Addressing Power Factor Non-Compliance at ElectraNet Connection Points

Options Screening Report

3 May 2024

SA Power Networks

www.sapowernetworks.com.au

Disclaimer

This Options Screening Report (OSR) has been prepared in accordance with clause 5.17.4(e) of the National Electricity Rules (NER) for the purpose of demonstrating why SA Power Networks believes there may be credible non-network options available on a standalone basis or significant part of a credible option to address the identified need.

This OSR makes use of historic non-network option costs and contains assumptions regarding, amongst other things, reactive power forecasts which by their nature, may or may not eventuate. SA Power Networks advises that anyone proposing to use this information should verify its reliability, accuracy and completeness before committing to any course of action.

Whilst care has been taken in the preparation of the information contained in this OSR, it is provided in good faith. SA Power Networks makes no warranties or representations as to its reliability, accuracy or completeness and accepts no responsibility or liability for any loss or damage that may be incurred by any person acting in reliance on this information or assumptions drawn from it.

This document is not intended to be used for other purposes, such as making decisions to invest in generation, transmission or distribution capacity.

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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 observed at ElectraNet / SA Power Networks' connection point substations (connection points) have been consistently trending further in the reverse direction (capacitive/leading) for at least the past decade. ElectraNet has observed that increasing capacitive power flows at connection points are causing 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(d) 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 considers the identified need for this investment to be a 'reliability corrective action' under the RIT-D framework, as it necessitates network investments to comply with the TCA and NER obligations outlined above. The timing of the identified need for this RIT-D is determined by the forecast increase in capacitive power flows and their adverse impact on system stability. This underscores the urgency to explore credible options to address the identified need and ensure the resilience and performance of the electricity transmission infrastructure in South Australia.

This OSR represents the first formal stage in the RIT-D process and will be followed by a Draft Project Assessment Report (DPAR) that will include a full net present value (NPV) economic assessment of all credible options (including any identified through this OSR). SA Power Networks' expected date for the publication of the DPAR is September 2024.

1.1 Invitation for submissions

SA Power Networks invites submissions from interested parties, particularly from proponents of non-network solutions, in response to this report. SA Power Networks is interested in exploring all potential non-network solutions with proponents.

Proponents may require information in addition to that provided in this report. Proponents seeking additional information are encouraged to contact SA Power Networks as early as possible to ensure that adequate time is available to fully assess feasible network and non-network potential solutions. Further engagement will also be possible following the submissions due date. It is critical that any solutions presented by proponents is done so in a manner that provides sufficient time for their evaluation and any necessary clarifications.

Submissions are due on or before Monday, 5 August 2024. Submissions and any subsequent response by SA Power Networks may be published.

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

1.2 Next steps

Following consideration of submissions made in response to this OSR, SA Power Networks will prepare the DPAR. The DPAR will present a detailed assessment of all credible options to address the identified need and will also include a summary and commentary on submissions received to this report.

SA Power Networks' expected date for the publication of the DPAR is September 2024.

2 Description of the identified need

This section sets out the ‘identified need’ for this RIT-D, as well as the key assumptions that underpin it. These assumptions have been used by SA Power Networks to determine that a non-network option could form a potential credible option on a standalone basis, or form a significant part of a potential credible option for this RIT-D. The assumptions are provided to assist proponents in preparing any solutions in response to this OSR.

2.1 Background

The electricity transmission network in South Australia plays a critical role in ensuring the reliable and efficient delivery of electricity to consumers across the region, adequate voltage control being a key aspect. Voltage control involves maintaining satisfactory steady-state voltage levels and ensuring dynamic voltage stability following contingency events.

ElectraNet draws on sources such as static VAr compensators (SVCs) and synchronous condensers to provide dynamic voltage control for the South Australian electricity transmission network. ElectraNet seeks to maintains a level of dynamic reactive power reserve during system normal conditions such that the dynamic reactive power capability can appropriately contribute to the maintenance of system stability following significant system disturbances. This involves operating each SVC and synchronous condenser within a normal operating target range of 0 – 25 MVAr (inductive). In total, this reserves 332 MVAr of dynamic inductive reactive power capability; 150 MVAr from ElectraNet’s SVCs and 182 MVAr from ElectraNet’s synchronous condensers.

ElectraNet is currently undertaking the Transmission Network Voltage Control RIT-T to optimise the performance of SVCs and synchronous condensers, particularly at forecast low transmission system loading levels.[1]

Recent developments have led to ElectraNet observing increasing capacitive power flows at connection points between ElectraNet and SA Power Networks, contributing to SVCs and synchronous condensers being operated outside the ranges specified above. Following the completion of ElectraNet’s RIT-T, the SVCs and synchronous condensers are expected to continue to operate outside the specified range, given the current levels of capacitive power flows at connection points.

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. Additionally, ElectraNet and AEMO are exploring the ability to operate the South Australian transmission system with fewer than two dispatched conventional generating units. This will further reduce the availability of reactive power support from generation and increase the reliance on ElectraNet’s SVCs and synchronous condensers to provide dynamic reactive power control.

Consistent with the NER, the TCA allows ElectraNet to permit a lower lagging or leading power factor where it will not detrimentally affect power system security or power transfers. ElectraNet has confirmed the need to enforce power factor requirements as per the TCA at 66kV connection points, such that excessively capacitive power factors do not detrimentally impact system security. This technical obligation requires SA Power Networks to ensure that capacitive reactive power does not flow into the transmission network from the distribution network at 66kV connection points.

1 The latest information about the progress of ElectraNet’s Transmission Network Voltage Control RIT-T is available at https://www.electranet.com.au/projects/south-australian-transmission-network-voltage-control/.

SA Power Networks has conducted investigations into the source of this change in reactive power behaviour, primarily focused on household appliance testing. Preliminary findings of the research indicate that modern appliances powered by switch-mode power supplies or inverters are typically capacitive, especially when in standby mode. These results have supported the observed network trend where reverse capacitive flows are high when the underlying load is low and appliances are likely to be on standby. This trend can be observed by isolating measurements at 5am (where reverse reactive power is typically the highest) and plotting them across time, an example of which is shown in Figure 2-1. For further explanation of how the trendline is determined and applied in the MVAr forecasting process, see Section 2.3.1.

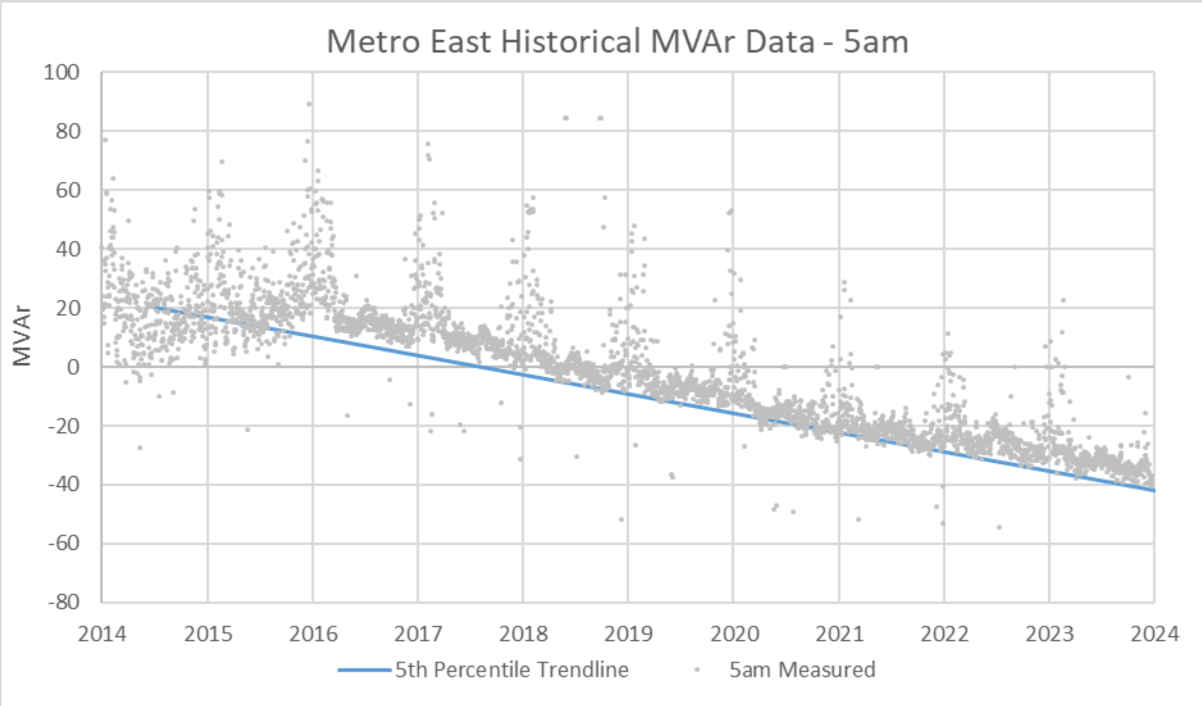

Figure 2-1: Example historical connection point MVAr measurements at 5am

The challenges associated with voltage control underscore the importance of addressing issues such as capacitive power flow from distribution networks, which can adversely impact system stability and reliability. The following sections of this report will provide forecasts, key assumptions and potential options for addressing these critical challenges, with the overarching goal of enhancing the performance and resilience of the electricity transmission infrastructure in South Australia.

2.2 Relevant area of SA Power Networks' distribution network

Correspondence with ElectraNet has confirmed that the need to maintain power factors within prescribed limits applies to 66kV connection points and does not currently apply to 33kV (and all other) connection points, due to their typically smaller size and hence limited impact on system security.

SA Power Networks' 66kV systems are often supplied via multiple 66kV connection point substations, but for the purposes of 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 SSD-403
    - Magill (TF2 & TF3) SSD-408
    - East Terrace SSD-366
    - City West (TF1) SSD-579
- Metro North, which comprises:
    - Parafield Gardens West SSD-453
    - Para SSD-161
    - Munno Para SSD-488
- Metro South, which comprises:
    - City West (TF2) SSD-453
    - Magill (TF1) SSD-408
    - Happy Valley SSD-209
    - Morphett Vale East SSD-115
- Metro West, which comprises:
    - Torrens Island Power Station SSD-255
    - Kilburn SSD-373
    - Lefevre SSD-510
    - New Osborne SSD-547
- Mount Barker, which comprises:
    - Mount Barker SSD-232
    - Mount Barker South SSD-346
- Riverland, which comprises:
    - Berri SSD-399
    - Monash SSD-565
    - North West Bend SSD-400

The Riverland 66kV 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 proposes to consider the aggregation of these connection points when addressing the identified need. This approach leads to a significantly more cost-effective network solution by allowing a single installation to resolve the non-compliance for two systems. 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 2-2 for a map of the state transmission system with 66kV connection points, and Figure 2-3 for the Adelaide Metropolitan insert. Additionally, refer to SA Power Networks' Network Visualisation Portal[2] 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.

[2] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

Figure 2-2: State level transmission map with 66kV connection points

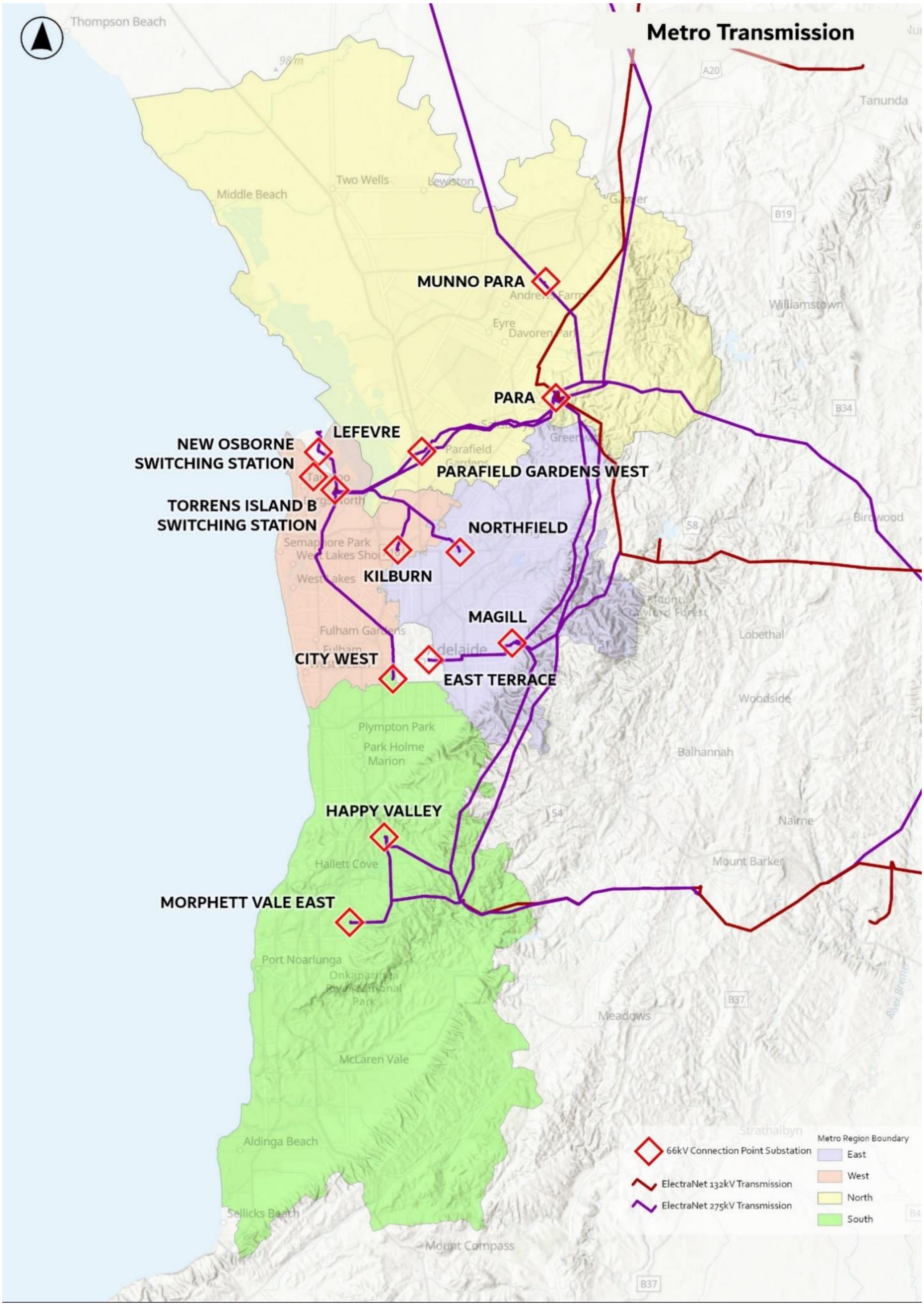

Figure 2-3: Adelaide metropolitan transmission map with 66kV connection points

2.3 Key assumptions underpinning the identified need

The identified need for this RIT-D is to prevent capacitive power flows (leading power factor) from SA Power Networks' distribution network into ElectraNet's transmission network. The forecast increase in capacitive power flow into ElectraNet's transmission network is attributed to numerous factors as the energy system evolves. One significant factor is the emerging trend of connected loads becoming less inductive throughout the day, thereby reducing the network's capacity to offset line charging.

Meeting this identified need will ensure power factors at connection points will remain inductive (lagging), safeguarding network stability and reliability amidst evolving energy dynamics.

The remainder of this section sets out the key assumptions that underpin the identified need.

2.3.1 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 are also produced for solar peak, assumed to be 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;
- Historic years are manually selected to form a forecast growth rate to reflect line of best fit.

The latest reactive power forecast (completed in 2024) estimates 159 MVAr of capacitive power will flow from distribution networks into the transmission networks in 2025 measured at 5am, increasing to 250 MVAr in 2030. Figure 2-4 below shows the reactive power forecast during low load time at 5am and 1pm.

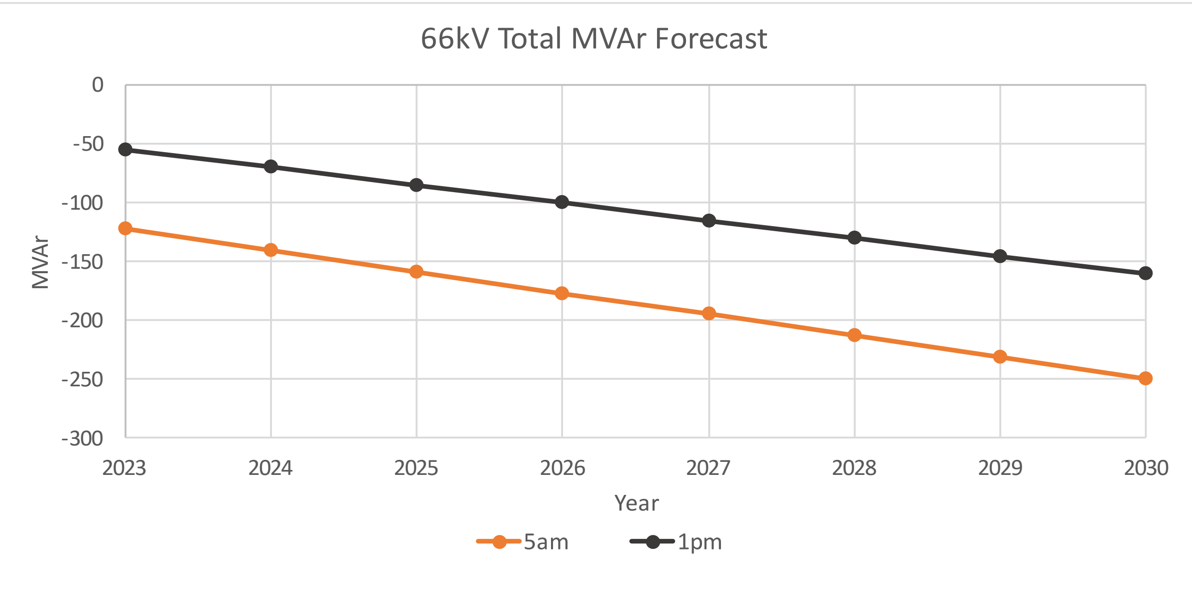

Figure 2-4: Reactive Power Flow Forecast during low demand times

Historical trends show that connection points in the Metro regions are showing a reduction of 3 MVAr to 6 MVAr per year during low demand times. The forecast capacitive (MVAr) flows are summarised for each region in Section 4 and a summary of all connection point forecast is shown in Appendix B.

2.3.2 Reliability Corrective Action

Reliability corrective action, as defined by the National Electricity Rules (NER) 5.10.2, 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.

In the case of South Australia's electricity transmission network, voltage control is a critical component essential for maintaining steady-state voltage levels and dynamic voltage stability following contingency events. The ongoing Transmission Network Voltage Control RIT-T initiative, led by ElectraNet, underscores the importance of optimising voltage control mechanisms. This is particularly relevant due to observed challenges such as increasing capacitive power flows at connection points between ElectraNet and SA Power Networks.

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 Technical Obligations outlined in Schedule 6, Part B item 3 of the Transmission Connection Agreement (TCA) between ElectraNet and SA Power Networks. These obligations are derived from Schedules 5.3.1a(d) and 5.3.5 of the NER, which mandates the absence of capacitive flow from 66kV (and higher voltage) connection points to ensure system stability and reliability.

SA Power Networks' pursuit of reliability corrective action through this RIT-D process stems from its commitment to upholding 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 enhance the resilience and efficiency of the electricity network in South Australia, ultimately benefiting consumers and stakeholders across the region.

2.3.3 Proposed scenarios for the forthcoming RIT-D NPV assessment

SA Power Networks proposes to assess three alternative future scenarios as part of the DPAR NPV assessment, including:

- a central scenario – consisting of assumptions that reflect a central set of estimates which reflects the most likely scenario;
- a high benefit scenario – reflecting an optimistic set of assumptions which reflect an upper bound of reasonably expected benefits; and
- a low benefit scenario – reflecting several assumptions that give rise to a lower bound NPV estimate for each credible option to represent a conservative future state of the world with respect to the benefits that could be realised under each potential option.

A summary of the key variables expected to be used for the scenarios is presented in table 2-1 below.

Table 2-1: Proposed scenarios for the forthcoming RIT-D NPV assessment

	Central	High benefits	Low benefits
Capex	Central estimates	-25%	+25%
MVAr Forecast	Central MVAr forecast	+20%	-20%
Discount rate	7%	3%	10.5%

SA Power Networks have developed the above scenarios to comprehensively assess the range of net benefits that can be expected from the credible options. We consider that this approach allows for a more robust test of the preferred option compared with adopting individual sensitivity tests because multiple inputs are changed together.

SA Power Networks currently proposes to apply the central scenario a weighting of 50 per cent in the NPV assessment since it reflects the most likely outcome, with the remaining two scenarios weighted equally at 25 per cent each.

Each credible option will undergo assessment over a 20-year period for the DPAR NPV assessment.

3 Potential network credible options

SA Power Networks has identified two credible network options to alleviate the network constraint, including:

- Option 1 – Install a series of 66kV and 11kV reactors;
- Option 2 – Install a combination of STATCOMs and reactors;

The two credible network options are discussed in turn in the sections below.

3.1 Option 1 – Reactor Program

Option 1 includes the installation of 12 reactors (66kV and 11kV) totalling 267 MVAr of reactive support at several connection points to meet TCA compliance requirements by 2030. These connection point installations are:

- Metro East
  - 1 x 30 MVAr 66kV Reactor in 2027
  - 1 x 30 MVAr 66kV Reactor in 2029
  - 1 x 30 MVAr 66kV Reactor in 2030
- Metro North
  - 1 x 9 MVAr 11kV Reactor in 2028
  - 1 x 30 MVAr 66kV Reactor in 2029
- Metro South
  - 1 x 9 MVAr 11kV Reactor in 2026
  - 1 x 15 MVAr 66kV Reactor in 2027
  - 1 x 30 MVAr 66kV Reactor in 2029
  - 1 x 30 MVAr 66kV Reactor in 2030
- Metro West
  - 1 x 30 MVAr 66kV Reactor in 2030
- Mount Barker
  - 1 x 15 MVAr 66kV Reactor in 2026
- Riverland (Berri/Monash and North West Bend)
  - 1 x 9 MVAr 11kV Reactor in 2030

The total cost of this option is expected to be $38.9M[3] with the program commencing in 2025 and completing in 2030, with indicative installation timing listed above. The annual deferred augmentation of this option is expected to be $2.7m.[4]

[3] Costs are expressed in 2025 dollars.
[4] Based on the deferral of the whole program using a Discount Rate of 7%

3.2 Option 2 – STATCOMs and Reactors

Option 2 includes the installation of nine reactors (66kV and 11kV) and four STATCOMs (66kV) totalling 267 MVAr of reactive support at several connection points to meet TCA compliance requirements by 2030. These connection point installations are:

- Metro East
  - 1 x 30 MVAr 66kV STATCOM in 2027
  - 1 x 30 MVAr 66kV Reactor in 2029
  - 1 x 30 MVAr 66kV Reactor in 2030
- Metro North
  - 1 x 9 MVAr 11kV Reactor in 2028
  - 1 x 30 MVAr 66kV STATCOM in 2029
- Metro South
  - 1 x 9 MVAr 11kV Reactor in 2026
  - 1 x 15 MVAr 66kV Reactor in 2027
  - 1 x 30 MVAr 66kV Reactor in 2029
  - 1 x 30 MVAr 66kV STATCOM in 2030
- Metro West
  - 1 x 30 MVAr 66kV STATCOM in 2030
- Mount Barker
  - 1 x 15 MVAr 66kV Reactor in 2026
- Riverland (Berri/Monash and North West Bend)
  - 1 x 9 MVAr 11kV Reactor in 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.

The total cost of this option is expected to be $83.6M[5] with the program commencing in 2025 and completing in 2030, with indicative installation timing listed above. The annual deferred augmentation of this option is expected to be $5.8m.[6]

3.3 Options considered but not proposed to be progressed to the DPAR

SA Power Networks considered an alternative network-option to meet the identified need that is not currently proposed to be progressed to the DPAR. 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.

[5] Costs are expressed in 2025 dollars.
[6] 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 currently adequate to support the successful implementation of this. 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 Required technical characteristics of non-network options

This section sets out the technical characteristics that a non-network option would be required to deliver to assist with meeting the identified need. The information is provided to enable proponents of non-network solutions to understand the identified need further and to tailor their proposals accordingly.

SA Power Networks is eager to explore all possible non-network solutions with proponents to deliver the most efficient overall option to satisfy the identified need. SA Power Networks welcomes submissions from potential proponents who consider that they could offer a credible non-network solution that is both commercially and technically feasible under the RIT-D.

Proponents may require information in addition to that provided in this report. Proponents seeking additional information are encouraged to contact SA Power Networks as early as possible to ensure that adequate time is available to fully assess feasible network and non-network potential solutions. Further engagement will also be possible following the submissions due date. It is critical that any solutions presented by proponents is done so in a manner that provides sufficient time for their evaluation and any necessary clarifications.

4.1 Metro East

4.1.1 Location

The Metro East area encompasses several key substations within the metropolitan distribution network, supplied via the following connection points:

- Northfield SSD-403
- Magill (TF2 & TF3) SSD-408
- East Terrace SSD-366
- City West (TF1) SSSD-579

See Figure 4-1 below for a map of the Metro East region (refer to the Network Visualisation Portal[7] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is recommended that locations closest to connection point substations or zone substations are more likely to be feasible.

[7] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

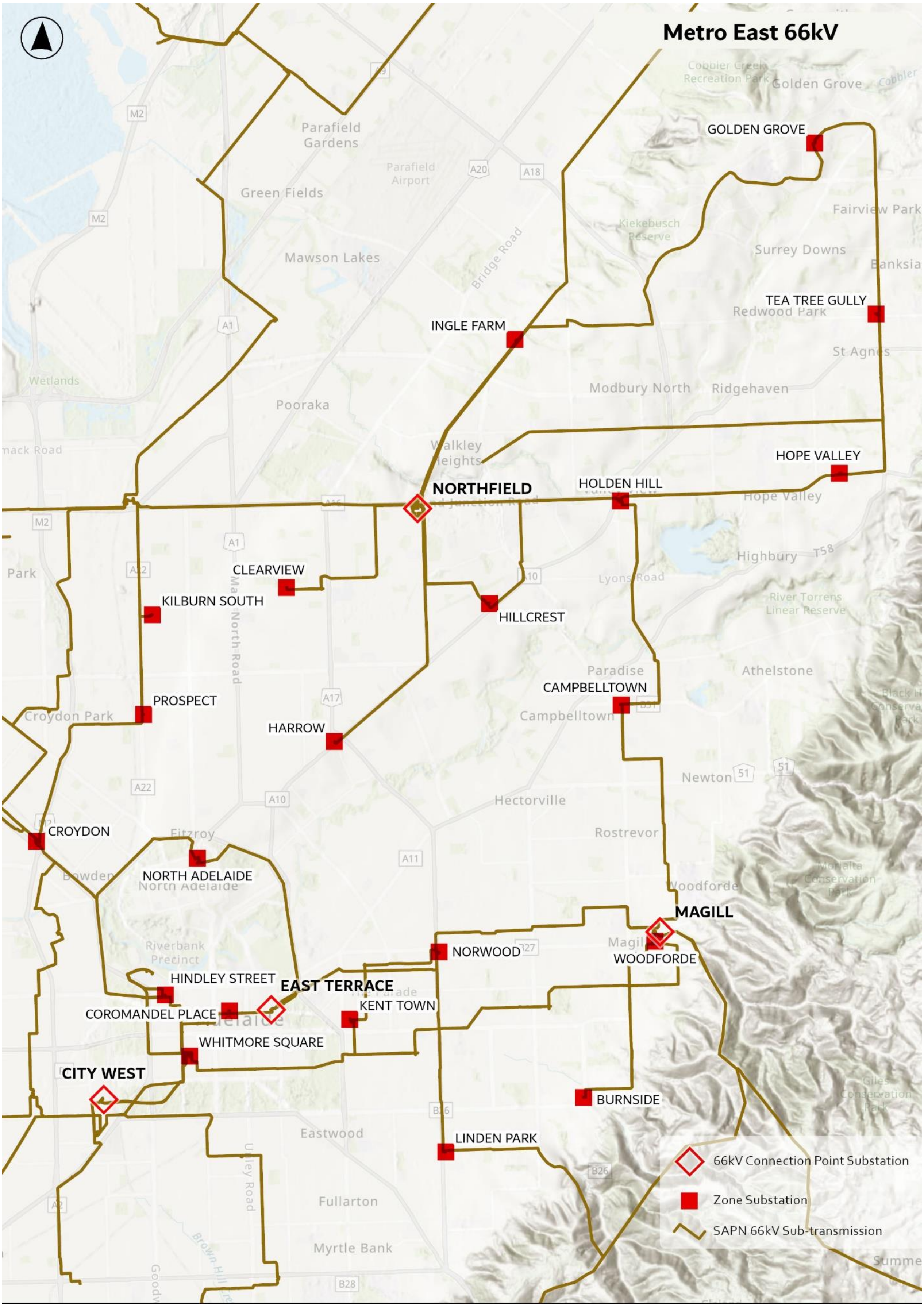

Figure 4-1: Metro East 66kV network map

4.1.2 Size of reactive power support

Based on latest forecasts and historical data, the Metro East region requires reactive power support to mitigate capacitive power flows. The required maximum size of reactive power support is estimated to be 49.2 MVAr in 2025, increasing to 77.9 MVAr in 2030, as shown in Figure 4-2.

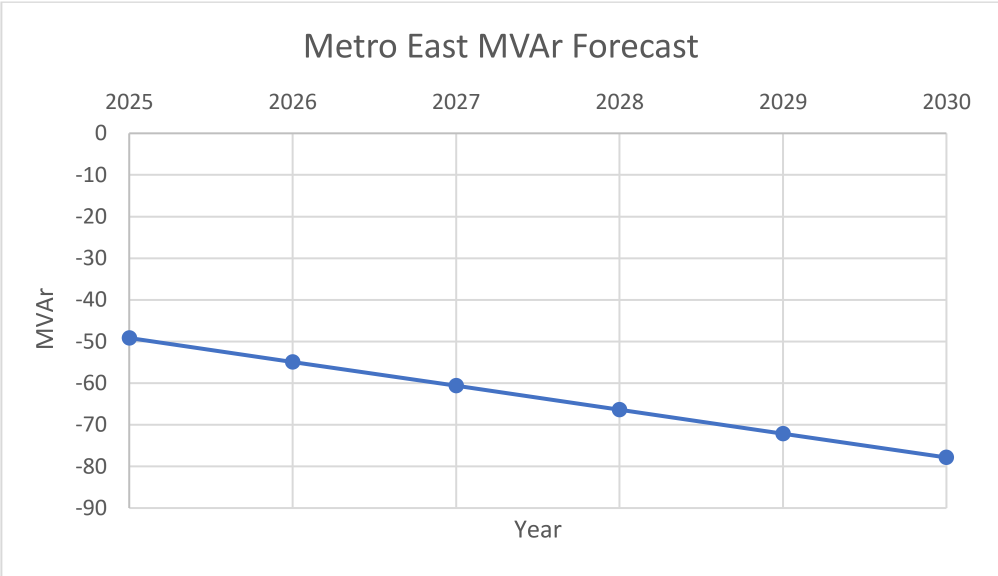

Figure 4-2: Metro East Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in Section 3.

4.1.3 Operating profile

A non-network solution in the Metro East area must be tailored to adhere to the operating profile depicted in Figure 4-3. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

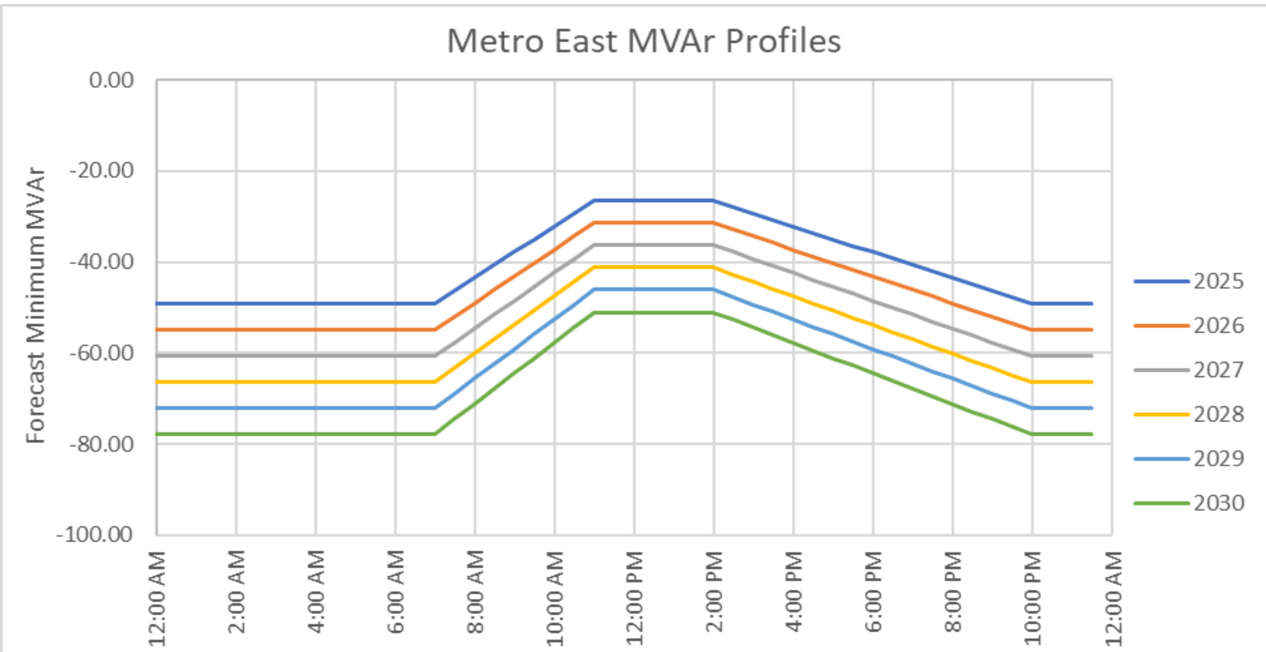

Figure 4-3: Metro East Forecast Minimum MVAr Profiles

While the provided daily operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.2 Metro North

4.2.1 Location

The Metro North area encompasses several key substations within the metropolitan distribution network, supplied via the following connection points:

- Parafield Gardens West SSD-453
- Para SSD-161
- Munno Para SSD-488

See Figure 4-4 below for a map of the Metro North region (refer to the Network Visualisation Portal[8] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is generally recommended that locations closest to connection point substations or zone substations are more likely to be feasible.

[8] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

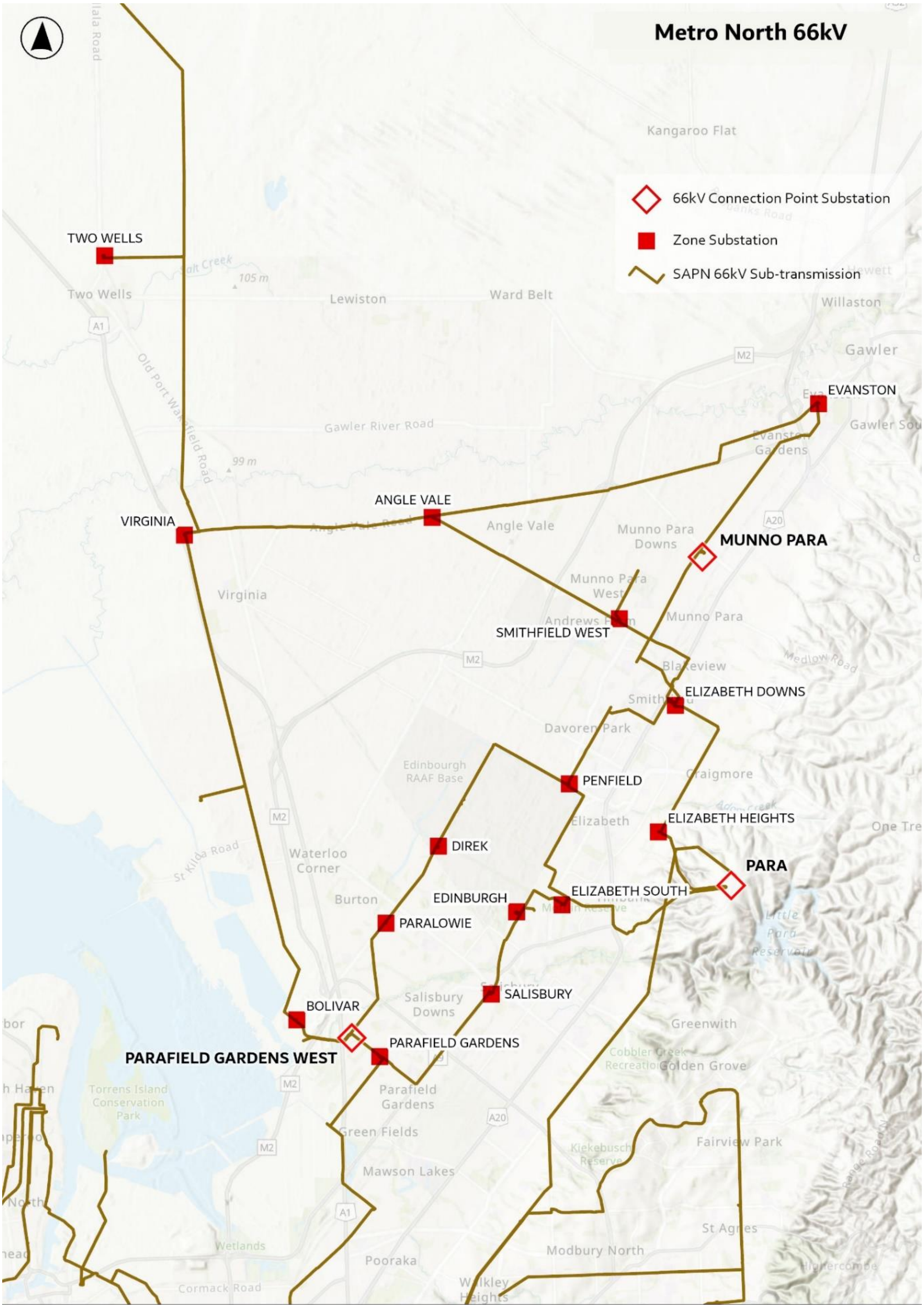

Figure 4-4: Metro North 66kV network map

4.2.2 Size of reactive power support

Based on latest forecasts and historical data, the Metro North region requires reactive power support to mitigate capacitive power flows. The required maximum size of reactive power support is estimated to be 22.2 MVAr in 2025, increasing to 37.5 MVAr in 2030, as shown in Figure 4-5.

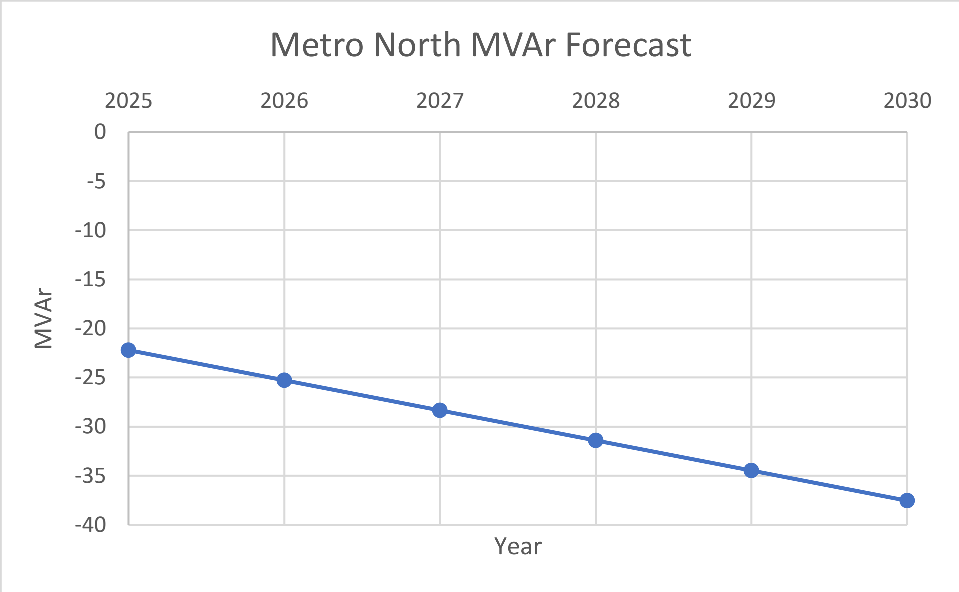

Figure 4-5: Metro North Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in Section 3.

4.2.3 Operating profile

A non-network solution in the Metro North area must be tailored to adhere to the operating profile depicted in Figure 4-6. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

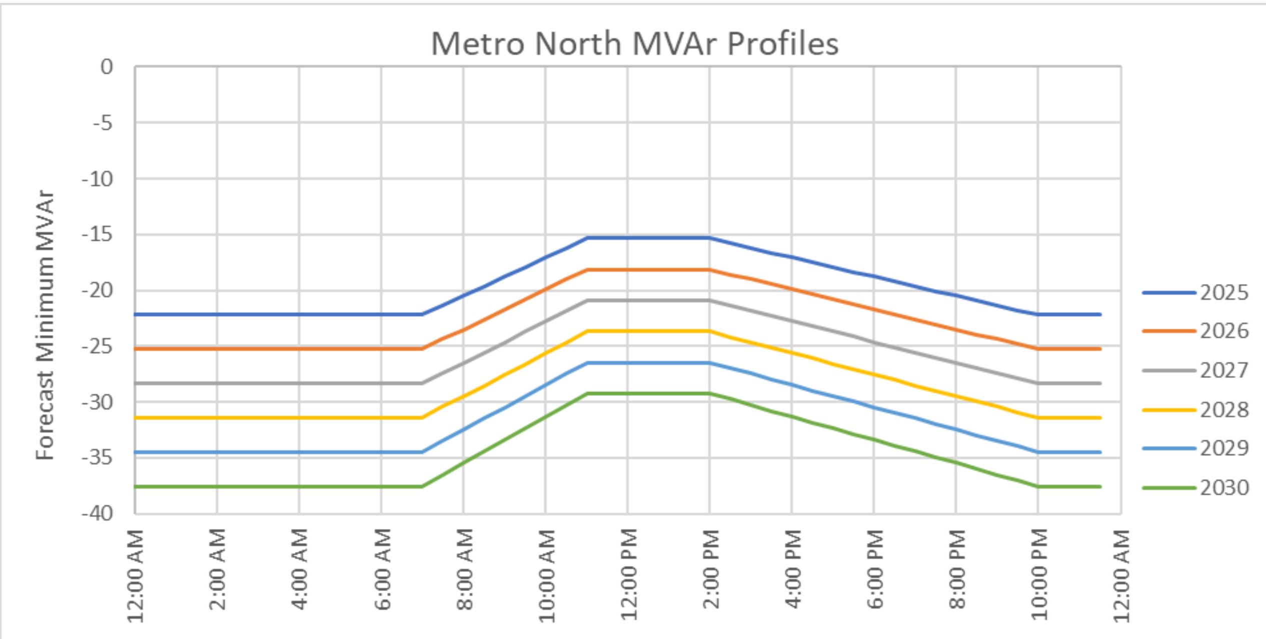

Figure 4-6: Metro North Forecast Minimum MVAr Profiles

While the provided daily operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.3 Metro South

4.3.1 Location

The Metro South area encompasses several key substations within the metropolitan distribution network, supplied via the following connection points:

- City West (TF2) SSD-453
- Magill (TF1) SSD-408
- Happy Valley SSD-209
- Morphett Vale East SSD-115

See Figure 4-7 below for a map of the Metro South region. Additionally, see Figure 4-8: Southern Rural 66kV network map

for a map of the Southern Rural region, where the network extends beyond the Metro South region (refer to the Network Visualisation Portal[9] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is generally recommended that locations closest to connection point substations or 66kV zone substations are more likely to be feasible. Being distant from connection point substations, the Southern Rural region presents limited opportunities for feasible non-network solutions due to weaker network infrastructure in the region.

[9] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

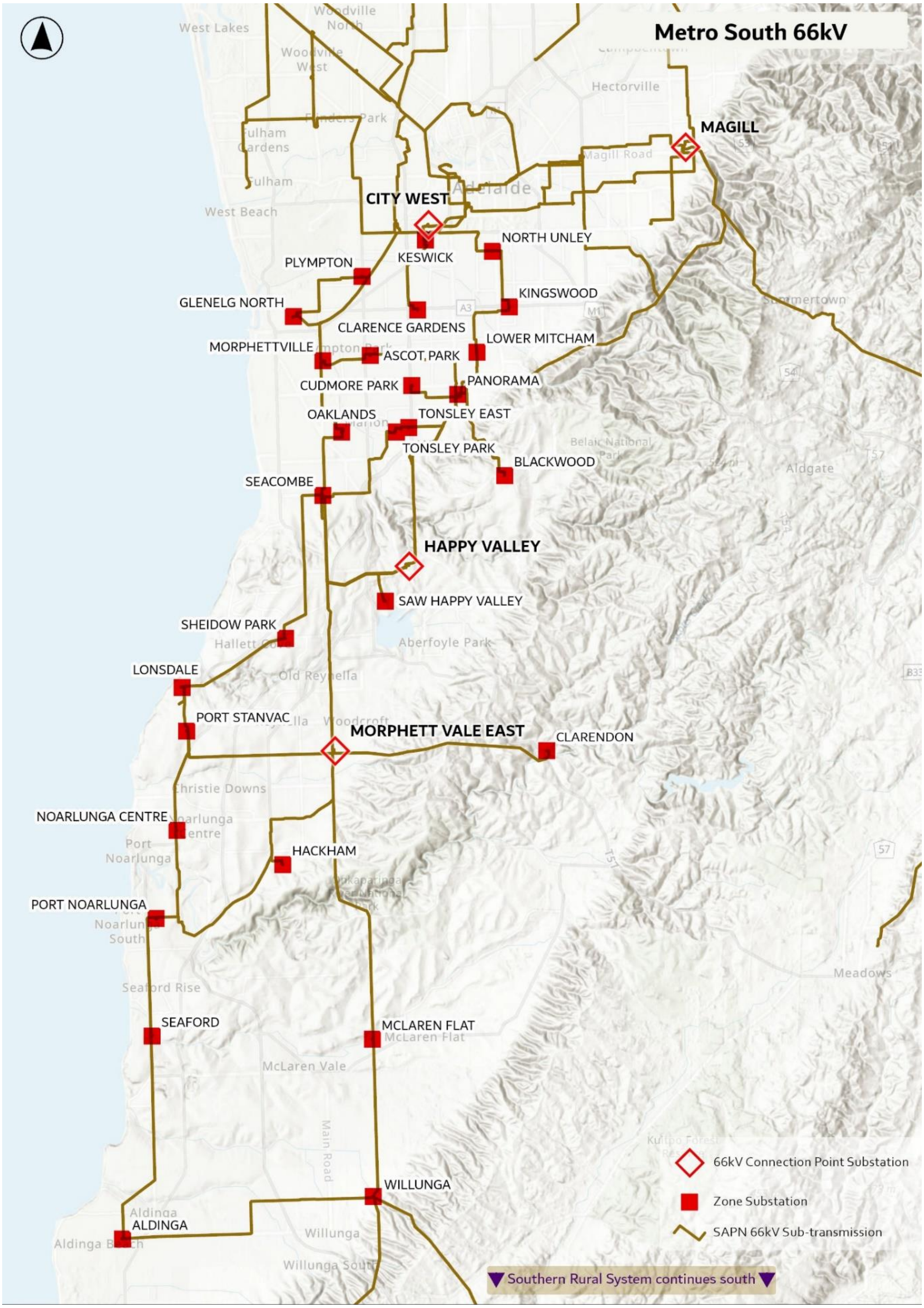

Figure 4-7: Metro South 66kV network map

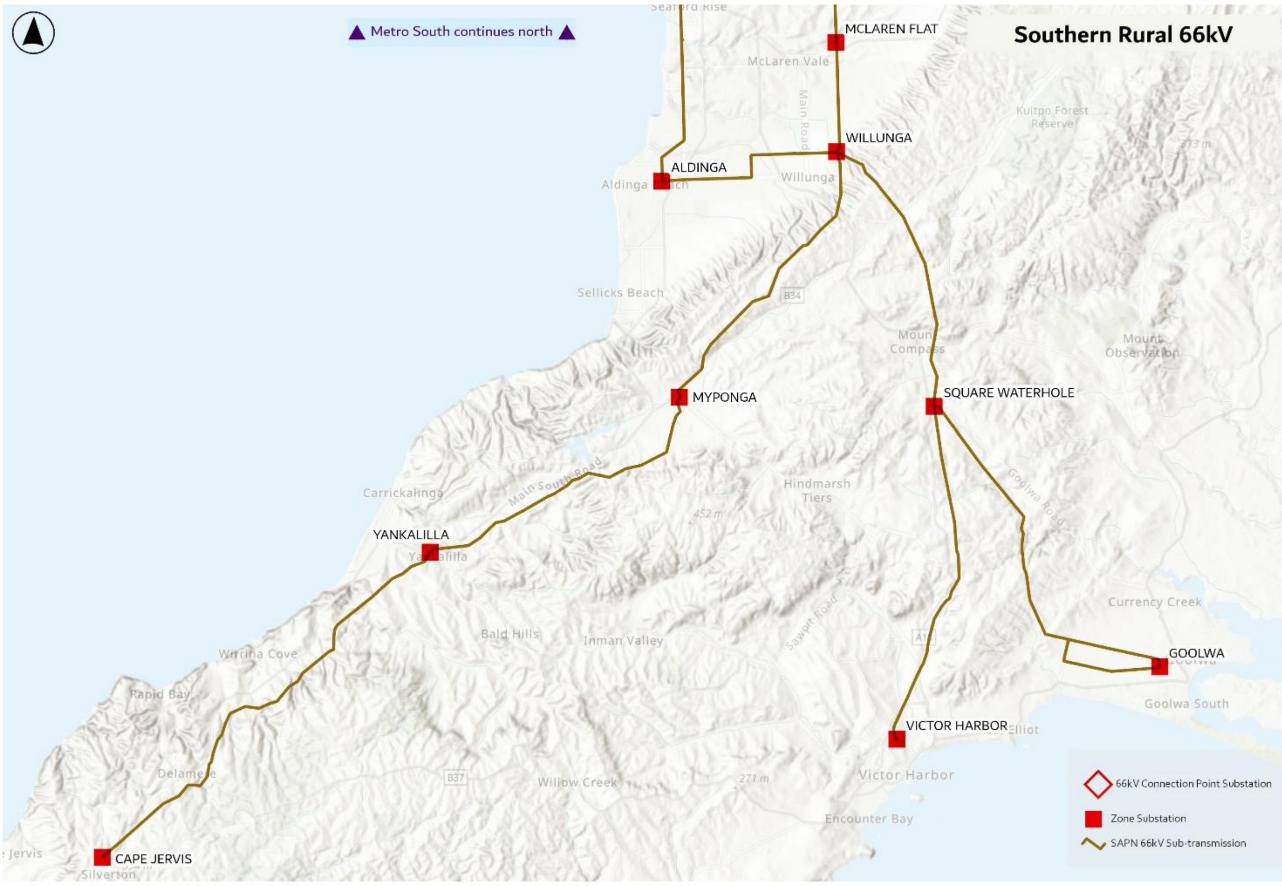

Figure 4-8: Southern Rural 66kV network map

4.3.2 Size of reactive power support

Based on latest forecasts and historical data, the Metro South region requires reactive power support to mitigate capacitive power flows. The required maximum size of reactive power support is estimated to be 52.0 MVAr in 2025, increasing to 76.9 MVAr in 2030, as shown in Figure 4-9.

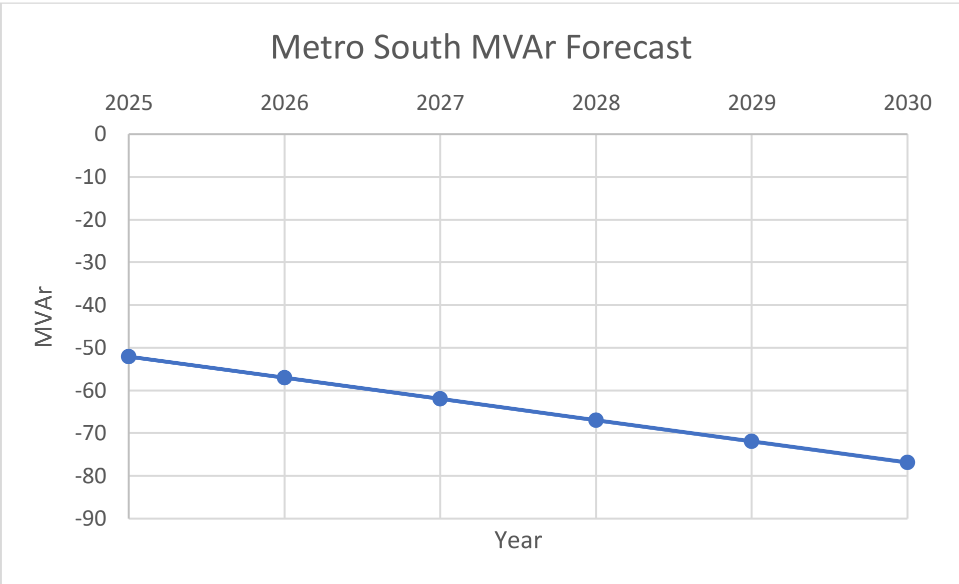

Figure 4-9: Metro South Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in Section 3.

4.3.3 Operating profile

A non-network solution in the Metro North area must be tailored to adhere to the operating profile depicted in Figure 4-10. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

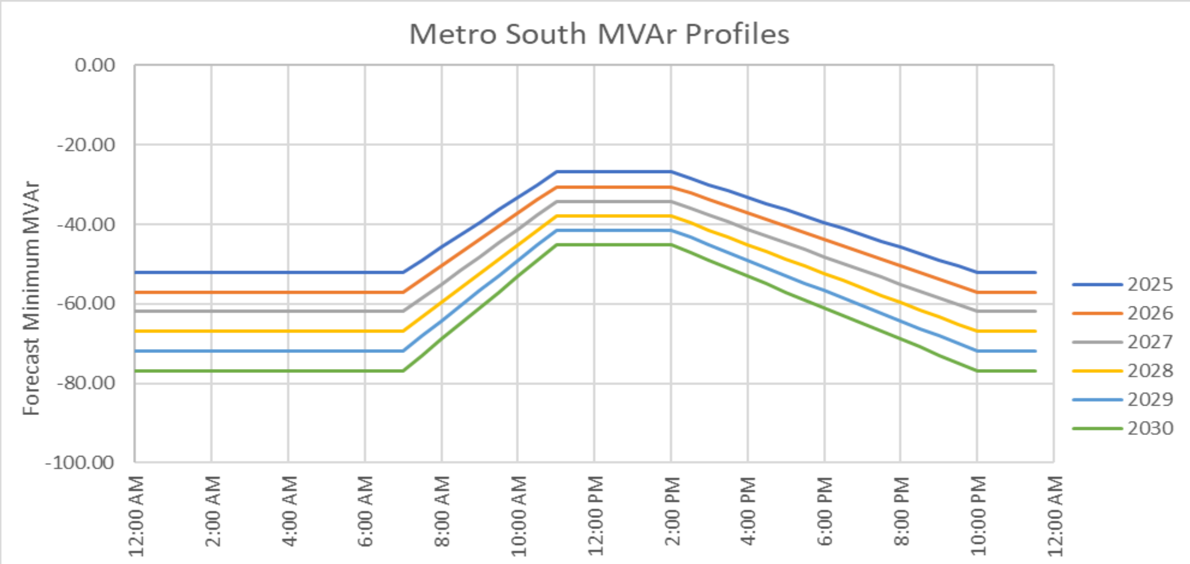

Figure 4-10: Metro South Forecast Minimum MVAr Profiles

While the provided daily operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.4 Metro West

4.4.1 Location

The Metro West area encompasses several key substations within the metropolitan distribution network, supplied via the following connection points:

- Torrens Island Power Station SSD-255
- Kilburn SSD-373
- Lefevre SSD-510
- New Osborne SSD-547

See Figure 4-11 below for a map of the Metro West region (refer to the Network Visualisation Portal[10] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is generally recommended that locations closest to connection point substations or zone substations are more likely to be feasible.

[10] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

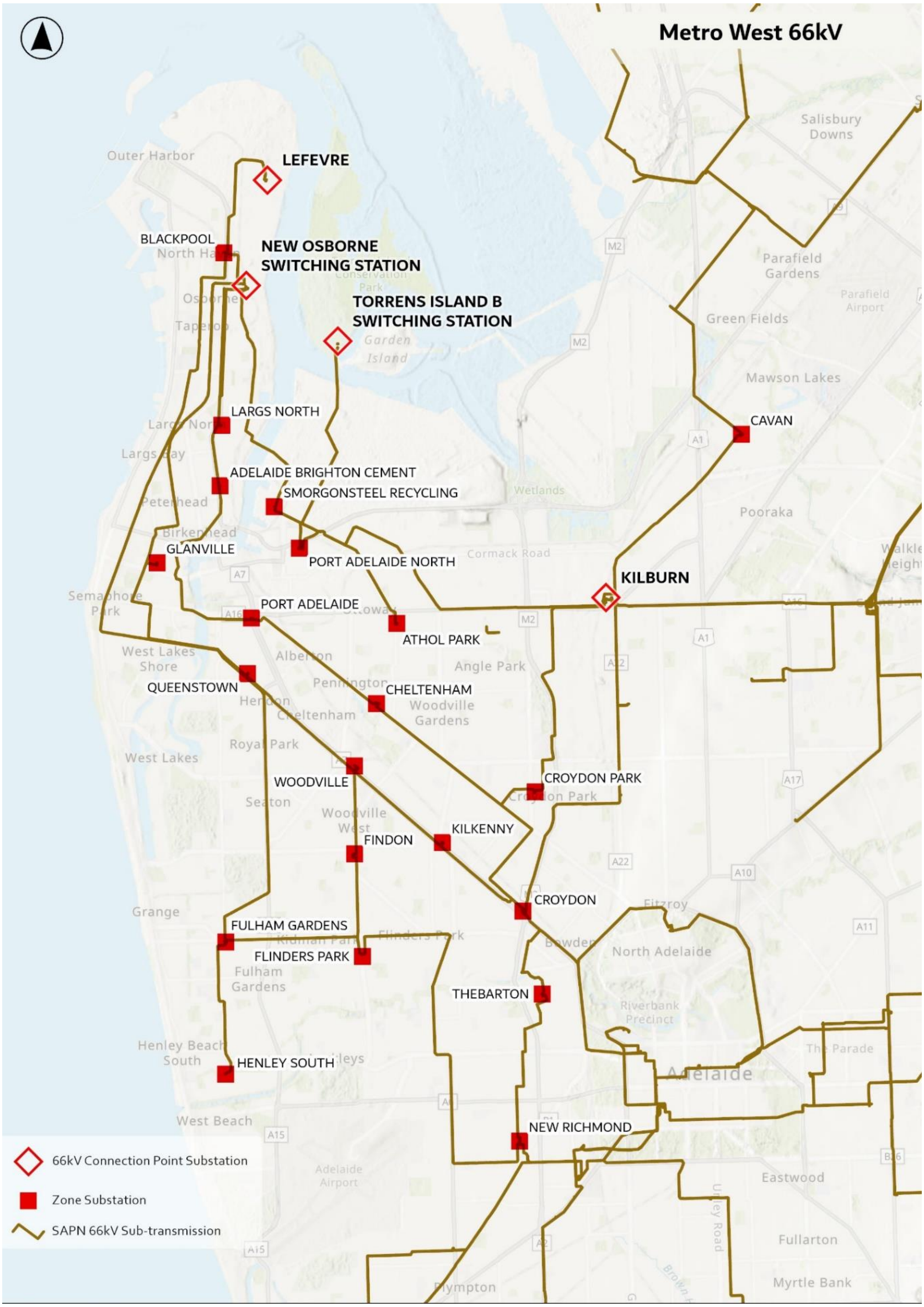

Figure 4-11: Metro West 66kV network map

4.4.2 Size of reactive power support

Based on latest forecasts and historical data, the Metro West region requires reactive power support to mitigate capacitive power flows. The required maximum size of reactive power support is estimated to be 9.5 MVAr in 2025, increasing to 25.2 MVAr in 2030, as shown in Figure 4-12.

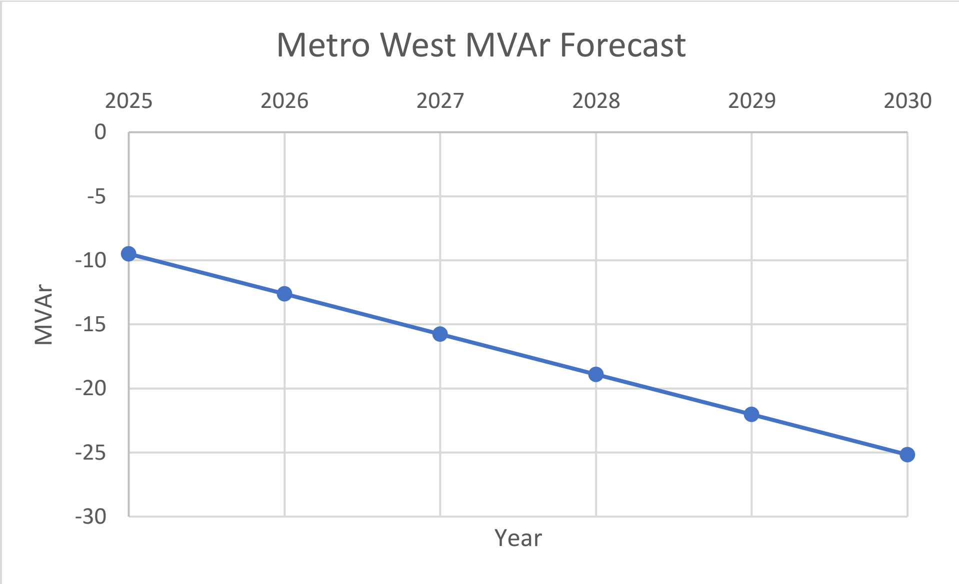

Figure 4-12: Metro West Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in section 3.

4.4.3 Operating profile

A non-network solution in the Metro North area must be tailored to adhere to the operating profile depicted in Figure 4-13. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

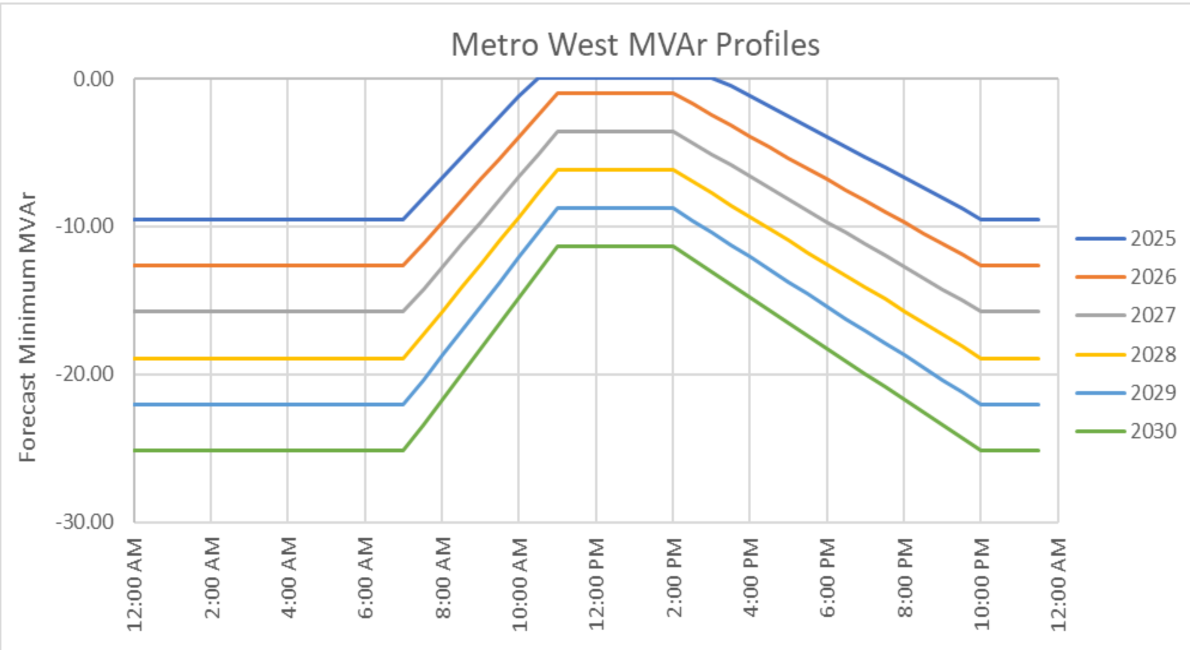

Figure 4-13: Metro West Forecast Minimum MVAr Profiles

While the provided daily operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.5 Mount Barker

4.5.1 Location

The Mount Barker 66kV system encompasses several key substations within the broader Eastern Hills region, supplied via the following connection points:

- Mount Barker SSD-232
- Mount Barker South SSD-346

See Figure 4-14 below for a map of the Mount Barker region (refer to the Network Visualisation Portal[11] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is generally recommended that locations closest to connection point substations or 66kV zone substations are more likely to be feasible.

[11] Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

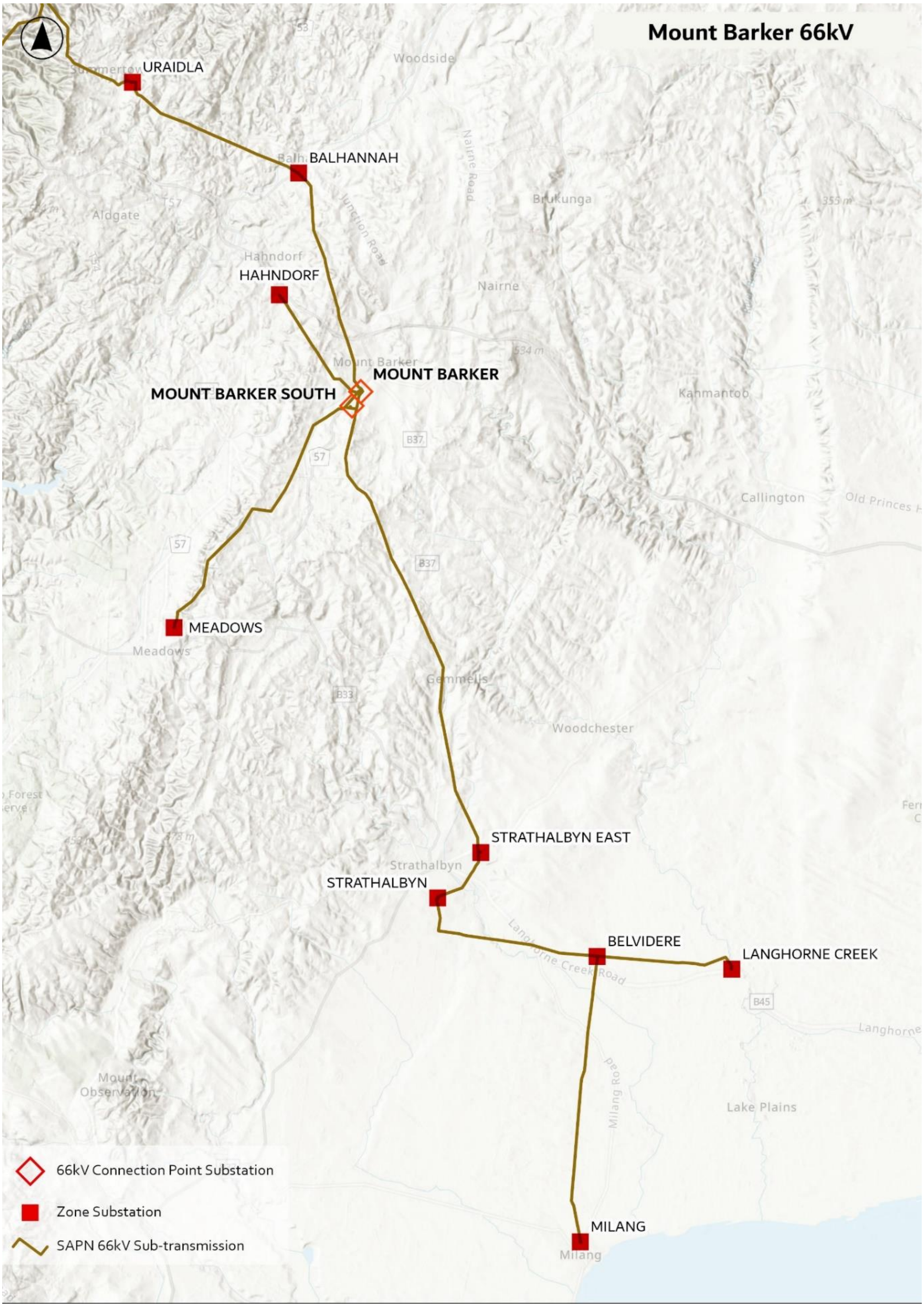

Figure 4-14: Mount Barker 66kV network map

4.5.2 Size of reactive power support

Based on latest forecasts and historical data, the Mount Barker 66kV system requires reactive power support to mitigate capacitive power flows. The required maximum size of reactive power support is estimated to be 9.1 MVAr in 2025, increasing to 13.7 MVAr in 2030, as shown in Figure 4-15.

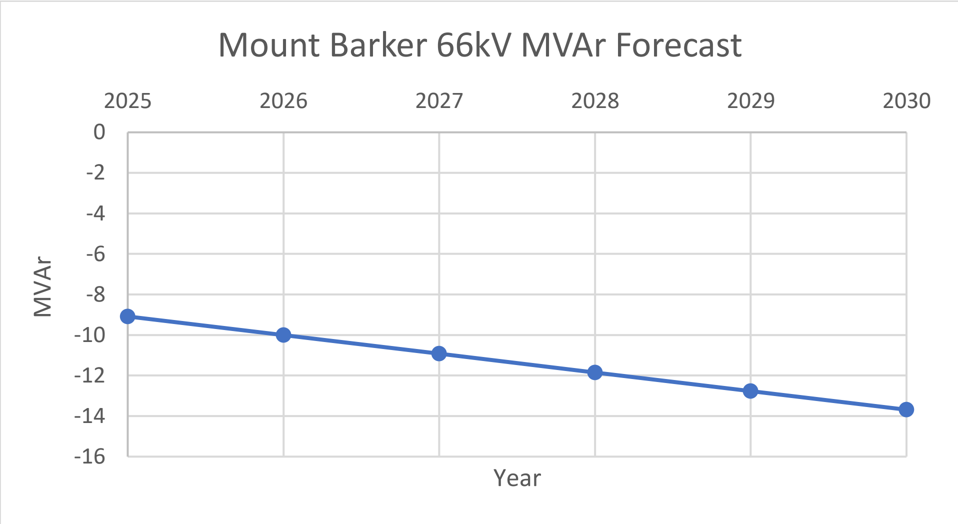

Figure 4-15: Mount Barker Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in Section 3.

4.5.3 Operating profile

A non-network solution in the Mount Barker area must be tailored to adhere to the operating profile depicted in Figure 4-16. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

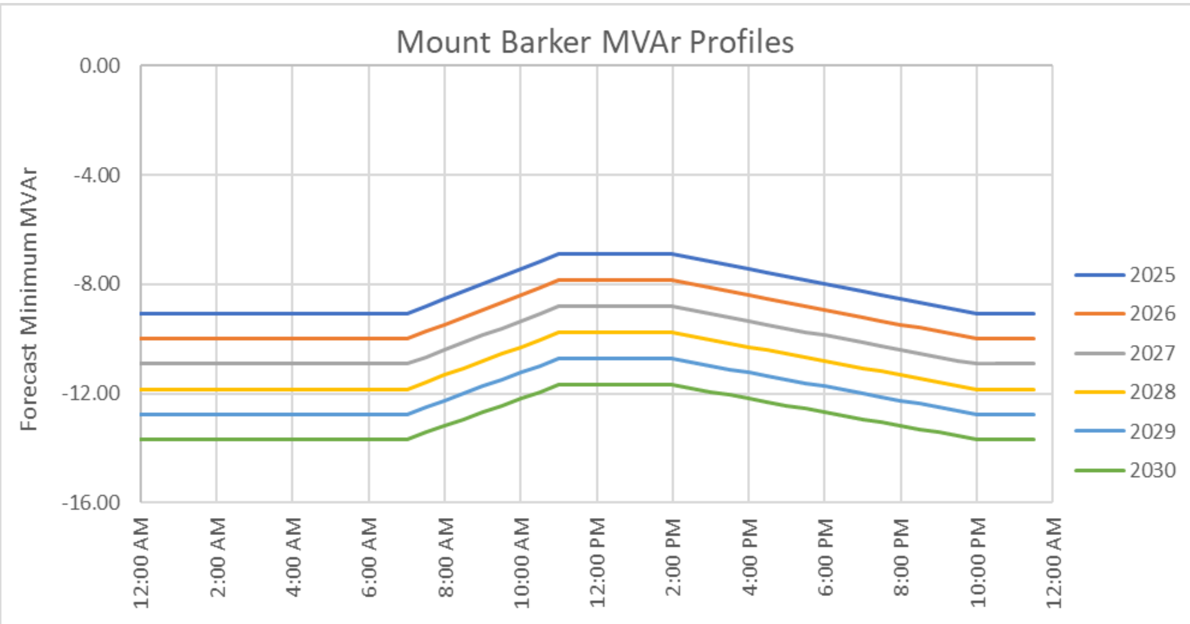

Figure 4-16: Mount Barker Forecast Minimum MVAr Profiles

While the provided daily operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.6 Riverland

4.6.1 Location

The Riverland 66kV system is a combination of the Berri/Monash and North West Bend connection points, and encompasses several key substations within the broader Riverland region, supplied via the following connection points:

- Berri SSD-399
- Monash SSD-565
- North West Bend SSD-400

See Figure 4-17 below for a map of the Riverland 66kV system (refer to the Network Visualisation Portal[12] for additional map information). The optimal location for a non-network solution may depend on the nature of the solution, however it is generally recommended that locations closest to connection point substations are more likely to be feasible.

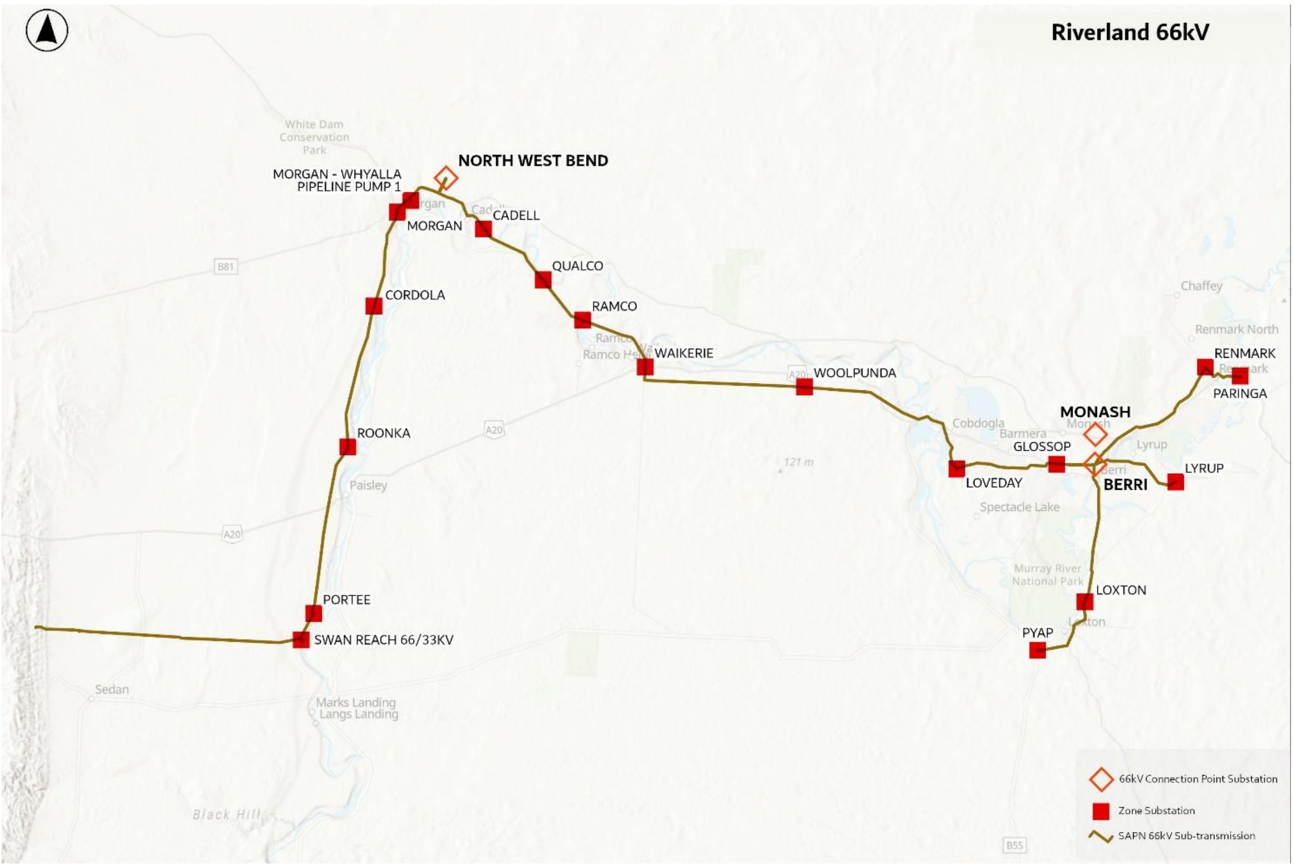

Figure 4-17: Riverland 66kV network map

12 Access the Network Visualisation Portal at: https://dapr.sapowernetworks.com.au/

4.6.2 Size of reactive power support

Based on latest forecasts and historical data, the Riverland 66kV system requires reactive power support to mitigate capacitive power flows. The required total maximum size of reactive power support is estimated to be 7.0 MVAr in 2025, increasing to 8.2 MVAr in 2030, as shown in Figure 4-18. The individual forecasts for Berri/Monash and North West Bend are also shown.

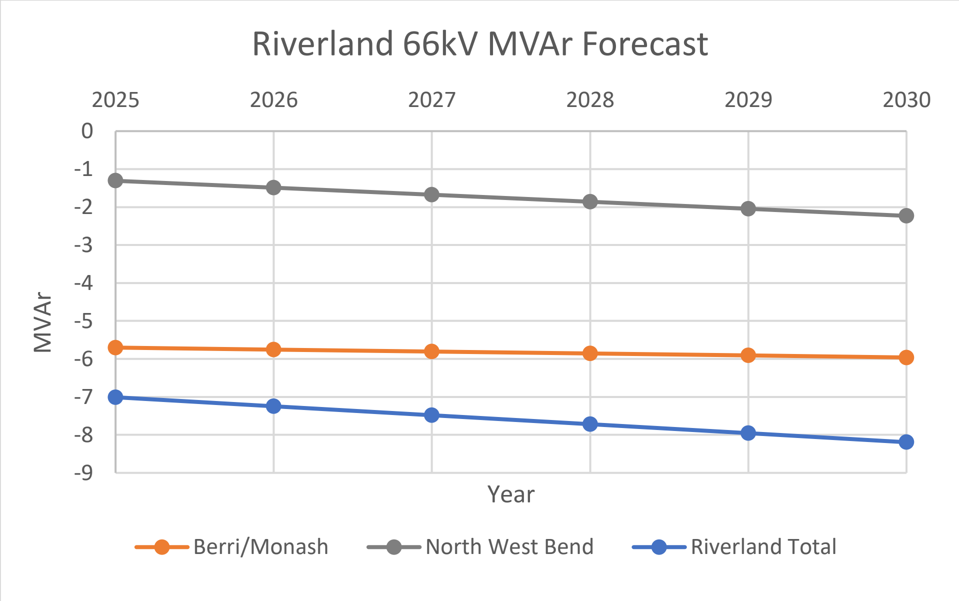

Figure 4-18: Riverland Reactive Power Minimum Forecast

Alternatively, SA Power Networks would consider non-network options that defer all or part of the network options discussed in Section 3.

4.6.3 Operating profile

A non-network solution in the Riverland area must be tailored to adhere to the operating profile depicted in Figure 4-19. This profile outlines the required reactive power support levels across one day relative to the provided support capacity.

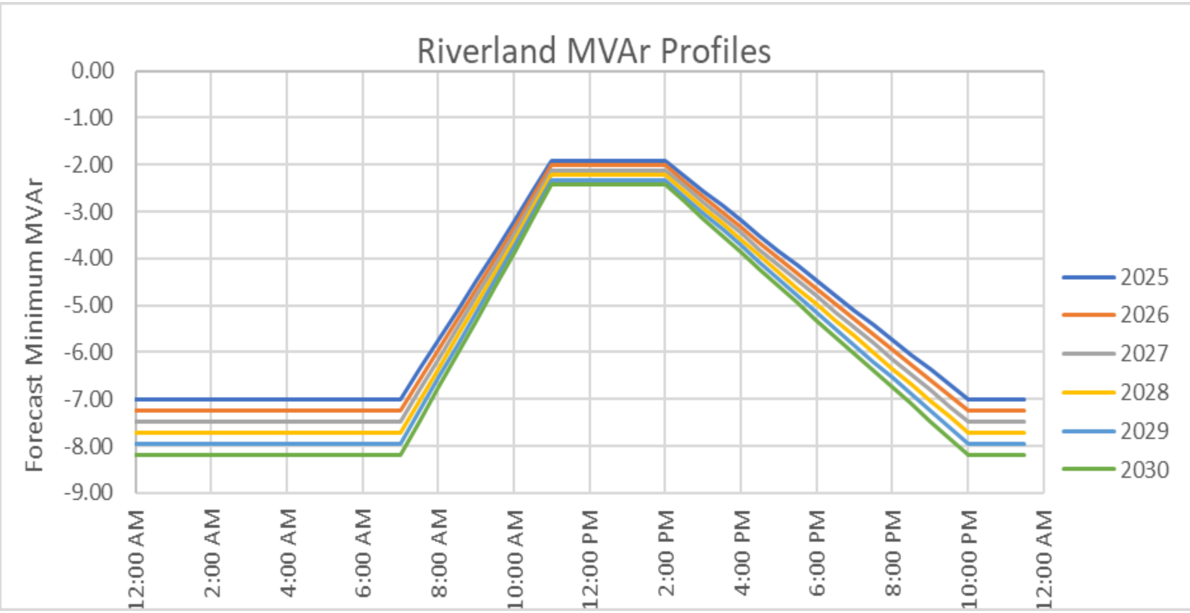

Figure 4-19: Riverland Forecast Minimum MVAr Profiles

While the provided operating profile is static, solutions with dynamic capability are welcome and encouraged to ensure optimal performance and flexibility in response to changing network conditions. Solutions may be able to provide reactive power support for only certain periods of the day but would need to defer investment of a component of the network solution to be considered a feasible option.

Note that the provided operating profile is indicative only and will be subject to further analysis as part of the non-network solution evaluation. Solutions that provide a dynamic time of day response will be evaluated by ElectraNet as part of the technical assessment to ensure operational risks are acceptable.

4.7 Contribution to power system reliability

Proposed services must be capable of reliably meeting electricity demand under a range of conditions and must meet all relevant National Electricity Rules (NER) requirements related to grid connection (if this is required as part of the solution).

SA Power Networks has obligations under the NER, its distributor's license and connection agreements to ensure supply reliability is maintained to its customers. Failure to meet these obligations may give rise to liability. Proponents of non-network options must also be willing to accept any liability that may arise from its contribution to a reliability of supply failure.

4.8 Contribution to power system fault levels

Non-network solutions are required to fully contribute to any issues in relation to increase in fault levels as part of this RIT-D. Subject to detailed studies, increase in fault level may result in upgrade works at SA Power Networks substations including earth grid, bus structure reinforcement, protection relay changes and telecommunications system changes.

4.9 Consideration of SAPS options

Recent changes to the NER, RIT-D and RIT-D application guidelines require SA Power Networks to consider whether a SAPS option can fully or partly address an identified need. In practice, this relates to consideration of whether an identified need could be fully or partly addressed by converting part of our distribution network forming part of the interconnected national electricity system to a regulated SAPS.[13] Regulated SAPS are set out in section 6B of the National Electricity Law (NEL), which defines a SAPS as a system that:[14]

- generates and distributes electricity; and
- does not form part of the interconnected national electricity system.

SA Power Networks considers that there is not a SAPS option that could form a potential credible option on a standalone basis, or that could form a significant part of the credible option, in this RIT-D.

[13] See definition of 'SAPS option' in the NER.
[14] Section 6B(6) of the NEL.

A. Checklist of compliance clauses

This section sets out the compliance checklist that demonstrates the requirements for Options Screening Reports (formerly non-network options reports) in accordance with clause 5.17.4(e) of the National Electricity Rules version 178.

Table A 1: Checklist of compliance clauses

Clause 5.17.4(e) requirement	Section of this OSR
1. Description of the identified need	2
2. Assumptions used in identifying the identified need	2.3
3. Relevant annual deferred augmentation charge associated with the identified need	3
4. The technical characteristics of the identified need that a non-network option or SAPS option would be required to deliver, such as: (i) the size of load reduction or additional supply; (ii) location; (iii) contribution to power system security or reliability; (iv) contribution to power system fault levels as determined under clause 4.6.1; and (v) the operating profile	4
5. Summary of potential credible options to address the identified need, as identified by the RIT-D proponent, including network options and non-network options	0
6. For each potential credible option, the RIT-D proponent must provide information, to the extent practicable, on: (i) a technical definition or characteristics of the option; (ii) the estimated construction timetable and commissioning date (where relevant); and (iii) the total indicative cost (including capital and operating costs)	0
7. Information to assist non-network providers wishing to present alternative potential credible options including details of how to submit a non-network proposal for consideration by the RIT-D proponent	4

B. Table of Forecast Minimum MVAr

Table B-1: Region Forecast Minimum MVAr

Connection Point	Forecast Time	Forecast MVAr					
		2025	2026	2027	2028	2029	2030
Metro East	5am	-49.16	-54.90	-60.64	-66.37	-72.11	-77.85
	1pm	-26.43	-31.34	-36.26	-41.17	-46.08	-51.00
Metro North	5am	-22.21	-25.28	-28.35	-31.41	-34.48	-37.55
	1pm	-15.36	-18.13	-20.91	-23.69	-26.47	-29.25
Metro South	5am	-52.08	-57.04	-61.99	-66.95	-71.91	-76.87
	1pm	-26.89	-30.52	-34.16	-37.79	-41.42	-45.06
Metro West	5am	-9.49	-12.63	-15.76	-18.90	-22.04	-25.17
	1pm	1.58	-1.00	-3.58	-6.17	-8.75	-11.33
Yadnarie	5am	-4.28	-4.31	-4.35	-4.39	-4.43	-4.46
	1pm	-3.93	-3.94	-3.95	-3.96	-3.98	-3.99
Wudinna	5am	-5.66	-5.73	-5.80	-5.87	-5.94	-6.01
	1pm	-5.63	-5.72	-5.81	-5.90	-5.99	-6.08
Mount Barker	5am	-9.08	-10.00	-10.92	-11.85	-12.77	-13.69
	1pm	-6.91	-7.87	-8.82	-9.78	-10.73	-11.69
North West Bend	5am	-1.31	-1.49	-1.68	-1.86	-2.05	-2.23
	1pm	0.47	0.46	0.45	0.43	0.42	0.40
Berri-Monash	5am	-5.70	-5.75	-5.80	-5.86	-5.91	-5.96
	1pm	-2.39	-2.48	-2.57	-2.66	-2.75	-2.83
66kV Network Total	5am	-158.97	-177.13	-195.30	-213.46	-231.62	-249.79
	1pm	-85.48	-100.55	-115.61	-130.68	-145.75	-160.81

C. Forecast MVAr Profile Tables

Table C-1: Metro East Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
1:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
2:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
3:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
4:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
5:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
6:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
7:00 AM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
8:00 AM	-43.5	-49.0	-54.5	-60.1	-65.6	-71.1
9:00 AM	-37.8	-43.1	-48.4	-53.8	-59.1	-64.4
10:00 AM	-32.1	-37.2	-42.4	-47.5	-52.6	-57.7
11:00 AM	-26.4	-31.3	-36.3	-41.2	-46.1	-51.0
12:00 PM	-26.4	-31.3	-36.3	-41.2	-46.1	-51.0
1:00 PM	-26.4	-31.3	-36.3	-41.2	-46.1	-51.0
2:00 PM	-26.4	-31.3	-36.3	-41.2	-46.1	-51.0
3:00 PM	-29.3	-34.3	-39.3	-44.3	-49.3	-54.4
4:00 PM	-32.1	-37.2	-42.4	-47.5	-52.6	-57.7
5:00 PM	-35.0	-40.2	-45.4	-50.6	-55.8	-61.1
6:00 PM	-37.8	-43.1	-48.4	-53.8	-59.1	-64.4
7:00 PM	-40.6	-46.1	-51.5	-56.9	-62.4	-67.8
8:00 PM	-43.5	-49.0	-54.5	-60.1	-65.6	-71.1
9:00 PM	-46.3	-52.0	-57.6	-63.2	-68.9	-74.5
10:00 PM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9
11:00 PM	-49.2	-54.9	-60.6	-66.4	-72.1	-77.9

Table C-2: Metro North Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
1:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
2:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
3:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
4:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
5:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
6:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
7:00 AM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
8:00 AM	-20.5	-23.5	-26.5	-29.5	-32.5	-35.5
9:00 AM	-18.8	-21.7	-24.6	-27.6	-30.5	-33.4
10:00 AM	-17.1	-19.9	-22.8	-25.6	-28.5	-31.3
11:00 AM	-15.4	-18.1	-20.9	-23.7	-26.5	-29.2
12:00 PM	-15.4	-18.1	-20.9	-23.7	-26.5	-29.2
1:00 PM	-15.4	-18.1	-20.9	-23.7	-26.5	-29.2
2:00 PM	-15.4	-18.1	-20.9	-23.7	-26.5	-29.2
3:00 PM	-16.2	-19.0	-21.8	-24.7	-27.5	-30.3
4:00 PM	-17.1	-19.9	-22.8	-25.6	-28.5	-31.3
5:00 PM	-17.9	-20.8	-23.7	-26.6	-29.5	-32.4
6:00 PM	-18.8	-21.7	-24.6	-27.6	-30.5	-33.4
7:00 PM	-19.6	-22.6	-25.6	-28.5	-31.5	-34.4
8:00 PM	-20.5	-23.5	-26.5	-29.5	-32.5	-35.5
9:00 PM	-21.4	-24.4	-27.4	-30.4	-33.5	-36.5
10:00 PM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5
11:00 PM	-22.2	-25.3	-28.3	-31.4	-34.5	-37.5

Table C-3: Metro South Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
1:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
2:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
3:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
4:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
5:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
6:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
7:00 AM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
8:00 AM	-45.8	-50.4	-55.0	-59.7	-64.3	-68.9
9:00 AM	-39.5	-43.8	-48.1	-52.4	-56.7	-61.0
10:00 AM	-33.2	-37.2	-41.1	-45.1	-49.0	-53.0
11:00 AM	-26.9	-30.5	-34.2	-37.8	-41.4	-45.1
12:00 PM	-26.9	-30.5	-34.2	-37.8	-41.4	-45.1
1:00 PM	-26.9	-30.5	-34.2	-37.8	-41.4	-45.1
2:00 PM	-26.9	-30.5	-34.2	-37.8	-41.4	-45.1
3:00 PM	-30.0	-33.8	-37.6	-41.4	-45.2	-49.0
4:00 PM	-33.2	-37.2	-41.1	-45.1	-49.0	-53.0
5:00 PM	-36.3	-40.5	-44.6	-48.7	-52.9	-57.0
6:00 PM	-39.5	-43.8	-48.1	-52.4	-56.7	-61.0
7:00 PM	-42.6	-47.1	-51.6	-56.0	-60.5	-64.9
8:00 PM	-45.8	-50.4	-55.0	-59.7	-64.3	-68.9
9:00 PM	-48.9	-53.7	-58.5	-63.3	-68.1	-72.9
10:00 PM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9
11:00 PM	-52.1	-57.0	-62.0	-67.0	-71.9	-76.9

Table C-4: Metro West Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
1:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
2:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
3:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
4:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
5:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
6:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
7:00 AM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
8:00 AM	-6.7	-9.7	-12.7	-15.7	-18.7	-21.7
9:00 AM	-4.0	-6.8	-9.7	-12.5	-15.4	-18.3
10:00 AM	-1.2	-3.9	-6.6	-9.4	-12.1	-14.8
11:00 AM	0.0	-1.0	-3.6	-6.2	-8.8	-11.3
12:00 PM	0.0	-1.0	-3.6	-6.2	-8.8	-11.3
1:00 PM	0.0	-1.0	-3.6	-6.2	-8.8	-11.3
2:00 PM	0.0	-1.0	-3.6	-6.2	-8.8	-11.3
3:00 PM	0.0	-2.5	-5.1	-7.8	-10.4	-13.1
4:00 PM	-1.2	-3.9	-6.6	-9.4	-12.1	-14.8
5:00 PM	-2.6	-5.4	-8.2	-10.9	-13.7	-16.5
6:00 PM	-4.0	-6.8	-9.7	-12.5	-15.4	-18.3
7:00 PM	-5.3	-8.3	-11.2	-14.1	-17.1	-20.0
8:00 PM	-6.7	-9.7	-12.7	-15.7	-18.7	-21.7
9:00 PM	-8.1	-11.2	-14.2	-17.3	-20.4	-23.4
10:00 PM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2
11:00 PM	-9.5	-12.6	-15.8	-18.9	-22.0	-25.2

Table C-5: Mount Barker Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
1:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
2:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
3:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
4:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
5:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
6:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
7:00 AM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
8:00 AM	-8.5	-9.5	-10.4	-11.3	-12.3	-13.2
9:00 AM	-8.0	-8.9	-9.9	-10.8	-11.7	-12.7
10:00 AM	-7.5	-8.4	-9.3	-10.3	-11.2	-12.2
11:00 AM	-6.9	-7.9	-8.8	-9.8	-10.7	-11.7
12:00 PM	-6.9	-7.9	-8.8	-9.8	-10.7	-11.7
1:00 PM	-6.9	-7.9	-8.8	-9.8	-10.7	-11.7
2:00 PM	-6.9	-7.9	-8.8	-9.8	-10.7	-11.7
3:00 PM	-7.2	-8.1	-9.1	-10.0	-11.0	-11.9
4:00 PM	-7.5	-8.4	-9.3	-10.3	-11.2	-12.2
5:00 PM	-7.7	-8.7	-9.6	-10.6	-11.5	-12.4
6:00 PM	-8.0	-8.9	-9.9	-10.8	-11.7	-12.7
7:00 PM	-8.3	-9.2	-10.1	-11.1	-12.0	-12.9
8:00 PM	-8.5	-9.5	-10.4	-11.3	-12.3	-13.2
9:00 PM	-8.8	-9.7	-10.7	-11.6	-12.5	-13.4
10:00 PM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7
11:00 PM	-9.1	-10.0	-10.9	-11.8	-12.8	-13.7

Table C-6: Riverland Forecast MVAr Profiles

	2025	2026	2027	2028	2029	2030
12:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
1:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
2:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
3:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
4:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
5:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
6:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
7:00 AM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
8:00 AM	-5.7	-5.9	-6.1	-6.3	-6.5	-6.8
9:00 AM	-4.5	-4.6	-4.8	-5.0	-5.1	-5.3
10:00 AM	-3.2	-3.3	-3.5	-3.6	-3.7	-3.9
11:00 AM	-1.9	-2.0	-2.1	-2.2	-2.3	-2.4
12:00 PM	-1.9	-2.0	-2.1	-2.2	-2.3	-2.4
1:00 PM	-1.9	-2.0	-2.1	-2.2	-2.3	-2.4
2:00 PM	-1.9	-2.0	-2.1	-2.2	-2.3	-2.4
3:00 PM	-2.6	-2.7	-2.8	-2.9	-3.0	-3.1
4:00 PM	-3.2	-3.3	-3.5	-3.6	-3.7	-3.9
5:00 PM	-3.8	-4.0	-4.1	-4.3	-4.4	-4.6
6:00 PM	-4.5	-4.6	-4.8	-5.0	-5.1	-5.3
7:00 PM	-5.1	-5.3	-5.5	-5.7	-5.8	-6.0
8:00 PM	-5.7	-5.9	-6.1	-6.3	-6.5	-6.8
9:00 PM	-6.4	-6.6	-6.8	-7.0	-7.3	-7.5
10:00 PM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2
11:00 PM	-7.0	-7.2	-7.5	-7.7	-8.0	-8.2