

OPTIONS EVALUATION REPORT (OER)

Wagga 330kV Secondary Systems Renewal

OER 000000001180 revision 3.0



Ellipse project no.: P0005200

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	6 January 2017	

Change history

Revision	Date	Amendment
0	24 June 2016	Initial issue
1	31 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	24 November 2016	Update to format
3	06 January 2017	Correction to Option A estimates

1. Need/opportunity

Wagga 330kV Substation is a customer connection point supplying the Essential Energy 132kV network in the area inclusive of Gadara, Uranquinty and Yanco. A significant proportion of secondary systems assets at Wagga 330kV 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 637 – Replacement of YTG Protection Relays
- > Need ID 606 – Replacement of THR Protection Relays
- > Need ID 638 – Replacement of THS Protection Relays
- > Need ID 1356 – Replacement of Reyrolle OHx Protection Relays
- > Need ID 1376 – Replacement of Alstom Pxxx Protection Relays
- > Need ID 1379 – Replacement of GE Multilin Protection Relays
- > Need ID 1383 – Replacement of GE FV2 Protection Relays
- > Need ID 1387 – Replacement of Capacitor Protection Relays
- > Need ID 1359 – Remote Terminal Unit (RTU) 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 or the risk cost associated with the Need. The risk cost of \$3.58m 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 or have limited spares and no manufacturer support. This therefore increases the likelihood of a hazardous event occurring and decreases TransGrid's ability to mitigate or repair any failures.
- > Relays have increasing numbers of faults, degradation of components or are prone to mechanical wear, increasing the likelihood of a hazardous event occurring.

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

Option A — Complete In-Situ Replacement [\[OFR 1180A, OFS 1180A\]](#)

Option A is to replace all secondary systems assets at the Wagga 330kV 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 \$6.00m . 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 \$6k per annum based on current maintenance plan settings.

A benefit figure of \$41k 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 \$0.290m per annum (base case risk cost = \$3.58m). 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 B — Strategic Asset Replacement [\[OFR 1180B, OFS 1180B\]](#)

Option B 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 this option total \$4.3m. This costing is estimated using TransGrid's "Success" estimating system. A further \$354k capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$6k 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 Installations.

The residual risk associated with this option upon completion of the project amounts to \$2.13m per annum (base case risk cost = \$3.58m). The risk reduction is realised through the reduction in the probability of failure for all assets.

Option C — SSB Replacement [\[OFR 1180C, OFS 1180C\]](#)

Option C is to carry out the complete upgrade and renewal of secondary systems at the Wagga 330kV 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 \$19.1m. 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 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 \$41k 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 \$0.29m per annum (base case risk cost = \$3.58m). 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 1180D](#), [OFS 1180D](#)]

Option D is to carry out complete replacement of the secondary system at Wagga 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, 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 \$13.8m. 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 \$41k 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 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 \$1.55m per annum (base case risk cost = \$3.58m). 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 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	N/A	0.006	3.58	N/A	N/A	5
A	Complete In-Situ Replacement	6.00	0.006	0.29	14.2	1.18	1
B	Strategic Asset Replacement	4.30	0.006	2.13	3.39	(2.14)	2

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
C	SSB Replacement	19.1	0.006	0.29	3.77	(9.20)	3
D	IEC-61850 Replacement	13.8	0.010	1.55	1.27	(8.10)	4

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 \$301k for Option A, C and D as Option B 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 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	10.4	20.1
B	Strategic Asset Replacement	1.90	5.88
C	SSB Replacement	0.67	8.85
D	IEC-61850 Replacement	(0.62)	4.38

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	Complete In-Situ Replacement	6,000	15 years	\$400

Option	Description	CAPEX	Expected Life	Annualised CAPEX
B	Strategic Asset Replacement	4,300	15 years	\$290
C	SSB Replacement	19,100	15 years	\$1,270
D	IEC-61850 Replacement	13,800	15 years	\$920

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	135	2,631	15	N/A	N/A	N/A
A	10	210	0	125	2,421	15
B	96	1,413	5	39	1,219	10
C	10	210	0	125	2,421	15
D	10	930	30	125	1,701	(15) ²

Table 5 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	707	400	Yes
B	300	290	Yes
C	707	1,270	No
D	455	920	No

Options A and B are reasonably practicable.

Options 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.

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).

² Due to it being an untested technology, IEC-61850 solution has higher probability of failure on transmission line assets at Wagga 330kV 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

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the four 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 to proceed with scoping Option A – Complete In-Situ Replacement in detail.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name			Wagga 330kV Secondary Systems Renewal - Option A		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$1.18m	NPV / Capital (Ratio)	0.20	
NPV @ upper bound rate	13.00%	\$0.18m	Pay Back Period (Yrs)	0.14 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$2.81m	IRR%	13.71%	
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%	\$14.15m	NPV / Capital (Ratio)	2.36	
NPV @ upper bound rate	13.00%	\$10.35m	Pay Back Period (Yrs)	1.83 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$20.08m	IRR%	44.19%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.31m
Systems (reliability)	\$2.63m	\$0.21m	\$2.42m	ENS Penalty	\$0.04m
Financial	\$0.70m	\$0.05m	\$0.65m	All other risk benefits	\$0.94m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.29m
People (safety)	\$0.13m	\$0.01m	\$0.12m	Benefits in the financial NPV*	\$1.02m
Environment	\$0.02m	\$0.00m	\$0.02m	*excludes VCR benefits	
Reputation	\$0.10m	\$0.02m	\$0.08m	Benefits in the economic NPV**	\$3.29m
Total Risk benefits	\$3.58m	\$0.29m	\$3.29m	**excludes ENS penalty	
Cost savings and other benefits			\$0.04m		
Total Benefits			\$3.33m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.01m	Write-off cost	-\$0.30m
Capital - initial \$m			-\$6.00m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment			\$0.40m	Re-investment capital	\$0.00m
Capitalisation period			3.00 Yrs	Start of the re-investment period	0.00 Yrs

Option B NPV calculation

Project_Option Name

Wagga 330kV Secondary Systems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$2.14m	NPV / Capital (Ratio)	-0.50
NPV @ upper bound rate	13.00%	-\$2.21m	Pay Back Period (Yrs)	-0.01 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$1.93m	IRR%	-0.90%

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%	\$3.39m	NPV / Capital (Ratio)	0.79
NPV @ upper bound rate	13.00%	\$1.90m	Pay Back Period (Yrs)	3.21 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$5.88m	IRR%	20.38%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.18m
Systems (reliability)	\$2.63m	\$1.41m	\$1.22m	ENS Penalty	\$0.01m
Financial	\$0.70m	\$0.58m	\$0.12m	All other risk benefits	\$0.26m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.45m
People (safety)	\$0.13m	\$0.10m	\$0.04m	Benefits in the financial NPV*	\$0.27m
Environment	\$0.02m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.10m	\$0.04m	\$0.05m	Benefits in the economic NPV**	\$1.44m
Total Risk benefits	\$3.58m	\$2.13m	\$1.45m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$1.45m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	\$0.00m
Capital - initial \$m	-\$4.30m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.29m	Re-investment capital	-\$0.35m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2023-24

Option C NPV calculation

Project_Option Name

Wagga 330kV Secondary Systems Renewal - Option C

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$9.20m	NPV / Capital (Ratio)	-0.48
NPV @ upper bound rate	13.00%	-\$9.50m	Pay Back Period (Yrs)	-0.02 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$8.42m	IRR%	-2.42%

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%	\$3.77m	NPV / Capital (Ratio)	0.20
NPV @ upper bound rate	13.00%	\$0.67m	Pay Back Period (Yrs)	5.81 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$8.85m	IRR%	13.83%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.31m
Systems (reliability)	\$2.63m	\$0.21m	\$2.42m	ENS Penalty	\$0.04m
Financial	\$0.70m	\$0.05m	\$0.65m	All other risk benefits	\$0.94m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.29m
People (safety)	\$0.13m	\$0.01m	\$0.12m	Benefits in the financial NPV*	\$1.02m
Environment	\$0.02m	\$0.00m	\$0.02m	*excludes VCR benefits	
Reputation	\$0.10m	\$0.02m	\$0.08m	Benefits in the economic NPV**	\$3.29m
Total Risk benefits	\$3.58m	\$0.29m	\$3.29m	**excludes ENS penalty	
Cost savings and other benefits			\$0.04m		
Total Benefits			\$3.33m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	-\$0.30m
Capital - initial \$m	-\$19.10m	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 D NPV calculation

Project_Option Name			Wagga 330kV Secondary Systems Renewal - Option D		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$8.10m	NPV / Capital (Ratio)	-0.59	
NPV @ upper bound rate	13.00%	-\$7.96m	Pay Back Period (Yrs)	-0.08 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$8.10m	IRR%	-7.67%	
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%	\$1.27m	NPV / Capital (Ratio)	0.09	
NPV @ upper bound rate	13.00%	-\$0.62m	Pay Back Period (Yrs)	6.41 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$4.38m	IRR%	11.88%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.66m
Systems (reliability)	\$2.63m	\$0.93m	\$1.70m	ENS Penalty	\$0.02m
Financial	\$0.70m	\$0.36m	\$0.34m	All other risk benefits	\$0.35m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$2.03m
People (safety)	\$0.13m	\$0.10m	\$0.03m	Benefits in the financial NPV*	\$0.81m
Environment	\$0.02m	\$0.03m	-\$0.01m	*excludes VCR benefits	
Reputation	\$0.10m	\$0.13m	-\$0.03m	Benefits in the economic NPV**	\$2.45m
Total Risk benefits	\$3.58m	\$1.55m	\$2.03m	**excludes ENS penalty	
Cost savings and other benefits			\$0.44m		
Total Benefits			\$2.47m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.01m	Write-off cost	-\$0.30m
Capital - initial \$m			-\$13.80m	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