OPTIONS EVALUATION REPORT (OER)

North West Area 330 kV Special Protection System

OER 000000001473 revision 3.0

Ellipse project description: P0008574 - North West 330kV Smart Grid Control
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 a need 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 similar significant voltage and dynamic stability constraints may arise under the non-credible contingencies of the loss of the 330 kV pair 85/86 Tamworth to Armidale lines, or the simultaneous loss of 330 kV lines 84 Liddell to Tamworth and 88 Tamworth to Muswellbrook.

2. Related needs/opportunities

- Need 1472 – Yass 330 kV Area 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. Past experiences of bushfires taking out multiple main system lines has seen control room operators manually restoring lines (refer to NOS-1473 for details).

The base case risk cost is $0.83 million. (refer to Attachment 1 in NS-1473 for Risk Cost summary), which is primarily made up of the value of unserved energy.

The risk cost was assessed for a loss of load of 1000 MW[1] The load restoration time is estimated to be 4 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:

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

$$Unserved\ Energy\ = (1000\ MW\ * 0.5 * 4\ hrs) * 1\%$$

$$\therefore\ Unserved\ Energy\ = 20\ MWh$$

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

[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 1,000 MW load lost due to the 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.

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

$$Risk\ Cost\ of\ Unserved\ Energy\ =\ 20\ MWh * \$38{,}350/MWh^{6}$$

$$\therefore\ Risk\ Cost\ of\ Unserved\ Energy\ =\ \$0.77\ million\ per\ year$$

Other Risk Cost

In addition there are financial and reputational risk costs totalling $0.06 million[4].

Total Risk Cost

∴ Total risk cost = $0.83 million per annum.

Option A — North West Area 330 kV Special Protection System <OFR-1473A, OFS-1473A>

This option involves the implementation of a SCADA/Protection-based Hybrid Special Protection System (SPS) for the 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-1473A.

The expected capital cost for this option is $3.24 million ± 25% in un-escalated 2016-17 dollars, spread over 3 years. Refer to OFS-1473A for details.

The post-project risk cost of Option A is assessed to be $0.31 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 to 400 MW per contingency event compared to the Base Case, due to the selected load shedding by the North West area smart grid control scheme[5]:

Unserved Energy Risk Cost

Unserved energy is calculated as:

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

$$Unserved\ Energy\ =\ (400\ MW\ *\ 0.5\ *\ 4\ hrs)\ *\ 1\%$$

$$\therefore\ Unserved\ Energy\ =\ 8\ MWh$$

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

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

$$Risk\ Cost\ of\ Unserved\ Energy\ =\ 8\ MWh * \$38{,}350/MWh^{6}$$

$$\therefore\ Risk\ Cost\ of\ Unserved\ Energy\ =\ \$0.31\ million\ per\ year$$

Other Risk Cost

In addition there are financial and reputational risk costs totalling $0[7].

Total Risk Cost

∴ Total risk cost = 0.31 million per annum.

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[4] The additional risks are due to this type of event occurring and the costs are derived from the risk tool.

[5] Due to the selected load shedding by the North West area smart grid control scheme – Load to be shed by tripping feeders at Newcastle, Tomago and Waratah West. The expected load to be shed is about 400 MW.

[6] 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.

[7] The additional risks are due to this type of event occurring and the costs are derived from the risk tool.

Option B – Construction of a parallel transmission path

This option involves the construction of a 330 kV transmission line between Armidale and Liddell substations to prevent the existing 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 $5.885. million for every year that the Need is not addressed. In contrast, Option A will reduce TransGrid's average annual risk to $5.34 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.	-	-	0.83	-	2
A	North West Area 330 kV Special Protection System	3.24	0.065	0.31	(0.05)	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 of the preferred Option A:

Discount Rate (%)	Economic NPV ($m)
6.75	(0.63)
13.00	(0.46)

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 $0.065 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 as it significantly reduces TransGrid's risk exposure and reduces the annual risk cost from $0.83m to $0.31m.

It is therefore recommended that an RPS be issued for the implementation of a North West Area 330 kV Special Protection System during the 2018/19 to 2022/23 Regulatory Control Period.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	North West Area Special Protection System

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$2.68m	*NPV / Capital (Ratio)*	*-0.83*
NPV @ upper bound rate	13.00%	-$2.52m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$2.87m	*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%	-$0.05m	*NPV / Capital (Ratio)*	*-0.02*
NPV @ upper bound rate	13.00%	-$0.46m	*Pay Back Period (Yrs)*	*7.22 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$0.63m	*IRR%*	*9.70%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.46m*
Systems (reliability)	*$0.77m*	*$0.31m*	*$0.46m*	*ENS Penalty*	*$0.00m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.06m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$0.52m
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.06m
Reputation	*$0.06m*	*$0.00m*	*$0.06m*	**excludes VCR benefits*	
Total Risk benefits	$0.83m	$0.31m	$0.52m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$0.52m
Total Benefits			$0.52m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.06m	Write-off cost	$0.00m
Capital - initial $m	-$3.24m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.22m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs