

OPTIONS EVALUATION REPORT (OER)

Haymarket Secondary Systems Replacement

OER 000000001493 revision 1.0



Ellipse project no.: P0008692

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	Investment Strategy Manager
Approved	Lance Wee	M/Asset Strategy
Date submitted for approval	24 November 2016	

Change history

Revision	Date	Amendment
0	29 June 2016	Initial issue
1	31 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	24 November 2016	Update to format & addition of OSR reference

1. Need/opportunity

Haymarket 330/132kV Substation comprises 1x 330kV feeders, 3x 330/132kV transformers, 14x 132kV feeders, and 1x 132kV reactor. The site was established in 2004, and the secondary systems assets have install dates between 2001 and 2015.

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 610 – Replacement of EDM I MK3 Energy Meters
- > 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 1385 – Replacement of Reyrolle DUOBIAS 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 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 Haymarket Substation of \$15.27m 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 — In-Situ Replacement (Combined Protection and Control) [OFR 1493A, OFS 1493A]

Option A is to carry out the complete upgrade and renewal of the secondary systems at Haymarket 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 will utilise combined protection and control design philosophies.

The expected capital costs for this option total \$8.06m. This costing is estimated using TransGrid's 'Success' estimating system. A further \$3.19m capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$7k per annum for this option based on current maintenance schedule.

A benefit figure of \$50k 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 \$10.58m per annum (base case risk cost = \$15.27m). 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 (Independent Control) [OFR 1493B, OFS 1493B]

Option B is to carry out the complete upgrade and renewal of the secondary systems at Haymarket 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 will utilise independent control and protection replacements using the latest automation IED philosophies.

The expected capital costs for this option total \$8.81m. This costing is estimated using TransGrid's 'Success' estimating system. A further \$3.19m capital investment would be required over the 15 year life cycle of this option through to 2038.

Operating costs have been estimated at \$7k per annum for this option based on current maintenance schedule.

A benefit figure of \$50k 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 \$11.36m per annum (base case risk cost = \$15.27m). 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

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 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 (O&M continues)	-	0.007	15.27	-	-	3
A	In-Situ Replacement (Combined Protection/Control)	8.06	0.007	10.58	16.22	(0.55)	1
B	In-Situ Replacement (Independent Control)t	8.81	0.007	11.36	11.99	(1.33)	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.
- > Capex excludes interest during construction.

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	In-Situ Replacement (Combined Protection/Control)	11.18	24.56
B	In-Situ Replacement (Independent Control)	7.95	18.77

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

Option	Description	CAPEX	Expected Life	Annualised CAPEX
A	In-Situ Replacement (Combined Protection/Control)	8,060	15 years	540
B	In-Situ Replacement (Independent Control)	8,810	15 years	590

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	398	13,509	0	N/A	N/A	N/A
A	21	9,842	0	377	3,668	0
B	21	10,579	0	377	2,930	0

Table 5 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ¹	Annualised CAPEX	Reasonably practicable ² ?
A	1,497	540	Yes
B	1,424	590	Yes

Both options A and B are 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 systems is Option A – Complete In-Situ Replacement (Combined Protection/Control).

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.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between all options and the Base Case. Deploying either 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.

¹ The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

² 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

It is the recommendation that Option A – Complete In-Situ Replacement (Combined Protection/Control) be scoped in detail.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name			Haymarket 330kV Secondary Systems Renewal - Option A		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$0.55m	NPV / Capital (Ratio)	-0.07	
NPV @ upper bound rate	13.00%	-\$1.27m	Pay Back Period (Yrs)	0.09 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$0.87m	IRR%	8.50%	
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%	\$16.22m	NPV / Capital (Ratio)	2.01	
NPV @ upper bound rate	13.00%	\$11.18m	Pay Back Period (Yrs)	1.71 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$24.56m	IRR%	41.07%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$3.57m
Systems (reliability)	\$13.51m	\$9.84m	\$3.67m	ENS Penalty	\$0.02m
Financial	\$1.17m	\$0.70m	\$0.47m	All other risk benefits	\$1.09m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$4.68m
People (safety)	\$0.40m	\$0.02m	\$0.38m		
Environment	\$0.00m	\$0.00m	\$0.00m	Benefits in the financial NPV*	\$1.16m
Reputation	\$0.19m	\$0.02m	\$0.17m	*excludes VCR benefits	
Total Risk benefits	\$15.27m	\$10.58m	\$4.68m		
Cost savings and other benefits			\$0.05m	Benefits in the economic NPV**	\$4.71m
Total Benefits			\$4.73m	**excludes ENS penalty	
Other Financial Drivers					
Incremental opex cost pa (no depreciation)		-\$0.01m	Write-off cost		\$0.00m
Capital - initial \$m		-\$8.06m	Major Asset Life (Yrs)		15.00 Yrs
Residual Value - initial investment		\$0.54m	Re-investment capital		-\$3.19m
Capitalisation period		5.00 Yrs	Start of the re-investment period		2027-28

Option B NPV calculation

Project_Option Name

Haymarket 330kV Secondary Systems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-\$1.32m	NPV / Capital (Ratio)	-0.15
NPV @ upper bound rate	13.00%	-\$1.94m	Pay Back Period (Yrs)	0.07 Yrs
NPV @ lower bound rate (WACC)	6.75%	-\$0.06m	IRR%	6.64%

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%	\$11.99m	NPV / Capital (Ratio)	1.36
NPV @ upper bound rate	13.00%	\$7.95m	Pay Back Period (Yrs)	2.24 Yrs
NPV @ lower bound rate (WACC)	6.75%	\$18.77m	IRR%	32.15%

Benefits

Risk cost	As Is	To Be	Benefit	VCR Benefit	\$2.84m
Systems (reliability)	\$13.51m	\$10.58m	\$2.93m	ENS Penalty	\$0.02m
Financial	\$1.17m	\$0.74m	\$0.43m	All other risk benefits	\$1.04m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$3.90m
People (safety)	\$0.40m	\$0.02m	\$0.38m	Benefits in the financial NPV*	\$1.11m
Environment	\$0.00m	\$0.00m	\$0.00m	*excludes VCR benefits	
Reputation	\$0.19m	\$0.02m	\$0.17m	Benefits in the economic NPV**	\$3.93m
Total Risk benefits	\$15.27m	\$11.36m	\$3.90m	**excludes ENS penalty	
Cost savings and other benefits			\$0.05m		
Total Benefits			\$3.95m		

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-\$0.01m	Write-off cost	\$0.00m
Capital - initial \$m	-\$8.81m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	\$0.59m	Re-investment capital	-\$3.19m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2027-28