

OPTIONS EVALUATION REPORT (OER)



Tenterfield Secondary Systems Renewal

OER 000000001194 revision 3.0

Ellipse project no.: P0005253

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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	23 June 2016	Initial issue
1	26 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

Tenterfield 132/22kV Substation comprises 2x132kV feeders, 2x132/22kV transformers and 3x22kV feeders. The site was established in 1970, and the secondary systems assets have install dates between 1970 (electro-mechanical type with 40 years average nominal asset life) and 2013 (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 1368 – Replacement of Feeder OC Protection Relays
- > Need ID 1383 – Replacement of GE FV2 Busbar Protection Relays

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 Tenterfield Substation of \$3.62m 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.

Tenterfield Substation is a customer connection point supplying Essential Energy's 22kV networks in the area inclusive of Tenterfield town and Timbarra mine. Key drivers for this risk cost are:

- > This is an unduplicated AC system and this constitutes 80% of the risk cost.
- > All relays protecting 22kV 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 — In-Situ Replacement [[OFR 1194A](#), [OFS 1194A](#)]

Option A is to carry out the complete upgrade and renewal of the secondary systems at Tenterfield 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 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 \$3.35m. 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 \$2k per annum for this option based on current maintenance schedule.

A benefit figure of \$27.5k 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 \$0.09m per annum (base case risk cost = \$3.62m). The risk reduction is realised through the reduction in the probability of failure for all assets, the reduction in likelihood of a hazardous event due to the installation of self-checking relays, and remediation of the AC system.

Option B — Strategic Asset Replacement [[OFR 1194B](#), [OFS 1194B](#)]

Option B is to carry out the replacement of individual secondary system assets at Tenterfield 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 \$1.70m. This costing is estimated using TransGrid's 'Success' estimating system. A further \$0.42m 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 \$2k 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 \$3.5m per annum (base case risk cost = \$3.62m). 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 — SSB Replacement [[OFR 1194C](#), [OFS 1194C](#)]

Option C is to carry out the complete upgrade and renewal of secondary systems at the Tenterfield Substation by using modular Secondary Systems Building (SSBs) and installing new cable throughout. 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 \$9.6m. 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 \$6k 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 \$27.5k 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 \$0.09m per annum (base case risk cost = \$3.62m). 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 D — IEC-61850 Replacement [[OFR 1194D](#), [OFS 1194D](#)]

Option D is to carry out complete replacement of the secondary system at Tenterfield 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 \$7.9m. 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 \$27.5k 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 \$300k in the 1st year, \$150k in the 2nd year and \$75k in the 3rd year is also included to account for to 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 \$0.39m per annum (base case risk cost = \$3.62m). 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' (O&M continues)	-	0.002	3.62	-	-	5
A	In-Situ Replacement	3.35	0.002	0.09	11.85	2.59	1
B	Strategic Asset Replacement	1.70	0.002	3.50	(0.89)	(0.94)	4
C	SSB Replacement	9.60	0.002	0.09	7.90	(1.36)	3
D	IEC-61850 Replacement	7.90	0.010	0.39	7.91	(1.30)	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.
- > Write-offs have been evaluated from the fixed asset register at \$27.1k in June 2023 for Option A, Option C and Option D as these options retire a 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 Table 2.

Table 2 – Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	In-Situ Replacement	8.39	17.48
B	Strategic Asset Replacement	(0.91)	(0.82)
C	SSB Replacement	4.92	12.91
D	IEC-61850 Replacement	5.14	12.55

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, 6 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	In-Situ Replacement	3,690	15 years	250
B	Strategic Asset Replacement	1,960	15 years	130
C	SSB Replacement	9,600	15 years	640
D	IEC-61850 Replacement	7,900	15 years	530

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	4	3,159	6	N/A	N/A	N/A
A	3	51	1	37	3,107	5
B	29	3,130	2	12	25	4
C	0	50	0	41	3,109	6
D	20	120	10	21	3,039	(4) ²

² Due to untested IEC61850 technology, there is a higher probability of failure for some transmission lines from status quo.

Table 5 - Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	453	250	Yes
B	62	130	No
C	469	640	No
D	342	530	No

Option A is reasonably practicable.

Options B, C and D are not reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A 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 system assets in Tenterfield Substation is Option A – In-Situ Replacement.

This option has been selected due to its technical viability, reduction in reliability risk and reduction in safety risk to as low as reasonably practicable. This option 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 the 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 – 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		Tenterfield Secondary System Renewal - Option A (Commercial)			
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$2.59m	NPV / Capital (Ratio)	0.77	
NPV @ upper bound rate	13.00%	\$1.52m	Pay Back Period (Yrs)	0.22 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$4.40m	IRR%	21.83%	
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%	\$11.85m	NPV / Capital (Ratio)	3.54	
NPV @ upper bound rate	13.00%	\$8.39m	Pay Back Period (Yrs)	1.11 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$17.48m	IRR%	45.98%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.51m
Systems (reliability)	\$3.16m	\$0.05m	\$3.11m	ENS Penalty	\$0.55m
Financial	\$0.31m	\$0.03m	\$0.28m	All other risk benefits	\$0.47m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.53m
People (safety)	\$0.04m	\$0.00m	\$0.04m	Benefits in the financial NPV*	\$1.05m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.11m	\$0.01m	\$0.10m	Benefits in the economic NPV**	\$3.01m
Total Risk benefits	\$3.62m	\$0.09m	\$3.53m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$3.56m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	-\$0.03m
Capital - initial \$m			-\$3.35m	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 B NPV calculation

Project_ Option Name

Tenterfield Secondary System Renewal - Option B (Commercial)

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$0.94m	NPV / Capital (Ratio)	-0.55
NPV @ upper bound rate	13.00%	-\$0.95m	Pay Back Period (Yrs)	-0.02 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$0.89m	IRR%	-2.13%

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%	-\$0.89m	NPV / Capital (Ratio)	-0.53
NPV @ upper bound rate	13.00%	-\$0.91m	Pay Back Period (Yrs)	Not measurable
NPV @ lower bound rate (WACC)	6.75%	-\$0.82m	IRR%	-1.27%

Benefits

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$3.16m	\$3.13m	\$0.03m	VCR Benefit	\$0.01m
<i>Financial</i>	\$0.31m	\$0.25m	\$0.05m	ENS Penalty	\$0.00m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.11m
<i>People (safety)</i>	\$0.04m	\$0.03m	\$0.01m	Total Risk benefits	\$0.12m
<i>Environment</i>	\$0.01m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$0.11m
<i>Reputation</i>	\$0.11m	\$0.09m	\$0.03m	*excludes VCR benefits	
Total Risk benefits	\$3.62m	\$3.50m	\$0.12m	Benefits in the economic NPV**	\$0.12m
Cost savings and other benefits			-\$0.00m	**excludes ENS penalty	
Total Benefits			\$0.12m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$1.70m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	-\$0.42m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2025-26

Option C NPV calculation

Project_Option Name

Tenterfield Secondary System Renewal - Option C (Commercial)

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$1.36m	NPV / Capital (Ratio)	-0.14
NPV @ upper bound rate	13.00%	-\$1.95m	Pay Back Period (Yrs)	0.06 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$0.17m	IRR%	6.41%

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%	\$7.90m	NPV / Capital (Ratio)	0.82
NPV @ upper bound rate	13.00%	\$4.92m	Pay Back Period (Yrs)	3.19 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$12.91m	IRR%	25.93%

Benefits

	As Is	To Be	Benefit		
Risk cost				VCR Benefit	\$2.51m
Systems (reliability)	\$3.16m	\$0.05m	\$3.11m	ENS Penalty	\$0.55m
Financial	\$0.31m	\$0.03m	\$0.28m	All other risk benefits	\$0.47m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.53m
People (safety)	\$0.04m	\$0.00m	\$0.04m		
Environment	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$1.05m
Reputation	\$0.11m	\$0.01m	\$0.10m	*excludes VCR benefits	
Total Risk benefits	\$3.62m	\$0.09m	\$3.53m	Benefits in the economic NPV**	\$3.01m
Cost savings and other benefits			\$0.03m	**excludes ENS penalty	
Total Benefits			\$3.56m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	-\$0.03m
Capital - initial \$m	-\$9.60m	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 D NPV calculation

Project_ Option Name

Tenterfield Secondary System Renewal - Option D (Commercial)

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$1.30m	NPV / Capital (Ratio)	-0.16
NPV @ upper bound rate	13.00%	-\$1.70m	Pay Back Period (Yrs)	0.06 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$0.46m	IRR%	5.55%

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%	\$7.91m	NPV / Capital (Ratio)	1.00
NPV @ upper bound rate	13.00%	\$5.14m	Pay Back Period (Yrs)	2.73 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$12.55m	IRR%	29.64%

Benefits

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$3.16m	\$0.12m	\$3.04m	VCR Benefit	\$2.49m
<i>Financial</i>	\$0.31m	\$0.19m	\$0.12m	ENS Penalty	\$0.54m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	All other risk benefits	\$0.20m
<i>People (safety)</i>	\$0.04m	\$0.02m	\$0.02m	Total Risk benefits	\$3.23m
<i>Environment</i>	\$0.01m	\$0.01m	-\$0.00m	Benefits in the financial NPV*	\$1.07m
<i>Reputation</i>	\$0.11m	\$0.05m	\$0.06m	*excludes VCR benefits	
Total Risk benefits	\$3.62m	\$0.39m	\$3.23m	Benefits in the economic NPV**	\$3.02m
Cost savings and other benefits			\$0.33m	**excludes ENS penalty	
Total Benefits			\$3.56m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	-\$0.03m
Capital - initial \$m	-\$7.90m	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