

OPTIONS EVALUATION REPORT (OER)

Muswellbrook Secondary Systems Renewal

OER 000000001247 revision 3.0



Ellipse project no.: P0005239

TRIM file: [TRIM No]

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

Project category: Prescribed - Replacement

Approvals

Author	Annie Welvaert	Secondary Systems Analyst
Endorsed	Philip Wong	Secondary Systems Asset Engineer
	Mark Jones	Secondary Systems and Communications Asset Manager
	Azil Khan	Investment Strategy Manager
Approved	Lance Wee	M/Asset Strategy
Date submitted for approval	24 November 2016	

Change history

Revision	Date	Amendment
0	27 June 2016	Initial issue
1	28 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	9 November 2016	Update to format
3	24 November 2016	Added OSR reference

1. Need/opportunity

Muswellbrook Substation is a customer connection point supplying Ausgrid's 132kV network in the area inclusive of Muswellbrook, Singleton, Mitchell Line and Barnard River. A significant portion of secondary systems assets at Muswellbrook Substation have been identified for replacement.

2. Related Needs/opportunities

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

- > Need ID 606 – Replacement of THR Protection Relays
- > Need ID 620 – Replacement of D Series Protection Relays
- > Need ID 621 – Replacement of DB Series Protection Relays
- > Need ID 629 – Replacement of Remote Terminal Unit (RTUs)
- > Need ID 637 – Replacement of YTG Protection Relays
- > Need ID 1359 – Remote Terminal Unit (RTU) Condition
- > Need ID 615 – Replacement of Optimho LFZP112 Protection Relays
- > Need ID 1380 – Protection - Schweitzer SELxxx 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 \$4.02m 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 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 1247A](#), [OFS 1247A](#)]

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 \$2.89m. This costing is estimated using TransGrid's "Success" estimating system. A further \$716k 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 \$2.99m per annum (Base Case risk cost = \$4.02m). The risk reduction is realised through the reduction in the probability of failure for all assets.

Option B — Complete In-situ Replacement [OFR 1247B, OFS 1247B]

Option B is to replace all secondary systems assets at the Muswellbrook 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 \$4.28m. 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 \$3k per annum based on current maintenance plan settings.

A benefit figure of \$30k 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 = \$4.02m). 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 1247C, OFS 1247C]

Option C is to carry out complete replacement of the secondary system at Muswellbrook 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 \$9.4m. 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 \$30k 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 IE61850 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 \$1.64m per annum (Base Case risk cost = \$4.02m). 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 the ALARP (As Low As Reasonably Practicable) regulatory requirements and economic considerations. The results of this evaluation are outlined below.

4.1 Commercial evaluation

The commercial evaluation of the technically feasible options is set out in the 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	4.020	N/A	N/A	4
A	Strategic Asset Replacement	2.89	0.004	2.98	2.53	(1.68)	3
B	Complete In-Situ Replacement	4.28	0.003	0.28	17.95	0.01	1
C	IEC-61850 Replacement	9.40	0.010	1.64	6.76	(5.18)	2

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 \$38k for Option B and C as 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 Net Present Value (NPV) for all three options with changing discount rates are shown in the Table 2.

Table 2 — Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @ 13%	Economic NPV @ 6.75%
A	Strategic Asset Replacement	1.47	4.31
B	Complete In-Situ Replacement	13.53	24.80
C	IEC-61850 Deployment	4.16	10.90

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:

- > Catastrophic failure of asset/uncontrolled discharge or contact with electricity/ unauthorised access to site - 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 Case	Do nothing	N/A	N/A	N/A
A	Strategic Asset Replacement	2,890	15 years	190
B	Complete In-Situ Replacement	4,280	15 years	290
C	IEC-61850 Deployment	9,400	15 years	630

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 Case	9	3,486	2	N/A	N/A	N/A
A	8	2,556	0	2	929	1
B	1	238	0	9	3,247	1
C	0	1,350	0	9	2,136	2

Table 5 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ²	Annualised CAPEX	Reasonably practicable ³ ?
A	106	190	No
B	358	290	Yes

² The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

³ Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

Option	Network Safety Risk Reduction ²	Annualised CAPEX	Reasonably practicable ³ ?
C	252	630	No

Option B is reasonably practicable.

Options A, and C are 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 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

Muswellbrook Secondary Systems Renewal - Option A

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$1.68m	NPV / Capital (Ratio)	-0.58
NPV @ upper bound rate	13.00%	-\$1.66m	Pay Back Period (Yrs)	-0.03 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$1.64m	IRR%	-3.38%

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%	\$2.53m	NPV / Capital (Ratio)	0.87
NPV @ upper bound rate	13.00%	\$1.47m	Pay Back Period (Yrs)	2.84 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$4.31m	IRR%	21.34%

Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.90m
Systems (reliability)	\$3.49m	\$2.56m	\$0.93m	ENS Penalty	\$0.01m
Financial	\$0.51m	\$0.42m	\$0.09m	All other risk benefits	\$0.12m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.03m
People (safety)	\$0.01m	\$0.01m	\$0.00m		
Environment	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.13m
Reputation	\$0.01m	\$0.01m	\$0.01m	*excludes VCR benefits	
Total Risk benefits	\$4.02m	\$2.99m	\$1.03m	Benefits in the economic NPV**	\$1.02m
Cost savings and other benefits			\$0.00m	**excludes ENS penalty	
Total Benefits			\$1.03m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$2.89m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$0.19m	Re-investment capital	-\$0.72m
Capitalisation period			5.00 Yrs	Start of the re-investment period	2028-29

Option B NPV calculation

Project_Option Name

Muswellbrook Secondary Systems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	\$0.01m	NPV / Capital (Ratio)	0.00
NPV @ upper bound rate	13.00%	-\$0.53m	Pay Back Period (Yrs)	0.10 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$0.91m	IRR%	10.05%

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%	\$17.95m	NPV / Capital (Ratio)	4.19
NPV @ upper bound rate	13.00%	\$13.53m	Pay Back Period (Yrs)	1.15 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$24.80m	IRR%	59.62%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$3.17m
Systems (reliability)	\$3.49m	\$0.24m	\$3.25m	ENS Penalty	\$0.03m
Financial	\$0.51m	\$0.04m	\$0.47m	All other risk benefits	\$0.54m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.74m
People (safety)	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.60m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.00m	\$0.01m	Benefits in the economic NPV**	\$3.74m
Total Risk benefits	\$4.02m	\$0.28m	\$3.74m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$3.77m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	-\$0.04m
Capital - initial \$m	-\$4.28m	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

Muswellbrook Secondary Systems Renewal - Option C

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$5.18m	NPV / Capital (Ratio)	-0.55
NPV @ upper bound rate	13.00%	-\$5.20m	Pay Back Period (Yrs)	-0.05 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$5.00m	IRR%	-4.81%

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%	\$6.76m	NPV / Capital (Ratio)	0.72
NPV @ upper bound rate	13.00%	\$4.16m	Pay Back Period (Yrs)	3.64 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$10.90m	IRR%	22.38%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.10m
Systems (reliability)	\$3.49m	\$1.35m	\$2.14m	ENS Penalty	\$0.01m
Financial	\$0.51m	\$0.28m	\$0.23m	All other risk benefits	\$0.27m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$2.38m
People (safety)	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.71m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.01m	\$0.00m	Benefits in the economic NPV**	\$2.80m
Total Risk benefits	\$4.02m	\$1.64m	\$2.38m	**excludes ENS penalty	
Cost savings and other benefits			\$0.43m		
Total Benefits			\$2.81m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	-\$0.04m
Capital - initial \$m	-\$9.40m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.63m	Re-investment capital	\$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs