OPTIONS EVALUATION REPORT (OER)

Supply to Broken Hill-Contingent Project

OER- 000000001754 revision 0.0

Ellipse project no(s):
TRIM file: [TRIM No]

Project reason: Reliability - To meet connection point reliability requirements
Project category: Prescribed - Augmentation - Contingent

Approvals

Author	Jay Esson	Network Modelling & Performance Engineer
Reviewed/Endorsed	Jahan Peiris	Network Modelling & Performance Manager
	Garrie Chubb	Investment Support Manager
Approved	Andrew Kingsmill	Manager/Network Planning
Date submitted for approval	21 December 2016	

Change history

Revision	Date	Amendment
0	December 2016	Initial Issue

1. Need/opportunity

The 220 kV connection point at Broken Hill 220/22 kV substation presently exceeds the proposed IPART recommended unserved energy minutes. There is an opportunity to increase the reliability of the BSP (Bulk Supply Point) to reduce the present unserved energy minutes from 10 minutes to the recommended 5 minutes.

Project Need ID 1649 investigated options to meet this need. This contingent project will be triggered:

(i) If the proposed IPART draft reliability standard is adopted as the Planning Standard for NSW with the proposed Expected Unserved Energy allowance of 5 minutes for Broken Hill 220 kV, **AND**
(ii) Demand Management contract with Perilya Mine (the preferred option identified in Need 1649 - Reliability of Supply to Broken Hill) is determined to be not-feasible.

The IPART recommended reliability standard has a commencement date of 1 July 2018.

2. Related needs/opportunities

- NOS 1649 – Reliability of Supply to Broken Hill

3. Options

Base case

This option is to continue to operate the present Broken Hill 220 kV supply arrangement and maintain the reliability level at the present 10 minutes expected unserved energy (USE).

The scope is to maintain the present Broken Hill assets through ongoing maintenance and will not involve any capital expenditure. However, this option would result in the Broken Hill 220 kV connection point being non-compliant with the proposed planning reliability standard, therefore making this option not technically feasible.

The primary risk for TransGrid not addressing the identified need is non-compliance with the *Electricity Transmission Reliability Standards*[1]. The results are anticipated to include, inter alia, the following:

- exposing the 220 kV customer load to an excess of 5 minutes[2] of unserved energy per year.[3]
- application of a fine similar to the civil penalty as defined in the National Electricity Law (1996).[4]

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[1] In the event this Standard is adopted

[2] That is, the existing 10 minutes minus the allowable 5 minutes.

[3] According to IPART's *Draft Electricity transmission reliability standards* (May 2016):

> *"The allowance for expected unserved energy [USE] per annum is calculated by dividing the optimal expected unserved energy (in MWh) produced by [IPART's] optimisation model, by estimated average annual demand at that bulk supply point (in MW) and converting it to "minutes" (by multiplying it by 60). [IPART has] estimated annual demand at each bulk supply point using forecast maximum demand (in MVA [at unity power factor]) and an estimated load factor" (p.21).*

This can be expressed mathematically as follows:

$$USE\ in\ "minutes" = \frac{[optimal\ expected\ unserved\ energy\ in\ MWh]}{[estimated\ average\ annual\ demand\ in\ MW]} * 60$$

[4] As the standard has not been signed off by the Minister at time of writing, it is uncertain whether any fines may apply for non-compliance. However, we have assumed that a fine similar to that stipulated in the NEL clause 2AA is entirely within the realm of possibility.

- damage to TransGrid's reputation (poor media coverage).
- litigation by customers/consumer groups.

The total cost of these risks has been calculated as below (refer to TransGrid investment risk tool):

$$USE\ in\ MWh = \frac{USE\ in\ "minutes"}{60} * [estimated\ average\ annual\ demand\ at\ Broken\ Hill\ 220\ kV\ in\ MW]$$

$$USE\ in\ MWh = \frac{5}{60} hrs * 15.85\ MW$$

$$\therefore\ USE\ in\ MWh = 1.32\ MWh$$

$$\therefore\ USE\ risk\ cost = 1.32\ MWh/year * \$38{,}350/MWh = \$\mathbf{50{,}654\ per\ annum}$$

$$estimated\ or\ assessed\ civil\ penalty =$$

$$[\$100k + \$10k\ per\ day\ that\ the\ violation\ persists][5] * probability\ that\ the\ X2\ line\ outage\ occurs$$

$$\therefore\ civil\ penalty = \left[\$100k\ +\ \left(\$10k\ *\ 365\ days\ *\ 5\ years[6]\right)\right] * 0.29 =\ \$5.32\ million\ for\ 5\ years =$$

$$\$\mathbf{1.06\ million\ per\ annum}$$

$$miscellaneous\ risk\ cost\ (reputation\ damage,\ litigation\ costs) = \$\mathbf{300{,}000\ per\ annum}[7]$$

$$\therefore\ \mathbf{total\ risk\ cost} = \$\mathbf{1.41\ million\ per\ annum}$$

Option A — Establish a second duplicate 220 kV transmission line

This option is to duplicate the 220 kV Line X2 from Buronga to Broken Hill to improve the reliability of the 220 kV connection point at Broken Hill.

The scope of the option involves constructing a 260 km 220 kV transmission line parallel to the existing Line X2 route, terminating at new switchbays at Buronga and Broken Hill substations.

The capital expenditure for this option is $169.8m in $2016-17 and will reduce the unserved energy minutes to less than 5 minutes (refer OSA 1754 and OFS 1754A).

X2 duplication transmission line work

The new transmission line parallel to line X2 will have twin ACSR Lemon 207mm2, 30/7/3.00mm (or twin SCA Panther 0.2", 30/7/0.118") conductor and design temperature = 85°C[8]:

Broken Hill Substation Work (Refer Figure A-1)

- 220 kV line switchbay for the new transmission line. Bay is to have the following ratings:
  - Continuous: 1300A

[5] As per NEL clause 2AA.
[6] Assuming that the violation persists over the entire 2018-2023 regulatory control period.
[7] Based on TransGrid's Risk Tool assumptions.
[8] Table W-2-1 from the Ratings for Southern 500, 330 & 220 kV Lines document, as determined using the Line Rating Program

- Fault rating: 20 kA

- Installation of line shunt reactors - 2 x 25 MVAr 220 kV shunt reactors

Buronga Switching Station Work (Refer Figure A-2)

- 220 kV line switchbay for the new transmission line. Bay is to have the following ratings:
  - Continuous: 1300A
  - Fault rating: 20 kA
- Installation of line shunt reactor - 1 x 25 MVAr 220 kV shunt reactor

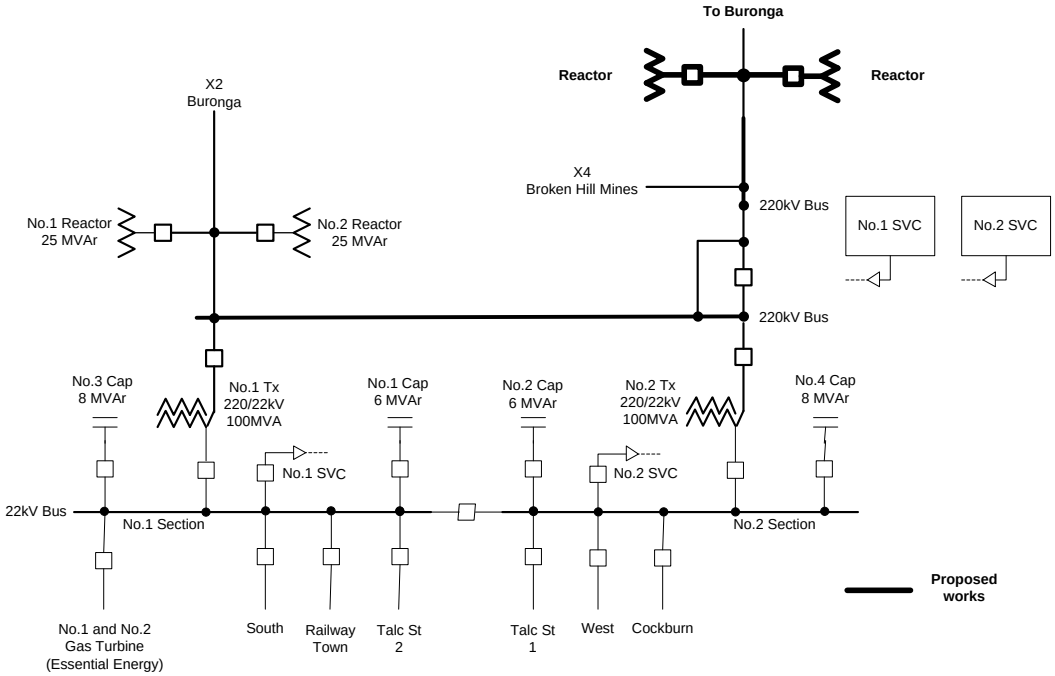

Figure A-1: Works at Broken Hill substation

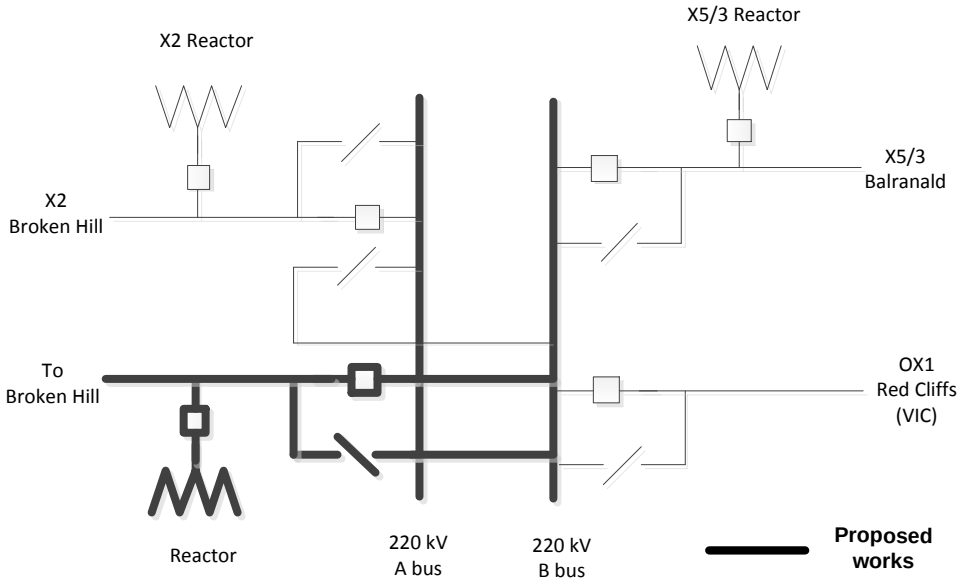

Figure A-2: Works at Buronga switching station

Option B — Establish a battery storage sufficient to meet reliability standard

This option is to operate the existing 22 kV 2x18 MW gas-turbines from cold-start, supplementing the load with battery banks during the gas-turbine start-up phase and any excess load (greater than GTs and Broken Hill Solar Farm) until the line X2 is restored. The gas-turbine is expected to take up to 1 hour to supply the 220 kV mine load. The battery storage needed is estimated to be about 35 MWh to meet the minimum IPART draft recommended reliability allowance minutes[9].

The cost of battery technology is estimated to be around $1.25 million per MWh. Taking into consideration the additional ancillary equipment required to be installed; the estimated cost of this option is $50 million. This option is technically feasible.

The capital expenditure for this option is $50 million in $2016-17 and will reduce the unserved energy minutes to less than 5 minutes (refer OSA 1754).

[9] This number is calculated assuming availability of Broken Hill Gas Turbines (up to 2 x 18 MW), Silverton Wind Farm and Broken Hill Solar Farm. Refer to file Broken Hill - Battery Storage(GT)_21122016.xlsx in PDGS supporting documents for calculation details.

4. Evaluation

4.1 Commercial evaluation

Both options are technically feasible. The commercial analysis of the feasible options being considered is shown below, as compared to the Base Case:

Table 1 - Commercial Evaluation

Option	Description	Capex 2016-17 ($m)	Yearly Opex ($m)	Post project yearly risk cost ($m)	Unserved energy minutes	Rank
Base Case	'Do Nothing'	-	-	To be determined by the RIT-T	10	To be determined by the RIT-T
A	Establish a second duplicate 220 kV transmission line	169.8	3.4	To be determined by the RIT-T	<5	To be determined by the RIT-T
B	Battery supplemented gas-turbine generation	50	1.0	To be determined by the RIT-T	5	To be determined by the RIT-T

4.2 Compliance with Reliability Legislation

The objective of the IPART Electricity Transmission Reliability Standards is to:

- *Move away from a standard that is heavily based on network capability and towards one which better focuses on what customers value*
- *Introduce the concept of positive expected unserved energy into TransGrid's decision making processes*
- *Make explicit provision for the standards to be met using non-network solutions*
- *Not result in a significant change from the current level of reliability experienced by customers*

IPART has recommended that the standards be adopted as a planning standard, and not a performance standard. TransGrid is expected to undertake simulation modelling as part of the planning process, which IPART can review when assessing compliance. IPART has recommended that simulations be undertaken using life-cycle average failure rates rather than actual condition based failure rates. Option A complies with the objective of the IPART planning reliability standard, as it addresses the connection point's excess USE by bringing the USE minutes to below the allowable amount.

Capital and Operating Expenditure

The yearly incremental operating expenditure of options are estimated to be 2% of the upfront capital cost of the option, escalated at a rate of 2.9% per annum.

Regulatory Investment Test

The RIT-T process will be required for both options, as the estimated capex cost is higher than the $6 million threshold for RIT-T.

4.3 Preferred Option

The preferred option will be identified based on the outcome of the RIT-T process, which will take place in the event this contingent project is triggered. However, the likely option (based on assessment in this OER) will be Option B – Battery supplemented gas-turbine generation. This is based on the lowest cost option to meet the IPART reliability standard for Broken Hill 220 kV load.

5. Recommendation

It is recommended that this Contingent Project to be included in the TransGrid Revenue Proposal for 2018-23 period and a RIT-T to be undertaken in the event of occurrence of the following triggers:

(i) If the proposed IPART draft reliability standard is adopted as the Planning Standard for NSW with the proposed Expected Unserved Energy allowance of 5 minutes for Broken Hill 220 kV, **AND**
(ii) Demand Management contract with Perilya Mine (the preferred option identified in Need 1649 - Reliability of Supply to Broken Hill) is determined to be not-feasible.

The preferred option will be determined through the RIT-T process based on detailed network analysis, market modelling, technical and economic feasibility. Following the RIT-T, a complete Options Evaluation Report will be issued.

Based on the options listed in Table 1, it is expected that this Contingent Project would incur a capital cost of approximately $50 million in 2016-17 dollars (based on the estimated capital cost for Option B given above).