

OPTIONS EVALUATION REPORT (OER)



Tuggerah Secondary Systems Renewal

OER 000000001263 revision 2.0

Ellipse project no.: P0005393

TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition

Project category: Prescribed - Replacement

Approvals

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Date submitted for approval	24 November 2016	

Change history

Revision	Date	Amendment
0	29 June 2016	Initial issue
1	31 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	21 November 2016	Update to format
3	24 November 2016	Added OSR reference

1. Need/opportunity

Tuggerah Substation is a customer connection point supplying the Ausgrid 132kV network in the area inclusive of Gosford, Ourimbah, Berkeley Vale and Wyong. A significant portion of secondary systems assets at Tuggerah Substation have been identified for replacement.

2. Related Needs/opportunities

The assets proposed to be replaced under this Secondary System Renewal were identified in the following Needs:

- > Need ID 606 – Replacement of THR Protection Relays
- > Need ID 608 – Replacement of 7SD511 Protection Relays
- > Need ID 610 – Replacement of EDM1 MK3 Energy Meters
- > Need ID 614 – Replacement of LFCB102 Protection Relays
- > Need ID 637 – Replacement of YTG Protection Relays
- > Need ID 1379 – Protection - GE Multilin Condition

3. Options

The options scoped for this need were identified as per the Options Screening Report – Secondary System Renewal.

All dollar values in this document are expressed in un-escalated 2016/17 dollars.

Base Case

The Base Case for this Need is to continue with TransGrid's operation and maintenance (O&M) for the site. This approach does not address the degrading condition of the secondary systems of the risk cost associated with the Need. The risk cost of \$4.27m per annum will increase due to:

- > The probability of failure increasing as the assets move further past their expected life; and
- > TransGrid's means of recovery from asset failure becoming exhausted, increasing the consequence of asset failure.

Key drivers for this risk cost are:

- > The majority of relays protecting assets are non self-checking and provide no feedback as to the health of the asset, therefore increasing the likelihood of a hazardous event occurring.
- > The majority of relays protecting assets at this site have reached their end of life, with limited spares and limited or no manufacturer support. This therefore increases the likelihood of a hazardous event occurring and decreases TransGrid's ability to react to mitigate or repair any failures.

Increasing maintenance on the equipment cannot reduce the probability of failure in order to reduce the risk cost.

Option A — Strategic Asset Replacement [[OFR 1263A](#), [OFS 1263A](#)]

Option A is to carry out individual replacements of assets that are identified for replacement up to 2023. The option is based on a 'like for like' approach whereby the asset is replaced by its modern equivalent. Additional system modifications or additional functionality would not be deployed under this option.

The expected capital costs for the option total \$2.58m. This costing is estimated using TransGrid's "Success" estimating system. A further \$1.50m capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$4k per annum for this option based on current maintenance plan settings.

Due to the 'like for like' nature of this option, no benefit has been calculated in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations¹.

The residual risk associated with this option upon completion of the project amounts to \$3.37m per annum (base case risk cost = \$4.27m). The risk reduction is realised through the reduction in the probability of failure for all assets.

Option B — Complete In-Situ Replacement [OFR 1263B, OFS 1263B]

Option B is to replace all secondary systems assets at the Tuggerah Substation with current designs and architectures. This option also replaces Direct Current (DC) supplies to account for increase in power requirements and remediates the 415V Alternating Current (AC) distribution in the building and the yard.

The expected capital costs for the option total \$4.53m. This costing is estimated using TransGrid's "Success" estimating system. No further capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$4k per annum based on current maintenance plan settings.

A benefit figure of \$34.7k per annum has been calculated for this option in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations.

The residual risk associated with this option upon completion of the project amounts to \$0.28m per annum (base case risk cost = \$4.27m). The risk reduction is realised through the reduction in the probability of failure for all assets and remediation of the risk posed by the 415V AC distribution.

Option C — IEC-61850 Replacement [OFR 1263C, OFS 1263C]

Option C is to carry out complete replacement of the secondary system at Tuggerah Substation by new IEC-61850 based secondary systems technology. This option will modernise the automation philosophy and will provide additional operational benefits. This option will utilise IEC-61850 protocol for unmanned substation site involving automation system, Supervisory Control And Data Acquisition (SCADA) system, substation surveillance and condition monitoring. This option assumes that reasonable advancements have been made in the IEC-61850 roll out program for a Secondary Systems Renewal across TransGrid.

The expected capital costs for this option total \$10.30m. This costing is estimated using TransGrid's 'Success' estimating system. No capital expenditure would be required over the 15 year life cycle of this option through to 2038 as this is a complete replacement option.

Operating costs have been estimated at \$10k per annum for this option based on current maintenance schedule.

A benefit figure of \$35k per annum has been calculated for this option in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations. Additional benefit of \$400k in the 1st year, \$200k in the 2nd year and \$100k in the 3rd year is also included to account for the development costs of standards that can be applied across multiple. The savings in the second year and third year is a high level assumption and considers the diminishing benefits due to the expected continual improvement of the IEC-61850 solution.

¹ Refer SSA Strategy – Renewal and Maintenance - Secondary Systems Site Installations

The residual risk associated with this option upon completion of the project amounts to \$2.41m per annum (base case risk cost = \$4.27m). The risk reduction is realised through the reduction in the probability of failure for all assets and the reduction in likelihood of a hazardous event due to the installation of self-checking relays.

All options have been assessed as technically feasible.

4. Evaluation

Evaluation of the proposed options has been completed using both commercial considerations and the ALARP (as low as reasonably practical) regulatory requirements. The results of these evaluations are outlined below.

4.1 Commercial evaluation

The result of commercial evaluation for each of the options is summarised in Table 1.

Table 1 – Commercial evaluation (\$ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
Base Case	Run-to-fail	N/A	0.004	4.27	N/A	N/A	4
A	Strategic Asset Replacement	2.58	0.004	3.371	1.88	(1.66)	2
B	Complete In-Situ Replacement	4.53	0.004	0.284	19.02	0.57	1
C	IEC-61850 Replacement	10.30	0.010	2.410	3.19	(5.38)	3

The commercial evaluation is based on:

- > Economic life of the assets is assumed 15 years, hence this assessment period has been applied.
- > Write-offs have been estimated at \$119k for Options B and C; Option A only addresses assets that have reached the end of their financial lives.
- > Capital cost is not escalated and it does not include capitalised interest.

Sensitivities on economic NPV for all options with changing discount rate are shown in Table 2.

Table 2 – Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Strategic Asset Replacement	1.00	3.39
B	Complete In-Situ Replacement	14.26	26.38
C	IEC-61850 Replacement	1.29	6.29

4.2 SFAIRP/ALARP evaluation

Options to reduce the network safety risk as per the risk treatment hierarchy have been considered in other lifecycle stages of the asset, and it has been determined that no reasonably practicable options exist to reduce the risk further than those capital investment options listed below.

Evaluation of the proposed options has been completed against the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) obligation, as required by the Electricity Supply (Safety and Network Management) Regulation 2014 and the Work Health and Safety Act 2011. The Key Hazardous Events and the disproportionality multipliers considered in the evaluation are as follows:

- > Conductor drop/structure failure - 6 times the bushfire risk, 3 times the safety risk and 10% of the reliability risk (applicable to safety)

The results of this evaluation are summarised in the tables below.

Table 3 – Feasible options (\$ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Do nothing	N/A	N/A	N/A
A	Strategic Asset Replacement	2,580	15 years	170
B	Complete In-Situ Replacement	4,530	15 years	300
C	IEC-61850 Replacement	10,300	15 years	690

Table 4 – Annual risk calculations (\$ thousand)

Option	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	99	3,574	5	N/A	N/A	N/A
A	8	2,789	2	91	785	2
B	1	231	1	99	3,342	4
C	10	2,040	10	89	1,534	(5) ²

Table 5 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	364	170	Yes

² Due to it being an untested technology, IEC-61850 solution has higher probability of failure on transmission line assets at Tuggerah Substation post investment

³ The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

⁴ Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
B	651	300	Yes
C	389	690	No

Options A and B are reasonably practicable.

Option C is not reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option B is the preferred option as it is reasonably practicable and provides the greatest network safety risk reduction, and is therefore required to satisfy the organisation's SFAIRP/ALARP obligations.

The preferred option to address the condition of the secondary systems is Option B – Complete In-Situ Replacement.

This option has been selected due to its technical viability and reduction in reliability risk. This option provides significant technical benefits and provides the greatest positive Net Present Value (NPV) while achieving the ALARP principles.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the two options and the Base Case. Deploying the Complete In-Situ Replacement option will provide benefits in terms of remote monitoring, control and interrogation, responding to faults more efficiently and phasing out of obsolete legacy systems. These have been captured as benefits for delivering the project.

Regulatory Investment Test

A Regulatory Investment Test for Transmission (RIT-T) is not required as this is an asset replacement project with no augmentation component.

5. Recommendation

It is recommended that Option B – Complete In-Situ Replacement be scoped in detail.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name			Tuggerah Secondary Systems Renewal - Option A		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$1.66m	NPV / Capital (Ratio)	-0.64	
NPV @ upper bound rate	13.00%	-\$1.63m	Pay Back Period (Yrs)	-0.02 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$1.62m	IRR%	-2.21%	
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%	\$1.88m	NPV / Capital (Ratio)	0.73	
NPV @ upper bound rate	13.00%	\$1.00m	Pay Back Period (Yrs)	2.92 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$3.39m	IRR%	19.37%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.76m
Systems (reliability)	\$3.57m	\$2.79m	\$0.79m	ENS Penalty	\$0.01m
Financial	\$0.67m	\$0.56m	\$0.10m	All other risk benefits	\$0.13m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.90m
People (safety)	\$0.01m	\$0.01m	\$0.00m	Benefits in the financial NPV*	\$0.14m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.01m	\$0.01m	Benefits in the economic NPV**	\$0.89m
Total Risk benefits	\$4.27m	\$3.37m	\$0.90m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$0.90m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$2.58m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$0.00m	Re-investment capital	-\$1.50m
Capitalisation period			5.00 Yrs	Start of the re-investment period	2026-27

Option B NPV calculation

Project_Option Name			Tuggerah Secondary Systems Renewal - Option B		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$0.57m	NPV / Capital (Ratio)	0.13	
NPV @ upper bound rate	13.00%	-\$0.20m	Pay Back Period (Yrs)	0.12 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$1.81m	IRR%	12.09%	
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%	\$19.02m	NPV / Capital (Ratio)	4.20	
NPV @ upper bound rate	13.00%	\$14.26m	Pay Back Period (Yrs)	1.14 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$26.38m	IRR%	52.02%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$3.26m
Systems (reliability)	\$3.57m	\$0.23m	\$3.34m	ENS Penalty	\$0.03m
Financial	\$0.67m	\$0.05m	\$0.62m	All other risk benefits	\$0.70m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.99m
People (safety)	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.76m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.00m	\$0.01m	Benefits in the economic NPV**	\$3.99m
Total Risk benefits	\$4.27m	\$0.28m	\$3.99m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$4.02m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	-\$0.12m
Capital - initial \$m			-\$4.53m	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

Option C NPV calculation

Project_Option Name			Tuggerah Secondary Systems Renewal - Option C		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$5.38m	NPV / Capital (Ratio)	-0.52	
NPV @ upper bound rate	13.00%	-\$5.43m	Pay Back Period (Yrs)	-0.04 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$5.12m	IRR%	-3.95%	
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%	\$3.19m	NPV / Capital (Ratio)	0.31	
NPV @ upper bound rate	13.00%	\$1.29m	Pay Back Period (Yrs)	5.12 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$6.29m	IRR%	15.94%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.51m
Systems (reliability)	\$3.57m	\$2.04m	\$1.53m	ENS Penalty	\$0.01m
Financial	\$0.67m	\$0.33m	\$0.34m	All other risk benefits	\$0.34m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.86m
People (safety)	\$0.01m	\$0.01m	-\$0.00m	Benefits in the financial NPV*	\$0.78m
Environment	\$0.00m	\$0.01m	-\$0.01m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.02m	-\$0.01m	Benefits in the economic NPV**	\$2.28m
Total Risk benefits	\$4.27m	\$2.41m	\$1.86m	**excludes ENS penalty	
Cost savings and other benefits			\$0.43m		
Total Benefits			\$2.29m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.01m	Write-off cost	-\$0.12m
Capital - initial \$m			-\$10.30m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$0.69m	Re-investment capital	\$0.00m
Capitalisation period			3.00 Yrs	Start of the re-investment period	0.00 Yrs