

OPTIONS EVALUATION REPORT (OER)

Lower Tumut Secondary Systems Renewal

OER 000000001192 revision 3.0



Ellipse project no.: P0005259

TRIM file: [TRIM No]

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

Project category: Prescribed - Replacement

Approvals

Author	Anuraag Malla	Jacobs Consultant
	Annie Welvaert	Secondary Systems Analyst
Endorsed	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	28 June 2016	Initial issue
1	24 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	15 November 2016	Update to format
3	24 November 2016	Added OSR reference

1. Need/opportunity

Lower Tumut 330kV Switching Station comprises 8x330kV feeders and 2x330 busbars. The site was established in 1968, and the secondary systems assets have install dates between 1968 (electro-mechanical type with 40 years average nominal asset life) and 2009 (microprocessor with 15 years average nominal asset life).

The Secondary Systems assets have been identified as reaching end of life and require addressing at the site. Additionally, there is an opportunity to improve the operational capacity of the site by modernising the automation philosophy to current design standards and practices.

2. Related Needs/opportunities

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

- > Need ID 601 – Replacement of MBCI Protection Relays
- > Need ID 604 – Replacement of Micromho (SHNB) Protection Relays
- > Need ID 609 – Replacement of DL910 Protection Relays
- > Need ID 1389 – Protection – Busbar Condition
- > Need ID 610 – Replacement of EDM I MKIII Meters
- > Need ID 629 – Replacement of Remote Terminal Replacement (RTUs)

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, manufacturer non-support, component deterioration of the secondary systems, and inaccurate measurement or the risk cost associated with the Need. The risk cost associated with all secondary system at Lower Tumut switching station of \$1.67m 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 either reached or will reach by 2023 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 Replacement with SSBs [\[OFR 1192A, OFS 1192A\]](#)

Option A is to carry out the complete upgrade and renewal of secondary systems at Lower Tumut switching station by using modular Secondary Systems Building (SSBs) and installing new cable throughout the substation. 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 secondary systems will be designed to be accommodated within a similar panel arrangement as the existing installation. Redundant panels and tunnel boards in the ASB relay room will need to be progressively decommissioned and removed as the new secondary systems are cut-over and commissioned.

The expected capital costs for this option total \$15.0m. 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 involves complete replacement of the existing secondary systems.

Operating costs have been estimated at \$5k per annum for this option based on current maintenance schedule.

A benefit figure of \$94k per annum has been calculated for this option in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations as well a reduction in maintenance of the existing control building and associated infrastructure.

The residual risk associated with this option upon completion of the project amounts to \$79.7k per annum (base case risk cost = \$1.67m). 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 — In-Situ Replacement [\[OFR 1192B, OFS 1192B\]](#)

Option B is to carry out the complete upgrade and renewal of the secondary systems at Lower Tumut switching station 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.

The expected capital costs for this option total \$8.0m. 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 \$5k 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.

The residual risk associated with this option upon completion of the project amounts to \$0.06m per annum (base case risk cost = \$1.67m). 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 C — Strategic Asset Replacement [\[OFR 1192C, OFS 1192C\]](#)

Option C is to carry out the replacement of individual secondary system assets at Lower Tumut switching station 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 \$4.40m. This costing is estimated using TransGrid's 'Success' estimating system. A further \$0.80m of capital expenditure would be required over the 15 year life cycle of this option through to 2038 to replace the remaining secondary systems asset.

Operating costs have been estimated at \$5k 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 \$800k per annum (base case risk cost = \$1.67m). 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 D — IEC-61850 Replacement [[OFR 1192D](#), [OFS 1192D](#)]

Option D is to carry out complete replacement of the secondary system at Lower Tumut switching station 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 \$13.1m. 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.

The residual risk associated with this option upon completion of the project amounts to \$0.88m per annum (base case risk cost = \$1.67m). 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.

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

4. Evaluation

Evaluation of the proposed options has been completed using the ALARP (As Low As Reasonably Practical) regulatory requirements and commercial considerations. The results of this evaluation 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' (O&M continues)	-	0.005	1.67	-	-	5
A	Complete Replacement with SSBs	15.0	0.005	0.08	(2.42)	(7.92)	3
B	In-Situ Replacement	8.00	0.005	0.06	2.29	(3.27)	1
C	Strategic Asset Replacement	4.40	0.005	0.80	0.30	(3.24)	2
D	IEC-61850 Replacement	13.1	0.010	0.88	(5.92)	(8.46)	4

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.
- > Write-offs have been evaluated from the fixed asset register at \$0.376m in June 2023 for Option A, Option B and Option D as these options retire few assets before the end of their financial lives.
- > Capex excludes interest during construction.

Sensitivities on all options with changing discount rate are shown in the following table.

Table 2 – Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Complete Replacement with SSBs	(3.81)	0.10
B	In-Situ Replacement	0.68	4.97
C	Strategic Asset Replacement	(0.44)	1.59
D	IEC-61850 Deployment	(6.25)	(5.14)

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)
- > Conductor drop/structure failure - 6 times the bushfire risk, 6 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 Replacement with SSBs	15,000	15 years	1000
B	In-Situ Replacement	9,000	15 years	600
C	Strategic Asset Replacement	4,422	15 years	290
D	IEC-61850 Deployment	13,100	15 years	870

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	1,125	12	0	1,071	11
A	0	54	0	0	1,071	11
B	0	37	0	0	1,088	11
C	0	369	2	0	756	10
D	0	650	20	0	475	(8) ²

² Option D actually increases bushfire risk from the base case

Table 5 - Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	175	1,000	No
B	178	600	No
C	134	290	No
D	0	870	No

No options are reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that none of the options presented above are reasonably practicable, and are therefore not required to satisfy the organisation's SFAIRP/ALARP obligations.

The preferred option to address the condition of the secondary system assets in Lower Tumut switching station is Option B – Complete In-Situ Replacement.

This option has been selected due to its technical viability, reduction in reliability risk and provision of operational benefits. This option provides significant technical benefits and provides the greatest positive NPV while exceeding the SFAIRP/ALARP value.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between all the 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 the recommendation that Option B – 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			Lower Tumut Secondary System Renewal - Option A (Commer		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$7.92m	NPV / Capital (Ratio)	-0.53	
NPV @ upper bound rate	13.00%	-\$8.01m	Pay Back Period (Yrs)	-0.03 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$7.45m	IRR%	-2.55%	
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%	-\$2.42m	NPV / Capital (Ratio)	-0.16	
NPV @ upper bound rate	13.00%	-\$3.81m	Pay Back Period (Yrs)	8.85 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$0.10m	IRR%	6.85%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.06m
Systems (reliability)	\$1.12m	\$0.05m	\$1.07m	ENS Penalty	\$0.00m
Financial	\$0.53m	\$0.03m	\$0.50m	All other risk benefits	\$0.53m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.59m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.62m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	-\$0.00m	Benefits in the economic NPV**	\$1.68m
Total Risk benefits	\$1.67m	\$0.08m	\$1.59m	**excludes ENS penalty	
Cost savings and other benefits			\$0.09m		
Total Benefits			\$1.68m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	-\$0.38m
Capital - initial \$m			-\$15.00m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$1.58m	Re-investment capital	\$0.00m
Capitalisation period			4.00 Yrs	Start of the re-investment period	0.00 Yrs

Option B NPV calculation

Project_Option Name

Lower Tumut Secondary System Renewal - Option B (Commer

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$3.27m	NPV / Capital (Ratio)	-0.41
NPV @ upper bound rate	13.00%	-\$3.56m	Pay Back Period (Yrs)	0.01 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$2.66m	IRR%	0.84%

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%	\$2.29m	NPV / Capital (Ratio)	0.29
NPV @ upper bound rate	13.00%	\$0.68m	Pay Back Period (Yrs)	4.89 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$4.97m	IRR%	14.76%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.07m
Systems (reliability)	\$1.12m	\$0.04m	\$1.09m	ENS Penalty	\$0.00m
Financial	\$0.53m	\$0.03m	\$0.50m	All other risk benefits	\$0.53m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.60m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.57m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	-\$0.00m	Benefits in the economic NPV**	\$1.64m
Total Risk benefits	\$1.67m	\$0.06m	\$1.60m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$1.64m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	-\$0.38m
Capital - initial \$m	-\$8.00m	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

Option C NPV calculation

Project_Option Name

Lower Tumut Secondary System Renewal - Option C (Commer

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$3.24m	NPV / Capital (Ratio)	-0.74
NPV @ upper bound rate	13.00%	-\$3.07m	Pay Back Period (Yrs)	-0.10 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$3.41m	IRR%	-10.08%

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%	\$0.30m	NPV / Capital (Ratio)	0.07
NPV @ upper bound rate	13.00%	-\$0.44m	Pay Back Period (Yrs)	6.04 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$1.59m	IRR%	11.05%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.75m
Systems (reliability)	\$1.12m	\$0.37m	\$0.76m	ENS Penalty	\$0.00m
Financial	\$0.53m	\$0.43m	\$0.10m	All other risk benefits	\$0.12m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.87m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.12m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	-\$0.00m	Benefits in the economic NPV**	\$0.87m
Total Risk benefits	\$1.67m	\$0.80m	\$0.87m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$0.87m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$4.40m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	-\$0.80m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2023-24

Option D NPV calculation

Project_Option Name

Lower Tumut Secondary System Renewal - Option D (Commer

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$8.46m	NPV / Capital (Ratio)	-0.65
NPV @ upper bound rate	13.00%	-\$8.19m	Pay Back Period (Yrs)	-0.09 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$8.63m	IRR%	-8.71%

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%	-\$5.92m	NPV / Capital (Ratio)	-0.45
NPV @ upper bound rate	13.00%	-\$6.25m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$5.14m	IRR%	-0.52%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.48m
Systems (reliability)	\$1.13m	\$0.65m	\$0.48m	ENS Penalty	-\$0.01m
Financial	\$0.53m	\$0.21m	\$0.32m	All other risk benefits	\$0.32m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.79m
People (safety)	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.34m
Environment	\$0.01m	\$0.02m	-\$0.01m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	-\$0.00m	Benefits in the economic NPV**	\$0.83m
Total Risk benefits	\$1.67m	\$0.88m	\$0.79m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$0.82m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	-\$0.38m
Capital - initial \$m	-\$13.10m	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