OPTIONS EVALUATION REPORT (OER)

Darlington Pt Secondary Systems Renewal

OER 000000001253 revision 3.0

Ellipse project no.: P0005329
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Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Replacement

Approvals

Author	Mark Jones	Secondary Systems and Communications Asset Manager
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	27 June 2016	Initial issue
1	28 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	17 November 2016	Update to format
3	24 November 2016	Added OSR reference

1. Need/opportunity

Darlington Point Substation is a customer connection point supplying Essential Energy's 132kV network in the Riverina agricultural irrigation area inclusive of Leeton which is the centre of the rice growing district in NSW. It also is the starting point for the 220kV network supplying far west NSW and interconnects to Victoria at Red Cliffs. A significant proportion of secondary systems assets connected to the 330kV and 220kV elements at Darlington Point Substation have been identified for replacement.

2. Related Needs/opportunities

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

- Need ID 602 – Replacement of RADSB Protection Relays
- Need ID 605 - Replacement of Quadramho (SHPM) Protection Relays
- Need ID 606 - Replacement of THR Protection Relays
- Need ID 621 – Replacement of DB Series Protection Relays
- Need ID 610 - Replacement of EDMI MKIII Meters

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 $2.40m 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 the 330kV and 220kV assets are non self-checking and provide no feedback as to the health of the asset, therefore increasing the likelihood of a hazardous event occurring.
- Darlington Point is the transition point from the interconnected network to the 220kV system that supplies Far Western NSW, including Broken Hill, and does not currently meet N -1 deterministic planning criteria. Therefore, the likelihood of a supply interruption hazardous event occurring is higher at Darlington Point compared with all other locations on the High Voltage (HV) Network that meet the N-1 planning criteria .

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

Option A — Strategic Asset Replacements [OFR 1253A, OFS 1253A]

Option A 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 $1.99m. This costing is estimated using TransGrid's "Success" estimating system. A further $2.84m 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[1].

The residual risk associated with this option upon completion of the project amounts to $1.77m per annum (base case risk cost = $2.40m). 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 B — Complete In-situ Replacement [OFR 1253B, OFS 1253B]

Option B is to replace all assets associated with the 330kV and 220kV HV plant at Darlington Point Substation with current designs and system 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 $4.12m. This costing is estimated using TransGrid's "Success" estimating system. A further $1.83m 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 based on current maintenance plan settings.

A benefit figure of $25k 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 $0.21m per annum (base case risk cost = $2.40m). The risk reduction is realised through the reduction in the probability of failure for all assets, the reduction in likelihood of a hazardous event due to the installation of self-checking relays and remediation of the risk posed by the 415V AC distribution.

Option C — IEC-61850 Replacement [OFR 1253C, OFS 1253C]

Option C is to carry out complete replacement of the secondary system at Darlington Point 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 $7.6m. 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 is a complete replacement option.

Operating costs have been estimated at $10k 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 $25k 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 $2.46m per annum (base case risk cost = $2.40m). 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 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	NA	0.006	2.40	NA	NA	4
A	Strategic Asset Replacements	1.99	0.006	1.77	0.98	(1.62)	2
B	Complete In-Situ Replacement	4.12	0.005	0.21	9.04	3.38	1
C	IEC-61850 Replacement	7.60	0.010	2.46	(5.91)	(1.45)	3

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 evaluated from the fixed asset register at $156k for Option B and C as Option A only addresses assets that at the end of their financial lives.
- Capital cost is not escalated and it does not include capitalised interest

Sensitivities on economic NPV for all three 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	Strategic Asset Replacement	0.39	2.02
B	Complete In-Situ Replacement	6.52	13.0
C	IEC-61850 Replacement	(5.60)	(6.22)

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	Strategic Asset Replacement	1,990	15 years	130
B	Complete In-Situ Replacement	4,120	15 years	270
C	IEC-61850 Deployment	7,600	15 years	510

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	17	1,224	7	N/A	N/A	N/A
A	16	662	4	1	562	2
B	2	137	4	15	1,087	3
C	10	2,030	30	7	(806)	(23)

Table 5 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
A	74	130	No
B	172	270	No

[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

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
C	0	510	No

No options are reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that no options are reasonably practicable in providing the greatest network safety risk reduction, and are therefore not required to satisfy the organisation's SFAIRP/ALARP obligations.

The preferred option to address the condition of the secondary systems is Option B – Complete In-Situ Replacement.

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) while exceeding the SFAIRP/ALARP requirements with the highest risk reduction.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the two options and Base Case. Deploying the Complete In-Situ Replacement option will provide additional 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 B - Complete In-Situ Replacement be scoped in detail.

Option A NPV calculation

Project_Option Name	Darlington Point Secondary Systems Renewal - Option A

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$1.62m	*NPV / Capital (Ratio)*	*-0.81*
NPV @ upper bound rate	13.00%	-$1.54m	*Pay Back Period (Yrs)*	*-0.03 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$1.65m	*IRR%*	*-3.21%*

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%	$0.98m	*NPV / Capital (Ratio)*	*0.49*
NPV @ upper bound rate	13.00%	$0.39m	*Pay Back Period (Yrs)*	*4.38 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$2.02m	*IRR%*	*16.14%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.55m*
Systems (reliability)	*$1.22m*	*$0.66m*	*$0.56m*	*ENS Penalty*	*$0.00m*
Financial	*$1.12m*	*$1.07m*	*$0.05m*	*All other risk benefits*	*$0.08m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$0.63m
People (safety)	*$0.02m*	*$0.02m*	*$0.00m*		
Environment	*$0.01m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.08m
Reputation	*$0.03m*	*$0.02m*	*$0.01m*	**excludes VCR benefits*	
Total Risk benefits	$2.40m	$1.77m	$0.63m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$0.63m
Total Benefits			$0.63m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	$0.00m
Capital - initial $m	-$1.99m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	-$2.84m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2023-24

Option B NPV calculation

Project_Option Name	Darlington Point Secodnary Systems Renewal - Option B

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	$3.38m	*NPV / Capital (Ratio)*	*0.82*
NPV @ upper bound rate	13.00%	$2.09m	*Pay Back Period (Yrs)*	*0.23 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$5.47m	*IRR%*	*22.97%*

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%	$9.04m	*NPV / Capital (Ratio)*	*2.19*
NPV @ upper bound rate	13.00%	$6.52m	*Pay Back Period (Yrs)*	*2.05 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$13.00m	*IRR%*	*40.50%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$1.02m*
Systems (reliability)	*$1.22m*	*$0.14m*	*$1.09m*	*ENS Penalty*	*$0.03m*
Financial	*$1.12m*	*$0.05m*	*$1.06m*	*All other risk benefits*	*$1.14m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$2.19m
People (safety)	*$0.02m*	*$0.00m*	*$0.02m*		
Environment	*$0.01m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$1.20m
Reputation	*$0.03m*	*$0.01m*	*$0.02m*	**excludes VCR benefits*	
Total Risk benefits	$2.40m	$0.21m	$2.19m		
Cost savings and other benefits			$0.02m	Benefits in the economic NPV**	$2.19m
Total Benefits			$2.22m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	-$0.16m
Capital - initial $m	-$4.12m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	-$1.29m
Capitalisation period	3.00 Yrs	Start of the re-investment period	2023-24

Option C NPV calculation

Project_Option Name	Darlington Point Secodnary Systems Renewal - Option C

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$1.45m	*NPV / Capital (Ratio)*	*-0.19*
NPV @ upper bound rate	13.00%	-$2.11m	*Pay Back Period (Yrs)*	*0.06 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.28m	*IRR%*	*6.16%*

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%	-$5.91m	*NPV / Capital (Ratio)*	*-0.78*
NPV @ upper bound rate	13.00%	-$5.60m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$6.22m	*IRR%*	*-9.62%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*-$0.79m*
Systems (reliability)	*$1.22m*	*$2.03m*	*-$0.81m*	*ENS Penalty*	*-$0.01m*
Financial	*$1.12m*	*$0.31m*	*$0.81m*	*All other risk benefits*	*$0.74m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	-$0.06m
People (safety)	*$0.02m*	*$0.01m*	*$0.01m*		
Environment	*$0.01m*	*$0.03m*	*-$0.02m*	Benefits in the financial NPV*	$1.15m
Reputation	*$0.03m*	*$0.08m*	*-$0.05m*	**excludes VCR benefits*	
Total Risk benefits	$2.40m	$2.46m	-$0.06m		
Cost savings and other benefits			$0.42m	Benefits in the economic NPV**	$0.37m
Total Benefits			$0.36m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	-$0.16m
Capital - initial $m	-$7.60m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.51m	Re-investment capital	-$1.29m
Capitalisation period	3.00 Yrs	Start of the re-investment period	2023-24