OPTIONS EVALUATION REPORT (OER)

Liverpool Secondary Systems Renewal

OER- 000000001599 revision 2.0

Ellipse project no.: P0009495
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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	27 October 2016	Initial issue
1	24 November 2016	Update to format
2	24 November 2016	Added OSR reference

1. Need/opportunity

Liverpool 330/132kV Substation comprises 2x 330kV feeders, 3x 330/132kV transformers and 3x 132kV feeders. The site was established in 1985, and the secondary systems assets have install dates between 1985 (discrete component type with 35 years average nominal asset life) and 2015 (microprocessor with 15 tear 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 606 – Replacement of THR Protection Relays
- Need ID 620 – Replacement of D21, D22, D202 & D203 Protection Relays
- Need ID 621 – Replacement of DB Series 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 FAC 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 systems at Liverpool Substation of $2.91m 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:

- 90% of 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 [OFR 1599A, OFS 1599A]

Option A is to carry out the complete upgrade and renewal of the secondary systems at Liverpool 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.

The expected capital costs for this option totals $3.0m. 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 in-situ replacement option.

Operating costs have been estimated at $3k 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 $0.584m per annum (base case risk cost = $2.91m). 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 — Strategic Asset Replacement [OFR 1599B, OFS 1599B]

Option B is to carry out the replacement of individual secondary system assets at Liverpool 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 totals $2.56m. This costing is estimated using TransGrid's 'Success' estimating system. A further $0.220m 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 $3k 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 Installations[1].

The residual risk associated with this option upon completion of the project amounts to $0.975m per annum (base case risk cost = $2.91m). 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 — IEC-61850 Deployment [OFR 1599C, OFS 1599C]

Option C is to carry out complete replacement of the secondary system at Liverpool 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 an unmanned substation site involving the 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.

[1] Refer SSA Strategy - Renewal and Maintenance - Secondary Systems Site Installations

The expected capital costs for this option totals $8.3m. 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 primary assets. 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 $4.27m per annum (base case risk cost = $2.91m). The risk increase is realised through the increase in the probability of failure for all assets due to the nature of an unproven technology.

All options have been assessed as technically feasible.

4. Evaluation

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	NA	0.006	2.91	NA	NA	4
A	In-Situ Replacement	3.00	0.003	0.584	11.01	(0.76)	1
B	Strategic Asset Replacement	2.56	0.003	0.975	7.03	(1.14)	2
C	IEC-61850 Deployment	8.30	0.010	4.27	(11.62)	(4.25)	3

The commercial evaluation is based on:

- a 10% discount rate
- a life of the investment of 15 years has been applied
- Capital expenditure 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	8.27	15.25

Option	Description	Economic NPV @13%	Economic NPV @6.75%
B	Strategic Asset Replacement	4.86	10.59
C	IEC-61850 Deployment	(10.05)	(13.86)

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	Run to Fail	N/A	N/A	N/A
A	Complete In-Situ Replacement	3,000	15 years	200
B	Strategic Asset Replacement	2,560	15 years	170
C	IEC-61850 Replacement	8,300	15 years	550

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	24	2,683	13	N/A	N/A	N/A
A	1	545	2	23	2,138	11
B	1	901	2	23	1,782	11
C	0	3,990	10	24	(1,307)	3

Table 5 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
A	349	200	Yes
B	313	170	Yes
C	0	550	No

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A and Option B presented above are reasonably practicable, and are therefore required to satisfy the organisation's SFAIRP/ALARP obligations.

The preferred option to address the condition of the secondary system assets in Liverpool 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 Net Present Value (NPV) while meeting the SFAIRP/ALARP requirements.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between all 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 the recommendation that Option A – be scoped in detail.

[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

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Liverpool Secondary ystems Renewal - Option A

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$0.76m	*NPV / Capital (Ratio)*	*-0.25*
NPV @ upper bound rate	13.00%	-$0.95m	*Pay Back Period (Yrs)*	*0.04 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.42m	*IRR%*	*4.22%*

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%	$11.01m	*NPV / Capital (Ratio)*	*3.67*
NPV @ upper bound rate	13.00%	$8.27m	*Pay Back Period (Yrs)*	*1.29 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$15.25m	*IRR%*	*61.16%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$2.68m*	*$0.55m*	*$2.14m*	*VCR Benefit*	*$2.08m*
Financial	*$0.16m*	*$0.03m*	*$0.13m*	*ENS Penalty*	*$0.02m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.22m*
People (safety)	*$0.02m*	*$0.00m*	*$0.02m*	Total Risk benefits	$2.32m
Environment	*$0.01m*	*$0.00m*	*$0.01m*	Benefits in the financial NPV*	$0.27m
Reputation	*$0.02m*	*$0.00m*	*$0.02m*	**excludes VCR benefits*	
Total Risk benefits	$2.91m	$0.58m	$2.32m		
Cost savings and other benefits			$0.03m	Benefits in the economic NPV**	$2.33m
Total Benefits			$2.35m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$3.00m	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

Option B NPV calculation

Project_Option Name	Liverpool Secondary ystems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$1.14m	*NPV / Capital (Ratio)*	*-0.45*
NPV @ upper bound rate	13.00%	-$1.21m	*Pay Back Period (Yrs)*	*0.00 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.96m	*IRR%*	*0.38%*

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%	$7.03m	*NPV / Capital (Ratio)*	*2.76*
NPV @ upper bound rate	13.00%	$4.86m	*Pay Back Period (Yrs)*	*1.33 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$10.59m	*IRR%*	*36.07%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$2.68m*	*$0.90m*	*$1.78m*	*VCR Benefit*	*$1.74m*
Financial	*$0.16m*	*$0.07m*	*$0.10m*	*ENS Penalty*	*$0.01m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.18m*
People (safety)	*$0.02m*	*$0.00m*	*$0.02m*	Total Risk benefits	$1.93m
Environment	*$0.01m*	*$0.00m*	*$0.01m*	Benefits in the financial NPV*	$0.19m
Reputation	*$0.02m*	*$0.00m*	*$0.02m*	**excludes VCR benefits*	
Total Risk benefits	$2.91m	$0.98m	$1.93m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$1.92m
Total Benefits			$1.93m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$2.55m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	-$0.22m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2025-26

Option C NPV calculation

Project_Option Name	Liverpool Secondary ystems Renewal - Option C

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$4.25m	*NPV / Capital (Ratio)*	*-0.51*
NPV @ upper bound rate	13.00%	-$4.27m	*Pay Back Period (Yrs)*	*-0.03 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$4.05m	*IRR%*	*-3.38%*

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%	-$11.62m	*NPV / Capital (Ratio)*	*-1.40*
NPV @ upper bound rate	13.00%	-$10.05m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$13.86m	*IRR%*	*Not measurable*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$2.68m*	*$3.99m*	*-$1.31m*	*VCR Benefit*	*-$1.30m*
Financial	*$0.16m*	*$0.25m*	*-$0.09m*	*ENS Penalty*	*-$0.01m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*-$0.05m*
People (safety)	*$0.02m*	*$0.00m*	*$0.02m*	Total Risk benefits	-$1.36m
Environment	*$0.01m*	*$0.01m*	*$0.00m*	Benefits in the financial NPV*	$0.52m
Reputation	*$0.02m*	*$0.02m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$2.91m	$4.27m	-$1.36m		
Cost savings and other benefits			$0.58m	Benefits in the economic NPV**	-$0.77m
Total Benefits			-$0.78m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	$0.00m
Capital - initial $m	-$8.30m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.55m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	2025-26