OPTIONS EVALUATION REPORT (OER)

Making the Grid More Resilient – Tomago 330kV

OER 000000001416 revision 2.0

Ellipse project no.: P0008185
TRIM file: [TRIM No]

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

Approvals

Author	Kanchana Amarasekara	Electrical Engineer – Industrial Placement
Reviewed	Charbel Lahoud	Network & Connection Analysis Engineer
Endorsed	Garrie Chubb	Investment Support Manager
	Azil Khan	Investment Analysis Manager
	Vincent Ong	Network & Connection Analysis Manager
Approved	Nalin Pahalawaththa	Manager/Power System Analysis
Date submitted for approval	[Publish Date]	

1. Need/opportunity

Tomago 330/132 kV substation supplies Tomago Aluminium Company (TAC) at 330 kV and Ausgrid at 132 kV. TAC's three pot lines consume [redacted]

The 330 kV Tomago switchyard is a double bus arrangement with two of the four TAC transformers dual selected (connected to both buses) and two single selected (one to each bus). Three TAC transformers are normally on load, each supplying one pot line, with the fourth on standby.

As referred to in NS-1416, recent reviews by the AEMO and AEMC have suggested that high impact, low probablitiy events have the potential to result in a significant loss of supply. TransGrid is required to manage this risk.

During outages that take a TAC transformer out of service, loss of another transformer will interrupt a potline and cause a significant load loss event. Loss of TAC potlines can have major impact on the NSW interconnector flows and also a major economic impact.

2. Related needs/opportunities

None

3. Options

Base case

The Base Case is to continue to operate the network using the status quo Tomago 330 kV busbar arrangement.

This will lead to an annual risk cost of $0.9 million. The risk cost summary is in the NOS-1416.

Cost Calculation

The unserved energy has been calculated using the following data:

- 330 kV bay CB failure rate = 0.024 / unit /annum[1]
- No. of CB failures that could lead to a bus trip[2] = 6
- [redacted]
- The value of customer reliability (VCR) for industrial loads in NSW is $44,720/MWh[5]
- Outage duration of a CB[1] in the event of a forced outage = 14 hours

Therefore:

- Unserved Energy = [Potline interruption due to a busbar trip as a result of a CB failure] + [Potline interruption due to a second CB trip during a forced outage of single connection feeder CB]

[1] Based on TransGrid historical CB failure rates(refer file CB Unplanned Outage Stats.xlsx in PDGS)

[2] Based on No. of CBs connected to Bus A and Bus B at Tomago 330 substation

[3] Based on typical TransGrid restoration times and Tomago Aluminium Company load transfer times

[4] Based on historical Tomago Aluminium Company Potline selections (refer file "1416- Tomago Historical Data_30MINAVE_140712_0000_to_160712_1535.xlsx" in PDGS

[5] AEMO, Value of Customer Reliability – Application Guide.

- Unserved Energy = [redacted] (no. of bus bars) * (no. of CBs per busbar) * (failure rate of a CB) * [redacted] (no. of CB forced outages in single switched potline connections) * (failure rate of a CB) * (failure rate of a second CB) * (CB failure duration due to forced outage)]
- Unserved Energy = [300 * 2 * 6* 0.024 * 0.3 * 0.5] + [300 * 2 * 0.024 * 0.024 * 14]
- Unserved Energy = 12.96 + 4.84 = 17.8 MWh

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

- Cost of Unserved Energy = Unserved Energy * VCR
- Cost of Unserved Energy = 17.8 MWh * $44,720
- Cost of Unserved Energy = $0.8 million

In addition, there is a reputational risk of $0.1 million.

Therefore the total risk is $0.9 million.

Option A — Upgrade connections for No. 1 Feeder and No. 4 Feeder from single switched connection to dual selected connection <OFR-1416A, OFS-1416A>

A potential interruption event can be avoided and the reliability of the supply to TAC can be increased by upgrading the connections for No. 1 and No. 4 feeders from single switched to dual selected connection.

The scope of works under this option can be found in OFR-1416A.

The expected capital cost for this option is $4.87 million ± 25% in un-escalated 2016-17 dollars, spread over 3 years. Refer to OFS-1416A for details.

In this case, taking a TAC 330 kV supply CB outage or a trip of a 330 kV busbar will not disturb the supply to TAC pot lines. Therefore there will be no unserved energy cost. The post-project risk cost of Option A will be $0.

Option B — Install a fifth TAC transformer connection to both busbars

This option would involve a significant cost increase above option A, with no further benefit, and as such was not analysed further.

Non-network option

No feasible non-network option has been identified.

4. Evaluation

The Base Case and Options A are technically feasible. However, implementing Option A would reduce the expected unserved energy cost.

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 of Technically Feasible Options

Option	Description	Capex ($m)	Opex ($m)	Yearly post project risk cost ($m)	Economic NPV ($m)	Rank
Base case	Base case – Do nothing	-	-	0.9	-	2
A	Upgrade connections for TAC transformers from single switched connection to dual selected connection	4.87	0.1	0	1.95	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	4.28
13.00	0.68

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 the Option A, as it provides significant 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 each option, which equates to $0.1 million, escalated at a rate of 2.9% per annum.[6]

Regulatory Investment Test-Transmission

This Need is not subject to the RIT-T process as it does not exceed the $6 million threshold requirement.

[6] TransGrid Success Database as at May 2016.

5. Recommendation

Based on the economic evaluation above, Option A is the preferred option to address the Need as it reduces the expected unserved energy cost by $ 0.9 million/year.

It is therefore recommended that a Project be initiated to implement Option A over the 2018-23 period.

Appendix A – Financial and Economic Evaluation Reports

Project_Option Name	Dual Selection of Tomago Nos. 1 and 4 Transformers

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$4.16m	*NPV / Capital (Ratio)*	*-0.85*
NPV @ upper bound rate	13.00%	-$3.96m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$4.34m	*IRR%*	*-4.74%*

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%	$1.95m	*NPV / Capital (Ratio)*	*0.40*
NPV @ upper bound rate	13.00%	$0.68m	*Pay Back Period (Yrs)*	*6.15 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$4.28m	*IRR%*	*15.43%*

Benefits						
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.80m*
Systems (reliability)	*$0.80m*	*$0.00m*	*$0.80m*	*ENS Penalty*	*$0.00m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.10m*
Operational/compliance	*$0.10m*	*$0.00m*	*$0.10m*	Total Risk benefits	$0.90m
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.10m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$0.90m	$0.00m	$0.90m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$0.90m
Total Benefits			$0.90m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.10m	Write-off cost	$0.00m
Capital - initial $m	-$4.87m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment	$2.24m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs