OPTIONS EVALUATION REPORT (OER)

Multiple 330 kV Cable outages

OER 000000001425 revision 3.0

Ellipse project description: P0008204
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	9 January 2017	

1. Need/opportunity

In securely operating the power system, as defined by Clause 4.2.6 of the NER, following a contingent trip of either of the 330 kV cables in the Sydney CBD, it may be necessary to shed load pre-contingent or radialise a significant block of CBD load within 30 minutes of the contingency taking place, to cater for the next contingency. While the power system is planned to avoid any loss of load as a result of a subsequent failure of a 132 kV cable, a subsequent failure of the another 330 kV cable will result in the loss of all the radialised loads. A Need Date of 2020 is assumed.

Refer to NOS-1425 for details.

2. Related needs/opportunities

> Need DCN43 – Supply to Sydney Inner Metropolitan Area and CBD
Need 1440 is independent of Need 43. These Needs are related only in that they apply to the same geographical area.

3. Options

Unserved Energy Cost Calculation

For all options, the unserved energy in the event of a simultaneous failure of two 330 kV cables has been calculated using the following data and assumptions:

> Load at risk assessed for Summer 2019/20[1]
> 330 kV cable failure rate = 0.11 / unit / annum with a cable repair time of 788 hours per event[2]
> 132 kV Ausgrid cable failure rate = 0.29 / unit / annum[2,3]
> 132 kV Ausgrid overhead (OH) line failure rate = 0.05 / unit / annum[2,3]
> NSW Value of Customer Reliability (VCR) = $38,350/MWh[4]

Base Case

The current transmission limitations is the contingent ratings of Ausgrid 132 kV cables in Sydney area that does not cater for the loss of multiple 330kV circuits during periods of high loads. The Base Case is to continue to operate the network using the status quo arrangements which leads to a significant amount of load at risk.

This will lead to an annual risk cost of $20.02 million.

$$Unserved\ Energy = \sum_{\substack{for\ all \\ Ausgrid \\ feeders}} \begin{bmatrix} MW\ at\ risk * Cable\ 41\ failure\ rate * Cable\ 42\ failure\ rate * \\ Ausgrid\ feeder\ failure\ rate * cable\ outage\ duration \end{bmatrix}$$

$$Unserved\ Energy = 11\% * 11\% * 788\ hrs \sum_{\substack{for\ all \\ Ausgrid \\ feeders}} [MW\ at\ risk * Ausgrid\ feeder\ failure\ rate]$$

$$\therefore\ Unserved\ Energy = 521.68\ MWh$$

[1] This is deemed a reasonable estimate of the average load at risk over the 2018-23 regulatory period.
[2] IPART, *Electricity Transmission Reliability Standards – An Economic Assessment.*
[3] If Ausgrid feeder is also out of service, the load at risk will be higher
[4] AEMO 2014, *Value of Customer Reliability – Application Guide* (mixed residential/commercial load).

The cost of unserved energy (which is included in the above risk cost) has been calculated as follows:

$$Cost\ of\ Unserved\ Energy\ =\ Unserved\ Energy\ *\ VCR$$

$$Cost\ of\ Unserved\ Energy\ =\ 521.68\ MWh * \$38{,}350/MWh$$

$$\therefore\ \boldsymbol{Cost\ of\ Unserved\ Energy\ =\ \$20\ million\ per\ annum}$$

In addition, there are financial and reputational risk costs of $0.02m per annum.

Therefore the total risk cost = $20.02m per annum

Option A — TransGrid and Ausgrid SCADA schemes <OFR-1425A, OFS-1425A>

The scope of works under this option can be found in OFR-1425A .

The benefit of this option is that it improves the contingent capability of the Ausgrid 132 kV network in Sydney area by reducing the amount of load at risk following a trip of either 330 kV cable. This can be achieved by implementing a control scheme that can be armed during periods of high CBD loads and following the trip of one of the 330 kV cables. This scheme will selectively shed low priority CBD load following a contingent trip of the remaining 330 kV cable and allows the post contingent 132 kV network to operate as meshed during periods that the Users place greatest value on the reliability of the transmission system.

The expected capital cost for this option is $140,000 ± 25% in un-escalated 2016-17 AUD, spread over 1 year. Refer to OFS-1425A Rev 2 for details.

The post-project risk cost of Option A is based on the unserved energy arising due to the controlled load shedding under this option.

The risk cost is expected to be $0.14m per annum.

$$Unserved\ Energy = 11\% * 11\% * 788\ hrs * load\ shed$$

$$Unserved\ Energy = 5.03\ MWh^{5}$$

The cost of unserved energy (which is included in the above risk cost) has been calculated as follows:

$$Cost\ of\ Unserved\ Energy\ =\ Unserved\ Energy\ *\ VCR$$

$$Cost\ of\ Unserved\ Energy\ =\ 5.03\ MWh * \$26{,}930/MWh^{6}$$

$$\therefore\ \boldsymbol{Cost\ of\ Unserved\ Energy\ =\ \$0.14\ million\ per\ annum}$$

In addition, there are financial and reputational risk costs of $6,625 per annum.

Therefore the total risk cost = $0.14m per annum

[5] See spreadsheet on PDGS "Unserved energy".

[6] AEMO 2014, *Value of Customer Reliability – Application Guide* (residential load).

4. Evaluation

Commercial Evaluation

Both the Base Case and Option A are technically feasible. However, as seen below, implementing the Base Case (i.e. refraining from making capital investment) would generate a total risk cost of $20.04 million for every year that the Need is not addressed. In contrast, Option A will reduce TransGrid's annual risk to zero.

The commercial evaluation of the technically feasible options is set out in Table 1.

The full financial and economic evaluations are shown in Appendix A.

Table 1: Commercial Evaluation of Technically Feasible Options

Option	Description	Total Capex ($m)	Yearly Ongoing Opex ($m)	Yearly Post Project Risk Cost ($m)	Financial NPV ($m)	Economic NPV ($m)	Rank
Base Case	"Do Nothing" (continue to operate the network as per status quo)	-	-	20.02	-	-	2
A	Implement a SCADA control scheme	0.14	0.00	0.14	(0.14)	62.86	1

The commercial evaluation is based on:

- a 10% discount, with sensitivities based on TransGrid's current AER-determined pre-tax real regulatory WACC of 6.75% for the lower bound, and 13% for the upper bound provided in Appendix A.
- the applied sensitivities on the discount rate give the following economic NPVs:

Discount Rate (%)	Economic NPV (2018/19 $m)
6.75	67.56
13.00	58.97

The preferred option is therefore Option A, as it significantly improves TransGrid's risk exposure, and yields the most benefits, as calculated using TransGrid's NPV Calculation Tool and Risk Tool (refer Appendix A).

ALARP Evaluation

An ALARP assessment is triggered by the following hazard with the associated disproportionate factor:

- Unplanned outage of high voltage equipment – 3 times the safety risk reduction and taking 10% of the reliability risk reduction as applicable to safety.

However, as this will only produce 30% of the benefit derived in the commercial evaluation, a full ALARP evaluation will not produce an alternative preferred solution.

Capital and operating expenditure

The preferred option is not expected to materially change the existing operating cost.

Regulatory Investment Test-Transmission

This Need is not subject to the RIT-T process as it does not exceed the $6 million threshold requirement.

5. Recommendation

Based on the economic evaluation above, Option A is the preferred option to address the Need as it significantly reduces TransGrid's risk exposure and reduces the risk from $20.02m to $0.14m.

It is therefore recommended that an RPS be issued for the implementation of a SCADA control scheme for cables 41 and 42 to allow project completion before 2020.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	Need 1415 - Option A - Cable SCADA tripping scheme

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$0.14m	*NPV / Capital (Ratio)*	*-1.02*
NPV @ upper bound rate	13.00%	-$0.14m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$0.14m	*IRR%*	*Not measurable*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	$62.86m	*NPV / Capital (Ratio)*	*448.98*
NPV @ upper bound rate	13.00%	$58.97m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$67.56m	*IRR%*	*14195.56%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$20.01m*	*$0.14m*	*$19.87m*
Financial	*$0.00m*	*$0.00m*	*-$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.01m*	*$0.00m*	*$0.01m*
Total Risk benefits	$20.02m	$0.14m	$19.88m
Cost savings and other benefits			$0.00m
Total Benefits			$19.88m

VCR Benefit	*$19.87m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.00m*
Total Risk benefits	$19.88m
Benefits in the financial NPV*	$0.00m
**excludes VCR benefits*	
Benefits in the economic NPV**	$19.88m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$0.14m	Major Asset Life (Yrs)	4.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs

Appendix B – Unserved Energy Calculation

Outages	Firm Capacity (MW)	Combined Failure Rate (%)	Unserved Energy (MWh)	Cost of Unserved Energy ($m)	Unserved Scenario No.
CB 41B (and Cable 41) + Cable 42	1582.18	0.012	5.03	0.19	1
CB 41B (and Cable 41) + Cable 42 + Cable 928	1324.97	0.000	49.48	1.90	2
CB 41B (and Cable 41) + Cable 42 + Cable 929	1324.97	0.000	49.48	1.90	3
CB 41B (and Cable 41) + Cable 42 + Cable 91A	1278.26	0.000	6.06	0.23	8
CB 41B (and Cable 41) + Cable 42 + Cable 91B	1278.26	0.000	6.06	0.23	9
CB 41B (and Cable 41) + Cable 42 + Cable 91X	1290.57	0.000	4.26	0.16	10
CB 41B (and Cable 41) + Cable 42 + Cable 91Y	1290.57	0.000	1.47	0.06	11
CB 41B (and Cable 41) + Cable 42 + Cable 92X	1245.91	0.000	78.24	3.00	12
CB 41B (and Cable 41) + Cable 42 + OH Line 245	1358.36	0.001	78.24	3.00	4
CB 41B (and Cable 41) + Cable 42 + OH Line 246	1358.36	0.001	69.74	2.67	5
CB 41B (and Cable 41) + Cable 42 + OH Line 911	1393.13	0.001	69.74	2.67	6
CB 41B (and Cable 41) + Cable 42 + OH Line 9F6	1486.82	0.001	103.88	3.98	7
Total			**521.68**	**20.01**	

Source: 1425- Unserved Energy.xlsx **(available on PDGS)**