

# OPTIONS EVALUATION REPORT (OER)

Cowra Secondary Systems Renewal

OER- 000000001252 revision 2.0



**Ellipse project no.:** P0005325

**TRIM file:** [TRIM No]

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

**Project category:** Prescribed - Replacement

## Approvals

Author	Adam Hoare	Secondary Systems Senior 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	27 October 2016	Initial issue
1	17 November 2016	Update to format
2	24 November 2016	Added OSR reference

## 1. Need/opportunity

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Cowra 132kV Substation is a customer connection point supplying the Essential Energy 66kV network in the area inclusive of Young, Canowindra and Grenfell. A significant proportion of secondary systems assets at Cowra 132kV Substation have been identified for replacement.

## 2. Related Needs/opportunities

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

- > 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 1381 – Replacement of Siemens 7xx Protection Relays
- > Need ID 1383 – Replacement of GE FV2 Protection Relays
- > Need ID 1387 – Replacement of Capacitor Protection Relays
- > Need ID 629 – Replacement of Remote Terminal Units (RTUs)
- > Need ID DCN539 – Cowra Auxiliary Supplies Upgrade

## 3. Options

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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 \$1.21m 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 1252A](#), [OFS 1252A](#)]

Option A is to replace all secondary systems assets at the Cowra 132kV Substation with current designs and architectures. This option also replaces Direct Current (DC) supplies to account for increase in power requirements.

The expected capital costs for the option total \$3.5m. 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 \$4k per annum based on current maintenance plan settings.

A benefit figure of \$34k per annum has been calculated for this option in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations<sup>1</sup>.

- > The residual risk associated with this option upon completion of the project amounts to \$0.108m per annum (base case risk cost = \$1.21m). 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 Alternating Current (AC) distribution.

### **Option B — Strategic Asset Replacement** [[OFR 1252B](#), [OFS 1252B](#)]

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 \$3.7m. This costing is estimated using TransGrid's "Success" estimating system. A further \$260k capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$5k 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 \$0.116m per annum (base case risk cost = \$1.21m). The risk reduction is realised through the reduction in the probability of failure for all assets.

### **Option C — SSB Replacement** [[OFR 1252C](#), [OFS 1252C](#)]

Option C is to carry out the complete upgrade and renewal of secondary systems at the Cowra 132kV 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 \$12.6m. 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 \$4k per annum for this option based on current maintenance schedule.

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<sup>1</sup> Refer SSA Strategy – Renewal and Maintenance – Secondary Systems Site Installations

A benefit figure of \$34k 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 \$0.100m per annum (base case risk cost = \$1.21m). 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 1252D](#), [OFS 1252D](#)]

Option D is to carry out complete replacement of the secondary system at Cowra 132kV 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 \$9.0m. 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 replacement option.

Operating costs have been estimated at \$10k per annum for this option based on current maintenance schedule.

A benefit figure of \$34k 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 gain due to standard development. The savings in the second year and third year is a high level assumption and considers the benefits diminishing due to potential spend in IE61850 solution to allow for improvements.

The residual risk associated with this option upon completion of the project amounts to \$0.77m per annum (base case risk cost = \$1.21m). 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.

## 4. Evaluation

### 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
<b>Base Case</b>	Run-to-fail	N/A	0.004	1.21	N/A	N/A	5
<b>A</b>	Complete In-Situ Replacement	3.5	0.004	0.108	3.29	(0.89)	1
<b>B</b>	Strategic Asset Replacement	3.7	0.005	0.116	1.78	(1.62)	2
<b>C</b>	SSB Replacement	12.6	0.004	0.100	(3.72)	(7.89)	3
<b>D</b>	IEC-61850 Replacement	9.0	0.010	0.770	(4.25)	(6.77)	4

The commercial evaluation is based on:

- > a 10% discount rate
- > a life of the investment of 15 years and a corresponding residual/terminal value

Sensitivities on economic Net Present Value (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%
<b>A</b>	Complete In-Situ Replacement	2.15	5.08
<b>B</b>	Strategic Asset Replacement	0.79	3.46
<b>C</b>	SSB Replacement	(4.37)	(2.49)
<b>D</b>	IEC-61850 Replacement	(4.37)	(3.94)

## 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 in **Error! Reference source not found..**

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 High Voltage (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
<b>Base</b>	Do nothing	N/A	N/A	N/A
<b>A</b>	Complete In-Situ Replacement	3,500	15 years	230
<b>B</b>	Strategic Asset Replacement	3,700	15 years	250
<b>C</b>	SSB Replacement	12,600	15 years	840
<b>D</b>	IEC-61850 Replacement	9,000	15 years	600

**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
<b>Base</b>	24	987	6	N/A	N/A	N/A
<b>A</b>	1	63	1	23	924	5
<b>B</b>	1	68	1	23	919	5
<b>C</b>	0	60	0	24	927	6
<b>D</b>	10	450	10	14	537	(4) <sup>2</sup>

**Table 5 – Reasonably practicable test (\$ thousand)**

Option	Network Safety Risk Reduction <sup>3</sup>	Annualised CAPEX	Reasonably practicable <sup>4</sup> ?
<b>A</b>	191	230	No
<b>B</b>	191	250	No
<b>C</b>	201	840	No
<b>D</b>	72	600	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 Cowra 132kV Substation is Option A – 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 the four options and 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.

<sup>2</sup> Option D actually increases bushfire risk from the Base Case

<sup>3</sup> The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

<sup>4</sup> Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

## **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**

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It is the recommendation that Option A – Complete In-Situ Replacement be scoped in detail.

## Attachment 1 – Commercial evaluation report

### Option A NPV calculation

Project_Option Name			Cowra Secondary ystems Renewal - Option A		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$0.89m	NPV / Capital (Ratio)	-0.25	
NPV @ upper bound rate	13.00%	-\$1.12m	Pay Back Period (Yrs)	0.04 Yrs	
NPV @ lower bound rate (WACC)	6.75%	-\$0.47m	IRR%	4.36%	
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%	\$3.29m	NPV / Capital (Ratio)	0.94	
NPV @ upper bound rate	13.00%	\$2.15m	Pay Back Period (Yrs)	3.33 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$5.08m	IRR%	25.86%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.81m
Systems (reliability)	\$0.99m	\$0.06m	\$0.92m	ENS Penalty	\$0.08m
Financial	\$0.16m	\$0.04m	\$0.12m	All other risk benefits	\$0.21m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.10m
People (safety)	\$0.02m	\$0.00m	\$0.02m		
Environment	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.32m
Reputation	\$0.03m	\$0.00m	\$0.03m	*excludes VCR benefits	
Total Risk benefits	\$1.21m	\$0.11m	\$1.10m		
Cost savings and other benefits			\$0.03m	Benefits in the economic NPV**	\$1.05m
Total Benefits			\$1.13m	**excludes ENS penalty	
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$3.50m	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 B NPV calculation

Project\_Option Name

Cowra Secondary systems Renewal - Option B

### 1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$1.62m	NPV / Capital (Ratio)	-0.43
NPV @ upper bound rate	13.00%	-\$1.74m	Pay Back Period (Yrs)	0.01 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$1.35m	IRR%	0.72%

### 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%	\$1.78m	NPV / Capital (Ratio)	0.48
NPV @ upper bound rate	13.00%	\$0.79m	Pay Back Period (Yrs)	3.98 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$3.46m	IRR%	16.76%

### Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.80m
Systems (reliability)	\$0.99m	\$0.07m	\$0.92m	ENS Penalty	\$0.08m
Financial	\$0.16m	\$0.04m	\$0.11m	All other risk benefits	\$0.21m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.09m
People (safety)	\$0.02m	\$0.00m	\$0.02m	Benefits in the financial NPV*	\$0.29m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.03m	\$0.00m	\$0.03m	Benefits in the economic NPV**	\$1.01m
Total Risk benefits	\$1.21m	\$0.12m	\$1.09m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$1.09m		

### Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$3.74m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.00m	Re-investment capital	-\$0.26m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2024-25

## Option C NPV calculation

Project\_Option Name

Cowra Secondary systems Renewal - Option C

### 1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$7.89m	NPV / Capital (Ratio)	-0.63
NPV @ upper bound rate	13.00%	-\$7.64m	Pay Back Period (Yrs)	-0.09 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$8.05m	IRR%	-9.25%

### 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%	-\$3.72m	NPV / Capital (Ratio)	-0.29
NPV @ upper bound rate	13.00%	-\$4.37m	Pay Back Period (Yrs)	11.82 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$2.49m	IRR%	3.02%

### Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.81m
Systems (reliability)	\$0.99m	\$0.06m	\$0.93m	ENS Penalty	\$0.08m
Financial	\$0.16m	\$0.04m	\$0.12m	All other risk benefits	\$0.22m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.11m
People (safety)	\$0.02m	\$0.00m	\$0.02m	Benefits in the financial NPV*	\$0.33m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.03m	\$0.00m	\$0.03m	Benefits in the economic NPV**	\$1.06m
Total Risk benefits	\$1.21m	\$0.10m	\$1.11m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$1.14m		

### Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$12.60m	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			Cowra Secondary systems Renewal - Option D		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$6.77m	NPV / Capital (Ratio)	-0.75	
NPV @ upper bound rate	13.00%	-\$6.34m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	-\$7.29m	IRR%	Not measurable	
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%	-\$4.25m	NPV / Capital (Ratio)	-0.47	
NPV @ upper bound rate	13.00%	-\$4.37m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	-\$3.94m	IRR%	-3.00%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.49m
Systems (reliability)	\$0.99m	\$0.45m	\$0.54m	ENS Penalty	\$0.05m
Financial	\$0.16m	\$0.27m	-\$0.12m	All other risk benefits	-\$0.10m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.44m
People (safety)	\$0.02m	\$0.01m	\$0.01m		
Environment	\$0.01m	\$0.01m	-\$0.00m	Benefits in the financial NPV*	\$0.38m
Reputation	\$0.03m	\$0.03m	\$0.00m	*excludes VCR benefits	
Total Risk benefits	\$1.21m	\$0.77m	\$0.44m		
Cost savings and other benefits			\$0.43m	Benefits in the economic NPV**	\$0.82m
Total Benefits			\$0.87m	**excludes ENS penalty	
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.01m	Write-off cost	\$0.00m
Capital - initial \$m			-\$9.00m	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