Baroota Substation Upgrade

RIT-T: Project Assessment Draft Report

June 2015

Version 1

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Glossary of Terms

Term	Description
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMD	Agreed Maximum Demand
ESCOSA	Essential Services Commission of South Australia
ETC	Electricity Transmission Code
NPV	Net Present Value
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
NER	National Electricity Rules
RET	Renewable Energy Target
RIT-T	Regulatory Investment Test for Transmission
Rules	National Electricity Rules
TNSP	Transmission Network Service Provider
USE	Unserved Energy
VCR	Value of Customer Reliability

1. Introduction

This Project Assessment Draft Report (PADR) has been prepared by ElectraNet and SA Power Networks in accordance with the requirements of the National Electricity Rules (NER) clause 5.16.4. It represents the second stage of the formal consultation process set out in the NER in relation to the application of the Regulatory Investment Test - Transmission (RIT-T) for the Baroota substation upgrade.[1] This PADR:

- Describes the identified need which ElectraNet and SA Power Networks are seeking to address, namely a corrective action to meet a reliability standard;
- Describes the credible options that ElectraNet and SA Power Networks consider may address the identified need;
- Summarises and provides commentary on the submissions received on the earlier Project Specification Consultation Report (PSCR);
- Provides a quantification of costs and classes of material market benefit for each of the credible options;
- Provides the results of the net present value (NPV) analysis for each credible option assessed, together with accompanying explanatory statements; and
- Identifies the preferred option that addresses the identified need.

Appendices to this PADR provide further information in relation to the assumptions adopted for the RIT-T assessment and the results of the assessment.

The identified need for this RIT-T is to undertake a reliability corrective action to ensure that the current South Australia Electricity Transmission Code (ETC) requirement of providing category 2 reliability at the Baroota exit point is met from 1 December 2017 (outlined in section 2.2).

1.1 Proposal not to proceed

ElectraNet has undertaken its own economic analysis of the reliability standard applying to Baroota in light of changes that have occurred since it was last reviewed and has found that a category 2 level of reliability is not justified from 1 December 2017.

ElectraNet's analysis has included revisiting the assumptions that underpinned earlier analysis undertaken in 2010, which resulted in the Essential Services Commission of South Australia (ESCOSA) changing the Baroota ETC reliability standard from category 1 to category 2.

The key factors relevant to this updated assessment include:

- The latest reduced demand forecasts for the Baroota Connection Point (impacted by factors such as rooftop solar PV uptake);
- More recent reduced value of customer reliability published by AEMO (which measures the cost of unserved energy); and
- Revised transformer outage assumptions.

[1] The first stage of this RIT-T process is: ElectraNet & SA Power Networks, *Baroota substation upgrade*, Project Specification Consultation Report, May 2014 – available at: http://www.electranet.com.au/assets/RIT-T/Baroota-substation-upgrade/BarootaSubstationUpgradeProjectSpecificationConsultationReportMay2014.pdf

While the 2010 analysis indicated that the benefits to customers from improved reliability would outweigh the costs, ElectraNet's revised economic analysis has shown a significantly lower customer benefit from the upgrade than the original analysis and that the least cost network solution to meet the category 2 reliability standard does not produce a positive net market benefit.

ElectraNet also actively considered non-network solution options and engaged with a non-network solution proponent to refine the technical and commercial characteristics of a solution it proposed. Despite the efforts of the proponent to reduce costs, the economic analysis shows that the identified non-network solution does not produce a positive net market benefit either.

In summary, no technically feasible option has been identified that meets the category 2 reliability standard and results in a positive net benefit to customers. Given this outcome, ElectraNet considers it would not be in the interests of consumers to proceed with the upgrade required by the ETC.

ElectraNet has therefore written to ESCOSA proposing that the Commission amend the ETC to remove the reclassification of the Baroota Connection Point to category 2 from 1 December 2017.

ElectraNet and SA Power Networks intend to discontinue the RIT-T process that is the subject of this PADR subject to ESCOSA accepting and making the proposed change to the ETC.

1.2 Submissions

ElectraNet and SA Power Networks welcome written submissions on this PADR.

Submissions are due on or before 31 July 2015.

Submissions should be emailed to consultation@electranet.com.au or requestforproposals@sapowernetworks.com.au. Submissions will be published on the ElectraNet and SA Power Networks websites. If you do not wish for your submission to be made publicly available please clearly stipulate this at the time of lodging your submission.

2. Identified Need

This section summarises the background to the region in which the existing Baroota substation operates, as well as the identified need under this RIT-T for upgrading the substation.

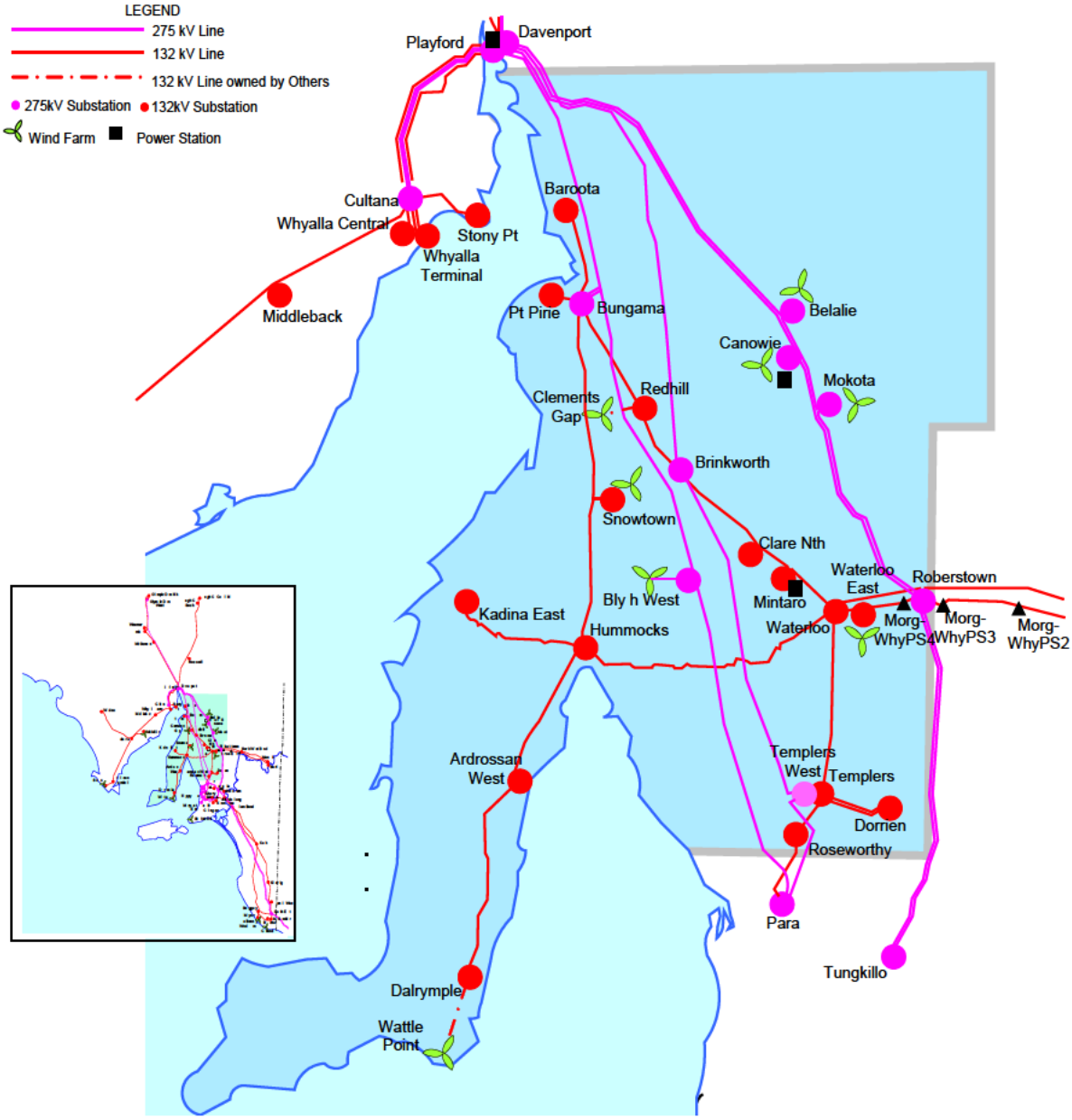
2.1 Background

The Baroota substation is located in the northern part of the Mid North region of South Australia. It is supplied by a 26 km long single circuit 132 kV line from Bungama substation. The majority of the existing plant is in poor condition except the 132/33 kV 10 MVA transformer which was installed as a replacement in 2006.

2.1.1 Existing Mid North network

The Mid North 132 kV transmission system comprises a network that supplies major load centres at Ardrossan, Brinkworth, Clare, Kadina and Port Pirie, as well as other loads in the Barossa Valley and Yorke Peninsula regions. It derives its supply from the Main Grid 275 kV system via 275/132 kV substations located at Para (near Elizabeth), Templers West, Robertstown, Brinkworth and Bungama (near Port Pirie). Figure 1 is a geographical diagram of the region.

Figure 1 Geographical Diagram of the Mid North region



The Mid North 132 kV system operates in parallel with the 275 kV Main Grid system that connects the major sources of generation at Port Augusta with the Adelaide metropolitan load centre. As a consequence, power flows in the Mid North 132 kV system are not only determined by the loads that must be supplied within the region but also by flows on the Port Augusta to Adelaide 275 kV system.

The Mid North of South Australia contains a mixture of electrical loads including agriculture, grazing, aquaculture and viticulture loads. Commercial loads also comprise a significant portion of total load at the major centres of Port Pirie, Kadina, Port Wakefield, Clare and on the Yorke Peninsula and in the Barossa Valley.

2.1.2 Committed network developments and existing generation

ElectraNet currently has no committed projects in the Mid North region that will affect this RIT-T assessment.

There are currently no anticipated network developments in the Mid North region that will affect this RIT-T assessment. The pending Dalrymple substation upgrade project will address unrelated supply reliability requirements in the Mid North. This project is summarised in Table 1 below.

Table 1: Pending projects in the Mid North region

Connection Point	Scope of Work	Timing
Dalrymple Substation	Install 2nd 25 MVA 132/33 kV Transformer	2016

Existing generation on the Mid North 132 kV network includes a mixture of gas turbine plant and wind farms.

The 90 MW Mintaro open cycle gas turbine (OCGT) is connected to the 132 kV system while the OCGTs at Hallett power station (192 MW) are connected to the 275 kV Main Grid. There is also a 50 MW distillate fired generator embedded in the SA Power Networks 33 kV distribution network at Angaston.

There are nine existing wind farms operating in the Mid North, which are widely scattered throughout the region.

The wind farms connected to the 132 kV system are:

- Wattle Point (90.8 MW, near Edithburgh on the Yorke Peninsula);
- Snowtown (98.7 MW);
- Clements Gap (56.7 MW, south of Port Pirie); and
- Waterloo (111.0 MW, east of the Waterloo area).

The wind farms connected to the 275 kV Main Grid are:

- Brown Hill (94.5 MW);
- Hallett Hill (71.4 MW);
- North Brown Hill (132.3 MW);
- Snowtown Stage 2 (270 MW); and
- The Bluff (52.5 MW).

2.2 Description of the identified need

In February 2012, ESCOSA released a revised ETC. The revised standards reclassified the Baroota connection point from reliability category 1 to category 2 from 1 December 2017. ETC reliability category 2 requires “N-1” continuous equivalent transformer capacity sufficient to meet 100% of contracted agreed maximum demand (AMD).

This RIT-T has been undertaken as a reliability corrective action[2] in order to ensure that ElectraNet meets the reliability standard set out in the ETC with respect to the Baroota connection point.

The existing Baroota substation currently has a single ("N") 10 MVA 132/33 kV transformer installed. Under the revised ETC reliability standards, reliability corrective action is therefore needed to ensure that, in the event of an unplanned outage of the existing Baroota transformer, ElectraNet and SA Power Networks can ensure uninterrupted supply in accordance with the new category 2 reliability standard applying to the Baroota connection point from 1 December 2017.

2.3 Electricity Transmission Code requirements

ESCOSA is responsible for establishing the ETC, which details the minimum reliability and restoration standards that ElectraNet is required to provide at individual exit points.[3]

Clause 2.4 of the ETC assigns the Baroota connection point to reliability category 1 until 1 December 2017. For category 1 connection points, ElectraNet is required to provide "N" equivalent transmission line and transformer capacity for at least 100% of contracted AMD.

From 1 December 2017, the ETC assigns the Baroota connection point to reliability category 2. For category 2 connection points, ElectraNet is required to provide "N" equivalent transmission line and "N-1" equivalent transformer capacity for at least 100% of contracted AMD.

Clause 2.6.1(b) of the ETC also requires ElectraNet to:

(i) *in the event of a failure of any installed transformer or network support arrangement, use its best endeavours to restore "N-1" equivalent transformer capacity as soon as practicable;*

(ii) *in the event of an interruption arising from the failure of the installed transformers or network support arrangements:*

A. *restore at least "N" equivalent transformer capacity within 8 days of the commencement of the interruption; and*

B. *use its best endeavours to restore "N-1" equivalent transformer capacity as soon as practicable after the commencement of the interruption.*

Clause 10.1 of the ETC defines "N-1" as follows:

> *"N-1" means the ability of the transmission system to continue to supply the contracted amount of agreed maximum demand connected to the transmission system without interruption should any one element fail.*

[2] Defined in NER Chapter 10 as *"Investment by a Transmission Network Service Provider in respect of its transmission network for the purpose of meeting the service standards linked to the technical requirements of schedule 5.1 or in applicable regulatory instruments and which may consist of network or non-network options".*

[3] An 'exit point' is defined in the ETC as a *connection point through which a transmission customer imports electricity from the transmission network.*

3. Submissions to the Project Specification Consultation Report

Two submissions were received on the PSCR; one from a group of generators and one from a non-network proponent, Vibe Energy. The two issues raised in these submissions are discussed below.

3.1 Justification for the 2017 reliability upgrade needs to be reassessed

The generators'[4] submission states that the assumptions underpinning the previous economic assessment justifying the 1 December 2017 reliability upgrade have not materialised as peak demand has declined, raising doubts about the economic justification and commercial viability of the proposed upgrade to the reliability standard. The generators consider a robust cost benefit analysis is now required in order to justify whether the upgrade should be undertaken, the results of which should be published, prior to the completion of the PADR.

As outlined in section 1.1, a number of factors have changed since the previous reliability review. These factors include the impact of rooftop solar PV on demand and updated Value of Customer Reliability (VCR) estimates for Baroota according to the latest VCR values published by AEMO.[5]

ElectraNet has separately undertaken a comprehensive review and option analysis to determine the overall solution that maximises net economic benefits to consumers, including revisiting the original assumptions. This was required to reflect changes that have occurred since the previous ETC review in which, as a result of the economic analysis at the time, ESCOSA amended the Baroota ETC reliability standard from category 1 to category 2 from 1 December 2017[6].

The outcomes and conclusions of this analysis are discussed in sections 1.1 and 7 of this report.

3.2 Consideration of a non-network option

Vibe Energy proposed a non-network solution utilising diesel generators combined with battery storage connecting to the 33 kV network at Baroota substation to provide equivalent transformer N-1 reliability.

ElectraNet has actively engaged with Vibe Energy to refine the technical and commercial characteristics of the solution it proposed. This resulted in the development of Option 3 - Diesel generators combined with battery storage connected to 33 kV at Baroota substation (as outlined in section 5).

[4] Generators represented in this submission are: AGL Energy, Alinta Energy, CS Energy, Delta Electricity, EnergyAustralia, Energy Brix, ERM Power, GDF SUEZ, Australian Energy, Hydro Tasmania, Macquarie Generation, Origin Energy, Snowy Hydro and Stanwell.

[5] AEMO, Value of Customer Reliability Review, Final Report, September 2015.

[6] Available at http://www.escosa.sa.gov.au/library/130701-ElectricityTransmissionCode-TC07_2.pdf

4. Description of methodology

This section provides a summary of the methodology adopted for the RIT-T assessment and discusses which market benefits are material for this RIT-T assessment.

4.1 Detailed description of methodologies

4.1.1 Analysis period

The RIT-T analysis has been undertaken over a period of 15 years, from 2017/18 through to 2032/33.

ElectraNet and SA Power Networks consider that that a 15 year period is appropriate in order to adequately assess the impact of the alternative credible options on future market benefits.

4.1.2 Discount rate

A discount rate of 10% (real, pre-tax) has been adopted in undertaking the Net Present Value (NPV) analysis for each credible option. The discount rate represents a reasonable commercial discount rate, appropriate for the analysis of a private enterprise investment in the electricity sector, as required by the RIT-T.[7]

ElectraNet and SA Power Networks have tested the sensitivity of the results to changes in this discount rate assumption by applying a lower bound discount rate of 4.87%[8] and an upper bound discount rate of 13%. The sensitivity of the RIT-T results to the discount rate assumption is presented in Section 6.3.3.

4.1.3 Market benefits relating to wholesale market are not material for this RIT-T

The AER has recognised that if the proposed investment will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated.[9]

The credible options in section 5 do not address network constraints between competing generating centres and are therefore not considered to result in any change in dispatch outcomes and wholesale market prices.

Therefore, ElectraNet and SA Power Networks consider that the following classes of market benefits are not material for this RIT-T assessment for the credible network options:[10]

[7] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 14, p.6.
[8] This is the lower bound sensitivity for the discount rate, specified in the RIT-T paragraph(15)(g). The estimate of the regulatory WACC (real, pre-tax) that would apply to ElectraNet is based on the AER's April 2015 Final Determination for TransGrid.
[9] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* June 2010, version 1, page 15.
[10] In accordance with Rules clauses 5.16.4(k)(5) and 5.16.4(v)(1).

- changes in fuel consumption arising through different patterns of generation dispatch;
- changes in voluntary load curtailment (since there is no impact on pool price);
- changes in costs for parties, other than for ElectraNet and SA Power Networks (since there will be no deferral of generation investment);
- changes in ancillary services costs;
- competition benefits; and
- Renewable Energy Target (RET) penalties.

The RIT-T requires that in estimating the magnitude of market benefits, a market dispatch modelling methodology must be used, unless the TNSP can provide reasons why this methodology is not relevant.[11] ElectraNet and SA Power Networks have not adopted a market dispatch modelling approach to estimating the market benefits for this RIT-T, as it would involve a disproportionate level of resources, given the credible options are not expected to generate market benefits associated with the wholesale market.

4.1.4 Other classes of market benefits

In addition to the wholesale market benefits listed above, clause 5.16.1(c)(4) of the Rules requires ElectraNet and SA Power Networks to consider the following classes of market benefits in relation to the credible options:

- differences in the timing of transmission investment;
- option value;
- changes in network losses; and
- changes in involuntary load shedding.

For the reasons set out below, ElectraNet and SA Power Networks consider that the following three classes of market benefits will not be material for this RIT-T assessment:

- differences in the timing of transmission investment;
- option value; and
- changes in network losses.

ElectraNet and SA Power Networks therefore consider that the only material category of market benefits relating to this RIT-T are those relating to changes in involuntary load shedding. The approach taken to estimating these benefits is outlined in section 6.2 below.

ElectraNet and SA Power Networks do not consider that there are any other classes of market benefits which would be material for the purposes of this RIT-T assessment.

4.1.4.1 Differences in the timing of transmission investment

ElectraNet and SA Power Networks consider that none of the credible options will affect the timing of other unrelated transmission investments (i.e. transmission investments

[11] AER, Regulatory Investment Test for Transmission, June 2010, p. 6.

based on a need that falls outside the scope of that described in section 2). Consequently, ElectraNet and SA Power Networks consider that market benefits associated with differences in the timing of unrelated transmission investment are not material to the credible options subject to this RIT-T assessment.

4.1.4.2 Option value

ElectraNet and SA Power Networks note the AER's view that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the TNSP are sufficiently flexible to respond to that change[12].

ElectraNet and SA Power Networks also note the AER's view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the Rules requirement to consider option value as a class of market benefit under the RIT-T.

ElectraNet and SA Power Networks note that changes in future demand levels will not affect the RIT-T outcome. In addition, the need for and timing of the required investment is being driven by an ETC category change rather than future demand growth. As a result, it is also not relevant to consider different demand scenarios in undertaking the RIT-T analysis (outlined in section 4.2).

The estimation of any additional option value benefit would require a significant modelling assessment, which would be disproportionate to any additional option value benefit that may be identified for this specific RIT-T assessment. ElectraNet and SA Power Networks do not therefore propose to estimate any additional option value market benefit for this RIT-T assessment.

4.1.4.3 Changes in network losses

Given both credible network options provide electricity supply at a nearby location, changes in network losses will be minimal compared to the current location. ElectraNet and SA Power Networks consider that the change in network losses is such that these categories of market benefit would not be expected to materially affect the RIT-T outcome and therefore are not material for this RIT-T assessment.[13]

4.2 Description of reasonable scenarios

The RIT-T requires the calculation of market benefits to be undertaken across relevant reasonable scenarios.[14]

The RIT-T states that the number and choice of reasonable scenarios must be appropriate to the credible options under consideration. Where the identified need is for reliability corrective action, the choice of reasonable scenarios must reflect any variables or parameters that are likely to affect the ranking of the credible options.[15] In addition, where there is a material degree of uncertainty in relation to the costs of a credible option, the RIT-T requires that the cost be calculated as a probability weighted present value of the direct costs under a range of different cost assumptions.[16]

[12] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* June 2010, version 1, pages 39 and 75.
[13] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 11.
[14] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 4, page 3.
[15] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 16(a), page 7.
[16] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 16(a), page 7.

Sensitivity analysis performed by ElectraNet and SA Power Networks, and presented in section 6.3.3 below, demonstrates that the ranking of the credible options considered in this RIT-T assessment is robust to changes in the key assumptions. Therefore, changes in these variables need not be included as additional reasonable scenarios for the purposes of the NPV assessment. This approach is consistent with the AER RIT-T Assessment Guidelines.[17]

[17] AER, Regulatory Investment Test for Transmission Application Guidelines, June 2010, p.26.

5. Credible Options to Address the Identified Need

The following three options have been included as potential credible options in the RIT-T analysis:

- Option 1: Upgrade Baroota substation on its existing site to include 2 x 10 MVA 132/33 kV transformers ("brownfield" option); and
- Option 2: Rebuild Baroota substation at a nearby site to include 2 x 10 MVA 132/33 kV transformers ("greenfield" option).
- Option 3: Diesel generators combined with battery storage connected to 33 kV at Baroota substation.

Both network options utilise the existing 10 MVA transformer and install a new 10 MVA 132/33 kV transformer to address the need for ElectraNet and SA Power Networks to continue to meet ETC reliability standards. The third option providing uninterrupted N-1 equivalent transformer reliability has been proposed by a non-network proponent in response to the PSCR.

As outlined in section 5.1 below, the condition of the existing assets at the Baroota substation means that an option involving simply adding an additional transformer within the confines of the existing substation is not considered to be technically feasible (given substantial existing substation assets need replacing currently).[18]

In addition, ElectraNet is assumed to incur replacement costs for the Baroota substation under the base case given its current state. While these replacement works would largely be undertaken simultaneously with the network augmentation works, only the augmentation capital costs have been included in this RIT-T assessment as these replacement costs are common to all options.

5.1 Option 1: Upgrade the existing Baroota substation as a brownfield option to include 2 x 10 MVA 132/33 kV transformers

An ElectraNet condition assessment report produced for the Baroota substation in March 2012 indicates that the majority of the primary equipment is in poor condition and that the existing 132 kV ganged interrupter and fuse arrangement are both out-dated and pose a safety hazard (some of the equipment on site dates back to the early 1950s). Most of the secondary equipment is also in average to poor condition and the overall switchyard, plant layout and equipment are not in accordance with current ElectraNet design standards or good electricity industry practice. In addition, the existing substation is located on a road easement and is subject to potential flooding.

It is for these reasons that an additional option of simply adding an additional transformer within the confines of the existing substation is not considered to be technically feasible given the supporting assets need to be replaced anyway.

[18] The AER RIT-T Guidelines state that an option is technically feasible if the TNSP reasonably considers that there is a high likelihood, that the option (if developed) will provide the services that it is assumed it will provide, while also complying with all mandatory requirements in relevant laws, regulations and administrative requirements. See: AER, Final Regulatory Investment Test for Transmission Application Guidelines, June 2010, version 1, p. 10.

Option 1 is therefore to upgrade the Baroota substation on its existing site, utilising the existing 10 MVA transformer installed in 2008. The scope is to include the following:

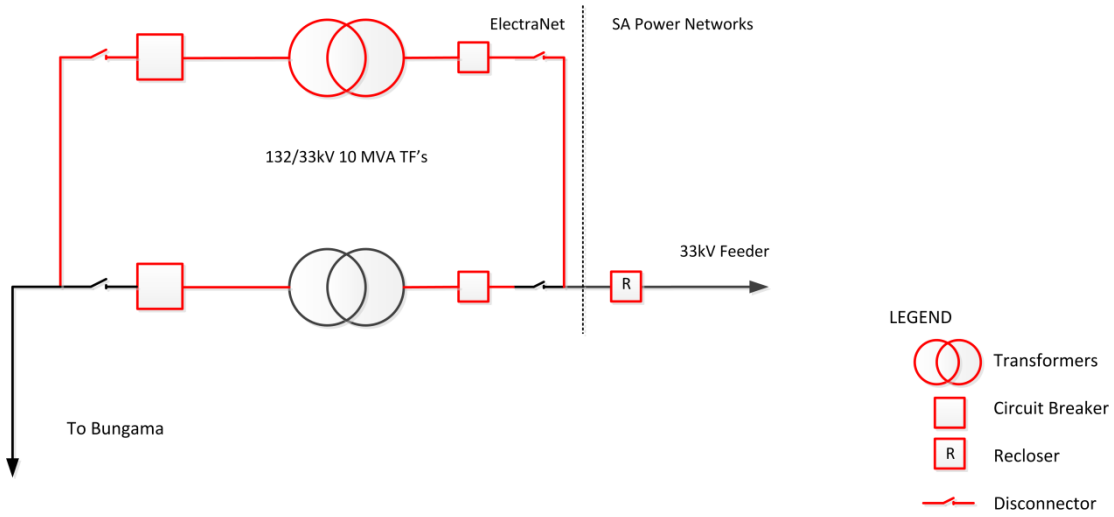
- Expand land for slightly bigger substation footprint;
- Install two 132 kV circuit breakers;
- Install additional 10 MVA 132/33 kV transformer;
- Install communication equipment;
- Install two 33 kV circuit breakers and a 33 kV recloser;
- Upgrade or replace associated substation infrastructure and control room based on condition; and
- Decommission and/or remediate redundant equipment and site to comply with Environmental Protection Agency (EPA) requirements.

Figure 2 below presents an electrical representation of the Baroota substation after augmentations required under this option are implemented. Existing assets are shown in black while new assets are shown in red.

The augmentation capital cost of this option is estimated to be $6.0 million[19]. ElectraNet and SA Power Networks note that the scope of Option 1 has been revisited since publication of the PSCR and the costs included in this PADR now reflect a reduced scope by significantly limiting future expandability and accepting the ongoing risk with the current substation location. Sacrificing future expandability is seen as prudent in the current low demand growth environment. Annual operating and maintenance costs have been estimated at 2% of the capital cost, consistent with the Grid Australia RIT-T Handbook.

The estimated construction timetable is about 12 months, with commissioning prior to 1 December 2017 as required by the ETC.

Figure 2: Configuration of the Baroota substation under Option 1



[19] ElectraNet and SA Power Networks note that the costs quoted in the PSCR included the replacement component of the total project cost.

5.2 Option 2: Rebuild Baroota substation at a nearby site to include 2 x 10 MVA 132/33 kV transformers

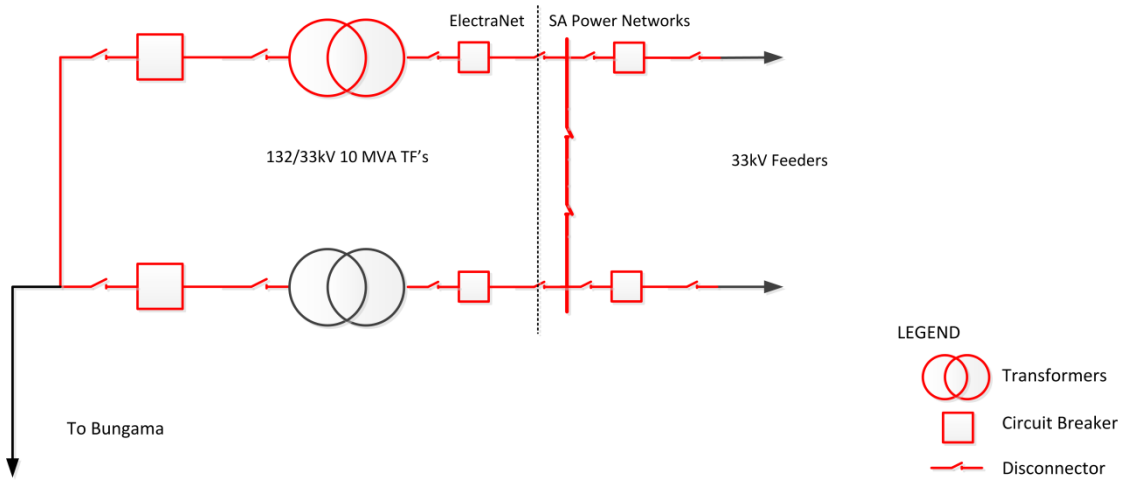
Option 2 is to rebuild the substation at a new site located near the current substation along the Bungama – Baroota 132 kV line. The new substation is to include the following:

- Purchase land for new substation;
- Install two 132 kV circuit breakers;
- Install two 10 MVA 132/33 kV transformers (One of the transformers is to be the existing 10 MVA transformer, relocated to the new site);
- Install communication equipment;
- Install two 33 kV circuit breakers
- Install 33 kV bus section and two 33 kV line exits;
- Associated substation infrastructure and control room; and
- Decommission and/or remediate redundant equipment and existing site to comply with Environmental Protection Agency (EPA) requirements.

Figure 3 below presents an electrical representation of the Baroota substation after augmentations required under this option are implemented. Existing assets are shown in black while new assets are shown in red.

The augmentation capital cost of this option is estimated to be $18.4 million[20]. Annual operating and maintenance costs have been estimated at 2% of the capital cost. The estimated construction timetable is about 12 months, with commissioning prior to 1 December 2017 as required by the ETC.

Figure 3: Configuration of the Baroota substation under Option 2



[20] ElectraNet and SA Power Networks note that the costs quoted in the PSCR included the replacement component of the total project cost.

5.3 Option 3: Diesel generators combined with battery storage connected to 33 kV at Baroota substation

Following the release of the PSCR, Vibe Energy proposed a non-network solution utilising diesel generators combined with battery storage on a nearby site connected to 33 kV at Baroota substation to provide equivalent transformer N-1 reliability. The installation would be operated by Vibe Energy to provide network support to ElectraNet during transformer outages.

ElectraNet has actively engaged with Vibe Energy to refine the technical and commercial characteristics of the solution it proposed. This resulted in the development of Option 3 - Diesel generators combined with battery storage connected to 33 kV at Baroota substation.

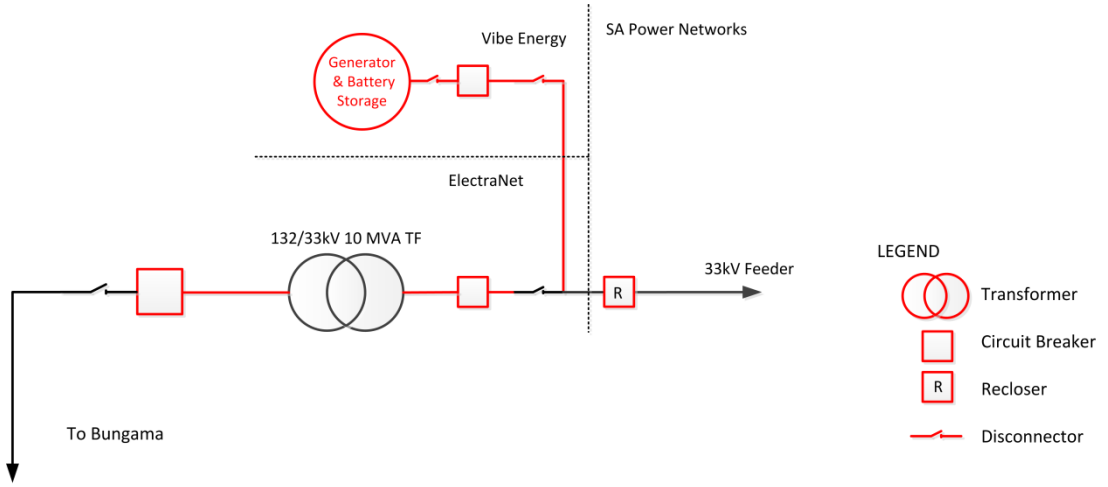
Figure 4 below presents an electrical representation of the Baroota substation after augmentations required under this option are implemented. Existing assets are shown in black while new assets are shown in red.

For the purposes of the RIT-T assessment, ElectraNet and SA Power Networks have modelled this option using operating costs provided by Vibe Energy, which are estimated to total $4.6 million (NPV) over the 15 year analysis period (Vibe Energy have requested that the specific operating cost breakdown be kept confidential as part of this PADR).

The substation scope is to include the following:

- Install a 132 kV circuit breaker;
- Install communication equipment;
- Install a 33 kV circuit breakers and a 33 kV recloser;
- Upgrade or replace associated substation infrastructure and control room based on condition; and
- Decommission and/or remediate redundant equipment and site to comply with Environmental Protection Agency (EPA) requirements.

Figure 4: Configuration of the Baroota substation under Option 3



ElectraNet estimates that there would be augmentation capital cost of $2.5 million associated with this option. Vibe Energy anticipates the proposed installation would be operational by July 2017 to ensure complete testing and commissioning prior to the 1 December 2017 date required under the current ETC. Vibe Energy state that a minimum 24 months lead time prior to July 2017 is preferable.

6. Detailed Option Assessment

This section summarises the results of the NPV analysis for each of the credible options discussed in section 5.

The Rules require that the PADR set out a detailed description of the methodologies used in quantifying each class of material market benefit and cost, together with the results of the NPV analysis, and accompanying explanatory statement regarding the results. This section therefore discusses how each of the costs and material categories of market benefits have been calculated, before presenting and discussing the market benefit results across each of the credible options.

6.1 Quantification of costs for each option

The capital costs for the network options have been based on ElectraNet's in-house cost estimates and have an accuracy range of ±30% (this accuracy range has been included in the sensitivity testing undertaken, as outlined in section 6.3.3 below). Annual operating and maintenance costs for each option have been estimated at 2% of the capital cost, as outlined in section 5 above.

The costs associated with the non-network option (Option 3) have been based on the estimates provided by Vibe Energy who have confirmed that they would like to be identified as a proponent for this option (i.e. the costs outlined in section 5.3 above). Option 3 includes a $2.5 million augmentation cost that has been estimated by ElectraNet and so is subject to a ±30% accuracy range (this augmentation cost has therefore also been included in the sensitivity testing undertaken, as outlined in section 6.3.3 below).

Table 2 presents the capital costs of each credible option.

Table 2: Base Capital Costs of credible options (2014-15 $M)

Credible Option	Components	Capital cost
Option 1	Upgrade the existing Baroota substation as a brownfield option to include 2 x 10 MVA 132/33 kV transformers	6.0
Option 2	Rebuild Baroota substation at a nearby site to include 2 x 10 MVA 132/33 kV transformers	18.4
Option 3	Diesel generators combined with battery storage connected to 33 kV at Baroota substation	2.5

Note: As discussed in section 5 above, ElectraNet is assumed to incur replacement costs for the Baroota substation under the base case given its current state. While these replacement works would largely be undertaken simultaneously with the network augmentation works, only the augmentation costs have been included in this RIT-T assessment for these options. Note also the capital costs listed above are additional to the operating costs applicable to each option discussed in Section 5.

6.2 Quantification of classes of material market benefit for each credible option

As outlined in section 4 above, all credible options provide a reliability corrective action to meet ETC category 2 requirements (N-1 transformer), and are only expected to generate one category of market benefit – a reduction in involuntary load shedding.

The section below provides a detailed description of the methodology used to quantify this category of market benefit, consistent with clause clauses 5.16.4(k)(4) of the Rules.

The historical measured Baroota load factor was applied to forecast demand to obtain an average demand for each year over the analysis period. ElectraNet and SA Power Networks used average demand and statistical system reliability data to calculate the unserved energy (in MWh) over the investment horizon.

This unserved energy (in MWh) has been valued at the Value of Customer Reliability (VCR, expressed in $/MWh) of $34,396/MWh, which represents a Baroota site-specific VCR that ElectraNet and SA Power Networks have derived based on an estimated category split between customer classes according to energy demand.[21]

Any change in cost of unserved energy from base case is then quantified as the material market benefit.

In the last review of the ETC, transformer outages were assumed to occur only under peak loading conditions. However, available evidence and existing literature does not support a strong correlation between the probability of transmission transformer failure and loading conditions.

The majority of failures result from the breakdown of the transformer insulation system, which are mainly caused by electrical disturbance and lightning strikes. These do not necessarily relate to peak load conditions. Based on this information, the assumption that transformer failures occur predominantly during peak load conditions has been removed in this assessment.

6.3 Net Present Value results

ElectraNet and SA Power Networks have undertaken an NPV assessment in relation to the net market benefit of each of the credible options set out in section 5, in line with the RIT-T requirements.

The RIT-T defines the net market benefit for each option as the gross market benefit for that option, minus the costs of each option, all in present value terms.

[21] Specifically, SA Power Networks provided an estimated energy breakdown for the Baroota connection point across load categories ‘Residential’, ‘Agriculture’, ‘Commercial’ and ‘Industrial’ as being 59%, 6%, 29% and 6%, respectively. These percentages were applied to the September 2014 VCR estimates published by AEMO to arrive at a Baroota site-specific VCR of $34,396/MWh.

6.3.1 Gross market benefits

Table 3 summarises the gross market benefit, in NPV terms, for each of the three credible options. These benefits represent reductions in involuntary load shedding.

Table 3: Gross market benefits (reduction in involuntary load shedding) estimated for each credible option (2014-15 $M, NPV)

Option	Gross Market Benefits
1 – Upgrade the existing Baroota substation	4.40
2 – Rebuild Baroota substation	4.40
3 – Diesel generators combined with battery storage connected to 33 kV at Baroota substation	4.50

ElectraNet and SA Power Networks note that there is estimated to be marginally lower involuntary load shedding (i.e. the gross market benefits are estimated to be marginally greater) for the non-network option (Option 3) than for the two network options (Options 1 and 2). This is because Option 3 involves an embedded generator, which can provide network support even when the transmission line is out of service.

6.3.2 Net market benefits

Table 4 summarises the net market benefit in NPV terms for each credible option.

The table also shows the corresponding ranking of each option under the RIT-T, with the options ranked in order of net market benefit. It shows that Option 1 is found to have the highest net economic benefit. While all options are found to be have a negative net market benefit (i.e. a net economic cost), this is allowable under the Rules, given the identified need is for reliability corrective action.[22]

Table 4: Net market benefit estimated for each credible option (2014-15 $M, NPV)

Option	Description	Cost	Gross market benefit	Net market benefit	Ranking under RIT-T
1	Upgrade the existing Baroota substation as a brownfield option to include 2 x 10 MVA 132/33 kV transformers	5.27	4.40	-0.87	1
2	Rebuild Baroota substation at a nearby site to include 2 x 10 MVA 132/33 kV transformers	16.21	4.40	-11.81	3
3	Diesel generators combined with battery storage connected to 33 kV at Baroota substation	6.80	4.50	-2.30	2

[22] Clause 15.6.1(c)(12) of the Rules.

6.3.3 Sensitivity analysis

ElectraNet and SA Power Networks have performed a series of sensitivity studies to test the robustness of the RIT-T assessment.

Specifically, the following five key assumptions have had sensitivity tests run on them:

1. Distribution network support – the base assumption is that 60% of Baroota connection point's net load can be supplied at high demand times under transmission outage conditions at the Baroota connection point – an assumption developed by SA Power Networks. A upper bound sensitivity has also been tested assuming that 80% could be supplied to allow for the possibility that the distribution network may be able to supply more than 60% of demand during low and medium demand or other periods.

2. Native load growth – the base assumption is that native load growth is approximately 1% per year based on historical observations of load growth. Sensitivities of 1.5% and 0.5% have also been included.

3. The VCR – the base assumption valued the Baroota site-specific VCR at $34,396/MWh (as outlined in section 6.2 above). Sensitivities of ±30% to the base have been applied, giving a high VCR of $44,715/MWh and a low VCR of $24,077/MWh.

4. The discount rate – a discount rate of 10% (real, pre-tax) has been adopted as the base assumption, representing a reasonable commercial discount rate, appropriate for the analysis of a private enterprise investment in the electricity sector, as required by the RIT-T.[23] ElectraNet and SA Power Networks have tested the sensitivity of the results to changes in this discount rate assumption by applying a lower bound discount rate of 4.87%[24] and an upper bound discount rate of 13%.

5. Capital costs – As noted in section 6.1 above, the capital costs for the network options (Options 1 and 2) have been based on ElectraNet's in-house cost estimates and have an accuracy range of ±30%. A sensitivity of ±30% has therefore been run on the capital costs of these options as well as on the $2.5 million augmentation cost assumed for the non-network option (as it is also subject to this accuracy range).

The table below presents the estimated NPV and option ranking (in parentheses) of all sensitivities run, as well as for the base set of assumptions (in italics). Option 1 is shown to be consistently ranked the option with the highest estimated net market benefits. However the estimated net market benefits remain negative in the majority of sensitivity cases.

[23] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 14, p.6.

[24] This is the lower bound scenario for the discount rate, specified in the RIT-T paragraph(15)(g). The estimate of the regulatory WACC (real, pre-tax) that would apply to ElectraNet is based on the AER's April 2015 Final Determination for TransGrid.

Table 5: Estimated net market benefits across all sensitivities (2014-15 $M, NPV)

Sensitivity	Option 1	Option 2	Option 3
Distribution Support – 60%	-0.87 (1)	-11.81 (3)	-2.3 (2)
Distribution Support – 80%	-2.9 (1)	-13.84 (3)	-4.36 (2)
Native Load Growth – 1%	-0.87 (1)	-11.81 (3)	-2.3 (2)
Native Load Growth – 0.5%	-1.09 (1)	-12.03 (3)	-2.53 (2)
Native Load Growth – 1.5%	-0.64 (1)	-11.58 (3)	-2.06 (2)
VCR - $34,396	-0.87 (1)	-11.81 (3)	-2.3 (2)
VCR - $24,077	-2.19 (1)	-13.13 (3)	-3.65 (2)
VCR - $44,715	0.45 (1)	-10.49 (3)	-0.95 (2)
Discount Rate - 10%	-0.87 (1)	-11.81 (3)	-2.3 (2)
Discount Rate – 4.87%	2.62 (1)	-11.77 (3)	0.38 (2)
Discount Rate – 13%	-1.56 (1)	-11.31 (3)	-2.76 (2)
Capital costs – base	-0.87 (1)	-11.81 (3)	-2.3 (2)
Capital costs – 30% lower	0.71 (1)	-6.95 (3)	-1.64 (2)
Capital costs – 30% higher	-2.45 (1)	-16.67 (3)	-2.96 (2)

7. Conclusions and next steps

The Rules require that the PADR include the identification of the proposed preferred option under the RIT-T.

As shown in the modelling results above, Option 1 (upgrading the existing Baroota substation as a brownfield option to include 2 x 10 MVA 132/33 kV transformers) is ranked first under all analysis undertaken and so is the preferred option under this RIT-T.[25] That is, Option 1 is found to have the highest net economic benefit to all those who produce, consume and transport electricity in the market (in present value terms).[26] While all options (including Option 1) are found to be have a negative net market benefit (i.e. a net economic cost), this is allowable under the Rules, given the identified need is for reliability corrective action.[27]

However, as noted in section 2.2, the identified need for the proposed investment is to provide a reliability corrective action by 1 December 2017 to ensure that ElectraNet can supply load with no interruption in the event of any unplanned loss of the existing 132/33 kV transformer at Baroota, to meet the ETC reliability standard assigned to the Baroota connection point from that date.

The ETC reliability standard reflects revisions made in February 2012. As part of these revisions, the Baroota connection point was re-categorised from reliability category 1 (which it currently is) to category 2 from 1 December 2017.

As discussed earlier in section 1.1, a number of factors have changed since the previous reliability review. These factors include the impact of rooftop solar PV on demand and an updated VCR value for Baroota according to the latest VCR values published by AEMO.[28]

ElectraNet has undertaken a comprehensive review and option analysis to determine the overall solution that maximises net economic benefits to consumers, including revisiting the assumptions that underpinned the previous AEMO analysis. ElectraNet's revised economic analysis has shown a lower market benefit than that which was indicated by the previous AEMO analysis and, furthermore, none of the options considered to meet the category 2 reliability standard (network or non-network) were found to produce a positive net market benefit.

In summary, no technically feasible option has been identified that meets the category 2 reliability standard and results in a positive net benefit to customers. Given this outcome, ElectraNet considers it would not be in the interests of consumers to proceed with the upgrade presently required by the ETC.

ElectraNet has therefore written to ESCOSA proposing that the Commission amend the ETC to remove the reclassification of the Baroota Connection Point to category 2 from 1 December 2017.

[25] Consistent with clause 15.16.4(l), ElectraNet is the proponent of the preferred option.
[26] In accordance with the clause 5.16.4(k) of the Rules, details of the technical characteristics and the estimated construction timetable and commissioning date for Option 1 can be found in section 5.1. Further, ElectraNet and SA Power Networks believe that the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission.
[27] Clause 15.6.1(c)(12) of the Rules.
[28] AEMO, Value of Customer Reliability Review, Final Report, September 2015.

ElectraNet and SA Power Networks intend to discontinue the RIT-T process that is the subject of this PADR subject to ESCOSA accepting and making the proposed change to the ETC.

ElectraNet also notes that its reliability analysis has indicated that a non-continuous N-1 equivalent transformer solution at Baroota connection point, which could be delivered at lower cost, may deliver positive net benefits to consumers. While not currently permitted under the category 2 ETC reliability standard, ElectraNet intends to explore this option further going forward as it may provide net benefits to customers under a revised category 1 reliability standard. ElectraNet and SA Power Networks therefore welcome input from parties on this proposal (particularly non-network proponents) and what the associated costs of providing non-network solution options would be.

ElectraNet and SA Power Networks welcome written submissions on this PADR.

Baroota Substation Upgrade

Appendices

June 2015

Version 1

Appendix A Checklist of compliance clauses

This section sets out a compliance checklist which demonstrates the compliance of this PADR with the requirements of clause 5.16.4(k) of the Rules version 71.

Rules clause	Summary of requirements	Relevant section in PADR
5.16.4 (k)	A Transmission Network Service Provider must prepare a project assessment consultation report, which must include:	-
	(1) a description of each credible option assessed;	5
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	3
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	5 & 6.3.1
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	4.1
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	4.1.3 & 4.1.4
	(6) the identification of any class of market benefit estimated to arise outside the region of the Transmission Network Service Provider affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	6.3
	(8) the identification of the proposed preferred option;	7
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: i. details of the technical characteristics; ii. estimated construction timetable and commissioning date; iii. if the proposed preferred option is likely to have a material inter-network impact and if the Transmission Network Service Provider affected by the RIT-T project has received an augmentation technical report, that report; and iv. a statement and the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission.	5.3 & 7

Appendix B Definitions

All laws, regulations, orders, licences, codes, determinations and other regulatory instruments (other than the Rules) which apply to Registered Participants from time to time, including those applicable in each participating jurisdiction as listed below, to the extent that they regulate or contain terms and conditions relating to access to a network, connection to a network, the provision of network services, network service price or augmentation of a network.

A comprehensive list of applicable regulatory instruments is provided in the Rules.

Applicable regulatory instruments	
AEMO	Australian Energy Market Operator
Base case	A situation in which no option is implemented by, or on behalf of the transmission network service provider.
Commercially feasible	An option is commercially feasible under clause 5.6.5D(a)(2) of the Electricity Rules if a reasonable and objective operator, acting rationally in accordance with the requirements of the RIT-T, would be prepared to develop or provide the option in isolation of any substitute options. This is taken to be synonymous with 'economically feasible'.
Costs	Costs are the present value of the direct costs of a credible option.
Credible option	A credible option is an option (or group of options) that: 1. address the identified need; 2. is (or are) commercially and technically feasible; and 3. can be implemented in sufficient time to meet the identified need.
Economically feasible	An option is likely to be economically feasible where its estimated costs are comparable to other credible options which address the identified need. One important exception to this Rules guidance applies where it is expected that a credible option or options are likely to deliver materially higher market benefits. In these circumstances the option may be "economically feasible" despite the higher expected cost. This is taken to be synonymous with 'commercially feasible'.
Identified need	The reason why the Transmission Network Service Provider proposes that a particular investment be undertaken in respect of its transmission network.
Market benefit	Market benefit must be: a) the present value of the benefits of a credible option calculated by: i. comparing, for each relevant reasonable scenario: A. the state of the world with the credible option in place to B. the state of the world in the base case, **And** ii. weighting the benefits derived in sub-paragraph (i) by the probability of each relevant reasonable scenario occurring. b) a benefit to those who consume, produce and transport electricity in the market, that is, the change in producer plus consumer surplus.
Net market benefit	Net market benefit equals the market benefit less costs.
Preferred option	The preferred option is the credible option that maximises the net economic benefit to all those who produce, consume and transport electricity in the market compared to all other credible options. Where the identified need is for reliability corrective action, a preferred option may have a negative net economic benefit (that is, a net economic cost).
Reasonable scenario	Reasonable scenario means a set of variables or parameters that are not expected to change across each of the credible options or the base case.

Appendix C Load Forecast

Table 6: Base growth demand forecast

Year	Demand (MW)
14/15	7.7
15/16	7.7
16/17	7.7
17/18	7.7
18/19	7.6
19/20	7.6
20/21	7.6
21/22	7.5
22/23	7.5
23/24	7.4
24/25	7.4
25/26	7.3
26/27	7.3
27/28	7.3
28/29	7.2
29/30	7.2
30/31	7.2
31/32	7.1

Appendix D Annual market impact Calculations

Table 7: The forecast market impact under the base case

Year	Demand (MW)	Unserved Energy (MWh)	Cost of unserved Energy	Cumulative cost of unserved Energy
17/18	7.7	16.8	$578 k	$0.58 M
18/19	7.6	17.0	$584 k	$1.16 M
19/20	7.6	17.2	$590 k	$1.75 M
20/21	7.6	17.3	$596 k	$2.35 M
21/22	7.5	17.5	$602 k	$2.95 M
22/23	7.5	17.7	$608 k	$3.56 M
23/24	7.4	17.8	$614 k	$4.17 M
24/25	7.4	18.0	$620 k	$4.79 M
25/26	7.3	18.2	$626 k	$5.42 M
26/27	7.3	18.4	$633 k	$6.05 M
27/28	7.3	18.6	$639 k	$6.69 M
28/29	7.2	18.8	$645 k	$7.34 M
29/30	7.2	18.9	$652 k	$7.99 M
30/31	7.2	19.1	$658 k	$8.65 M
31/32	7.1	19.3	$665 k	$9.31 M

Table 8: The forecast market impact with N-1 transformer reliability

Year	Demand (MW)	Unserved Energy (MWh)	Cost of unserved Energy	Annual savings of unserved Energy
17/18	7.7	0.4	$14.6 k	$564 k
18/19	7.6	0.4	$14.7 k	$569 k
19/20	7.6	0.4	$14.9 k	$575 k
20/21	7.6	0.4	$15.0 k	$581 k
21/22	7.5	0.4	$15.2 k	$587 k
22/23	7.5	0.4	$15.3 k	$593 k
23/24	7.4	0.5	$15.5 k	$598 k
24/25	7.4	0.5	$15.6 k	$604 k
25/26	7.3	0.5	$15.8 k	$610 k
26/27	7.3	0.5	$16.0 k	$617 k
27/28	7.3	0.5	$16.1 k	$623 k
28/29	7.2	0.5	$16.3 k	$629 k
29/30	7.2	0.5	$16.4 k	$635 k
30/31	7.2	0.5	$16.6 k	$642 k
31/32	7.1	0.5	$16.8 k	$648 k