OPTIONS EVALUATION REPORT (OER)

Making the Grid More Resilience - Yass 330kV Bus CB Capacity Augmentation

OER 000000001399 revision 2.0

Ellipse project description: P0008097 – Yass 330 kV Bus CB Capacity Augmentation
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	30 November 2016	

1. Need/opportunity

Yass 330kV substation is situated in a critical transmission point of the NSW network. A number of critical 330kV lines 2, 3, 4, 5, 9 and 3J are marshalled onto the two 330kV busbars.

TransGrid studies indicated that on a day with high power flow (approximately 3,000 MW) from Snowy to NSW (cut-set), a double 330 kV busbar outage at Yass will potentially cause the system to shut down due to voltage stability issues. The cut-set thermal limit post a double 330 kV busbar trip is approximately 995 MW, which is a reduction of approximately 2,100 MW from the system normal thermal limit.

As referred to in NS-1399, recent reviews by the AEMO and AEMC have suggested that high impact, low probability events have the potential to result in a significant loss of supply. TransGrid is required to manage this risk.

There is an opportunity to augment Yass substation to avoid voltage stability issues following a double 330 kV busbar.

For further details, refer to NOS-1399.

2. Related needs/opportunities

> None

3. Options

Base case

The Base Case for this Need is to continue operating the network as is at Yass substation.

On a warm day, the combined Sydney–Wollongong–Newcastle load is at least 8,000 MW. The primary risk of TransGrid not addressing this need is a cost of unsupplied demand to customers in the Dapto, Wollongong and Sydney South area. A double 330 kV busbar outage at Yass may result in an 8,000 MW load loss for duration of 8 hours, however restoration can begin immediately after an incident so a factor of 0.5 is used to account for this in the calculation.

The unserved energy has been calculated using the following data:

> 330 kV bay CB unplanned outage rate that will cause a bus outage = 0.079 / unit /annum[1]
> 330 kV bay CB failure rate that could lead to a bus trip = 0.024 / unit /annum[2]
> No. of CB failures that could lead to a bus unplanned outage/trip[3] = 5
> The value of customer reliability (VCR) for NSW is $38,350/ MWh[4]
> Probability where cut-set flow exceeds the secure limit[5] = 108/(24* 365) = 1.3% of the time/year

[1] Based on TransGrid historical CB unplanned outage rates(refer file CB Unplanned Outage Stats.xlsx in PDGS)

[2] Based on TransGrid historical CB failure rates(refer file CB Unplanned Outage Stats.xlsx in PDGS)

[3] Based on No. of CBs connected to Bus A and Bus B at Yass 330 kV substation

[4] AEMO, Value of Customer Reliability – Application Guide.

[5] The cut-set flow to maintain transient stability is about 1150 MW. Based on historical Canberra- Yass to north cut-set flows – refer file "1399 - Historical Yass-Canberra cut-set flows.xlsx" in PDGS

Therefore, the risk cost if calculated as follows:

$$Unserved\ Energy = (Load\ at\ risk) * P_{unplaned\ outage\ of\ one\ 330kV\ bus} * P_{failure\ of\ one\ 330\ kV\ bus} * P_{cut-set\ flow\ exceeds\ the\ secure\ limit} * D_{load\ interruption}$$

$$Unserved\ Energy = 8000\ MW * (0.079 * 5) * (0.024 * 5) * (\frac{1.3}{100}) * (0.5 * 8\ hrs)$$

$$\therefore\ Unserved\ Energy = 19.72\ MWh$$

The risk cost of unserved energy has been calculated as follows:

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

$$Risk\ Cost\ of\ Unserved\ Energy = 19.72\ MWh * \$38{,}350/MWh$$

$$\boldsymbol{\therefore\ Risk\ Cost\ of\ Unserved\ Energy = \$0.76\ million\ per\ year}$$

In addition, there is an operational/compliance risk of $0.01 million.

Therefore the total risk is $0.77 million.

Option A —Addition of bus section breakers to Yass 330 kV busbar A and busbar B <OFR-1399A, OFS-1399A>

This option involves adding bus section breakers to both 330 kV busbar A and busbar B at Yass substation. This option can significantly reduce the risk of supply interruption and improve network reliability. It could prevent or minimise the effect of wide spread interruptions and a partial or full system collapse in the event of critical non-credible double busbar outages.

The expected capital cost for this option is $4.78 million ± 25% (in un-escalated 2016 - 17 dollars), spread over 3 years. The scope of works included in this option is outlined in OFS-1399A.

The post-project risk cost of Option A is assessed to be $0 million per year.

Option B —New 330 kV Transmission Line from Canberra to Marulan

This option is to install a new 330 kV transmission line from Canberra to Marulan to provide geographic diversity from Yass. New 33 kV switchbays will also be required at Canberra and Marulan. This option can reduce the risk of supply interruption and improve network reliability if a double 330 kV busbar outage were to occur at Yass.

It is anticipated that the cost to implement this option will be orders of magnitude larger than the cost to implement Option A. For this reason, Option B is deemed to be neither economically nor financially viable.

Non-network Solutions

No feasible non-network solutions have been identified to address this Need.

4. Evaluation

4.1 Technical evaluation

The Base Case and Options A are technically feasible. However, implementing the Base Case would generate a total risk cost of $0.77 million for every year. In contrast, Option A will reduce TransGrid's average annual risk to $0 million per year.

4.2 Commercial evaluation

The commercial evaluations of the technically feasible options are 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 ($m)	Annual Opex / yr ($m)	Annual post project risk cost ($m)	Financial NPV ($m) @ 10% ($m)	Economic NPV ($m) @ 10% ($m)	Rank
Base case	Base case – Do nothing	0	0	0.77	-	-	2
A	Addition of bus section breakers to Yass 330 kV busbar A and busbar B	4.78	0.1	0	(4.33)	0.94	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	2.77
13.00	0.00

4.3 Preferred Option

The preferred option is therefore Option A, as it 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 yearly incremental operating expenditure is estimated to be 2% of the upfront capital cost of each option, which equates to $0.1 million, escalated at a rate of 2.9% per annum.[6]

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 reduces the risk cost by $ 0.77m/year to $0.

It is therefore recommended that a Project be initiated to implement Option A in the 2018-2023 regulatory period.

[6] TransGrid Success Database as at May 2016.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	Yass 330kV Bus CB Capacity Augmentation

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$4.33m	*NPV / Capital (Ratio)*	*-0.91*
NPV @ upper bound rate	13.00%	-$3.90m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$4.90m	*IRR%*	*-8.27%*

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%	$0.94m	*NPV / Capital (Ratio)*	*0.20*
NPV @ upper bound rate	13.00%	$0.00m	*Pay Back Period (Yrs)*	*7.24 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$2.77m	*IRR%*	*13.00%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.76m*	*$0.00m*	*$0.76m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*
Operational/compliance	*$0.01m*	*$0.00m*	*$0.01m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$0.77m	$0.00m	$0.77m
Cost savings and other benefits			$0.00m
Total Benefits			$0.77m

VCR Benefit	*$0.76m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.01m*
Total Risk benefits	$0.77m
Benefits in the financial NPV*	$0.01m
**excludes VCR benefits*	
Benefits in the economic NPV**	$0.77m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.10m	Write-off cost	$0.00m
Capital - initial $m	-$4.78m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	$2.20m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs