Augmentation Expenditure (Augex) Forecasting Approach

Supporting Document 5.4.1

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SA Power Networks

Empowering South Australia

Contents

Glossary

Acronym / term	Definition
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Augex	Augmentation expenditure
Capex	Capital expenditure
CER	Customer Energy Resources
DNSP	Distribution Network Service Provider
EDC	Electricity Distribution Code
EPA	Environmental Protection Agency
ESCoSA	Essential Services Commission of South Australia
ETC	Electricity Transmission Code
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
NEO	National Electricity Objective
PLEC	Powerline Environmental Committee
POE	Probability of Exceedance
QoS	Quality of Supply
RCP	Regulatory Control Period
SCS	Standard Control Services

1 Introduction

1.1 Purpose

The purpose of this document is to outline SA Power Networks' methods for forecasting capital expenditure on network asset augmentation (**augex**) for the Regulatory Control Period (**RCP**) from 1 July 2025 to 30 June 2030 (2025-30 RCP).

1.2 Principles used in developing a forecast

SA Power Networks has sought to align its approach to forecasting augex with:

- requirements relating to reliability and system security contained in Schedule 5.1 of the Rules
- service obligations imposed by the South Australian Electricity Distribution Code (**EDC**)
- license conditions imposed at the time of sale in 2000
- industry best practice
- the expenditure objectives, factors and criteria in the National Electricity Rules (**NER**)
- the National Electricity Objective (**NEO**) in the National Electricity Law

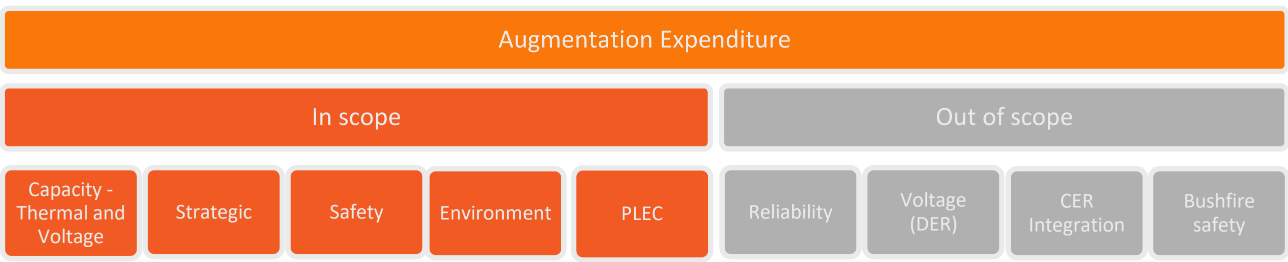
1.3 Scope

This document covers the augex forecast required to expand or upgrade network assets to:

1. Address changes in demand for Standard Control Services (**SCS**), excluding DER integration
2. Maintain quality, safety and security of supply, excluding bushfire safety; and
3. Comply with regulatory requirements.

Figure 1 provides an overview of the sub-categories of augmentation expenditure that are within the scope of this document. The forecasting methodologies for Reliability, Customer Energy Resources (**CER**) Integration and Bushfire Safety are covered separately in their own respective and specific documents.

Figure 1 - Overview of the categories of augmentation expenditure that are in-scope and out-of-scope of this document



A short description for each of the relevant in-scope categories is provided below

- **Capacity** – works required to meet forecast demand[1] that necessitate the extension or upgrade of our sub-transmission, distribution and LV networks.
- **Strategic** – specific one-off programs to manage key network risks and compliance issues and / optimise long term expenditure.

[1] Demand refers to the supply of electrical loads. Constraints related to the output of embedded generation (i.e. reverse flow) are addressed via the DER Integration investment category

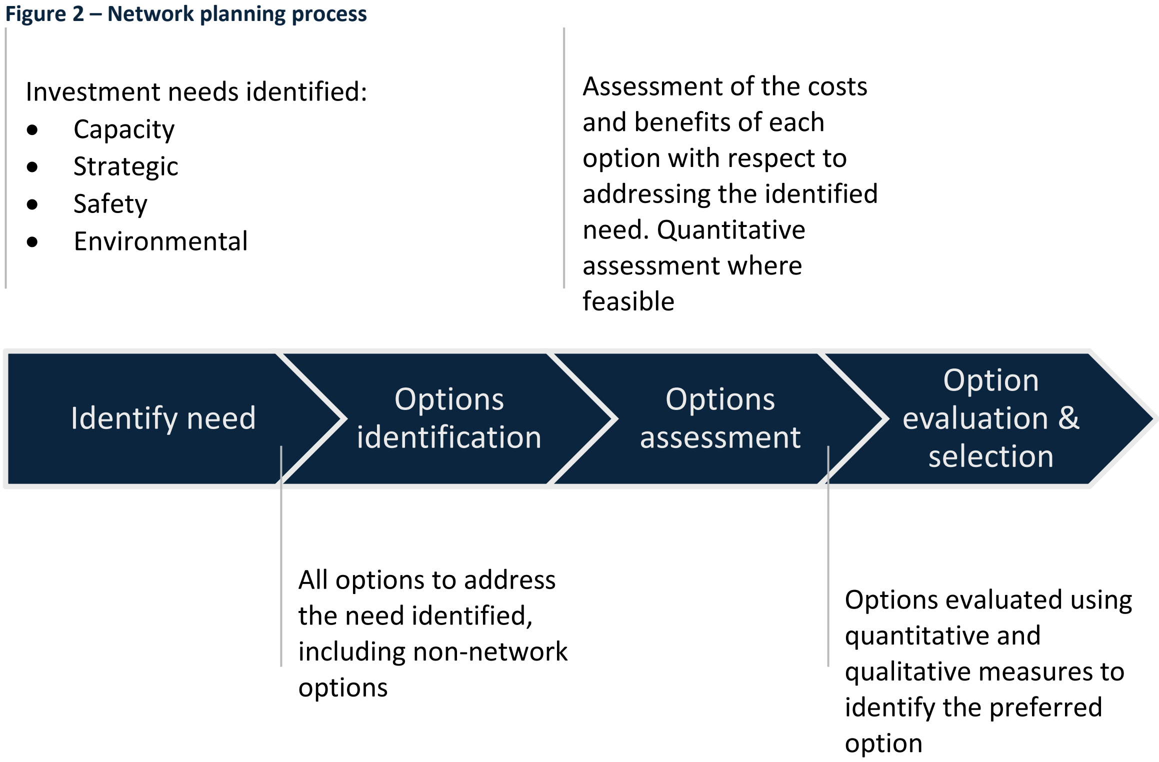
- **Safety** – expenditure necessary to maintain the safety of our network (excluding repex) for SA Power Networks' workforce and the general public and include a number of initiatives arising from our customer engagement program. This includes upgrades to network protection and earthing systems as a result of changes (e.g. load growth) within the network, but excludes bushfire safety.
- **Environmental** – works necessary to address environmental risks within the network to comply with Environmental Protection Authority (**EPA**) requirements.
- **Powerline Environmental Committee (PLEC)** – expenditure to underground parts of the network in accordance with State Government legislation.

2 Augmentation expenditure forecasting approach

The foundation of SA Power Networks' approach to forecasting augmentation expenditure is the requirement to maintain the security and quality of supply at the lowest cost to customers. This ultimately ensures that the network delivers on the capital expenditure objectives in clauses 6.5.7(a)(1) and (2) of the NER.

The need to augment the sub-transmission and distribution network is determined as an output of a thorough planning process. The network planning process considers the adequacy and security of the network to meet the forecast demand, and other relevant obligations, into the future. The process is summarised in Figure 2.

Figure 2 – Network planning process



2.1 Investment needs

There are several drivers that can trigger the requirement for augmentation expenditure. These can be broadly categorised into the following categories:

- Capacity
- Strategic

- Environmental
- Safety
- PLEC

Capacity

The capacity related augex program consists of works required to meet or manage the expected demand for standard control services. Key inputs that underpin capacity driven augex forecasts are the:

- **Spatial peak demand growth**. We use an independent and transparent spatial forecasting tool which reconciles with the Australian Energy Market Operator's (**AEMO's**) State-wide forecast. For the spatial peak demand forecasts, a 10% and 50% Probability of Exceedance (**PoE**) forecasting methodology is applied, consistent with most other distributors in the National Electricity Market (**NEM**); and
- **Network planning criteria**. The planning criteria define the level of redundancy required (at our connection points, zone substations and transmission lines) to meet the EDC and the Electricity Transmission Code (**ETC**) standards, reliability standards and standards related to the maintenance of security of supply. The network planning criteria also includes the associated network planning procedures used for establishing the thermal and emergency ratings of network asset used for network planning purposes.

Strategic

The strategic expenditure category primarily includes a number of one-off strategic projects aimed at ensuring the security of supply of the network.

Safety

Augmentation safety is expenditure on network assets to improve the management of safety risks to the public and network workers from those assets. Expenditure to address bushfire safety risks is addressed within a separate document.

Environmental

Environmental expenditure is required to ensure prudent management of environmental risks to comply with EPA legislation, regulations, policies and standards and achieve the capex objectives set out in clause 6.5.7(a)(2) of the NER.

The *Environment Protection Act 1993* (SA) (**Environment and Protection Act**) and the Environment Protection (Water Quality) Policy 2015 (SA) places a legal responsibility on SA Power Networks to not undertake any activity that pollutes, or has the potential to pollute, the environment unless we take all reasonable and practicable measures to prevent or minimise any resulting harm. New regulations established under the policy place a greater onus on industry and business to take steps to avoid potential environmental harm, emphasising the need for SA Power Networks to continue its environmental management and substation oil containment programs in a prudent manner.

Power Line Environment Committee

The PLEC program provides for the undergrounding of selected parts of the network in accordance with State Government legislation and the PLEC Charter.

The PLEC program is an undergrounding program to improve the aesthetics of electricity infrastructure to benefit the community, having regard to road safety and electrical safety. SA Power Networks is obliged to implement the PLEC program under the section 58A of the Electricity Act. The PLEC program is further defined in Part 3A of the Electricity (General) Regulations. Expenditure is required in order for comply with these applicable regulatory obligation as contemplated by clause 6.5.7(a)(2) of the NER.

The PLEC program is an 'un-scoped allowance' in accordance with the Electricity (General) Regulations. PLEC projects are approved by an independent committee that was previously convened by the Essential Services Commission of South Australia and is now the Office of the Technical Regulator. Typically projects are funded two-thirds by SA Power Networks and one third by councils, and construction is completed via a competitive tender process.

2.2 Method of calculating forecast expenditure

There are two methods that have been employed to forecast the required future expenditure for each augmentation investment trigger, 'Historic' and 'Modelled'.

Historic is used for investment needs where historical expenditure has proven to be steady, and where this is not expected to change materially into the future. In this respect, the capital expenditure requirement has a recurrent nature, whereby the forecast remains consistent with historical levels and individual projects (investment needs) are identified and rectified in a short timeframe. Examples of this include Quality of Supply and SWER augmentation works where the investment need is identified from testing, monitoring and feedback received from customers, and the rectification works are scheduled within a short window after the constraint / issue has been confirmed.

Modelled is used for augex drivers where there is some degree of variability in the investment driver inputs, but where these inputs can be estimated and forecast.

2.3 Categorisation of programmes by investment need

Within each investment need, there are several different programmes of investment, structured around similar asset types or sub-drivers.

Table 1 shows the allocation of each investment programme to the applicable augex investment trigger and forecasting method.

Table 1 Expenditure Determination Methods

Title	ID	Description	Category (AER Forecast Model)	Augex investment trigger	Forecasting method
Connection Point Capacity (ETC/NER)	AUG001	Capacity augmentation resulting from ElectraNet Works	Capacity Upgrade	Capacity	Modelled
LV & Distribution Transformers (QoS BAU)	AUG002	LV augmentation expenditure (unrelated to reverse power flows) – reactive & proactive	Capacity Upgrade	Capacity	Historic & Modelled
Distribution Feeders (11 & 7.6kV)	AUG003	Feeder capacity augmentation	Capacity Upgrade	Capacity	Modelled
Strategic Network Capacity (Other)	AUG004	Labour capitalization for long term planning and network architecture (where no specific project / investment is ultimately developed)	Capacity Upgrade	Capacity	Historic
Substation Capacity	AUG005	Substation capacity augmentation	Capacity Upgrade	Capacity	Modelled
Subtransmission Network	AUG006	Subtransmission capacity augmentation	Capacity Upgrade	Capacity	Modelled
Distribution Line – SWER Replacements	AUG007	SWER capacity augmentation	Capacity Upgrade	Capacity	Modelled
Voltage Regulation	AUG008	Work required to maintain QoS within NER requirements including connection agreements with ElectraNet (e.g. power factor).	Capacity Upgrade	Capacity	Modelled
Land	AUG009	Substation capacity augmentation	Capacity Upgrade	Capacity	Modelled
Oil Containment – Substation	AUG017	Installation of oil bunds for substation assets with >1kL of oil	Environment	Environment (Substations)	Historic
Substation Lighting	AUG019	Installation of (predominantly) indoor lighting to meet minimum safety standards	Safety	Safety – Substations	Historic
Substation Security & Fencing	AUG020	Upgrade of substation fences to high security to minimise break-ins and therefore public safety	Safety	Safety – Substations	Historic
Substation Infrastructure - Earth systems	AUG021	Upgrade and testing of substation earthing to meet minimum safety standards	Safety	Safety – Substations	Historic
Rural Protection **66kV protection systems - compliance**	AUG022/ 35	Back up protection in country areas – program continuation 66kV protection clearing times based on ElectraNet requirements	Safety Safety	Safety – Protection Augmentation Safety – Protection Augmentation	Modelled Modelled
CBD 33kV Substation Migration to 11kV	AUG024	Work required to meet safety standards for workers	Safety	Safety – Substations	Historic & modelled

Dynamic Arming of UFLS	AUG036	Prescriptive safety standard requirements	Network Control	Strategic	Modelled
PLEC – Non Specific Gross	AUG031	Undergrounding for community benefit	PLEC	Jurisdictional	Historic/formula

3 Asset augmentation programs

3.1 Capacity

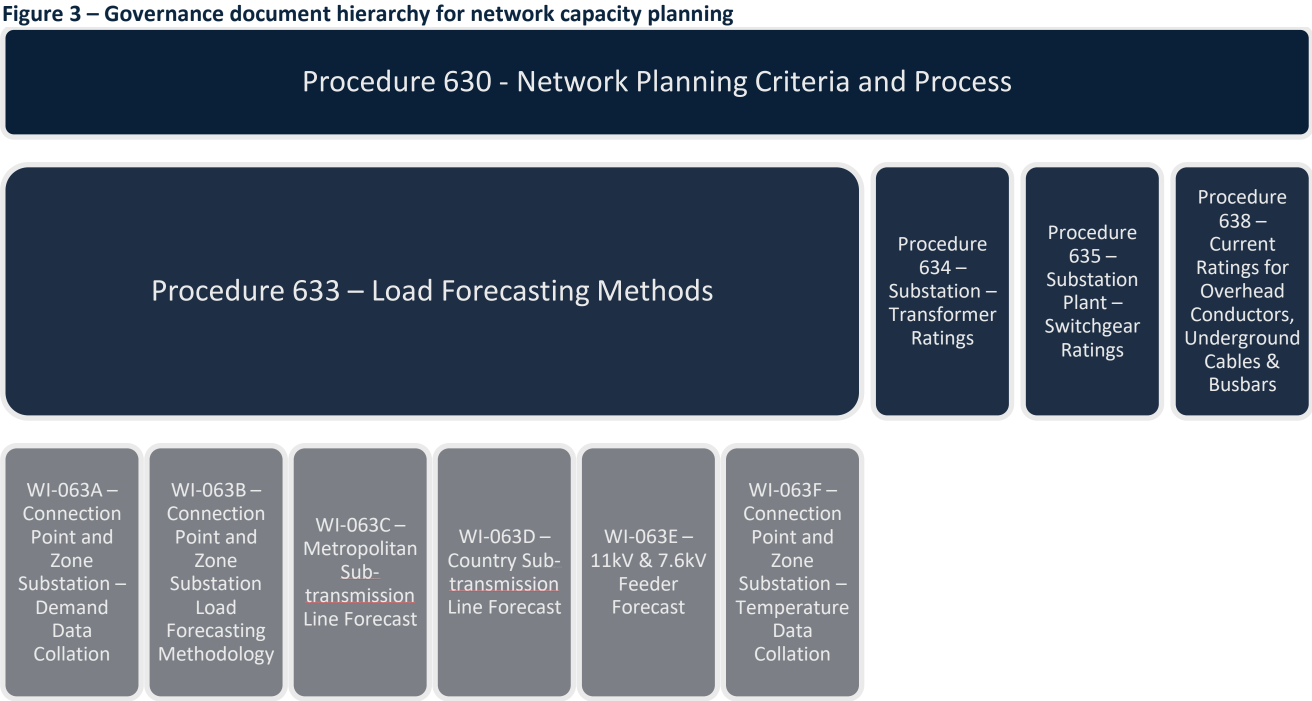
Capacity augex requirements are forecast using a ‘Modelled’ approach. The Modelled approach considers the forecast of future network demand, the capacity of the network to deliver the forecast demand, the subsequent identification of network or connection point thermal and voltage constraints and evaluation of options to alleviate the constraints.

SA Power Networks’ approach to network planning (excluding the LV network) is documented in the Network Planning Criteria and Process[2]. The following sections provide an overview of the approach.

Thermal and Fault Rating (AUG001, AUG002, AUG003, AUG005, AUG006, AUG007, AUG009)

The expenditure forecast for thermal and fault rating constraints is an output of the network planning process. The planning process is governed by documented procedures and work instructions as shown in Figure 3.

Figure 3 – Governance document hierarchy for network capacity planning



The steps involved in the planning process to generate the expenditure forecast for the regulatory period are as follows:

1. Determine network capacity (Procedures 630, 634, 635, 638)
2. Prepare load forecasts (Procedure 633 and Work Instructions)
3. Compare forecast demand to capacity for future years for all connection points, sub-transmission lines, zone substations and feeders
4. Model the sub-transmission network using load flow software to determine 10 PoE sub-transmission line loading and connection point transformer loading

[2] Procedure 630, Network Planning Criteria and Process

5. Identify the year when the forecast demand (at the relevant PoE level) exceeds capacity under normal or contingency conditions (Procedure 630)
6. Prepare long-term development plans for regions describing sub-transmission line and zone substation projects and capacity upgrades (10 year horizon) and distribution feeders (5 year horizon).
7. Prepare options / solutions to meet the need and timing requirements including cost and risk range for inclusion in the expenditure forecast

A concise overview of the Network Planning Criteria and Process for each expenditure category is provided below:

- **Connection Points and Zone Substations (AUG001, AUG005, AUG009)**: For connection points, the capacity is required to meet the standards set out in the ETC and the SA Power Networks / ElectraNet Transmission Connection Agreement. The import ratings are planned to not be exceeded for any transmission system or distribution network contingent event. For zone substations, overloads under normal conditions are to be completed prior to the summer in which the PoE 10 forecast exceeds the normal rating. Overloads under contingency conditions need to be addressed when the PoE 50 forecast load exceeds the contingency capacity[3] by 3MVA[4]. Feeder transfer options and the connection of a mobile substation (for contingency analysis) are considered in the planning process. Cost estimates are prepared for the options to allow comparison and evaluation, and the identification of a preferred option. Where land is required for the preferred option, this is included in the AUG009 category.
- **Metropolitan and country sub-transmission lines (AUG006)**: where lines are forecast to exceed their normal ratings, reinforcement is planned in the year before the PoE 10 forecast exceeds the line's normal import rating. In circumstances where the planning criteria stipulate that back-up supply is required, reinforcement is planned for the year before the 10 PoE forecast exceeds the line's emergency rating.
- **11kV and 7.6kV feeders (AUG003)**: where lines are forecast to exceed their normal ratings, reinforcement is planned in the year before the PoE 10 forecast exceeds the line's normal import rating. Under contingency conditions, feeders in the CBD and urban areas shall be able to be backed up with no load at risk at the PoE 10 (CBD) and PoE 50 (Urban) forecast load by means of transferring load to adjacent feeders. Rural feeders are planned to only meet peak load under normal conditions and therefore do not have backup for contingencies.
- **LV and distribution transformers (AUG002)**: There are three types of investment within the expenditure forecast for LV and distribution transformers category, thermal and voltage constraints associated with reverse power flows (DER), thermal and voltage constraints associated with forward power flows (load), and, maintaining power quality compliance (harmonics, flicker, neutral voltage). The expenditure forecasting approach for each type is as follows:
    1. Thermal and voltage constraints associated to reverse power flows (DER) – expenditure forecast covered within DER Integration expenditure (not within the scope of this document) and modelled
    2. Thermal and voltage constraints associated to forward power flow (Load) – expenditure modelled in LV model.
    3. Power quality compliance (harmonics, flicker, neutral voltage) – expenditure forecast based on historic trend.

[3] Contingency capacity represents the emergency import rating of the zone substation plus the amount of load that can be transferred to feeders from adjacent zone substations after feeder switching, without violating the feeder's emergency import rating and quality of supply standards applicable to contingency conditions.

[4] Except for those zone substations subject to sections Error! Reference source not found. of the Network Planning Criteria and Process Procedure 630, w hich have a different set of planning criteria imposed on them due to customer criticality and location, namely CBD, major industrial or commercial, dedicated supplies and zone substations where mobile plant cannot be used.

- **SWER (AUG007)**: There are two major limitations impacting SWER feeders; voltage excursion outside the limits and transformer overloads. The SWER upgrade expenditure forecast is based on results from conducting testing on SWER lines. Approximately 100 tests are conducted each year across a population of approximately 440 SWER lines (3-4 year testing cycle). The testing will identify lines and transformers that are overloaded or experiencing overvoltage. SWER transformers loaded above 130% of their name plate rating will be included in the upgrade program for the 2025-2030 period. The severity of the overloads will set the priority for replacement program during the period.

Voltage (AUG008)

The voltage category includes three expenditure types, with all being based on a Modelled approach:

1. Thermal constraints on voltage control assets and reactive plant.

   The expenditure forecasting approach is the same as that used for thermal and fault level constraints outlined in section 0.

2. Solutions for managing ElectraNet connection point voltages

   This is a relatively new type of expenditure and is being driven by the changing nature of customer energy use. ElectraNet has formally[5] advised SA Power Networks that the power factor at some connection points is outside of the range of that required in the relevant connection agreement[6]. In addition to those connection points that are already non-compliant, trending the historic power factor into the future for all connection points shows that additional sites will become non-compliant over time. Identifying the optimal solution for resolving the voltage excursions outside of the connection agreement range is performed on a case-by-case basis. Where the solution involves investment on the HV network, the forecast is included within this category.

3. Voltage non-compliance

   The continuing increase of DER and load across the network is resulting in broader voltage operating bands and excursions outside of the standard. By modelling the voltage profile of the sub-transmission network under minimum and maximum demand forecast scenario (with sensitivities for curtailment and increases in loads), voltage limitations at the LV network level can be identified across the network. Identifying the optimal solution for resolving the voltage excursions is performed on a case-by-case basis. Where the solution involves investment on the HV network, the forecast is included within this category.

3.2 Strategic

Dynamic Arming of UFLS (AUG036)

The forecast expenditure is based on a Modelled approach where the number of sites requiring work is multiplied by the historic unit rate per site.

The program is driven by a compliance requirement from the Office of the Technical Regulator (OTR) which have developed a list of sites where dynamic arming of UFLS is required. In the current period, as the costs were not forecasted, and are material, they were the subject of a cost pass through application to the AER, which was approved by AER in September 2022.

For the 2025-2030 period, the OTR have not yet determined the sites where dynamic arming of the UFLS will be needed, and it is expected that the OTR will revise the standard post 2024. In order to forecast expenditure for the 2025-2030 period, SA Power Networks will engage with AEMO to model future UFLS requirements.

[5] Refer ElectraNet letter RE: Power factors at connection points dated 21 September 2022
[6] SA Power Networks' load must comply with a power factor range between 0.95 lagging and unity at Exit Points between 50 kV and 250 kV.

AEMO will forecast the new sites where dynamic arming of UFLS is expected to be required (existing sites where work has already been completed will only require setting changes) and this will be multiplied by the unit rate of sites delivered in the current period.

3.3 Safety

Substation Lighting (AUG019)

The forecast expenditure for the substation lighting program is based on historic expenditure.

The program commenced in 2001 and is focused on improving the indoor emergency lighting at substation sites. The program was initiated following an incident that occurred at a CBD substation where a power failure of the local lights and power circuits resulted in workers being left in the vicinity of energised equipment with no visibility.

Since the commencement of the program, 160 sites have been rectified and 78 sites remain. A risk assessment of the sites is used to prioritise the delivery of the program. Based on the current deployment rate, we expect to complete the program over the next two RCPs.

Substation Security & Fencing (AUG020)

The forecast expenditure for substation security and fencing is based on historical expenditure.

The sites are prioritised for improvement based on the risk and frequency of break-ins and this has seen a focus on the metro areas. Over time, the type of theft from break-ins has changed with thieves targeting copper earthing on transformer neutrals. Over the last several years, there have been around 12 break-ins per year. In 2021, we experienced 18 break-ins through substations with a basic level of security and 4 break-ins through high-security fences.

Historically, the program included the work to deliver an interim measure to meet the minimum-security requirements. This included, raising the height of fences from 2-2.1 metres to 2.5 metres, installing barb wire and/or tiger loops to the top of the fence and a rail to the bottom to prevent burrowing. The program now includes targeted high security fencing solutions, subject to risk assessment. This is an ongoing program to ensure we maintain adequate levels of security on a risk basis and as vulnerabilities are identified.

Substation Infrastructure – Earth systems (AUG021)

The substation earthing program forecast is based on historic expenditure.

The program is well established and involves routine testing of sites and rectification of sites where constraints with the earthing system are identified. The purpose is to achieve compliance with step and touch potential standards (ENA EG1 and ENA EG0) and ensure correct operation of protection systems across the whole High Voltage network. The program also includes retrofitting CMEN (Common Multiple Earth Neutral) systems to address substandard earthing on overhead street equipment in some rural townships.

Costs increased part-way through the 2020-25 RCP largely due to cost sharing with ElectraNet at shared sites. Historically, ElectraNet had borne the total cost at these sites, however SA Power Networks recently conceded to a cost sharing arrangement.

Protection compliance (AUG022 and AUG035)

The rural back-up protection program commenced in 2013 to address inadequate protection arrangements across the network, notably in rural areas. NER clause S5.1.9 (f) requires that back-up protection be provided to ensure that a fault is cleared prior to it causing damage to other parts of the network.

The expenditure is based on a Modelled approach. Backup protection deficiencies across the network are identified through protection compliance audits. These deficiencies, that fail to meet NER clause S5.1.9 (f), are then prioritised based on quantifying the safety, asset damage and bushfire risk consequences.

Since the commencement of the program, the back-up protection arrangements on approximately 200 feeders will have been addressed to the end of the current RCP. There are a further 134 known feeders and 30 known substations with inadequate backup protection. Further sites are likely to be identified through ongoing protection compliance audits. Highest risk sites will be identified for rectification in the next RCP, with a program commensurate with the historical rectification rates.

The forecast expenditure for 66kV protection is Modelled and based on the number of sites requiring an upgrade to the protection system multiplied by the historic unit rate of the upgrade.

ElectraNet has assessed system stability in South Australia and has advised SA Power Networks that there are several sites on the 66kV system that do not comply with the requirements of NER clause S5.1a.8 with respect to fault clearing times necessary to maintain system stability.

Following receipt of this advice, SA Power Networks has actively worked with ElectraNet to identify the sites where primary and back-up protection clearing times either have the potential to damage non-faulted parts of the network, or do not meet the stability requirements for the system. By considering the potential system stability impacts and constraints, outage size, outage duration, and the cost of non-faulted elements that could be damaged, SA Power Networks and ElectraNet will assess the risk at each site and prioritise rectification to allow SA Power Networks to rectify all non-compliances over two RCPs. Sites will be prioritised for remediation based on the risk, and the value of the least cost, technically viable solution.

CBD 33kV Substation Migration to 11kV (AUG024)

The CBD 33kV substation migration to 11kV program commenced in 2012/13. The program aims to mitigate identified safety risks for the workers at older 33kV CBD sites by migrating sites to the 11kV network, thereby removing the 33kV site from operation.

The sites targeted for migration are typically located in building basements and were identified through a specific site hazard assessment. These sites have a range of identified safety hazards, including inadequate electrical clearances, and are generally inadequate to house modern 33kV transformers and switchgear. The larger size of 33kV assets compared to 11kV assets means that current clearance requirements cannot be achieved using modern 33kV assets.

Since program inception in 2012/13, sites were prioritized based on the risks and logical sequencing for optimal schedule planning.

The forecast method for this expenditure category is both modelled and historic. Only sites with identified significant safety hazards are included in the program. The program is expected to conclude at the end of the 2025 – 2030 regulatory control period based on historic completion rates.

3.4 Environment

Containment – Substation (AUG017)

The forecast expenditure is based on historic costs.

The program is focused on improving the oil containment systems of substations, across the 400 substation population, to comply with EPA requirements.

This is a long established program that has been running since 2002/03. The program includes a suite of solutions applied on a risk of site basis. Solutions include a full concrete bund with an oil water separator (or SIPP unit) for larger and higher risk power transformers. Solutions may also include an “oil mat” that allows water to pass through the mat; however, if oil interacts with the mat, the molecules in the mat react and effectively create an impenetrable seal that won’t allow the oil to pass through.

The augmentation program is expected to be completed in the 2025-30 RCP, however replacement expenditure and a possible change in EPA regulations will likely mandate ongoing capex beyond 2030.

3.5 Labour capitalisation

Strategic Network Capacity (Other) (AUG004)

The forecast expenditure is based on historic costs.

Labour capitalisation consists of the long term design of the Network not necessarily attributable to projects being commissioned in the next reset period but includes all planning and design work required to ensure SA Power Networks complies with the requirements of the NER regarding the planning, security and quality of supply delivered by its distribution network within nominated standards. This program has historically been included in the compliance related capacity capex for previous RCPs which is consistent with the intent for our next RCP.

3.6 PLEC

Powerline Environmental Committee (gross) (AUG031)

Annually the OTR

The forecast expenditure is based on historic expenditure adjusted in accordance with a prescribed formula set out in the *Electricity General Regulations 2012*, regulation 44, as follows:

For the purposes of section 58A(3) of the Act, the amount is—

(a) for the financial year 2011/2012—$6.093 million;

(b) for each subsequent financial year—the amount determined by the Minister in accordance with the following formula:

where—

CPIx is the Consumer Price Index, All Groups Index Number (All Cities) published by the Australian Bureau of Statistics, for the March quarter preceding the financial year concerned;

CPI1 is the Consumer Price Index, All Groups Index Number (All Cities) published by the Australian Bureau of Statistics, for the March quarter 2011;

Ax is the amount (in dollars) determined by the Minister under this regulation for the purposes of section 58A(3) of the Act for the previous financial year;

TCx is the total cost (in dollars) of the undergrounding work undertaken in the previous financial year in accordance with programs prepared under section 58A of the Act;

GSTx is the amount (in dollars) determined by the Minister as being the total GST (within the meaning of the A New Tax System (Goods and Services Tax) Act 1999 of the Commonwealth, as amended from time to time) paid in respect of all undergrounding work undertaken in the previous financial year in accordance with programs prepared under section 58A of the Act.