFI
- Reduction in network energy at risk
- Reduced maintenance

Related documents:

- AMS 20-258 Planning Report SMR ZSS Rebuild
- AMS 20-54 Circuit Breakers
- AMS 20-63 Instrument Transformers
- AMS 20-54 Circuit Breakers

Moe (MOE) Rebuild

Summary:

MOE zone substation commenced operation in 1975. The current transformers and most of the circuit breakers have provided around 40 years of service. The physical and electrical condition of these assets has deteriorated and they are now presenting an increasing failure risk. The asset replacements will significantly reduce supply risks in the region and remove explosive failure risks at the zone substation. The project is planned to start in 2017 and scheduled for completion in 2020/2021.

Scope of works:

- Replace two 66kV circuit breakers and associated CTs
- Install new Capacitor bank
- Install new amenities room

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduction in supply risk
- Reduced maintenance

Related documents:

- AMS20-256 Planning Report MOE ZSS Rebuild
- AMS 20-54 Circuit Breakers
- AMS 20-63 Instrument Transformers

Watsonia (WT) Rebuild

Summary:

WT zone substation commenced operation in the late 1950's and the condition of the station assets including the 22 kV bulk oil circuit breakers and the 22 kV capacitor bank continues to deteriorate increasing the risk of wide-spread supply outages. The replacement of these circuit breakers will significantly reduce supply risks in the area and remove explosive failure risks at the zone substation. The project is planned to start in 2018 and scheduled for completion in 2020/2021.

Scope of works:

- Replace seventeen 22 kV circuit breakers
- Install three new modular indoor switchboards
- Replace 22 kV capacitor bank

Benefits and Investment drivers:

- Improve safety
- Network reliability
- Reduction in supply risk due to aging equipment and station configuration.
- Reduced maintenance

Related documents:

- AMS 20-257 Planning Report WT ZSS Rebuild

Phillip Island (PHI) Rebuild

Summary:

PHI zone substation commenced operation in 2003 but the condition of the single indoor Ampcontrol switchboard (purchased in 1999 and relocated from Berwick) presents a significant safety and supply security risk. The switchboard does not have acceptable arc fault containment and cannot be entered whilst alive and the loading is too high to allow an outage for modifications. Two similar switchboards have had major failures. Additionally, a number of protection schemes are not to the required standard. The project to reduce station risk is planned to start in 2015 and is scheduled for completion in 2017/18.

Scope of works:

- Install one new 22 kV circuit breaker.
- Install new 22 kV dis-connector and switches either side of switchboard
- Install new control room
- Install new protection and control

Benefits and Investment drivers:

- Improve safety
- Reduction in supply risk due to aging equipment and station configuration.
- Reduced maintenance

Related documents:

- AMS20-253 Planning Report PHI ZSS Rebuild
- AusNet Services' Distribution Annual Planning Report

12.3.5 Secondary and Protection

Protection systems are an essential part of the electricity distribution network. Protection systems operate circuit breakers to rapidly disconnect faulted circuits from the healthy network, limiting the exposure of workers and the general public to unsafe voltages. These systems also maintain network operating voltage and limit the damage to electrical plant and equipment.

Secondary systems include devices to measure network operating parameters and monitor the status of network assets. This data is essential for the effective operation of the network and improves the strategic planning and operation management of expensive primary assets.

Secondary and protection technology is constantly developing and new secondary and protection assets typically become obsolete over a 10-15 year period. This results in equipment becoming uneconomic to maintain due to incompatibility with newer equipment or because it is no longer supported by manufacturers. Additionally, some obsolete equipment does not comply with relevant industry rules. AusNet Services will focus on 14 discrete projects over the forecast EDPR period to replace obsolete secondary and protection systems. The forecast expenditure for secondary and protection is shown in Table 20.

Secondary and Protection	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	7,658	7,807	5,429	3,597	3,475	27,965

Table 20 – Secondary and Protection expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace obsolete protection relays at WGL, BWR and MFA
- Replace obsolete RTU's at WFL, BWR and 15 other sites
- Replace obsolete bus distance and line distance relays at multiple zone substations
- Continue copper supervisory replacement program

- Replace VRR's at various zone substations
- Enhance remote engineering access security
- Implement zone substation security architecture for 15 sites
- Migrate TRESIS to a SAP compatible platform

Benefits and Investment drivers:

- Compliance
- Network reliability
- Health and Safety

Related documents:

- AMS 20-72 Protection and Control Systems

12.3.6 Underground Cables

Underground insulated cable systems have been in service since the 1970's. This population of assets has significantly increased over the past two decades as most new housing is constructed in underground residential development (URD) estates using medium voltage and low voltage underground cables.

Underground insulated cable systems are currently exhibiting low failure rates. However, objective health information of the cable systems is limited as routine condition assessment of cables has not been justified. As cables deteriorate with age and failure rates increase, routine condition assessment will be required to ensure prudent future economic replacement programs are developed.

The expenditure forecast shown in Table 21 has been prepared based on 3 year historical expenditure.

Underground Cable	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	2,156	2,156	2,156	2,156	2,156	10,782

Table 21 – Underground cables expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replacement of underground cable sections following cable failure
- Replacement of underground cable joints following failure.

Benefits and Investment drivers:

- Network reliability

Related documents:

- AMS 20-65 Insulated Cable Systems

12.3.7 Distribution Transformers

AusNet Services has approximately 62,500 distribution transformers in the distribution network. Approximately 93% of distribution transformers are mounted on poles located in road reserves or on private property. The remainder are in kiosks, small outdoor switchyards or within a room in a commercial building.

Replacements are driven by winding failures initiated by lightning strikes or thermal overloads, or to prevent failures due to significant loss of insulating oil. The failure rate is expected to increase over the next decade as a larger proportion of the fleet approaches the end of its practical service life.

Over the period 2016 to 2020 the maintenance of network reliability risk, safety, quality of supply and security will require the replacement of approximately 300 distribution transformers per annum to match the deterioration of older units. The forecast expenditure and replacement rates per year for distribution transformers are shown in Table 22 and Table 23 respectively.

Distribution Transformers	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	2,158	2,158	2,158	2,158	2,158	10,793

Table 22 – Distribution transformers expenditure forecast for the 2016-2020 regulatory period.

Distribution Transformers	2016	2017	2018	2019	2020	Total
Replacement Volumes	300	300	300	300	300	1,500

Table 23 – Distribution transformers replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace distribution transformers when external inspection indicates they are no longer fit for service or when the transformer fails
- Includes associated equipment including animal proofing, fuses etc.

Benefits and Investment drivers:

- Maintain public safety
- Network reliability

Related documents:

- AMS 20-58 Distribution Transformers

12.3.8 Services

There are approximately 456,500 service cables connecting customers to low voltage (LV) circuits in the electricity distribution network.

The condition assessment of the service cable population has highlighted Neutral Screened service cables being in the worst condition. There is currently a targeted planned replacement project for Neutral Screened service cables to be replaced with Twisted Black aerial service cables.

Economic modelling of the projected failure rates indicates that a planned replacement program scheduled for completion by 2020 is more efficient than allowing the services to 'run to failure'. Modelling suggests approximately 2,000 corrective (failed) service cable replacements and approximately 4,000 declining to 3,000 preventative service cable replacements per annum for a total of 6,000 declining to 5,000 replacements each year over the next decade. The forecast expenditure and replacement rates per year for services are shown in Table 24 and Table 25 respectively.

Services	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	5,260	4,836	4,484	4,209	4,017	22,809

Table 24 – Services expenditure forecast for the 2016-2020 regulatory period.

Services	2016	2017	2018	2019	2020	Total
Replacement Volumes	6,189	5,691	5,277	4,954	4,727	26,838

Table 25 – Services expenditure replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Preventative replacement program of approximately 4,000 units per annum declining to 3,000 units per annum over the period 2016 to 2020 focused on Neutral Screened service cables.
- Replace 2,000 service cables per year after they fail or are detected faulty. Includes both overhead and underground services.

Benefits and Investment drivers:

- Maintain public safety
- Network reliability

Related documents:

- AMS 20-76 Service Cables

12.3.9 Switches and Other

This category includes the following assets:

- Surge arresters
- Switches and ACR's
- Line voltage regulators
- Pole top capacitors
- Insulators

There are 24 different types of surge arresters installed on the network. The majority of those to be replaced are porcelain types that will be replaced with polymeric types. Polymeric insulators include explosion relief features and improved fire performance.

Switches and ACR's are an integral part of managing network reliability. The majority of expenditure will involve the replacement of air-break switches due to their low reliability and high operating and maintenance costs.

The fleet of 134 line voltage regulators has an average service life of 60 years. A small replacement program is proposed which aligns with the long run average replacement volume per annum.

No replacement expenditure is planned for pole top capacitors and insulators. The forecast expenditure and replacement rates per year for all of the assets under 'Switches and Other' are shown in Table 26 and Table 27 respectively.

Switches and Other	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	6,927	6,927	6,927	6,927	6,927	34,636

Table 26 – Switches and other expenditure forecast for the 2016-2020 regulatory period.

Switches and Other Replacement Volumes	2016	2017	2018	2019	2020	Total
Surge arresters	2,800	2,800	2,800	2,800	2,800	14,000
Switches & ACRs	135	135	135	135	135	675
Line voltage regulators	2	2	2	2	2	10
Total	*2,937*	*2,937*	*2,937*	*2,937*	*2,937*	*14,685*

Table 27 – Switches and other replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace failed or damaged surge arresters following routine inspection
- Replace specific Bowthorpe, Stanger and ASEA surge arresters located in high fire risk areas in conjunction with other maintenance works
- Replace air break and gas switches, and ACRs when they are no longer operable or routine inspection indicates that replacement is required

- Replace line voltage regulators and associated equipment on failure or when inspection indicates replacement is necessary to ensure ongoing voltage regulation

Benefits and Investment drivers:

- Maintain public and worker safety
- Maintain bushfire risk by targeted replacement of surge arrester cohorts
- Network reliability
- Maintain network security and capacity by replacing line voltage regulators

Related documents:

- AMS 20-67 Line Surge Arresters
- AMS 20-60 MV Switches & ACR's
- AMS 20-68 Line Voltage Regulators
- AMS 20-66 Insulators MV

12.3.10 Zone Substation Plant

Circuit Breakers and Indoor Switchboards

There are 957 circuit breakers located in zone substations within the electricity distribution network. 18% of the circuit breaker fleet are in very poor condition. They have declining reliability, high maintenance requirements and little remaining service life. Routine maintenance is no-longer able to stabilise their declining conditions. Ongoing circuit breaker replacements in conjunction with replacements during major zone substation rebuilds are planned slow the reducing reliability of the network as asset condition deteriorates and create a safer working environment by reducing the risk of plant collateral damage from explosive failure. In addition to replacements incorporated with zone substation rebuilds, 83 additional circuit breaker replacements are forecast to address assets in poor condition and/or high risk during the 2016–2020 period.

There are no planned replacements of indoor switchboards. Allowance has been made in 2020 for 1 unplanned replacement.

The forecast expenditure and replacement rates per year for circuit breakers and indoor switchboards are shown in Table 28 and Table 29 respectively.

Circuit Breakers and Indoor Switchboards	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	4,458	4,458	4,458	4,458	5,938	23,768

Table 28 – Circuit breakers and indoor switchboards expenditure forecast for the 2016-2020 regulatory period.

Circuit Breakers and Indoor Switchboards	2016	2017	2018	2019	2020	Total
Replacement Volumes	16	17	16	17	18	84

Table 29 – Circuit breakers and indoor switchboard replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace 83 circuit breakers at 15 zone substations. The majority of these circuit breakers are of the minimum oil and bulk oil type. The bulk oil types have an average age of greater than 50 years and the 22 kV EMAIL 345GC bulk oil CB will be targeted.
- Allowance for 1 unplanned replacement of an indoor switchboard has been made.

Benefits and Investment drivers:

- Provide a safe environment for workers by removing breakers subject to explosive failure
- Network reliability
- Reduce increasing environmental risk by replacing bulk oil circuit breakers with gas or vacuum breakers
- Reduced risk of plant collateral damage from explosive failure

Related documents:

- AMS 20-54 Circuit Breakers

Power Transformers

The power transformer fleet includes 158 transformers with nameplate continuous ratings ranging from 2 MVA, to maximum continuous power ratings of 45 MVA. Over the period of 2008 to 2013, 7 major power transformer failures were experienced, driving the fleet failure rate to 0.82% per annum which is now marginally above the CIGRE Australia failure rate of 0.73% per annum.

Power transformers are replaced as part of zone substation rebuild projects or as individual replacements or following failure. Power transformer components such as bushings are replaced to extend the life of transformers.

The expenditure proposed in this category does not include the replacement of transformers in zone substation rebuild projects. This expenditure is shown in 12.3.4.

The program involves the purchase of two additional spare transformers to mitigate the risk of failure from deteriorating and ageing transformers, unplanned replacement of one transformer, and a program of component replacements.

The forecast expenditure and replacement rates per year for power transformers are shown in Table 30 and Table 31 respectively.

Power Transformers (Expenditure in $000's)	2016	2017	2018	2019	2020	Total
Power transformers	1,320	1,320	-	1,320	-	3,960
Power transformer components	1,164	1,694	1,958	1,694	1,694	8,203
Total	*2,484*	*3,014*	*1,958*	*3,014*	*1,694*	*12,163*

Table 30 – Power transformers expenditure forecast for the 2016-2020 regulatory period.

Power Transformers Replacement Volumes	2016	2017	2018	2019	2020	Total
Power transformers	1	1	0	1	0	3
Power transformer components	4	6	7	7	7	31
Total	*5*	*7*	*7*	*8*	*7*	*34*

Table 31 – Power transformers replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Purchase of spare transformer for North region (north vector group) in 2016
- Purchase of spare transformer for East region (east/central vector group) in 2017
- Unplanned replacement of one zone substation transformer (assumed to occur in 2019)
- Program of power transformer component replacements to extend life of transformers including replacement of seals, on-line tap changer replacements, bushing replacements and OTI/WTI replacements.

Benefits and Investment drivers:

- Provide a safe environment for workers by removing bushings subject to explosive failure
- Network reliability
- Maintain network security by establishing spare transformers in locations where a large number of aged and deteriorating transformers are located
- Reduced risk of plant collateral damage from explosive failure

Related documents:

- AMS 20-71 Power Transformers and Station Voltage Regulators

Instrument Transformers

There are 1,297 independent single-phase and three-phase post type current transformers and 608 voltage transformers, magnetic voltage transformers (MVTs) and capacitive voltage transformers (CVTs) in the electricity distribution network.

10% of the population of VTs and 3% of CTs are in very poor condition. The poor condition of these assets is indicated by faulty contacts and loose connections providing false readings, overheating due to internal faults, moisture ingress, oil leaks and degradation. Instrument transformers are replaced in both zone substation rebuild projects and as programs of work. Analysis indicates that 195 instrument transformers should be replaced in the forecast period. Of these, 143 will be replaced in zone substation rebuild projects. The remaining 52 instrument transformers form the programs of replacement shown in Table 33.

Instrument Transformers (Expenditure in $000's)	2016	2017	2018	2019	2020	Total
VTs	977	977	977	977	977	4,885
CTs	153	153	153	153	153	765
Total	*1,130*	*1,130*	*1,130*	*1,130*	*1,130*	*5,650*

Table 32 – Instrument transformers expenditure forecast for the 2016-2020 regulatory period.

Instrument Transformers Replacement Volumes	2016	2017	2018	2019	2020	Total
VTs	7	7	7	7	7	35
CTs	3	4	3	4	3	17
Total	*10*	*11*	*10*	*11*	*10*	*52*

Table 33 – Instrument transformers replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace 7 VTs per year
- Replace approximately 3 CTs per year

Benefits and Investment drivers:

- Maintain public and worker safety by ensuring that measuring devices for protection systems are operable
- Network reliability
- Reduced risk of plant collateral damage from explosive failure

Related documents:

- AMS 20-63 Instrument Transformers

Other Zone Substation Plant

This category includes the following assets:

- HV switches, earth switches and isolators
- Surge arresters
- Civil infrastructure
- NERs and NEDs
- Capacitor banks and reactors

Other zone substation plant includes plant and facilities necessary to house and support the safe operation and proper functioning of electrical equipment forming the zone substation.

Zone substation equipment is inspected on a cyclic basis with routine maintenance applied to many items. Inspections are used to assess the condition of the equipment with replacement programs developed where asset condition and consequence of failure indicate that it is economic to replace equipment.

The forecast expenditure for other zone substation plant is shown in Table 34.

Other Zone Substation Plant	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	2,640	2,640	2,640	2,640	2,640	13,200

Table 34 – Other zone substation plant expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace Stanger Duo Roll, Switchgear HPV and Taplin manufacture cohorts of disconnectors
- Replace gapped silicon carbide porcelain housing surge arresters with polymer type surge arresters
- Replace roofs, doors, windows; renew roads and drains as part of civil infrastructure replacements
- Replace AEI and GEC type NERs due to their frequent resistor welding failures (AEI) and poor design and older technology (GEC)
- Replace WTW type series reactors in Ampcontrol capacitor banks.

Benefits and Investment drivers:

- Health and safety
- Reduced risk of plant collateral damage from explosive failure
- Network security and reliability

Related documents:

- AMS 20-62 HV Switches, Disconnectors and Earth Switches
- AMS 20-77 Surge Arresters in Zone Substations
- AMS 20-55 Civil Infrastructure
- AMS 20-79 Neutral Earthing Devices
- AMS 20-53 Zone Substation Capacitor Banks

12.3.11 SCADA and Network Control

The electricity distribution network employs communication systems primarily for protection signalling, monitoring and control (SCADA), operational voice communications and operational data communication. The distribution communications network has grown significantly over the last six years as part of communication network expansion programs into distribution sites. It is expected the communications network will continue to grow in the next five years primarily due to modernisation.

The condition and suitability for purpose of communication assets have been evaluated based on their current performance, historical failure events and vendor supportability with spare parts and ongoing technical advice. Lack of vendor support and shortage of spare parts for legacy systems has played an important role in deciding the effect of failure and risk to business continuity.

There are a number of areas of the communication network that require attention in the forecast EDPR period. The forecast expenditure for SCADA and network control is shown in Table 35.

SCADA and Network Control	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	4,247	3,958	4,272	4,124	3,497	20,101

Table 35 – SCADA and network control expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- TRIO Remote Replacement – decommission 4 TRIO base stations at COCK and MTBW and replace 51 TRIO remotes with 3G/4G modems
- PDH Replacement Project – replace PDH nodes which have reached economic end-of-life
- SDH Replacement Project - replace SDH nodes which have reached economic end-of-life
- DIC Switches and Serial Server Replacement Project – replace switches and serial servers which have reached economic end-of-life
- Radio Infrastructure Replacement
- OTN Extension to ZSS – extend the Operational Telephone Network to zone substations
- CEOT Console System Replacement – replace the existing CEOT Console system with a new CEOT Console system to prevent the failure of ageing equipment
- TMR Console Replacement
- Telephony Service Replacement (POTS to NBN)
- Implement and Integrate SIEM Visibility to the Field
- Implement Authentication, Access Control
- TMR Mobile Replacement

Benefits and Investment drivers:

- Safety
- Network Reliability
- Compliance
- Enabling new technology

Related documents:

- AMS 20-81 Communication Systems

12.4 Safety, Security and Environment

12.4.1 Infrastructure Security

Infrastructure security systems protect network assets and network functionality from unauthorised entry to zone substations. Unauthorised entry can result in significant damage to assets (intentional or unintentional) impacting network security and the reliability of customer supply. This program is important to reliably secure and safely operate AusNet Services zone substations.

The forecast expenditure for infrastructure security is shown in Table 36.

Infrastructure Security	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	440	440	440	440	440	2,200

Table 36 – Infrastructure security expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace and upgrade damaged zone substation, line voltage regulator and ground type distribution substation fencing
- Install zone substation SCADA lighting controls
- Replace zone substation mechanical locks and keys.

Benefits and Investment drivers:

- Improved public safety
- Security of supply of essential infrastructure

Related documents:

- AMS 20-14 Security Infrastructure

12.4.2 Environmental Works

Some primary plant equipment can present environmental risks; especially power transformers and circuit breakers that contain large volumes of insulating oils. Environmental systems at 16 zone substations impose environmental risks. The installation of oil containment and water treatment systems at stations that are not part of a scheduled rebuild will continue in the forecast period. These works will ensure zone substations meet the requirements of AS2067.

Asbestos is also present in a number of zone substations. A program to remove asbestos from accessible workplaces is ongoing.

The forecast expenditure for environmental works is shown in Table 37.

Environmental Works	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	1,020	1,020	1,020	1,020	1,020	5,100

Table 37 – Environmental works expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Remove asbestos containing materials from accessible workplaces
- Improve the environmental systems of Clover Flat, Sale, Warragul, Yallourn (YPS), Wodonga, Newmerella, Belgrave, Foster and Croydon zone substations to meet the requirements of AS2067 by 2025.

Benefits and Investment drivers:

- Health and safety
- Environment

Related documents:

- AMS 20-55 Civil Infrastructure

12.4.3 Armour Rods and Vibration Dampers

Armour rods and vibration dampers are currently required on overhead conductors in line with VESI standards. Armour rods are a layer of short steel strands which wrap around conductors to form a protective barrier. They are installed where conductors are secured to insulators to protect them from wear and vibration damage. Spiral vibration dampers are helixes of polyvinyl chloride tubing which wrap around a conductor. They are installed along the span, approximately one hand span away from the end of the armour rod. Their purpose is to reduce the intensity and amplitude of vibrations experienced by the conductor and the armour rods. The ESV issued a Directive, dated 4 January 2011, to install armour rods and vibration dampers. This program will be completed in two stages with the first stage directed at the highest risk areas to be completed in the current regulatory period and the second stage involving the remainder of the network completed by the end of 2020.

The expenditure and replacement volumes for the forecast EDPR period represent Stage 2 of this program and are presented in Table 38 and Table 39 respectively.

Armour Rods and Vibration Dampers	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	26,400	26,400	26,400	26,400	26,400	132,000

Table 38 – Armour rods and vibration dampers expenditure forecast for the 2016-2020 regulatory period.

Armour Rods and Vibration Dampers	2016	2017	2018	2019	2020	Total
Volumes	22,000	22,000	22,000	22,000	22,000	110,000

Table 39 – Armour rods and vibration dampers replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Install armour rods and vibration dampers on overhead conductors at 110,000 locations.

Benefits and Investment drivers:

- Compliance

Related documents:

- AMS 20-52 Conductor
- AMS 20-13 Enhanced Network Safety

12.4.4 Vegetation Overhang Removals

The introduction of the Electricity Safety (Electric Line Clearance) Regulations 2010 removed a previous option to risk manage vegetation overhanging bare overhead power lines in hazardous bushfire risk areas. It is now a requirement to eliminate overhanging vegetation by removing the tree or reconfiguring the network. A number of locations where it is impractical to remove or trim significant trees have been identified. This program will reconfigure the network to obtain the prescribed clearance space above the power lines.

This program, which commenced in the current EDPR period, will be completed in the 1st year of the 2016-2020 regulatory period.

Overhang Removals	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	29,475	-	-	-	-	29,475

Table 40 – Overhang removals expenditure forecast for the 2016-2020 regulatory period.

Overhang Removals	2016	2017	2018	2019	2020	Total
Replacement Volumes	655	-	-	-	-	655

Table 41 – Overhang removals replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Reconfigure network by introducing insulated conductors, relocating assets or undergrounding network sections.

Benefits and Investment drivers:

- Reduction in bushfire ignition risk
- Public Safety

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.5 Expulsion Drop Out (EDO) Fuses

EDO fuses have been identified as a bushfire ignition risk in rural areas. During the current EDPR period, a program to replace EDO units with Boric Acid (BA) units came into effect. The forecast figures below are a continuation of the existing program to replace EDO fuses at high bushfire risk locations.

Expulsion Drop Out (EDO) Fuses	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	1,254	1,254	1,254	1,254	1,254	6,270

Table 42 – EDO fuses expenditure forecast for the 2016-2020 regulatory period.

Expulsion Drop Out (EDO) Fuses	2016	2017	2018	2019	2020	Total
Replacement Volumes	1,900	1,900	1,900	1,900	1,900	9,500

Table 43 – EDO fuses replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Continue to replace EDO fuses with BA fuses

Benefits and Investment drivers:

- Network Reliability
- Public safety
- Prevent bushfire ignition

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.6 Line Clearances and Low Services/Conductor

This program involves three components; rectification of HV spans with insufficient clearance between conductors on complex circuits/multiple circuit lines, clearance of services and low conductors, and safety clearances in substations.

The rectification of HV spans with insufficient clearance between conductors on complex circuits/multiple circuit lines will be based on survey results and risk. The volumes and expenditure for low services/conductor is based on historical expenditure over the 2010 to 2014 period. The program for safety clearances is driven by worker safety where, for example, exposed LV assets in switch rooms cause high risk to workers.

The forecast figures below indicate the expenditure and replacement volumes for line/safety clearances and low services/conductors for the forecast EDPR period.

Line/Safety Clearances and Low Services/Conductor Expenditure in $000's	2016	2017	2018	2019	2020	Total
Low services/conductor	591.3	591.3	591.3	591.3	591.3	2,957
Line clearances	1,917	1,917	1,917	1,917	1,917	9,583
Safety clearances	50	50	50	50	50	250
Total	*2,558*	*2,558*	*2,558*	*2,558*	*2,558*	*12,790*

Table 44 – Line/safety clearances and low services/conductor expenditure forecast for the 2016-2020 regulatory period.

Line/Safety Clearances and Low Services/Conductor Replacement Volumes	2016	2017	2018	2019	2020	Total
Low services/conductor	242	242	242	242	242	1,208
Line clearances	87	87	87	87	87	435
Safety clearances	1	1	1	1	1	5
Total	*330*	*330*	*330*	*330*	*330*	*1,648*

Table 45 – Line/safety clearances and low services/conductor replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Rectify HV spans with insufficient clearance based on risk
- Increase ground clearance of services and low conductors if they do not meet standards as identified during routine inspection
- Install protective measures in indoor substations to prevent accidental contact with live equipment

Benefits and Investment drivers:

- Improve public safety
- Prevent bushfire ignition
- Network Reliability

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.7 Bird and Animal Proofing

An initiative and standard for reducing the risk of bushfires caused by bird and animal flashovers is installing animal and bird proofing to prevent animals access to assets. An assessment has established the efficient level for the program to retro-fit existing high voltage complex structures in hazardous bushfire risk areas (HBRA) is 1,915 per annum. This requires the retro-fit of 9,575 installations over the 2016-2020 period. Additionally, insulated leads and covers will be fitted to approximately 11,675 new complex high voltage structures in HBRA areas.

As a continuation of the program from the current EDPR period, Table 46 and Table 47 show the forecast expenditure and replacement volumes in the 2016-2020 regulatory period respectively.

Bird and Animal Proofing	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	10,676	10,676	10,676	10,676	10,676	53,380

Table 46 – Bird and animal proofing expenditure forecast for the 2016-2020 regulatory period.

Bird and Animal Proofing	2016	2017	2018	2019	2020	Total
Animal Bird Proofing installed during asset replacement	2,335	2,335	2,335	2,335	2,335	11,675
Proactive Animal Bird Proofing (fit to existing assets)	1,915	1,915	1,915	1,915	1,915	9,575
Total	*4,250*	*4,250*	*4,250*	*4,250*	*4,250*	*21,250*

Table 47 – Bird and animal proofing replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Retrofit bird and animal proofing in defined HBRA locations
- Install bird and animal proofing on new complex high-voltage structures

Benefits and Investment drivers:

- Reduced bushfire risk
- Network Reliability
- Safety

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.8 SWER Earths

Testing has identified a number of SWER earthing systems which exceed the Upper Specification Limit (USL). In particular, there are a significant proportion of SWER MV concrete poles that exceed the USL. The test results show a higher percentage of exceedance of the USL relative to previous years.

A program is planned to progressively remediate non-compliant earths on SWER MV concrete poles to less than 3% by 2020. The forecast expenditure and remediation volumes for SWER earths are shown in Table 48 and Table 49 respectively.

SWER Earths	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	553	553	553	553	553	2,766

Table 48 – SWER earths expenditure forecast for the 2016-2020 regulatory period.

SWER Earths	2016	2017	2018	2019	2020	Total
Replacement Volumes	318	318	318	318	318	1,590

Table 49 – SWER earths replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Remediate 318 SWER earths per annum

Benefits and Investment drivers:

- Network Reliability
- Safety

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.9 Fall Arrest Systems

Installing fall arrest systems is a safety initiative which is required to comply with the OHS (Prevention of Falls) Regulations 2003 administered by Work Safe Victoria. The regulations apply to climbing and working on line structures and station rack structures.

AusNet Services has adopted the ‘rail system’ mounted on ladders as its permanent fall arrest system. This system consists of a ‘carriage’ that a line worker attaches to a rail that is part of a ladder centrally located on the tower body. The carriage is attached to the line worker’s harness which travels with the person as the tower is climbed or descended. A program to install fall arrest systems on transmission towers is underway and it is planned to extend this program to the 465 distribution sub-transmission lattice towers. The program will commence in the forecast regulatory period and be completed in the 2021 to 2025 regulatory period.

The forecast expenditure and replacement volumes for fall arrest systems are shown in Table 50 and Table 51 respectively.

Fall Arrest Systems	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	1,650	1,650	1,650	1,650	1,650	8,250

Table 50 – Fall arrest systems expenditure forecast for the 2016-2020 regulatory period.

Fall Arrest Systems	2016	2017	2018	2019	2020	Total
Replacement Volumes	50	50	50	50	50	250

Table 51 – Fall arrest systems replacement volume forecast for the 2016-2020 regulatory period.

Scope of works:

- Install fixed fall arrest systems on 250 sub-transmission lattice towers.

Benefits and Investment drivers:

- Compliance
- Safety

Related documents:

- AMS 20-64 Sub-transmission Towers and Insulators

12.4.10 Enhanced Protection and Control

Protection systems are an essential part of the electricity distribution network that operate circuit breakers to ensure the safety of workers and the general public from unsafe voltages. In addition, they maintain network operating voltage within sustainable limits and limit damage to electrical plant and equipment.

Projects to reduce the risk of fire starts using enhanced protection and control techniques commenced in the 2011-2015 regulatory period. Replacement of Oil Circuit Reclosers (OCRs) protecting SWER circuits with Automatic Circuit Reclosers (ACRs) enabling the alteration of the reclose function on high fire risk days has been largely completed. Trials of Rapid Earth Fault Current Limiters (REFCLs) have also commenced and are ongoing.

There is great potential for enhanced control and protection systems to economically reduce the risk of bushfire ignition. Further trials and installation of enhanced control and protection systems will continue in the forecast EDPR period. The forecast expenditure for enhanced protection and control techniques for the forecast EDPR period is shown in Table 52.

Enhanced Protection and Control	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	3,715	5,138	5,631	5,294	4,428	24,206

Table 52 – Enhanced protection and control expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace SWER OCRs with ACRs – Finalisation of program that enables the alteration of reclose functions or settings on reclosers in high bushfire risk areas during the fire season (either at the start of each fire season or by changing it on high fire risk days).
- Satellite Services for Remote Areas – Installing satellite based communications services to those ACRs which cannot be reached by other communications technologies.
- Downed Conductor Sectionalisation –Replace existing MEF protection schemes with new ABB REF630 relays. Implement automation to detect downed conductors to prevent risks of fire starts and the potential to electrocute members of the public and staff coming into contact with the conductor and isolate the faulted section.
- FTR Fault Level Reduction – Install a fault level reducing system (NER) to add to the safety of the network at FTR zone substation including the replacement of obsolete distance protection relays and the installation of new MEF and NER monitoring schemes.
- KLK Fault Level Reduction - Install a fault level reducing system (NER) to add to the safety of the network at KLK zone substation including the replacement of obsolete distance protection relays and the installation of new MEF and NER monitoring schemes.

Benefits and Investment drivers:

- Reduced risk of bushfire ignition
- Improved public and worker safety
- Network Reliability
- Protection of primary assets
- Mitigation of risk of extended outage

Related documents:

- AMS 20-13 Enhanced Network Safety

12.4.11 Government Funded

In 2011 the Victorian Government announced a $750 million Powerline Bushfire Safety program (PBSP). The 10-year program will deliver on recommendations (27 and 32) of the 2009 Victorian Bushfires Royal Commission and aims to reduce the risk of bushfires caused by electrical assets without causing significant impact on electricity supply reliability. The program includes the replacement of the most dangerous power lines in the State that would otherwise not have been replaced.

Areas of high risk in AusNet Services' network have been identified and replacement work involving the undergrounding of conductor or installation of covered conductor to replace bare conductor has commenced. The size of the program and the allocation of the funds to Distribution Network Businesses or other overhead line owners is determined by the Government. Included in the AusNet Services capital forecast is expenditure of approximately $12.9m per annum. It is assumed that any work undertaken is fully funded by Government.

Government Funded	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	12,857	12,857	12,857	12,857	12,857	64,285

Table 53 – Government funded expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Replace existing bare overhead conductor with underground or insulated cable systems in areas of very high risk.

Benefits and investment drivers:

- Bushfire risk reduction
- Network reliability
- Health and safety

Related documents:

- AMS 20-13 Enhanced Network Safety

12.5 Non-network IT

Non-network IT has been included in this document for completeness. Full details of the ICT program are included in Appendix 7E Information and Communication Technology Strategy.

IT expenditure accounts for the majority of non-network capital expenditure. The IT Infrastructure and Operations Program forecasts investments in various infrastructures. This spans from data centres and their related facilities through to servers, storage, operating systems, infrastructure software and communication networks.

The forecast expenditure for non-network IT is shown in Table 54.

Non-network IT	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	32,334	30,892	31,626	28,599	13,835	137,288

Table 54 – Non-network IT expenditure forecast for the 2016-2020 regulatory period.

12.6 Non-network General

Non-network general items such as motor vehicles and plant, non-network buildings and other items have been included in this document for completeness.

12.6.1 Motor Vehicles and Plant

AusNet Services maintains a fleet of vehicles both owned and leased. These vehicles are used to carry out routine work on the network, to respond to network events, to travel between our office sites and to travel to meet stakeholders.

The forecast is based on replacement of existing vehicles that meet defined replacement criteria (distance travelled and age).

The capital expenditure forecast for motor vehicles and plant is shown in Table 55.

Motor Vehicles and Plant	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	1,372	2,617	1,735	3,408	3,007	12,139

Table 55 – Motor vehicles and plant expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Purchase of replacement vehicles including trucks, utility vehicles and sedans

Benefits and Investment drivers:

- Travel to meet stakeholders
- Timely response to network events
- Efficient network maintenance and monitoring

12.6.2 Non-network Buildings

AusNet Services owns many buildings and properties, and is responsible for their management and maintenance. These buildings include staff workplaces such as depots, and storage locations for plant and equipment.

The forecast is based on specific identified capital items with the expenditure forecast smoothed over the forecast period. The capital expenditure forecast for non-network buildings is shown in Table 56.

Non-network Buildings	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	2,120	2,120	2,120	2,120	2,120	10,599

Table 56 – Non-network buildings expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Ongoing minor building works such as the installation of partitions
- Purchase and replacement of building capital items such as air conditioners
- Replacement of items such as roofs

Benefits and Investment drivers:

- Maintaining safe work environments
- Maintaining operation efficiency

12.6.3 Other

'Other' expenditure captures miscellaneous non-network spending. Historically, expenditure in this category has mainly comprised of spending on tools and measurement equipment. The forecast in Table 57 has been prepared based on average actual annual expenditure in the current regulatory period.

Other	2016	2017	2018	2019	2020	Total
Expenditure (in $000's)	2,299	2,299	2,299	2,299	2,299	11,494

Table 57 – Other expenditure forecast for the 2016-2020 regulatory period.

Scope of works:

- Tools
- Measurement equipment
- Other miscellaneous capital items

Benefits and Investment drivers:

- Efficient operating expenditure
- Improved decision making.

13 Abbreviations and Definitions

Term	Definition
AEMO	Australian Energy Market Operator
AMS	Asset Management Strategy
ACR	Automatic Circuit Recloser
ACSR	Aluminium Conductor with Steel Reinforcing strands
CT	Current Transformers
CB	Circuit Breaker
DFA	Distribution Feeder automation
DSP	Design Service Provider
ESL	Environment, Safety and Legal (ESL) requirements
ESV	Energy Safety Victoria
ESMS	Electricity Safety Management Scheme
FLCM	Fire Loss Consequence Model
FMECA	Failure Mode Effect Criticality Analysis
GFN	Ground Fault Neutraliser
HVABC	High Voltage Aerial Bundled Cable
ISP	Installation Service Provider
LVABC	Low Voltage Aerial Bundled Cable
MD	Maximum Demand
MEF	Master Earth Fault (Relay)
NPV	Net Present Value
OLTC	On Load Tap Changer
PIR	Post Implementation Review
PQM	Power Quality Meter
Record	Collection of either electronic or printed material which provides a documentary history of
RCM	Reliability Centred Maintenance
RSP	Remaining Service Potential
REFCL	Rapid Earth Fault Current Limiter
SWER	Single Wire Earth Return
TFB	Total Fire Ban
USAIFI	Unplanned System Average Interruption Frequency Index

Appendix 7A

Term	**Definition**
VCR	Value of Customer Reliability
VT	Voltage Transformer
ZSS	Zone Substation