Appendix 4A:

Victorian Electricity Transmission Network

Capital Expenditure Overview – 2014/15 to 2016/17

SP AusNet
A member of Singapore Power Group

ISSUE / AMENDMENT STATUS

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1 Executive Summary

As part of the current revenue proposal, SPI PowerNet Pty Ltd (SP AusNet) must submit a forecast of capital expenditure for the relevant regulatory period, in accordance with National Electricity Rule (NER) 6A.6.7a. This revenue proposal does not include any responsibility of SPI Electricity Pty Ltd which is a Distribution Network Service Provider (DNSP). This report describes the forecast, shown in Table 1, explains how the forecast was developed, describes the drivers of expenditure, and outlines the benefits of the proposed capital program.

All forecasts set out in this document are in direct terms (exclude overheads and escalations) and real 2012-13 dollars.

Table 1: Capital expenditure 2014 – 2017 ($'000, 2012 direct costs)

Capital Program	14/15	15/16	16/17	Total Cost
Major projects – Stations rebuilds and refurbishments	87,886	96,874	118,024	302,784
Lines	15,876	16,965	17,585	50,426
Stations	13,744	11,025	9,489	34,258
Secondary & Protection Program	7,496	8,090	10,116	25,702
Communications Program	11,802	11,211	12,719	35,732
Non-network	22,906	17,085	15,352	54,638
Total (Excluding Overheads and escalation)	**159,710**	**161,250**	**183,285**	**504,540**

The capital expenditure forecast only includes capital expenditure which is required to meet the capital expenditure objectives as defined in rule 6A.6.7a. This excludes expenditure required to:

- augment the network to allow for load growth
- connect customers

The planning and procurement of augmentation for the shared electricity transmission network is an Australian Energy Market Operator (AEMO) responsibility and connection asset augmentations are the responsibilities of Distribution Network Service Providers (DNSP's).

National Electricity Rule 6A.6.7a

a) A *Revenue Proposal* must include the total forecast capital expenditure for the relevant *regulatory control period* which the *Transmission Network Service Provider* considers is required in order to achieve each of the following (the *capital expenditure objectives*):

1. meet the expected demand for *prescribed transmission services* over that period;
2. comply with all applicable *regulatory obligations or requirements* associated with the provision of *prescribed transmission services*;
3. maintain the quality, reliability and security of supply of *prescribed transmission services*; and
4. maintain the reliability, safety and security of the *transmission system* through the supply of *prescribed transmission services*.

This document sets out SP AusNet's capital expenditure (capex) forecasts for the forthcoming regulatory period. The document contains four sections:

- **Background:** This section provides some background to the Victorian Electricity Transmission Network. It describes the network and the service age of its assets. This section also gives an overview of recent capital works and places future capital expenditures within the longer term capital plan.
- **Capital Expenditure Forecast Methodology:** This section describes how the capital expenditure forecast was calculated.
- **Expected Benefits of Capital Expenditure:** This section gives a high level overview of outcomes expected from the delivery of the forecast capital expenditure program.
- **Capital Expenditure Forecast**: This section details proposed expenditure for each different area of capital investment.

1.1 Major projects – Station Refurbishment Program

Many of the terminal stations in the Victorian electricity transmission network were built or significantly augmented in the 1960's. Major assets at these stations have now delivered more than forty years' service and consequently, some are in poor condition. The Major Projects capital program will replace selected high-risk assets in these stations where economic assessments confirm there is a net benefit.

Major projects include existing committed projects. Committed expenditure is dominated by the redevelopment of the Richmond Terminal Station (RTS) and West Melbourne Terminal Station (WMTS). This work is the most significant expenditure included in the capital expenditure forecast. These two projects are critical to securing supply to the central business district (CBD) and inner metropolitan Melbourne suburbs and comprise around 36% of the total capital expenditure program. The timely delivery of these projects is essential to augmentation plans developed by distribution businesses (DNSP's) managing connection assets at both stations. SP AusNet has committed to these expenditures with construction works at RTS and the detailed design of WMTS underway.

Table 2 details the program of major projects forecast in the forthcoming regulatory period. The major project program will continue through the next two regulatory periods, and is expected to taper off after that. Four major projects in the capital expenditure forecast are planned for completion later than economic timing suggests smoothing expenditure and workloads across the planning period.

Table 2: Major projects capital expenditure 2014 – 2017 ($'000, 2012 direct costs)

Major projects	14/15	15/16	16/17	Total Cost
WMTS redevelopment	30,000	31,000	32,000	93,000
RTS redevelopment	28,550	19,900	21,200	69,650
HTS redevelopment	5,737	12,431	15,300	33,468
SMTS H transformer replacement	7,135	12,074	7,684	26,893
YPS 220kV CB replacement Stage 1	5,253	8,889	5,657	19,799
FBTS B1 transformer, 220kV and 66kV CB replacement	473	6,150	10,407	17,030
SVTS Redevelopment Stage 1	341	1,365	8,192	9,898
BLTS 220kV, 66kV & 22kV CB replacement		694	9,017	9,711
GNTS redevelopment	3,953	1,588	-	5,541
HWPS 220kV CB Replacement – Stage 4		303	3,939	4,242
RWTS 220kV circuit breaker replacement	2,868	945	369	4,182
RWTS B4 Transformer & CB replacement		266	3,458	3,724
HWPS CB Replacement Stage 3	1,384	1,268	-	2,652
MWTS B2 transformer replacement	1,791			1,791
KTS A4 and B4 Transformer replacement			801	801
TTS 66kV Bus Tie CB replacement	401			401
Total	**87,886**	**96,873**	**118,024**	**302,783**

Some of the key projects within the program are summarised below with detailed descriptions of all major projects included in section 8.

- **West Melbourne Terminal Station (WMTS) redevelopment:**

  The majority of existing electrical equipment has been in service for 49 years. Redevelopment drivers include plant reliability and load criticality. Several faults have been experienced at this station in recent years and many of the circuit breakers are currently unsupported by manufacturers. Power transformers and switchgear are in poor condition and require replacement due increasing failure risk. CitiPower has significant load at risk on hot days until the redevelopment has been completed as load transfers to Brunswick Terminal Station are currently not possible. The SP AusNet Board has approved the rebuild of WMTS to secure supply to the CBD and inner Melbourne.

- **Richmond Terminal Station (RTS) redevelopment:**

Richmond Terminal Station (RTS) is a critical station which supplies the eastern portion of the CBD and the inner east and south-east of metropolitan Melbourne. Power transformers at this station rank amongst the highest risk assets on the Victorian transmission network. The Distribution business service providers (DNSP's), who are responsible for planning of the connection assets at RTS, are considering augmenting RTS with a 4th 225 MVA 220/66 kV transformer; however, due to space limitations at the site this work cannot proceed until the proposed redevelopment project is completed.

- **Heatherton Terminal Station (HTS) redevelopment:**

HTS was commissioned in 1964. Power transformers and key circuit breakers at this station have provided more than 40 years' service. Deteriorating plant condition and consequent supply and safety risks make the replacement of selected assets economic.

- **South Morang Terminal Station (SMTS) H1 and H2 transformer replacement:**

The H1 and H2 330/220 kV transformers at South Morang Terminal Station were installed in the 1960's. There is currently no spare for these transformers, which present a significant supply risk following a major failure of one of these two H transformers. Transformer condition and high marginal market costs are the key drivers for the replacement of one of these two H transformers (H2) within the forthcoming regulatory period. The H2 transformer will remain as one of three H transformers (H1, H2 & H3) at the station in order to provide redundancy as a cold spare.

- **Yallourn Power Station (YPS) circuit breaker replacement:**

Most of the 220 kV switchgear and infrastructure at YPS have deteriorated over more than 45 years' service and are now approaching the end of their technical lives. This project will greatly reduce safety and reliability risks associated with plant failure through selective replacement and refurbishment of several circuit breakers and replacement of instrument transformers. This project is planned to commence in 2013/14.

- **Fisherman's Bend Terminal Station (FBTS) transformer and circuit breaker replacement:**

Established in late 1960s, assets at FBTS have deteriorated and have increasing risks of failure. Economic studies support the replacement of critical transformers and circuit breakers in the forthcoming period taking into account the probability of failure and community cost of failures. This project is being completed later than economic timing suggests smoothing expenditure and workloads across the planning period.

- **Springvale Terminal Station (SVTS) redevelopment:**

SVTS has a range of poor condition assets, which pose reliability and some safety risks. Poor condition of transformers at SVTS has resulted from sustained high utilisation levels. A staged replacement and reconfiguration project is economic.

- **Brooklyn Terminal Station (BLTS) circuit breaker replacement:**

Brooklyn Terminal Station was commissioned in 1963 and is currently being partially redeveloped. However, at the end of this development some original current transformers and circuit breakers will remain in service. These are in deteriorating condition and replacement will become economic toward the end of the forthcoming regulatory period.

- **Glenrowan Terminal Station (GNTS) redevelopment:**

  GNTS was developed in 1970 and consequently the majority of the electrical assets have reached the end of their reliable service lives. These assets are in poor condition and as a result, have a high probability of failure. This project was approved in 2011 with the majority of the project expenditure occurring in the current regulatory period.

1.1.1 Station rebuild drivers

Three terminal stations, West Melbourne, Richmond and Fisherman's Bend are essential to the security of supply to Melbourne CBD and the inner suburbs, as shown in Figure 1 below. Richmond and West Melbourne Terminal Stations are amongst the most heavily loaded 220/66 kV terminal station on the Victorian network, supplying load to many customers.

Critical assets, in particular power transformers and switchgear, at RTS and WMTS are currently in poor condition and require replacement. Poor asset condition and out dated station designs reflect the service ages of these stations.

Figure 1: Urban terminal stations

1.1.2 Station rebuild complexity

When Richmond and West Melbourne Terminal Stations were originally built in the 1960's, their immediate surroundings were largely industrial. RTS is now surrounded by densely populated residential areas with no scope for site expansion and there are plans for significant residential development around the WMTS site. Space within the Richmond Terminal Station is very limited causing design constraints which affect the staging of the project and the type of switch gear able to be deployed. Gas-insulated switchgear (GIS) has been selected for these station rebuilds as a modern alternative which is compact and reliable. GIS is essential to overcome project delivery issues posed by severe space restrictions and to comply with the planning permit conditions for the RTS site.

The compact nature of the GIS design enables rebuild works to be completed without long outage whilst allowing for future augmentation works required to meet forecast demand growth including the installation of a fourth 225 MVA transformer. Furthermore, feedback received following community consultation warranted the adoption of GIS for RTS as it satisfied community expectations regarding visual amenity.

Further information on the RTS and WMTS rebuild projects is provided in section 8.

1.2 Lines

There are four substantial capital programs focussed on transmission lines expenditure, as shown in Table 3. Each program is essential to maintaining acceptable levels of safety and reliability for the Victorian transmission network.

Table 3: Lines capital expenditure 2014 – 2017 ($'000, real 2012-13 direct costs)

Lines	14/15	15/16	16/17	Total Cost
Line Structure (Towers) replacement program	5,855	6,273	6,691	18,819
Conductor and Ground wire replacements	5,188	5,858	6,060	17,106
Line Structures – fall arrest installation program	3,284	3,284	3,284	9,852
Insulator replacement program	1,250	1,250	1,250	3,750
Station racks – fall arrest installation program	300	300	300	900
Total	**15,877**	**16,965**	**17,585**	**50,427**

Tower replacement program

Similar to conductor replacement, risk analysis has identified a number of transmission towers for replacement. The structural strength of some towers, constructed to out-dated design standards, is inadequate and cannot withstand high wind events which frequent certain parts of Victoria. There are multiple examples of these towers collapsing during extreme wind events. This program targets "at risk" towers in locations where a falling tower presents a large market impact or public safety risk. For example, towers located adjacent to roads or railways on lines which form important interconnectors within the National Electricity Market.

Conductor and ground wire replacement

The conductor and ground wire replacements program targets spans which are in poor condition.

Visual inspection of these conductors shows that they are corroded, especially where conductors are located near the ocean and exposed to salt, or in areas of industrial pollution. Thirteen spans of phase conductor on the Heywood (HYTS) to Portland (APD) 500 kV lines along with other individual phase conductor spans have been selected for replacement based on thorough risk analysis which considers both the probability and consequence of failure. This prioritises conductor spans that pose a risk to public safety such as those spanning roads or railways or which are essential in maintaining security of supply, such as the Portland Alcoa aluminium smelter. SP AusNet forecasts increasing volumes of conductor replacements over the next 20 to 30 years and are implementing advanced condition assessment techniques required to support the development of more efficient replacement programs.

Tower structures and station racks – fall arrest installation program

The tower structures and stations racks - fall arrest installation program is a safety initiative which is required to comply with the OHS (Prevention of Falls) Regulations 2003 administered by Work Safe Victoria. This ongoing program will install cable-based fall arrest systems which mitigate risks associated with working from heights.

Insulator replacement program

SP AusNet's insulator replacement program began in 2006. More than 17,000 insulator strings or approximately 20 per cent of the fleet has now been replaced based on condition data gathered during tower climbing inspections. Typically, this has involved replacing insulators with corroded pins, which are at risk of mechanical failure (the pin breaking). SP AusNet will continue replacements through the remainder of the current regulatory period; however, fewer replacements are forecast in forthcoming period.

1.3 Stations

In addition to the major projects station refurbishment program, stations expenditure, shown below in Table 4, includes a variety of more routine asset replacement projects. Fifty-three per cent of this expenditure is required to replace or refurbish primary equipment. Replacement and upgrade programs are driven by the need to maintain high levels of network reliability, safety, security and to ensure legal compliance.

Table 4: Stations capital expenditure 2014 – 2017 ($'000, real 2012-13 direct costs)

Stations	14/15	15/16	16/17	Total Cost
Upgrade / Replacement of Fire Protection Systems	1,869	1,900	1,829	5,598
Infrastructure Security Systems Upgrade	2,095	2,095	850	5,040
Synchronous Condenser Refurbishment / Life extension – Stage 2	2,400	1,200	1,100	4,700
Oil CB replacement program	2,500	950	950	4,400
Instrument transformer replacements	1,100	1,500	1,700	4,300
Civil Infrastructure / Station Facilities Assets Replacement	1,510	1,110	790	3,410
Transformer – Improved safe maintenance access	830	830	830	2,490
Transformer – 220kV Bushing Replacement Program	800	800	800	2,400
Transformer – OTI/WTI Replacement – Stage 2	640	640	640	1,920
Total	**13,744**	**11,025**	**9,489**	**34,258**

Key programs in this area include:

- **Upgrade/ Replacement of Fire Protection Systems:** Fire protection systems are needed to protect assets, personnel and help prevent bushfire ignition. This program will replace assets which are deteriorating rapidly towards unacceptable condition whilst ensuring compliance with Australian Standards.

- **Infrastructure Security Systems Upgrade:** The Infrastructure Security Systems Upgrade will increase security at sensitive sites, commensurate with the requirements of the Victorian Terrorism (Community Protection) Act 2003. SP AusNet has implemented numerous security enhancement projects since the introduction of the Act including the upgrade of security fencing at 23 terminal stations.
- **Synchronous Condenser Refurbishments:** There are a total of three Synchronous Condensers (SCOs) on the Victorian transmission network located at Brooklyn (BLTS), Fisherman's Bend (FBTS) and Templestowe terminal stations (TSTS). Minor refurbishment of ancillary equipment on the BLTS unit was completed on this unit in 2006. Units at FBTS and TSTS are in poor condition and require refurbishment by 2017 and 2018 respectively.
- **Oil CB replacement program:** The fleet of two types of Circuit Breakers (CBs) are the last examples of bulk oil breaking technology, in Victoria's electricity transmission network. These ageing assets are maintenance intensive, in poor condition, some contain asbestos, have fault level limitations and insufficient bunding (as per EPA requirements). This program will replace 16 high-risk circuit breakers with modern SF_6 circuit breakers.
- **Instrument Transformer Replacements:** This program will replace 122 poor condition instrument transformers throughout the network to maintain worker safety and network reliability.
- **Civil Infrastructure / Station Facilities Assets Replacement:** Civil Infrastructure and station facilities support the safe operation and efficient functioning of electrical equipment. This program will replace or upgrade poor condition and non-compliant systems.
- **Transformer - Improved safe maintenance access:** Maintenance of transformers involves working at heights. This project will retrofit handrails and ladder access points to multiple power transformers.
- **Transformer 220kV Bushing Replacements:** This program will replace oil impregnated paper and synthetic resin bonded paper transformer bushings now assessed as in poor condition to maintain worker safety and network reliability.
- **Transformer OTI/WTI Replacements:** This program will replace faulty and obsolete Oil and Winding temperature indicators to better manage transformer capacity and deterioration, which improves utilisation and transformer life.

1.4 Secondary, protection and DC systems

Forecast expenditure for secondary, protection and DC systems is driven by modernisation of the network, compliance to current design standards and operating costs of obsolete equipment. Expenditure is categorised into four key areas as displayed in Table 5.

Table 5: Secondary, protection and DC systems capital expenditure 2014 – 2017 ($'000, real 2012-13 direct costs)

Program Title	14/15	15/16	16/17	Total Cost
Control Systems	4,885	2,730	4,240	11,855
Protection Systems	830	1,910	3,376	6,116
Monitoring and Metering	50	2,450	2,500	5,000
DC Supply	1,000	1,000	0	2,000

Program Title	14/15	15/16	16/17	Total Cost
Existing Secondary Projects	731	0	0	731
Total	**7,496**	**8,090**	**10,116**	**25,702**

Descriptions of asset categories and their associated programs are included below:

- **Control Systems:** This is the largest component of the secondary asset replacement investment. This program includes installation of circuit breaker management relays, replacement of Static VAR Compensator (SVC) controls, capacitor bank and reactor Automatic Voltage controls, and programmable logic controllers at several terminal stations due to technological obsolescence and asset condition.
- **Protection Systems:** Protection assets are combined in systems to detect electrical faults on the transmission network and, via the operation of circuit breakers, rapidly disconnect faulted circuits from sound circuits. These systems are essential to meet the Power System Security requirements of the National Electricity Rules. This program mainly consists of relay upgrades to intelligent electronic devices (IED) for transformer protection, bus protection, line & feeder protection and SVC protection schemes.
- **Monitoring and Metering:** New monitoring and metering equipment will replace obsolete equipment which is either non-compliant or no longer supported by the original manufacturer.
- **DC Supply:** DC systems provide energy for SCADA, instrumentations, communications equipment, alarm systems, circuit breaker controls and auxiliary power and emergency lighting. This program includes selective replacement of batteries and chargers at multiple terminal stations.
- **Existing secondary projects:** There are numerous secondary projects underway in the current regulatory period. Some of these projects will extend into the forthcoming regulatory period. Key committed projects include the upgrade of SVC control at Kerang Terminal Station (KTS) and replacement of out-dated line differential protection schemes.

1.5 Communications

The biggest component of communications expenditure is Network Technology, which accounts for around $15.6 million over the three year period. Network technologies provide an interface between communication services/applications and communications bearers. They are the telecommunications "highway on-ramp" for communications services and applications, and enable those services to access the communications bearers for secure, efficient and reliable transport to/from their interconnecting application/device. SP AusNet network technologies mostly consist of multiplex (digital) networks, asset data gathering networks (WAN), telephony, teleprotection and Video Frequency (VF) systems.

Network technology expenditure is mostly driven by replacement of obsolete assets which are uneconomic to maintain, either because they are incompatible with newer equipment or because they are no longer supported by manufacturers. Some expenditure will also be used to support evolving data transport needs.

The second largest area of Communications investments is Bearer Technology. Communications bearers enable the transfer of critical communications data and information. They are the telecommunications "highways" that provide the interconnectivity medium on which individual communication services can be transported from one physical location to another. Typical communication bearers include optical fibre ground wire (OPGW), copper supervisory cable, radio and power line carrier (PLC).

Around $10.4 million will be spent on network bearer technology over the three year period. Bearer Technology includes communications assets needed to meet the rules and regulations set out in the NER and by AEMO regarding Transmission Network Service Provider (TNSP) communications services. One of the factors driving spending in communications over the next three years is the replacement of some "legacy" bearer technologies (i.e. PLC, copper supervisory). There have been numerous outages due to failure of communication bearers some of which have been in service for 40 years and are displaying signs of established deterioration.

The remaining Communications expenditure over the next three years amounts to $9.7 million in total. This spending includes:

- **Operational Support Systems:** Provide operational and administration support to the communications network.
- **Infrastructure:** This includes all infrastructure which supports the communications network such as buildings, generators, air conditioning and antenna towers.
- **Security:** This includes network security systems designed to prevent network intrusion or monitoring and auditing functions.

Table 6: Communications capital expenditure 2014 – 2017 ($'000, real 2012-13 direct costs)

Program Title	14/15	15/16	16/17	Total Cost
Network Technology	5,018	4,962	5,639	15,619
Bearers	3,061	3,108	4,254	10,423
Infrastructure	1,534	1,231	892	3,657
Security	1,433	1,063	685	3,181
Operational Support Systems	756	847	1,249	2,852
Total	**11,802**	**11,211**	**12,719**	**35,732**

1.6 Non-network

Non-network expenditure, shown in Table 7, includes spending in four unrelated areas; IT, other, vehicles and buildings and property.

Table 7: Non-network capital expenditure 2014 – 2017 ($ '000, real 2012-13 direct costs)

Non-network	14/15	15/16	16/17	Total Cost
IT	18,291	12,495	11,322	42,108
Other	2,630	2,630	2,630	7,890
Vehicles	1,785	1,760	1,200	4,745

Non-network	14/15	15/16	16/17	Total Cost
Buildings & Property	200	200	200	600
Total	**22,906**	**17,085**	**15,352**	**55,343**

IT expenditure accounts for the majority of non-network capital expenditure. The IT Infrastructure and Operations Program forecasts investment in various infrastructure spanning from data centres and their related facilities, server, storage, operating systems, infrastructure software and communications network.

“Other” expenditure will continue at near historic levels. “Other” expenditure primarily consists of field tools and testing equipment.

Over the forthcoming regulatory period, the existing motor vehicle capability will be maintained at its current level. This will require replacing 68 motor vehicles; mainly commercial station wagons and two wheel drive (2WD) vehicles, costing an estimated $4.7 million. This is higher than vehicle expenditure in the current period due to replacement timing rather than fleet expansion.

Buildings and property expenditure will continue at near historic levels.

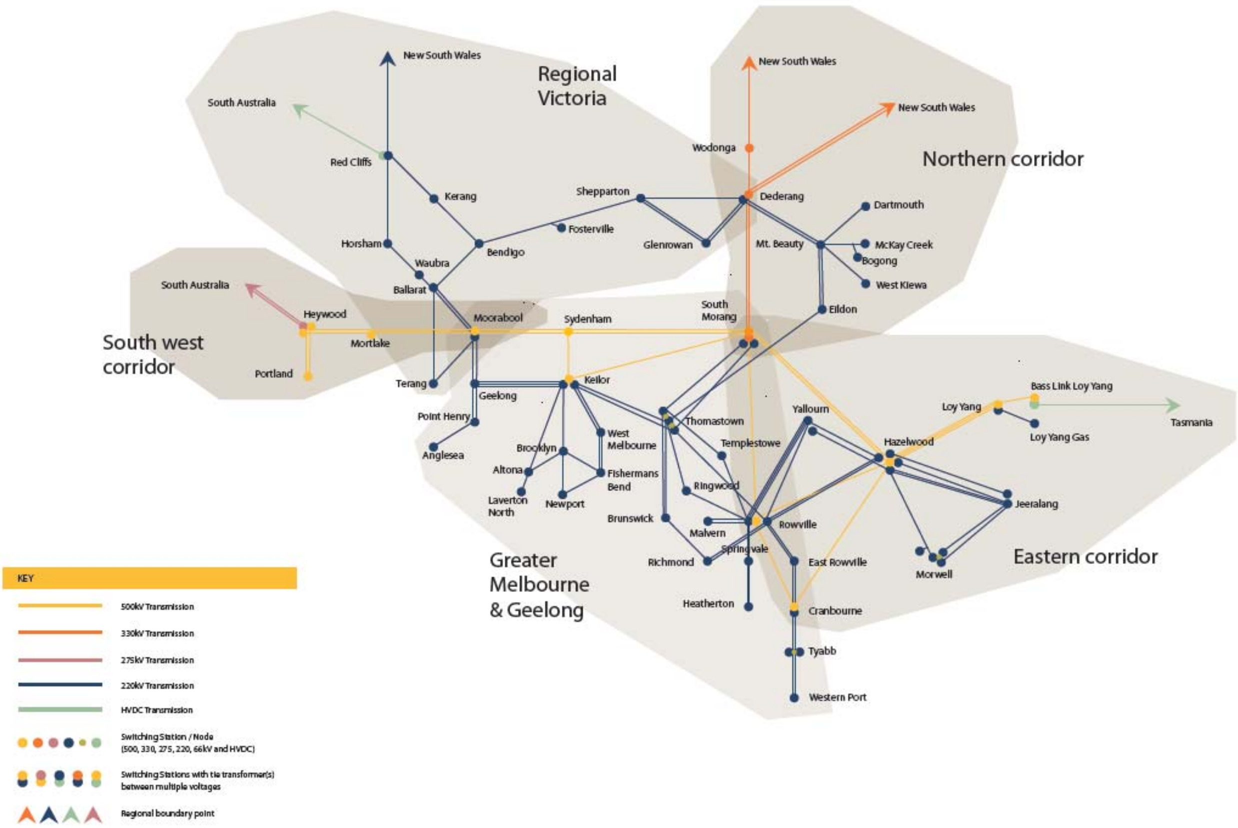
2 Background

2.1 The Victorian transmission network

SP AusNet's electricity transmission network, shown in Figure 2, serves more than 2.2 million Victorian households and businesses with more than 6,500 kilometres of transmission lines which transport electricity from power generation stations to five electricity distributors and large customers.

The network is centrally located among Australia's five eastern states that form the National Energy Market (NEM), providing key connections between South Australia, New South Wales and Tasmania's electricity transmission networks. The network transferred over 50,261 GW hours of energy in 2011/12 and served a peak demand of 9,190 MW.

Figure 2 : The Victorian transmission network



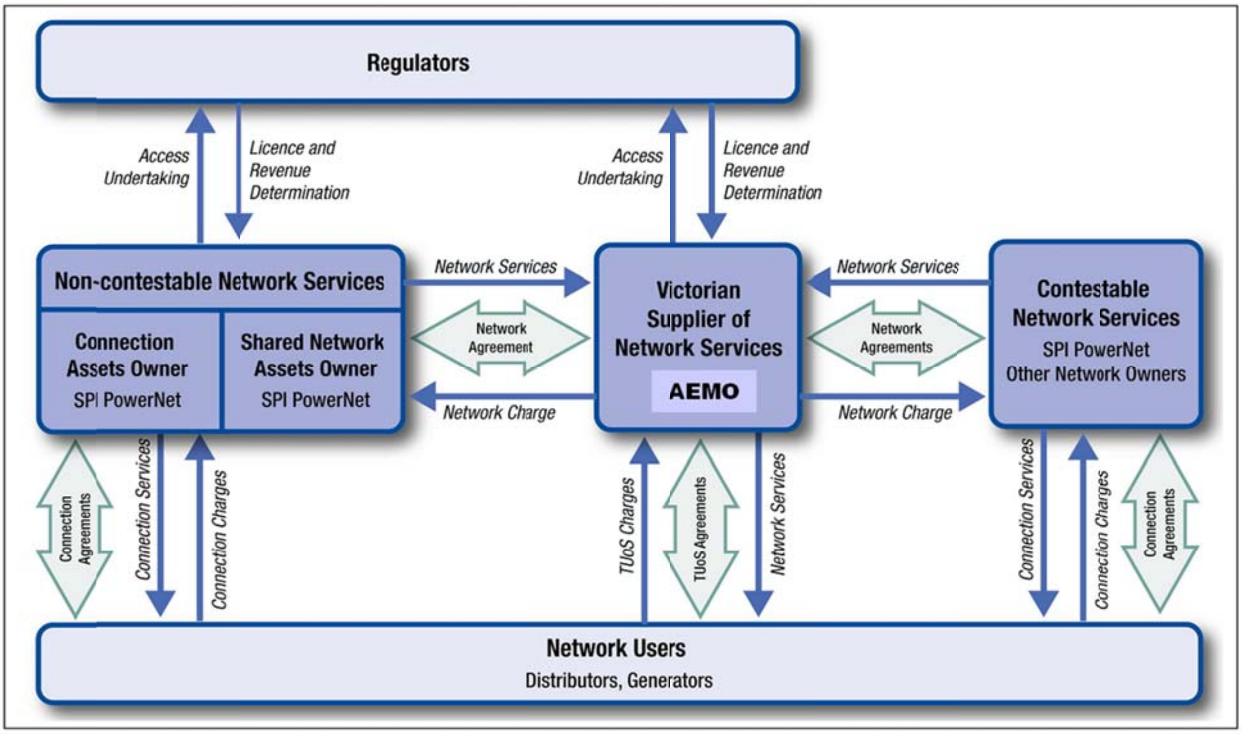
2.1.1 Victorian Planning Framework

Responsibility for planning of transmission network services in Victoria is shared by three different parties:

- Australian Energy Market Operator (AEMO) is responsible for planning the shared network[1] and procuring network support and shared network augmentations;
- SPI PowerNet Pty Ltd (SP AusNet) plans asset replacements on the transmission network; and
- Transmission network customers (distribution companies, generation companies and directly-connected industrial customers) are responsible for planning and directing the augmentation of their respective transmission connection facilities.

In Victoria, the transmission network planning functions are separated from the functions of ownership and operation. These arrangements differ from other states in Australia, where planning and responsibility for augmentation remains integrated with the incumbent transmission company (although independent planning oversight occurs in South Australia). The relationships between these parties and the Regulators are shown in Figure 3.

Figure 3 – Regulatory and commercial relationships



1 The shared transmission network is the main extra high voltage network that provides or potentially provides supply to more than a single point. This network includes all lines rated above 66 kV and main system tie transformers that operate between two voltage levels above 66 kV.

Note: AEMO's revenue determination under rule 6A.6.7a ends on 1st July 2014 and will not be replaced.

2.1.2 Asset Age

The Victorian transmission network experienced large levels of growth between 1950 and 1980 with approximately 40% of existing network assets constructed within this period. Large proportions of these assets are now approaching or have exceeded their original expected service lives. SP AusNet asset management strategies are driven by asset condition and the consequences of asset failure. Some older assets are displaying deterioration consistent with increasing failure risk.

Table 8 below gives an overview of the current and forecast age of SP AusNet's key assets and their expected useful lives. Most asset classes currently have less than half of their asset lives remaining and transformers have considerably less — only 25%. Over the forthcoming regulatory period, the average remaining life of transformers is expected to increase to 36% due primarily to a focus on power transformer replacement in planned terminal station rebuilds.

Twenty-six per cent of the circuit breaker fleet has been replaced since 2007 increasing the average remaining life to 63%. Forecast replacement of a further 11% of the existing air insulated circuit breaker fleet with gas insulated switchgear in the Richmond and West Melbourne re-build projects will increase remaining lives to 68% by 2017. Remaining lives of transmission line conductors and structures, however, will decrease by eight per cent and seven per cent respectively as minimal replacements are forecast prior to 2017. The remaining lives of other major asset classes are expected to remain at similar levels or decrease slightly through the planning period.

Table 8: Network Age (Years)

Asset Type	Average Age (years)		Average Remaining Life (years)		Average Expected Life[2] (Years)	% Remaining Life	
	2012	2017	2012	2017		2012	2017
Transformers	33.6	29.0	11.4	16.0	45.0	25%	36%
Circuit Breakers	21.6	18.6	36.5	39.3	57.9	63%	68%
Structures	42.2	47.9	48.9	43.2	91.1	54%	47%
Conductors	39.4	44.7	30.8	25.5	70.2	44%	36%

Weighted Average Remaining Life (WARL) is a useful high level indicator of remaining network asset life. The current WARL estimate for SP AusNet is 49.7%, meaning that on average, network assets are practically half way through their expected service life. Even with considerable investment proposed for the replacement of transformers and circuit breakers over the next period, the WARL of

[2] Each asset type contains several groups of assets and each group of assets can have a distinct expected life. The average expected life is the weighted average of the expected lives of all the groups of assets that make up the asset type.

SP AusNet's assets are expected to decrease to 46.2%. The magnitude of the decrease reflects increasing ages of transmission line conductor and structures, which make up more than half of the total network asset replacement value.

Compared to other TNSPs, SP AusNet's assets are relatively old. This reflects an approach to asset management which prioritises the replacement of assets based on condition and failure risk rather than age. Table 9 below shows the average age of SP AusNet's major assets compared with the average age of assets across European and Australian TNSPs, as surveyed by ITOMS[3] (2009). In each asset class SP AusNet's assets are older than the benchmarks.

Table 9: Average age of major network assets compared to other TNSPs

Asset	SP AusNet (years)	Australia (years)	Europe (years)
Overhead lines	43	35	34
Transmission Breakers >200 kV	22	15	17
Transformers >200 kV	33	25	21

Source: SP AusNet, European and Australian benchmarks taken from ITOMS (2009). SP AusNet transformer age taken from internal data.

SP AusNet's risk based approach to asset replacement means that the proportion of older assets is likely to increase by 2020, as shown in Table 10. This demonstrates the targeted nature of risk based replacements which focus on assets with high probability and consequence of failure only.

Table 10: Proportion of SP AusNet assets with relatively old service age

Asset Type	2012	2020
Transformers over 45 years	9%	12%
Circuit Breakers over 45 years	1%	4%
Conductor & Towers over 60 years	5%	16%

2.1.3 Asset Condition

SP AusNet applies a condition and risk based asset replacement approach, rather than replacing assets on the basis of service age. This method involves the use of objective condition assessments in determining remaining service potential (RSP) of individual assets. Results of condition assessments are incorporated into quantitative risk assessments which are an integral part of SP AusNet's economic decision making process.

A number of factors affect the condition of network assets; adverse factors can accelerate asset deterioration prompting replacement. Factors known to have accelerated the deterioration of assets

[3] International Transmission Operations and Maintenance Study.

on the Victorian network in recent years include high utilisation of primary plant coupled with high ambient operating temperatures and corrosive environmental conditions.

As discussed in section 0, the Australian Energy Market Operator (AEMO) is responsible for planning the augmentation of the shared Victorian transmission network and the five Victorian Distribution Businesses are responsible for planning and directing augmentation of the facilities that connect their distribution networks to the shared Victorian transmission network. AEMO and the Distribution Businesses use a probabilistic planning approach to optimise capital expenditure. This approach can result in power transformers being subjected to very high levels of utilisation for long periods.

These high loading levels accelerate the deterioration of power transformers, especially when combined with high ambient temperatures. High ambient temperatures and associated air conditioning loads coupled with high growth in customer connections culminated in a peak demand on the Victorian electricity transmission network of 10,603 MW in the summer of 2008-09. Peak demands have since moderated due to a combination of mild weather, lower economic activity, improved energy efficiency, increased photovoltaic generation and higher energy prices. However, this historic period of high demand has had a lasting impact on both the reliability and the condition of power transformers.

Since 2004, there have been major power transformers failures at Keilor, Morwell, Mount Beauty and Thomastown terminal stations. This has driven the Victorian major transformer failure rate above the CIGRE Australia average of 0.4% per annum. Additionally, unusually high levels of deterioration have been detected in the cores and coils of 14% of the power transformer fleet. Poor core and coil condition of power transformers presents clear evidence of increasing probability of failure.

Continuing investment in power transformer refurbishment and replacement is economical over the next decade to manage failure risks based on the value of unserved energy.

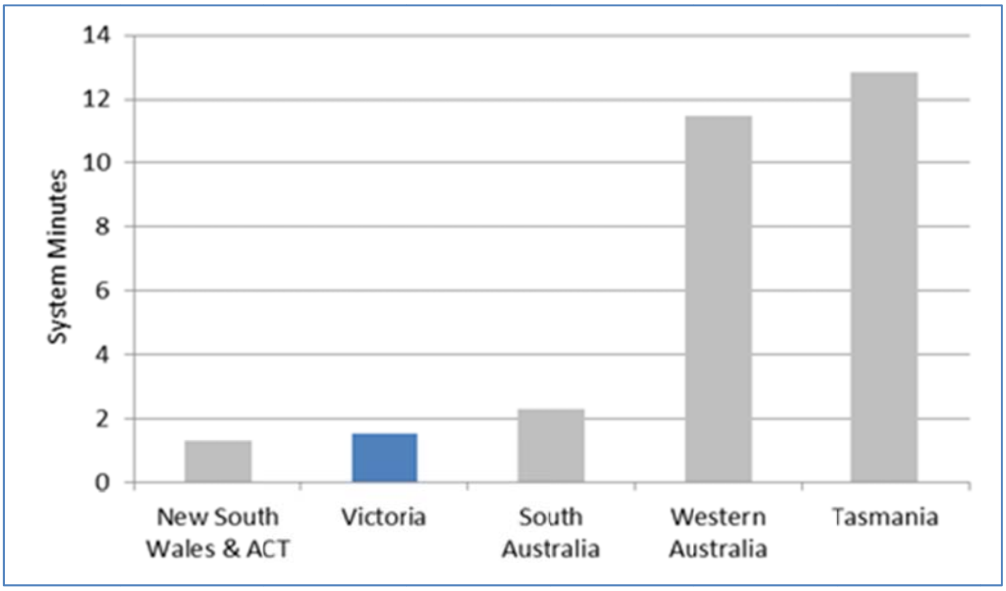
Transmission line assets are especially sensitive to the environments in which they operate. Assets exposed to coastal salt or industrial pollution can degrade to poor condition rapidly. Such degradation resulted in the functional failure of phase conductors on the Heywood (HYTS) to Portland (APD) 500 kV line in 2008 after just 25 years of service. Analysis of samples of the failed conductor revealed considerable corrosion at the interface between the steel core of the conductor and the inner aluminium strands.

The HYTS – APD 500 kV lines are situated close to Victoria's western coast and are exposed to coastal salt deposition. Since the functional failure in 2008, SP AusNet has replaced six kilometres of conductor or 20 per cent of the line between HYTS and APD. A further nine kilometres is expected to be replaced by April 2014. Although minimal conductor and ground wire replacements are forecast in the forthcoming regulatory period their continuing degradation foreshadows the need for accelerated replacements in future regulatory periods.

2.1.4 Network performance

Figure 4 illustrates that, along with New South Wales and the ACT, Victoria has enjoyed good electricity transmission network reliability with low average system minutes unsupplied in comparison to other NEM states over the period decade from 2000-2011.

Figure 4 – System Minutes Unsupplied



Source: Survey data from ESAA, which does not include data for Queensland since 2005-06. To SP AusNet's knowledge, data for Queensland is not otherwise publically available.

Note: System minutes unsupplied is used as a measure of the service level of the transmission network as perceived by network customers. It is calculated as energy unsupplied in MWh divided by MW annual peak demand (divided by 60 to convert to system minutes) using sent-out peak demand. Energy not supplied to customers as a result of forced and fault unplanned outages is included.

3 Asset management

SP AusNet capital investment forecasts are underpinned by an asset management system certified to the British Standard Institute's Publically Available Specification 55 (PAS 55: 2008) and features robust asset management practices designed to achieve customer, regulatory and shareholder expectations. Key asset management drivers are recognised and addressed as part of a dynamic process. Capital efficiency is supported by an internationally accepted approach to asset management and a proactive approach to continuous improvement in capital efficiency. Asset management elements vital to developing efficient capital investment forecasts are discussed in this section.

3.1 Asset Management Drivers

SP AusNet identifies a number of factors which drive the development of prudent asset management plans as described below:

- **Network safety** – Victorian Safety Legislation requires network businesses to lodge an Electricity Safety Management Scheme (ESMS) with Energy Safe Victoria (ESV). The safety initiatives included in the transmission ESMS programs have been driven by increasing community expectations and a shift in Victoria's energy safety regime that places greater emphasis on individual company accountability for safety and targeted risk management. SP AusNet has performed formal safety assessments for the electricity transmission network and identified the relevant mitigating management strategies. SP AusNet's ESMS for the electricity transmission network was formally accepted by Energy Safe Victoria in 2011.
- **Network risk** – Corporate and asset related risks are key to the development of asset management plans for the transmission network. SP AusNet 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 SP AusNet's risk management information system, CURA. Asset risks are quantified through the application of Reliability Centred Maintenance (RCM) techniques. Asset condition data collected during scheduled maintenance tasks is used to determine dynamic time based probability of failures and percentage of remaining service potential (RSP) of each asset. RCM models include the consequence of failure for each major asset and provide risk profiles for each asset category which are used to establish optimised maintenance and asset replacement plans.
- **Performance** – Network performance is recognised as a key driver for asset investment decisions. The performance of the transmission network is monitored against the service target performance incentive scheme (STPIS). Under the scheme network performance is measured against four inter-related elements; reliability, plant availability, supply security and supply quality.

[4] RM 001-2006 Risk Management Framework, 2007, SP AusNet.

- **Sustainability** – Climate change (both in terms of the physical effects and government policies) and funding pressures are likely to continue to dominate energy sector direction over the next five years, although the precise impacts remain uncertain, with ongoing global research and debate about near-term climate effects, and evolving national and international climate policy. Aside from emission management, SP AusNet focuses on the protection of the immediate environment in which it operates through its AS/NZS ISO 14001 certified environmental management systems. The environmental management system is the principle tool through which SP AusNet identifies environmental risks, develops and implements solutions and monitors success in controlling such risks.
- **Augmentation** – Network augmentation investments are driven by growth in electricity consumption and demand, and rising fault levels. AEMO and Victorian DNSPs are responsible for the planning and justification of transmission network augmentation projects. SP AusNet works closely with AEMO and DNSPs in planning future asset replacement programs ensuring that alignment with planned augmentation works is optimised.
- **Advances in technology** – The nature of the energy sector will change fundamentally over the next decade, responding to community expectations of safety and reliability, climatic change and emerging technologies. Advances in technology are facilitating new electricity generation techniques and more efficient small-scale embedded generation solutions, and in the future, the introduction of electric vehicles. Integration of these new sources of generation presents new challenges to the transmission network.

3.2 PAS 55

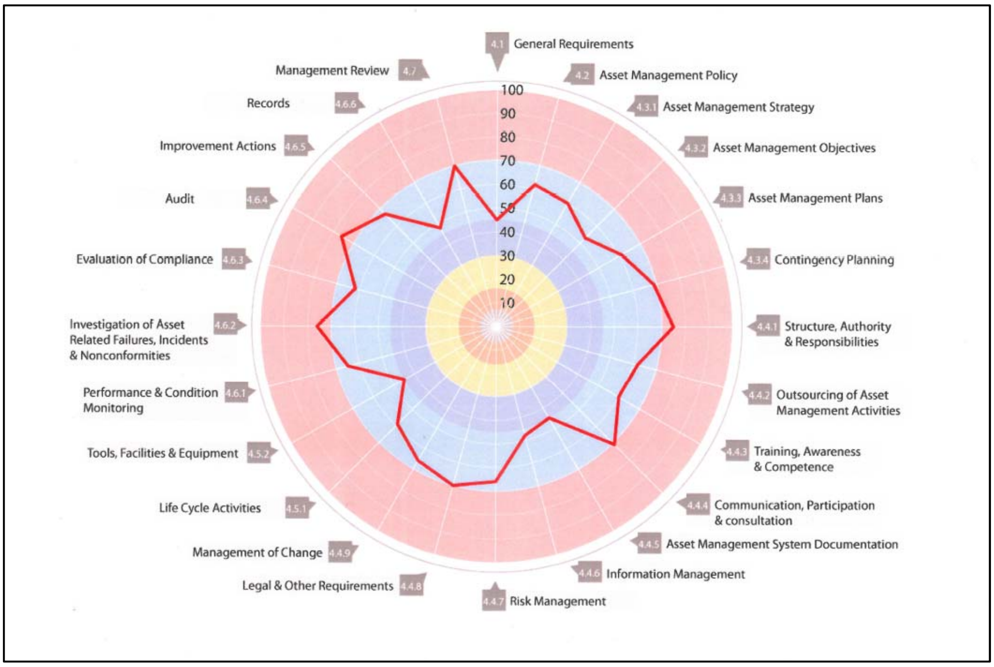
In September 2011 SP AusNet re-certified its transmission asset management practices to Publically Available Specification 55 (PAS 55-1:2008), which is administered by the British Standards Institute. This completed the alignment of asset management systems across SP AusNet's regulated energy networks. In concluding the reviews the auditors, AMCL Pty Ltd, said:

> ***"SP AusNet remains an effective, efficient and competent Asset Manager. It operates an appropriate and effective Asset Management System which is now developing a good level of consistency across electricity transmission, electricity distribution and gas distribution networks under its control"***

The auditors went even further when assessing the maturity of asset management practices, stating our practices are ***"fully effective and are being integrated throughout the business"***.

SP AusNet first attained certification of its electricity transmission asset management practices to PAS 55 in 2008. Since then SP AusNet has improved its asset management practices and maintained PAS 55 certification demonstrating a solid platform for the development of efficient capital investment programs. Asset management processes, such as program delivery, which support the development and implementation of the capital expenditure forecast are recognised as robust and efficient as part of the accreditation. Figure 5 illustrates SP AusNet's maturity at March 2011 against each of the PAS 55 requirements for accreditation.

Figure 5 – SP AusNet's PAS 55 Maturity (March 2011)



Note – Measured performance improves as results move outward.

SP AusNet scored within the "effective" (45% – 70%) range of maturity for most PAS 55 clauses and scored within the "excellent" (70% – 100%) range for three clauses which corresponds with performance levels beyond PAS 55 compliance requirements.

4 Historic capital expenditure

Table 11 below, summarises a selection of major projects from the current regulatory period. Historic capital expenditure can be categorised as major projects, asset replacement and safety improvement programs.

Table 11: Major projects from the current regulatory period

Project Category	Project	Description
Major projects	Terminal station refurbishment	- **Thomastown Terminal Station (TTS):** Refurbished the 220 kV switchyard, replacing one 220/66 kV transformer, 66kV switchyard replacements and associated switchgear. - **Brooklyn Terminal Station (BLTS):** Replaced 220/66 kV and 220/22 kV transformers and switchgear. - **Keilor Terminal Station (KTS):** Replaced poor condition circuit breakers and current transformers. - **Ringwood Terminal Station (RWTS):** Replaced two 22 kV transformers and rebuilt the 22 kV switching facilities. - **Hazelwood Terminal Station (HWTS):** Major refurbishment included, replacing 500 kV CBs & CTs. - **Morwell Terminal Station (MWTS):** Replace a poor condition 150 MVA transformer, at the end of its expected service life.
Asset replacement	Tower / Conductor replacements	Replaced over 15 km of corroded conductor which supplies the Portland Alcoa Aluminium Smelter.
Safety improvement programs	Replacement of insulators and fittings	Replaced 17,000 poor condition insulators and fittings.
Safety improvement programs	Fall restraints on towers	Installed fall arrest systems to comply with a Work Safe agreement. This will work will continue into the next regulatory period.
Safety improvement programs	Replacement of post type current transformers	Replaced a large number poor condition / high risk current transformers. These posed a safety risk and reliability risk due to the potential for explosive failure.
Safety improvement programs	Installation of station security fences	Fences were augmented to prevent unauthorised access at multiple locations as per Victorian "Terrorism (Community Protection) Act 2003.

4.1 Major projects

Rebuild works have been completed at eleven stations during the previous regulatory period; with eight of these stations situated in regional Victoria. The scope of these rebuild projects varied somewhat, however, the main drivers were the replacement of assets displaying poor condition. Station rebuilds completed during this period provided invaluable insight for SP AusNet into the complexities associated with the delivery of such large scale projects in the metropolitan environment.

Major stations refurbishments have taken place or are under way at a further six terminal stations in the current regulatory period. These stations comprise a mix of regional stations and stations supplying the Melbourne Metropolitan area. In all cases objective condition ratings have been used as key inputs into risk based economic assessments used to determine scope of works and the timing of economic asset replacements. The high level scope of these replacement projects are detailed in Table 11.

4.2 Asset replacement

During the current regulatory period, over 15 km (38 spans) of aluminium conductor steel reinforced (ACSR), supplying the Portland Alcoa aluminium smelter, was replaced. Replacements took place following a conductor functional failure on this line in 2008 after just 25 years of service. Subsequent condition assessments revealed the conductor to be in very poor condition as a result of corrosion caused by coastal salt deposition. This conductor failure had significant financial impacts on SP AusNet and its customers and presented serious health and safety risks to workers and the general public.

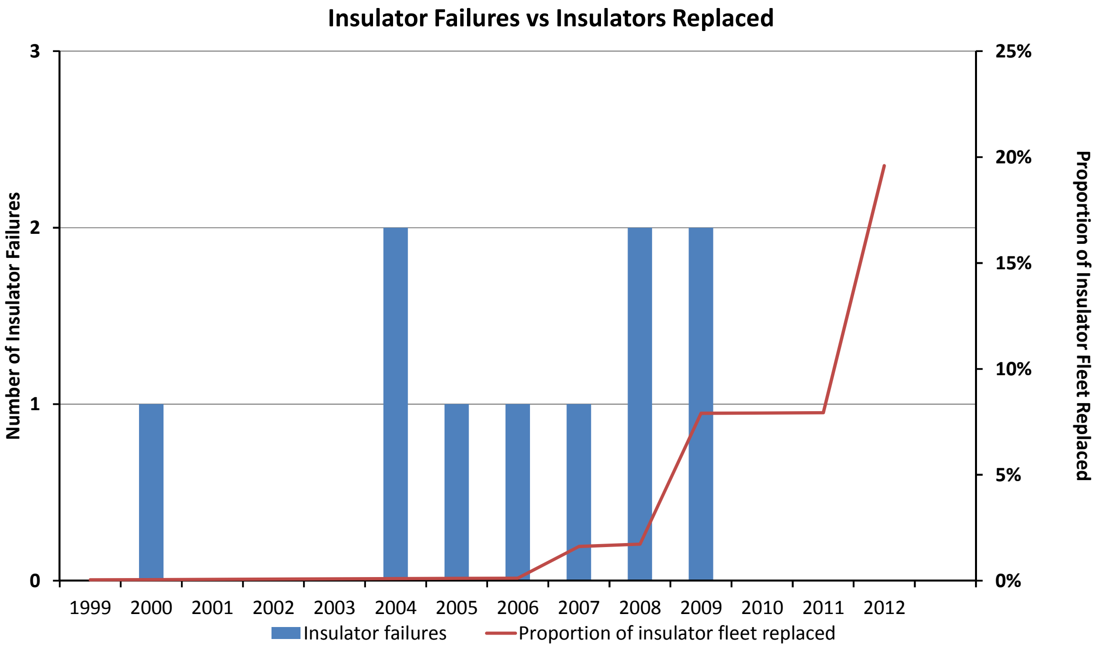
4.3 Safety improvement programs

As a Major Electrical Company (MEC) SP AusNet must meet obligations set out in the Electricity Safety Act 1998 and the Electricity Safety (Management) Regulations 2009. Energy Safe Victoria's (ESV) accepted of SP AusNet's Electricity Safety Management Scheme (ESMS) in March 2011. SP AusNet also meets its requirements under the Occupational Health and Safety Act (2004) through its Mission Zero program designed to improve safety of all employees and contractors.

Consequently, capital works during the current regulatory period have substantially improved safety both as a result of safety specific projects and as a result of safe work practices. Key safety specific projects have included installing fall restraints on transmission towers and augmenting security fences around terminal station sites. Other safety improvements have been achieved through the installation of modern technologies which are more reliable, less prone to dangerous failure modes (e.g. explosive failure) and generally safer by design.

Noticeable safety benefits have been realised following large scale replacement of porcelain transmission line insulators which began in 2006. Failure of porcelain insulators can result in conductor drops presenting serious health and safety risks especially in populated areas. Failure of porcelain insulators began to accelerate from 2000 onwards as significant volumes of the fleet were found to be in poor condition. Since 2006 approximately 20 per cent of the insulator fleet have been replaced targeting high risk assets as priorities. This replacement program has reduced safety risks considerably as no insulator failures have occurred since 2009. Figure 6 displays the history of insulator failure since 1999 against the proportion of the insulator fleet replaced. SP AusNet intends to continue the economic replacement of porcelain insulators to meet the requirements of the Electricity Safety Act and the Occupational Health and safety Act, albeit at a lower forecast volumes.

Figure 6 : Porcelain cap and pin insulator failures

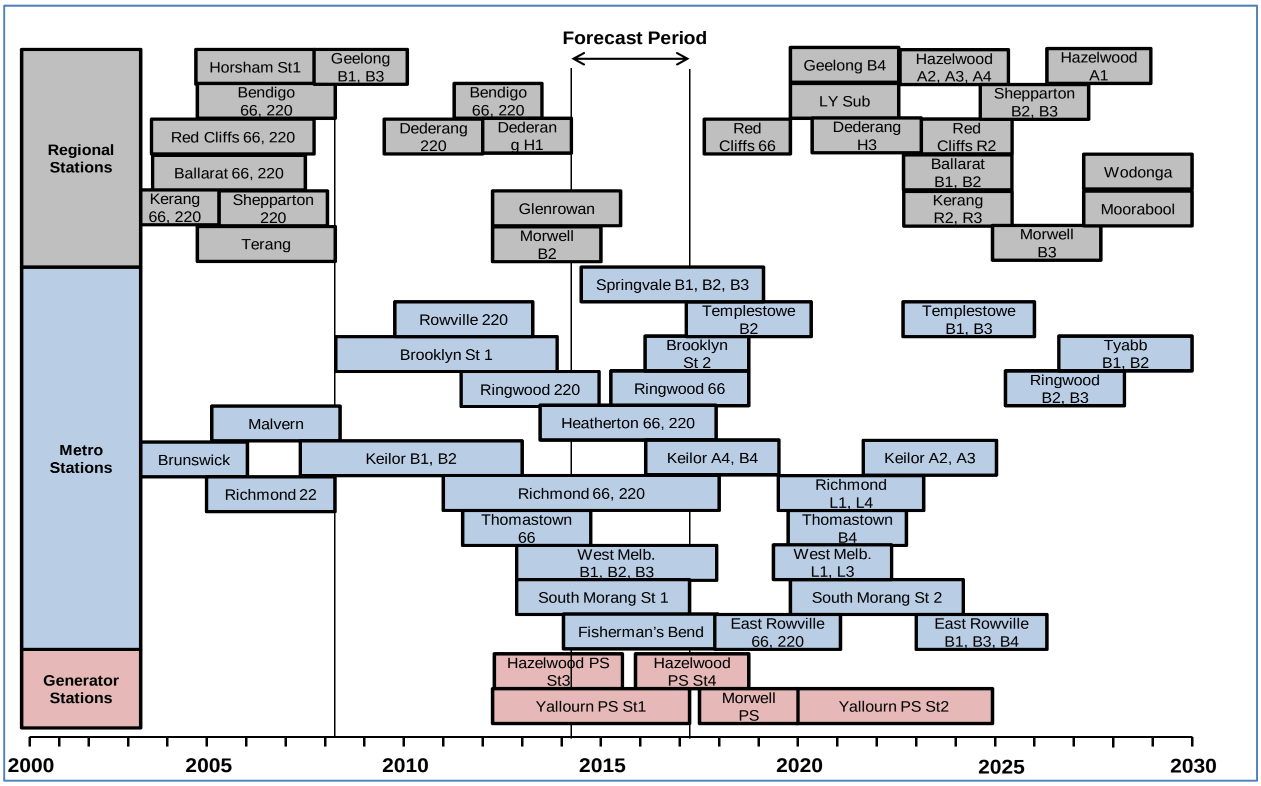


Safety risks associated with the circuit breaker (CB) and circuit transformer (CT) population have been reduced during the current regulatory period. This reduction was driven by proactive replacement programs targeting bulk oil CBs and specific types of CTs assessed as in poor condition and presenting high risks of failure. Targeted CBs and CTs had demonstrated explosive failure modes and therefore presented tangible safety risks to those accessing switchyards. SP AusNet intends to continue the replacement of similar assets demonstrating poor condition and high failure risks throughout the forthcoming regulatory period.

5 Long term capital expenditure forecasts

In the longer term, and acknowledging deteriorating condition in a significant proportion of assets installed more than 50 years ago, SP AusNet forecasts continued expenditure on major station refurbishments over the next two to three regulatory periods. This is driven by expected replacements in major station rebuild projects, consistent with the timing of the replacement schedule set out in the 2007 Victorian regulatory submission. As shown below in Figure 7, spending to date has mostly focused on regional stations; spending over the next period will mainly focus on metropolitan stations, and spending in the following periods will focus mostly on generator switching connection stations.

Figure 7 : Timeline of station rebuilds



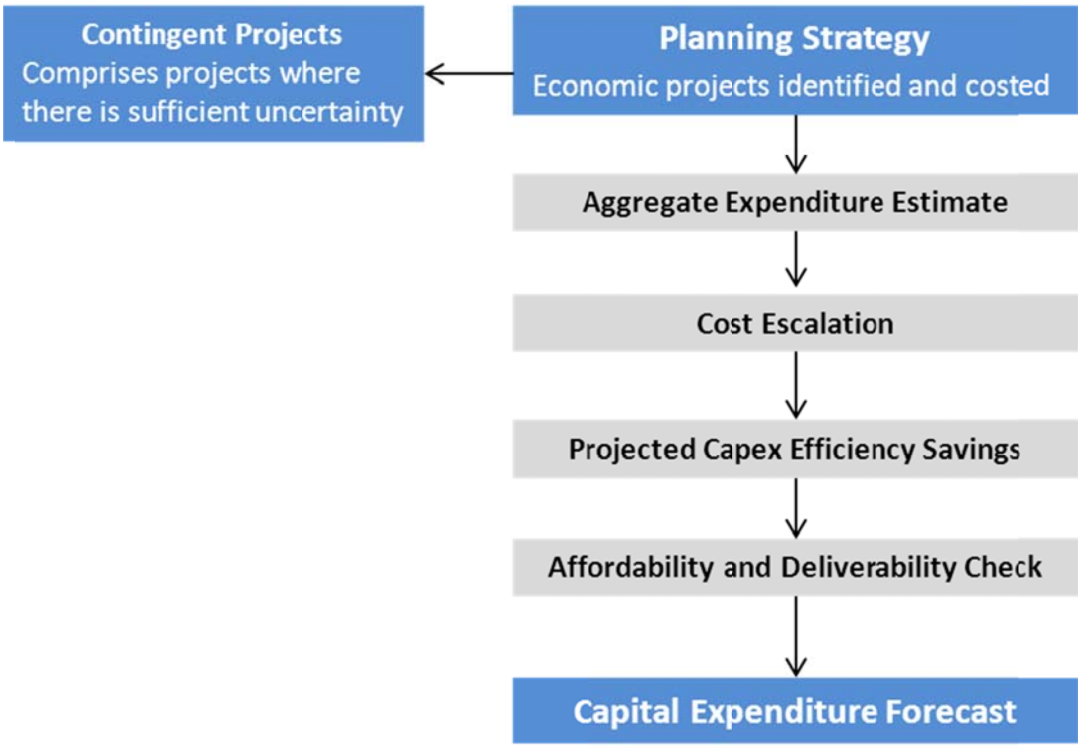
Further significant investment will be required to replace line conductors and towers in the longer term. Forecast line expenditure is expected to at least double current investment levels over a 10 year period beyond 2022. This expectation is driven by the fact that currently there are high volumes of line assets with similar service age and condition profiles. The condition of large proportions of these asset classes are expected to progressively deteriorate simultaneously triggering large scale replacement programs which will require careful integration with the augmentation needs of AEMO.

6 Capital Expenditure Forecast Methodology

In accordance with Schedule 6A.1.1, this section describes the methodology used for developing the capex forecast, and the key assumptions that underlie the forecasts. The capex forecasts presented in this chapter reflect, and are consistent with the implementation and efficient execution of this methodology and SP AusNet's Asset Management Strategy[5].

SP AusNet's overall forecasting approach is based on a bottom-up build of individual project costs summated to form an initial total forecast. Cost escalation or de-escalation is then applied across the entire suite of forecast projects (according to their labour and material profile) to account for expected changes in input costs. Finally, the expected savings from continuous capital project management and governance (capex efficiency) is applied across the entire program of works to provide the final forecast. The overall forecasting methodology is illustrated in the Figure 8 below.

Figure 8 : Capital Expenditure Forecasting Process



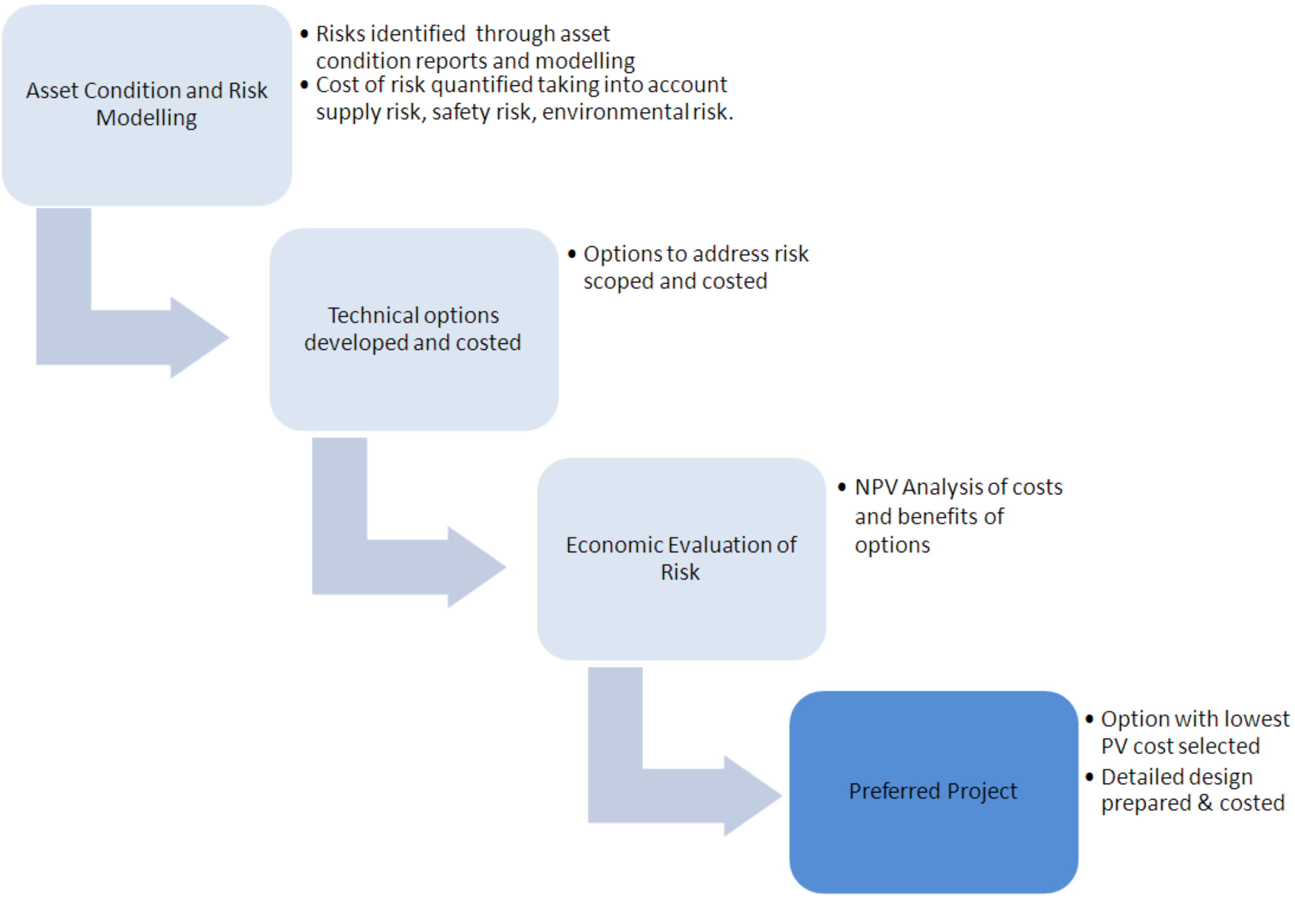
The major stages of the bottom-up build are outlined in detail in section 6.1.

5 AMS 10-01 Transmission Network Asset Management Strategy.

6.1 Bottom-up forecasting

The bottom up capital expenditure forecast is estimated by summing-up expenditure across all of SP AusNet's programs and projects. This involves identifying, scoping and costing every project and program over the entire regulatory period, 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.

Figure 9 : Capital expenditure forecasting methodology



6.1.1 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 the principles of Reliability Centred Maintenance (RCM) techniques.

A wide range of methods and techniques are used to assess the condition of all major asset categories as described in

Table 12. 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.

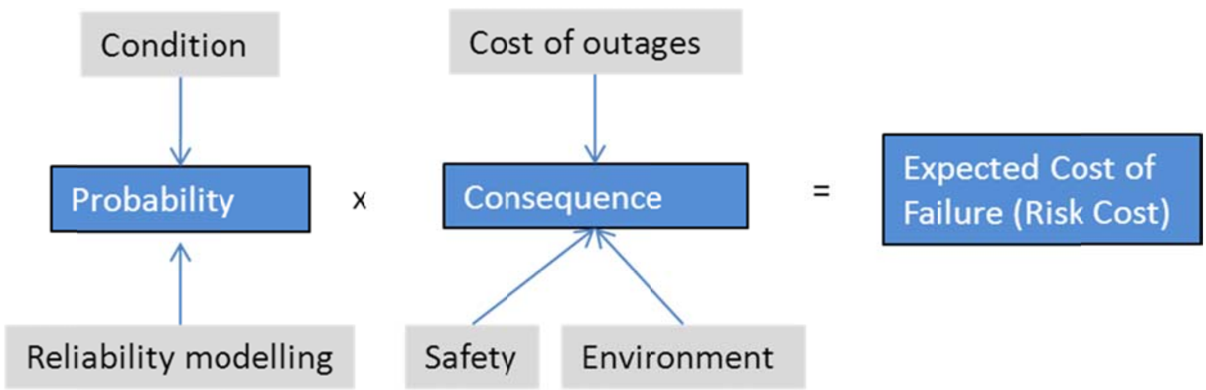
Table 12 – Condition assessment methods

Asset type	Condition assessment methods
Transformers	- Offline electrical testing - Dissolved Gas Analysis - SF6 analysis
Power Cables	- Visual inspection of cable joints for signs of corrosion
Insulators	- Visual inspection for degradation
Circuit breakers	- Gas and oil sampling - Offline electrical testing - SF^6 analysis
Switchgear	- Visual inspection for corrosion - Thermal imaging
Conductors	- Visual inspection for corrosion

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 or 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 the condition based probabilities to quantify the overall cost of failure for each asset as illustrated in Figure 10. The probability weighted cost of failure is referred to as the "risk cost".

Figure 10 – Quantifying cost of asset failure



6.1.2 Estimated Costs of Technical Options

RCM models output the risk cost of failure for each individual asset, technical options are then developed as part of an engineering assessment to address those assets where the risk cost exceeds the generic cost of funding remedial action. Models assign risk rankings which, assist with prioritising assets for engineering assessment. A range of deliverable options to address the risk are identified and scoped including options involving refurbishment of assets. The shared network augmentation needs of AEMO and the connection asset augmentation needs of the distribution businesses over the planning period are taken into account in the scoping and scheduling of these asset replacement options. There is also analysis undertaken across projects to identify the potential efficiencies to be achieved through the coordination of the scope and timing of different projects. For example, some minor replacement work may be included in a major replacement project to attain synergies in project design, project management and project establishment costs. This reduces the cost of minor replacement work and ensures that new assets are configured to function reliably with other assets, as an integrated system. Project cost estimates are then provided for each technically feasible option.

6.1.3 Economic Evaluation of Technical Options

Following the development of project cost estimates for each technically feasible option, economic evaluations are performed to determine the preferred option. Net Present Value (NPV) models facilitate the economic evaluation. NPV studies analyse the costs and benefits of each option, with the aim of identifying the most economic option (the preferred option). 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.

SP AusNet also explores the potential for efficiencies to be derived by carrying large complex projects in discrete stages. Under this approach, SP AusNet identifies the highest asset failure risks so that these can be addressed in a timely fashion, while the timing of lower-risk project components may be adjusted to assist with delivery of the overall capital program.

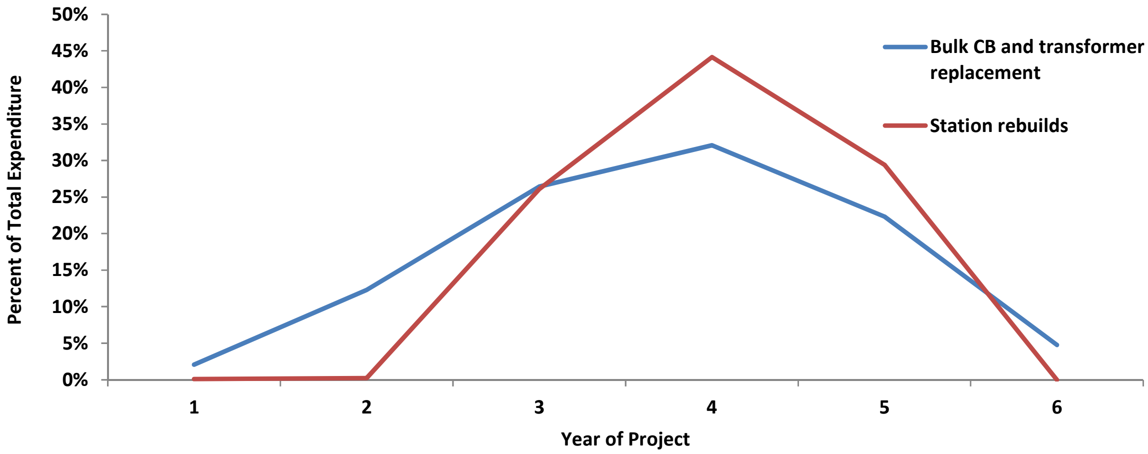
Overall, SP AusNet's approach is consistent with that documented in the Victorian distributors' annual Transmission Connection Planning Report and in the Distribution System Planning Reports published by Victorian distributors each year. It is also consistent with the principles underpinning the regulatory investment test.

6.1.4 Project Cost and Timing

Once the preferred option has been economically selected a highly detailed project scope and detailed project cost can be estimated. SP AusNet 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. The estimate does not capture likely changes in unit costs (discussed in the next section). However, the expected cost of various project contingencies, are estimated using Monte Carlo analysis.

In large complex projects a greater proportion of expenditure occurs toward the middle of a project on equipment procurement and construction contracts. Smaller proportions are spent on design at the beginning and on commissioning toward the end of the project. This expenditure profile forms characteristic S-curves, as shown below in Figure 11. For the forecast capital expenditure program SP AusNet has calculated average S-curves, based on historic project expenditure, and allocated expenditure on planned projects accordingly. This has resulted in some costs from projects scheduled for late in the forthcoming regulatory period being pushed into the subsequent regulatory period.

Figure 11 : Project spend profiles (S-Curves)



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.

6.1.5 Real cost escalators

The price of a 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 SP AusNet 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 ten different sub-categories: secondary equipment, switchgear, transformers, reactive equipment, lines and towers, establishment, communications, non-network, land and easements.

For each category, SP AusNet has commissioned an expert forecast of real price changes relative to the base year. These 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.

6.1.6 Improvements in capital efficiency

SP AusNet 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. However we expect that some small further improvement will occur over the next period of around 1.44%. This has already been factored into the overall forecast.

7 Expected Benefits of Capital Expenditure

This section provides an overview of the key benefits of SP AusNet's forecast capital investment over the regulatory period. The aggregate outcomes of the capital program are consistent with those identified in the detailed underlying project justifications. The key outcomes are outlined below.

7.1 Safety and safety compliance

SP AusNet must comply with the requirements of the Electricity Safety Act (1998) and the Occupational Health and Safety Act (2004).

The Electricity Safety Act requires SP AusNet to: operate its electricity transmission network to minimise, as far as is practicable, hazards to the safety of any person. Under the Occupational Health and Safety Act SP AusNet is required to: as far as is reasonably practicable, maintain for employees a working environment that is safe and without risks to health.

When evaluating alternative remediation options SP AusNet must have regard to the likelihood and harm and what is known or should be known about the safety hazards. Ways to eliminate or mitigate hazards and the availability and suitability of ways to eliminate or mitigate safety hazards must be considered. SP AusNet is further obliged to have regard to the cost of removing or mitigating the safety hazard or risk. In economic terms; "reasonably practicable" requires SP AusNet to address safety hazards up until the point that the costs of remediation become grossly disproportionate to the benefits.

SP AusNet maintains an accepted Electricity Safety Management Scheme (ESMS) as required under the *Electricity Safety Act 1998* and in compliance with the *Electricity Safety (Management) Regulations 2010*. The ESMS forms an outcome based regulatory framework against which Energy Safe Victoria (ESV) maintains regular audits to monitor SP AusNet's compliance. Energy Safe Victoria endorsed SP AusNet's ESMS[6] for the transmission network in March 2011.

Endorsement of SP AusNet's ESMS recognises adherence to obligations of the act in developing prudent asset management practices including the development and implementation of capital programs. The use of formal safety assessments, in particular, is an ESMS obligation which has influenced the scopes of projects included in the capital forecast which are primarily driven by safety compliance.

Many of the safety improvements delivered by the capex program will arise incidentally as a result of replacing old equipment with new, safer equipment and through the application of modern, safer station design standards. Other improvements will result directly from projects aimed at improving safety (or safety compliance). A high level summary of the safety outcomes provided by SP AusNet's forecast capital works program is shown in Table 13.

[6] ESMS 20-01 Electricity Safety Management Scheme, Overview for Electricity Transmission Network.

Table 13: Safety outcomes of capital program

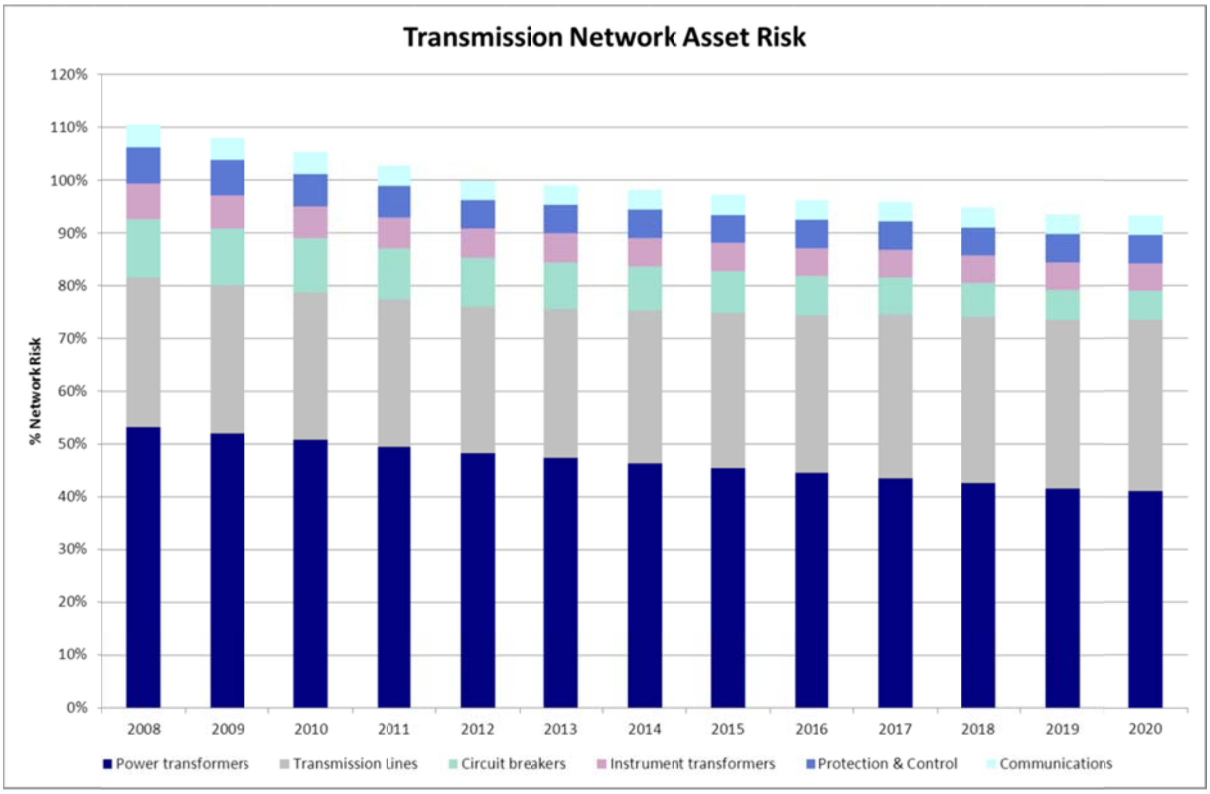
Project or Type of Project	Outcome
Tower replacement	- Reduced risk of public injury or death from a tower collapse
Cable fall arrests systems	- Reduced risk of death or injury to an employee from falling
Transformer replacement	- Reduced risk of death or injury from an explosion or fire
Indoor switchgear	- Reduced risk of electrocution
Conductor replacement	- Reduced risk of conductor drop causing injury or death
Site security	- Reduced risk of injury or death resulting from unauthorised persons approaching electrical equipment
Insulator replacement	- Reduced risk of conductor drop causing injury or death
Circuit breaker replacement	- Reduced risk of death or injury from an explosive failure of circuit breaker bushings or oil fire

A program to eliminate asbestos from SP AusNet properties by 2025 will reduce critical safety risks in the forthcoming regulatory period. If left unaddressed, asbestos has proven to be life-threatening. As part of SP AusNet's commitment to making its workplaces safe for all staff and the public, the company has initiated an asbestos removal program. As part of this program, SP AusNet has performed asbestos audits at all of its terminal stations identifying nine sites which require asbestos removal. Asbestos will be safely removed from these sites over the forthcoming regulatory period as part of this forecast capital work program.

7.2 Network risk and reliability

Risk models, which are developed using results of objective condition assessments and historic failure consequences, output risk profiles for each asset category. The total risk resulting from the operation of the transmission network can be estimated by summing the outputs (risk costs) from these risk models. These profiles provide a dynamic view of changes in risk of asset failure considering past and future capital investment levels. Asset risk profiles for the period between 2008 and 2020 are displayed in Figure 12.

Figure 12 : Forecast changes in asset failure risk



Since 2008 SP AusNet has progressively reduced the asset failure risk in the Victorian electricity transmission network by 15%. All asset replacement programs have contributed to this reduction. The replacement of deteriorated insulators, which has reduced the frequency of line conductor drops, and the replacement of deteriorated instrument transformers, which has minimised the risk of explosive failures in switchyards, have been important contributors to this reduced level of overall risk. The removal of air blast circuit breakers and their associated compressed air operating systems, and the progressive replacement of electro-mechanical protection relays have also contributed to the risk reduction.

Asset replacement over the forthcoming regulatory period will largely be driven by the risk associated with power transformer failures and to a lesser extent, instrument transformers and circuit breakers. A majority of the expected risk reduction will be delivered as a direct result of asset replacements during station rebuilds. On the other hand, the risk associated with transmission lines will marginally increase as the overall condition associated with large proportions of the transmission line conductor and structure fleets continues to decline.

Overall, the asset renewal program for the electricity transmission network, will progressively improve asset failure risks by 5% in the period to 2020, as illustrated in Figure 12, above. This improvement represents continued levels service for consumers and reduces health and safety risks associated with asset failure for workers and the general public.

7.3 Environment

Some primary plant equipment can present environmental risks especially those power transformers and circuit breakers containing large volumes of insulating oils. Typically, these risks arise from oil leaking from transformers and circuit breakers, pollution caused by a fire or from uncontrolled release of SF_6 gas insulants. Station rebuild works will replace many bulk oil circuit breakers and several deteriorated power transformers which will benefit the environment through the reduction of risks of spills. Additional circuit breakers will be replaced as part of asset replacement program targeting high failure risk bulk oil units.

SP AusNet will continue the installation of oil containment and water treatment systems at stations not scheduled for refurbishment. These water treatment systems will ensure compliance with Environmental Protection Agency (EPA) guidelines before the conclusion of the forthcoming regulatory period. SP AusNet's capital forecast includes refurbishment of fire deluge systems installed above power transformers. Deluge systems operate to extinguish fires mitigating the impact to the environment.

7.4 Enhancing future capital expenditure programs

SP AusNet is committed to optimising the efficiency of future capital expenditure by identifying further improvements which can be made to the processes in which capital programs are developed and implemented. Enhancement of current condition monitoring techniques provides opportunities to prevent asset failures whilst optimising the timing of future capital investment by avoiding premature replacement of network assets. This opportunity is especially pertinent to lines assets. Furthermore, sustained collaboration with AEMO and the DNSP's will ensure careful co-ordination of augmentation and asset replacement projects allowing capital works programs to be delivered as efficiently as possible.

7.4.1 Enabling future development

In Victoria, AEMO is responsible for network planning and augmentation, and SP AusNet is responsible for maintaining the network assets. However, these two activities need to be carefully coordinated to ensure the two capital programs are aligned. Specifically, any significant asset replacements must consider the longer term shared network and connection network development plans to ensure individual decisions do not compromise security of supply or impede economic future capacity augmentation. For example the Richmond and West Melbourne terminal station outdoor air insulated switchyards will be converted to more compact indoor GIS switchgear in the next regulatory period. As a collateral benefit, this will release the necessary space on the existing sites for future network augmentations. SP AusNet will enhance its coordination with AEMO and the distribution businesses to ensure that network augmentation and asset replacement needs are integrated in economic project development processes.

7.4.2 Improving condition assessments

As discussed in section 6.1.1 asset condition data collected during scheduled maintenance tasks and specific assessment testing has become a key input to risk models which focus the development of asset replacement programs. The accuracy of the condition data acquired can impact upon the scope and timing of asset replacement programs.

Condition grading of transmission ACSR line conductors can be difficult to perform visually as the corrosion starts and progresses internally at the interface between the steel core of the conductor and the inner aluminium strands before it is visible upon the outer aluminium strands. Traditional practices for assessing the condition of transmission line ACSR conductors require the asset inspector to visually inspect the conductor using image stabilised binoculars. These methods are basic and are unsuitable for accurately assessing large populations of deteriorating conductor which may require replacement over the next 20 years.

SP AusNet has successfully trialled several new technologies, such as overhead line Corrosion monitoring (CORMON) and Smart Aerial Image Processing (SAIP), which offer more accurate assessment of conductor condition. SP AusNet will expand the application of these more accurate condition assessment techniques in the forthcoming regulatory period to better inform the development of economic line replacement programs. These new technologies will require a step change in operating costs. However, the data captured by these technologies will improve the targeting of future risk based conductor replacement programs whilst simultaneously preventing conductor failure incidents similar to that on the HYTS-APD 500 kV line in 2008.

8 Capital Expenditure Forecast

All expenditure forecasts in this section are expressed in $2012 P50 direct costs only. The forecast costs do not include overhead costs overheads or escalation. SP AusNet regulated capital expenditure authority process requires main Board approval for projects which cost in excess of $50 million, approval from the Managing Director for projects which cost up to $50 million, approval from the General Manager of Network Strategy and Development for projects which cost up to $5 million and approval from all other relevant General Managers for projects which cost up to $1 million.

8.1 Major Projects – Station Rebuilding and Refurbishment Program

8.1.1 West Melbourne Rebuild (XA14)

Summary:

West Melbourne Terminal Station (WMTS) is one of three terminal stations in Melbourne supplying the CBD plus the surrounding residential, commercial and industrial areas to the west. It sits on a relatively small site bounded on all sides. Expansion at this site is constrained by limited space.

Much of the existing equipment was installed in 1964, has deteriorated and is now at a high and increasing risk of failure. The redevelopment of WMTS is driven by reliability considerations, load criticality and asset performance, particularly as several faults have already been experienced and manufacturers have withdrawn further support for many of the circuit breakers now assessed as at risk. CitiPower is relying on completion of this project to deliver a reliable and secure supply to the CBD. The SP AusNet Board has approved the rebuild of WMTS to manage supply risk to the CBD and inner Melbourne areas.

The planned rebuild will replace end-of-life assets with modern, safe and more compact equivalents. The station will also be re-designed to accommodate future capacity expansions planned by AEMO and CitiPower to meet future demand.

As a committed project, work commenced on the WMTS rebuild in 2012/13 with completion due 2017/18.

The table below sets out the forecast capex requirements for WMTS. These have been informed by the most recent, detailed cost forecasts for RTS.

Table 14: Expenditure on the West Melbourne Rebuild

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	30,000	31,000	32,000	93,000

Scope of works:

- Replace 22 kV, 66 kV and 220 kV switchyards with indoor GIS switchgear in four buildings
- Replace B1, B2 and B4 220 / 66 kV transformers
- Establish a new control room in the existing control building
- Establish new AC and DC supplies
- Install a new oil separation and water treatment facility

- Replace protection and control systems for the 220 kV switchyard
- Upgrade Fire detection and suppression systems

Benefits and investment drivers:

- Reliability (primary project justification)
- Improved safety
- Improved visual amenity at the site
- Releasing space for future developments on site

Related documents:

- Board paper: West Melbourne Terminal Station Project (15 May 2012)
- Business Case Application for Approval: XA14 WMTS Redevelopment Project

8.1.2 Richmond Rebuild (XA09)

Summary:

Richmond Terminal Station (RTS) provides supply to the eastern Central Business District and the inner east and south-east suburban areas of metropolitan Melbourne. Three of the four existing transformers have been assessed as presenting some of the highest risks of failure of any transformers in the Victorian electricity transmission network. The RTS 220 kV, 66 kV and 22 kV switchgear also present supply risks due to deteriorated condition. Failure of transformers or switchgear assets at RTS will have significant consequences as this station is critical to the reliable supply of load to Melbourne's CBD and inner suburbs. Supply risk posed by deteriorating assets at this station is the primary driver for rebuild works.

RTS is situated within a very compact site which makes replacement work complex as it requires careful planning to maintain secure supplies due to the number and duration of circuit outages required to undertake the work. The Distribution business service providers (DNSP's), who are responsible for planning of the connection assets at RTS, are considering augmenting RTS with a another 220/66 kV transformer; however, there is no space to increase the station capacity or to improve the switching configuration within the existing arrangement. These factors influenced decisions relating to the optimum station design required to resolve the existing supply risks.

The 220 kV switching configuration presents a particular supply risk as it is possible that two lines and three transformers can be forced out of service by a single circuit breaker failure. The redevelopment of RTS will reduce these supply risks by replacing the existing switchgear with indoor gas insulated switchgear (GIS) that provides more secure switching of the 220 kV lines, cable and transformers. The use of GIS is essential as its use reduces the existing switchgear footprint allowing rebuild works to take place without long outages whilst providing for economic future augmentation at the site.

Replacement of the four deteriorated 150 MVA 220 / 66 kV transformers with three 225 MVA units is essential to reducing supply risks at the station. These replacements will create the necessary space to facilitate the station redevelopment and provide for future capacity augmentation including the installation of a fourth 225 MVA transformer. In this project the transformer N-1 capacity will be maintained at current levels. Significant replacement of protection, control, metering and communications equipment is also required.

The redevelopment of RTS was included in the capex forecast approved by the AER in its 2008 Revenue Determination for SP AusNet, and completion of the project was expected in the regulatory period commencing on 1 April 2014. SP AusNet forecast $122 million (real 2007/08) in capex for this project; whereas the AER included $96 million (real 2007/08) in its capex allowance for the project in the current regulatory period.

The project received approval from SP AusNet's Board in 2010.

Following Board approval, further detailed planning and initial design was undertaken leading to a revision to the project scope in 2012. The decision was made to:

- Redevelop the entire 66 kV switchyard with indoor GIS rather than a combination of AIS and GIS. This followed studies that revealed the existing pile foundations for the site may not be able to support the weight of AIS switchgear over their expected life and that the cost, safety risks and supply risks of 66 kV AIS replacements might be higher than what has been assumed in the original project plan[7]. The expected benefits of the use of GIS technology include:
  - avoiding the need to reinforce some or all of the existing pile structures for the 66 kV switchyard, which may have been required for redevelopment with AIS
  - enabling a 'greenfield' approach to be adopted for switchgear replacements. The GIS equipment can be assembled and pre-commissioned in a new building without impact on existing infrastructure.
  - minimising the risk of transmission network outages during construction phases.
  - reducing the safety risk associated with implementation as the majority of works will be effectively isolated to the new GIS building, largely eliminating the risks associated with working in close proximity to energised equipment.
  - meeting the future plans for RTS.
  - minimising the need for SP AusNet to rely on the existing resource pool to complete the work because the installation of GIS equipment will use specialised resources provided by the equipment manufacturer. This reduces potential project delays.
- Improve the site's visual amenity consistent with the expectations of the local community and Council. Following SP AusNet's experiences with the Brunswick Terminal Station (BTS) augmentation project, it was important to address the planning approval requirements of the local Council and endeavour to meet the needs of the local community to ensure smooth delivery of this project.

The revised project was approved by SP AusNet's Board in May 2012. The project cost approved was higher than the original forecast from 2010 due to the changed project scope and updated cost estimates.

As committed expenditure, work on the RTS rebuild project commenced in 2011/12 with expected completion now due in 2017/18.

Since May 2012, SP AusNet has developed more accurate cost forecasts as the project has progressed. As the detailed design for RTS was completed, it became clear that some technical aspects of the project, such as site layout, fault levels, protection and building requirements, are less demanding than initially expected. Also, tendering for some of the works has been undertaken and

[7] An AIS replacement will require work to be undertaken in a live switchyard with consequent safety and supply risks. The piles for the 66 kV switchyard would have to be reinforced for an AIS 66 kV redevelopment, which would be more complex and expensive.

the cost of plant and equipment such as transformers and GIS will be lower than expected. As such, the current forecast costs for RTS are lower than the internally approved estimate from May 2012. These lowered forecasts are reflected in SP AusNet's capex forecast for the next regulatory control period.

The table below sets out the forecast capex requirements for RTS.

Table 15: Expenditure on the Richmond Rebuild

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	28,550	19,900	21,200	69,650

Scope of works:

- Rebuilding 22 kV, 66 kV and 220 kV switchyards using indoor GIS technology
- Replacing four 150 MVA 220/66 kV transformers with three 225 MVA transformers
- Architecturally treated buildings, buffer zones around the site and landscaping

Benefits and investment drivers:

- Reliability (primary project justification)
- Improved safety
- Creating necessary space for future developments on site
- Reduced environmental risk
- Improved visual amenity and meeting local government objectives

Related documents:

- Business Case Application for Approval: XA09 Richmond Terminal Station (RTS) redevelopment project (29 May 2012)
- Board paper: Richmond Terminal Station Redevelopment Project (15 May 2012)

8.1.3 Heatherton Terminal Station Redevelopment (XB59)

Summary:

Heatherton Terminal Station (HTS) is the main source of supply for much of bay side Melbourne, from Brighton in the north to Edithvale in the south.

HTS was commissioned in 1964, and the primary and secondary assets at the station have deteriorated. This is leading to high and increasing risks of failure and inefficient operation and maintenance. Further, the security of supply risks presented by a failure of a 220/66 kV transformer, 220 kV circuit breakers or 66 kV circuit breakers are high. Economic studies support their replacement in the next period taking into account the probability of failure and cost of failure risk.

Table 16: Expenditure on Heatherton Terminal Station Redevelopment

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	5,737	12,431	15,300	33,468

Scope of works:

- Replace three 150 MVA 220/66 kV transformers
- Replace the 220 kV switchgear and reconfigure the transformer and line connections
- Upgrade the 220 kV busbars
- Replace 66 kV switchgear
- Upgrade the 66 kV busbars
- Replace secondary systems

Benefits and investment drivers:

- Reliability (primary project justification)
- Health and safety
- Reduced risk of plant collateral damage from explosive failure
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XB59 –Heatherton Terminal Station Redevelopment
- Board Paper - Heatherton Terminal Station (13 Sept 2012)
- Business Case Application for Approval: XB59 HTS Redevelopment Project
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations
- AMS 10-144 Asset Health Review for Transmission Circuit Breaker
- AMS 10-64 Instrument Transformers
- AMS 10-106 Circuit Breakers

8.1.4 South Morang Terminal Station H1 and H2 Transformer Replacement (XC19)

Summary:

South Morang Terminal Station (SMTS) is located approximately 23km north-east from Melbourne's CBD and it supplies 292 MVA of directly connected 66 kV load as well as load in the northern Melbourne metropolitan area. SMTS consists of four switchyards operating at voltages of 500 kV, 330 kV, 220 kV and 66 kV.

Six 330/220 kV single-phase H transformers were installed at the station in the 1960s. These transformers are in poor condition and present a rising probability of failure. In the absence of a spare transformer, the potential for a major failure of one of these transformers is a significant supply risk, with an expected annual risk cost rising from $2 million to $26 million over the period from 2014 to 2020.

This project will replace the three 330/220 kV single-phase H transformers with a new 700 MVA 330/220 kV transformer bank of three single-phase units and install a new 330 kV switch bay for the connection of the new transformer. Replacement of the second 330/220 kV transformer has been deferred to the following regulatory control period.

Approval to proceed with this project will be received in before mid-2013.

Table 17: Expenditure on South Morang Terminal Station H1 and H2 Transformer Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	7,135	12,074	7,684	26,893

Scope of works:

- Install a new 700 MVA 330/220 kV transformer bank of three single-phase units.
- Install new 330 kV switch bay for the new transformer
- Retain the existing two transformers. One as an in-service unit and the other as a cold spare on site.

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environmental
- Reduced risk of plant collateral damage
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XC19 – South Morang Terminal Station H1 and H2 Transformer Replacement
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations

8.1.5 Yallourn Power Station Switchyard Refurbishment (XC18)

Summary:

YPS is located approximately 126 km south-east from Melbourne's CBD. It is connects the Yallourn West Power Station to the transmission network and closes the Hazelwood, Yallourn, Rowville 220 kV transmission loop.

Most of the 220 kV switchgear and infrastructure at YPS are more than 45 years old, have deteriorated and are now approaching the end of their technical lives. These deteriorated assets present unacceptable safety risks. Furthermore, in the absence of an economic refurbishment/replacement project, reliability will decline and maintenance costs will rise to inefficient levels. This project will avoid this by refurbishing YPS, including the replacement of several circuit breakers and transformers. This project is planned to commence in 2013/14.

Table 18: Expenditure on Yallourn Power Station Switchyard Refurbishment

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	5,253	8,889	5,657	19,799

Scope of works:

- Replace four 220 kV circuit breaker (ROTS No.7 and 8, YWPS Generator No.2 and 4) and all 220 kV oil current transformers
- Refurbish remaining 220 kV circuit breakers

Benefits and investment drivers:

- Safety (primary driver)
- Reliability
- Environmental
- Reduced operational and maintenance costs
- Reduced risk of plant collateral damage
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XC18 Yallourn Power Station Switchyard Refurbishment
- AMS 10-106 Circuit Breakers – Summary of Issues and Strategies
- AMS 10-144 Asset Health Review for Transmission Circuit Breaker
- AMS 10-122 Asset Health Review for Current Transformers

8.1.6 Fisherman's Bend Terminal Station Refurbishment (XC17)

Summary:

Fisherman's Bend Terminal Station (FBTS) is located approximately 3 km south-west of Melbourne's CBD and is the main source of supply for Docklands and Southbank, Port Melbourne, Fisherman's Bend, Albert Park, Middle Park and St Kilda West.

Established in late 1960s, the primary and secondary assets at FBTS have deteriorated and are leading to increasing risks of failure, and inefficient operation and maintenance costs. Economic studies support their replacement in the next period taking into account the probability of failure and cost of failure risk. This project will replace 66 kV circuit breakers and the B1 transformer with a 150 MVA 220/66 kV transformer.

This project is being completed later than economic timing suggests smoothing expenditure and workloads across the planning period.

Table 19: Expenditure on Fisherman's Bend Terminal Station Refurbishment

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	473	6,150	10,407	17,030

Scope of works:

- Replace the B1 transformer with a 150 MVA 220/66 kV transformer
- Replace critical 220 kV and 66 kV Circuit breakers

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environmental
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Project – XC17 Fisherman's Bend Terminal Station Refurbishment
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations
- AMS 10-106 Circuit Breakers – Summary of Issues and Strategies
- AMS 10-144 Asset Health Review for Transmission Circuit Breaker

8.1.7 Springvale Terminal Station Redevelopment (XB61)

Summary:

Springvale Terminal Station (SVTS) is located in south-east Melbourne. It supplies the eastern Melbourne zone substations of Clarinda, East Burwood, Glen Waverley, Notting Hill, Noble Park, Oakleigh East, Riversdale, and three Springvale stations via 66 kV feeders.

Many of the primary and secondary assets at SVTS have deteriorated. The risks associated with plant failure are increasing and assets are becoming more difficult and expensive to maintain. This is, in part, because the manufacturers no longer support many of these assets and spare parts are now generally unavailable.

Economic studies support their replacement in the next period taking into account the probability of failure and cost of failure risk. The staged redevelopment with 220 kV and 66 kV air insulated switchgear and 150 MVA transformers will be undertaken to address asset condition and circuit configuration risks at SVTS. This project is planned to commence in 2014/15 and be completed in 2019/20.

Table 20: Expenditure on Springvale Terminal Station Redevelopment (XB61)

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	341	1,365	8,192	9,898

Scope of works:

- Replace three of the four 150 MVA 220/66 kV transformers
- Replace 220 kV switchgear and reconfigure the transformer and line connections
- Upgrade 220 kV busbars
- Replace 66 kV switchgear
- Upgrade 66 kV busbars
- Replace secondary systems

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environmental
- Reduced operational and maintenance costs
- Reduced risk of plant collateral damage
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XB61 Springvale Terminal Station Redevelopment
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations
- AMS 10-144 Asset Health Review for Transmission Circuit Breaker
- AMS 10-64 Instrument Transformers

- AMS 10-106 Circuit Breakers

8.1.8 Brooklyn Terminal Station Circuit Breaker Replacement (XC14)

Summary:

Brooklyn Terminal Station (BLTS) supplies the inner western residential area of Melbourne and various large commercial entities in the west of the metropolitan area. It is supplied from Keilor Terminal Station (KTS) and is connected in the western metropolitan 220 kV ring.

BLTS commenced operation as a 220/66/22 kV transformation station in 1963 and is currently being redeveloped to replace the 220/66 kV and 220/22 kV transformers, which present a high risk of failure. The staging of works at BLTS means that the next stage of works will involve replacing 220 kV circuit breakers connecting the four 220 kV transmission lines to BLTS, SPI PowerNet's 22 kV circuit breakers and the deteriorated 66 kV circuit breakers.

This project is planned to complete in 2018/19.

Table 21: Expenditure on Brooklyn Terminal Station Circuit Breaker Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	-	694	9,017	9,711

Scope of works:

- Replace 220 kV minimum oil circuit breakers protecting the four incoming 220 kV transmission lines
- Replace two SPI Power Net's bulk oil 22 kV circuit breakers
- Replace five minimum oil 66 kV circuit breakers and fifteen bulk oil 66 kV circuit breakers.

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environmental
- Reduced operational and maintenance costs
- Reduced risk of plant collateral damage
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XC14 – Brooklyn Terminal Station Circuit Breaker Replacement
- AMS 10-64 Instrument Transformers
- AMS 10-106 Circuit Breakers – Summary Issues and Strategies
- AMS 10-144 Asset Health Review for Transmission circuit breaker

8.1.9 Glenrowan Rebuild (XB12)

Summary:

Glenrowan Terminal Station (GNTS) is critical to the reliability and availability of supply to customers located in north eastern Victoria. The geographic area supplied by the station includes Wangaratta, Euroa, Mansfield, Mount Buller and Benalla.

GNTS was developed in 1970 and consequently the majority of the electrical assets have reached the end of their reliable service lives. Some assets are in poor condition and as a result, have a high probability of failure. The planned rebuild will replace these deteriorated assets with modern, safer and more compact equivalents and redesign the site to facilitate future development. The rebuild will also result in a small increase in transformer capacity. However, the additional cost of this increase in capacity is less than $5 million and is supported by Powercor, the distribution business responsible for connection asset planning at GNTS. Consequently, a Regulatory Investment Test (RIT-T) is not required. This project was approved in 2011 and is expected to be completed in 2015.

Table 22: Expenditure on the Glenrowan Rebuild

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	3,953	1,588	-	5,541

Scope of works:

- Replace 220 kV air blast circuit breakers with dead tank circuit breakers
- Replace 16 remote operated isolators
- Replace 14 single phase capacitive voltage transformers
- Replace the 1A/1B transformer with a new 220/66/22kV 150 MVA transformer
- Replace 66 kV transformer incomer circuit breakers and 66 kV bus tie circuit breakers with new dead tank circuit breakers
- Install station service transformers
- Install protection and control panels for new switchgear and transformer

Benefits and investment drivers:

- Reliability (primary project justification)
- Improved safety
- Creating space for AEMO's future developments on site
- Reduced environmental risk
- Lower network losses resulting from more efficient transformation

Related documents:

- Business Case Application for Approval: Glenrowan Terminal Station (7 Oct 2011)

8.1.10 Hazelwood Circuit Breaker Replacement (XC28)

Summary:

Stage 4 of the redevelopment of HWPS will replace the remaining 220 kV bulk oil CBs and all remaining 220 kV isolators. This project will complete the redevelopment of HWPS.

This project is being completed later than economic timing suggests smoothing expenditure and workloads across the planning period.

Table 23: Expenditure on the Hazelwood Power Station Redevelopment

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	0	303	3,939	4,242

Scope of works:

- Replace remaining bulk oil 220 kV CBs
- Replace all isolators, which have not been replaced in the previous redevelopment stages

Benefits and investment drivers:

- Safety risk presented by an explosive failure of the CB bushings (primary project justification)
- Supply risk
- Reduced maintenance

Related Documents:

- AMS – Electricity Transmission Network: Planning Report Project XC28 – Hazelwood Power Station Circuit Breaker Replacement Planning Report

8.1.11 Ringwood CB Replacement (XB54)

Summary:

Ringwood Terminal Station (RWTS) is critical to the reliability of supply to customers located in the eastern suburbs of Melbourne including Boronia, Bayswater, Croydon, Lilydale, Ringwood and Woori Yallock. RWTS is also an integral part of the transmission network and connects to Rowville and Thomastown terminal stations.

The 220 kV switchyard at RWTS was developed in the 1960's. Consequently, a number of electrical assets have now reached the end of their reliable service lives. This project focuses on replacing deteriorated circuit breakers that presents a failure risk and was approved in 2012 with substantial expenditure occurring in the current regulatory period.

Table 24: Expenditure on Ringwood CB Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	2,868	945	369	4,182

Scope of works:

- Replace 10 circuit breakers with nine new dead tank circuit breakers
- Replace dis-connectors with motorised dis-connectors
- Rearrange line terminations
- Replace protection and control systems

Benefits and investment drivers:

- Reduced health and safety risks (primary project justification)
- Reliability
- Increased capacity
- Improved visual amenity
- Improved layout to allow for future developments

Related documents:

- Business Case Application for Approval: XB54 Ringwood Terminal Station (RWTS) 220 kV Circuit Breaker Replacements.

8.1.12 Ringwood Terminal Station Transformer and Circuit Breakers Replacement (XC21)

Summary:

Ringwood Terminal Station (RWTS) is located approximately 25km east from Melbourne's CBD and supplies a major part of outer-eastern metropolitan Melbourne. The supply area spans from Lilydale and Woori Yallock in the north-east, to Croydon, Bayswater and Boronia in the east and more centrally, Box Hill, Nunawading, Mitcham and Ringwood.

RWTS was commissioned in 1963 and currently being partially redeveloped (Project X7F0) to replace the 220/22 kV transformers and outdoor 22 kV switchgear which present a high risk of failure. A second project (XB54) has recently been approved. It will replace the next group of risky assets – deteriorated bulk oil 220 kV circuit breakers – between 2014 and 2015. Once these projects are completed, around 2015, several important but deteriorated assets will remain on the site. These include a 220/66 kV B4 transformer and 66 kV circuit breakers. These assets will approach the end of their technical lives between 2014 and 2020.

This project will replace the B4 220/66 kV transformer and six 66 kV circuit breakers and change the circuit configuration to reduce the probability of multiple transformer outages arising from a single asset failure. This project is scheduled for completion in 2017/18.

This project is being completed later than economic timing suggests smoothing expenditure and workloads across the planning period.

Table 25: Expenditure on Ringwood Terminal Station Replace B4 Transformer and Six 66kV Circuit Breakers

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	-	266	3,458	3,724

Scope of works:

- Replace B4 220/66 kV transformer
- Replace six 66 kV circuit breakers

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environmental
- Reduced operational and maintenance costs
- Reduced risk of plant collateral damage
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XC21 – Ringwood Terminal Station Replace B4 transformer and six 66 kV circuit breakers
- AMS 10-106 Circuit Breakers – Summary Issues and Strategies

8.1.13 HWPS CB Replacement Stage 3 (XB56)

Summary:

HWPS 220 kV Switchyard is a key node in the Victorian electricity transmission network. The switchyard has eight International Power (IP) generators connected with a combined output of approximately 1600MW. The Jeeralang Power Station, Yallourn Power Station and Morwell Power Station are also connected at HWPS. HWPS is also one of the main inputs into the Latrobe Valley 500 kV systems via the Hazelwood Terminal Station (HWTS) 500/220 kV transformers.

The HWPS 220 kV switchyard was constructed in the mid-1960s and hence the majority of the assets are approximately 45 years of age with the exception of those assets that have been replaced in Stage 1 or 2 of this extended re-development program. The HWPS 220 kV switchyard occupies land immediately east of International Power's power station. The switchyard accommodates thirty-three 220 kV circuit breakers interconnecting six busbars.

This project is to replace eleven 220kV bulk oil type circuit breakers in the 220 kV switchyard. The key project driver is health and safety risk presented by explosive failures of the sixty-six circuit breaker bushings. The project was approved in 2012 and targets a completion date of December 2014. A substantial proportion of the forecast total expenditure will be incurred in the current regulatory period.

Table 26: Expenditure on Ringwood CB Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,384	1,268		2,652

Scope of works:

- Remove eleven bulk oil circuit breakers
- Supply and install eleven new SF_6 dead tank circuit breakers
- Supply and install bus capacitive voltage dividers (CVD) to replace loss of CB capacitor tapping points
- Replace capacitive voltage transformers (CVT) on JLTS lines 2, 3, & 4
- Supply and install SEL2411 remote input / output modules to monitor circuit breaker functions

Benefits and investment drivers:

- Safety risk presented by an explosive failure of the CB bushings
- Health and safety (primary project justification)

Related documents:

- Business Case for Approval: Redevelopment of HWPS 220 kV Switchyard, Stage 3 (XB56)

8.1.14 Morwell Terminal Station – B2 Transformer Replacement (XB64)

Summary:

Morwell Terminal Station (MWTS) is the main source of supply for a major part of south-eastern Victoria including Gippsland. The supply area spans from Phillip Island, Wonthaggi, and Leongatha in the west; to Moe and Traralgon in the central area; to Omeo in the north; and to Bairnsdale and Mallacoota in the east.

The MWTS 230/66/11 kV 165 MVA B2 transformer which was installed in 1971 is now approaching the end of its useful life. This transformer exhibits type defects now with major faults occurring which have forced the replacement of similar transformers. Additionally, load on the B2 transformer will increase as Morwell Power Station reduces operations. As a result, the impact of a failure on reliability will increase. This project will replace the B2 transformer with a 150MVA transformer adjacent to its present location.

Asset Management Strategy (AMS) 10-01 relates to and supports this project. It describes SP AusNet's objective to improve the risk profile of its fleet of power transformers over the next decade. The transformer replacement project is proceeding with some. A substantial proportion of the forecast total expenditure to occur will be incurred in FY14/15.the current regulatory period.

Table 27: Expenditure on the Morwell Terminal Station - B2 Transformer Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,791	-	-	1,791

Scope of works:

- Replace the MWTS 230/66/11kV 165MVA B2 transformer with a new 150MVA transformer

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety
- Environment
- Reduced maintenance

Related documents:

- Business Case Application for Approval: MWTS B2 Transformer Replacement (XB64)

8.1.15 Keilor Terminal Station A4 and B4 Transformer Replacement (XC24)

Summary:

Keilor Terminal Station (KTS) was developed in the 1960's and has recently undergone a multi-stage redevelopment of the 500 kV and 220 kV switchyards. These works have involved the replacement of most circuit breakers (CBs), current transformers (CTs), voltage transformers (VTs) and associated protection systems.

The remaining original assets include the A4 and B4 transformers. Both are over 40 years old, in poor condition and are approaching the end of their technical lives. This project will replace these transformers. A substantial proportion of the forecast total expenditure will be incurred in the subsequent regulatory period.

This project is being completed later than economic timing suggests smoothing expenditure and workloads across the planning period.

Table 28: Expenditure on the Keilor Terminal Station A4 and B4 Transformer Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)			801	801

Scope of works:

- Replace the A4 transformer adjacent to the existing transformer
- Replace the B4 Transformer in-situ including new foundations and noise enclosure
- Install new transformer protection and control equipment

Benefits and investment drivers:

- Reliability (primary project justification)
- Health and safety
- Reduced risk of plant collateral damage from explosive failure
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network: Planning Report Project XC24 Keilor Terminal Station A4 and B4 Transformer Replacement
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations

8.1.16 Thomastown Terminal Station Redevelopment (XC16)

Summary:

Thomastown Terminal Station (TTS) is located in the northern part of the Melbourne metropolitan area (Melway map reference 8 H-11). It supplies customers in the Thomastown, Coburg, Preston, Watsonia, North Heidelberg, Lalor, Coolaroo and Broadmeadows areas. TTS is a main 220 kV transmission hub connecting Keilor, South Morang, Templestowe, Ringwood, Rowville and Brunswick terminal stations.

TTS was developed in the 1960's. The majority of the electricity assets at TTS have provided more than 40 years' service and are approaching the end of their technical lives. In particular, the 220/66 kV B4 transformer and 66 kV circuit breakers present significant security of supply risk.

The most economical solution is a staged redevelopment of TTS. This involves replacing the Bus 1-2 and Bus 3-4 66 kV tie circuit breakers before 2015 and replacing the B4 transformer and the remaining bulk oil circuit breakers in Stage 2. Stage 2 is only economical around 2024, nominally revenue. A substantial proportion of the forecast total expenditure will be incurred in the current regulatory period.

Table 29: Expenditure on the Thomastown Terminal Station Redevelopment

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	401		-	401

Scope of works:

- Replace the existing 1 – 2 and 3 – 4 66 kV bus tie circuit breakers and isolator
- Supply and install two dead tank circuit breakers as 1 – 2 and 3 – 4 bus tie circuit breakers

Benefits and investment drivers:

- Reliability (primary project justification)
- Health and safety
- Reduced risk of plant collateral damage from explosive failure
- Reduced maintenance

Related documents:

- AMS – Electricity Transmission Network : Planning Report Project XC16 – Thomastown Terminal Station Redevelopment
- AMS 10-141 Asset Health Review for Power Transformers in Terminal Stations
- AMS 10-67 Power Transformers & Oil-filled Reactors
- AMS 10-106 Circuit Breakers

8.2 Lines

8.2.1 Line Structure (Tower) Replacement

Summary:

SP AusNet has over 12,800 steel lattice towers supporting transmission lines. Early towers were not built to the current design standard and some of them are not able to withstand convective downdraft winds during storm events.

Towers on one identified line have structural constraints and are susceptible to failures induced by high intensity winds. There have been two incidents on this line during wind events, resulting in 6 tower collapses. SP AusNet can recover network functionality following a tower collapse using Emergency Restoration Structures. However, a tower collapse on the lines will significantly constrain the national electricity market and may cause injury or death, ignite a bush fire or damage property.

This project will replace 48 towers on the lines by 2020. It will focus on towers with a high consequence of collapse due to their proximity to rail and road crossings.

Table 30: Expenditure on Line Structure Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	5,855	6,273	6,691	18,818

Scope of works:

- Replace 12 towers on one line

Benefits and investment drivers:

- Improved public safety
- Reliability (primary project justification)

Related documents:

- Program of Works – Transmission Line Structure Replacement Program 2014-15 to 2016-17
- Business Case Application for Approval: XB21-Replacement of 12 towers
- AMS 10-77 Transmission Line Structures

8.2.2 Conductor and Ground wire Replacements

Summary:

There is a combined total of 13,982 kilometres of transmission line conductor and ground-wire in service on the transmission network as of November 2012. Three different types of phase conductors are used including aluminium conductor steel reinforced (ACSR), all aluminium conductor (AAC) and all aluminium alloy conductor (AAAC).

Reliability Centred Maintenance (RCM) techniques have been used to model failure risks associated with the conductor and ground-wire fleets. RCM risk models use current condition data to determine the volume of planned conductor and ground-wire replacements necessary to maintain acceptable levels of risk into the future. SP AusNet forecasts increasing volumes of conductor replacements over the next 20 to 30 years and are implementing advanced condition assessment techniques required to support the development of more efficient replacement programs.

Economic evaluations performed as part of RCM risk modelling have identified spans of conductor and ground-wire where replacement is economic. Thirteen spans of phase conductor on the Heywood (HYTS) to Portland (APD) 500kV lines along with other individual phase conductor spans have been selected for replacement. These spans exhibit high levels of risk due to poor condition and high consequences of failure due to their proximity to road and rail crossings or impact on incentive scheme performance. The results of economic evaluations quantify the replacement of 10 kilometres of the conductor and 35 kilometres of ground-wire by 2017.

Table 31: Expenditure on Conductor and Ground wire replacements

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	5,188	5,858	6,060	17,106

Scope of works:

- Replace 10 kilometres of conductor
- Replace 35 kilometres of ground-wire

Benefits and investment drivers:

- Public health and safety
- Preventing bushfire ignition
- Mitigate incentive scheme penalties
- Avoid emergency repair costs

Related documents:

- AMS 10 – 79 Transmission Line Conductors
- Program of Works - Transmission Line Conductor and Ground-wire Replacement Program 2014-15 to 2016-17

8.2.3 Tower and Station Rack – Fall Arrest Installation

Summary:

In March 2004, the OHS (Prevention of Falls) Regulations 2003 came into effect creating a new higher standard for preventing falls. The regulations had application to SP AusNet's fleet of line structures and station rack structures. SP AusNet began the installation of a rail-based fall arrest system but shortly after commencing the program, implemented a review of the chosen system design following an unrestrained fall. This review revealed the fall to be an isolated incident and confirmed that TNSP's in the UK and Europe were also transitioning to similar methods of fall restraint on line and station structures. Furthermore, a directive from Energy Safe Victoria (ESV), which involved increasing the inspection frequency of most transmission line structures to once every 36 months, escalated the need for the program as the exposure of line workers to fall from heights risk increased.

SP AusNet intends to continue the installation of a system produced by Latch ways which has been installed extensively in the UK and Europe. This system has been tested by staff on several occasions and modified to meet their specific needs. In particular, the selected system is easy to use and does not impede climbing or working.

This project has installed cable fall arrest systems across 5,200 towers from 2008-2014, the program will continue in the forthcoming regulatory period at a further 5,200 towers.

Table 32: Expenditure on Structure Fall Arrest Installation

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	3,284	3,284	3,284	9,851

Table 33: Expenditure on Station Rack Fall Arrest Installation

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	300	300	300	900

Scope of works:

- Install cable based fall arrest systems across 5,200 towers
- Install cable based fall arrest systems on rack structures and other ancillaries at 26 terminal stations

Benefits and investment drivers:

- Compliance (primary project justification)
- Safety
- Maintenance costs

Related documents:

- X7G6 Approved business case: Installation of Fall Arrests on EHV Steel Lattice Towers
- Program of Works – Rack Structure Fall Arrest Systems 2014-15 to 2016-17
- Program of Works – Structures (Towers): Fall Arrest Installation Program 2014-15 to 2016-17
- AMS 10-77 Transmission Line Structures

8.2.4 Insulator Replacement

Summary:

There are 89,525 transmission line insulator strings in service on the transmission network as at June 2012. Failure of these assets can lead to circuit outages and falling overhead conductors, which are a risk to public safety and to a lesser extent network reliability and security.

Since 2006, 17,480 insulator strings have been replaced based on condition data gathered during tower climbing inspections. Typically, this has involved replacing insulators with corroded pins, which are at risk of mechanical failure. Since this program began, there have been no major insulator failures. There remain however smaller volumes of insulators in service which are in poor condition and due to their proximity to rail and road crossings pose a high risk of failure. The current program will continue through 2013. A reduced program is forecast for the 2014/15 to 2016/17 period. This reduced program is based on progressively replacing 4.9% of the insulator fleet by 2020 to reduce the risk of major insulator failures by 88% at an estimated direct cost of $7.5M.

Table 34: Expenditure on Insulator Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,250	1,250	1,250	3,750

Scope of works:

- Planned replacement of 2.45% of the insulator fleet which present public safety risks by FY16/17 at an estimated direct cost of $3.75M

Benefits and investment drivers:

- Improved public safety (primary project justification)
- Improved employee safety
- Reliability
- Compliance

Related documents:

- AMS 10-75: Transmission Lines Insulators
- Program of Works – Transmission Line Insulator Replacement Program 2014-15 to 2016-17

8.3 Stations

8.3.1 Upgrade / Replacement of Fire Protection Systems

Summary:

Fire protection systems include detection and suppression capability to protect SP AusNet's assets from fire damage, and maintain network security and reliability. These systems are designed to extinguish fires which may ignite around station assets such as transformer or in buildings. Existing protection systems mostly extinguish fires using automatic water deluge or sprinkler systems.

A fire in a terminal station control building or in a relay building could result in network outages and loss of supply to customers. Uncontrolled fires within terminal station or communication buildings pose risks to the health and safety of employees and contractors. A major terminal station fire also poses a bushfire ignition risk under adverse weather conditions and therefore a risk to public safety.

Existing fire protection systems at some sites are deemed inadequate for a variety of reason including, deterioration, corrosion and obsolete systems that cannot meet the appropriate Australian Standards. This program will replace and rebuild these systems.

Table 35: Expenditure on Upgrade/ Replacement of Fire Protection Systems

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,869	1,900	1,829	5,598

Scope of works:

- Upgrade / replacement of fire hydrant systems at 10 terminal stations sites
- Upgrade / replacement of fire detectors and fire indicators panels (FIP) at identified (during monthly inspection) terminal stations
- Upgrade / replacement of deluge systems for 6 transformers installed at Heywood, Keilor and South Morang terminal stations (HYTS, KTS & SMTS respectively) and identified with issues related with corrosion and age
- Installation of fire walls at Hazelwood terminal station (HWTS) required for spare transformers.

Benefits and investment drivers:

- Network security and reliability
- Asset protection and damage mitigation
- Worker and public safety

Related document:

- AMS 10-62 – Fire detection and Suppression
- AMS 10–142 – Fire hydrant systems for Terminal Stations
- AMS 10–140 – Fire protection for power transformers and oil filled reactors
- Program of Works - Fire Protection Systems Upgrade & Replacement Program 2014-15 to 2016-17

8.3.2 Infrastructure Security Systems Upgrade

Summary:

Infrastructure security systems protect network assets and network functionality from unauthorised entry to terminal station switch yards and control buildings. Unauthorised entry could result in significant damage to assets (intentional or unintentional) impacting network security and the reliability of consumer supples or death severe injury to the unauthorised person.

The threat of terrorism has led the Commonwealth and State governments to impose legal responsibility on the owners and operators of critical infrastructure, such as electricity transmission installations to take all necessary preventative security measures to ensure the continuity of supply. The Victorian Terrorism (Community Protection) Act 2003 requires electricity and gas providers to develop and monitor risk management plans – including all appropriate preventative security and emergency restoration measures. This project will upgrade security at selected sites to ensure compliance with this legislation and reduce the risks of unauthorised access to key assets in the Victorian electricity transmission network.

Table 36: Expenditure on Infrastructure Security Systems Upgrade

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	2,095	2,095	850	5,040

Scope of works:

- Install CCTV surveillance cameras at six sites
- Upgrade security fencing at six sites
- Upgrade access controlled vehicle gates at six sites
- Install remotely operated switchyard lights at 20 sites
- Upgrade Access Control at eight sites

Benefits and investment drivers:

- Compliance
- Network Security
- Asset damage mitigation

Related documents:

- SP AusNet Document AMS 10-63 – Infrastructure Security
- Program of Works - Infrastructure Security Systems Upgrade/Replacement Program 2014-15 to 2016-17

8.3.3 Synchronous Condenser Refurbishment

Summary:

There are 3 Synchronous Condensers (SCOs) located at Brooklyn, Fisherman's Bend and Templestowe terminal stations in the Victorian electricity transmission network. SCO's offer spinning reactive compensation for the Melbourne area, which is essential for maintaining network voltages and energy transfer capability. AEMO has confirmed that reactive support is required for the foreseeable future and SP AusNet and AEMO have confirmed that refurbishment of the SCOs is the most economic technique for providing that reactive support for at least a further 10 years.

Electrical faults within the rotor initiated an overhaul of the Brooklyn unit in 2005. Relatively minor refurbishment of ancillary equipment was completed on this unit in 2006.

The condition of the other two SCOs has been assessed by an external consultancy, Machine Monitor. These units are near the end of their expected life and a series of refurbishments are recommended to continue reliable operation. Refurbishment of the FBTS unit is forecast for completion in 2017, with the unit at TSTS expected to be completed in 2018.

Table 37: Expenditure on Synchronous Condenser Refurbishment – Stage 2

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	2,400	1,200	1,100	4,700

Scope of works:

- Complete refurbishment of synchronous condensers at FBTS by 2017
- Begin the refurbishment of synchronous condenser at TSTS in 2017, completion of this work is forecast to occur in 2019

Benefits and investment drivers:

- Network security, reliability and energy transfer capability is maintained
- Least cost provision of necessary network reactive support
- Defers further investment in network reactive support

Related documents:

- AMS 10-74 Synchronous Condensers
- Program of Works - Synchronous Condensers Refurbishment 2014-15 to 2016-17

8.3.4 Oil CB Replacement Program

Summary:

The fleet of one type of 22 kV Circuit Breakers (CBs) have an average service life of 47 years and are the last examples of bulk oil breaking technology, in Victoria's electricity transmission network. These ageing assets are maintenance intensive, in poor condition, have fault level limitations and insufficient bunding (as per EPA requirements). Additionally, the manufacturer no longer supplies spares or offers product support. This program will replace four high risk circuit breakers with modern SF_6 circuit breakers.

A fleet of 66 kV CBs have an average service life of 46 years and are the last examples of bulk oil breaking technology, in Victoria's 66kV networks. These ageing assets are maintenance intensive, in poor condition, contain asbestos, have known design constraints, fault level limitations and insufficient bunding (as per EPA requirements). Additionally, the manufacturer no longer supplies spares or product support. This program will replace 12 high-risk circuit breakers with modern SF6 circuit breakers.

Table 38: Expenditure on Oil CB Replacement Program

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	2,500	950	950	4,400

Scope of works:

- Replace 4 off 22kV bulk oil circuit breakers with SF_6 circuit breakers
- Replace 12 off 66kV bulk oil circuit breakers with SF_6 circuit breakers

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety

Related documents:

- AMS 10-54 Circuit Breakers
- Program of Works – Bulk Oil Circuit breaker replacement program 2014-15 to 2016-17

8.3.5 Instrument transformers including Current Transformers Replacements

Summary:

Circuit (CTs), Voltage Transformers (VTs) and Capacitive Voltage Transformers (CVTs). The primary insulating systems of oil filled porcelain-clad HV instrument transformers progressively deteriorates with duty and service age. Beyond a manageable level, deterioration accelerates leading to an explosive failure. The consequences of such a failure are well known and can result in injury to nearby workers, damage to nearby equipment and unplanned network outages.

SP AusNet assesses the condition of CTs and VTs using Dissolved Gas Analysis. This analysis combined with known asset defects and degradation patterns has identified 57 poor condition circuit transformers for replacement before April 2017.

This program will also replace three CVTs. Decisions regarding the replacement of CVT's are primarily driven by condition based risk assessments with planned replacements occurring when risk costs outweigh replacement costs.

Online condition monitoring provides additional protection against CVT failure. Incipient CVT failure can actually be detected in real time, via CAMS (CVT Asset Monitoring System). This allows CVTs to be removed from service just before they pose a threat of failure, providing there is a good condition spare readily available.

Table 39: Expenditure on Instrument Transformer Replacements

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,100	1,500	1,700	4,300

Scope of works:

- Replace twelve 500kV circuit transformers
- Replace fifteen 220kV circuit transformers
- Replace thirty 66kV circuit transformers
- Replace three 500kV circuit transformers

Benefits and investment drivers:

- Reliability (primary project justification)
- Safety

Related documents:

- TRR Capex Forecast – Instrument Transformer XC44 XC45 September v5.doc
- Program of Works - Instrument Transformer Replacement Program 2014-15 to 2016-17
- AMS 10-64 Instrument Transformers

8.3.6 Civil Infrastructure/ Station Facilities Assets Replacement

Summary:

Civil Infrastructure and station facilities house and support the safe operation and proper functioning of electrical equipment forming the electricity transmission network. Infrastructure and facilities are needed, and often legally required, to maintain a safe work environment for employees and the public. Civil infrastructure houses high cost assets that would otherwise be damaged by exposure to dust or the weather and facilitates necessary maintenance which ensures low life cycle costs and economic service provision.

Economic and compliance analysis has identified civil assets which need to be replaced or upgraded over the forthcoming regulatory period to ensure safe reliable functioning of key electrical assets.

Table 40: Expenditure on Civil Infrastructure/ Station Facilities Assets Replacement

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,510	1,110	790	3,410

Scope of works:

- Replace asbestos tiles/cement sheets / claddings at 3 highest risk terminal stations
- Replace roofing of control buildings at 2 terminal stations
- Replace access roads/switchyard surfaces at 3 terminal stations
- Replace metallic cabinets and switchboards in 4 switchyards
- Replace retaining walls, handrails and support structures including lighting poles and flood protection levees at 1 terminal station
- Station Service Upgrades at 1 terminal stations
- Provision for replacement of AC units and other minor replacement at 6 terminal stations

Benefits and investment drivers:

- Occupational Health and Safety
- Compliance
- Extended asset life

SP AusNet Documents:

- AMS 10 – 55 – Civil infrastructure
- AMS 10 – 126 – Station service supply review
- Program of Works - Civil Infrastructure / Station facilities Replacement Program 2014-15 to 2016-17

8.3.7 Transformer – Improved safe maintenance access

Summary:

Periodic transformer maintenance requires workers to access gas relays and other equipment on the top of large power transformers. This generally involves working at significant heights and presents an ongoing fall risk. Current safety arrangements are insufficient to meet occupational health and safety standards for working at heights.

This project will retrofit handrails and ladder access points to multiple power transformers, 80 per cent of the total program of works is expected to be completed by the end of March 2017.

Table 41: Expenditure on Transformer - Improved safe maintenance access

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	830	830	830	2,490

Scope of works:

- Retrofit transformer handrails and ladder access points to multiple transformers covering 80 per cent of the total program of works.

Benefits and investment drivers:

- Safety
- Compliance

Related documents:

- Program of Works - Transformer Improved Safe Maintenance Access Program 2014-15 to 2016-17
- AMS 10-67 Power Transformers and Oil Filled Reactors

8.3.8 Transformer – 220kV Bushing Replacement Program

Summary:

Bushings are a relatively small proportion of the cost of a transformer, but are a very important component, providing the connection between the transformer and external circuits. The failure of a bushing has a high probability of causing an explosion and oil fire. Many of such failures have resulted in the complete destruction of the transformer and damage to adjacent equipment. SP AusNet's network has experienced 220 kV bushing failures and transformer fires in 1965 and 1987. In last decade, four interstate bushing failures (two in Queensland and another two in New South Wales) have involved explosions, fire and complete loss of the entire transformer.

SP AusNet's oldest high voltage transformer bushings were installed in the 1960s and 1970s. Bushings from this period are of two basic designs; oil impregnated paper and synthetic resin bonded paper. Both types are now showing signs of advanced deterioration that could lead to an insulation failure and possibly, an explosion and transformer fire. Consequently, this project will replace 28 oil impregnated paper and synthetic resin bonded paper transformer bushings now assessed as in poor condition.

Table 42: Expenditure on Transformer – Stage 3 HV Bushing Replacement Program

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	800	800	800	2,400

Scope of works:

- Replacement of 28 deteriorated in-service HV bushings on 220 & 500 kV transformers

Benefits and investment drivers:

- Reliability (primary project justification)
- Reduced risk of collateral damage to other equipment
- Worker Safety

Related documents:

- AMS 10-141 Asset Health review for power transformers
- Program of Works – Transformer 220kV Bushings Replacement Program 2014-15 to 2016-17
- AMS 10-67 Power Transformers and Oil Filled reactors

8.3.9 Transformer – OTI / WTI Replacement – Stage 2

Summary:

Higher power transformer operating temperatures accelerate transformer deterioration and very high temperatures indicate an imminent transformer failure. Winding Temperature Indicators (WTI) are used to remotely measure hot-spots within transformers, in real-time, and so better manage transformer capacity and deterioration, which improves utilisation and transformer life. During times of high loading and high ambient temperature the ability to monitor the simulated winding hotspot temperature has become more critical, especially at stations serving loads above their N-1 ratings (firm transformer capacity) during peak demand periods.

The winding temperature indicator and transducer circuits on older transformers are now fault prone and inaccurate. Consequently, lengthy, costly and inconvenient investigations are necessary to define operational network constraints. On high temperature or high demand day's manual techniques cannot accurately respond to highly dynamic network control requirements. This project will replace non-functional or inaccurate WTIs on 38 power transformers.

Table 43: Expenditure on Transformer – OTI/WTI Replacement – Stage 2

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	640	640	640	1,920

Scope of works:

- Replace non-functional or inaccurate Winding Temperature Indicators on 38 power transformers

Benefits and investment drivers:

- Monitor and control power transformer operating temperatures
- Improved capability and accuracy in managing network loadings during heavy demand periods
- Avoid foreshortening expected transformer life

Related documents:

- AMS 10-67 Power Transformers and Oil Filled Reactors
- Program of Works – Transformer Oil & Winding Temperature Replacement Program 2014-15 to 2016-17

8.4 Secondary, Protection and DC Program

8.4.1 Control Systems

Summary:

Control systems include a range of equipment that provides either automatic or remote control of primary assets. These types of system are essential for the effective and efficient operation of the network and include transformer voltage regulation and cooling control, VAR control, load shedding and runback schemes. Runback schemes monitor load transfer through interstate connectors ensuring network stability is maintained.

Control technology changes rapidly, especially compared to the technology for primary electrical assets. Consequently, new control equipment typically becomes obsolete over a 10 year period. When this happens the equipment can become uneconomic to maintain, either because it is incompatible with newer equipment or because it is no longer supported by manufacturers. Additionally, some obsolete equipment does not comply with relevant industry rules for protection equipment. Some plant control schemes are old and failure will result in indefinite outages and rebate penalties because of lack of internal and external expertise.

Table 44: Expenditure on Control Systems

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	4,885	2,730	4,240	11,855

Scope of works:

- Begin the Installing 500 kV circuit breaker management relays at Sydenham Terminal Station (SYTS), Moorabool Terminal Station (MLTS), Hazelwood Terminal Station (HWTS), Keilor Terminal Station (KTS) and Loy Yang Power Station (LYPS).
- Begin installation of 220 kV circuit breaker management relays at Moorabool Terminal Station (MLTS) and East Rowville Terminal Station (ERTS).
- Begin the replacement of CB PLC controls in 2017. This work will carry over into the forthcoming regulatory period beyond March 2017 and will be completed by 2020.

- Completing replacement of reactive plant control at ROTS by end of March 2017 and replacement of reactive plant control at Horsham Terminal Station (HOTS) will begin in 2015 and will be completed in 2018.
- Upgrading voltage regulation at Richmond Terminal Stations (RTS), Templestowe Terminal Station (TSTS) and West Melbourne Terminal Station (WMTS).

Benefits and investment drivers:

- Protection of expensive primary assets
- Elimination of risk of extended outage
- Safety
- Compliance
- Operating efficiency
- Capital efficiency

Related documents:

- AMS 10-68: Secondary Systems (Protection, Control & Automation Assets)
- Program of Works – Secondary Systems Replacement Program 2014-15 to 2016-17

8.4.2 Protection Systems

Summary:

Protection systems are an essential part of the electricity transmission network that operate circuit breakers to rapidly disconnect faulted circuits from the healthy network, limiting the exposure of workers and the general public to unsafe voltages, maintaining network operating voltage within sustainable limits and limiting damage to electrical plant and equipment.

Protection system technology is changing rapidly, especially compared to the technology for primary electrical assets. New microprocessor based digital devices are evolving, integrating multiple functions. Consequently, protection assets typically become obsolete over a 15 year period. Obsolete protection equipment is uneconomic to integrate in modern systems as it limits the necessary functionality of newer equipment or because it is no longer supported by manufacturers and cannot be economically maintained. Additionally, some obsolete equipment cannot comply with relevant industry rules for protection system functionality. Over the forthcoming regulatory period SP AusNet's protection systems program is targeted at replacing non-compliant and non-supported protection assets which are not included in the scope of works of major asset replacement projects.

Table 45: Expenditure on Protection Systems

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	830	1,910	3,376	6,116

Scope of works:

- Begin the replacement of 500 kV and 220 kV bus protection schemes at Moorabool terminal station (MLTS) in 2017, this work will be completed in 2018.
- Complete the replacement of 66 kV X & Y bus protection at Horsham terminal station (HOTS) by end of March 2017.

- Complete replacement of extra high voltage line protection on the Bendigo (BETS) 220 kV line at Ballarat terminal station (BATS) by March 2017.
- Complete replacement of extra high voltage line protection on Horsham to Red Cliffs (HOTS-RCTS) 220 kV line by March 2017.
- Complete replacement of extra high voltage line protection on the Glenrowan (GNTS) No.3 220 kV line at Shepparton terminal station (SHTS) by March 2017.
- Terang (TGTS) 220 kV line at Moorabool terminal station (MLTS)
- Begin the replacement of extra high voltage line protection on the Eildon Power station (EPS) No 1 & No 2 220 kV line at Mount Beauty terminal station (MBTS). This work will be completed in 2018.
- Begin the replacement of extra high voltage line protection on the Dederang to Wodonga (DDTS-WOTS) 330 kV line, this work will be completed in 2018.
- Begin the replacement of extra high voltage line protection on the Dederang to South Morang (DDTS-SMTS) No 1 & No 2 330 kV lines. This work will completed IN 2018
- Begin the replacement of extra high voltage line protection on the Murray No 1 & No 2 330 kV lines at Dederang terminal station (DDTS). This work will be completed in 2020.
- Begin the replacement of extra high voltage line protection on the Rowville to Yallourn (ROTS-YPS) No 5, 6, 7 & 8 220 kV lines. This work will be completed in 2020.
- Complete replacement of extra high voltage line protection on the Yallourn to Yallourn West power station (YPS-YWPS) line by March 2017.
- Complete replacement of extra high voltage line protection on the Yallourn to Yallourn West power station (YPS-YWPS) aux trans lines.
- Complete replacement of the pilot wire protection on Hazelwood power station to Hazelwood terminal station (HWPS-HWTS) lines by March 2017.
- Complete replacement of the pilot wire protection on Hazelwood power station to Jeeralang terminal station (HWPS-JLTS) lines and 1990 vintage line differential protection at various terminal stations by March 2017.
- Complete the replacement of high voltage (HV) feeder protection at Wodonga, Geelong and Morwell terminal stations (WOTS, GTS and MWTS respectively) by end of March 2017.
- Begin the replacement of high voltage (HV) feeder protection at Horsham terminal stations (HOTS); this work will be completed in 2018.
- Replace the existing power system quality monitoring equipment at various stations and installing additional equipment as per Australian Energy Market Operator's (AEMO's) requirements by end of March 2017.
- Complete the replacement of transformer protection at Wodonga (WOTS) by end of March 2017.
- Begin the replacement of transformer protection at Keilor terminal stations (KTS); this work will be completed in 2018.
- Continue with replacement of reactive plant protection at Kerang, Horsham and Rowville terminal stations (KGTS, HOTS and ROTS respectively); this work will be completed in 2018.

Benefits and investment drivers:

- Public and worker safety
- Network reliability and security
- Compliance
- Damage mitigation primary assets
- Lower life cycle costs

Related documents:

- Program of Works – Secondary Systems Replacement Program 2014-15 to 2016-17
- AMS 10-68: Secondary Systems (Protection, Control & Automation Assets)

8.4.3 Monitoring and Metering

Summary:

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 operational management of expensive primary assets. Examples include, revenue metering, power quality monitoring, transformer loading and temperature monitoring, circuit breaker operation, insulating oil degradation, prevailing weather.

The SCADA system gathers remote station data such as instrumentation (volts, amps, frequency, watts, VARs, transformer temperature, conductor strain, environmental measurements) circuit breaker and plant status, station alarms, interprets it and displays it to operations personnel to take appropriate action to control the network. The revenue meters monitor wholesale energy flows, calculate losses and facilitate invoicing amongst National Electricity Market (NEM) participants.

Similar to other secondary equipment, monitoring and measuring technology is constantly developing and new secondary assets typically become obsolete over a 15 year period. Obsolete monitoring equipment is normally uneconomic to maintain, either because it is incompatible with newer equipment or because it is no longer supported by manufacturers. Over the forthcoming regulatory period SP AusNet will replace non-compliant and non-supported assets. This program focusses on those monitoring and metering assets which are not included in the scope of works for major asset replacement projects.

Table 46: Expenditure on Monitoring and Metering

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	50	2,450	2,500	5,000

Scope of works:

- Replace fourteen RTU's with Substation Control and Information Management Systems (SCIMS) station architecture at twelve terminal stations.

Benefits and investment drivers:

- Optimum operation of primary assets
- Safety
- Compliance
- Operating efficiency
- Capital efficiency

Related documents:

- AMS 10-68: Secondary Systems (Protection, Control & Automation Assets)
- Program of Works – Secondary Systems Replacement Program 2014-15 to 2016-17
- Program of Works – RTU Replacement Program 2014-15 to 2016-17

8.4.4 DC Supply

Summary:

The Victorian electricity transmission network includes more than 240 individual Direct Current (DC) power supply system's comprising batteries, battery chargers, DC power distribution switch boards, isolation, wiring and monitoring and alarm equipment. The DC power systems are located in terminal stations to provide critical DC power for the operation of electrical protection, control, metering and SCADA systems associated with the electricity transmission network. Complete failure of DC supplies at a terminal station renders energy flows and station equipment uncontrollable and disables electrical protection system placing consumer, public and worker safety at risk.

The Australian Energy Market Operator's (AEMO's) Protection and Control Requirements specify duplicated and physically segregated "X" & "Y" DC batteries and chargers are provided with sufficient capacity to run identified station DC services for up to 10 hours. Batteries are essential to the station protection and control systems, communications, and remote control and energy monitoring. They also present risks in respect of acid spills, potential for explosion and injury to workers during manual handling.

Replacement of DC system assets is typically driven by duty related degradation, which occurs faster than for many primary assets. Batteries, in particular, degrade quickly and typically last only 15 years. Currently, the oldest batteries have been in service for 20 years. This project will focus on replacing the oldest batteries and related systems.

- Performance risks and functionality limitations of deteriorating batteries and chargers beyond their economic service life,
- Occupational health and safety risks associated with maintaining batteries and battery rooms in compliance with current Australian Standards, and
- Establishment of a condition monitoring program for economic management of DC systems.

Table 47: Expenditure on DC Supply

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,000	1,000		2,000

Scope of works:

- Upgrade DC supply systems at 6 terminal stations by end of March 2017

Benefits and investment drivers:

- Reliability
- Protection of expensive primary assets

Related documents:

- Program of Works – Secondary Systems Replacement Program 2014-15 to 2016-17
- AMS 10-52: DC Power Supplies

8.5 Communications Program

8.5.1 Network Technology

Summary:

This program will replace a number of obsolete communications systems such as point to point radio links, asset data gathering packet-based network elements and the operational telephony network.

SP AusNet's telecommunications network consists of a number of technologies that enable the communications and data interconnectivity of various systems, applications and devices. Over 1600 individual (access) circuits cater for various protection, SCADA, control and signalling, business/data gathering (Wide Area Network) and telephony systems. Many of these applications are mission critical to the operation of the transmission electricity network; such that any failure of the corresponding communications channel to effectively perform its function will inhibit the ability to effectively operate the electricity network within its operational constraints.

Information and Communications Technology (ICT) systems within SP AusNet's network typically experience rapid technological evolution, particularly when compared to other electricity network assets. This results in new assets becoming obsolete over a 5-15 year period. Obsolete equipment is normally uneconomic to maintain, either because it is incompatible with newer equipment or because it is no longer supported by manufacturers.

Additional communication investment is also being driven by evolving data transport needs. This includes the migration of some systems onto the Ethernet/IP (packet) system and a general growth in demand for bandwidth. As with the rest of the world, the demand for increased bandwidth is being driven by ever more data intensive applications and an increasing number of connected devices.

Table 48: Expenditure on Network Technology

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	5,018	4,962	5,639	15,619

Scope of works:

- Replace 9 point to point radio links
- Replace SDH nodes with Next Generation Transport System equivalent
- Replace PDH nodes with Next Generation (Access) equivalent
- Replace Asset Data Gathering (non-Mission critical) packet-based network elements

- Replace and/or migrate lease-service (access) technology
- Replace Operational Telephony Network (OTN)
- Update the transmission asset management system with new bearer, transport system and access network data, following completion of works.

Benefits and Investment drivers:

- Safety
- Reliability
- Enabling new technology (which reduces operating costs)

Related documents:

- Program of Works - Network Technologies Replacement Program 2014-15 to 2016-17
- AMS 10-56 Communications Systems

8.5.2 Bearers

Summary:

The communications network is installed, operated and maintained to enable SP AusNet meet its obligations as a Transmission Network Service Provider (TNSP).

SP AusNet, as a TNSP, must ensure that protection operation signals, remote control, power system data, and voice traffic of Extra High Voltage (EHV) terminal stations and generating stations function as stipulated in the rules and regulations set by NER and AEMO.

Other communications traffic carried on the network supports functions within SP AusNet that contribute to company meeting its code and agreement obligations.

SP AusNet still maintains some "legacy" bearer technologies (i.e. PLC, copper supervisory) that are struggling to meet both the technological and regulatory requirements of operating and maintaining the electricity transmission network. Increasing bandwidth and performance requirements are driving changes to bearers capable of delivering higher bandwidth digital services.

Where justified, optical fibre cable (e.g. OPGW) is now the preferred bearer for the SP AusNet communication systems to enable the establishment of modern optical communications systems and applications. The OPGW option is reinforced by the EHV ground wire replacement project which reduces the cost of replacing PLC with optical fibre. From a power system operational requirement, it has been identified that the existing PLC bearers do not respond to some specific fault instances. Therefore, PLC bearers should be replaced or where the cost is prohibitive, the old bearers should be replaced with newer (digital) models to reduce the risk of failure of the EHV network due to loss of signal.

Table 49: Expenditure on Bearers

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	3,061	3,108	4,254	10,423

Scope of works:

The work will include:

- Transmission tower inspections for OPGW
- Microwave radio line-of-sight analysis for Point to Point links
- Site acquisitions, tower design, and tower erection for point to point radio
- Design, installation and commissioning of bearer
- Transferring and/or commissioning of communications services/circuits
- Update asset management system with new bearer data

Benefits and Investment drivers:

- Safety
- Reliability
- Compliance
- Enabling new technology (which reduces operating costs)

Related documents:

- Program of Works - Network Bearers Replacement Program 2014-15 to 2016-17
- AMS 10-56 Communications Systems
- AMS 10-79 Transmission Line Conductors

8.5.3 Communications Infrastructure

Summary:

Over the next 10 years, approximately 70% of the communications 48VDC battery systems will require replacement due to degradation and/or the need to increase battery capacity/charging to enable effective operation of communication systems during (AC) power outages of up to 72 hours.

Fixed remote diesel generator systems will be gradually decommissioned and “plug-in” transportable emergency diesel generator sets will be introduced.

Communication supporting infrastructure assets are essential to supporting the communications system, but do not actively carry or transport communications traffic. These assets include:

- Antenna towers and associated attachments
- Radio site buildings and fencing
- 48VDC batteries and charging systems
- Standby generators
- Air conditioning systems
- Reticulation cabling

Dedicated communication sites, buildings and antenna structures are generally in good physical condition. However, some sites require improvement of the physical security given their remote nature and lack of modern key access and site monitoring. Recent bushfire experience has also identified some high-risk mountain top sites that require bushfire hardening measures to minimise the risk of infrastructure loss during bushfires.

Table 50: Expenditure on Communications Infrastructure

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,534	1,231	892	3,657

Scope of works:

- Replace communications DC battery systems at approximately 27 sites
- Design and build two external diesel generator sets
- Replace waveguide connections at 15 sites
- Replace radio dehydrators at 43 communications sites
- Replace fibre connectors
- Update the asset management system with new asset data following completion of works

Benefits and Investment drivers:

- Safety
- Reliability
- Enabling new technology (which reduces operating costs)

Related documents:

- Program of Works – Communication Supporting Infrastructure Replacement Program 2014-15 to 2016-17
- Program of Works – Operational Support Systems Replacement Program 2014-15 to 2016-17
- AMS 10-56 Communications Systems

8.5.4 Security

Summary:

SP AusNet's remote radio sites are typically located in remote locations, utilise hard keys for site/building access, and are accessed by personnel from a number of (3rd party) organisations. To establish risk of site entry and potential breaching of communication network integrity, each remote site will require a physical security risk audit to establish potential risk and associated control measures. Some recent upgrades have included electronic (building) access and video surveillance.

Given increased cyber security awareness and sensitivity within IT and communications systems, particularly within highly critical industries such as power utilities, and the introduction internationally of some critical infrastructure security standards, an increased focus is being placed on solidifying network security and monitoring capability. This is expected to include improved authorisation, authentication and auditing (AAA) of telecommunications network devices and applications, in line with company-wide practices and policies.

A number of safety programs and initiatives include:

- the upgrade/installation of radio tower fall arrest systems in line with current company standards;
- the upgrading or improving of some radio site earthing practices to minimise risk to apparatus and personnel, particularly during high storm activity (lightning) events;

- the standardisation and updating of radio communication site management records to effectively outline EMF hazards on radio towers/antennas for field workers or site visitors.

Table 51: Expenditure on Communications Security

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,433	1,063	685	3,181

Scope of works:

- Physical hardening and/or monitoring of security at high-risk remote radio communications sites
- Implementing a "best practice" standard for "centralised" authenticating, authorising, and accounting of communications and IED device access
- Implementing a "best practice" standard for logical/physical separation of communications networks to ensure continuation of critical services
- Implementation of dedicated communications network test and support lab to test and maintain latest network environment and potential upgrades and enhancements
- Install radio tower fall arrest systems to incorporate latest standard and system improvements
- Improve radio infrastructure earthing at identified radio sites
- Implement bushfire protection at identified radio sites
- Establish radio site (EMR) records and practice in line with ACMA requirements
- Update the transmission asset management system with new asset data following completion of works

Benefits and Investment drivers:

- Safety
- Security
- Compliance
- Reliability
- Enabling new technology (which reduces operating costs)

Related documents:

- Program of Works - Safety and Security of Communications Replacement Program 2014-15 to 2016-17
- AMS 10-56 Communications Systems

8.5.5 Operational Support Systems

Summary:

Operational Support Systems (OSS) are designed to assist in the maintenance, administration and operation of the telecommunications network and include:

- Element Management Systems – providing network status, fault and performance information on telecommunications components
- An overarching network wide view for fault and status information regardless of network technology
- Geographical Information System (GIS) – providing geographical location and configuration information of the network
- Asset and Inventory Management Systems
- Document Management System – provide documentation of network configurations, standards and technical design details

Currently, the management systems comprise SDH and WDM management systems from two manufacturers. A further manufacturer provides the overarching monitoring of the multi-vendor management systems. Some of the management systems have reached (or will reach) end-of-life and will have to be replaced and the current versions will require hardware and software upgrades. Additionally, OSS capability is required to determine network/service performance to enable service level assurance and benchmarking of performance. Current OSS system programs are expected to provide a platform for these further enhancements.

Some communications devices have no remote management/monitoring capability, reducing the service level visibility of these applications and impacting capability to quickly determine and react to service failures, Remote management capability can be extended to these devices through current proven (serial server) engineering practices.

The telecommunications GIS system has recently been introduced to better establish location of physical communication assets and technologies. Further enhancements will drive the ability to migrate documentation of logical services to link physical and logical telecommunications systems within the GIS. Existing communications documentation and data consolidation and standardisation will enhance this capability.

Table 52: Expenditure on Operational Support Systems

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	756	847	1,249	2,852

Scope of works:

- Integrate Communication Assets into GIS
- Network management Systems upgrade
- Operational Support System enhancement
- Drawings Standardisation and Data consolidation
- IED Communications software upgrade
- Out of band management of communication devices
- Update the asset management system with new asset data following completion of works

Benefits and Investment drivers:

- Safety
- Reliability

- Enabling new technology (which reduces operating costs)

Related documents:

- Program of Works: Operational Support Applications Capital Works 2014-15 to 2016-17
- AMS 10-56 Communications Systems

8.6 Non-network

8.6.1 IT

IT expenditure accounts for the majority of non-network capital expenditure. The IT Infrastructure and Operations Program forecasts investment in various infrastructure spanning from data centres and their related facilities, server, storage, operating systems, infrastructure software and communications network.

Summary:

Table 53: IT expenditure

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	18,291	12,495	11,321	42,108

Scope of works:

- Tools
- Measurement equipment

Other Benefits and investment drivers:

- Improved decision making
- Reduced operating expenditure

Related Documents:

- ICT Project Justification FY2014/15 – FY2019/20 Transmission Network
- ICT Strategy document

8.6.2 Other

'Other' expenditure captures miscellaneous non-network spending. Historically, spending in this area has been mainly comprised of spending on tools and measurement equipment. Over the next period we anticipate spending at levels similar to historic levels.

Summary:

Table 54: Other non-network expenditure

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	2,630	2,630	2,630	7,890

Scope of works:

- Tools
- Measurement equipment

Benefits and investment drivers:

- Better equipment reduces operating expenditure
- Better measurement equipment improves decision making

8.6.3 Vehicles

Summary:

SP AusNet 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.

Over the forthcoming regulatory period, we will maintain the current fleet size and capability. This will require the replacement of 68 vehicles, costing a total of $4.7 million.

Table 55: Expenditure on Vehicles

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	1,785	1,760	1,200	4,745

Scope of works:

- Purchase of 68 vehicles

Benefits and investment drivers:

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

8.6.4 Buildings & property

Summary:

SP AusNet owns many buildings and properties, and is responsible for their management and maintenance. Expenditure in this area covers these expenses and is forecast to continue at near historic levels.

Table 56: Expenditure on Buildings and Property

	FY14/15	FY15/16	FY16/17	Total
$'000 (Real 2012)	200	200	200	600

Scope of works:

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

Benefits and investment drivers:

- Maintaining safe work environments
- Maintaining operational efficiency
- Extending the life of assets

Related Documents:

- Program of works – Facilities maintenance in Yarraville/Richmond

APPENDIX A – Terminal Station Acronyms

Acronym	Station Name
APD	Portland Aluminium Customer Substation
ATS	Altona Terminal Station
BATS	Ballarat Terminal Station
BETS	Bendigo Terminal Station
BLTS	Brooklyn Terminal Station
BTS	Brunswick Terminal Station
CBTS	Cranbourne Terminal Station
DDTS	Dederang Terminal Station
DPS	Dartmouth Power Station
EPSY	Eildon Power Station Yard
ERTS	East Rowville Terminal Station
FBTS	Fisherman's Bend Terminal Station
FTS	Frankston Terminal Station
FVTS	Fosterville Terminal Station
GNTS	Glenrowan Terminal Station
GTS	Geelong Terminal Station
HOTS	Horsham Terminal Station
HTS	Heatherton Terminal Station
HWPS	Hazelwood Power Station
HWTS	Hazelwood Terminal Station
HYTS	Heywood Terminal Station
JDSS	Jinderra Switching Station
JLA	Bluescope Steel Customer Substation
JLGA	Jeeralang A Gas Station
JLGB	Jeeralang B Gas Station
JLTS	Jeeralang Terminal Station
KGTS	Kerang Terminal Station
KTS	Keilor Terminal Station
LYGS	Loy Yang Gas Station
LYPA	Loy Yang A Power Station
LYPB	Loy Yang B Power Station
LYPS	Loy Yang Power Station
MBTS	Mount Beauty Terminal Station
MKPS	McKay Creek Power Station

MLTS	Moorabool Terminal Station
MOPS	Mortlake Power Station
MPS	Morwell Power Station
MSS	Murray Switching Station
MTS	Malvern Terminal Station
MWTS	Morwell Terminal Station
NPSD	Newport D Power Station
PTH	Point Henry Customer Substation
RCTS	Red Cliff Terminal Station
ROTS	Rowville Terminal Station
RTS	Richmond Terminal Station
RWTS	Ringwood Terminal Station
SESS	South East Switching Station
SHTS	Shepparton Terminal Station
SMTS	South Morang Terminal Station
SVTS	Springvale Terminal Station
SYTS	Sydenham Terminal Station
TBTS	Tyabb Terminal Station
TGTS	Terang Terminal Station
TRTS	Tarrone Terminal Station
TSTS	Templestowe Terminal Station
TTS	Thomastown Terminal Station
WBTS	Waubra Terminal Station
WETS	Wemen Terminal Station
WKPS	West Kiewa Power Station
WMTS	West Melbourne Terminal Station
WOTS	Wodonga Terminal Station
YPS	Yallourn Power Station
YWPS	Yallourn West Power Station