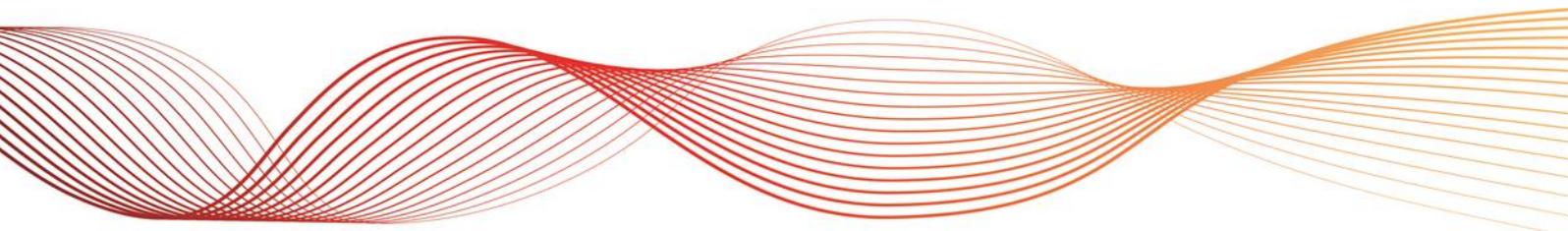


INDEPENDENT PLANNING REVIEW – ELECTRANET CAPITAL EXPENDITURE PROJECTS

SOUTH AUSTRALIAN ADVISORY FUNCTIONS

March 2017





IMPORTANT NOTICE

Purpose

This document reviews ElectraNet's capital expenditure project proposals for the regulatory period 2018–19 to 2022–23.

The Australian Energy Market Operator Limited (AEMO) publishes this document as part of its South Australian advisory functions in accordance with section 50B of the National Electricity Law.

This publication is based on information available to AEMO as at 1 February 2017, unless otherwise specified.

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Acknowledgement

AEMO acknowledges the co-operation and contribution of ElectraNet in providing data and information used in this publication.

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EXECUTIVE SUMMARY

This planning review provides an independent technical assessment of emerging transmission network investment requirements in South Australia over ElectraNet's regulatory period 2018–19 to 2022–23.

AEMO conducted this independent review of ElectraNet's network capital expenditure (capex) projects under its South Australian advisory functions at the request of the South Australian Government.

AEMO's review was completed in two stages.

- In September 2016, AEMO published an independent review of ElectraNet's preliminary proposals provided for AEMO's review between May and June 2016.¹
- This report provides the consolidated findings of AEMO's independent review of all ElectraNet's network capex projects provided to AEMO as at 1 February 2017. This report supercedes the report published in September 2016.

AEMO expects that the Australian Energy Regulator (AER) will use the information supplied in this report to inform their assessment of ElectraNet's revenue proposal for the regulatory period 2018–19 to 2022–23.

Key insights

The driver for investment in South Australia's transmission network has shifted from meeting peak demand, to enabling a secure and reliable transformation to a low carbon future.

Investments in South Australia's transmission network are required in the next regulatory period to:

- Provide reactive power support to manage high voltages as minimum demand declines.
- Replace and restore ageing assets.
- Install additional circuit breakers to provide switching flexibility as supply becomes increasingly intermittent, so that critical generation can be dispatched during network outages.
- Upgrade the network, under specific scenarios, to enable industrial load growth and ensure power system security.

Table 1 outlines the 12 ex-ante capex project proposals assessed by AEMO.² Seven of these projects relate to security and compliance, four to asset replacement, and one to connection. AEMO's review found that:

- Based on assessment of power system security and economic benefits, six of the seven security and compliance projects proposed by ElectraNet and assessed by AEMO are appropriate for inclusion in ElectraNet's capex proposal. The remaining one of the seven projects is not economically justified.
- All four asset replacement projects³ proposed by ElectraNet are considered appropriate within the scope of this review.
- A connection project proposed by ElectraNet to address an emerging limitation in SA Power Networks' distribution network is considered to be appropriate.

AEMO considers that the investment identified in this review is adequate to address load-driven limitations, and to meet the current requirements of the South Australian Electricity Transmission Code (ETC) and the National Electricity Rules (NER).

¹ AEMO. *Independent Planning Review – ElectraNet Preliminary Capital Expenditure Projects*, September 2016. Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2016/Independent-Planning-Review-ElectraNet-Preliminary-Capital-Expenditure-Projects.pdf.

² ElectraNet initially proposed 15 projects—after discussion with AEMO, two were withdrawn and one was identified as being out of scope.

³ AEMO did not assess asset condition, but rather assessed the ongoing need for assets based on ElectraNet's assessment of asset condition.

ElectraNet is currently undertaking a Regulatory Investment Test for Transmission (RIT-T) exploring efficient options to enable South Australia’s energy transformation and improve power system resilience.⁴ The conclusions outlined in this document are subject to change if the South Australian Energy Transformation RIT-T delivers outcomes that overlap with ElectraNet’s capex proposal.

Review of ex-ante capex proposals

AEMO’s review of ElectraNet’s proposed projects assessed the following considerations:

- The need for each proposed project to meet the reliability requirements set out in the South Australian ETC.
- Economic justification for individual projects, where the proposed expenditure is driven by increasing market benefit.⁵
- Whether the South Australian transmission network is expected to meet the requirements set out in the ETC for the 2018–19 to 2022–23 regulatory period.

For asset replacement projects where ElectraNet identified that the assets are in poor condition or approaching the end of their asset service life, AEMO did not assess the condition of ElectraNet’s assets or their retirement decisions. Instead, AEMO assessed whether there would be an ETC breach assuming the poor condition assets were retired in the next regulatory period, and whether the reinvestment option recommended by ElectraNet is economical compared to alternative options. The AER may decide that the condition of the existing assets and subsequent risks posed do not warrant retirement and that investment to replace the assets is not efficient.

Following feedback from AEMO, ElectraNet withdrew two of the 15 projects initially proposed. One further project was beyond the scope of AEMO’s review.⁶ AEMO’s assessment of the remaining 12 projects is summarised in the following table.

Table 1 Summary of ex-ante capex projects assessed in this report

Investment driver	Projects assessed	AEMO’s assessment
Connection	1	The Gawler East project is driven by distribution network limitations arising from demand growth. AEMO considers there is a need for this proposed project if SA Power Networks’ demand forecast eventuates. Note that the Gawler East area is located within a large distribution network. AEMO’s connection point demand forecast does not capture growth in this particular area.
Asset replacement	4	These projects are driven by the need to address ETC compliance requirements and the poor condition assets identified by ElectraNet. AEMO agrees with this need, and considers that ElectraNet’s proposal is reasonable.
Security and compliance	7	AEMO considers six out of the seven projects proposed by ElectraNet are reasonably required to facilitate the secure, reliable, and efficient operation of the power system. AEMO considers that the remaining project cannot be economically justified.

Review of contingent projects

AEMO’s review of contingent projects was different to the review of the ex-ante capex projects, because contingent projects are subject to further justification after revenue determination.

ElectraNet proposed five contingent projects. Two of these projects address power system security and reliability, and deliver net market benefits, while the other three projects are to augment the transmission network to meet load growth.

AEMO supports ElectraNet’s contingent project proposals, and considers them prudent in managing future uncertainty.

⁴ ElectraNet. South Australian Energy Transformation. Available at: <https://www.electranet.com.au/projects/south-australian-energy-transformation/>.

⁵ Using project cost information provided by ElectraNet.

⁶ ElectraNet and AEMO agreed that a monitoring and protection scheme (\$786,000) relating to transformer neutral earthing was not within the scope of this review because it does not relate to the capacity of the transmission network and because insufficient information is available.



This support means AEMO is satisfied that:

- For non-load-driven contingent projects, preliminary high level modelling showed that positive net market benefits are likely.
- For load-driven projects, there are public development announcements in the region where ElectraNet's contingent proposals are targeted for network augmentations. If the quantum of step changes in load specified by ElectraNet materialises, the proposed contingent projects (or their more economical alternative options, serving the same purpose) are expected to be required.

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1. BACKGROUND

At the request of the South Australian Government, AEMO conducted a review of ElectraNet's proposed capital expenditure projects for the period 2018–19 to 2022–23.

This review was undertaken in two stages:

- The first stage was to assess ElectraNet's preliminary capex projects provided for AEMO's review between May and June 2016.
 - In September 2016, AEMO published the findings of AEMO's review of the project proposals provided to AEMO between May and June 2016 (the first stage review).⁷
- The second stage was to review ElectraNet's formal capex projects prior to its submission to the Australian Energy Regulator (AER).
 - ElectraNet provided further project proposal information for AEMO's review between September 2016 and 1 Feb 2017. This report provides consolidated findings of AEMO's review of all the project proposal information provided to AEMO as at 1 February 2017, and supersedes the September 2016 report.

AEMO has worked closely with ElectraNet during this review. The assessment process involved an independent review of information provided by ElectraNet (see Appendix B for process and methodology). This information included individual project proposals, load flow models, and economic assessments. Assessing project costs was not within the scope of this review.

ElectraNet is currently undertaking a Regulatory Investment Test for Transmission (RIT-T) exploring efficient options to facilitate South Australia's energy transformation.⁸ The conclusions outlined in this document may be subject to change, depending on the outcome of the RIT-T.

1.1 The scope of this review

AEMO's assessment consisted of an independent review of the ongoing power system need for ElectraNet's proposed ex-ante and contingent capex projects.

1.1.1 Ex-ante capex projects

The assessment for ex-ante capex projects focused on the following:

- Projects proposed to ensure the South Australian transmission network's compliance with the South Australian Electricity Transmission Code (ETC).
- Economic justification for projects proposed to deliver increased market benefits.⁹

In this review, AEMO assessed ElectraNet's proposal by considering, for each proposal:

- Whether, from the perspectives of meeting the ETC supply reliability requirements or delivering increased market benefit, the need exists.
- Whether the option ElectraNet has proposed is economically efficient, based on project cost information provided by ElectraNet and AEMO's assessment of the ongoing power system need.¹⁰
- Where relevant, whether the project timing is appropriate.¹¹

⁷ AEMO. *Independent Planning Review – ElectraNet Preliminary Capital Expenditure Projects*, September 2016. Available at: http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2016/Independent-Planning-Review-ElectraNet-Preliminary-Capital-Expenditure-Projects.pdf.

⁸ ElectraNet. *South Australian Energy Transformation*. Available at: <https://www.electranet.com.au/projects/south-australian-energy-transformation/>.

⁹ AEMO's economic assessment involves use of project cost information provided by ElectraNet and AEMO's own assessment of the project work scopes.

¹⁰ AEMO's review of ElectraNet's economic assessment focused on the relative merit of the options (for purpose of option ranking within the scope of this review), rather than the exact quantum of the net project benefit. Based on ElectraNet's advice, poor condition assets at Mount Barker, Mount Gambier, Mannum, and Leigh Creek South and Leigh Creek Coalfield need to be addressed in the next regulatory period to meet ETC requirements. The 'do nothing' option (not addressing poor asset condition) was not considered in this review.

¹¹ In this review, the relevant projects are a new connection point at Gawler East and the installation of 50 MVAR reactors.

AEMO has based its review on information provided by ElectraNet. Although AEMO discussed alternative investment options with ElectraNet throughout the review process, AEMO has not independently developed its own strategy to meet the ETC requirements and deliver increased market benefits. In particular, AEMO has not assessed the condition of ElectraNet's assets or ElectraNet's decision that poor asset condition needs to be addressed in the regulatory period 2018–19 to 2022–23.

The review of the ex-ante capex projects in ElectraNet's proposal included the following network investment categories:

- Connection.
- Asset replacement.
- Security and compliance.

1.1.2 Contingent capex projects

ElectraNet's contingent proposals include both load-driven and non-load-driven contingent projects. AEMO's assessment of ElectraNet's contingent proposals focused on the following:

- For non-load-driven contingent projects, the potential market benefit of the proposed projects.
- For load-driven projects, the likelihood of step load growth in the next regulatory period.

1.1.3 Exclusions

AEMO's independent review of ElectraNet's ex-ante capex projects was limited to the network capex categories listed above, and did not assess:

- Operational expenditure.
- Cost estimates for proposed network investment.
- The condition of existing assets or the driver for their retirement or replacement.
- Secondary plant such as instrumentation and protection.
- Any other aspects of the revenue proposal not associated with network projects or asset-condition driven replacement projects that were not provided to AEMO for review.

AEMO's assessment used its independent forecasts in the *2016 Connection Point Forecasting Report for South Australia*¹², except for the assessment of the proposed Gawler East connection point proposal. The Gawler East limitation is located within the distribution network. AEMO's connection point demand forecast does not capture the demand growth driving the particular distribution network limitation, therefore the forecast provided by ElectraNet (originated from SA Power Networks) was used in assessing this project.

General assumptions are provided in Appendix A, and AEMO's review methodology is outlined in Appendix B.

¹² Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting>.

2. FINDINGS OF AEMO'S REVIEW

ElectraNet originally provided 15 ex-ante capex projects for AEMO's review:

- Two projects were withdrawn following initial discussions.
- ElectraNet and AEMO agreed that one project was beyond the scope of AEMO's review.¹³

For a detailed summary of the 12 projects addressed in this report, as well as a list of the three projects that were withdrawn, or considered beyond scope of this review, see Appendix C.

For a detailed summary of the five contingent projects, see Appendix G.

2.1 Connection assets

ElectraNet has proposed one load-driven connection project (Gawler East) in its capex project proposal.

Gawler East connection point

ElectraNet's capex proposal includes the establishment of a 132 kilovolt (kV) connection point at Gawler East (about 40 kilometres north of Adelaide), which it estimates to cost around \$4.5 million. ElectraNet and SA Power Networks propose to establish this transmission connection point before summer 2022 to address a forecast distribution network limitation.

AEMO considers ElectraNet's proposal to be reasonable, based on the advice provided by ElectraNet and SA Power Networks, that:

- Distribution network limitations are expected to arise by 2022–23 and increase thereafter.
- Establishing a new 132/11 kV connection point at Gawler East is the preferred option based on preliminary findings in SA Power Networks' upcoming Regulatory Investment Test for Distribution (RIT-D).

Because the Gawler East limitation is located within the distribution network, AEMO's connection point forecasts do not capture the demand growth driving this limitation.

AEMO was able to consider:

- The rapid technological changes that the electricity industry is predicted to be facing over the next five to ten years.
- Recent changes to SA Power Networks' demand forecast for the Evanston 66/33 kV substation and the proposed timing of the Gawler East 132/11 kV substation establishment (as reflected in SA Power Networks' 2016 Distribution Annual Planning Report¹⁴), which serve to highlight the difficulty in forecasting in this environment.
- The year that the distribution network limitations are expected to arise, 2022–23, is the last year of ElectraNet's regulatory period and is outside SA Power Networks' current five-year planning horizon.

Based on this assessment, AEMO considers the forecast demand growth at Gawler East is uncertain. It follows that consideration should also be given to non-network options to defer the development of the Gawler East connection point, prior to committing to a network investment, to mitigate the risk of the new Gawler East substation becoming a stranded asset. The most economical solution should be confirmed through the RIT-D analysis, which means that the cost impact on ElectraNet is uncertain.

Further details relating to AEMO's review of this project are presented in Appendix D.

¹³ ElectraNet and AEMO agreed that a monitoring and protection scheme (\$786,000) relating to transformer neutral earthing was not within the scope of this review because it does not relate to the capacity of the transmission network and because insufficient information is available.

¹⁴ SA Power Networks. *Distribution Annual Planning Report 2016/17 to 2020/21*. Available at: <http://www.sapowernetworks.com.au/public/download.jsp?id=28109>

2.2 Asset replacement

ElectraNet proposed the following four asset replacement projects:

- Mount Barker substation refurbishment.
- Mount Gambier 132/33 kV transformer No. 1 (50 megavolt amperes (MVA)) replacement.
- Leigh Creek South 132/33 kV transformer replacement.
- Mannum 132/33 kV transformer 1 and 2 replacement.

The outcomes of AEMO's independent review are summarised below. Further details relating to the projects are provided in Appendix E.

It is important to note that:

- AEMO did not assess asset condition. Based on ElectraNet's advice, AEMO assumed that the poor condition assets at Mount Barker, Mount Gambier, Leigh Creek South, and Mannum need to be retired or replaced in the next regulatory period. The AER may decide that the condition of the existing assets and subsequent risks posed do not warrant retirement and that investment to replace the assets is not efficient.
- AEMO assessed whether there would be an ETC breach if the poor condition assets were retired. Where retiring the poor condition assets without reinvestment would result in an ETC breach, AEMO assessed which reinvestment option is most economical based on project cost estimates provided by ElectraNet.
- AEMO did not assess the potential option to defer the reinvestment beyond the next regulatory period based on asset condition.

Mount Barker substation refurbishment

The Mount Barker and Mount Barker South connection points are currently supplied by two 60 MVA 132/66 kV transformers at Mount Barker, and one 225 MVA 275/66 kV transformer at Mount Barker South. ElectraNet identified that some assets in the existing Mount Barker 132 kV substation are in poor condition and require replacement to ensure supply reliability to meet the ETC requirements in the 2018–19 to 2022–23 regulatory period.

Mount Barker and Mount Barker South are Category 4 connection points under the ETC. Under Category 4 connection reliability requirements, Mount Barker and Mount Barker South must have N-1¹⁵ equivalent transmission line and transformer capacity to meet 100% of agreed maximum demand. Retiring poor condition assets at Mount Barker without replacement would lead to non-compliance with ETC requirements.

ElectraNet considered multiple reinvestment options to address the emerging need to manage poor condition assets at Mount Barker.¹⁶ Based on economic analysis carried out to rank the economic efficiency of these options, ElectraNet proposes refurbishing the poor condition assets at Mount Barker substation.

Based on ElectraNet's advice that the existing assets need to be replaced in the next regulatory period, the need to meet the ETC reliability requirement, and the economic efficiency of different reinvestment options, AEMO considers ElectraNet's proposal to be appropriate.

Mount Gambier 132/33 kV transformer No. 1 (50 MVA) replacement

The existing Mount Gambier substation is supplied by two 132/33 kV transformers (one 25 MVA transformer and one 50 MVA transformer). ElectraNet identified that the existing 50 MVA transformer is

¹⁵ N-1 means the transmission system would be able to continue to supply the contracted amount of agreed maximum demand connected to the transmission system without interruption should any one element fail.

¹⁶ Based on ElectraNet's advice, poor condition assets at Mount Barker 132 kV substation need to be retired or replaced in the next regulatory period to meet ETC requirements. The 'do nothing' option is therefore not applicable as it could not meet ETC requirements.

in poor condition and requires replacement in the regulatory period 2018–19 to 2022–23 to ensure the safe and reliable operation of the network.

Mount Gambier is a Category 4 connection point under the ETC. Under Category 4 connection reliability requirements, Mount Gambier must have N-1 equivalent transmission line and transformer capacity to meet 100% of agreed maximum demand. Retiring the 50 MVA transformer without replacement would lead to non-compliance with the ETC.

ElectraNet considered multiple reinvestment options to ensure supply reliability at Mount Gambier. Based on analysis carried out to rank the efficiency of different reinvestment options, ElectraNet propose replacing the existing 50 MVA transformer with a 25 MVA transformer.

The 33 kV distribution systems supplied from Mount Gambier and Blanche are adjacent to each other and separated electrically with a normally open point. There is also a normally open 33 kV distribution link between the Mount Gambier distribution system and the Penola West distribution system. Three of the four options that ElectraNet assessed in detail involve strengthening the 33 kV distribution network for the retirement of Mount Gambier substation assets.

AEMO assessed the distribution network augmentation requirements, and agrees with ElectraNet's findings that options to strengthen the 33 kV distribution network are expected to be much more costly than the transformer replacement option.

AEMO considers ElectraNet's proposal to replace the existing 50 MVA transformer at Mount Gambier with a 25 MVA transformer to be reasonable on this basis.

Leigh Creek South transformer replacement

The Leigh Creek South substation supplies the Leigh Creek township and the surrounding areas. Electricity demand in the town is strongly influenced by the coal mining operation north of the town. Leigh Creek Coalfield substation supplied electricity to the Alinta Energy owned Leigh Creek coal mine when it was in operation. Alinta closed the mine in November 2015 and ceased operation of Northern Power Station in May 2016.

ElectraNet identified that the transformers at both Leigh Creek South and Leigh Creek Coalfield substations are in poor condition, and the poor asset condition needs to be addressed in the next regulatory period to ensure the safe and reliable operation of the network.

ElectraNet has explored various options including establishment of a micro-grid (comprising small wind generation, solar generation, diesel generation, and battery storage) to address the potential transformer failure risks. ElectraNet also carried out detailed economic assessment under a scenario where Alinta will not require electricity supply from the Leigh Creek Coalfield substation.

Based on the economic assessment, ElectraNet recommended installing one 5 MVA transformer at Leigh Creek South substation to replace the existing two 5 MVA 132/33 kV transformers in the next regulatory period. As an interim solution to address the poor asset condition concerns, ElectraNet plans to use the next outage opportunity to reconfigure the supply at Leigh Creek South to one transformer supplying load with another on hot standby, by opening an 11 kV switch which is normally closed. This allows the standby transformer to be switched into service in the event of a transformer failure, thus reducing the risks of supply interruption at Leigh Creek South.

ElectraNet's proposal considers asset condition, demand forecasts, reinvestment efficiencies, and the uncertainty of supply requirement at Leigh Creek South and Leigh Creek Coalfield.

AEMO agrees with ElectraNet that an ongoing need exists for providing supply at Leigh Creek South.

AEMO, however, considers that the demand at Leigh Creek South is uncertain on the following basis:

- The demand supplied by Leigh Creek South substation is strongly influenced by the mining operation. Alinta closed the Leigh Creek Coal mine in November 2015 before it ceased the operation of the Northern Power Station in May 2016.

- ElectraNet advised that, based on SA Power Networks' November 2016 forecast (currently not publicly available), the demand at Leigh Creek South would settle at around 0.9 MW in the next five-year period, which is about 0.5 MW to 0.6 MW higher than the forecast reported in AEMO's 2016 *Connection Point Forecasting Report for South Australia*, published in July 2016.

It follows that consideration should be given to defer the replacement (if the condition of the asset permits), to mitigate the risk of the new transformer becoming a stranded asset. AEMO further suggests that replacing the existing transformers with a smaller transformer (rather than 5 MVA) and non-network options should also be considered prior to committing to an investment.

Mannum Transformer 1 and 2 Replacement

The existing Mannum substation is supplied by two 132/33 kV 20 MVA transformers. ElectraNet identified that the existing transformers are in poor condition, and the poor condition needs to be addressed in the next regulatory period to ensure the safe and reliable operation of the network.

Mannum is a Category 4 connection point under the ETC. Under Category 4 connection reliability requirements, Mannum must have N-1 equivalent transmission line and transformer capacity to meet 100% of agreed maximum demand.

ElectraNet considered different reinvestment options to ensure supply reliability at Mannum. Based on economic assessment carried out to rank the economic efficiency of different reinvestment options, ElectraNet proposes replacing the existing two 20 MVA transformers with two 25 MVA transformers (25 MVA is ElectraNet's standard transformer size) in the next regulatory period.

On the premise that the poor condition of the existing transformers at Mannum needs to be addressed in the next regulatory period to meet the ETC reliability requirement, and based on the economic efficiency of credible investment options, AEMO considers ElectraNet's proposal to be reasonable.

2.3 Security and compliance

ElectraNet initially proposed 10 security and compliance projects. Following initial discussions with AEMO, ElectraNet withdrew two projects that could not be economically justified. Another project¹⁷ is considered beyond the scope of AEMO's review. AEMO has assessed the seven remaining projects.

The outcomes of AEMO's independent review are summarised below, and further details relating to the projects are provided in Appendix F. Details on the methodology of AEMO's assessment are provided in Appendix B. Key inputs and assumptions can be found in Appendix A.

Robertstown circuit breaker arrangement upgrade

Maintenance of 275 kV circuit breakers and switchgear at Robertstown is operationally difficult to schedule under the existing 275 kV configuration, because Murraylink interconnector flow and generation north of Robertstown¹⁸ may be constrained during maintenance. Scheduling maintenance on 275 kV circuit breakers at Robertstown is expected to become more challenging following the connection of more renewable generation in northern South Australia. The addition of a circuit breaker at the Robertstown substation (see Figure 13) will address this issue.

AEMO carried out a high level economic assessment, which shows potential positive net market benefits for this project. Compared to the high level economic assessment carried out during AEMO's

¹⁷ ElectraNet and AEMO agreed that a monitoring and protection scheme (\$786,000) relating to transformer neutral earthing was not within the scope of this review because it does not relate to the capacity of the transmission network and because insufficient information is available.

¹⁸ Including North Brown Hill Wind Farm (Hallett 4), The Bluff Wind Farm (Hallett 5), Brown Hill Wind Farm (Hallett Stage 1), Hallett Hill Wind Farm (Hallett Stage 2), Hallett GT, Hornsdale Wind Farms (Stage 1, Stage 2, and Stage 3), and any future wind farms connected to transmission lines between Davenport and Robertstown.

preliminary review¹⁹, this assessment captured additional market benefits not previously considered (that is, cost of labour, and cost of safety-related and security-related works – see Appendix F.1).

AEMO now considers ElectraNet's proposal to be reasonable.

Blanche circuit breaker arrangement upgrade

Planned outages at the Blanche 132 kV substation are operationally difficult to schedule, as they might constrain generation connected at Snuggery²⁰, and expose customers to a risk of supply interruption. ElectraNet proposes to install an additional 132 kV circuit breaker to create a meshed substation configuration that allows independent switching of transformers and lines terminated at the Blanche 132 kV substation.

AEMO carried out an economic benefit assessment of this project and did not find it to be economically justified.

Kilburn 275 kV emergency bypass

During the planned and unplanned outages of Kilburn 275 kV gas-insulated switchgear (GIS), the Northfield 275 kV bus would be supplied radially from Torrens Island Power Station 'A' switchyard (TIPS 'A'), and a single fault on the Northfield – TIPS 'A' 275 kV line would result in the concurrent loss of three 225 MVA 275/66 kV transformers at the Northfield 275 kV substation.

ElectraNet proposes installing an emergency bypass to bypass Kilburn substation as necessary. This will mitigate the reliability and security risk of supply to the Eastern Suburbs including Adelaide CBD.

AEMO considers ElectraNet's proposal to be reasonable.

Canowie circuit breaker arrangement upgrade

A planned or unplanned outage of the Canowie – Robertstown 275 kV line and relevant plant, including switchgear, would result in the disconnection of the Hallett gas power station (installed capacity 228 MW) and Hallett wind farm (installed capacity 95 MW).

Adding a circuit breaker at Canowie would allow the independent switching of Hallett generators (both the gas turbine generators and the wind farm) and the Canowie – Robertstown 275 kV line. This would reduce the potential downtime of Hallett gas turbine (GT) and Hallett wind farm.

AEMO carried out high level economic assessment, which shows potential positive net market benefit of this project. The potential market benefits are primarily expected from the increased availability of Hallett GT to respond to high market price in South Australia.

AEMO considers ElectraNet's proposal to be reasonable.

Installation of reactors at Templers West, Blyth West, and Para 275 kV substations

ElectraNet's capex project proposal included the following three projects for managing potential high voltage issues:

- Installation of a 50 megavolt amperes reactive (MVar) reactor at Templers West (2018).
- Installation of a 50 MVar reactor at Blyth West (2021).
- Installation of a 50 MVar reactor at Para (2023).

AEMO's 2016 *National Electricity Forecasting Report* (NEFR)²¹ forecasts that minimum operational demand in South Australia will decline to about 200 megawatts (MW) by June 2023. AEMO's

¹⁹ AEMO. *Independent Planning Review – ElectraNet Preliminary Capital Expenditure Projects*, September 2016. Available at: http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2016/Independent-Planning-Review-ElectraNet-Preliminary-Capital-Expenditure-Projects.pdf.

²⁰ Including Snuggery GT, Lake Bonney wind farms, and Canunda wind farm.

²¹ Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report>.

assessment found that about 150 MVAR²² of additional inductive reactive power support needs to be provided in the 2018–19 to 2022–23 regulatory period to manage the potential over voltages.

AEMO considers ElectraNet's proposals to be reasonable. Because these projects are inter-related and address a single emerging need, however, the AER might consider it appropriate for these projects to be combined. This project combination would exceed the current RIT-T cost threshold. The RIT-T process would ensure that the impacts of other projects are optimised, and that a robust solution is delivered.

2.4 Contingent projects

ElectraNet proposes the following five contingent projects:

- Eyre Peninsula transmission supply reinforcement.
- South Australia Energy Transformation.
- Yorke Peninsula reinforcement.
- Upper Northern Region Western 132 kV line reinforcement.
- Upper Northern Region Eastern 132 kV line reinforcement.

The first two projects are for addressing power system security and reliability issues, as well as delivering net market benefits (non-load-driven). The remaining three projects are for reinforcing the relevant parts of the transmission network under specific step load growth scenarios (load-driven).

AEMO supports ElectraNet's contingent project proposals, and considers them prudent in managing future uncertainty. AEMO's support is based on an independent assessment, which confirmed:

- For non-load-driven contingent projects, preliminary high level modelling showed that positive net market benefits are likely.
- For load-driven projects, there are public announcements in the region where ElectraNet's contingent proposals are targeted for network augmentation. If the quantum of step changes in load growth specified by ElectraNet materialises, the proposed contingent projects (or their more economical alternative options, serving the same purpose) are expected to be required.

AEMO's review of contingent projects was different to the review of the ex-ante capex projects, with the ex-ante projects required to be assessed more rigorously, due to a revenue allowance being made at this stage. Contingent projects are subject to further justification.

For a complete list of these contingent projects and AEMO's assessment comments, see Appendix G.

²² ElectraNet's preliminary capex project proposal only included installation of one 50 MVAR reactor. Additional reactive power support requirement has been identified because ElectraNet has decided to cancel the RIT-T for Northern South Australia dynamic voltage control and considers that switching off Magill – East Terrace cable for voltage control should not be included as a planning solution to manage voltage levels. See Appendix F for details.

3. REVIEW SUMMARY AND NEXT STEPS

AEMO’s review of ElectraNet’s proposed ex-ante capex projects assessed the need for the proposed expenditure and whether this investment could be expected to result in the South Australian transmission network complying with the requirements set out in the South Australian ETC.

AEMO’s review of contingent projects was different to the review of the ex-ante capex projects, with the ex-ante projects required to be assessed more rigorously, due to a revenue allowance being made at this stage. Contingent projects are subject to further justification.

3.1 Summary of AEMO’s review

Of the 15 ex-ante capex projects proposed by ElectraNet, two projects that could not be economically justified were withdrawn, and one project was considered beyond the scope of AEMO’s review.²³

With the information presently available, and based on the need, project timing, and economic justification where relevant, AEMO considers that 11 of the 12 remaining projects proposed by ElectraNet are currently appropriate for inclusion in their capex proposal. These findings are summarised in the table below.

Table 2 Summary of the projects addressed in this report

Investment driver	Projects assessed	AEMO’s assessment
Connection	1	<p>The Gawler East project is driven by distribution network limitations arising from demand growth. AEMO considers there is a need for this proposed project if SA Power Networks’ forecast eventuates. AEMO considers, however, that non-network options should be considered to mitigate the risk of the new Gawler East substation becoming a stranded asset.</p> <p>Note that the Gawler East area is located within the distribution network. AEMO’s connection point demand forecast does not capture this growth.</p>
Asset replacement	4	<p>AEMO considers there is a need for these proposed projects. These projects are driven by the need to address the poor asset conditions identified by ElectraNet and ETC compliance requirements.</p> <p>This report does not attempt to provide advice on the condition of ElectraNet’s assets or ElectraNet’s asset retirement decisions. The AER may decide that the condition of the existing assets and subsequent risks posed do not warrant retirement and that investment to replace the assets is not efficient.</p>
Security and compliance	7	<p>AEMO considers six out of the seven projects are reasonably required to facilitate the secure, reliable, and efficient operation of the power system.</p> <p>AEMO considers that the remaining project cannot be economically justified.</p>

ElectraNet’s proposal includes five contingent projects. Two of the five projects are for addressing the power system security and reliability issues, as well as delivering net market benefits. The remaining three projects are for reinforcing the relevant parts of the transmission network under specific step load growth scenarios.

AEMO supports ElectraNet’s contingent project proposals, and considers them prudent for managing future uncertainty.

AEMO considers that the investment identified in this review is adequate to address load-driven limitations, and to meet the requirements of ETC and the National Electricity Rules (NER). These requirements will be met regardless of the inclusion of projects not considered appropriate by AEMO.

²³ ElectraNet and AEMO agreed that a monitoring and protection scheme (\$786,000) relating to transformer neutral earthing was not within the scope of this review because it does not relate to the capacity of the transmission network and because insufficient information is available.

The conclusions outlined in this document are subject to change, depending on the outcome of the South Australian Energy Transformation RIT-T which ElectraNet is currently undertaking.²⁴

AEMO's assessment outcomes for the ex-ante capex projects are summarised in Appendix C.

AEMO's assessment outcomes for the contingent projects are summarised in Appendix G.

3.2 Next steps

Key dates relating to ElectraNet's revenue determination process for the 2018–19 to 2022–23 regulatory control period are summarised in the table below.²⁵

Table 3 Upcoming dates in ElectraNet's revenue proposal

Milestone	Date
ElectraNet revenue proposal	March 2017
AER draft decision	September 2017
ElectraNet revised revenue proposal	December 2017
AER final decision	April 2018

²⁴ ElectraNet. *South Australian Energy Transformation*. Available at: <https://www.electranet.com.au/projects/south-australian-energy-transformation/>.

²⁵ ElectraNet. *Regulated Revenue Determination Process*. Available at: <https://www.electranet.com.au/what-we-do/network/regulated-revenue-determination-process/>.



4. SUPPLEMENTARY INFORMATION

The table below provides links to additional information provided.

Table 4 Links to supporting information

Information source	Website address
<i>2016 National Electricity Forecasting Report</i>	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report
<i>2016 Transmission Connection Point Forecasting Report for South Australia</i>	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting
AEMO Generation Information page	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information
AEMO publications under its South Australian advisory functions	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/South-Australian-Advisory-Functions
<i>2016 National Transmission Network Development Plan</i>	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Transmission-Network-Development-Plan

APPENDIX A. GENERAL ASSUMPTIONS

This chapter outlines the underlying assumptions of AEMO's independent review. Any assumptions unique to a specific project are specified in the discussion of that project.

Ratings

AEMO used transmission line and transformer ratings data provided by ElectraNet, with the following assumptions:

- Transmission lines used continuous ratings.
- Singular transformers (without parallel transformers) used normal cyclic ratings.
- Parallel transformers used long-term emergency cyclic ratings (following the outage of a parallel transformer). Where an emergency cyclic rating was not available, a normal cyclic rating was used.

Demand level

At the connection point level, AEMO used 10% Probability of Exceedance (POE) forecasts from its *2016 Transmission Connection Point Forecast for South Australia*.²⁶

At the regional level, AEMO used 10% POE state-wide maximum demand forecasts from AEMO's *2016 National Electricity Forecasting Report* (NEFR).²⁷ Similarly, minimum demand was assessed using the 90% POE summer minimum demand from AEMO's 2016 NEFR.

In general, for connection point asset and regional network analysis, loads were assumed to reach the regional peak based on AEMO's 2016 connection point load forecast (undiversified). For 275 kV network investigations, loads were modelled at levels consistent with the demand at the time of the state-wide summer peak (diversified) as in AEMO's 2016 NEFR forecast.

Interconnector flow assumptions

To capture the worst case scenario, the Victoria to South Australia (Heywood) Interconnector was assessed with up to 650 MW import into South Australia, and the Murraylink Interconnector was assessed with 0 MW import into South Australia.²⁸ Murraylink flows up to 200 MW (export and import) were considered when carrying out load flow studies for assessing the proposed Robertstown circuit breaker arrangement upgrade project.

Wind farm availability

To capture the worst case scenario, wind farm output was assessed in the range 0% to 90% of installed capacity. Reactive power output from individual wind farms was kept within generator performance standards.

Generation assumptions

Generator availability was sourced from AEMO's Generation Information page.²⁹

TIPS 'A' (480 MW) was assumed to remain in service.³⁰ Committed generators (Hornsedale Wind Farm Stage 1, Stage 2, and Stage 3) were assumed commissioned.

²⁶ AEMO. *2016 Transmission Connection Point Forecast for South Australia*. Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting>.

²⁷ AEMO. *2016 National Electricity Forecasting Report*. Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report>.

²⁸ This is the most onerous condition for testing the supply reliability of the Riverland region network.

²⁹ AEMO. *Generation Information Page*. Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information>.

³⁰ In line with AGL's recent announcement to defer the previous planned mothballing of generating units in TIPS 'A', available at: <https://www.agl.com.au/about-agl/media-centre/article-list/2016/june/agl-to-defer-mothballing-of-south-australian-generating-units>.



The possibility of existing generation not being in service was also considered from an operational perspective.

When assessing the potential economic benefits of security and compliance projects, the potential impact of new generation developments reported in the 2016 National Transmission Network Development Plan (NTNDP)³¹ were considered.

Voltage limits

The voltage limits stipulated in AEMO's voltage control guide for the South Australian region were applied. Where limits are not specified in AEMO's voltage control guide, 0.95 per unit (p.u.) to 1.05 p.u. was used for system normal conditions, and 0.90 p.u. to 1.10 p.u. for contingency conditions.

³¹ AEMO. *2016 National Transmission Network Development Plan*. Available at: <http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Transmission-Network-Development-Plan>.

APPENDIX B. PROCESS AND METHODOLOGY

B.1 General process

AEMO's assessment process involved progressively reviewing the information provided by ElectraNet, seeking clarification where necessary, carrying out independent studies, and discussing the outcomes with ElectraNet.

The general process is summarised below:

1. Review the individual projects proposed by ElectraNet.
 - Perform load flow studies and where relevant economic assessments, considering operational strategies.
 - Seek clarification from ElectraNet on assumptions used in ElectraNet's assessment where necessary.
2. Identify possible residual network limitations assuming the projects proposed by ElectraNet are proceeding.
 - Review relevant planning documents.³²
 - Perform load flow studies and where relevant economic assessments, considering operational strategies.
 - Discuss outcomes with ElectraNet.

B.2 Specific methodologies

Connection asset assessment

The assessment was primarily carried out using contingency analysis (N-1). Transformer and transmission line loadings were maintained within the ratings discussed in Appendix A.

Replacement project assessment

AEMO did not assess the conditions of the assets. AEMO's assessment scope was confined to the following three key aspects:

- Compliance with the ETC requirements, if the asset was retired in the next regulatory period.
- Whether there were any additional feasible reinvestment options, not identified by ElectraNet.
- The economic efficiency of the reinvestment options recommended by ElectraNet.

It is important to point out that this report does not attempt to provide advice on the condition of ElectraNet's assets or ElectraNet's asset retirement decisions.

Security and compliance projects assessment

In reviewing the security and compliance projects proposed by ElectraNet, except the reactive power compensation projects, AEMO investigated:

- The potential impacts of the proposed projects on network security and reliability, in relation to the ETC requirement and the NER requirement.

³² Including *National Transmission Network Development Plan* (NTNDP), *Network Support and Control Ancillary Services* (NSCAS), *Electricity Statement of Opportunities* (ESOO), *ElectraNet's Transmission Annual Planning Report* (TAPR), and AEMO and ElectraNet's joint studies on renewable integration in South Australia carried out in 2014 and 2015.

- The qualitative security benefits of the proposed investment, based on AEMO’s and ElectraNet’s operational experience and assessment of reliability implications if maintenance could not be performed.

AEMO also performed high level economic analysis of the proposed investment and load flow studies to assist the assessment where relevant.

AEMO’s assessment that ElectraNet’s proposals will meet the security and reliability requirements of the ETC and NER may be subject to change, depending on the outcome of the South Australian Energy Transformation RIT-T.

In reviewing reactive power support projects proposed by ElectraNet, AEMO carried out two types of detailed load flow studies to assess the adequacy of reactive power support in the regulatory period 2018–19 to 2022–23:

- Contingency analysis (N-1 studies) to assess voltage limits under maximum demand and minimum demand conditions.
- Reactive Power-Voltage (Q-V) analysis to calculate the reactive power margins at key 275 kV and 132 kV substations. Reactive power margins are required to be maintained within the requirements of the NER (1% of fault level in MVA³³). Maximum fault levels reported in the *2016 South Australian Transmission Annual Planning Report (TAPR)*³⁴ were used as the basis for calculating the fault level margin requirement.

Contingent projects assessment

In reviewing contingent projects, AEMO assessed the following considerations:

- For non-load-driven contingent projects, preliminary investigations showed that positive net market benefits are likely.
- For load-driven projects, whether:
 - In the region where ElectraNet’s contingent proposals are targeted for network reinforcement, step load growth in the next regulatory period is likely.
 - The quantum of step changes in load specified by ElectraNet to trigger the contingent projects appears to be reasonable.

³³ Clause S.5.1.8 of the NER.

³⁴ ElectraNet. South Australian Transmission Annual Planning Report. Available at: <https://www.electranet.com.au/wp-content/uploads/report/2016/06/20160630-Report-SouthAustralianTransmissionAnnualPlanningReport.pdf>.

APPENDIX C. EX-ANTE CAPEX PROJECTS SUMMARY

Table 5 summarises the projects that are addressed in this report. In relation to asset replacement projects, this report does not attempt to provide advice on the condition of ElectraNet’s assets or ElectraNet’s asset retirement decisions. The AER may decide that the condition of the existing assets and subsequent risks posed do not warrant retirement and that investment to replace the assets is not efficient.

Table 6 summarises the two projects proposed by ElectraNet that were withdrawn following initial discussions with AEMO, and the one project considered out of scope of this assessment.

Table 5 Summary of projects addressed in this report and the assessment outcome

ElectraNet proposal	Project category	AEMO assessment summary
Gawler East connection point	Connection	<p>The project is driven by a distribution network limitation to meet the forecast demand growth in Gawler East region. AEMO considers ElectraNet’s proposal to be reasonable.</p> <p>AEMO considers, however, that the forecast demand growth in Gawler East is uncertain, and that the latest load forecasts and non-network options should be considered to defer the development of the Gawler East connection point, prior to committing to a network investment, to mitigate the risk of the new Gawler East substation becoming a stranded asset. The most economical solution should be confirmed through the RIT-D analysis.</p>
Mount Barker substation refurbishment	Asset replacement	<p>An ongoing need exists for retaining the existing transformer capacity at Mount Barker. ElectraNet advised that some assets in Mount Barker 132 kV substation are in poor condition and the poor asset condition needs to be addressed in the next regulatory period. ElectraNet recommended refurbishing the existing 132 kV Mount Barker substation to address the need to replace the poor condition assets. AEMO considers ElectraNet’s proposal reasonable.</p>
Mount Gambier 132/33 kV transformer No. 1 (50 MVA) replacement	Asset replacement	<p>An ongoing need exists for maintaining the supply capacity in Mount Gambier substation. ElectraNet advised that the existing 50 MVA transformer is in poor condition and the poor asset condition needs to be addressed in the next regulatory period. ElectraNet recommended replacing the existing 50 MVA transformer in poor condition with a new 25 MVA transformer. AEMO considers ElectraNet’s proposal reasonable.</p>
Leigh Creek South transformer replacement	Asset replacement	<p>An ongoing need exists for providing supply at Leigh Creek South. ElectraNet advised that the transformers in Leigh Creek South and Leigh Creek Coalfield substations are in poor condition and the poor asset condition needs to be addressed in the next regulatory period.</p> <p>While AEMO considers ElectraNet’s proposal to be reasonable, AEMO also considers that the demand at Leigh Creek South is uncertain, thus consideration should be given to defer the replacement if the condition of the asset permits, to mitigate the risk of the new transformer becoming a stranded asset.</p>
Mannum transformer 1 and 2 replacement	Asset replacement	<p>An ongoing need exists for maintaining the supply capacity at Mannum substation. ElectraNet advised that the existing two 20 MVA transformer at Mannum are in poor condition and the poor asset condition needs to be addressed in the next regulatory period. AEMO considers the proposal reasonable, however, replacing the existing transformers with two 15 MVA transformers should be investigated in detail prior to committing to an investment.</p>
Robertstown circuit breaker arrangement upgrade	Security and compliance	<p>Scheduling maintenance on 275 kV circuit breakers at Robertstown is operationally difficult, and is expected to become more challenging following the connection of more renewable generation in northern South Australia. A high level economic assessment showed potential positive net market benefit of this project. AEMO considers ElectraNet’s proposal to be reasonable.</p>
Blanche circuit breaker arrangement upgrade	Security and compliance	<p>Adding a circuit breaker and creating a meshed substation configuration at Blanche would contribute to improving network reliability and security. AEMO does not, however, consider ElectraNet’s proposed project to be economically justified.</p>

ElectraNet proposal	Project category	AEMO assessment summary
Kilburn 275 kV emergency bypass	Security and compliance	ElectraNet proposed to install an emergency bypass to bypass the Kilburn substation as necessary. This is a low-cost project that would mitigate the reliability and security risks of supply to the Eastern Suburbs including Adelaide CBD. AEMO considers ElectraNet’s proposal reasonable.
Canowie circuit breaker arrangement upgrade	Security and compliance	For outages of the Canowie – Robertstown 275 kV line, the Hallett GT (228 MW) and Hallett wind farm (95 MW) would be disconnected. Adding a circuit breaker at Canowie will address this issue and is expected to reduce the costs to consumers by reducing the potential downtime of Hallett GT as well as Hallett wind farm. AEMO considers ElectraNet’s proposal to be reasonable.
Installation of a 50 MVAR reactor at Templers West	Security and compliance	Additional inductive reactive power support capability is expected to be required to manage the high voltages in South Australia. AEMO considers ElectraNet’s proposal reasonable.
Installation of a 50 MVAR reactor at Blyth West	Security and compliance	Additional inductive reactive power support capability is expected to be required to manage the high voltages in South Australia. AEMO considers ElectraNet’s proposal reasonable.
Installation of a 50 MVAR reactor at Para	Security and compliance	Additional inductive reactive power support capability is expected to be required to manage the high voltages in South Australia. AEMO considers ElectraNet’s proposal reasonable. Note that the three reactor-projects are inter-related and address a single emerging need. The AER might consider it appropriate for the three projects to be considered together, such that a robust solution could be delivered through undertaking a RIT-T.

Table 6 Summary of projects withdrawn by ElectraNet or outside the scope of this review

ElectraNet Proposal	Project Category	Comments
Kilburn Substation upgrade to complete mesh configuration	Security and compliance	Withdrawn (not economically justified; substituted with Kilburn 275 kV emergency bypass).
Murray Bridge/Hahndorf No 3 Pumping Station substation 132 kV mesh bus	Security and compliance	Withdrawn (not economically justified).
Neutral earthing resistors and reactors	Security and compliance	Beyond the scope of AEMO’s review. ElectraNet and AEMO agreed that a monitoring and protection scheme (\$786,000) relating to transformer neutral earthing was not within the scope of this review because it does not relate to the capacity of the transmission network and because insufficient information is available.

APPENDIX D. CONNECTION PROJECT ASSESSMENT

D.1 New connection point at Gawler East

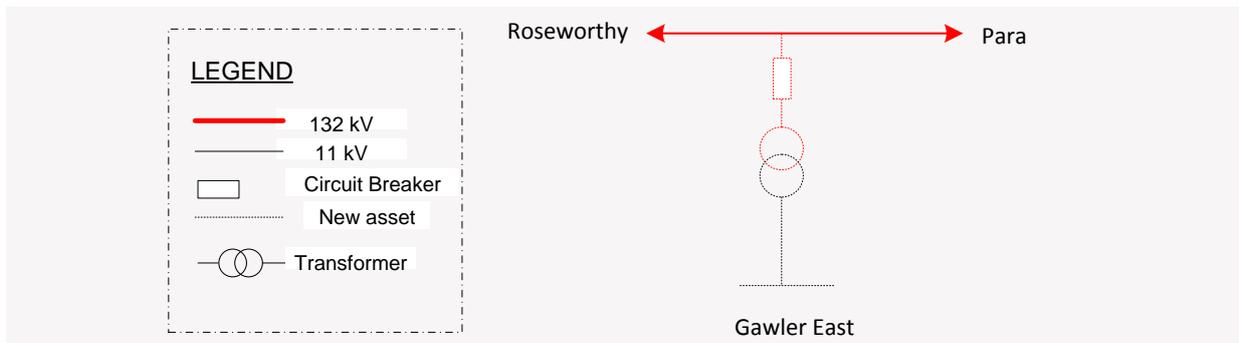
Background

SA Power Networks identified a need for an additional supply to Gawler East to meet the new greenfield type residential development in the area. The residential development site allows for up to 2,450 allotments and a commercial centre with an ultimate residential demand estimated at 22 MVA and 2.5 MVA of commercial load. ElectraNet and SA Power Networks propose to establish a 132/11 kV connection point at Gawler East.

ElectraNet’s proposal

ElectraNet and SA Power Networks proposed to supply the 132/11kV connection point from ElectraNet’s existing Para – Roseworthy 132 kV line, as shown in Figure 1.

Figure 1 Single line diagram illustrating the establishment of the Gawler East connection point



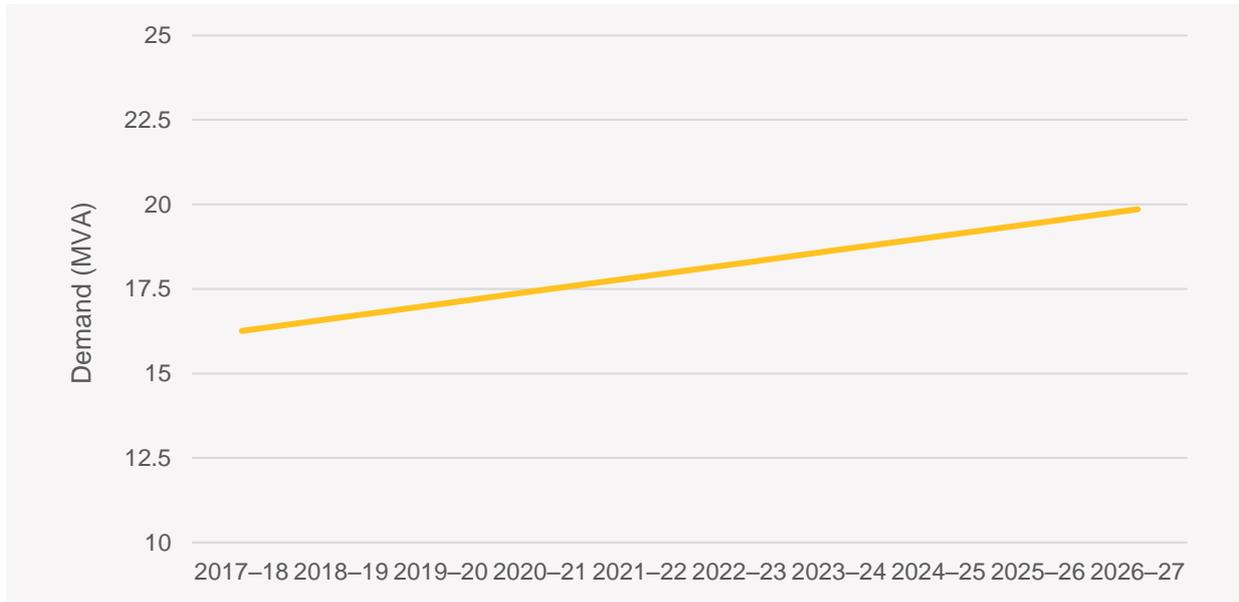
SA Power Networks’ demand forecasts

Figure 2 shows the combined demand forecasts for Gawler North 11 kV feeder and Gawler East 11 kV feeder for the next 10 years. The information was provided by ElectraNet (originated from SA Power Networks) to support the Gawler East connection point proposal.

ElectraNet and SA Power Networks further advised that:

- SA Power Networks’ ultimate demand forecast for the Gawler East area is about 25 MVA, though the development is expected to take at least 20 to 25 years.
- A development that is two to three times larger than Gawler East development is planned in Concordia, which is adjacent to Gawler East. Although the exact timing of this development is not committed, it is expected to commence in the next five years.

Figure 2 SA Power Networks’ combined demand forecasts for Gawler East 11 kV feeder and Gawler North 11 kV feeder ^A



A. The forecast shown after 2022–23 is an extrapolation of the growth in the period from 2017–18 to 2022–23.

SA Power Networks’ distribution network limitations

Based on the demand forecasts and equipment capacity provided by ElectraNet and SA Power Networks:

- Gawler North 11 kV feeder would become overloaded from summer 2020–21, and the overloading would reach 22% within the subsequent 10 years.
- Gawler East 11 kV feeder would become overloaded in summer 2021–22, and the overloading would reach 21% within the subsequent 10 years.
- Evanston 66/11 kV zone substation would become overloaded in summer 2023–24, and the overloading would reach about 9% by 2025–26.

Options considered by ElectraNet and SA Power Networks

The options considered by ElectraNet and SA Power Networks are:

- Option 1: Construct a 132/11 kV substation as tee-off from the existing Roseworthy–Para 132 kV (ElectraNet to provide a 132 kV bus and connection point, and SA Power Networks to provide a 25 MVA 132/11 kV transformer).
- Option 2: Same scope of works as Option 1, but ElectraNet to own the 25 MVA 132/11 kV transformer and provide an 11 kV connection point.
- Option 3: SA Power Networks to construct a new 66/11 kV zone substation in conjunction with 66 kV line augmentation (no scope of works for ElectraNet).
- Option 4: SA Power Networks to construct a new 33/11 kV zone substation in conjunction with 33 kV network augmentation (no scope of work for ElectraNet).

AEMO’s assessment

AEMO considers ElectraNet’s proposal for the establishment of a new 132 kV connection point at Gawler East to be reasonable. This is based on:



- Information provided by ElectraNet (originated from SA Power Networks), which showed that the existing 11 kV distribution feeders supplying the Gawler East region would be overloaded up to 5% from summer 2022–23 and the overloading would continue to increase.
- ElectraNet and SA Power Networks' advice that a preliminary RIT-D analysis showed that the preferred option is to establish a new 132/11 kV connection point at Gawler East.

The most economical solution needs to be confirmed by the RIT-D analysis.

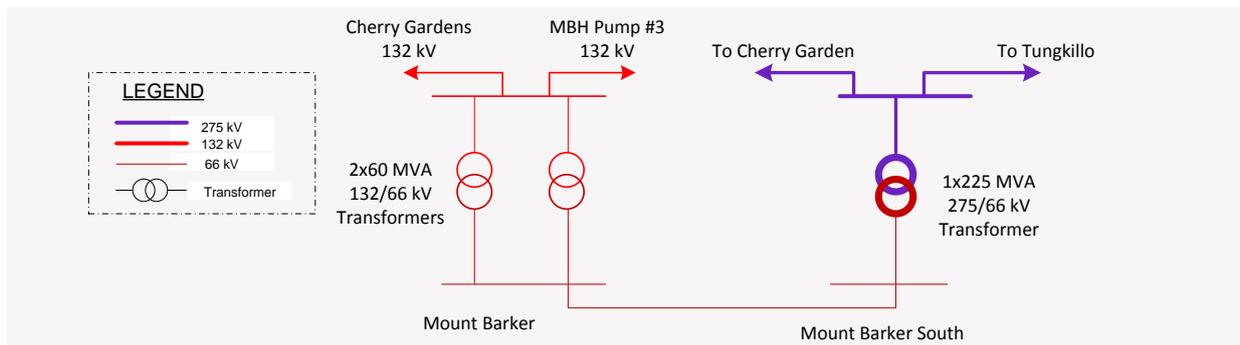
APPENDIX E. ASSET REPLACEMENT PROJECTS ASSESSMENT

E.1 Mount Barker substation asset refurbishment

Background

The Mount Barker and Mount Barker South area is supplied by two 132/66 kV transformers at Mount Barker and one 275/66 kV transformer at Mount Barker South, as shown in Figure 3.

Figure 3 Mount Barker and Mount Barker South area supply



ElectraNet's proposal

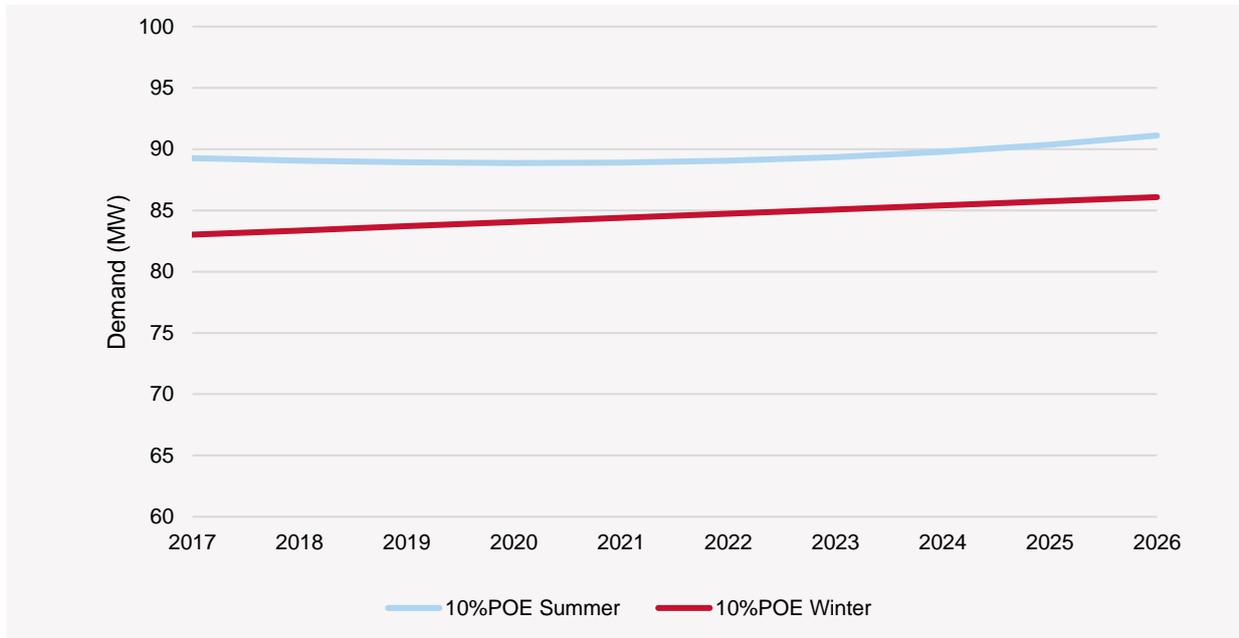
ElectraNet has investigated the following options:

- Option 1: Install a second Mount Barker South 275/66 kV transformer and join the existing 132 kV lines supplying Mount Barker inside the existing Mount Barker substation. Major work includes:
 - Install a second Mount Barker South 275/66 kV transformer.
 - Decommission the Mount Barker 132 kV substation including transformers and circuit breakers.
 - Form a Cherry Gardens – Murray Bridge Hahndorf Pump #3 (MBH Pump #3) 132 kV line by joining the existing Cherry Gardens – Mount Barker 132 kV line and the Mount Barker – MBH Pump #3 line inside the existing Mount Barker station.
 - Additional 66 kV distribution line between Mount Barker and Mount Barker South.
- Option 2: Install a second Mount Barker South 275/66 kV transformer and join the existing 132 kV lines supplying Mount Barker outside the existing Mount Barker substation. Major work includes:
 - Install a second Mount Barker South 275/66 kV transformer.
 - Decommission the Mount Barker 132 kV substation including transformers and circuit breaker.
 - Form a Cherry Gardens – Murray Bridge Hahndorf Pump #3 (MBH Pump #3) 132 kV line by joining the exiting Cherry Gardens – Mount Barker 132 kV line and the Mount Barker – MBH Pump #3 line outside the existing Mount Barker station (including construction of a short 132 kV line).
 - Additional 66 kV distribution line between Mount Barker and Mount Barker South.
- Option 3: Refurbish the poor condition Mount Barker 132 kV assets. Major work includes refurbishment of the following elements:
 - Transformer bushings, surge arrestors, and isolators.
 - Relevant panels and accessories, such as control, protection, and monitoring.

AEMO’s transmission connection point forecast

The 10% POE maximum demand at Mount Barker and Mount Barker South connection points is forecast to reach 91 MW during the 2016–17 to 2025–26 demand forecast period. Figure 4 shows the connection point forecasts for Mount Barker and Mount Barker South.

Figure 4 AEMO connection point maximum demand forecasts for Mount Barker and Mount Barker South



Network capacity

The combined short-term transformer capacity (N-1 capacity) at the existing Mount Barker and Mount Barker South substations is currently approximately 140 to 150 MVA³⁵, which is sufficient to support forecast demand throughout and beyond the 2016–17 to 2025–26 period.

AEMO’s assessment

The load at Mount Barker and Mount Barker South area is classified as a Category 4 under the ETC. This classification requires Mount Barker and Mount Barker South to ensure N-1 equivalent transmission line and transformer capacity to meet 100% of agreed maximum demand. Retiring the existing Mount Barker 132 kV substation without replacement would lead to a single 275/66 kV transformer connection and a breach of the ETC requirements.

ElectraNet performed an economic assessment to rank the economic efficiency of different reinvestment options. Based on the outcome of the economic assessment, ElectraNet proposes refurbishing the existing poor condition Mount Barker substation assets to address the requirement.

AEMO agrees with ElectraNet that there is an ongoing need for the supply from Mount Barker and Mount Barker South substations. Based on the need to meet the ETC reliability requirement, ElectraNet’s advice that the existing assets need to be replaced in the next regulatory period, and the economic efficiency of different reinvestment options, AEMO considers ElectraNet’s proposal to be appropriate.

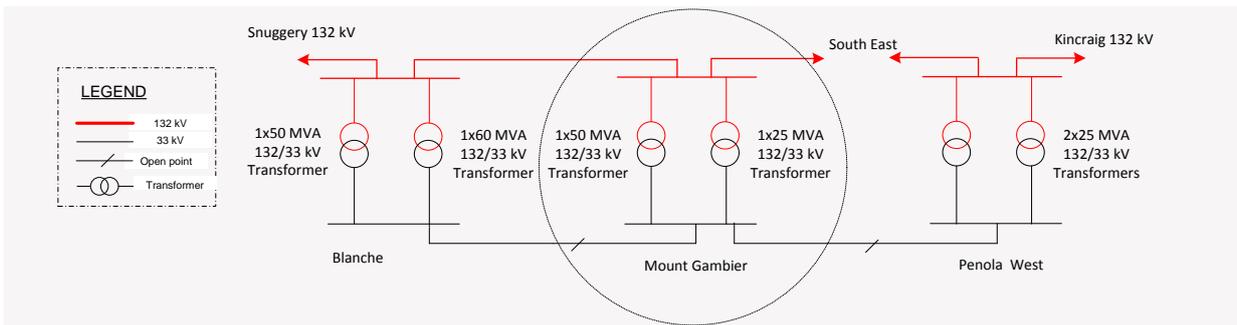
³⁵ Short-term transformer ratings are considered in line with ElectraNet’s operational practice.

E.2 Replace the Mount Gambier 132/33 kV No.1 transformer

Background

The existing Mount Gambier substation is supplied by two 132/33 kV transformers (one 50 MVA and one 25 MVA), as shown in Figure 5. The 33 kV distribution systems at Mount Gambier and Blanche are adjacent and separated electrically. Historically, loads were transferred to and from these substations through the 33 kV distribution systems. There is a 33 kV distribution network link between the Mount Gambier distribution system and the Penola West distribution system. The two systems are electrically separated and load transfer between Mount Gambier and Penola West is limited.

Figure 5 Mount Gambier substation supply



ElectraNet’s proposal

ElectraNet has investigated the following options³⁶:

- Option 1: Replace the existing poor condition 50 MVA transformer with a new 25 MVA transformer at Mount Gambier substation. Major work includes:
 - Install one 25 MVA 132/33 kV transformer at the existing Mount Gambier substation to replace the existing poor condition 50 MVA transformer.
 - Uprate SA Power Networks’ existing Mount Gambier – Mount Gambier West 33 kV line.
- Option 2: Decommission the poor condition Mount Gambier 50 MVA transformer and mesh the 33 kV distribution system. Major work includes:
 - Decommission the existing poor condition Mount Gambier 50 MVA 132/33 kV transformer.
 - Augment SA Power Networks’ 33 kV network connection to supply the existing Mount Gambier load from Blanche and Penola West.
- Option 3: Decommission Mount Gambier substation and transfer the load to Blanche and Penola West. Major work includes:
 - Decommission the existing Mount Gambier 132/33 kV transformers.
 - Augment SA Power Networks’ 33 kV network connection to supply existing Mount Gambier load from Blanche and Penola West.
 - Form a Blanche – South East 132 kV line by joining the existing Blanche – Mount Gambier 132 kV line and the Mount Gambier – South East 132 kV line.
- Option 4: Rebuild the Mount Gambier substation on a new site to replace the existing Mount Gambier substation. Major work includes:
 - Build a new substation on the adjacent site to replace the existing Mount Gambier substation.

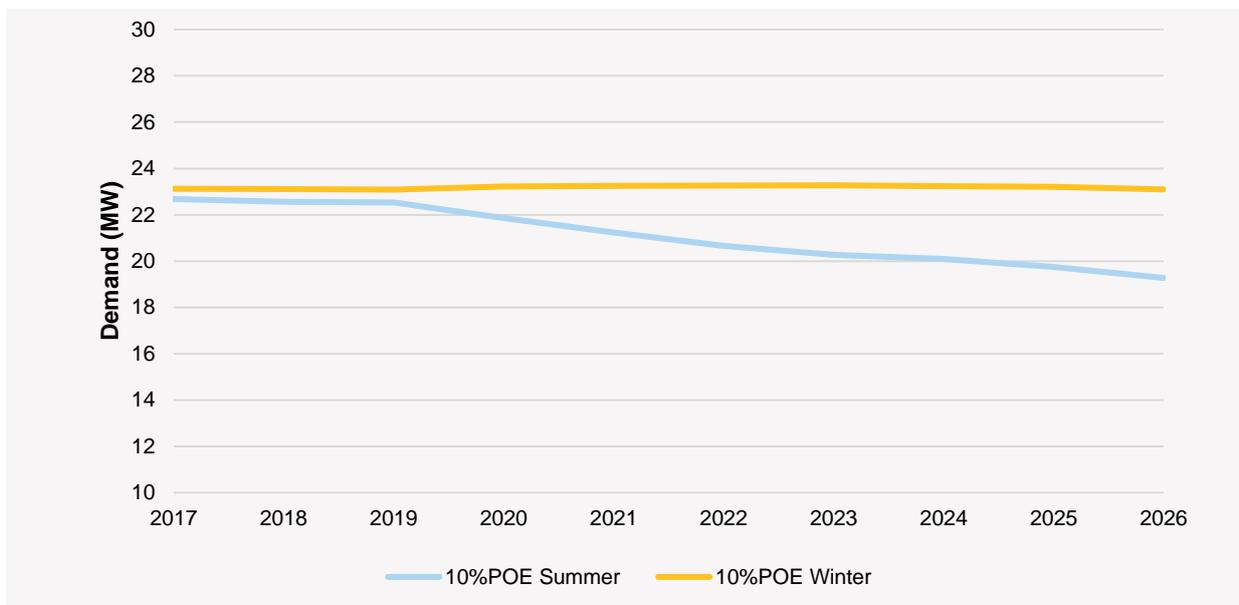
³⁶ All options considered the replacement of the Blanche 132/33 kV transformer No.2 (50 MVA) in the regulatory period 2023–24 to 2027–28. The scope described in this report only covers the works proposed by ElectraNet in the 2018–19 to 2022–23 regulatory period.

- Works on SA Power Networks’ 33 kV distribution network in relation to the new site.

AEMO’s connection point forecasts

The 10% POE maximum demand in Mount Gambier substation is forecast to reach approximately 23 MW during the 2016–17 to 2025–26 demand forecast period. Figure 6 shows the transmission connection point forecasts for Mount Gambier substation.

Figure 6 AEMO connection point demand forecast for Mount Gambier



Network capacity

The firm transformer capacity (N-1 capacity) at Mount Gambier is approximately 30 MVA³⁷, which is sufficient to support demand during and beyond the 2016–17 to 2025–26 period.

AEMO’s assessment

The load in the Mount Gambier area is classified as Category 4 under the ETC. Under this category, Mount Gambier is required to have N-1 equivalent transmission line and transformer capacity to meet 100% of maximum demand. Retiring the existing Mount Gambier 132 kV substation without replacement would breach the ETC requirement.

ElectraNet carried out an economic assessment to rank the economic efficiency of different credible replacement options. Based on the assessment outcome, ElectraNet proposes replacing the existing Mount Gambier 50 MVA transformer with a new 25 MVA transformer in the 2018–19 to 2022–23 regulatory period. Following this replacement, Mount Gambier would have N-1 transformer capacity of approximately 30 MVA.

ElectraNet’s proposal includes SA Power Networks’ distribution network augmentations, which are outside the scope of AEMO’s review.

AEMO agrees with ElectraNet that there is an ongoing need for the supply from Mount Gambier. Based on the need to meet the ETC reliability requirement, ElectraNet’s advice that the existing assets need to be replaced in the next regulatory period, and the economic efficiency of different reinvestment options,

³⁷ Short-term rating is considered in line with ElectraNet’s operational practice.

AEMO considers ElectraNet’s proposal to replace the existing 50 MVA transformer at Mount Gambier with a 25 MVA transformer to be reasonable.

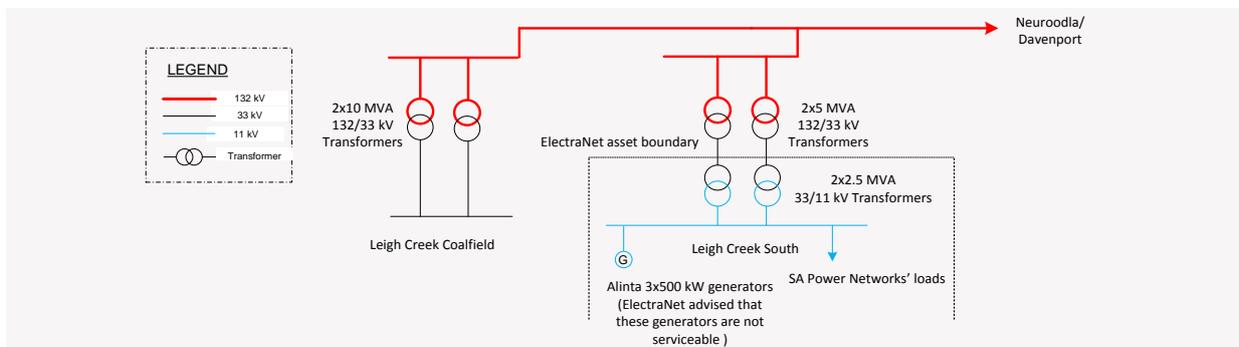
E.3 Leigh Creek South transformer replacement

Background

The Leigh Creek South substation supplies the Leigh Creek mining town. Electricity demand in the town is strongly influenced by the mining operation. Leigh Creek Coalfield substation supplied electricity to the Alinta Energy owned Leigh Creek coal mine when it was in operation. Alinta closed the mine in November 2015 before it ceased operation of Northern Power Station in May 2016.

ElectraNet identified that the transformers at both Leigh Creek South and Leigh Creek Coalfield substations are in poor condition and are prone to failure (a nearby fault may permanently damage these transformers, which would interrupt the supply to Leigh Creek South and Leigh Creek Coalfield). The current network arrangement at Leigh Creek South and Leigh Creek Coalfield is shown in Figure 7.

Figure 7 Leigh Creek South and Leigh Creek Coal field supply



ElectraNet’s proposal

ElectraNet investigated the following options:

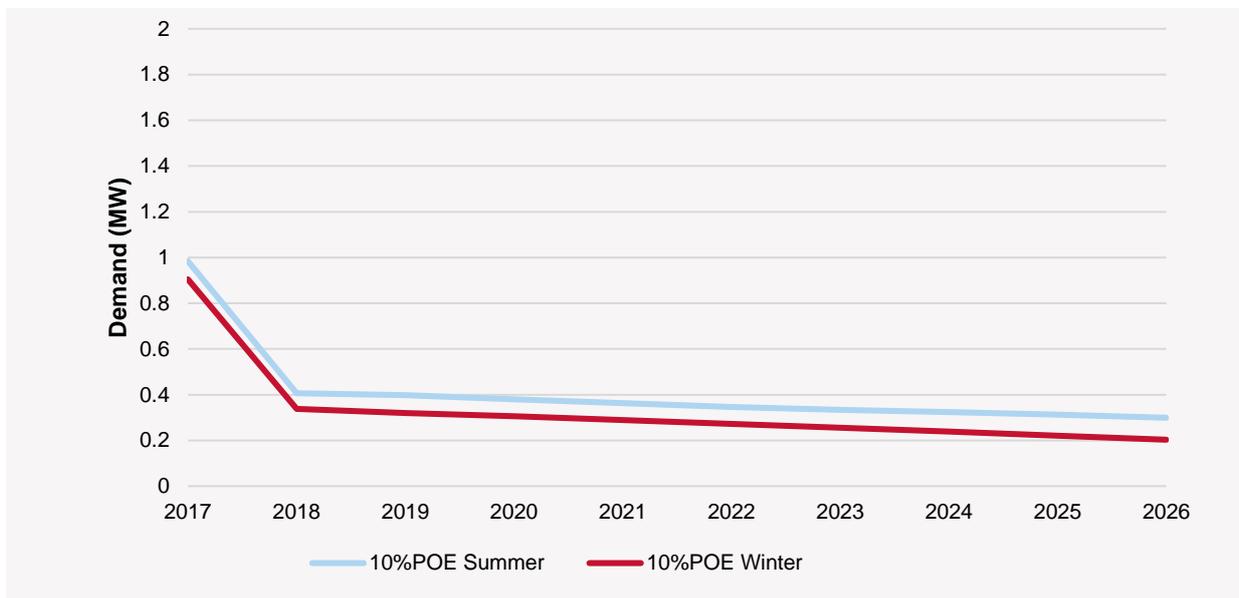
- Option 1: Replace the Leigh Creek South transformer. Major work includes:
 - Install a 5 MVA 132/11 kV transformer at the Leigh Creek South substation to replace the existing two 5 MVA 132/33 kV transformers.
 - Decommission the Leigh Creek Coalfield substation.
 - De-energise the Leigh Creek Coalfield – Leigh Creek South 132 kV circuit.
 - Decommission two of SA Power Networks’ 2.5 MVA 33/11 kV transformers at the Leigh Creek South substation.
- Option 2: Establish a micro-grid at Leigh Creek South (off-grid option). Major work includes:
 - Establish a micro-grid comprising a mix of standby generators, wind generators, solar photovoltaic (PV), and battery storage.
 - Decommission the Neuroodla – Leigh Creek South – Leigh Creek Coalfield 132 kV lines.
 - Decommission the 132/33 kV and 33/11 kV transformers owned by ElectraNet and SA Power Networks.
- Option 3: Same scope of works for Option 2, except de-energising, rather than decommissioning, the Neuroodla – Leigh Creek South – Leigh Creek Coalfield 132 kV lines.

As an interim solution to address the supply risks associated with the poor asset conditions (prior to implementation of any of the above options), ElectraNet plans to use the next outage opportunity to reconfigure the supply at Leigh Creek South to one transformer supplying load with another on hot standby, by opening an 11 kV switch which is normally closed. This allows the standby transformer to be switched into service in the event of a transformer failure, thus reducing the risks of supply interruption at Leigh Creek South.

AEMO’s connection point forecasts

The 10% POE maximum demand at Leigh Creek South substation is forecast to be approximately 1 MW for the duration of the 2016–17 to 2025–26 demand forecast period. Figure 8 shows the connection point forecasts for Leigh Creek South. The forecast for Leigh Creek Coalfield is 0 MW due to closure of Northern Power Station.

Figure 8 AEMO connection point demand forecast for Leigh Creek South



Network capacity

The total transformer supply capacity at Leigh Creek South is 5 MVA, which is more than sufficient to support the demand forecast for the 2016–17 to 2025–26 period and beyond.

AEMO’s assessment

The load at Leigh Creek South is classified as Category 1 under the ETC. Under this category, Leigh Creek South needs to have equivalent transmission line and transformer capacity to meet 100% of agreed maximum demand. In terms of transformer supply capacity, retaining one of the existing two 5 MVA 132/33 kV transformers would meet this ETC reliability requirement.

ElectraNet carried out an economic assessment of different credible options, which also considered the uncertainty of the demand at Leigh Creek South substation.³⁸ Based on the assessment, ElectraNet proposes installing one 5 MVA 132/11 kV transformer to replace the existing two 5 MVA 132/33 kV transformers (Option 1) in the next regulatory period. As an interim solution to address supply risks associated with the poor asset condition, ElectraNet plans to use the next outage opportunity to put one

³⁸ ElectraNet advised that, based on SA Power Networks’ November 2016 forecast (currently not publicly available), the demand at Leigh Creek South would settle at around 0.9 MW in the next five-year period, which is about 0.5 MW to 0.6 MW higher than the forecast reported in AEMO’s 2016 Connection Point Forecasting Report for South Australia, published in July 2016.

of the existing two Leigh Creek South substation transformers on hot standby. ElectraNet also indicated that they will review the proposals if it becomes more likely that Alinta require electricity supply from Leigh Creek Coalfield.

ElectraNet’s proposal considers asset conditions, demand forecasts, reinvestment efficiencies, and the uncertainty with respect to the load to be supplied at both Leigh Creek South and Leigh Creek Coalfield substations.

Based on the need to meet the ETC reliability requirement, ElectraNet’s advice that the poor condition of existing assets need to be addressed in the next regulatory period, and the economic efficiency of different reinvestment options, AEMO considers ElectraNet’s recommendation to be appropriate at this stage. However the AER may decide that the condition of the existing assets and subsequent risks posed do not warrant retirement and that investment to replace the assets is not efficient.

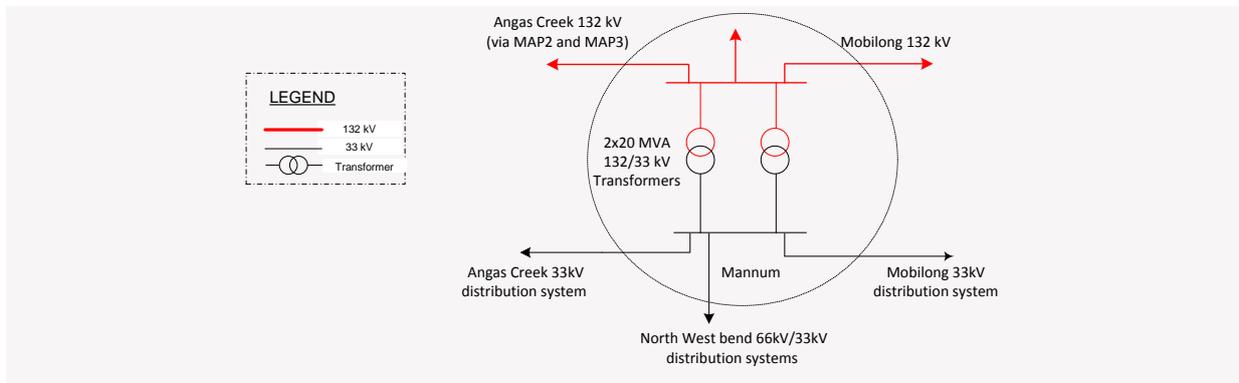
Furthermore, AEMO considers that the demand at Leigh Creek South is uncertain, thus consideration should be given to defer the replacement if the condition of the asset permits and replace the existing transformers with a smaller transformer or non-network options, to mitigate the risk of the new transformer becoming a stranded asset.

E.4 Mannum transformer 1 and 2 replacement

Background

The existing Mannum substation is supplied by two 20 MVA 132/33 kV transformers. There are 33 kV distribution network links between the distribution systems at Mannum, Mobilong, Angas Creek, and North West Bend, as shown in Figure 9.

Figure 9 Mount Gambier substation supply



ElectraNet’s proposal

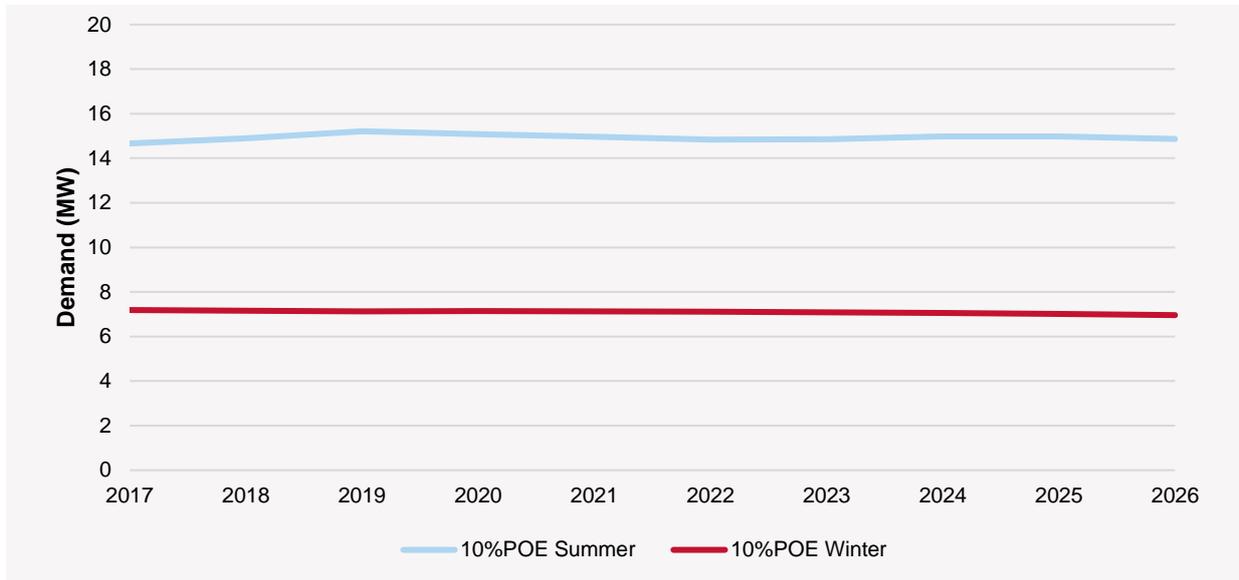
ElectraNet has investigated the following options:

- Option 1: Replace the existing two 20 MVA transformers in poor condition with two 25 MVA transformers in 2018–19.
- Option 2: Replace the existing two 20 MVA transformers in poor condition with two 25 MVA transformers in 2023–24.
- Option 3: Augment the 33 kV distribution network to supply the entire Mannum load from Mobilong. Decommission the existing Mannum transformers.

AEMO’s connection point forecasts

The 10% POE maximum demand in Mannum substation is forecast to reach approximately 15 MW during the 2016–17 to 2025–26 demand forecast period. Figure 10 shows the transmission connection point forecasts for Mannum substation.

Figure 10 AEMO connection point demand forecast for Mannum



Network capacity

The firm transformer capacity (N-1 capacity) at Mannum is approximately 20 MVA³⁹, which is sufficient to support demand during and beyond the 2016–17 to 2025–26 period.

AEMO’s assessment

The load in the Mannum area is classified as Category 4 under the ETC. Under this category, Mannum substation is required to have N-1 equivalent transmission line and transformer capacity to meet 100% of maximum demand. Retiring the existing Mannum 132 kV substation without replacement would breach the ETC requirement.

ElectraNet carried out an economic assessment to rank the economic efficiency of different credible replacement options. Based on the assessment outcome, ElectraNet proposes replacing the existing two 20 MVA transformers at Mannum with two new 25 MVA transformers in the 2018–19 to 2022–23 regulatory period.

AEMO agrees with ElectraNet that there is an ongoing need for the supply from Mannum substation. ElectraNet’s economic assessment shows that replacing the existing transformers in the next regulatory period (Option 1) is more economic than deferring the replacement by five years (Option 2). AEMO cannot comment on this assessment outcome, because the technical feasibility and economic efficiency of deferring the asset replacement depend entirely on the condition of the existing transformers at Mannum, which is beyond the scope of AEMO’s assessment.

³⁹ Short-term rating is considered in line with ElectraNet’s operational practice.

In response to AEMO's question why 20 MVA or 15 MVA transformers were not selected as the replacement transformers, ElectraNet explained that:

- ElectraNet does not consider selecting 15 MVA transformers to be a prudent investment solution, because 15 MVA transformers do not accommodate any future demand growth or the potential need of load transfer within the distribution network.
- Any possible saving from selecting 20 MVA transformers may be eroded by other issues inherent in going for non-standard size transformers (ElectraNet's standard 132/33 kV transformer size greater than 15 MVA is 25 MVA).

In view of the above, and on the premise that the poor condition of the existing transformers at Mannum need to be addressed in the next regulatory period to meet the ETC reliability requirement, AEMO considers ElectraNet's proposal to be reasonable. Replacing the existing transformers with two 15 MVA transformers should, however, be investigated in detail prior to committing to a network investment.

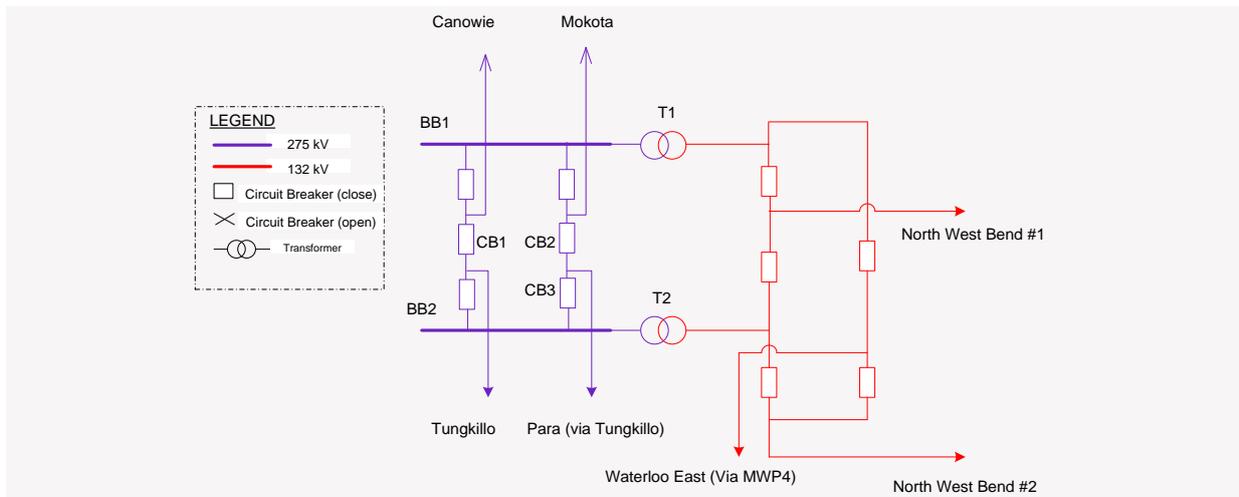
APPENDIX F. SECURITY AND COMPLIANCE PROJECTS ASSESSMENT

F.1 Robertstown circuit breaker arrangement upgrade

Background

The circuit breaker arrangement at the Robertstown 275/132 kV substation is shown in Figure 11.

Figure 11 Single line diagram illustrating the circuit breaker arrangement at Robertstown 275/132 kV substation

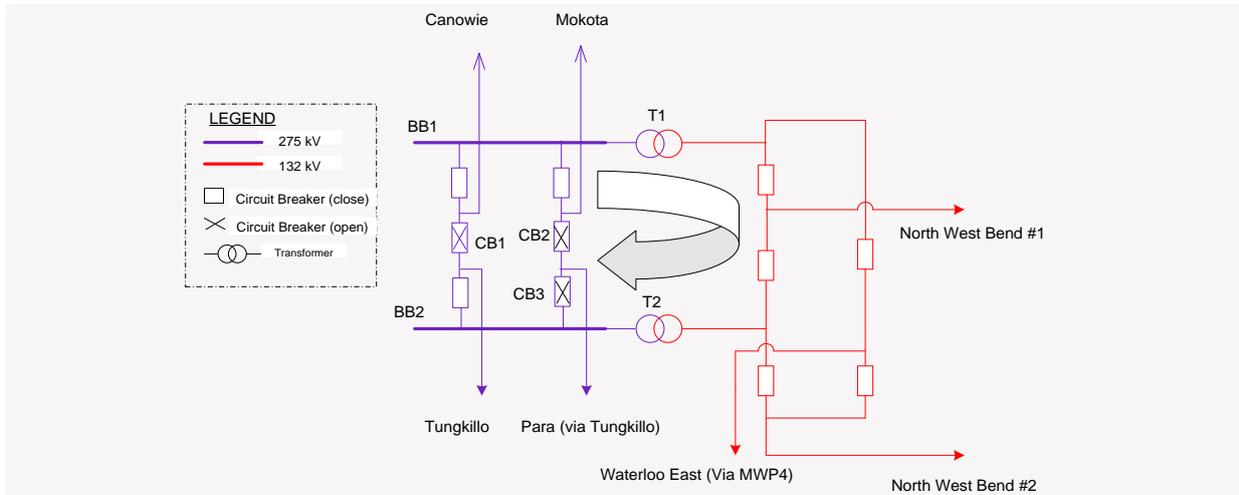


During some planned outage conditions, a line fault could split the 275 kV bus into two isolated sections. For example, when maintenance is scheduled for circuit breaker CB1, a line fault on the Robertstown – Mokota 275 kV line or on the Robertstown – Para 275 kV line will split the 275 kV bus into two isolated sections.

This would result in power flow travelling from the 275 kV “BB1” busbar to the 132 kV system through one 275/132 kV transformer (T1), and then from the 132 kV system back to the 275 kV through the other transformer (T2), as shown in Figure 12.

Therefore, during scheduled maintenance, the generation north of Robertstown and the Murraylink interconnection flow might be constrained to ensure secure operation.

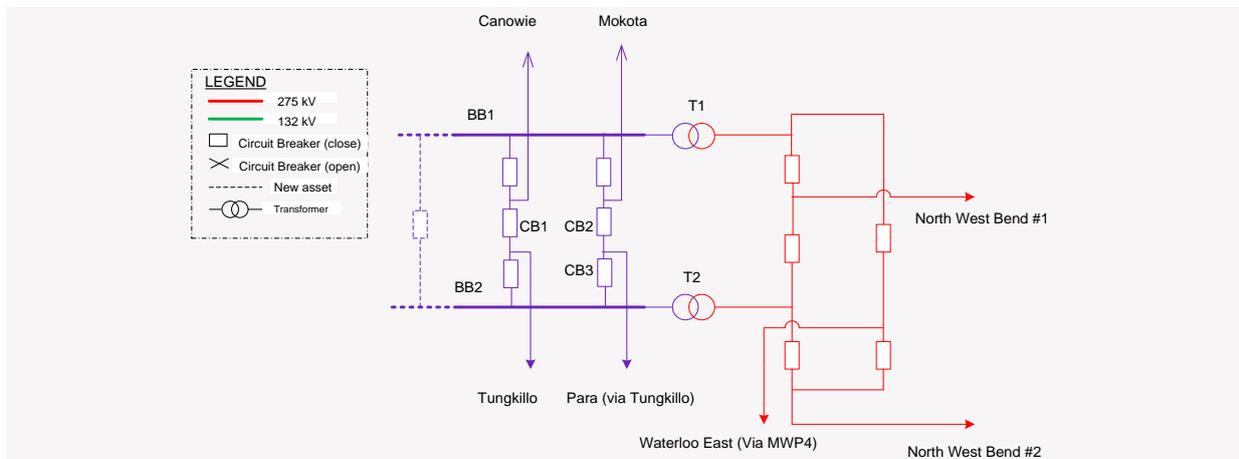
Figure 12 Single line diagram illustrating the load flow when Robertstown 275 kV bus is split into isolated sections



ElectraNet’s proposal

ElectraNet proposes installing a single 275 kV circuit breaker between the existing Robertstown 275 kV busbars to reduce potential constraints on generation north of the Robertstown substation and on the Murraylink interconnector, as shown in Figure 13.

Figure 13 Single line diagram illustrating the addition of a single 275 kV circuit breaker diameter at the existing Robertstown 275/132 kV substation



AEMO’s assessment

AEMO is aware of the operational challenges in scheduling maintenance of the 275 kV assets at Robertstown substation. Historically, there were circumstances where maintenance had to be deferred due to difficulties in creating necessary constraints to manage network security issues.

Relevant outage constraints are now available and can be created as required to manage the system security issues during maintenance periods, however scheduling maintenance on 275 kV circuit breakers at Robertstown is still difficult and expected to become more challenging following the connection of more renewable generation in northern South Australia.

AEMO carried out a high level economic assessment, which shows net market benefit of this project. The potential market benefits considered in the assessment include:

- The avoidable cost of the potential constraints on the generation north of Robertstown and Murraylink interconnector flow.
- The avoidable cost of extra works required of ElectraNet’s and AEMO’s operational staff to schedule/reschedule the outages and maintenance
- The avoidable cost of works that need to be carried out to address the concerns associated with the environmental/drainage issues at the existing Robertstown substations, as advised by ElectraNet.

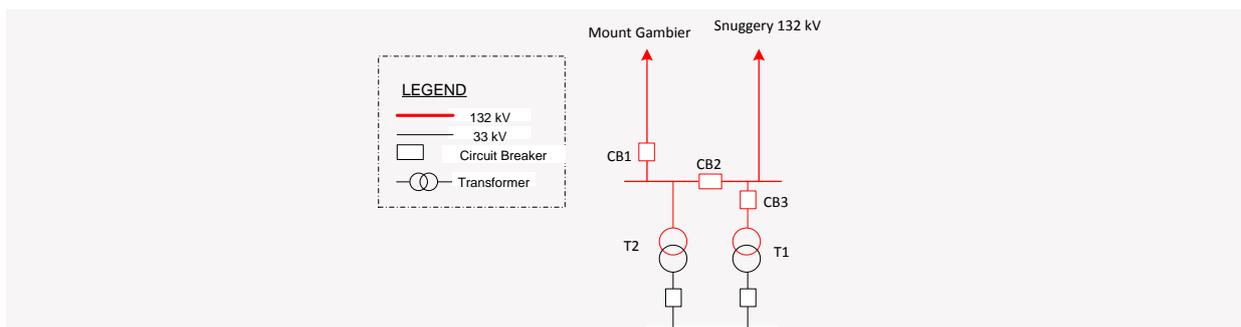
AEMO considers ElectraNet’s proposal to be reasonable.

F.2 Blanche circuit breaker arrangement upgrade

Background

Blanche 132 kV substation has a single bus bar arrangement, as illustrated in Figure 14. The outage of transformer T2 (planned or forced outage) will split the Snuggery – Blanche – Mount Gambier network, and radialise the supply to Blanche, potentially constraining generation in the Snuggery area.

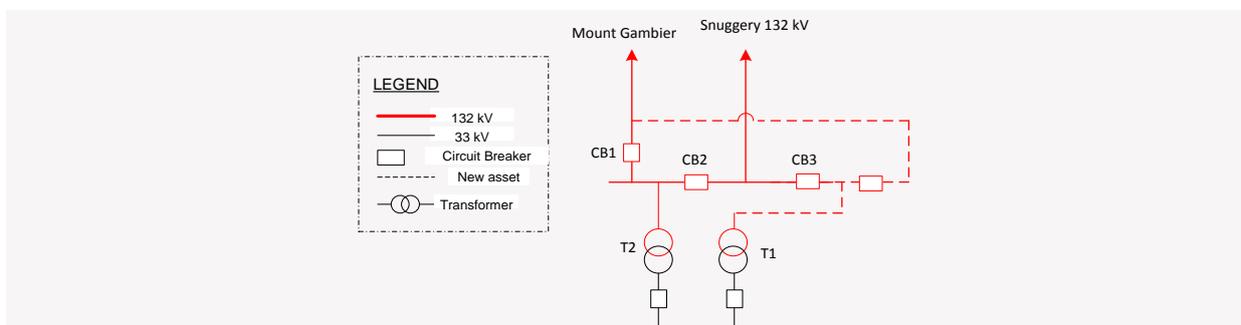
Figure 14 Single line diagram illustration of circuit breaker arrangement in Blanche 132 kV substation



ElectraNet’s proposal

ElectraNet proposed installing a 132 kV circuit breaker at Blanche substation to form a meshed circuit breaker arrangement, as shown in Figure 15.

Figure 15 Single line diagram illustrating addition of a 132 kV circuit breaker at Blanche substation



AEMO’s assessment

AEMO agrees with ElectraNet that installing a 132 kV circuit breaker to mesh the 132 kV circuit breaker arrangement will allow the independent switching of transformers and lines terminated at Blanche 132 kV. As a result, this will improve the reliability of supply to Blanche and alleviate the potential constraints on generation in the Snuggery area.

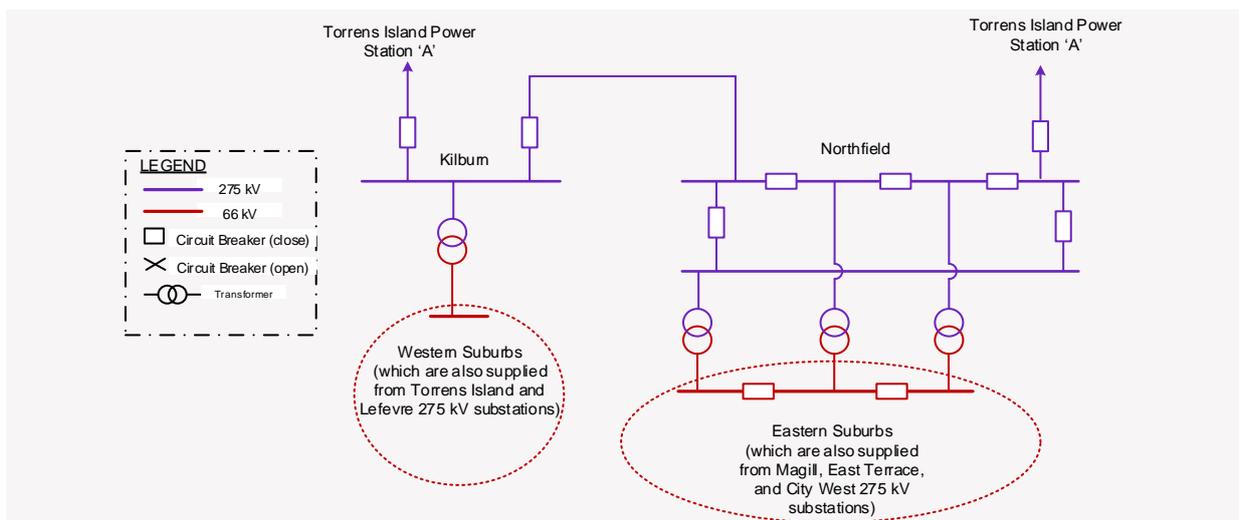
AEMO carried out an economic assessment of this project. Based on ElectraNet’s current cost assumptions, the assessment outcome found that the project is not economically justified within the period 2018–19 to 2022–23.

F.3 Kilburn 275 kV emergency bypass

Background

Figure 16 illustrates the supply arrangements as well as the switchyard configurations at both Kilburn and Northfield 275/66 kV substations. When 275 kV supply to Northfield is radialised (as result of outages of Kilburn GIS, or Northfield–Kilburn line, or Kilburn – TIPS ‘A’ line), a single fault on the TIPS ‘A’ – Northfield 275 kV line will result in the loss of three 225 MVA 275/66 kV transformers at Northfield.

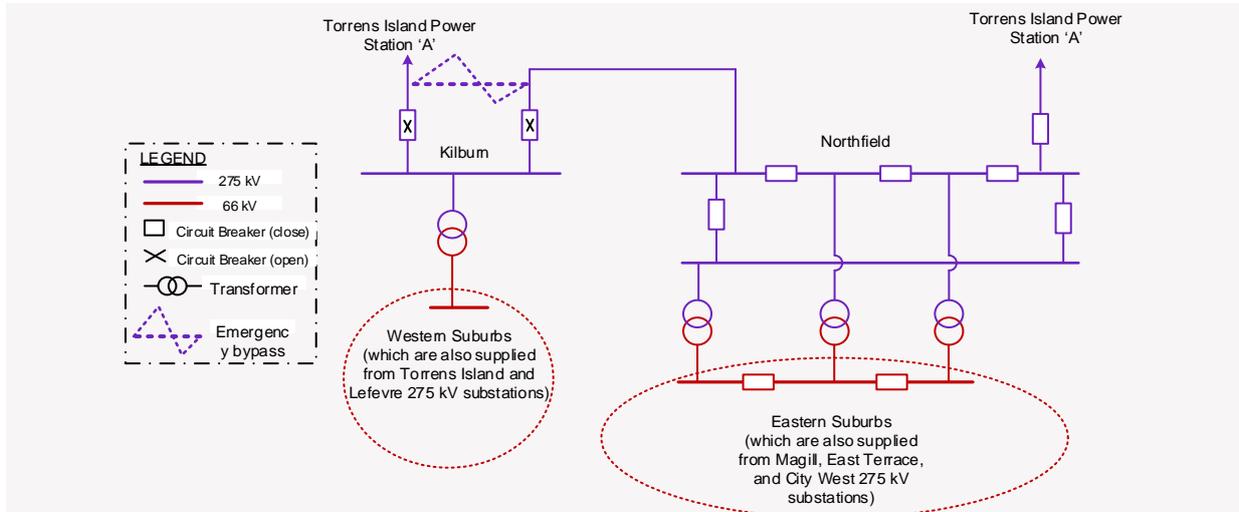
Figure 16 Single line diagram illustrating the supply configurations in Kilburn and Northfield 275 kV substations



ElectraNet’s proposal

ElectraNet proposes installing an emergency bypass, as shown in Figure 17, to bypass Kilburn substation as necessary. This will minimise the length of time during which Northfield is supplied radially, thus mitigating the risk of losing three 225 MVA transformers in Northfield due to a single fault.

Figure 17 Single line diagram illustrating the proposed emergency bypass outside the Kilburn substation



AEMO’s assessment

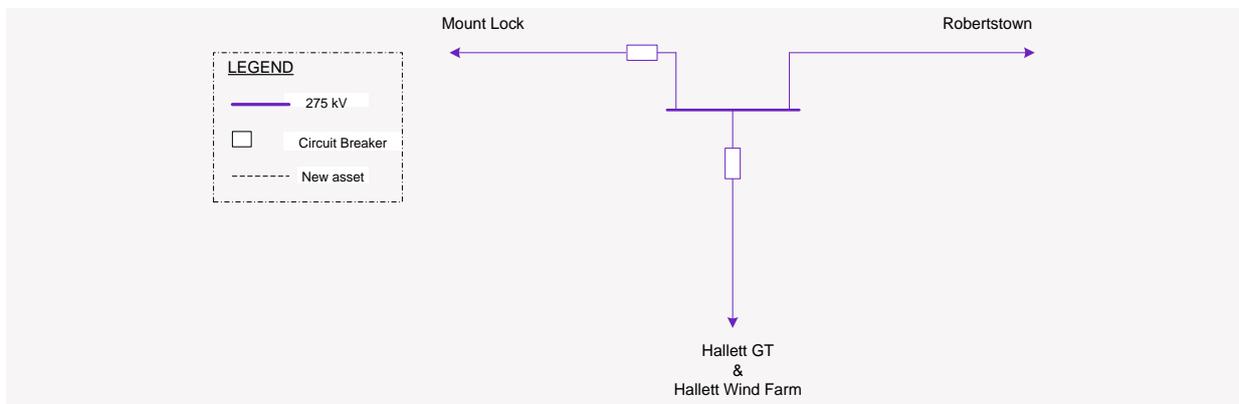
AEMO agrees with ElectraNet’s proposal, as it would mitigate the reliability and security risks of the supply to the Eastern Suburbs which covers the Adelaide CBD electrically. AEMO’s high level load flow studies showed that when Northfield is supplied from TIPS ‘A’ radially, pre-contingent load shedding would be required to manage the network security at times of peak demand, otherwise a single fault on the TIPS ‘A’ – Northfield line may cause the Eastern Suburbs to collapse. ElectraNet’s proposal is a low-cost option (ElectraNet’s cost estimate is \$0.13m), for mitigating a high impact low probability event. Detailed economic benefit assessment was considered unnecessary. AEMO considers ElectraNet’s proposal to be reasonable.

F.4 Canowie circuit breaker arrangement upgrade

Background

The circuit breaker arrangement at the Canowie 275 kV substation is illustrated in Figure 18. A planned or unplanned outage of Robertstown–Canowie 275 kV line would result in the disconnection of Hallett gas power station (Hallett GT–228 MW) and Hallett wind farm (95 MW).

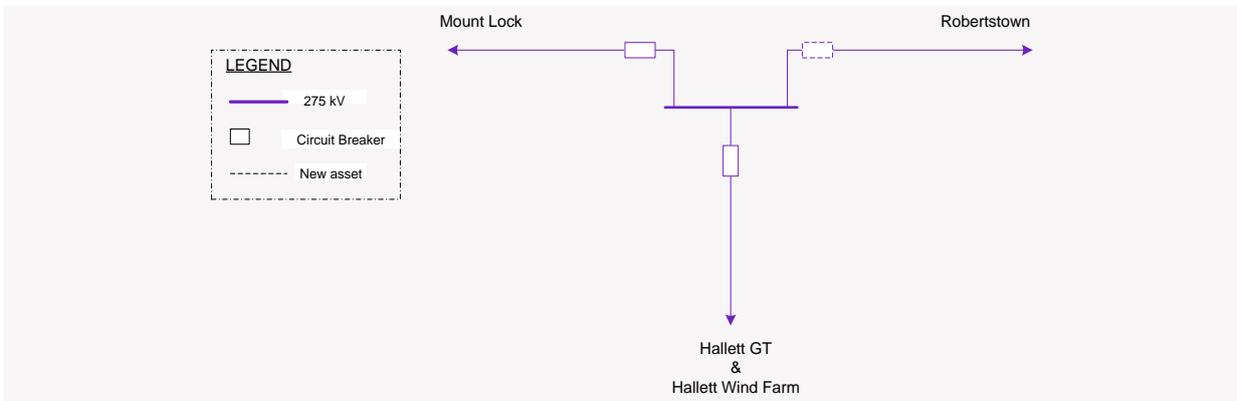
Figure 18 Single line diagram illustrating the circuit breaker arrangement at Canowie 275 kV substation



ElectraNet’s proposal

ElectraNet proposes installing a 275 kV circuit breaker at Canowie substation as per the ultimate layout for the site to minimise the downtime of Hallett GT and Hallett wind farm, as shown in Figure 19.

Figure 19 Single line diagram illustrating addition of a 275 kV circuit breaker at Canowie substation



AEMO’s assessment

AEMO carried out a high level economic assessment, which shows potential net market benefit of this project. The potential market benefits are primarily expected from the increased availability of Hallett GT to respond to high market prices in South Australia. AEMO considers ElectraNet’s proposal to be reasonable.

F.5 Reactive power support adequacy

Detailed load flow studies were carried out to assess the adequacy of reactive power support in the 2018–19 to 2022–23 regulatory period. Details on the methodology of AEMO’s assessment are provided in Appendix B. Details on the general assumptions can be found in Appendix A. This section summarises other key study inputs, assumptions, and the assessment outcome.

Peak load studies

To assess the emerging voltage control issues under peak load conditions, AEMO investigated the following two scenarios:

- High demand and high wind farm output.
- High demand and low wind farm output.

Reactive power-Voltage (Q-V) analysis was performed to determine the reactive power margin at the buses of interest. Q-V curves were obtained for system normal and for a single outage of any element connected to the bus. No reactive margin shortfall was identified.

AEMO’s initial Q-V analysis, carried out in June–July 2016 as part of AEMO’s review of ElectraNet’s preliminary capex projects⁴⁰, showed that

- The reactive power margin at Davenport 275 kV substation does not meet the reserve margin required by clause S.5.1.8 of the NER.
- The provision of approximately 50 MVar of capacitive reactive power support at Davenport will address the reactive power shortfall.

⁴⁰ AEMO. *Independent Planning Review – ElectraNet Preliminary Capital Expenditure Projects*, September 2016. Available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2016/Independent-Planning-Review-ElectraNet-Preliminary-Capital-Expenditure-Projects.pdf.

ElectraNet recently advised that, as part of ElectraNet's RIT-T to provide dynamic reactive power support in the Northern South Australian region, ElectraNet:

- Developed more accurate models for Olympic Dam load in consultation with BHP Billiton.
- Carried out detailed steady state and dynamic studies using the updated model which confirmed that there is no reactive margin shortfall at Davenport.
- Will be cancelling the RIT-T for providing dynamic reactive power support in the Northern South Australian region.

AEMO also revisited AEMO's Q-V analysis using the updated model provided by ElectraNet. The updated Q-V analysis shows no reactive margin shortfall.

Light load studies

To assess the inductive reactive power support adequacy of the South Australian transmission networks under low demand conditions, AEMO investigated the following three scenarios:

- Low demand and low wind farm output.
- Low demand and medium wind farm output.
- Low demand and high wind farm output.

AEMO's assessment found that approximately 100 MVar of additional inductive reactive power support needs to be provided by 2019 to manage the possible high voltage issues in South Australia. This requirement will increase to 150 MVar towards the end of the 2018–19 to 2022–23 regulatory period.

AEMO also identified that switching out the existing Magill – East Terrace 275 kV cable is equivalent to absorbing 50 to 60 MVar of reactive power at the Para 275 kV bus.

ElectraNet's capex project proposal includes installing three 50 MVar reactors in 2018–19 to 2022–23 regulatory period. AEMO discussed with ElectraNet the viability of reducing the number of proposed reactors to two by considering the reactive power that can be provided by switching out this cable under relevant contingency conditions. ElectraNet advised that switching out the Magill – East Terrace 275 kV cable for over voltage control should not be included as a planning solution to manage high voltage levels. Rather, it should be reserved as an operational solution to meet situations that fall outside of the planning envelope, so high voltages can be managed as minimum demand diminishes and during prolonged outages of existing reactive plants. AEMO considers ElectraNet's consideration to be reasonable.



APPENDIX G. CONTINGENT PROJECTS SUMMARY

ElectraNet proposes five contingent projects. Two of the five projects are for addressing the power system security and reliability issues being investigated, as well as delivering net market benefits (non-load- driven). The remaining three projects are for reinforcing the relevant parts of the transmission network under specific step load growth scenarios (load-driven). Details on ElectraNet’s contingent proposals and AEMO’s assessment can be found in the following table.

Table 7 summarises the contingent projects and associated trigger events proposed by ElectraNet as well as AEMO’s assessment outcome.

Table 7 Summary of contingent projects

Project name	Project description	Trigger events defined by ElectraNet	AEMO assessment summary
Eyre Peninsula Transmission Supply	Replace the existing single-circuit radial 132 kV transmission lines from Cultana to Yadnarie and from Yadnarie to Port Lincoln with new, double-circuit, 132 kV or 275 kV lines (depending on which voltage level provides the greatest net market benefit).	<ol style="list-style-type: none"> 1. Successful completion of the regulatory investment test for transmission including a comprehensive assessment of credible options showing that replacement of the existing single-circuit radial 132 kV transmission lines with double-circuit 132 kV or 275 kV lines produces greater net market benefits than replacing the sections of line that are in poor condition, and 2. ElectraNet board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules. 	<p>AEMO agrees with ElectraNet that rebuilding the existing Cultana – Yadnarie – Port Lincoln 132 kV lines into double circuit lines is likely to have net market benefits.</p> <p>AEMO supports including this project as a contingent project, so ElectraNet can carry out detailed assessment of this option. AEMO understands from ElectraNet that:</p> <ul style="list-style-type: none"> • This contingent project proposal is subject to AER's acceptance of ElectraNet's ex-ante capex project proposal for replacing the poor condition spans of the existing lines, which is not in the scope of AEMO's review. • The contingent funding is for the difference between the said ex-ante proposal and the contingent proposal • ElectraNet has discussed the arrangement with the AER.
South Australia Energy Transformation	Increase interconnection to the Eastern states via a new interconnector and/or implementing non-network solutions to create a net benefit to consumers and producers of electricity and support energy market transition in South Australia.	<ol style="list-style-type: none"> 1. Successful completion of the regulatory investment test for transmission demonstrating positive net market benefits, and 2. ElectraNet Board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules. 	<p>High level modelling carried out as part of 2016 NTNDP suggests positive net benefits for potential interconnection developments. AEMO supports including this project as a contingent project.</p>



Project name	Project description	Trigger events defined by ElectraNet	AEMO assessment summary
Yorke Peninsula Reinforcement	Construct a new single circuit 275 kV transmission line from Blyth West to Hummocks (cut into the existing Para to Bungama 275 kV circuit at Blyth West) and establish a 275/132 kV substation at Hummocks, replacing the 132 kV section at Hummocks.	<ol style="list-style-type: none"> 1. Customer commitment to a step load increase exceeding 60 MW on the transmission network south of Ardrossan West substation, causing the Bungama to Snowtown to Hummocks 132 kV transmission line to exceed its thermal limit (105 MVA) on loss of the Waterloo to Hummocks 132 kV transmission line (and vice versa), and 2. Successful completion of the regulatory investment test for transmission including a comprehensive assessment of credible options showing that reinforcement of the transmission network supplying Hummocks is justified, and 3. ElectraNet Board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules. 	<p>AEMO agrees that the existing network on the Yorke Peninsula needs to be augmented if there is a step load growth of about 60 MW.</p> <p>ElectraNet provided information showing that step load growth in the Yorke Peninsula region is possible. AEMO, however, has no information at this time which supports that the step load growth of 60 MW in the Yorke Peninsula region is probable in the next regulatory period.</p>
Upper Northern Region Western 132 kV Line Reinforcement	Rebuild the Pimba 132 kV line and establish associated substation assets (including reactive support).	<ol style="list-style-type: none"> 1. Customer commitment to connect a step load along the Davenport – Pimba 132 kV line corridor that causes the total load to exceed 55 MW; and 2. Successful completion of the regulatory investment test for transmission including an assessment of credible options showing a new connection point and line upgrade is justified, and 3. ElectraNet board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules. 	<p>AEMO agrees that the existing Davenport – Pimba line needs to be augmented if there is a step load growth which results in the total load exceeds 55 MW. ElectraNet provided information showing that step load growths along this supply corridor are possible. AEMO, however, has no information at this time which supports that a step load growth causing the total load to exceed 55 MW is probable in the next regulatory period.</p>
Upper Northern Region Eastern 132 kV Line Reinforcement	Rebuild the Leigh Creek 132 kV line and establish associated substation assets (including reactive support).	<ol style="list-style-type: none"> 1. Customer commitment to connect a step load along the Davenport – Leigh Creek 132kV line that causes the total load to exceed 5 MW, and 2. Successful completion of the regulatory investment test for transmission including an assessment of credible options showing a new connection point and line upgrade is justified, and 3. ElectraNet board commitment to proceed with the project subject to the AER amending the revenue determination pursuant to the Rules. 	<p>AEMO agrees that the existing Davenport – Leigh Creek 132 kV line needs to be augmented if there is a step load growth which results in the total load exceeds 5 MW. ElectraNet provided information showing that step load growth along this supply corridor is possible. AEMO, however, has no information at this time which supports that a step load growth causing the total load to exceed 5 MW is probable in the next regulatory period.</p>

MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of measure
kV	Kilovolts
MW	Megawatts
MVA	Megavolt amperes
MVA _r	Megavolt amperes reactive
p.u.	Per unit

Abbreviations

Abbreviation	Expanded name
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ETC	South Australian Electricity Transmission Code
NEFR	National Electricity Forecasting Report
NER	National Electricity Rules
NTNDP	National Transmission Network Development Plan
TNSP	Transmission Network Service Provider
RIT-T	Regulatory Investment Test for Transmission
RIT-D	Regulatory Investment Test for Distribution

GLOSSARY

This report uses many terms that have meanings defined in the National Electricity Rules (NER). The NER meanings are adopted unless otherwise specified.

Term	Definition
Annual planning report	An annual report providing forecasts of gas or electricity (or both) supply, capacity, and demand, and other planning information.
Augmentation	The process of upgrading the capacity or service potential of some part of a transmission (or a distribution) network.
Connection point	The point at which the transmission and distribution network meet.
Constraint	Any limitation on the operation of the transmission system that will give rise to unserved energy (USE) or to generation re-dispatch costs.
Contingent project	In relation to a revenue determination, a proposed contingent project that is determined by the Australian Energy Regulator (AER), in accordance with clause 6A.8.1 (b) of the NER, to be a contingent project for the purposes of that revenue determination. Contingent projects are excluded from the capital expenditure allowance in a revenue determination because of uncertainty around requirement, timing, or cost. Under Clause 6A.8.2 (d) of the NER, the Transmission Network Service Provider (TNSP) can apply to the AER to amend their revenue determination to include the revenue required for a contingent project if the trigger event arises.
Customer	A person who engages in the activity of purchasing electricity supplied through a transmission or distribution system to a connection point.
Distribution network	A network that is not a transmission network.
Generation	The production of electrical power by converting another form of energy in a generating unit.
Load	A connection point or defined set of connection points at which electrical power is delivered to a person or to another network or the amount of electrical power delivered at a defined instant at a connection point, or aggregated over a defined set of connection points.
Maximum demand (MD)	The highest amount of electrical power delivered, or forecast to be delivered, over a defined period (day, week, month, season, or year) either at a connection point, or simultaneously at a defined set of connection points.
National Electricity Law (NEL)	The National Electricity Law (NEL) is a schedule to the National Electricity (South Australia) Act 1996, which is applied in other participating jurisdictions by application acts. The NEL sets out some of the key high-level elements of the electricity regulatory framework, such as the functions and powers of NEM institutions, including AEMO, the AEMC, and the AER.
National Electricity Market (NEM)	The wholesale exchange of electricity operated by AEMO under the NER.
National Electricity Rules (NER)	The NER are made under the National Electricity Law, and describe the day-to-day operations of the NEM and the framework for network regulations. See also 'National Electricity Law'.
National Transmission Network Development Plan (NTNDP)	An annual report to be produced by AEMO that replaces the existing National Transmission Statement (NTS) from December 2010. Having a 20-year outlook, the NTNDP will identify transmission and generation development opportunities for a range of market development scenarios, consistent with addressing reliability needs and maximising net market benefits, while appropriately considering non-network options.
Network	The apparatus, equipment, plant and buildings used to convey, and control the conveyance of, electricity to customers (whether wholesale or retail) excluding any connection assets. In relation to a network service provider, a network owned, operated or controlled by that network service provider.
Non-network option	An option intended to relieve a limitation without modifying or installing network elements. Typically, non-network options involve demand-side participation (DSP) (including post contingent load relief) and new generation on the load side of the limitation.

Term	Definition
Normal cyclic ratings	The continuous cyclical load that a transformer can deliver. Normal cyclic rating is higher than nameplate rating by a margin that is dependent on the load shape.
Power system	The National Electricity Market’s (NEM) entire electricity infrastructure (including associated generation, transmission, and distribution networks) for the supply of electricity, operated as an integrated arrangement.
Power system security	The safe scheduling, operation, and control of the power system on a continuous basis in accordance with the principles set out in clause 4.2.6 (of the NER).
Probability of exceedance (POE) maximum demand	The probability, as a percentage, that a maximum demand (MD) level will be met or exceeded (for example, due to weather conditions) in a particular period of time. For example, for a 10% POE MD for any given season, there is a 10% probability that the corresponding 10% POE projected MD level will be met or exceeded. This means that 10% POE projected MD levels for a given season are expected to be met or exceeded, on average, 1 year in 10.
Reliability	The probability that plant, equipment, a system, or a device, will perform adequately for the period of time intended, under the operating conditions encountered. Also, the expression of a recognised degree of confidence in the certainty of an event or action occurring when expected.
Supply	The delivery of electricity.
Transmission network	A network within any National Electricity Market (NEM) participating jurisdiction operating at nominal voltages of 220 kV and above plus: (a) any part of a network operating at nominal voltages between 66 kV and 220 kV that operates in parallel to and provides support to the higher voltage transmission network, (b) any part of a network operating at nominal voltages between 66 kV and 220 kV that is not referred to in paragraph (a) but is deemed by the Australian Energy Regulator (AER) to be part of the transmission network.
Transmission system	A transmission network, together with the connection assets associated with the transmission network (such as transformers), which is connected to another transmission or distribution system.



LIST OF COMPANY NAMES

The following table lists the full name and Australian Business Number (ABN) of companies that may be referred to in this document.

Company	Full company name	ABN/ACN
AEMO	Australian Energy Market Operator	92 072 010 327
AGL	AGL Energy	74 115 061 375
Alinta	Alinta Energy	16 108 664 151
BHP	BHP Billiton	49 004 028 077
ElectraNet	ElectraNet	41 094 482 416
SA Power Networks	SA Power Networks	13 332 330 749