INDEPENDENT PLANNING REVIEW–ELECTRANET PRELIMINARY CAPITAL EXPENDITURE PROJECTS

SOUTH AUSTRALIAN ADVISORY FUNCTIONS

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

This document reviews ElectraNet's preliminary 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 30 June 2016, 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.

Version control

Version	Release date	Changes
1	9/9/2016	

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.

In September 2016, ElectraNet published a preliminary revenue proposal for public consultation. AEMO is conducting an independent review of ElectraNet's preliminary revenue proposal under its South Australian advisory functions, and at the request of ElectraNet and the South Australian Government.

AEMO's review is being completed in two stages:

1. Independent assessment of ElectraNet's preliminary capital expenditure (capex) project proposals (this document), prior to ElectraNet's public consultation on their preliminary revenue proposal.
2. Independent assessment of ElectraNet's formal capex project proposals, after this public consultation and prior to its submission to the Australian Energy Regulator (AER) in January 2017. The formal capex project proposals assessed in Stage 2 will also include the following type of projects, about which information is not yet available:
   - Proposed contingent projects (expected to include a possible new interconnector that ElectraNet and TransGrid are currently undertaking analysis for a Regulatory Investment Test for Transmission (RIT-T)).
   - Network Capability Incentive Parameter Action Plan (NCIPAP)[1] projects.

This document, which represents the stage one review, presents AEMO's findings on ElectraNet's preliminary capex project proposals. This review is based on project proposal information provided to AEMO between May and June 2016. The conclusions outlined in this document are subject to change during the second stage assessment if new information becomes available.

Review of preliminary capex proposals

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

- The need for each proposed project to meet the reliability requirements set out in the South Australian Electricity Transmission Code (ETC).
- Economic justification for individual projects, where the proposed expenditure is driven by increasing market benefit.[2]
- 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, AEMO did not assess the condition of ElectraNet's assets or their retirement decisions. The economic efficiency of these projects was assessed on the premise that the relevant poor asset conditions need to be addressed in the next regulatory period as advised by ElectraNet. The AER may reject these proposed projects on the grounds that the existing assets are in reasonable condition.

Following initial discussions with AEMO, ElectraNet withdrew two of the 12 projects initially proposed, and deferred two projects for consideration in stage two. One further project was beyond the scope of AEMO's review.[3]

With the information presently available, and based on the need to meet the reliability requirements set out in the ETC, and (where relevant) project timing and economic justification, AEMO considers that:

[1] The NCIPAP was designed by the AER to support improved usage of existing network assets through low-cost projects.
[2] Using project cost information provided by ElectraNet.
[3] ElectraNet and AEMO agreed that a monitoring and protection scheme ($670,000) 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.

- Five of the seven remaining projects proposed by ElectraNet are currently appropriate for inclusion in ElectraNet's preliminary capex proposal.
- Two projects, which are intended to deliver increased market benefits, cannot currently be economically justified. One of these projects will be further investigated during the Stage 2 review.

AEMO's assessment of these seven projects is summarised in Table 1.

Table 1 Summary of the projects assessed in this report

Investment driver	Projects assessed	AEMO's assessment
Connection	1	This 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.
Asset replacement	3	These projects are driven by the need to address the poor asset conditions identified by ElectraNet and ETC compliance requirements. AEMO agrees with this need, and that ElectraNet's proposal is reasonable. It is important to note that this report does not attempt to provide advice on the condition of ElectraNet's assets or ElectraNet's asset retirement decisions. Rather this report assessed the economic efficiency of credible reinvestment options on the premise that the relevant poor asset conditions need to be addressed in the next regulatory period as advised by ElectraNet. The AER may reject these proposed projects on the grounds that the existing assets are in reasonable condition.
Security and compliance	3	AEMO considers the project proposed to provide voltage support following the closure of Northern Power Station is required to maintain power system security. AEMO considers that the remaining two projects cannot currently be economically justified but agrees with ElectraNet that one of these projects (upgrading Robertstown 275 kV circuit breaker arrangement) should be investigated further during the second stage of this review.

These findings are consistent with AEMO's *2015 National Transmission Network Development Plan* (NTNDP), which highlighted:

- The role of the transmission grid is evolving, from transmission of bulk power, to include secure operation of the power system.
- There is a continuing trend for investment to shift to the efficient replacement of aging assets.

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). To facilitate this review, AEMO carried out steady state power system studies and, where relevant, economic assessments. The steady state power system studies carried out in this review include the following two types of load flow studies:

- A contingency analysis for assessing the shared transmission network and connection point supply adequacy and voltage quality (magnitude).
- Reactive Power-Voltage (QV) analysis for assessing the reactive power margins at key 275 kV and 132 kV substations.

When information is available about contingent projects, AEMO will undertake a detailed ETC compliance assessment in stage two of this review. ElectraNet and TransGrid are currently undertaking analysis on a possible new interconnector and expect to be conducting an assessment of potential projects against the RIT-T. Any such project would be treated as a contingent project and may be separately reviewed.

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TABLES

FIGURES

1. BACKGROUND

At the request of ElectraNet and the South Australian Government, AEMO is conducting this review of ElectraNet's preliminary regulatory proposal for the period 2018–19 to 2022–23.

This review is being undertaken in two stages:

- The first stage is to assess ElectraNet's preliminary capex projects.
- The second stage is to review ElectraNet's formal capex projects. This stage will also assess the following type of projects, about which information is not yet available:
  - Contingent projects[4]. ElectraNet and TransGrid are currently undertaking analysis on a possible new interconnector and expect to be conducting an assessment of potential projects against the RIT-T. Any such project would be treated as a contingent project and may be separately reviewed.
  - Network Capability Incentive Parameter Action Plan (NCIPAP)[5] projects.

This document, which represents the stage one review, presents AEMO's findings on ElectraNet's preliminary capex project proposal for the period 2018–19 to 2022–23.

The conclusions outlined in this document are subject to change during the second stage assessment if new information becomes available.

AEMO has worked closely with ElectraNet during this review. The assessment process involved an independent review of information provided by ElectraNet. This information included individual project proposals, load flow models, and economic assessment where relevant. Project costs were not independently assessed by AEMO.

1.1 The scope of this review

AEMO's assessment consisted of an independent review of the ongoing power system need for ElectraNet's preliminary projects. The assessment focussed on the following:

- Capex projects proposed to ensure the South Australian transmission network's compliance with the South Australian Electricity Transmission Code (ETC).
- Economic justification for capex projects proposed to deliver increased market benefits.[6]

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

- 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.[7]
- Where relevant, whether the project timing is appropriate.[8]

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 identified needs. In particular, AEMO has not assessed ElectraNet's asset condition or ElectraNet's decision that the poor asset conditions need to be addressed in the regulatory period 2018–19 to 2022–23.

[4] 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 National Electricity Rules (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.

[5] The NCIPAP was designed by the AER to support improved usage of existing network assets through low-cost projects.

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

[7] Based on ElectraNet's advice, poor condition assets at Mount Barker, Mount Gambier, 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.

[8] In this review, the relevant projects are a new connection point at Gawler East and installation of 50 MVAr reactor.

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

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

Exclusions

AEMO's independent review 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 replacement.
- Any other aspects of the revenue proposal not associated with network projects.
- Contingent projects and NCIPAP proposals, which will be considered in the second stage of AEMO's review.

AEMO's assessment used its independent forecasts in the *2016 Connection Point Forecasting Report for South Australia*.[9]

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

[9] 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 suggested 12 projects for AEMO's review:

- The assessment of two projects was placed on hold by ElectraNet until further studies can be completed.
- Two more projects were withdrawn following initial discussions.
- ElectraNet and AEMO agreed that one project was beyond the scope of AEMO's review.[10]

For a detailed summary of the seven projects addressed in this report, as well as a list of the five projects that were put on hold, withdrawn, or considered beyond scope of this review, see Appendix C.

2.1 Connection assets

ElectraNet has proposed one load-driven connection project in its preliminary capex proposal.

Gawler East connection point

ElectraNet's preliminary 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 between $4 million and $6 million. SA Power Networks had asked ElectraNet to provide this transmission connection point in 2019 to address a forecast distribution network limitation.

AEMO agrees with ElectraNet that the establishment of a 132 kV connection point at Gawler East is likely to be the most economical solution, but this will be confirmed by a Regulatory Investment Test for Distribution (RIT-D). AEMO understands that SA Power Networks will commence a RIT-D assessment in 2016 to confirm the preferred option.

Because the Gawler East limitation is localised within the distribution network, AEMO's connection point forecasts do not capture the demand growth driving this limitation. At this stage, AEMO considers there is a need for this proposed project if SA Power Networks' demand forecast for Gawler East eventuates, and will provide further review in the Stage 2 assessment when information relating to SA Power Networks' demand forecast becomes available.

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

2.2 Asset replacement

ElectraNet initially proposed the following four asset replacement projects:

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

Following initial discussions with AEMO, ElectraNet placed the assessment of the Mannum transformer replacement project on hold until further studies can be completed. AEMO assessed the three remaining projects. The outcomes of AEMO's independent review are summarised below, and 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 in Mount Barker, Mount Gambier, and Leigh Creek South and Leigh Creek

[10] ElectraNet and AEMO agreed that a monitoring and protection scheme ($670,000) 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.

Coalfield substations need to be retired or replaced in the next regulatory period. The AER may reject the proposed projects on the grounds that existing assets are in reasonable condition.

- 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 the ranking of the reinvestment options based on project cost estimates provided by ElectraNet.

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-1[11] 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[12] to address the emerging need to manage poor condition assets at Mount Barker. Based on economic analysis carried out to rank the economic efficiency of these options, ElectraNet proposed to refurbish 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 ETC reliability requirement, and the economic efficiency of different reinvestment options, AEMO considers ElectraNet's proposal to be appropriate.

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

The existing Mount Gambier substation is supplied by two 132/66 kV transformers (one 25 MVA transformer and one 50 MVA transformer). ElectraNet identified the existing 50 MVA transformer is 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 requirement.

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

The 33 kV distribution systems at 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.

In principle, AEMO considers ElectraNet's proposal to replace the existing 50 MVA transformer at Mount Gambier with a 25 MVA transformer to be reasonable. AEMO assessed the potential scope of

[11] 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.

[12] 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.

distribution network augmentation required, 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.

Reconfigure Leigh Creek Coalfield and Leigh Creek South substations

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 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. It 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 reconfiguration of 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.

ElectraNet indicated that it will review this proposal if the electricity supply requirement for Leigh Creek Coalfield becomes more likely or if an updated demand forecast for Leigh Creek South becomes available.

ElectraNet's proposal considers asset condition, demand forecasts, reinvestment efficiencies, and the uncertainty of supply requirement at Leigh Creek South and Leigh Creek Coalfield. Based on the assumed future outlook, AEMO agrees with ElectraNet's recommendation at this stage.

2.3 Security and compliance

ElectraNet initially proposed six security and compliance projects. Following initial discussions with AEMO, ElectraNet withdrew two projects that could not be economically justified. Another project[13] is considered beyond the scope of AEMO's review. AEMO has assessed the three remaining projects.

The outcomes of AEMO's independent review are summarised below, and further details relating to the projects are provided in Appendix F.

Installation of a 50 MVAr reactor at Templers West 275 kV substation

ElectraNet's preliminary capex proposal included the installation of a 50 megavolt amperes reactive (MVAr) reactor at Templers West 275 kV substation by 2023 to manage potential high voltage issues. AEMO carried out load flow studies to assess the need for this project and the reactive power compensation requirements in the 2018–19 to 2022–23 regulatory period.

Capacitive reactive power support adequacy assessment

Without augmentation, the reactive power margin at the Davenport 275 kV bus cannot be maintained within the requirement of the National Electricity Rules (NER) (1% of fault level in megavolt-amperes (MVA), see NER clause S.5.1.8). The reactive support shortfall is primarily a result of the Northern Power Station closure in May 2016. This shortfall can be addressed through the provision of about +50 MVAr of capacitive reactive power support at Davenport.

[13] ElectraNet and AEMO agreed that a monitoring and protection scheme ($670,000) 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.

ElectraNet is progressing a RIT-T to provide dynamic reactive power support in the Northern South Australia region (in the range of +/-50 MVAr to +/-100 MVAr) for completion in 2019.[14] ElectraNet has also reported this project in its 2016 *Transmission Annual Planning Report* (TAPR).[15] It is worth pointing out that this project is not one of the preliminary capex projects that ElectraNet provided for AEMO's review. This project is discussed in this report because it will impact on the additional inductive reactive power support required to be provided in the next regulatory period (discussed immediately below).

Inductive reactive power support adequacy assessment

AEMO's *2016 National Electricity Forecasting Report* (NEFR)[16] forecasts that minimum operational demand in South Australia will decline to 300 megawatts (MW) by end of the 2018–19 to 2022–23 regulatory period. AEMO's assessment found that operational solutions[17] are inadequate to manage the potential high voltage issues that are likely to occur. AEMO agrees that about 50 MVAr of additional inductive reactive power support needs to be provided by 2019, and a further 50 MVAr of inductive reactive power support is needed towards the end of the 2018–19 to 2022–23 regulatory period.

If ElectraNet proceeds with the project to provide dynamic reactive power support at Davenport as described above, AEMO considers ElectraNet's proposal to provide 50 MVAr inductive reactive power to manage the high voltages towards the end of the next regulatory period to be reasonable.[18] However, AEMO's assessment shows that the installation of the proposed reactor at Para substation should be considered instead. This would have the added advantage of assisting in maintaining reactive power reserves on the Para Static VAR compensators, which is very important for maintaining voltage quality and stability.

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 275kV 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 Robertstown[19] may be constrained during maintenance.

The addition of a circuit breaker at the Robertstown substation (see Figure 10) will address this issue. However, AEMO's economic assessment does not support this expenditure based on ElectraNet's current cost estimates.

Given the operational difficulties that AEMO and ElectraNet have encountered in scheduling maintenance on 275 kV circuit breakers at Robertstown in the past, AEMO will work with ElectraNet to ensure the full range of market benefits are considered during the second stage assessment.

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 Snuggery[20] and expose customers to a risk of supply interruption. ElectraNet proposes to install an additional 132 kV circuit breaker and create a meshed substation

[14] ElectraNet. Northern South Australia region voltage control (RIT-T: Project specification consultation report). Available at: https://www.electranet.com.au/wp-content/uploads/resource/2016/08/20160803-Report-NorthernSARegionVoltageControlPSCR.pdf.
[15] Available at: https://www.electranet.com.au/wp-content/uploads/report/2016/06/20160630-Report-SouthAustralianTransmissionAnnualPlanningReport.pdf.
[16] Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report.
[17] Referring to switching out the Magill – East Terrace 275 kV cable under relevant contingency conditions. AEMO considered but did not find switching other lines to be feasible operational solutions.
[18] Otherwise, two 50 MVAr reactors will need to be provided at Para or Templers West to manage the potential high voltages.
[19] 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, as well as Hornsdale Wind Farm (Stage 1) and Hornsdale Wind Farm (Stage 2).
[20] Including Snuggery GT, Lake Bonney wind farms, and Canunda wind farm.

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. AEMO does not consider this project to be appropriate for inclusion in ElectraNet's capex allowance for the next regulatory period.

3. REVIEW SUMMARY AND NEXT STEPS

AEMO's review of ElectraNet's proposed 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 Electricity Transmission Code (ETC).

3.1 Summary of AEMO's review

Of the 12 projects proposed by ElectraNet, two projects that could not be economically justified were withdrawn, two projects were deferred until further studies can be performed, and one project was considered beyond the scope of AEMO's review.[21]

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

Table 2 Summary of the projects addressed in this report

Investment driver	Projects assessed	AEMO's assessment
Connection	1	This project is driven by distribution network limitations arising from demand growth. AEMO considers there is a need for this proposed project if SA Power Network's forecast eventuates.
Asset replacement	3	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. This report does not attempt to provide advice on the condition of ElectraNet's assets or ElectraNet's asset retirement decisions. The AER may reject these proposed projects on the grounds that the existing assets are in reasonable condition.
Security and compliance	3	AEMO considers the project proposed to provide voltage support following the closure of Northern Power Station is required to maintain power system security. AEMO considers that the remaining two projects cannot be economically justified but agrees with ElectraNet that one of these projects (upgrading Robertstown 275 kV circuit breaker arrangement) should be investigated further during the second stage of this review.

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 NER. These requirements will be met regardless of the inclusion of projects not considered appropriate by AEMO. Following the availability of contingent project information, AEMO will undertake a detailed ETC compliance assessment in stage two of this review.

AEMO's assessment outcomes are summarised in Appendix C.

3.2 Next steps

AEMO will undertake the second stage of this review after receiving ElectraNet's proposed NCIPAP and contingent projects, as well as any further information regarding their proposed capex projects.

AEMO's findings will be published prior to ElectraNet's submission of its revenue proposal to the AER in January 2017.

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.

[21] ElectraNet and AEMO agreed that a monitoring and protection scheme ($670,000) 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.

Table 3 Upcoming dates in ElectraNet's revenue proposal

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

4. SUPPLEMENTARY INFORMATION

The table below provides links to additional information provided.

Table 4 Links to supporting information

Information source	Website address
2016 National Electricity Forecasting Report	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report
2016 Transmission Connection Point Forecasting Report for South Australia	http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting
Generator 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

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 summer 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 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.*[22]

At the regional level, AEMO used 10% POE state-wide maximum demand forecasts from AEMO's *2016 National Electricity Forecasting Report* (NEFR).[23] 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.[24] 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 the individual generator performance standards.

Generation assumptions

Generator availability was sourced from AEMO's generation information page.[25] Torrens Island 'A' (480 MW) was assumed to remain in service.[26] Except for generation projects classified as committed (Hornsdale Wind Farm Stage 1 and Stage 2), AEMO's assessment assumes that no other new

[22] Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting.
[23] Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/National-Electricity-Forecasting-Report.
[24] This is the most onerous condition for testing the supply reliability of the Riverland region network.
[25] Available at: http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information. Viewed: 28 July 2016.
[26] In line with AGL's recent announcement to defer the previous planned mothballing of generating units in Torrens Island 'A' power station. See AGL's announcement at: https://www.agl.com.au/about-agl/media-centre/article-list/2016/june/agl-to-defer-mothballing-of-south-australian-generating-units. Viewed: 28 July 2016.

generation is commissioned for the regulatory period 2018–19 to 2022–23. Investment requirements likely to be incurred due to future generation connections are expected to be addressed using contingent projects during the second stage of this review. Where these investment requirements are below the contingent project threshold level[27], they should be handled on case by case basis. AEMO particularly noted that any additional generation connected to the 275 kV network between Robertstown and Davenport (for example, Hornsdale Wind Farm Stage 3) will increase the economic benefits of the proposed project for upgrading the circuit breaker arrangement at Robertstown 275kV substation. The possibility of existing generation not being in service was considered from an operational perspective.

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.

[27] Either $30 million or 5% of the value of the maximum allowed revenue for the relevant Transmission Network Service Provider for the first year of the relevant regulatory control period whichever is the larger amount (see Clause 6A.8.1(b)(2)(iii) of the NER).

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 capital 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.[28]
   - 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 any feasible reinvestment options were missing.
- 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. The AER may reject the proposed expenditure on the grounds that the existing assets are in reasonable condition.

Security and compliance projects assessment

In reviewing the security and compliance projects proposed by ElectraNet, except the reactive power compensation projects, the following steps were followed:

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

[28] 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), 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 were investigated, based on AEMO's and ElectraNet's operational experience and assessment of reliability implications if maintenance could not be performed.

Economic analysis of the proposed investment and load flow studies were performed to assist the assessment where relevant.

In reviewing reactive power support projects proposed by ElectraNet, the following steps were followed:

- Detailed load flow studies were carried out to assess the adequacy of reactive power support in the regulatory period 2018–19 to 2022–23. Two types of load flow studies were carried out.
  - Contingency analysis (N-1 studies) was performed to assess voltage quality (magnitude) under maximum demand and minimum demand conditions.
  - Reactive Power-Voltage (Q-V) analysis was carried out 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 MVA[29]). Fault levels reported in the 2016 South Australian TAPR[30] were used as the basis for calculating the fault level margin requirement.

[29] Clause S.5.1.8 of the NER.
[30] Available at: https://www.electranet.com.au/wp-content/uploads/report/2016/06/20160630-Report-SouthAustralianTransmissionAnnualPlanningReport.pdf.

APPENDIX C. PROJECT SUMMARY

Table 5 summarises the projects that are addressed in this report. Table 6 summarises projects proposed by ElectraNet that were withdrawn or deferred following initial discussions with AEMO, and one project considered out of scope of this assessment.

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

ElectraNet proposal	Project category	AEMO assessment summary[31]
Gawler East Connection Point	Connection	The project is driven by a distribution network limitation to meet the forecast demand growth in Gawler East region. AEMO agrees with ElectraNet that establishing a 132 kV connection point at Gawler East, to meet SA Power Networks' forecast demand increase, is likely to be more economical than augmenting the distribution network. AEMO will reassess this project when more information surrounding the demand forecast in Gawler East and the distribution network limitation becomes available.
Mount Barker substation refurbishment	Asset replacement	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 substations to address the need to replace the poor condition assets. AEMO considers ElectraNet's proposal reasonable.
Mount Gambier 132/33 kV transformer No. 1 (50 MVA) replacement	Asset replacement	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.
Reconfigure Leigh Creek Coalfield and Leigh Creek South substations	Asset replacement	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. ElectraNet recommended reconfiguring the Leigh Creek South supply to put one transformer on hot standby assuming the most likely scenario where Alinta will not require electricity supply at Leigh Creek Coalfield. ElectraNet also indicated that they will review this proposal if ElectraNet receives updated demand forecasts for Leigh Creek South and Leigh Creek Coalfield substations. AEMO considers ElectraNet's proposal reasonable.
Robertstown circuit breaker arrangement upgrade	Security and compliance	Adding a circuit breaker at Robertstown would alleviate constraints on generation north of Robertstown and on the Murraylink interconnector. AEMO considers the proposed project, however, is not currently economically justifiable. Understanding the operational difficulties encountered in scheduling maintenance in the past, AEMO will work with ElectraNet to ensure the full range of market benefits are considered in the second stage of the review.
Blanche circuit breaker arrangement upgrade	Security and compliance	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 justifiable.
Para – Davenport additional reactive support (install a 50 MVAr reactor)	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.

[31] 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 reject the proposed expenditure on the grounds that existing assets are in reasonable condition.

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

ElectraNet Proposal	Project Category	Comments
Dalrymple ESCRI-SA Energy Storage (should the ARENA application progress)	Demonstration	Placed on hold
Mannum 132/33 kV transformer 1 and 2 replacement	Replacement	Placed on hold
Kilburn Substation upgrade to complete mesh configuration	Security and compliance	Withdrawn
Murray Bridge / Hahndorf No 3 Pumping Station substation 132 kV mesh bus	Security and compliance	Withdrawn
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 ($670,000) 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.

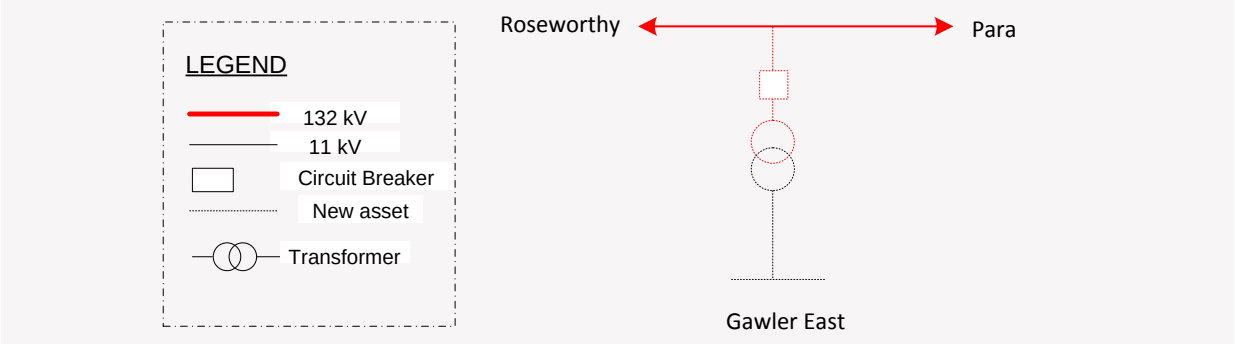
APPENDIX D. CONNECTION PROJECT SUMMARY

D.1 New connection point at Gawler East

Background

Based on information provided by ElectraNet, AEMO understands that SA Power Networks proposes the establishment of a 132/11 kV connection point at Gawler East by 2019 to supply forecast demand in a new residential development. This solution will involve supplying the proposed 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



Options considered by ElectraNet and SA Power Networks

The options considered by ElectraNet and SA Power Networks are:

- Option 1: Build a 132 kV bus to provide supply to a 132/11 kV substation (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: Build a 132 kV substation with a single 25 MVA 132/11 kV transformer (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 66 kV line to meet demand growth supplied from the Gawler East region.

Based on advice from ElectraNet, SA Power Networks' ultimate demand forecast for the Gawler East area is about 25 MVA. SA Power Networks' demand forecasts for individual years and distribution network limitations are not available.

AEMO's assessment

AEMO notes that demand growth in the Gawler East area can potentially be supplied from the existing Northern Suburbs (grouped connection points), Templers substation, and Dorrien substation. If the demand forecast by SA Power Networks eventuates, distribution network capacity needs to be enhanced. As the existing Para – Roseworthy 132 kV line traverses the Gawler East area, establishment of a new 132 kV connection point in Gawler East is likely to be the most economical solution, but this needs to be confirmed by a Regulatory Investment Test for Distribution (RIT-D).

AEMO understands that SA Power Networks will commence a RIT-D assessment in 2016 to identify the preferred option. AEMO will review this project when information relating to the demand forecast and distribution limitation becomes available.

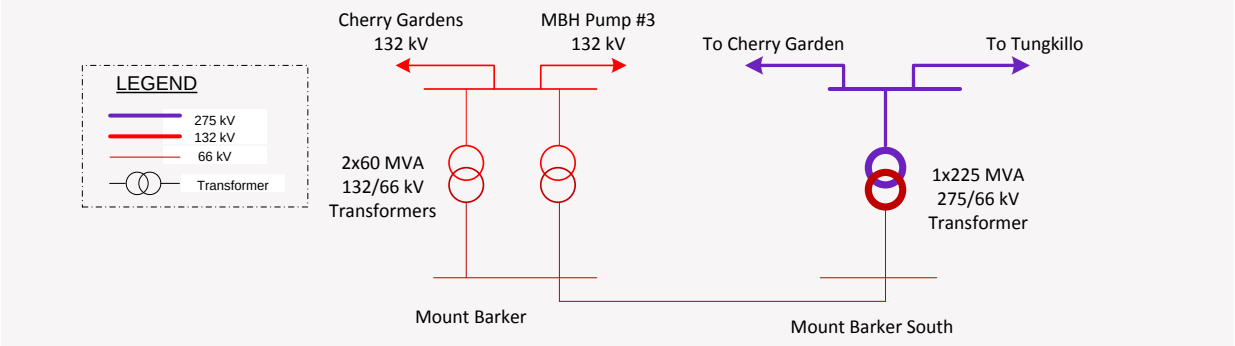
APPENDIX E. ASSET REPLACEMENT PROJECTS SUMMARY

E.1 Mount Barker substation asset replacement

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 2.

Figure 2 Mount Barker and Mount Barker South area supply



ElectraNet's proposal

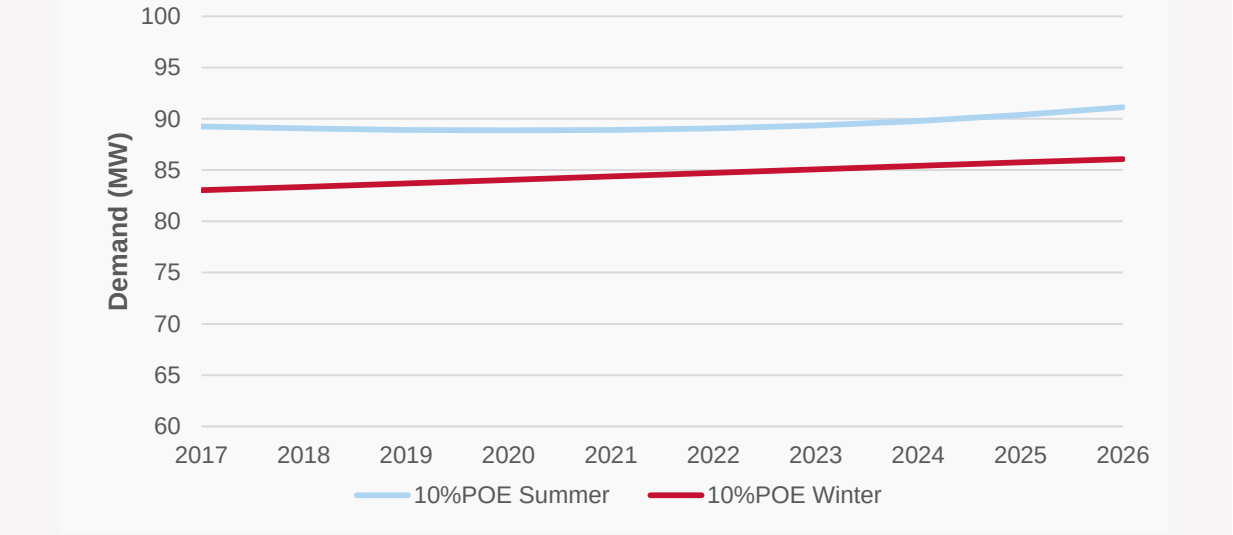
ElectraNet has investigated the following options:

- 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.
  - Augment the distribution networks 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).
  - Augment the distribution network 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 3 shows the connection point forecasts for Mount Barker and Mount Barker South.

Figure 3 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 MVA[32], which is sufficient to support forecast demand throughout and beyond the 2016–17 to 2025–26 period.

AEMO's assessment

The load at Mt Barker and Mt 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 proposed to refurbish the existing poor condition Mount Barker substation assets to address the requirement.

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. However, it is important to note that the AER may reject the proposed expenditure on the grounds that the existing assets at Mount Barker are in reasonable condition.

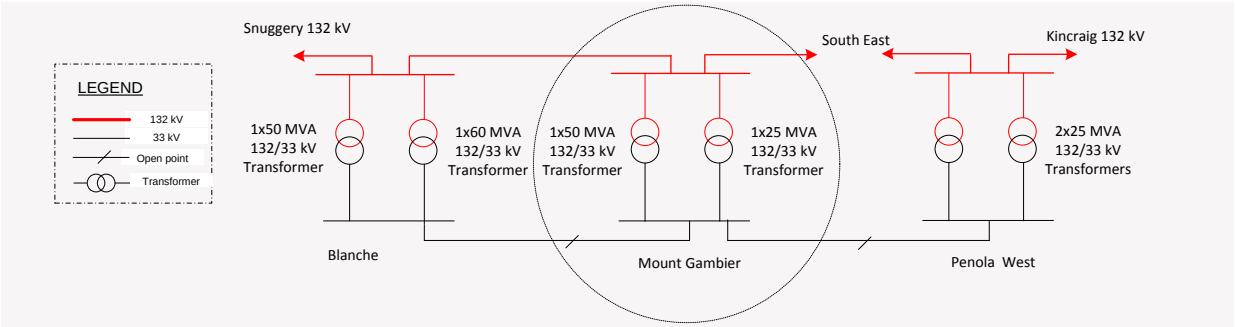
[32] Short-term transformer ratings are considered in line with ElectraNet's operational practice.

E.2 Replace the Mount Gambier 132/33kV transformer No.1 (50 MVA) with a 25 MVA transformer

Background

The existing Mount Gambier substation is supplied by two 132/33 kV transformers, as shown in Figure 4. 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 4 Mount Gambier substation supply



ElectraNet's proposal

ElectraNet has investigated the following options[33]:

- 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 MVA132/33 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:

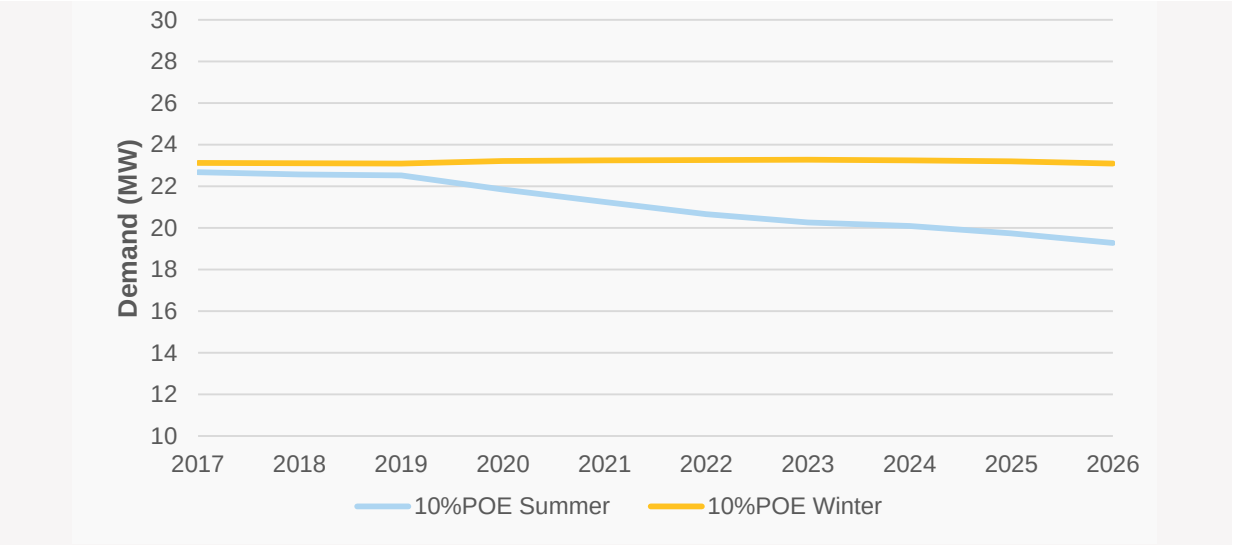
[33] All options considered the replacement of the Blanche 132/33 kV transformer No.2 (50 MVA) in the regulatory period 2023–24 to 2027–28. The scope described in this report only covers the works proposed by ElectraNet in the 2018–19 to 2022–23 regulatory period.

- Build a new substation on the adjacent site to replace the existing Mount Gambier substation.
- 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 5 shows the transmission connection point forecasts for Mount Gambier substation.

Figure 5 AEMO connection point demand forecast for Mount Gambier



Network capacity

The firm transformer capacity (N-1 capacity) at Mount Gambier is approximately 30 MVA[34], 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 proposed to replace 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 will 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.

Based on the need to meet 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 replace the existing 50 MVA transformer at Mount Gambier with a 25 MVA transformer to be reasonable. However, it is important to note that the AER

[34] Short-term rating is considered in line with ElectraNet's operational practice.

may reject the proposed expenditure on the ground that the existing 50 MVA transformer at Mount Gambier is in reasonable condition.

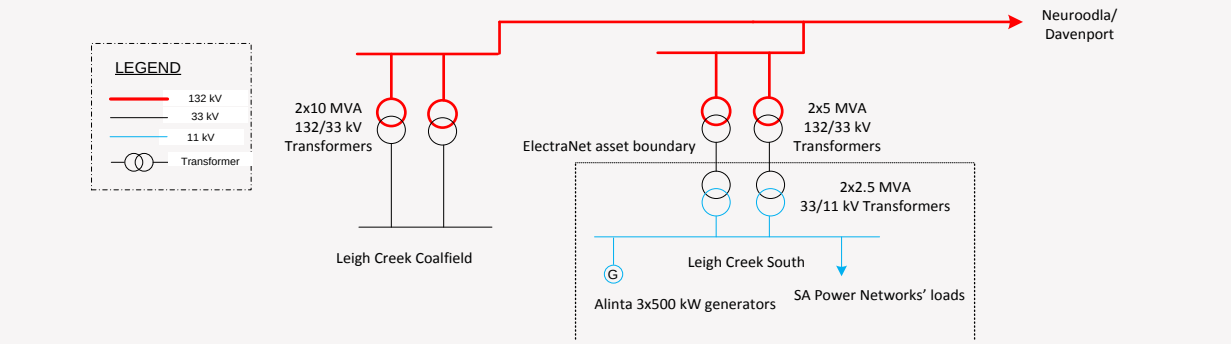
E.3 Reconfigure Leigh Creek South and Leigh Creek Coalfield substations

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 they 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 6.

Figure 6 Leigh Creek South and Leigh Creek Coal field supply



ElectraNet's proposal

ElectraNet investigated the following options:

- Option 1: Substation reconfiguration at Leigh Creek South. Major work includes:
  - Reconfigure Leigh Creek South to put one 132/33 kV transformer on hot standby by opening an 11 kV switch.
  - Decommission the Leigh Creek Coalfield connection point.
  - De-energise the Leigh Creek Coalfield – Leigh Creek South 132 kV circuit.
- Option 2: 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 3: Establish a micro-grid at Leigh Creek South. Major work includes:
  - Establish a micro-grid comprising a mix of standby generators, wind generators, solar 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 4: Establish a micro-grid at Leigh Creek South. Major work includes:
  - Establish a micro-grid comprising a mix of standby generators, wind generators, solar PV and battery storage.
  - De-energise 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.

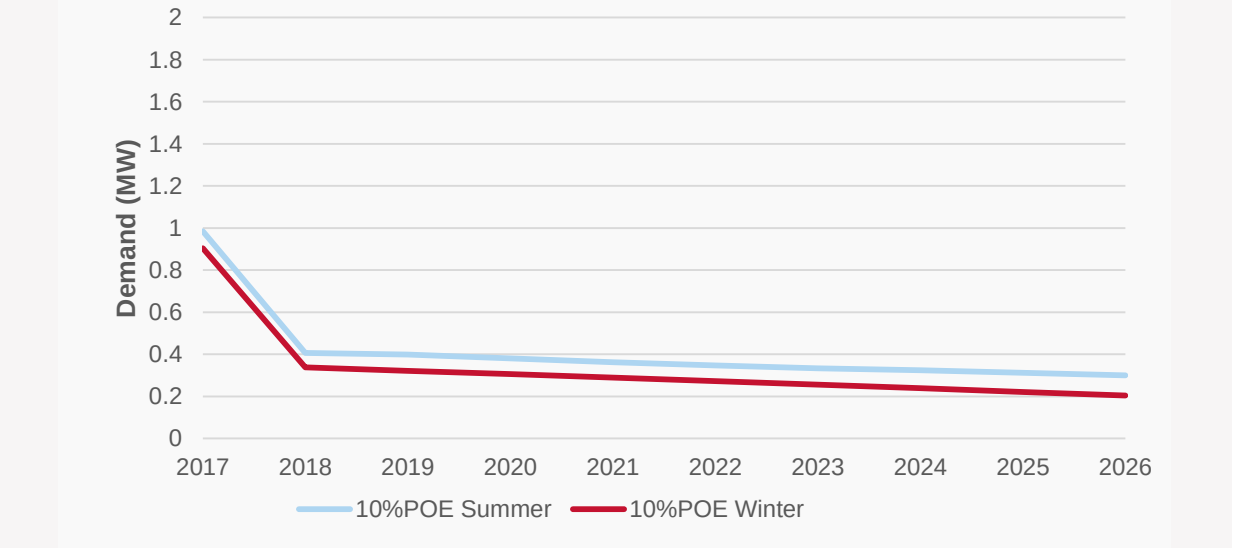
ElectraNet also investigated the following combinations of options:

- Option 1-2: Implement Option 1, followed by Option 2.
- Option 1-3: Implement Option 1, followed by Option 3.
- Option 1-4: Implement Option 1, followed by Option 4.

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 7 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 7 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. Based on the assessment, ElectraNet proposed to carry out switching reconfiguration to put one 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, or if an updated demand forecast for the Leigh Creek South becomes available.

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 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, it is important to note that the AER may reject the proposed expenditure on the grounds that the existing assets are in reasonable condition.

AEMO understands that when the total demand required from Leigh Creek South and Leigh Creek Coalfield declines to a certain level, the micro-grid option may become competitive. AEMO will work with ElectraNet to further explore the benefit of the micro-grid options during the second stage of review.

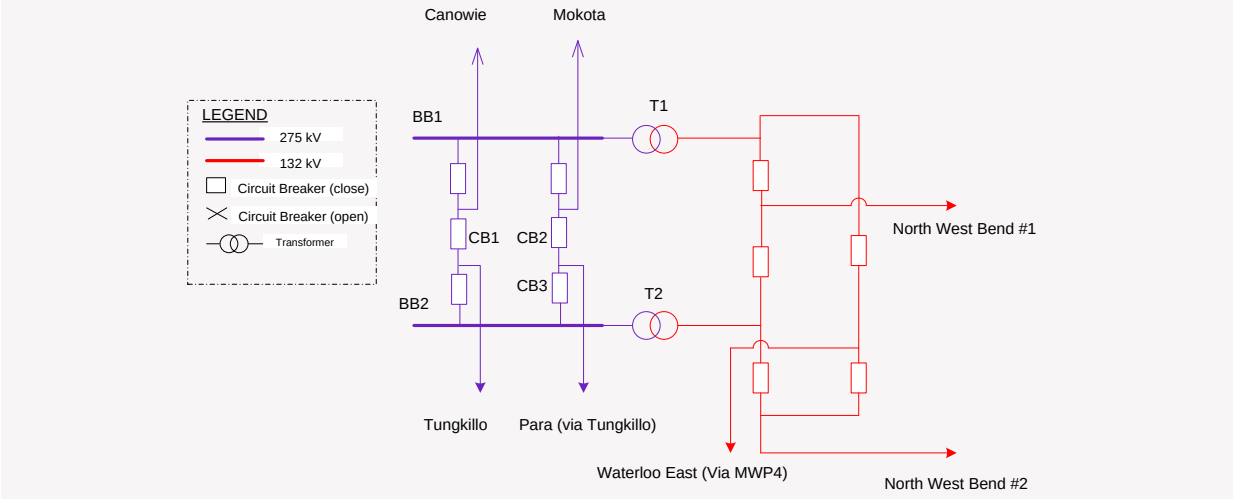
APPENDIX F. SECURITY AND COMPLIANCE PROJECTS

F.1 Robertstown circuit breaker arrangement upgrade

Background

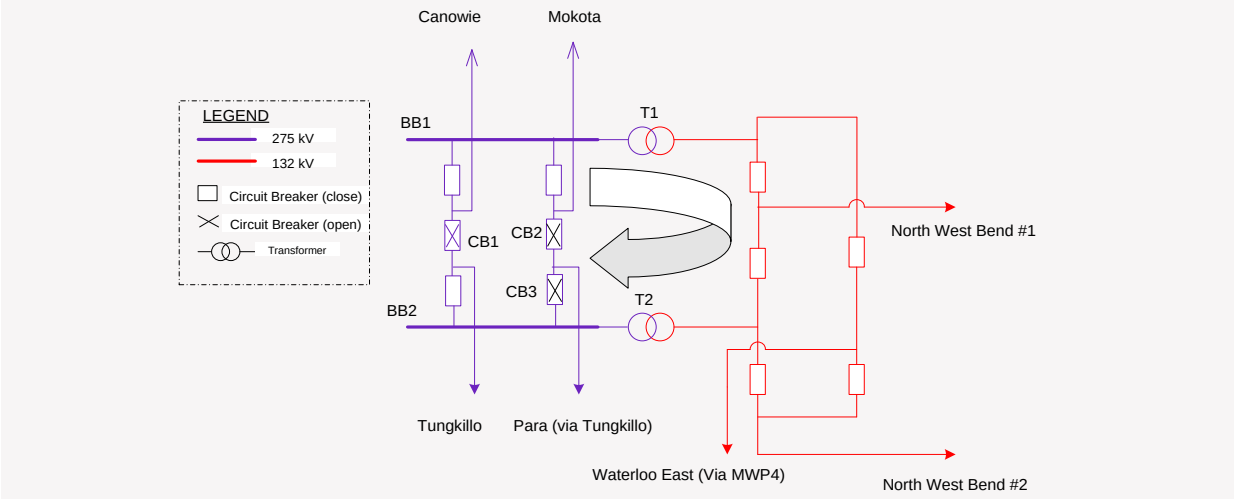
The circuit breaker arrangement at the Robertstown 275/132 kV substation is shown in Figure 8.

Figure 8 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 results 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 9. Therefore, during scheduled maintenance, the generation north of Robertstown and the Murraylink interconnection flow might be constrained to ensure secure operation.

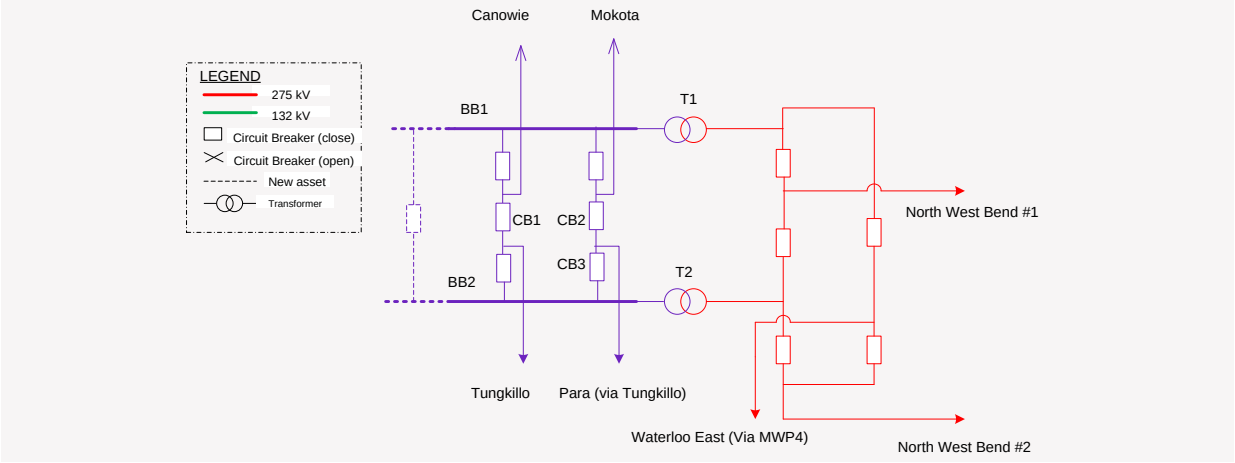
Figure 9 Single line diagram illustrating the load flow when Robertstown 275 kV bus is split into isolated sections



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 10.

Figure 10 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 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.

AEMO carried out an economic assessment in consultation with ElectraNet. The assessment found that the potential economic benefit is not sufficient to support the expenditure proposed by ElectraNet.

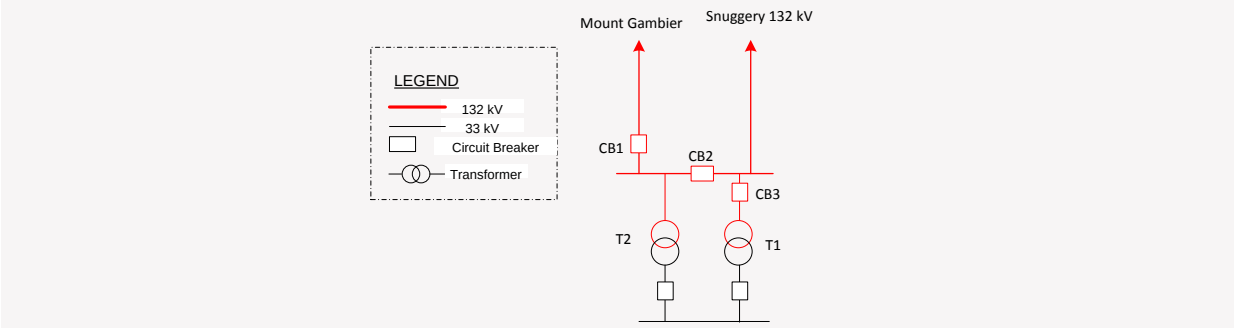
Considering the operational difficulties in scheduling maintenance on the 275 kV circuit breakers at Robertstown in the past, AEMO will collaborate with ElectraNet to ensure the full range of market benefits are considered during the Stage two assessment.

F.2 Blanche circuit breaker arrangement upgrade

Background

Blanche 132 kV substation has a straight bus arrangement as illustrated in Figure 11. 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.

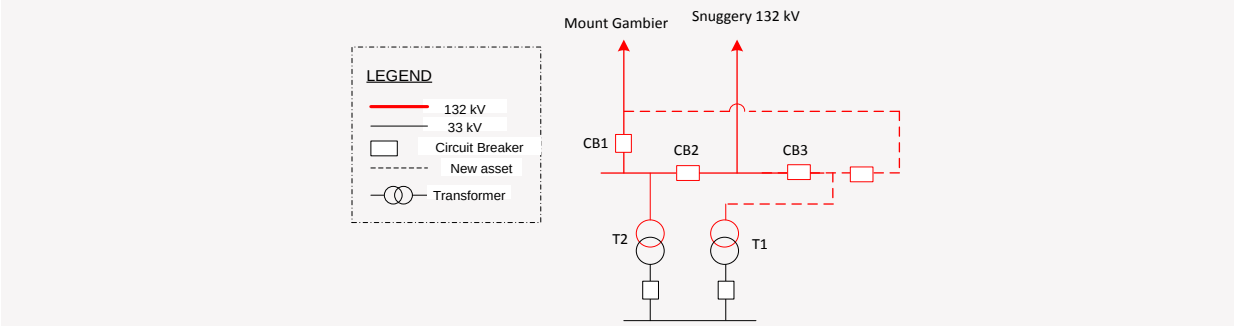
Figure 11 Single line diagram illustration of circuit breaker arrangement in Blanche 132 kV substation



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 12.

Figure 12 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 in consultation with ElectraNet. Based on ElectraNet's current cost assumptions, the assessment outcome found that the project is not economically justified.

Therefore, AEMO considers that including this project as a capex project for the 2018–19 to 2022–23 regulatory period is inappropriate.

F.3 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, the following two scenarios were investigated:

- 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. The Q-V analysis 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 reactive power support shortfall was largely driven by the closure of the Northern Power Station in May 2016. The provision of approximately 50 MVAr of capacitive reactive power support at Davenport will address the reactive power shortfall. ElectraNet is progressing a RIT-T to provide dynamic reactive power support (in the range of +/-50 MVAr to +/-100 MVAr) for completion in 2019.[35] This is also reported in ElectraNet's 2016 TAPR. AEMO considers that this project is sufficient to provide the required capacitive reactive support at Davenport.

Light load studies

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

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

The following sensitivities were also considered:

- The number of South Australian synchronous generators in service.
- The availability of additional dynamic support at the Davenport 275 kV bus.

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 identified that switching out the existing Magill – East Terrace 275 kV cable is equivalent to injecting 50 to 60 MVAr of inductive reactive power at the Para 275 kV bus. Considering the reactive power that can be provided by switching out this cable under relevant contingency conditions, AEMO considers that an additional 50 MVAr of reactive power needs to be provided by 2019, and a further 50 MVAr will be needed towards the end of the 2018–19 to 2022–23 regulatory period.

ElectraNet is progressing a RIT-T to provide dynamic reactive power support (in the range of +/-50 MVAr to +/-100 MVAr) at Davenport for completion in 2019. This is also reported in ElectraNet's 2016 TAPR. Assuming that ElectraNet proceeds with this project, only 50 MVAr reactive power support will be needed by end of the 2018–19 to 2022–23 regulatory period.

[35] Before 2019, the reactive power shortfall risk will be managed with an under-voltage load shedding scheme.

MEASURES AND ABBREVIATIONS

Units of measure

Abbreviation	Unit of measure
kV	Kilovolts
MW	Megawatts
MVA	Megavolt amperes
MVAr	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
NCIPAP	Network Capability Incentive Parameter Action Plan
NEFR	National Electricity Forecasting Report
NER	National Electricity Rules
NTNDP	National Transmission Network Development Plan
TNSP	Transmission Network Service Provider

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.
Contingency event	An event affecting the power system, such as the failure or unplanned removal from operational service of a generating unit or transmission network element.
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.
Network capability	The capability of the network or part of the network to transfer electricity from one location to another.

Term	Definition
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.
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 reliability	The ability of the power system to supply adequate power to satisfy customer demand, allowing for credible generation and transmission network contingencies.
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.
Primary plant	Equipment which are directly connected to the high voltage. These include circuit breakers, isolators, current transformers, voltage transformers and bushings etc.
Region	An area determined by the AEMC in accordance with Chapter 2A of the NER.
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
ElectraNet	ElectraNet	41 094 482 416
SA Power Networks	SA Power Networks	13 332 330 749