

OPTIONS EVALUATION REPORT (OER)



Sydney North West 330 kV Special Protection System (SPS)

OER 00000001491 revision 3.0

Ellipse project description: Sydney NthWest 330kV Smart Grid Controls
TRIM file: [TRIM No]

Project reason: Imposed Standards - Control Systems to meet NER requirements

Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	9 January 2017	

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 frequency and voltage following these multiple contingencies.

TransGrid studies have identified critical non-credible contingencies of two or more of these 330 kV lines: 21 Tuggerah – Sydney North, 22 Vales Point – Sydney North, 2M Munmorah - Tuggerah, 25 Eraring – Vineyard, and 26 Munmorah – Sydney West could lead to cascading failures in the greater Sydney load area. Such a multiple contingency event could result in voltage collapse in the Sydney area.

Refer to [NS-1491](#) for details.

2. Related needs/opportunities

- > Need 1472 – Yass Area 330 kV Smart Grid Control
- > 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 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 \$4.6 million (refer to Attachment 1 in NS-1491 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 North West cut-set causing a loss of load of 3,000 MW¹. The load restoration time is estimated to be 8 hours². 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 years³.

Unserved Energy Risk Cost

Unserved energy is calculated as:

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

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

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.

$$\therefore \text{Unserv ed Energy} = 120 \text{ MWh}$$

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

$$\text{Risk Cost of Unserv ed Energy} = \text{Unserv ed Energy} * \text{VCR}$$

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

$$\therefore \text{Risk Cost of Unserv ed Energy} = \$4.6 \text{ million per year}$$

Total Risk Cost

$$\therefore \text{Total risk cost} = \$4.6 \text{ million per annum.}$$

Option A — Sydney North West 330 kV Area Special Protection System <OFR-1491A, OFS-1491A>

This option involves the implementation of a SCADA/Protection-based Hybrid Special Protection System (SPS) for the Sydney North 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-1491A](#).

The expected capital cost for this option is \$2.83 million \pm 25% in un-escalated 2016-17 dollars, spread over 3 years. Refer to [OFS-1491A](#) for details.

The post-project risk cost of Option A is assessed to be \$2.3 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 North West area special protection system⁵:

Unserv ed Energy Risk Cost

$$\text{Unserv ed Energy} = (\text{MW at risk} * 0.5 * \text{failure duration}) * (\text{overall failure rate})$$

$$\text{Unserv ed Energy} = (1500 \text{ MW} * 0.5 * 8 \text{ hrs}^6) * 1\%$$

$$\therefore \text{Unserv ed Energy} = 60 \text{ MWh}$$

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

$$\text{Risk Cost of Unserv ed Energy} = \text{Unserv ed Energy} * \text{VCR}$$

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

$$\therefore \text{Risk Cost of Unserv ed Energy} = \$2.3 \text{ million}$$

Total Risk Cost

$$\therefore \text{Total risk cost} = \$2.3 \text{ million per annum.}$$

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 Due to the selected load shedding by the Sydney North West smart grid control scheme – Load to be shed by tripping feeders at Sydney West, Sydney East and Sydney North. The expected load to be shed is about 1500 MW.

⁶ Restoration time is based on TransGrid Control Room historical experience and OM666 Black Start.

Option B – Construction of a parallel transmission path

This option involves the construction of a 330 kV transmission line between the Sydney North substation and any of the Central Coast substations (Tuggerah, Munmorah, Vales Point or Eraring) to prevent the existing transmission paths 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 \$4.6 million for every year that the Need is not addressed. In contrast, Option A will reduce TransGrid’s average annual risk to \$2.3 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.	-	-	4.6	-	2
A	Sydney North West 330 kV Area Special Protection System	2.83	0.06	2.3	10.4	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 for the preferred option, A:

Discount Rate (%)	Economic NPV (2018/19 \$m)
6.75	14.52
13.00	7.74

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 \$0.057 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 take this opportunity as it significantly reduces TransGrid's risk exposure and reduces the annual risk cost from \$4.6m to \$2.3m.

It is therefore recommended that an RPS be issued for the implementation of a SCADA/Protection-based hybrid SPS for the Sydney North 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 North West Smart Grid Control System

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$2.74m	NPV / Capital (Ratio)	-0.97
NPV @ upper bound rate	13.00%	-\$2.56m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$2.98m	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%	\$10.40m	NPV / Capital (Ratio)	3.68
NPV @ upper bound rate	13.00%	\$7.74m	Pay Back Period (Yrs)	1.26 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$14.52m	IRR%	47.89%

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	\$0.00m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$2.30m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.00m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$2.30m
Total Risk benefits	\$4.60m	\$2.30m	\$2.30m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$2.30m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.06m	Write-off cost	\$0.00m
Capital - initial \$m	-\$2.83m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.19m	Re-investment capital	\$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs