

OPTIONS EVALUATION REPORT (OER)



Ingleburn Secondary Systems Renewal

OER 000000001255 revision 1.0

Ellipse project no.: P0005331

TRIM file: [TRIM No]

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

Project category: Prescribed - Replacement

Approvals

Author	Annie Welvaert	Secondary Systems Analyst
Endorsed	Philip Wong	Secondary Systems Asset Engineer
	Mark Jones	Secondary Systems and Communications Asset Manager
	Azil Khan	Invest Analysis Manager
Approved	Lance Wee	M/Asset Strategy
Date submitted for approval	17 November 2016	

Change history

Revision	Date	Amendment
0	27 June 2016	Initial issue
1	31 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	1 November 2016	Minor amendments
3	17 November 2016	Update to format

1. Need/opportunity

Ingleburn 330/66kV Substation is a customer connection point supplying Endeavour Energy's 66kV network in the area inclusive of Macquarie Fields and Minto. It comprises of 2x330kV feeders, 2x330/66kV transformers and 5x66kV feeders. The site was established in 1970, and the secondary systems assets have installed dates between 1970 (solid state type with 35 years average nominal asset life) and 2015 (microprocessor with 15 years average nominal asset life).

A significant portion of secondary systems assets at Ingleburn Substation have been identified for replacement. 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 Systems Renewal were identified in the following Needs:

- > Need ID 606 – Replacement of THR Protection Relays
- > Need ID 637 – Replacement of YTG Protection Relays
- > Need ID 1379 – Protection – GE Multilin Condition
- > Need ID 1380 – Protection - Schweitzer SELxxx Condition

3. Options

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 \$3.71m 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, with limited spares and limited or no manufacturer support. This therefore 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 1255A](#), [OFS 1255A](#)]

Option A is to replace all secondary systems assets at the Ingleburn 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 \$4.02m. 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 as this is a complete in-situ replacement option.

Operating costs have been estimated at \$3k per annum based on current maintenance plan settings.

A benefit figure of \$32k 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 amounts to \$0.40m per annum (base case risk cost = \$3.71m). 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 – IEC-61850 Deployment [[OFR 1255B](#), [OFS 1255B](#)]

Option B is to replace and upgrade all secondary systems assets using IEC-61850 technology and methodologies. This option also includes the remediation of the 415V AC distribution in the building and the yard.

The expected capital costs for the option total \$4.60m. 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 as this is a full IEC-61850 deployment option.

Operating costs have been estimated at \$10k per annum based on a standard rate required for defect maintenance.

A benefit figure of \$32k 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 \$0.075k in the 3rd year is also included to account for gain due to standard development. The savings in the second and third year is a high level assumption and considers the benefits diminishing due to potential spend in IEC-61850 solution to allow for improvements.

The residual risk associated with this option upon completion amounts to \$0.79m per annum (base case risk cost = \$3.71m). 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 C – Strategic Asset Replacement [[OFR 1255C](#), [OFS 1255C](#)]

Option C 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 the option total \$2.08. This costing is estimated using TransGrid's "Success" estimating system. A further \$1.07m capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$3k 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 \$2.05m per annum (base case risk cost \$3.71m). The risk reduction is realised through the reduction in the probability of failure for all assets.

Options A, B & C have all 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 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)	-	0.003	3.71	-	-	4
A	Complete In-Situ Replacement	4.02	0.003	0.396	15.66	0.40	1
B	IEC-61850 Replacement	4.60	0.010	0.786	13.48	(0.41)	2
C	Strategic Asset Replacement	2.08	0.003	2.046	6.14	(0.57)	3

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 \$38k for Option A and \$31k for Option B as these options retire few assets before the end of their financial lives.
- > Capex excludes interest during construction.

Sensitivities on economic NPV for 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 In-Situ Replacement	11.74	21.73
B	IEC-61850 Replacement	10.06	18.79
C	Strategic Asset Replacement	4.27	9.20

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)

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	4,020	15 years	270
B	IEC-61850 Replacement	4,600	15 years	310
C	Strategic Asset Replacement	2,080	15 years	140

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	12	3,089	7	N/A	N/A	N/A
A	2	310	3	10	2,779	4
B	5	580	8	6	2,509	0
C	7	1,621	1	4	1,468	6

Table 5 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ²	Annualised CAPEX	Reasonably practicable ³ ?
A	333	270	Yes
B	270	310	No
C	195	140	Yes

Options A and C are reasonably practicable. Option C however does not recognise the continued investment required during the expected life of Option A that is considered in the NPV analysis.

Option B is not reasonably practicable.

² The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

³ Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

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 at Ingleburn 330kV Substation is Option A – 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 and greatest reduction in network safety risk.

As no project has yet been delivered using the technology described in Option B – IEC-61850, there is potential that the capital estimate may be further refined as TransGrid's capabilities with this technology increase. For that reason, it is proposed that Option B be further scoped to confirm the preferred option.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the option and Base Case. Implementing Option B 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.
- > At such time in the future when the organisation is more experienced with the deployment of IEC-61850 systems onto the network, Option B – IEC-61850 be scoped in detail.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name		Ingleburn Secondary Systems Renewal - Option A			
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$0.40m	NPV / Capital (Ratio)	0.10	
NPV @ upper bound rate	13.00%	-\$0.22m	Pay Back Period (Yrs)	0.12 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$1.42m	IRR%	11.79%	
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%	\$15.66m	NPV / Capital (Ratio)	3.90	
NPV @ upper bound rate	13.00%	\$11.74m	Pay Back Period (Yrs)	1.21 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$21.73m	IRR%	53.28%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.70m
Systems (reliability)	\$3.09m	\$0.31m	\$2.78m	ENS Penalty	\$0.03m
Financial	\$0.58m	\$0.08m	\$0.51m	All other risk benefits	\$0.59m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.32m
People (safety)	\$0.01m	\$0.00m	\$0.01m	Benefits in the financial NPV*	\$0.65m
Environment	\$0.01m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.02m	\$0.01m	\$0.02m	Benefits in the economic NPV**	\$3.32m
Total Risk benefits	\$3.71m	\$0.40m	\$3.32m	**excludes ENS penalty	
Cost savings and other benefits			\$0.03m		
Total Benefits			\$3.35m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			-\$0.00m	Write-off cost	-\$0.04m
Capital - initial \$m			-\$4.02m	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

Ingleburn Secondary Systems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$0.41m	NPV / Capital (Ratio)	-0.09
NPV @ upper bound rate	13.00%	-\$0.82m	Pay Back Period (Yrs)	0.08 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$0.30m	IRR%	7.96%

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%	\$13.48m	NPV / Capital (Ratio)	2.93
NPV @ upper bound rate	13.00%	\$10.06m	Pay Back Period (Yrs)	1.44 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$18.79m	IRR%	54.36%

Benefits

Risk cost	As Is	To Be	Benefit		
<i>Systems (reliability)</i>	\$3.09m	\$0.58m	\$2.51m	<i>VCR Benefit</i>	\$2.45m
<i>Financial</i>	\$0.58m	\$0.18m	\$0.40m	<i>ENS Penalty</i>	\$0.02m
<i>Operational/compliance</i>	\$0.00m	\$0.00m	\$0.00m	<i>All other risk benefits</i>	\$0.46m
<i>People (safety)</i>	\$0.01m	\$0.01m	\$0.01m	Total Risk benefits	\$2.93m
<i>Environment</i>	\$0.01m	\$0.01m	-\$0.00m	Benefits in the financial NPV*	\$0.81m
<i>Reputation</i>	\$0.02m	\$0.01m	\$0.01m	<i>*excludes VCR benefits</i>	
Total Risk benefits	\$3.71m	\$0.79m	\$2.93m	Benefits in the economic NPV**	\$3.24m
Cost savings and other benefits			\$0.33m	<i>**excludes ENS penalty</i>	
Total Benefits			\$3.26m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	-\$0.03m
Capital - initial \$m	-\$4.60m	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 C NPV calculation

Project_Option Name

Ingleburn Secondary Systems Renewal - Option C

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$0.57m	NPV / Capital (Ratio)	-0.27
NPV @ upper bound rate	13.00%	-\$0.71m	Pay Back Period (Yrs)	0.05 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$0.28m	IRR%	4.81%

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%	\$6.14m	NPV / Capital (Ratio)	2.95
NPV @ upper bound rate	13.00%	\$4.27m	Pay Back Period (Yrs)	1.26 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$9.20m	IRR%	37.53%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$1.43m
Systems (reliability)	\$3.09m	\$1.62m	\$1.47m	ENS Penalty	\$0.01m
Financial	\$0.58m	\$0.41m	\$0.17m	All other risk benefits	\$0.23m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.67m
People (safety)	\$0.01m	\$0.01m	\$0.00m	Benefits in the financial NPV*	\$0.24m
Environment	\$0.01m	\$0.00m	\$0.01m	*excludes VCR benefits	
Reputation	\$0.02m	\$0.01m	\$0.02m	Benefits in the economic NPV**	\$1.66m
Total Risk benefits	\$3.71m	\$2.05m	\$1.67m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$1.67m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m	-\$2.08m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.14m	Re-investment capital	-\$1.07m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2032-33