Addressing Power Factor Non-Compliance at ElectraNet Connection Points

Final Project Assessment Report (FPAR)

8 September 2026

SA Power Networks

www.sapowernetworks.com.au

Disclaimer

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1 Introduction

SA Power Networks is South Australia's principal Distribution Network Service Provider (DNSP) and is responsible for the distribution of electricity to all distribution grid connected customers within South Australia under a regulatory framework. SA Power Networks' sub-transmission networks are supplied by ElectraNet's transmission network, connected via 52 transmission connection point substations which are typically operated at either 275/66kV, 132/66kV or 132/33kV.

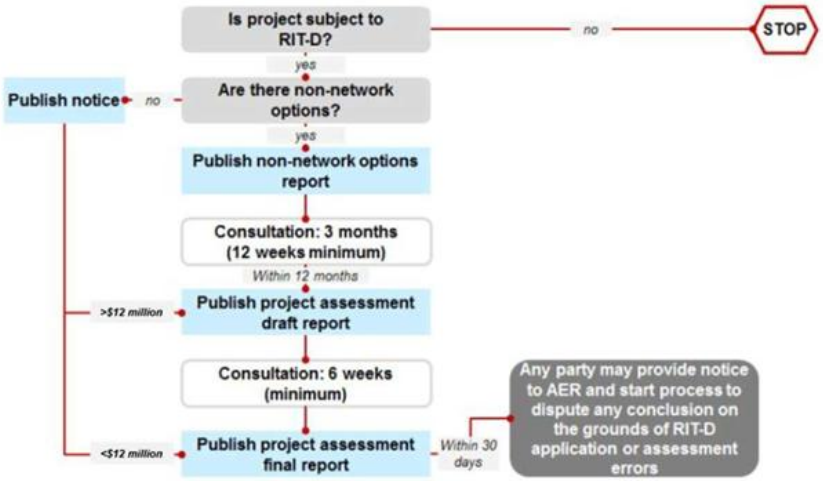
Reactive power flow from SA Power Networks distribution network into ElectraNet's transmission network has been observed at ElectraNet / SA Power Networks' connection point substations (connection points) and has been increasingly become more capacitive. ElectraNet has observed that increasing capacitive power flows at connection points are resulting in their Static VAr Compensators (SVCs) to be operated outside designated ranges. This limits ElectraNet's ability to use the SVCs to respond to system disturbances and in-turn compromises system security by jeopardising ElectraNet's capacity to maintain dynamic voltage stability during critical contingencies.

SA Power Networks is obligated to meet the technical obligations within the Transmission Connection Agreement (TCA) between ElectraNet and SA Power Networks, which has reciprocated system stability and reliability obligations outlined in schedule 5.3.1a within the National Electricity Rules (NER). SA Power Networks have a responsibility to ensure the reliable and efficient delivery of electricity to consumers, in compliance with industry standards and regulatory obligations.

SA Power Networks has prepared this Final Project Assessment Report (FPAR) in accordance with the requirements of clause 5.17.4 of the NER. It is the final stage of the formal consultation process set out in the NER in relation to applying the Regulatory Investment Test - Distribution (RIT-D) – as illustrated by Figure 1.1: Overview of the RIT-D process.

This FPAR follows the publication by SA Power Networks of the Draft Project Assessment Report (DPAR). SA Power Networks has concluded that there are no non-network options, or Stand Alone Power System (SAPS) options, which could form a potential credible option on a standalone basis, or that could form a significant part of a potential credible option for this RIT-D.

Figure 1.1: Overview of the RIT-D process



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The purpose of this FPAR is to:

- Describe the identified need SA Power Networks is seeking to address, together with the assumptions used in identifying it;
- Provide a description of each credible option assessed;
- Quantify relevant costs and market benefits for each credible option;
- Describe the methodologies used in quantifying each class of cost and market benefit;
- Explain why SA Power Networks has determined that classes of market benefits or costs do not apply to the credible options;
- Present the results of a net present value analysis of each credible option, including an explanation of the results; and
- Identify the proposed preferred option.

1.1 SA Power Networks Contact

If you have any comments or enquiries regarding this FPAR, please send to the following email: requestforproposals@sapowernetworks.com.au.

2 Description of the Identified Need

This section describes the identified need for this RIT-D and sets out the key assumptions and methodologies that underpin this need.

2.1 Power Factor Limits

SA Power Networks and ElectraNet maintain a TCA as per the NER. The power factor provisions aim to achieve the performance standards under NER schedule 5.3.5 that outlines the power factor requirements. The power factor limits for 66kV connection points includes the following:

- For load levels from 30% to the agreed maximum demand (AMD) of the connection point, the desired acceptable lagging power factor is 0.95 to unity;
- For load levels below 30% of the AMD, the desired acceptable lagging power factor is less than 0.95; and
- ElectraNet acknowledges the limitations of switched reactors and has recommended modifying the 30% limit in the next revision of the TCA to allow for a lower lagging power factor at times of low demand.

SA Power Networks has a responsibility to ensure the reliable and efficient delivery of electricity to customers, in compliance with industry standards and regulatory obligations.

2.2 Relevant area of SA Power Networks' distribution network

Correspondence with ElectraNet has confirmed the requirement to maintain power factors within prescribed limits described in section 2.1, applies to all 66kV connection points.

SA Power Networks' 66kV systems are often supplied via multiple 66kV connection point substations, but for the purposes of joint system planning, these substations are aggregated into a single connection point. Therefore, the following 66kV connection points are considered relevant to this identified need:

- Metro East, which comprises:
  - Northfield SSD403;
  - Magill (TF2 & TF3) SSD408;
  - East Terrace SSD366; and
  - City West (TF1) SSD579.
- Metro North, which comprises:
  - Parafield Gardens West SSD453;
  - Para SSD161; and
  - Munno Para SSD488.
- Metro South, which comprises:
  - City West (TF2) SSD579;
  - Magill (TF1) SSD408;
  - Happy Valley SSD209; and
  - Morphett Vale East SSD115.

- Metro West, which comprises:
    - Torrens Island Power Station SSD255;
    - Kilburn SSD373;
    - Lefevere SSD510; and
- Mount Barker, which comprises:
    - Mount Barker SSD232; and
    - Mount Barker South SSD346.

- Riverland, which comprises:
    - Berri SSD399;
    - Monash SSD565; and
    - North West Bend SSD400.

The Riverland system is generally not considered to be a single connection point, but rather two separate systems, being Berri/Monash and North West Bend. Due to the small total amounts of reactive support required and the relative proximity of these connection points, SA Power Networks has negotiated with ElectraNet to defer the installation of a reactor in the Riverland system, reflecting the lower levels of reactive power injection currently being observed. As a result, SA Power Networks may prioritise investment in other areas of the network where the need is greater. This position is supported by ElectraNet.

The above list captures all 66kV connection points except Yandarie and Wudinna. The power factors observed at these two Eyre Peninsula systems have historically been much more capacitive than other regions, driven mostly by line charging as a result of very long line distances, rather than the changing behaviour of customer load. The high impedance and low capacity of these systems also means that the installation of sufficient shunt reactors to compensate for this line charging will be significantly more expensive compared to other systems. It is for this reason that SA Power Networks proposes to exclude these connection points from the identified need, provided that the total reactive support from all other 66kV systems is sufficient to compensate for these two systems, i.e. the power factor of the aggregate of all 66kV connection points will be compliant. This position is also supported by ElectraNet.

See Figure 2-1 for a map of the state transmission system with 66kV connection points, and Figure 2-2 for the Adelaide Metropolitan insert. Additionally, refer to SA Power Networks' Network Visualisation Portal for an interactive geospatial view of the network infrastructure including information such as zone substation sites, high voltage overhead and underground lines, demand forecasts, generation forecasts, headroom/hosting capacity and system strength indication.

Figure 2.1: State level transmission map with 66kV Connection Points

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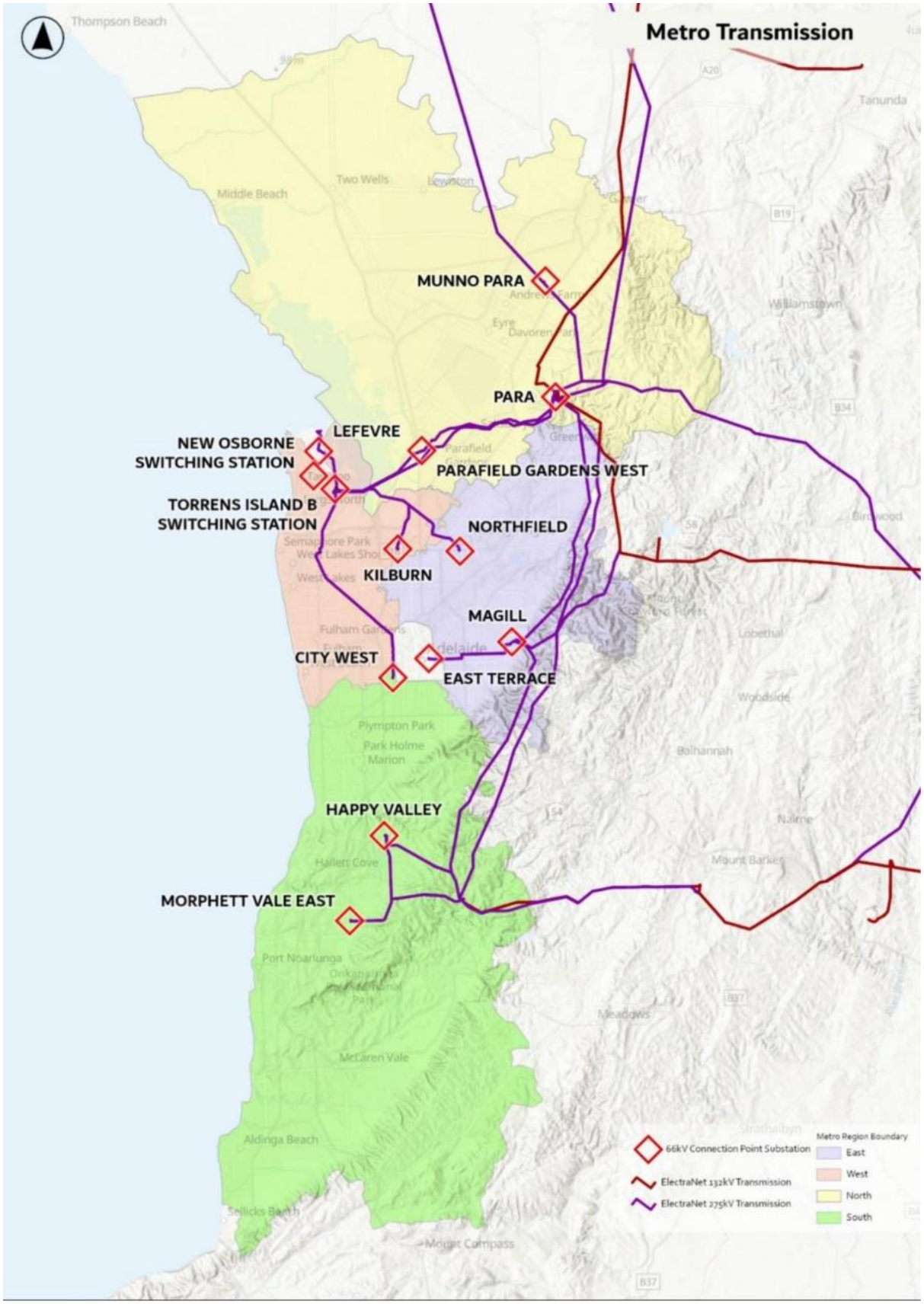
Figure 2.2: Adelaide metropolitan transmission map with 66kV Connection Points



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2.3 Network Constraints

In September 2022, SA Power Networks received formal notification from ElectraNet advising that the capacitance of the distribution system is contributing to the occurrence of unacceptably high voltage levels on the South Australian transmission system, especially at times of low demand.

ElectraNet has observed increasing capacitive power flows at connection points between ElectraNet and SA Power Networks, contributing to its static VAR compensators (SVCs) and synchronous condensers being operated outside the ranges specified in 2.1. ElectraNet has completed the Transmission Network Voltage Control Regulatory Investment Test – Transmission (RIT-T) to optimise the performance of its SVCs and synchronous condensers, particularly at forecast low transmission system loading levels. Following the completion of ElectraNet's Transmission Voltage Control project, its SVCs and synchronous condensers are still expected to continue to operate outside the specified range with the current levels of capacitive power flows at the connection points.

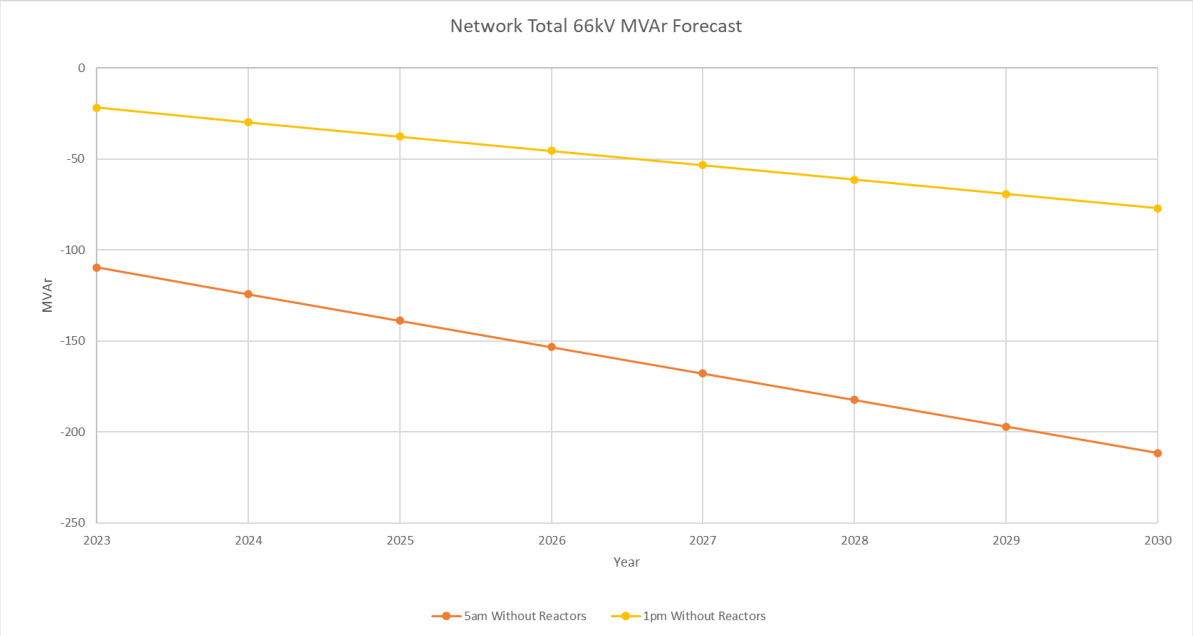
2.4 Reactive Power Forecast

SA Power Networks has historically not forecast reactive power minimums (independent of load forecasts) at any level of the network. In response to the power factor concerns raised by ElectraNet, SA Power Networks has developed a simple methodology to forecast reactive power minimums at connection points, based on the following assumptions:

- Reactive power minimums occur at 5am, which are used to derive the year-on-year historic trend and forecast;
- Forecasts produced for solar peak, is assumed to be at 1pm;
- Reactive power minimums will follow a linear trend for the forecast period;
- To track historic trends, the 5th percentile of measurements is used instead of minimums to counteract the impact of capacitor bank switching and network abnormalities; and
- Historic years are manually selected to form a forecast growth rate to reflect a line of best fit.

The latest reactive power forecast (completed in 2026) estimates 153 MVAr of capacitive power will flow from distribution networks into the transmission networks in 2025 measured at 5am, increasing to 212 MVAr in 2030. Figure 2.3 below shows the reactive power forecast during low load times at 5am and 1pm.

Figure 2.3: Reactive Power Flow Forecast during low demand times



Historical trends show that connection points in the Metro regions are showing a reduction of capacitive (MVAr) flows during low demand times.

2.5 Reliability Corrective Action

Reliability corrective action, as defined in 5.10.2 of the NER, pertains to network investments aimed at meeting service standards linked to technical requirements outlined in schedule 5.1 or applicable regulatory instruments. These investments address identified needs that align with these service standards, ensuring the reliability and stability of the electricity network.

The identified need to prevent capacitive reactive power flows from SA Power Networks' distribution network into ElectraNet's transmission network at 66kV connection points aligns with the TCA between ElectraNet and SA Power Networks. These performance standards are derived from Schedules 5.3.1a(d) and 5.3.5 of the NER, which provides a permissible power factor range for 66kV (and higher voltage) connection points to ensure system stability and reliability. In addition, reactive power flows have implications on the voltage levels at the connection point. The target voltage at the 66kV connection point should not deviate more than 10 percent from its nominal voltage to comply with NER S5.1a.4.

SA Power Network is committed to upholding mandatory service standards and regulatory obligations, thereby safeguarding the reliability and performance of the electricity transmission infrastructure in South Australia. By addressing the identified need in accordance with industry standards and regulatory requirements, SA Power Networks seeks to ensure the resilience and efficiency of the electricity network in South Australia, ultimately benefiting consumers and stakeholders across the region.

3 Proposed network options to meet the identified need

SA Power Networks has identified two credible network options to address the identified need. This section provides more information on the scope and cost of these options. It also outlines options considered but that SA Power Networks does not propose to progress further.

3.1 Option 1 – Air Core Reactor Program

Option 1 includes the installation of seven 30MVAr and two 15MVAr 66kV connected shunt reactors totalling approximately 240MVAr of reactive support at several connection points to meet TCA compliance requirements by 2030.

The use of air cored reactors has been explored as part of the further assessment following confirmation that oil cored reactor solutions are materially higher in cost than originally estimated and are also subject to significant equipment lead times. On that basis, air cored shunt reactors have been investigated as a technically viable alternative, with the potential to provide the required reactive support within the necessary delivery timeframe while reducing overall implementation risk relative to oil cored reactor installations.

The total cost of this option is expected to be $28.8M[1] with the program commencing in 2026 and completing in 2030. The annual deferred augmentation of this option is expected to be $2m[2].

3.2 Option 2 – Static Synchronous Compensators and Reactors

Option 2 includes the installation of five air cored reactors (66kV) and four static synchronous compensators (STATCOMs) (66kV) totalling 240MVAr of reactive support at several connection points to meet TCA compliance requirements by 2030.

This option is designed to offer the additional benefits of a STATCOM in each of the four Metro regions. These STATCOMs will further future-proof the option in providing increased voltage stability and power quality to these regions, as well as the ability to both import and export reactive power. STATCOMs have a very fast dynamic nature that provides additional benefits when compared to the static nature of reactors, however they are significantly more expensive.

The total cost of this option is expected to be $78.8[3] with the program commencing in 2026 and completing in 2030. The annual deferred augmentation of this option is expected to be $5.5m[4].

3.3 Options considered but not progressed to the FPAR

SA Power Networks considered an alternative network-option to meet the identified need that is not progressing to the FPAR stage. This option includes:

- Household level control utilising existing customer energy resources via smart technologies and energy management systems within individual households to optimise energy consumption and contribute reactive power support to address capacitive reactive power flows.

[1] Costs are expressed in 2026 dollars, capital expenditure.
[2] Based on the deferral of the whole program using a Discount Rate of 7%
[3] Costs are expressed in 2026 dollars, capital expenditure.
[4] Based on the deferral of the whole program using a Discount Rate of 7%

Upon evaluation of this alternative option, it was determined that the current capacity and infrastructure is not adequate to support the successful implementation of this solution. The focus remains on prioritising solutions that offer the most cost-effective and technically feasible means to address the identified need while ensuring the reliability and stability of the electricity network in South Australia.

4 Assessment of non-network solutions and SAPS

Upon release of the Options Screening Report (OSR) in May 2024, SA Power Networks did not receive a formal submission for a non-network solution.

As a result, credible non-network or stand-alone power system (SAPS) options were not included in the options analysis assessement.

5 How the options have been assessed

This section outlines the methodology that SA Power Networks has applied in assessing market benefits and costs associated with the credible options considered in this RIT-D.

5.1 Overview of the assessment framework

All costs and benefits for each credible option have been measured against a 'do nothing' base case.

The RIT-D analysis has been undertaken over a 20-year period. SA Power Networks considers that a 20-year period considers the size, complexity and expected life of the relevant credible option to provide a reasonable indication of the market benefits and costs of the option. While the capital components of the credible option have asset lives greater than 20 years, SA Power Networks has taken a terminal value approach to incorporate capital costs in the assessment, which ensures that the capital cost of long-lived options is appropriately captured in the 20-year assessment period.

The commercial rate determined by the Australian Energy Market Operator (AEMO) from its Integrated System Plan has been used as the central discount rate, which is currently 7%. This is a rate that reflects an energy business operating in the NEM. The high scenario discount rate has been set at 3%, reflecting the latest Australian Energy Regulator (AER) WACC determinations for DNSPs. The low discount rate determined by AEMO from its ISP has been which is currently 10%.

5.2 Approach to estimating project costs

SA Power Networks has estimated capital costs through estimations conducted by experts within the business in conjunction with information and qoutations provided by Original Equipment Manufacturers (OEMs).

Planned routine maintenance and unplanned corrective maintenance costs have been excluded in this RIT-D as they are deemed immaterial in comparison to the identified capital costs. While 66kV poles and wires are subject to routine inspections, identified defects are generally relatively low cost to remediate.

5.3 Market Benefits

SA Power Networks considers the relevant categories of market benefits prescribed under the NER for this RIT-D relate to compliance of regulatory requirements under the NER.

5.3.1 Classes of material market benefits

No credible options were considered to provide material market benefits under Chapter 5 of the NER. As part of this RIT-D, SA Power Networks did not quantify any market benefits in the NPV assessment. The result was decided based on the NPV that was the most financially viable and sustainable in the long term.

5.3.2 Classes of market benefits not expected to be material

If a DNSP can demonstrate that a specific category of market benefit is unlikely to materially affect the ranking of the options under consideration, then the DNSP is not required to quantify that category of market benefit. This is to ensure that the RIT-D process is efficient and does not require unnecessary effort in quantifying benefits that are unlikely to influence the outcome of the analysis.

As part of the RIT-D, certain classes of market benefits are considered immaterial if:

- The class is unlikely to affect the outcome of the assessment of a credible option. This means that even if the benefit were quantified, it would not change the ranking of the options under consideration.
- The estimated costs of undertaking analysis to quantify market benefits of the class are not feasible. This means that the effort and resources required to quantify the benefit would outweigh the potential impact of the benefit on the decision-making process.

The categories of immaterial market benefits may include, but are not limited to:

- Compliance of NER regulations: This refers to power factor and voltage levels remaining within specified ranges to ensure reliability and quality of electricity supply.
- Changes in voluntary or involuntary load curtailment: This refers to the changes in costs (or benefits) associated with either voluntary reductions in electricity use during peak periods or involuntary interruptions to electricity supply.
- Changes in costs for parties other than the RIT-D proponent: This refers to changes in costs for other participants in the electricity market, such as generators, retailers, or consumers.
- Changes in network losses: This refers to changes in the amount of electricity lost in transmission and distribution due to the resistance of electrical cables and equipment.
- Changes in ancillary service costs: This refers to changes in the costs of services that are necessary to support the transmission of electricity from generators to consumers and maintain the reliability and stability of the power system.

Credible options may impact these categories of market benefits. For example, in this case, it could reduce involuntary load curtailment by improving voltage stability, reduce network losses by providing reactive power support, and reduce ancillary service costs by freeing up existing dynamic voltage support equipment. However, these benefits would need to be quantified and compared to the costs of the option and unknown market factors to determine the economic benefit.

5.4 Scenarios to address uncertainty

RIT-D assessments are required to be based on a cost-benefit analysis that includes an assessment of ‘reasonable scenarios’, which are designed to test alternate sets of key assumptions and whether they affect the outcome of the preferred option.

SA Power Networks has elected to assess three alternative scenarios – namely:

- Central Sensitivity Scenario – the central scenario consists of assumptions that reflect SA Power Networks' central set of variable estimates which, in SA Power Networks' opinion, provides the most likely scenario;
- Low Sensitivity Scenario – SA Power Networks has adopted a number of assumptions that give rise to a lower bound estimate for each credible option, in order to represent a conservative future state of the world with respect to potential market benefits that could be realised under the credible option; and
- High Sensitivity Scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected market benefits.

A summary of the key variables in each scenario is provided in Table 5.1.

Table 5.1: Summary of three scenarios investigated; Central, Low and High Benefits

Variable	Central Scenario	Low Scenario	High Scenario
Discount Rate	7%	10%	3%
Capital Costs	100% of capital cost estimate	125% of capital cost estimate	75% of capital cost estimate
MVAr Forecast	Central MVAr forecast	-20%	+20%

SA Power Networks considers that the Central Scenario is most likely, since it is based on a set of central assumptions. SA Power Networks has therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios each being weighted equally at 25 per cent.

The overall sensitivity of the proposed options is independent of the MVAr forecast, as there are no benefits or costs directly corresponding to this forecast. As a result, there is no impact on the NPV for each option, and the sensitivity of the MVAr forecast has been excluded from the analysis. The MVAr forecast will primarily influence whether sufficient reactive support is installed to achieve connection point compliance, rather than determining which specific solution should be implemented.

The proposed solutions are required to meet compliance standards and are unlikely to result in a positive NPV. Therefore, the option selected will be the one with the least negative NPV.

6 Assessment of the credible options

This section provides a description of the credible network options SA Power Networks has identified as part of its network planning activities to date. Each option is compared against a base case option.

The present value of market benefits has been omitted from this report as other benefits (aside from the primary benefit of achieving compliance) have not been assessed.

6.1 Net present value assessment outcomes

Table 6.1 below summarises the net market benefit in Net Present Value (NPV) terms for the credible options under each scenario. Overall, Option 1 is the preferred option on value-for-money grounds as it delivers the compliance outcome at the lowest net cost to consumers.

Table 6.1 Present value of weighted net benefits relative to the base case, $m 2026

Option	Weighted PV of costs	Weighted PV of gross benefits	Weighted NPV	Ranking
Option 1	-22.2	0	-22.2	1
Option 2	-56.3	0	-56.3	2

7 Proposed preferred option

SA Power Networks proposes Option 1, the installation of 240MVAr of air core reactors for reactive support at several connection points to meet TCA compliance requirements by 2030.

As observed in Table 6.1 in the central, low and high scenarios, Option 1 is shown as the favourable solution, even when making adjustments to the sensitivities detailed in Table 5.1. This is largely due to the inherent nature of the project addressing a non-compliance in our TCA, as opposed to a market benefit.

SA Power Networks considers that detailed analysis within this FPAR identifies Option 1 as the preferred option and that this satisfies the RIT-D. SA Power Networks is the proponent for Option 1.

Upon completion of detailed final design and field checks, the following factors will be assessed and considered so that the project can be delivered in an overall efficient manner:

1. Time of year site access – wet and dry weather impacts terrain, access, demand, or significantly impacts customers, such as avoid vintage and agricultural cropping season.
2. Limitations of localities – equipment area and clearance requirements impacting land requirements.

Materials procurement – long lead times for Major Plant may introduce difficulties with delivery timeframes.

7.1 Community engagement and social license

SA Power Networks has considered potential community, stakeholder and social-licence impacts associated with the preferred option for addressing Power Factor non-compliance at ElectraNet Connection Points.

The proposed works involve the installation of Air Core Shunt Reactors within the boundaries of existing operational substations. Works do not require provision of new substations, new overhead lines, new easements, acquisition of third-party land, or material changes to the established use of the identified sites.

On the basis of the current scope, SA Power Networks expects impacts on the broader community to be minimal. Any construction activity is expected to be temporary, contained within existing substation sites and managed in accordance with SA Power Networks' safety, environmental and construction controls. No material ongoing visual, access, traffic, noise or land-use impacts are anticipated outside the existing substation boundaries and are being actively considered in the project design.

Accordingly, SA Power Networks considers that broad community engagement is not proportionate to the scale and nature of the anticipated impacts. SA Power Networks will instead undertake targeted stakeholder engagement and notification where required, including coordination with ElectraNet and any directly affected parties, particularly in relation to outage planning, access arrangements, construction timing or any identified local impacts.

SA Power Networks will review this assessment as the project design is progressed. Should the scope change in a way that creates material off-site impacts—for example, planned customer supply interruptions—SA Power Networks will implement engagement proportionate to those impacts.

Consideration	Assessment	Engagement implication
Project location	Works are within existing SA Power Networks substation boundaries	No site-specific community engagement anticipated
Land and property	No new easements, land acquisition or third-party property access anticipated	No landholder engagement expected, subject to confirmation during detailed design
Visual and amenity effects	Equipment is within existing operational infrastructure sites; no material changes to surrounding amenity anticipated	No broad community engagement required
Construction impacts	Temporary and contained within substation boundaries; routine controls to apply	Targeted notification only if a specific off-site impact is identified
Traffic and access	No material changes to public access or traffic anticipated.	Engage relevant parties if temporary access or traffic management is needed.
Customer impacts	Any planned outage or operational impact will be assessed and managed through established customer and stakeholder processes	Targeted communication with directly affected customers, if applicable
Key network stakeholder	ElectraNet connection points are directly relevant to the works	Ongoing technical and delivery coordination with ElectraNet
First Nations, environmental and heritage	No material ground disturbance outside established substation footprints anticipated	Apply normal project screening and engage if an issue is identified

7.2 Assessment of greenhouse-gas emissions market benefit

SA Power Networks has considered whether the credible options may result in a material change in Australia's greenhouse-gas emissions, consistent with the AER's RIT-D application guidelines.

For the proposed works, the only relevant potential emissions impact identified is a change in network electrical losses resulting from changes in reactive-power flows at the ElectraNet connection points.

SA Power Networks' existing technical assessment indicates that the reactor options are intended to address power-factor compliance requirements and are not expected to result in a material change in annual real-power losses relative to the base case. The options that are under consideration are expected to affect power flows in a similar manner, with any resulting change in system losses—including marginal generation and associated greenhouse-gas emissions—being negligible and unlikely to affect the ranking of credible options.

Accordingly, SA Power Networks considers that a detailed quantitative assessment of greenhouse-gas emissions is not proportionate. The potential greenhouse-gas emissions market benefit has been assessed as immaterial and has not been included in the calculation of net market benefits.

This conclusion will be reviewed if detailed design or operational studies identify a material change in real-power losses or any other material emissions impact.

Item	Assessment
Potential emissions pathway	Change in real-power network losses due to altered reactive-power flows
Expected loss impact	No material change anticipated, based on existing technical assessment
Change in generation dispatch	Not expected to be material
Construction / embodied emissions	Expected to be minor relative to the investment; works are within existing substations
Impact on option ranking	Not expected to affect the ranking of credible options
RIT-D treatment	Assessed qualitatively as immaterial; not monetised

8 Definitions and Contractions

Words and phrases within this document should be read with the meaning given to them within the National Electricity Rules.

Term	Meaning
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Base Case	The case considered most likely used as the reference case when considering alternative plausible market scenarios
DAPR	Distribution Annual Planning Report
DPAR	Draft Project Assessment Report
DNSP	Distribution Network Service Provider
FPAR	Final Project Assessment Report
Identified Need	The objective or purpose of a proposed network investment
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
OSR	Options Screening Report
PoE	Probability of Exceedance. The probability that, in any one year, peak demand will exceed the forecast value. For instance demand is expected to exceed a 10% PoE forecast, 1 year in 10.
RCA	Reliability Corrective Action
RIT-D	Regulatory Investment Test – Distribution
Rules	National Electricity Rules (NER)
SAPN	SA Power Networks
SAPS	Stand Alone Power System
TNSP	Transmission Network Service Provider