OPTIONS EVALUATION REPORT (OER)

Sydney West 330 kV Special Protection System (SPS)

OER 000000001522 revision 3.0

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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 have identified critical non-credible contingencies of 330 kV lines: 32 Bayswater – Sydney West, and 31 Bayswater – Regentville, could lead to voltage collapse in the Sydney region. The load at risk can be in the order of 3000 MW.

Refer to NS-1522 for details.

2. Related needs/opportunities

- Need 1472 – Yass Area 330 kV Smart Grid Control
- Need 1473 – West Area 330 kV Smart Grid Control
- Need 1482 – Sydney South Area 330 kV Smart Grid Controls
- Need 1484 – Snowy Area 330 kV Smart Grid Control
- Need 1487 – Eraring-Kemps Creek 500 kV Smart Grid Control
- Need 1488 – Eraring 330 kV Smart Grid Control
- Need 1491 – Sydney North 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 $4.65 million (refer to Attachment 1 in NOS1522 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 Sydney West Area cut-set causing a loss of load of 3,000 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].

[1] This event is noted to occur during severe bushfires, and it is expected that the total NSW load will be at maximum demand, resulting in 3,000 MW load lost due to the worst case combination of multiple 330 kV line outages.

[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.

Unserved Energy Risk Cost

Unserved energy is calculated as:

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

$$Unserved\ Energy\ = (3000\ MW\ * 0.5 * 8\ hrs) * 1\%$$

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

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

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

$$Risk\ Cost\ of\ Unserved\ Energy\ = 120\ MWh * \$38{,}350/MWh^{4}$$

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

Other Risk Cost

In addition there are financial and reputational risk costs of $0.05million[5].

Total Risk Cost

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

∴ Total risk cost = $4.65 million per annum.

Option A — Sydney West 330 kV Area Special Protection System <OFR-1522A, OFS-1522A>

This option involves the implementation of a SCADA/Protection-based Hybrid Special Protection System (SPS) for the Sydney West 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-1522A.

The expected capital cost for this option is $2.56 million ± 25% in un-escalated 2016-17 dollars, spread over 3 years. Refer to OFS-1522A for details.

The post-project risk cost of Option A is assessed to be $1.16 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 Sydney West Area smart grid control scheme[6]:

Unserved Energy Risk Cost

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

$$Unserved\ Energy\ = (1500\ MW\ * 0.5\ * 8\ hrs^{7}) * 1\%$$

$$\therefore\ Unserved\ Energy\ = 60\ MWh$$

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

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

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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.

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

[6] Due to the selected load shedding by the Sydney West Area smart grid control scheme – Load to be shed by tripping feeders at Sydney West, Liverpool and Regentville. The expected load to be shed is about 1500 MW.

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

$$Risk\ Cost\ of\ Unserved\ Energy\ =\ 60\ MWh * \$38{,}350/MWh^{4}$$

$$\therefore\ Risk\ Cost\ of\ Unserved\ Energy\ =\ \$2.3\ million$$

Other Risk Cost

In addition there are financial and reputational risk costs of $0.003 million .**Total Risk Cost**

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

∴ Total risk cost = $2.303 million per annum.

Option B – Construction of a parallel transmission path

This option involves the construction of a 330 kV transmission line between substations to prevent the existing 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 have been identified 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 $4.65 million for every year that the Need is not addressed. In contrast, Option A will reduce TransGrid's average annual risk to $2.303 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.	-	-	4.65	-	2
A	Sydney West 330 kV Area Special Protection System	2.56	0.051	2.303	10.91	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 ($m)
6.75	15.12
13.00	8.19

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 the preferred option, which equates to $0.051 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 $4.65m to $2.303m.

It is therefore recommended that an RPS be issued for the implementation of a SCADA/Protection-based hybrid SPS for the Sydney West 330 kV area during the 2018/19 to 2022/23 Regulatory Control Period.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	Sydney West Area Smart Grid Control System

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$2.23m	*NPV / Capital (Ratio)*	*-0.87*
NPV @ upper bound rate	13.00%	-$2.11m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$2.38m	*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%	$10.91m	*NPV / Capital (Ratio)*	*4.26*
NPV @ upper bound rate	13.00%	$8.19m	*Pay Back Period (Yrs)*	*1.11 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$15.12m	*IRR%*	*52.23%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$2.30m*
Systems (reliability)	*$4.60m*	*$2.30m*	*$2.30m*	*ENS Penalty*	*$0.00m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.05m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$2.35m
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.05m
Reputation	*$0.05m*	*$0.00m*	*$0.05m*	**excludes VCR benefits*	
Total Risk benefits	$4.65m	$2.30m	$2.35m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$2.35m
Total Benefits			$2.35m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.05m	Write-off cost	$0.00m
Capital - initial $m	-$2.56m	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