

OPTIONS EVALUATION REPORT (OER)



Murrumburrah Secondary Systems Renewal

OER 000000001186 revision 3.0

Ellipse project no.: P0005445

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	25 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	11 November 2016	Update to format
3	15 November 2016	Minor amendment to format
4	24 November 2016	Added OSR reference

1. Need/opportunity

Murrumburrah 132/66kV Substation comprises 2x132kV feeders, 2x132/66/11kV transformers and 6x66kV feeders. The site was established in 1970, and the secondary systems assets have install dates between 1970 and 1985 and thus they have been identified for replacement by 2023.

Secondary Systems assets have been identified as reaching end of life and require addressing at the site.

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 637 – Replacement of YTG Protection Relays
- > Need ID 1380 – Schweitzer SELxxx Condition
- > Need ID 1382 – GE FAC Condition
- > Need ID 620 – Replacement of D Series Protection Relays
- > Need ID 621 – Replacement of DB Series Protection Relays
- > Need ID 610 – Replacement of EDMI MK3 Energy Meters
- > Need ID 630 – Siemens 7EC Meter Replacements
- > Need ID 624 – Replacement of Landis and Gyr ZF and ZMB Meters

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 technological obsolescence, spares unavailability, and component deterioration of the secondary systems or the risk cost associated with the Need. The risk cost associated with all secondary system at Murrumburrah 132/66kV Substation of \$2.20m 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 mitigating and repairing these failures being almost exhausted.

Key drivers for this risk cost are:

- > All the relays protecting assets at this site have reached their end of life, with limited spares and no manufacturer support. This 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 — Complete In-Situ Replacement [OFR 1186A, OFS 1186A]

Option A is to carry out the complete upgrade and renewal of the secondary systems at Murrumburrah Substation by reusing the existing building, tunnel boards and where practicable, the cabling. This option will modernise the automation philosophy to current design standards and practices and will provide additional operational benefits. This option assumes that the new panels will be installed in the exact location as the existing racks.

The expected capital costs for this option total \$4.4m. 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 in-situ replacement option.

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

A benefit figure of \$33.6k per annum has been calculated for this option 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 \$99k per annum (base case risk cost = \$2.20m). 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.

Option B — Strategic Asset Replacement [OFR 1186B, OFS 1186B]

Option B is to carry out the replacement of individual secondary system assets at Murrumburrah Substation that are in need of renewal during the 2019-2023 regulatory period. This option involves replacing the old assets "like for like" with a modern equivalent asset by utilising the existing building, tunnel boards and where practicable, the cabling. This option excludes additional system modification or delivery of additional functionality.

The expected capital cost for this option total \$3.38m. This costing is estimated using TransGrid's 'Success' estimating system. No further capital expenditure would be required over the 15 year life cycle of this option through to 2038 as all the existing assets has been identified for replacement in 2019-23 regulatory period.

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

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 \$1.85m per annum (base case risk cost = \$2.20m). The risk reduction is realised through the reduction in the probability of failure for all assets and reduction in likelihood of a hazardous event due to the installation of self-checking relays.

Option C — IEC-61850 Replacement [OFR 1186C, OFS 1186C]

Option C is to carry out complete replacement of the secondary system at Murrumburrah 330kV 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, 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 \$9.2m. 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.

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

A benefit figure of \$33.6k 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.

The residual risk associated with this option upon completion of the project amounts to \$0.47m per annum (base case risk cost = \$2.2m). 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 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 (O&M continues)	-	0.004	2.20	-	-	4
A	Complete In-Situ Replacement	4.40	0.004	0.10	7.74	(0.26)	1
B	Strategic Asset Replacement	3.38	0.004	1.85	(0.92)	(1.82)	3
C	IEC-61850 Replacement	9.20	0.010	0.47	2.47	(4.96)	2

The commercial evaluation is based on:

- > Economic life of assets is assumed 15 years. Therefore the Net Present Value (NPV) assessment period is also 15 years.
- > No write-offs at 2023 have been determined from the fixed asset register for Option A as all the retiring assets are past their financial lives.
- > Capex excludes interest during construction.

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

Table 2 – Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Complete In-Situ Replacement	5.34	11.59

Option	Description	Economic NPV @13%	Economic NPV @6.75%
B	Strategic Asset Replacement	(1.16)	(0.47)
C	IEC-61850 Replacement	0.74	5.35

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 - three times the safety risk and 10% of the reliability risk (applicable to safety)
- > Unplanned outage of HV equipment - 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	Complete In-Situ Replacement	4,400	15 years	290
B	Strategic Asset Replacement	3,380	15 years	230
C	IEC-61850 Replacement	9,200	15 years	610

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	0	1,601	79	N/A	N/A	N/A
A	0	55	14	0	1,546	65
B	0	1,410	14	0	191	65
C	0	170	11	0	1,431	(31) ²

² An increased probability of failure for IEC61850 assets due to a lack of experience with the new technology has resulted in higher environmental risks

Table 5 - Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	544	290	Yes
B	409	225	Yes
C	0	610	No

Both 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 A – Complete In-Situ Replacement 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.

This option also provides significant technical benefits and provides the greatest positive NPV.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the option and Base Case. Implementing Option A will reduce callouts to address defects and this benefit has been captured in the economic evaluation. 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 the recommendation that Option A – Complete In-Situ Replacement be scoped in detail.

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

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name			Murrumburrah Secondary System Renewal - Option A (Comm	
1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-\$0.26m	NPV / Capital (Ratio)	-0.06
NPV @ upper bound rate	13.00%	-\$0.76m	Pay Back Period (Yrs)	0.09 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$0.62m	IRR%	8.87%
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%	\$7.74m	NPV / Capital (Ratio)	1.76
NPV @ upper bound rate	13.00%	\$5.34m	Pay Back Period (Yrs)	2.06 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$11.59m	IRR%	33.19%
Benefits				
Risk cost	As Is	To Be	Benefit	VCR Benefit
Systems (reliability)	\$1.60m	\$0.06m	\$1.55m	\$1.54m
Financial	\$0.52m	\$0.03m	\$0.49m	ENS Penalty
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	All other risk benefits
People (safety)	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits
Environment	\$0.08m	\$0.01m	\$0.06m	\$2.10m
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*
Total Risk benefits	\$2.20m	\$0.10m	\$2.10m	\$0.59m
Cost savings and other benefits			\$0.03m	*excludes VCR benefits
Total Benefits			\$2.13m	Benefits in the economic NPV**
				\$2.13m
				**excludes ENS penalty
Other Financial Drivers				
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost
Capital - initial \$m			-\$4.40m	\$0.00m
Residual Value - initial investment			\$0.00m	Major Asset Life (Yrs)
Capitalisation period			4.00 Yrs	15.00 Yrs
				Re-investment capital
				\$0.00m
				Start of the re-investment period
				0.00 Yrs

Option B NPV calculation

Project_Option Name			Murrumburrah Secondary System Renewal - Option B (Comm)		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$1.82m	NPV / Capital (Ratio)	-0.54	
NPV @ upper bound rate	13.00%	-\$1.82m	Pay Back Period (Yrs)	-0.04 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$1.75m	IRR%	-3.55%	
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%	-\$0.92m	NPV / Capital (Ratio)	-0.27	
NPV @ upper bound rate	13.00%	-\$1.16m	Pay Back Period (Yrs)	9.79 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$0.48m	IRR%	4.55%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.19m
Systems (reliability)	\$1.60m	\$1.41m	\$0.19m	ENS Penalty	\$0.00m
Financial	\$0.52m	\$0.42m	\$0.10m	All other risk benefits	\$0.16m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.35m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.16m
Environment	\$0.08m	\$0.01m	\$0.06m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$0.35m
Total Risk benefits	\$2.20m	\$1.85m	\$0.35m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$0.35m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$3.40m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$0.00m	Re-investment capital	\$0.00m
Capitalisation period			5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option C NPV calculation

Project_ Option Name

Murrumburrah Secondary System Renewal - Option A (Comm

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$4.96m	NPV / Capital (Ratio)	-0.54
NPV @ upper bound rate	13.00%	-\$4.93m	Pay Back Period (Yrs)	-0.05 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$4.84m	IRR%	-5.12%

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%	\$2.47m	NPV / Capital (Ratio)	0.27
NPV @ upper bound rate	13.00%	\$0.74m	Pay Back Period (Yrs)	4.84 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$5.35m	IRR%	14.77%

Benefits

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$1.60m	\$0.17m	\$1.43m	VCR Benefit	\$1.43m
<i>Financial</i>	\$0.52m	\$0.19m	\$0.33m	ENS Penalty	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.30m
<i>People (safety)</i>	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.73m
<i>Environment</i>	\$0.08m	\$0.11m	-\$0.03m	Benefits in the financial NPV*	\$0.73m
<i>Reputation</i>	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Total Risk benefits	\$2.20m	\$0.47m	\$1.73m	Benefits in the economic NPV**	\$2.16m
Cost savings and other benefits			\$0.43m	**excludes ENS penalty	
Total Benefits			\$2.16m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	\$0.00m
Capital - initial \$m	-\$9.20m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	\$0.00m
Capitalisation period	4.00 Yrs	Start of the re-investment period	0.00 Yrs