

OPTIONS EVALUATION REPORT (OER)

Making the Grid Smarter – Armidale north coast Line Overload Load Shedding (LOLS) Expansion

OER 000000001458 revision 3.0



Ellipse project description: P0008572

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	[Publish Date]	

1. Need/opportunity

TransGrid studies have identified non-credible contingencies of both Line 87 and one of 132 kV lines (Line 96S, 96G, 96C, 96H, 96L and 96R) in Armidale north coast area could lead to overloading on 132 kV lines 96G and 96C. The Armidale north coast Line Overload Load Shedding (LOLS) scheme was implemented to ensure that loading on 132 kV lines 96G and 96C do not exceed their contingency ratings. If an overload is detected and the overload remains after a time delay of 25 seconds, the scheme commences tripping of feeders at Coffs Harbour, Koolkhan and Kempsey until the overload no longer exists.

When the Armidale north coast LOLS scheme was implemented, 896 was the only feeder supplying Essential Energy's Maclean substation. However a second feeder (feeder 8G1) to Maclean substation was recently commissioned by Essential Energy. Hence load at Maclean will not be interrupted if only feeder 896 is tripped under the existing LOLS scheme.

As referred to in NS-1458, 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.

In order to meet this requirement, there is a need to ensure that loading on 132kV lines 96G and 96C do not exceed their contingency ratings.

2. Related needs/opportunities

No related needs or opportunities have been identified.

3. Options

Base case

The base case for this Need is to continue operating the network "as is" for managing multiple simultaneous contingencies. The existing scheme will not interrupt load to Maclean due to 8G1. Thus the scheme is ineffective for its intended use, which is to trip load and remove any overload on 96G and 96C post-contingent. The alternative is pre-contingent load shedding or radialising of the north coast area load when an overload is expected.

The primary risks of TransGrid not addressing this need is a cost of unsupplied demand to customers in Armidale north coast area. The risk cost was calculated using the Risk Tool.

The risk cost was calculated using the Risk Tool and as follows:

$$Unservd Energy = \sum_{\substack{i=for all \\ 132 kV trips}} [MW at risk_i * P_{line 87 failure} * P_i]$$

$$\therefore Unservd Energy = 52.7 MWh^1$$

Where:

- > Failure rate of 330 kV line 87 = 0.324 / year with a restoration time of 17.8 hours
- > Failure rate of North Coast 132 kV lines² = 0.39 /year per 100 km with a restoration time of 23.5 hrs

¹ Refer to the attached file "1458- Unserved Energy.xlsx"

² This is the total failure rate for lines 96S, 96G, 96C, 96H, 96L and 96R – outage of these lines lead to increased loading on 96G and 96C.

- > Load at risk is the total North Coast area load once firm capacity is reached, as a cascading overloads will be the result of the LOLS scheme not working effectively

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

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

$$\text{Risk Cost of Unserved Energy} = 52.7 \text{ MWh} * \$38,350/\text{MWh}$$

$$\therefore \text{Risk Cost of Unserved Energy} = \$2.02 \text{ million per year}$$

In addition, there are financial, environmental and reputational risk costs of \$1.08m per annum

Therefore the total risk cost is \$3.1m per annum.

Option A — LOLS Expansion Including 8G1 and 896

The effectiveness of the Armidale north coast LOLS scheme can be restored with the inclusion of both 896 (already included in Group 2) and 8G1 (currently not included) in Group 2 of the tripping sequence.

The expected capital cost for this option is \$0.024 million \pm 25% (in un-escalated 2016/17 dollars). The scope of works included in this option is outlined in [OFS-1458A Rev 3](#).

The inclusion of 8G1 in Group 2 of the Armidale north coast LOLS scheme is not expected to materially change any existing ongoing operations and maintenance costs. The residual risk associated with this option upon completion of the project is minimal as the risk of TransGrid not meeting the power system security needs by maintaining transmission lines within their contingency ratings is eliminated by the augmentations proposed under this option. The post-project risk cost to Option A is assessed to be \$0.11 million per year.

The post-project risk cost is calculated as follows:

$$\text{Unserved Energy} = \sum_{\substack{i=\text{for all} \\ 132 \text{ kV trips}}} [\text{MW at risk}_i * P_{\text{line 87 failure}} * P_i]$$

$$\therefore \text{Unserved Energy} = 2.9 \text{ MWh}^3$$

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

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

$$\text{Risk Cost of Unserved Energy} = 2.9 \text{ MWh} * \$38,350/\text{MWh}$$

$$\therefore \text{Risk Cost of Unserved Energy} = \$0.11 \text{ million per year}$$

In addition, there are financial, environmental and reputational risk costs of \$0.7m per annum

Therefore the total risk cost is \$0.81m per annum.

Non-network Solutions

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

³ Refer to the attached file "1458- Unserved Energy.xlsx"

4. Evaluation

4.1 Technical evaluation

The base case of “Do Nothing” is considered not feasible as it would:

- > Violate TransGrid’s statutory requirements under the National Electricity Rules to maintain power system security
- > Generate a VCR risk cost to TransGrid of \$2.02 million per year, for every year the Need is not addressed.

In contrast, Option A is technically feasible and will reduce TransGrid’s average annual risk.

4.2 Commercial evaluation

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	Capex (\$m)	Opex (\$m)	Post project risk cost (\$m)	Economic NPV (\$m) @10%	Financial NPV (\$m) @10%	Rank
Base case	“Do Nothing” (O&M ceases)	0	0	3.1	-	-	-
A	LOLS Expansion Including 896 and 8G1	0.024	0	0.81	17.35	2.83	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	21.12
13.00	14.74

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.

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 expansion of the Armidale north coast LOLS scheme to include feeder 8G1 is not expected to materially change any existing ongoing operations and maintenance costs.

Regulatory Investment Test

The RIT-T is not required as this is a network augmentation project with the cost of the preferred option under \$6 million.

5. Recommendation

Based on both technical and economic evaluations above, Option A to expand the Armidale north coast LOLS scheme is the preferred option to address the Need as it significantly reduces TransGrid's risk exposure and reduces the risk from \$3.1m to \$0.81 m (as shown in Appendix A).

It is therefore recommended that a project be initiated for Option A in the 2018-2023 regulatory period.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name

Armidale north cost Line Overload Load Shedding Expansion

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	\$2.83m	NPV / Capital (Ratio)	117.77
NPV @ upper bound rate	13.00%	\$2.40m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$3.44m	IRR%	1561.25%

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%	\$17.35m	NPV / Capital (Ratio)	723.08
NPV @ upper bound rate	13.00%	\$14.74m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	\$21.12m	IRR%	9519.58%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.91m
Systems (reliability)	\$2.06m	\$0.15m	\$1.91m	ENS Penalty	\$0.00m
Financial	\$0.04m	\$0.04m	\$0.00m	All other risk benefits	\$0.37m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$2.28m
People (safety)	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.37m
Environment	\$0.35m	\$0.00m	\$0.35m	*excludes VCR benefits	
Reputation	\$0.65m	\$0.63m	\$0.02m	Benefits in the economic NPV**	\$2.28m
Total Risk benefits	\$3.10m	\$0.81m	\$2.28m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$2.28m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$0.02m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	1.00 Yrs	Start of the re-investment period	0.00 Yrs