OPTIONS EVALUATION REPORT (OER)

Thermal Limitation on 969 Line

OER 000000001489 revision 3.0

Ellipse project description: Thermal Limitation on 969 Line
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

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Date submitted for approval	9 January 2017	

1. Need/opportunity

In a study commissioned by TransGrid[1], Ernst & Young (EY) has identified a number of projects which may impact the TransGrid network development plan. The EY study identifies, as a minimum, a total of 354 MW not considered by TransGrid in demand forecasts over the upcoming planning horizon. One of these projects is the proposed 40 MW Shenhua coal mine, connected within Essential Energy's network near Gunnedah, supplied from TransGrid's Gunnedah 132/66 kV Substation.

TransGrid has analysed the impact of the additional loads and identified a thermal constraints on line 969 during system normal conditions and voltage stability constraints in the area following a contingency on 132 kV line 968 between Narrabri and Tamworth. TransGrid expects the constraints to occur by 2023 if the uncommitted projects were to progress.

TransGrid's analysis hence determines that thermal constraints and voltage stability issues in the region necessitates a solution if Shenhua coal mine is to occur within the next planning horizon.

TransGrid has estimated a 53.5% weighted likelihood of the Need eventuating within the 2018-23 regulatory period.

2. Related needs/opportunities

> Need 1693 – EE connection for Narrabri Gas

  This need is for a possible connection of the Narrabri Gas Project to the Essential Energy network near Narrabri. Should this project eventuate, a constraint in the Gunnedah and Narrabri area will eventuate, requiring an investment to support the network.

3. Options

Base case

The base case for this Need is to continue operating the network "as is".

Scenario 1: Assuming the additional uncommitted loads are realised this option is not deemed credible as it would lead to constraints in the network and an unacceptable risk, as outlined in NOS-1489.

The primary risk of not addressing this Need is voltage instability and thermal limitation resulting in a loss of load, that is unserved energy (USE), in the Narrabri and Gunnedah area following a single critical contingency of TransGrid line 969 between Tamworth and Gunnedah or 968 between Tamworth and Narrabri.

Unserved Energy Risk Cost

Unserved energy is calculated as:

$$Unserved\ Energy = 430\ MWh$$ [2]

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

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

$$Risk\ Cost\ of\ Unserved\ Energy = 430\ MWh * \$33{,}460/MWh$$ [3]

[1] EY 2016, Expansion of demand scenarios, Ernst and Young, 10 October 2016.

[2] Calculated using scaled 2015 hourly data.

[3] 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.

$\therefore\ Risk\ Cost\ of\ Unserved\ Energy\ =\ \$14.39\ million\ per\ annum$

Reliability Risk Cost

There is an additional reliability risk cost of $0.06 million.

Other Risk Cost

There are financial and reputational risk costs of $0.06 million per annum.[4]

Total Risk Cost

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

∴ Total risk cost = $14.46 million per annum.

Scenario 2: Assuming the additional uncommitted loads are not realised, the Base case option results in optimal utilisation of assets.

Option A — Reconductoring 969 Line with Higher Operating Temperature Conductor [OFR-1489A, OFS-1489A]

This option is for reconductoring of 969 line with a higher capacity conductor to reach a summer day contingency rating of at least 150 MVA. The estimate has been based on supply of Oriole ACSS/TW/HS285 conductor with standard ACSR conductor stringing, clipping, and fittings, which will enable all existing structures to be reused.

The expected capital cost for the option is $5.72 million (in un-escalated 2016-17 AUD).

[4] These risk costs are due to this type of low probability event occurring and derived from the risk tool

- The use of high temperature conductor is not expected to materially change the existing ongoing operations and maintenance cost of 969 line.
- The residual risk associated with this option upon completion of the project is minimal as the risk of TransGrid not meeting the reliability standard for the supply to Gunnedah/Narrabri area is eliminated by the augmentation of the network under this option.

Scenario 1: Assuming the additional uncommitted loads are realised, the post-project risk cost of Option A is assessed to be zero. The key driver of this risk cost is that should one of the lines 968 trips, no load would be at risk, and therefore there would be no unserved energy.

Scenario 2: Assuming the additional uncommitted loads are not realised, Option A results in underutilisation of assets for the immediate planning horizon (from 2023 onwards). However Option A would negate the requirement for existing load shedding schemes to existing mines in the area.

Option B — Non-Network Solutions to Manage Risk

- Diesel generation

  It is not clear how much potential there is for diesel generation in the study area. Diesel generation as demand response could either be through dispatching existing embedded generation from within a customer site, or through establishment of new dedicated generation plant (by an external provider).

  For dedicated diesel generation sites, TransGrid has received several proposals in the last two years in response to Requests for Proposals for demand response. The lowest price offered was approximately $300,000 per MW per annum.

  In addition, in the last few years a demand response aggregator has provided TransGrid with a high-level assessment of demand response potential in the areas supplied by TransGrid's Gunnedah and Narrabri Substations. Their finding is that procurement of around 4 MW of demand response may be viable, where that demand response is made up of both post-contingent load curtailment as well as diesel generation.

- Negotiate with mines

  As there has been low mine activity to date, a high penetration of distributed energy resources in the area, and a trend of declining demand in the area, the energy at risk may decline further even with the current network configuration.

  This option would involve paying the mines annually to reduce their accepted level of reliability. The size of the payment that would be economically effective to eliminate the need for investment would need to be greater than $31,000 per annum but less than the next least cost credible option.

  Depending on the negotiations with the mines, this may not be feasible. In February 2015, we wrote to Idemitsu (Boggabri Coal) and Whitehaven Coal (Maules Creek) to clarify their expected load forecasts. In response, Idemitsu forecast 5 MVA for 2016, and Whitehaven provided their anticipated energy usage and coal production for the second half of 2015, as well as 2016 and 2017. Based on this information, the estimated 50% PoE maximum demands are shown in the table below.

	Winter 2015		Summer 2015/16 onwards	
Boggabri Coal	4	3	4	3
Maules Creek	4	3	11	7

> Storage technology

The cost of energy storage devices have declined significantly in the past few years, with the residential segment attracting much activity due to the high penetration of solar rooftop photovoltaic systems. To date there is approximately 7 MW of rooftop PV solar capacity in the Gunnedah-Narrabri area. The Narrabri area has an extremely high penetration of rooftop PV, with 42% of dwellings (N=1358) having a rooftop PV. Home owners in this area are highly likely to purchase a battery storage system.

Presently, residential energy storage systems - based on lithium chemistry - costs circa $10,000 (not installed) for 7kWh sized systems, which are being offered by all the large retailers with various finance options. The NSW Solar Bonus Scheme (feed-in tariffs) will cease at the end of 2016 and will encourage households to store the excess PV output during the daytime and 'self-consume' the energy during the evening.

This non-network option would involve paying a battery aggregator/retailer an annual license fee of $300,000 per annum to trigger their network of distributed batteries post-contingently. This improves the value proposition for potential battery owners (through subsidies), and the individual battery owners would be compensated by the energy they self-consume rather than draw from the network.

As these batteries have yet to be installed, a lead time of 12 to 18 months would be required for the retailer/installer to roll 1300 units out.

We have estimated that a rate of $25/kWh (delivered) is commercially attractive, which is significantly higher than the maximum FiT ($0.60) most households are receiving currently.

For demand response to be effective in a post-contingent situation, TransGrid will require the battery aggregator/retailer to have adequate communications to trigger the end-user battery management system to self-consume. On top of that, the battery aggregator must be able to communicate with TransGrid's OpenADR 2.0b server known as a Virtual Top Node (VTN).

> Consumer load curtailment

Customer demand for electricity at Gunnedah currently has a peak demand of 26 MW. The peak for Narrabri is presently 49 MW. This demand is made up of:

- Residential loads, for a population of approximately 21,000
- Agricultural loads for growing cotton, crops and cattle farming
- Industrial load, primarily for mining and cotton ginning.

In the last two years a demand response aggregator has provided TransGrid with a high-level assessment of demand response potential in the areas supplied by TransGrid's Gunnedah and Narrabri Substations. Their finding is that procurement of around 4 MW of demand response may be viable, where that demand response is made up of both post-contingent load curtailment (pump curtailment) as well as diesel generation.

Neither TransGrid nor the local distribution networks Essential Energy have previously procured customer load curtailment for network support in this area.

In the case of load curtailment, it is likely that a demand response aggregator would install equipment (OpenADR Virtual End Node (VEN) device) to commercial and industrial customers who are willing participants in providing demand response.

The following analysis applies to all non-network solutions:

Scenario 1: If the Shenhua mine project does proceed, this option would require up to 15-20 MW of load curtailment during times of higher area load, under system normal operation. This level of load curtailment would need a large proportion to come from the mine itself and would depend on its ability to do so (technological & financial dependence). This will only be able to be determined if/when the mine materialises. At this point in time, it is not possible to provide an accurate cost of obtaining a demand management agreement with the mine. However this option will be further reviewed as additional information becomes available.

The residual risk associated with this option upon completion of the project is assumed to be minimal as the risk of TransGrid not meeting the reliability standard for the supply to Gunnedah/Narrabri area is eliminated by the use of load curtailment and battery storage.

Scenario 2: Assuming the Shenhua mine project does not proceed, the expected total risk cost is zero

4. Evaluation

4.1 Technical evaluation

Based on the analysis in OSA-1693, only Option A is deemed technically feasible at this point in time. Therefore Option A is compared in Table 1 to the base case option.

4.2 Commercial evaluation

The commercial evaluations of the technically feasible options are set out in Table 1. The full financial and economic evaluations are shown in Appendix A.

Table 1 — Commercial evaluation ($ million)

Option	Description	Capex ($m)	Opex pa ($m)	Post investment risk cost pa ($m)	Economic NPV ($m) @10%	Financial NPV ($m) @10%	Rank
Base case	'Do Nothing'	N/A	N/A	14.46	N/A	N/A	-
A	Reconductoring 969 Line with Higher Operating Temperature Conductor	5.72	No additional opex	0	96.05	(3.82)	1
B	Non-Network Solutions to Manage Risk Exposures	TBD	TBD	TBD	TBD	TBD	2

The above 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 gives the following economic NPVs for the preferred option (option A)

Table 2 — Discount rate sensitivities ($ million)

Option	Description	Economic NPV @ 13%	Economic NPV @ 6.75%
A	Reconductoring 969 Line with Higher Operating Temperature Conductor	70.16	141.46

4.3 ALARP Evaluation

An ALARP assessment is triggered by the following hazard and the disproportionate factor:

> Unplanned outage of HV equipment - 3 times the safety risk reduction and taking 10% of the reliability risk reduction as being applicable to safety

However, as this will only produce 30% of the benefit derived in the economic evaluation, a full ALARP evaluation will not produce an alternative preferred solution.

4.4 Preferred Option

The preferred option is Option A – Reconductoring 969 line with higher operating temperature conductor as it ranks 1 under both commercial and sensitivity analysis.

Capital and operating expenditure

The yearly incremental operating expenditure of Option A is estimated to be $0 per annum above the yearly operating expenditure of the Base Case.

Regulatory Investment Test

Option A is not subject to the RIT-T process as it has an estimated cost less than the mandated $6 million threshold.

5. Recommendation

Based on the economic evaluation above, Option A is the preferred option to address the Need as it:

> Enables TransGrid to meet its supply obligations under the National Electricity Rules.

> Significantly reduces TransGrid's risk exposure and reduces the annual risk cost from $14.46m to zero

Appendix A - Financial and Economic Evaluation Reports

Project_Option Name	Need 1489 - Option A - Reconductoring Scenario 2

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$3.82m	*NPV / Capital (Ratio)*	*-0.67*
NPV @ upper bound rate	13.00%	-$3.73m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$3.74m	*IRR%*	*-1.05%*

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%	$96.05m	*NPV / Capital (Ratio)*	*16.79*
NPV @ upper bound rate	13.00%	$70.16m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$141.46m	*IRR%*	*151.01%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$14.40m*	*$0.00m*	*$14.40m*	*VCR Benefit*	*$14.39m*
Financial	*$0.01m*	*$0.00m*	*$0.01m*	*ENS Penalty*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.07m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$14.46m
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV* **excludes VCR benefits*	$0.07m
Reputation	*$0.05m*	*$0.00m*	*$0.05m*		
Total Risk benefits	$14.46m	$0.00m	$14.46m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV** ***excludes ENS penalty*	$14.46m
Total Benefits			$14.46m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$5.72m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	$2.63m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs