OPTIONS EVALUATION REPORT (OER)

Making the Grid Smarter - Yass 330 kV Area Loads Special Protection System (SPS)

OER 000000001472 revision 2.0

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1. Need/opportunity

In order to meet the National Electricity Rules (NER) requirements to protect the NSW high voltage transmission system against high impact low probability multiple simultaneous contingencies, there is an opportunity for TransGrid to implement control, protection or other systems to manage the stability of both frequency and voltage following these multiple contingencies.

TransGrid studies indicated that loss of both Yass – Marulan (4 and 5) and Yass – Bannaby 330 kV (3J or 61) lines at times of high transfer in a northerly direction from Snowy and Victoria could result in significant flows on the Canberra - Capital – Kangaroo Valley – Dapto 330 kV path. The flow could be more than 2000 MW. This could result in significant overloading leading to loss of the line (even damage to the lines). Such a multiple contingency event could result in voltage collapse and significant under-frequency in the NSW and QLD regions, and significant over-frequency in VIC and South Australia.

Refer to NS-1472 for details.

2. Related needs/opportunities

- Need 1473 – North West 330kV Smart Grid Control
- Need 1482 – Sydney South 330 kV Smart Grid Controls
- Need 1484 – Snowy 330 kV Area Smart Grid Control
- Need 1487 – Eraring 500 kV Smart Grid Control
- Need 1491 – Sydney North West 330 kV Smart Grid Control
- Need 1522 – Sydney West Area 330 kV Smart Grid Control

3. Options

Base Case

The Base Case is to continue to operate the network using the status quo arrangements for managing multiple simultaneous contingencies.

The base case total risk cost is estimated to be $12.57 million (refer to Attachment 1 in NS-1472 for Risk Cost summary), which is primarily made up of the value of unserved energy.

The risk cost was calculated using the Risk Tool, and considers the worst-case outage of multiple 330 kV lines within the Yass Area cut-set causing a loss of load of 8,000 MW[1]. The load restoration time is estimated to be 8 hours[2] . Furthermore, during works to restore the load, it is expected that the demand will decrease over time, as such a factor of 0.5 is used to account for this. The probability of such an event occurring is deemed to be 1 in 100 years[3].

Unserved Energy Risk Cost

Unserved energy is calculated as:

$$Unserved\ Energy\ = (MW\ at\ risk * 0.5 * failure\ duration) * (overall\ failure\ rate)$$

$$Unserved\ Energy\ = (8000\ MW\ * 0.5 * 8\ hrs) * 1\%$$

[1] This event is noted to occur during severe bushfires, and it is expected that the NSW load will be at maximum demand.

[2] Restoration time is based on TransGrid Control Room historical experience and OM666 Black Start.

[3] It is assumed that this type of outage is a 1 in 100 year event.

$\therefore \ Unserved\ Energy \ = \ 320\ MWh$

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

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

$$Risk\ Cost\ of\ Unserved\ Energy \ = \ 320\ MWh * \$38{,}350/MWh^{4}$$

$\therefore \ Risk\ Cost\ of\ Unserved\ Energy \ = \ \$12.32\ million\ per\ year$

Other Risk Cost

In addition there financial and reputational risk costs totalling $0.25 million.[5]

Total Risk Cost

Total risk cost = Unserved energy risk cost + other risk costs

∴ Total risk cost = $12.57 million per annum.

Option A — Yass Area 330 kV Special Protection System <OFR-1472A, OFS-1472A>

This option involves the implementation of a SCADA/Protection-based Hybrid Special Protection System (SPS) for the Yass 330 kV area to prevent or minimise the effect of wide spread interruptions and a partial or full system collapse in the event of critical non-credible multiple contingencies.

The scope of works under this option can be found in OFR-1472A.

The expected capital cost for this option is $3.63 million ± 25% in un-escalated 2016-17 dollars, spread over 3 years. Refer to OFS-1472A for details.

The post-project risk cost of Option A is assessed to be $4.64 million per year.

The annual unserved energy has been calculated using the same data as in the Base Case, except the load lost is targeted to be reduced compared to the Base Case due to the selected load shedding by the Yass area special protection system[6]:

Unserved Energy Risk Cost

$$Unserved\ Energy \ = (MW\ at\ risk * \ 0.5 * failure\ duration) * \ (overall\ failure\ rate)$$

$$Unserved\ Energy \ = \left(3000\ MW \ * \ 0.5 \ * 8\ hrs^{7}\right) * \ 1\%$$

$\therefore \ Unserved\ Energy \ = \ 120\ MWh$

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

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

$$Risk\ Cost\ of\ Unserved\ Energy \ = \ 120\ MWh * \$38{,}350/MWh^{8}$$

$\therefore \ Risk\ Cost\ of\ Unserved\ Energy \ = \ \$4.6\ million$

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[4] TransGrid's Investment Risk Tool bases the Value of Customer Reliability (VCR) on figures published by AEMO in its Value of Customer Reliability Review - Final Report, September 2014. In this case we use the mixed residential/industrial figure of $38,350/MWh.

[6] Due to the selected load shedding by the Yass area smart grid control scheme – Load to be shed by tripping feeders at Sydney West, Liverpool, Regentville, Dapto and Macarthur. The expected load to be shed is about 3000 MW.

[7] Restoration time is based on TransGrid Control Room historical experience and OM666 Black Start.

[8] TransGrid's Investment Risk Tool bases the Value of Customer Reliability (VCR) on figures published by AEMO in its Value of Customer Reliability Review - Final Report, September 2014. In this case we use the mixed residential/industrial figure of $38,350/MWh.

Other Risk Cost

In addition there are financial and reputational risk costs totalling $0.035 million[9].

Total Risk Cost

Total risk cost = Unserved energy risk cost + other risk costs

∴ Total risk cost = $4.635 million per annum.

Option B – Construction of a parallel transmission path between Canberra and Marulan

This option involves the construction of a 330 kV transmission line between Canberra and Marulan substations to prevent the existing Canberra to Dapto transmission path becoming overloaded. It is anticipated that the capital costs for this option would be in excess of $100m and would reduce the risk cost to zero.

Due to the significantly larger expected capital cost, this option will not deliver value for money and has not been considered.

Non-network Solutions

No feasible non-network solutions are available to address this Need.

4. 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 $12.57 million for every year that the Need is not addressed. In contrast, Option A will reduce TransGrid's average annual risk to $5.68 million.

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 ($m)	Economic NPV ($m)	Rank
Base Case	'Do nothing' – allow load to be lost and rely on manual restoration.	-	-	12.57		2
A	Yass Area 330 kV Special Protection System	3.63	0.07	4.64	42.02	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	56.64
13.00	32.51

[9] The operational/compliance risk are due to this type of event occurring and derived from the risk tool

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.

Preferred Option

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).

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 $0.07 million, escalated at a rate of 2.9% per annum.

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 $12.57 million to $4.64 million.

It is recommended that a Request for Project Scoping (RPS) be issued for the implementation of a SCADA/Protection-based hybrid special protection system for the Yass area during the 2018/19 to 2022/23 Regulatory Control Period.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	Yass 330 Area Smart Grid Control System

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$1.81m	*NPV / Capital (Ratio)*	*-0.50*
NPV @ upper bound rate	13.00%	-$1.84m	*Pay Back Period (Yrs)*	*-0.04 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$1.70m	*IRR%*	*-3.58%*

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%	$42.02m	*NPV / Capital (Ratio)*	*11.58*
NPV @ upper bound rate	13.00%	$32.51m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$56.64m	*IRR%*	*133.34%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$12.32m*	*$4.61m*	*$7.72m*	*VCR Benefit*	*$7.67m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*	*ENS Penalty*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.27m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$7.94m
Environment	*$0.00m*	*$0.00m*	*$0.00m*		
Reputation	*$0.25m*	*$0.03m*	*$0.22m*	Benefits in the financial NPV*	$0.27m
Total Risk benefits	$12.57m	$4.64m	$7.94m	**excludes VCR benefits*	
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$7.94m
Total Benefits			$7.94m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.07m	Write-off cost	$0.00m
Capital - initial $m	-$3.63m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs