OPTIONS EVALUATION REPORT (OER)

Remote or self reset of Bus Protection

OER 000000001422 revision 3.0

Ellipse project description: Remote or self reset of Bus Protection
TRIM file: [TRIM No]

Project reason: Reliability - To meet connection point reliability requirements
Project category: Prescribed - NCIPAP

Approvals

Author	Bhavin Sanghavi Jay Esson	Operations Analysis Engineer Network Modelling & Performance Engineer
Reviewed / Endorsed	Hoang Tong	Operations Analysis Manager
	Jahan Peiris	Network Modelling and Performance Manager
	Garrie Chubb	Investment Support Manager
Approved	Andrew Kingsmill	Manager/Power System Analysis
Date submitted for approval	26 August 2016	

1. Need/opportunity

Leveraging off the rollout of modern control systems and availability of broadband communications it is proposed to provide the Asset Monitoring Centre (AMC) with high definition Closed Circuit Television (CCTV) of busbar areas in the switchyard and facility to reset busbar protections via SCADA at selected sites.

Provision of these facilities would enable rapid assessment of the situation and, if warranted, resetting of the protections and restoration of supplies. Busbars would be targeted where there is a single busbar protection zone and the amount of radial load and typical response time combine to make it likely that a bus trip would result in significant supply interruptions. There are 22 sites that have been identified as having significant load at risk and this solution is proposed for these sites in this proposal.

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" with the non-credible contingent trips of busbars resulting in longer than acceptable restoration times.

The expected total VCR risk cost is $3.8 million/year. The total pre-project risk cost is $3.84 million/year. The VCR risk cost is the estimated value of unserved energy in the event of terminal equipment failure.

The risk cost summary is included in Attachment 3.

Cost Calculation

The unserved energy has been calculated using the following data:

- 132 kV terminal equipment failure rate = 0.07 / unit /annum; 66 kV terminal equipment failure rate = 0.05 / unit /annum; and 33 kV or lower terminal equipment failure rate = 0.12 / unit /annum[1]
- Load form factor of 0.5 (average demand = maximum demand * load form factor)
- The value of customer reliability (VCR) for NSW is $38,350/MWh[2]

$$Unserved\ Energy = \sum_{\substack{for\ all \\ 22\ busbars}} \begin{bmatrix} MW\ at\ risk * Load\ Form\ Factor * \\ Bus\ terminal\ failure\ rate * Restoration\ Time \end{bmatrix}$$

$$\therefore Unserved\ Energy = 99.3\ MWh^{3}$$

[1] IPART, *Electricity Transmission Reliability Standards – An Economic Assessment.*

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

[3] Refer to the attached file "1422- Unserved Energy.xlsx"

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

- Cost of Unserved Energy = Unserved Energy * VCR
- Cost of Unserved Energy = 99.3 * $38,350
- Cost of Unserved Energy = $3.80 million

Option A — Installing high definition CCTV and facility to reset busbar protections

The option involves the rollout of high definition Closed Circuit Television (CCTV) of busbar areas in the switchyard and facility to reset busbar protections via SCADA at 22 selected sites.

The scope of works under this option can be found in OFS-1422A.

The expected capital cost for this option is $3.8 million ± 25% (in un-escalated 2016/17 dollars), spread over 3 years. Refer to OFS-1422A for details.

The residual risk associated with this option upon completion of the project will be reduced significantly since the time to restore power supplies will be reduce with the augmentations proposed under this option.

The expected total post project VCR risk cost is $1.9 million/year. The total post project risk cost is $1.92 million/year (see the Attachment 3 – Risk Cost Summary).

Cost Calculation

The unserved energy has been calculated using the same data as the base case, however the time to restore supplies have been conservatively assumed to be half of the original restoration times.

$$Unserved\ Energy = \sum_{\substack{for\ all \\ 22\ busbars}} \left[\begin{matrix} MW\ at\ risk * Load\ Form\ Factor * \\ Bus\ terminal\ failure\ rate *\ Restoration\ Time * 0.5 \end{matrix}\right]$$

$$\therefore Unserved\ Energy = 49.6\ MWh^{4}$$

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

- Cost of Unserved Energy = Unserved Energy * VCR
- Cost of Unserved Energy = 49.6 * $38,350
- Cost of Unserved Energy = $1.90 million

[4] Refer to the attached file "1422- Unserved Energy.xlsx"

Benefit Calculation

The benefit gained from the reduction in unserved energy is therefore:

- Market Benefit = Unserved Energy Improvement * VCR
- Market Benefit = 49.6 * 38,350
- Market Benefit = $1.90 million

4. Evaluation

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

- Generate a VCR risk cost to TransGrid of $3.84 million per year, for every year the Need is not addressed. . The risk cost is primarily made up of the value of unserved energy. The risk cost summary is included in Attachment 3.

Option A is technically feasible and has been assessed commercially.

The commercial evaluation of the technically feasible options is set out in Table 1.

Table 1

Option	Description	Capex ($m)	Opex ($m)	Post project risk cost ($m)	Economic NPV ($m) @10%	Rank
Base case	'Do Nothing' – continue to incur risk costs	n/a	n/a	3.84	n/a	2
A	Installing high definition CCTV and facility to reset busbar protections	3.8	0.08	1.92	7.33	1

The full financial and economic evaluations are shown in Attachment 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 Attachment 1.

The applied sensitivities on the discount rate give the following economic NPVs:

Discount Rate (%)	Economic NPV (2018/19 $m)
6.75	10.56
13.00	5.26

Preferred Option

The preferred option is therefore the Option A, as it provides significant benefits, as calculated using TransGrid's NPV Calculation Tool (refer to Attachment 1) and Risk Tool. Risk summaries for the base case and the preferred option are included in Attachment 3.

A summary of the preferred option can be found in Attachment 2.

Sensitivity Analysis of Value of Customer

The pre-project VCR risk of $3.84 million is based on the probability of non-credible contingencies occurring on 132 kV, 66 kV and 33 kV busbars at the 22 locations in the TransGrid network, resulting in supply interruptions to the customers at these locations.

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 $0.08 million, escalated at a rate of 2.9% per annum.[5]

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 the economic evaluation above, Option A is the preferred option to address the Need as it reduces TransGrid's risk exposure and yields yearly benefits of $1.8 million (includes risk saving $1.92 million and ongoing opex $0.08 million).

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

[5] TransGrid Success Database as at May 2016.

Attachment 1 – Financial and Economic Evaluation Reports

Project_Option Name	Remote reset of bus protection

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$3.51m	*NPV / Capital (Ratio)*	*-0.92*
NPV @ upper bound rate	13.00%	-$3.24m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$3.87m	*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%	$7.33m	*NPV / Capital (Ratio)*	*1.93*
NPV @ upper bound rate	13.00%	$5.26m	*Pay Back Period (Yrs)*	*2.07 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$10.56m	*IRR%*	*36.48%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$3.80m*	*$1.90m*	*$1.90m*
Financial	*$0.01m*	*$0.01m*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.03m*	*$0.01m*	*$0.02m*
Total Risk benefits	$3.84m	$1.92m	$1.92m
Cost savings and other benefits			$0.00m
Total Benefits			$1.92m

VCR Benefit	*$1.90m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.02m*
Total Risk benefits	$1.92m
Benefits in the financial NPV*	$0.02m
**excludes VCR benefits*	
Benefits in the economic NPV**	$1.92m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.08m	Write-off cost	$0.00m
Capital - initial $m	-$3.80m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs

Attachment 2 – Summary of Preferred Option

Rapid Restoration following Busbar Trips	**Busbar trips are rare, high consequence outages. Busbar protections are designed to latch and must be reset at site before the busbar may be re-energised. In country areas, radial feeders are the norm and a bus trip will often result in a supply interruption. Following the protection operation, TransGrid must call-out staff, have them travel to site, inspect the equipment and investigate the fault source before attempting restoration. Though the load interrupted is small, the duration of such outages results in a significant unserved energy. The installation of rapid restoration system will improve the contingency limit of the injection point.**
Transmission Circuit / Injection Point	132 kV, 66 kV, and 33 kV busbars at 22 sites in the TransGrid network
Scope of works	The rollout of high definition Closed Circuit Television (CCTV) of busbar areas in the switchyard and facility to reset busbar protections via SCADA at 22 selected sites.
Reasons to undertake the project	Busbar protections are designed to latch and must be reset at site before the busbar may be re-energised. Installation of high definition Closed Circuit Television (CCTV) of busbar areas in the switchyard and facility to reset busbar protections via SCADA at selected sites will significantly reduce restoration time and duration of supply interruptions following a busbar fault.
Current value of the limit	0 MW for the duration that staffs are sent to site to restore power.
Target limit	Load supplied at the particular injection point with half the restoration time (see NOS for list of 22 sites).
Capital Cost	The total capital cost is $3.8M.
Operating Cost	$0.08M per annum
Market benefits	Market Benefit = Annual unserved energy improvement x VCR Market Benefit = 69.49 MWh x $38,350 Market Benefit = $1.9 M / year
Pay-back period	Pay-back period = 2.07 years
Completion date	Over the 2018-23 period

Attachment 3 – Risk Cost Summaries

Current Option Assessment - Risk Summary

Project Name: Rapid Restoration following Busbar Trips

Option Name: 1422 - Base Case

Option Assessment Name: 1422 - Base Case - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF ($M)	Failure Mechanism	NoxLoC xCoF ($M)	PoF (Yr 1)	Total Risk ($M)	Risk ($M) (Rel)	Risk ($M) (Op)	Risk ($M) (Fin)	Risk ($M) (Peo)	Risk ($M) (Env)	Risk ($M) (Rep)
132kV Busbar Fault	1	Busbar	Unplanned Outage - HV (132kV Busbar Fault)	$38.00	Structural Failure	$38.00	7.00%	$2.66	$2.64		$0.00			$0.01
33 kV Busbar Fault	1	Busbar	Unplanned Outage - HV (33 kV Busbar Fault)	$6.07	Structural Failure	$6.07	12.00%	$0.73	$0.72		$0.00			$0.01
66kV Busbar Fault	1	Busbar	Unplanned Outage - HV (66kV Busbar Fault)	$8.99	Structural Failure	$8.99	5.00%	$0.45	$0.45		$0.00			$0.00
				$53.07		$53.07		$3.84	$3.81		$0.01			$0.03

Total VCR Risk: $3.80 **Total ENS Risk:** $0.00

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Current Option Assessment - Risk Summary

Project Name: Rapid Restoration following Busbar Trips

Option Name: 1422 - Preferred Option

Option Assessment Name: 1422 - Option A - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF ($M)	Failure Mechanism	NoxLoC xCoF ($M)	PoF (Yr 1)	Total Risk ($M)	Risk ($M) (Rel)	Risk ($M) (Op)	Risk ($M) (Fin)	Risk ($M) (Peo)	Risk ($M) (Env)	Risk ($M) (Rep)
132kV Busbar Fault	1	Busbar	Unplanned Outage - HV (132kV Busbar Fault)	$19.04	Structural Failure	$19.04	7.00%	$1.33	$1.32		$0.00			$0.01
33 kV Busbar Fault	1	Busbar	Unplanned Outage - HV (33 kV Busbar Fault)	$3.05	Structural Failure	$3.05	12.00%	$0.37	$0.36		$0.00			$0.00
66kV Busbar Fault	1	Busbar	Unplanned Outage - HV (66kV Busbar Fault)	$4.51	Structural Failure	$4.51	5.00%	$0.23	$0.22		$0.00			$0.00
				$26.59		$26.59		$1.92	$1.90		$0.01			$0.01

Total VCR Risk: $1.90 **Total ENS Risk:** $0.00