OPTIONS EVALUATION REPORT (OER)

Line 12-76 - Refurb

OER- N2476 revision 1.0

Ellipse project no(s):
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Replacement

Approvals

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Change history

Revision	Date	Amendment
0	14/09/2021	Initial Issues

Executive summary

Line 12/76 is a double circuit, steel pole 330kV transmission line between the suburb of Glenfield and the Sydney South Substation, with a route length of 10km. The transmission line is a key part of the supply infrastructure for the Sydney metropolitan region including the CBD. There are 37 structures on the transmission line, and it mainly traverses bushland area on the fringe of urban areas and near the Holsworthy Defence Force base.

Detailed analysis of asset condition information has identified that 36 of the 37 structures on line 12/76 have several condition issues on the line which require refurbishment to address asset health and maintain appropriate risk levels across the network.

The main drivers of the need to remediate these issues are:

- Manage network safety risk levels "As-Low-As Reasonably-Practicable" in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe'; and
- Provide economic benefit to consumers through reduction in safety and bushfire risks.

. The assessment of the options considered to address the need/opportunity appears in Table 1.

Table 1 - Evaluated options

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[1] ($m)	Weighted NPV (PV, $m)	Rank
Option A	Refurbish asset components that meet the primary condition criteria only	3.47	0.33	3.80	128.84	2
Option B	Refurbish all asset components that have been identified as having condition issues	5.19	0.48	5.67	506.24	1

The preferred option is Option B, as it has the highest weighted NPV result of the technically and commercially feasible options which were considered. It is therefore recommended that Option B be scoped in detail and progressed from DG1 to DG2.[2]

In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2025/2026.

[1] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

[2] DG stands for 'decision gate' that forms a part of TransGrids investment decision process.

1. Need/opportunity

The transmission line is a key part of the supply infrastructure for the Sydney metropolitan region including the CBD. There are 37 structures on the transmission line, and it mainly traverses bushland area on the fringe of urban areas and near the Holsworthy Defence Force base. These are located in the high bushfire consequence area.

Line 12/76 has widespread condition issues on various line components, all of which increase the risk of asset failure. This presents a bushfire and safety risk which TransGrid is obligated to manage.

Detailed analysis of asset condition information has identified that 36 of the 37 structures on line 12/76 have several condition issues on the line which require refurbishment to address asset health and maintain appropriate risk levels across the network.

The most significant element of concern is the corrosion of the steel poles at the connection to their concrete foundations. The connection cannot easily be remediated if its condition passes a stage where rectification work is no longer possible. Deterioration of the steel pole footing compromises structural integrity and could lead to subsequent failure of a structure.

Other issues on the line include, but are not limited to:

- Corrosion of steel pins ceramic insulators, which has been identified through line inspections. The pins on the underside of suspension insulator discs build up pollution and are not adequately washed by rain, which leads to an increased rate of corrosion.
- Condition of conductor and earthwire fittings.
- Deterioration on asset components relating public safety such as earthing and aerial markers.

There is a need to remediate these issues to:

- Manage network safety risk levels “As-Low-As Reasonably-Practicable” in accordance with the regulation obligations and TransGrid’s business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 ‘A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe’; and
- Provide economic benefit to consumers through reduction in safety and bushfire risks.

Consequently, the proposed project has an economic benefits need, and addressed this need will provide avoided cost savings from reduced in bushfire and safety risk, and maintenance costs that would otherwise occur without refurbishment.

2. Related needs/opportunities

- Need 000000001271: Line 12 (Single Circuit) Refurbishment)
- Need 000000001272: Line 13 (Single Circuit) Refurbishment)
- Need N2474: Line 13/78 Refurbishment
- Need N2477: Line 76/78 Refurbishment
- Need N2493: Line 76/77 Refurbishment

3. Options

The base case for this assessment is a ‘do nothing’ scenario, where the assets will remain in service until they fail and are subsequently replaced. In addition to the base case, two remediation options have been considered which are discussed in Section 3.2 which focus on a targeted or complete refurbishment of the line.

3.1 Base case

It is noted that a 'run to fail' scenario, where the issues are addressed through increased asset monitoring and preventative maintenance tasks, is not a valid base case for this Need. The condition issues on the asset have already been identified through maintenance inspections, and increasing the frequency of inspections to monitor the condition issues will not necessarily address them.

The base case will instead be defined as a 'do nothing' scenario, where the assets will remain in service until they fail and are subsequently replaced. The replacement cost has been captured in the NPV assessment under financial risk cost.

3.2 Options evaluated

Option A — Remediate asset components that meet the primary condition criteria only. [NOSA N2476, OFS N2476A]

Detail of scope can be found in Appendix B.

It is estimated that this option would cost $3.80 million ± 25% in $2020-21. This option is expected to be completed within the 2024 – 2028 regulatory period, and is expected to be completed within 24 months following DG1.

Option B — Remediate all asset components that have been identified as having condition issues. [NOSA N2476, OFS N2476B]

Detail of scope can be found in Appendix B.

It is estimated that this option would cost $5.67 million ± 25% in $2020-21.This option is expected to be completed within the 2024 – 2028 regulatory period, and is expected to be completed within 25 months following DG1.

Option B will provide efficiency in delivery by addressing all identified condition issues for line components in a single mobilisation whilst reducing bushfire risks on the line.

3.3 Options considered and not progressed

The following options were considered but not progressed:

Table 2 Options considered but not progressed

Option	Reason for not progressing
Increased inspections	The condition issues have already been identified and cannot be rectified through increased inspections, and therefore is not technically feasible.
Elimination of all associated risk	This can only be achieved through retirement and decommissioning of the associated assets which is not technically feasible as the line is a key part of the supply infrastructure for Sydney Metropolitan region including the CBD.
New transmission line	Due to significant costs of this option, a new double circuit 330 kV transmission line is not considered commercially feasible.
Non-network solutions	TransGrid does not consider non-network options to be commercially and technically feasible to assist with meeting the identified need, as non-network options will not mitigate the environment (bushfire) and safety posed as a result of corrosion-related asset deterioration.

4. Evaluation

4.1 Commercial evaluation methodology

The economic assessment undertaken for this project includes three scenarios that reflect a central set of assumptions based on current information that is most likely to eventuate (central scenario), a set of assumptions that give rise to a lower bound for net benefits (lower bound scenario), and a set of assumptions that give rise to an upper bound on benefits (higher bound scenario).

Assumptions for each scenario are set out in the table below.

Table 3 Scenario Inputs

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Capital cost	100%	125%	75%
Risk cost benefits	100%	75%	125%
Scenario weighting	**50%**	**25%**	**25%**

Parameters used in this commercial evaluation:

Table 4 Parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2020/2021
Base year	The year that dollar value outputs are expressed in real terms	2020/2021 dollars
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 years
Expected asset life	Period of depreciation of the asset	35 years
ALARP disproportionality	Multiplier of the environmental and safety related risk cost included in NPV analysis to demonstrate implementation of obligation to reduce to ALARP.	Refer to section 4.3 for details.

The capex figures in this OER do not include any real cost escalation.

4.2 Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 5. Details appear in Appendix A.

Table 5 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	3.15	114.22	53.45	233.47	128.84	2
Option B	4.69	447.80	211.21	918.15	506.24	1

Based on the commercial analysis Option B is the preferred option as it yielded the highest weighted NPV and is technically and commercially feasible. The main driver of the benefit in the NPV is bushfire risk benefit.

4.3 ALARP evaluation

TransGrid manages and mitigates bushfire and safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.' TransGrid maintains an Electricity Network Safety Management System (ENSMS) to meet this obligation.[3]

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor[4], the weighted benefits are expected to exceed the cost. TransGrid's analysis concludes that the costs are less than the weighted benefits from mitigating bushfire and safety risks. The proposed investment will enable TransGrid to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP.

Evaluation of the above options has been completed in accordance with As Low As Reasonably Practicable (ALARP) obligations. The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction.

Results of the ALARP evaluation are set out in Table 6.

Table 6 - Reasonably practicable test ($ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable?[5]
A	4.79	0.23	Y
B	16.29	0.34	Y

The result of the ALARP evaluation is that both options meet the ALARP threshold.

4.4 Preferred option

[3] TransGrid's ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach

[4] In accordance with the framework for applying the ALARP principle, a disproportionality factor of 6 has been applied to risk cost figures. The values of the disproportionality factors were determined through a review of practises and legal interpretations across multiple industries, with particular reference to the works of the UK Health and Safety Executive. The methodology used to determine the disproportionality factors in this document is in line with the principles and examples presented in the AER Replacement Planning Guidelines and is consistent with TransGrid's Revised Revenue Proposal 2023/24- 2027/28.

[5] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction.

The preferred option is Option B, as it has the highest weighted NPV result of all the technically and commercially feasible options considered as part of this need. Option B also meets the ALARP threshold. The optimal delivery date for this option is 2025/2026 based on an optimal timing analysis (see Section 5).

Capital and Operating Expenditure

The required capex expenditure is $5.67 million

Regulatory Investment Test

A regulatory investment test for transmission (RIT-T) is not required as the estimated capital cost for the preferred option is below the threshold of $6 million.

5. Optimal Timing

In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2025/2026.

The test for optimal timing of the preferred option has been undertaken. The approach taken is to identify the optimal commissioning year for the preferred option where net benefits (including avoided costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The commencement year is determined based on the required project disbursement to the meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

- Optimal commissioning year: 2025/2026
- Commissioning year annual benefit: $16.32 million
- Annualised cost: $0.34 million

Based on the optimal timing, the project is expected to commence in the 2024-2028 Regulatory Period.

6. Recommendation

The preferred option is Option B, as it has the highest weighted NPV result of the technically and commercially feasible options which were considered.

It is therefore recommended that this option be scoped in detail, so that it can be progressed from DG1 to DG2. Total project cost is $5.67 million including an amount of $0.5 million to progress the project from DG1 to DG2.

Appendix A – Option Summaries [6]

Project Description	Line 12/76 Refurbishment		
Option Description	Option A - Refurbish components that meet primary condition criteria only		
Project Summary			
Option Rank	*2*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	114.22	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.23
NPV @ Lower Bound Scenario (PV, $m)	53.45	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 4.79
NPV @ Higher Bound Scenario (PV, $m)	233.47	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	128.84	Optimal Timing	Optimal timing (Business Case) 2026
Cost (Central Scenario)			
Total Capex ($m)	3.80	Cost Capex (PV,$m)	3.01
Terminal Value ($m)	1.09	Terminal Value (PV,$m)	0.28
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.24	Reliability Risk (Post) 0.19	Pre – Post 0.05
Financial (PV,$m)	Financial Risk (Pre) 0.57	Financial Risk (Post) 0.44	Pre – Post 0.13
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 0.06	Safety Risk (Post) 0.02	Pre – Post 0.04
Environmental (PV,$m)	Environmental Risk (Pre) 525.25	Environmental Risk (Post) 408.55	Pre – Post 116.70
Reputational ($m)	Reputational Risk (Pre) 0.23	Reputational Risk (Post) 0.18	Pre – Post 0.05
Total Risk (PV,$m)	Total Risk (Pre) 526.34	Total Risk (Post) 409.39	Pre – Post 116.95
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit 116.95

Commissioning year annual benefit ($k): **4800.54**

[6] Figures may not add due to rounding

Project Description	Line 12/76 Refurbishment		
Option Description	Option B - Refurbish all asset components identified as having condition issues		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	447.80	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.34
NPV @ Lower Bound Scenario (PV, $m)	211.21	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 16.29
NPV @ Higher Bound Scenario (PV, $m)	918.15	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	506.24	Optimal Timing	Optimal timing (Business Case) 2026
Cost (Central Scenario)			
Total Capex ($m)	5.66	Cost Capex (PV,$m)	4.69
Terminal Value ($m)	1.62	Terminal Value (PV,$m)	0.42
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.24	Reliability Risk (Post) 0.05	Pre – Post 0.19
Financial (PV,$m)	Financial Risk (Pre) 0.57	Financial Risk (Post) 0.08	Pre – Post 0.49
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 0.06	Safety Risk (Post) 0.01	Pre – Post 0.05
Environmental (PV,$m)	Environmental Risk (Pre) 525.25	Environmental Risk (Post) 74.11	Pre – Post 451.14
Reputational ($m)	Reputational Risk (Pre) 0.23	Reputational Risk (Post) 0.03	Pre – Post 0.20
Total Risk (PV,$m)	Total Risk (Pre) 526.34	Total Risk (Post) 74.27	Pre – Post 452.07
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit 452.07

Commissioning year annual benefit ($k): **16318.14**

Appendix B Asset Condition

Asset Component Category	Cause	Effect	Consequence	No. of Structures with condition issues	
				Option A	Option B
Conductor Fittings	Corrosion of fittings.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1	26
Conductor Spacers	Corrosion of spacers. Deteriorated spacer may fail and fall to ground. Ineffective conductor spacing may lead to conductor clashing.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	0	2
Corona Rings	Corrosion of corona rings. Deteriorated spacer may fail and fall to ground. Ineffective corona protection may lead to accelerated corrosion of insulators and fittings.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	0	1
Earthwire Fittings	Corrosion of fittings and/or hot joints.	Fallen earthwire	Safety incident resulting in potential injury or death	1	10
Foundations	Corrosion of pole connection to concrete base.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	30	30
Insulator	Porcelain insulators have reached end of serviceable life. Early stage corrosion detected on insulator pins.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	6	20
Public Safety – Aerial Marker Balls	Faded.	Aircraft collision with conductor	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	21	21

Steel Pole	Corrosion of steel pole, no galvanisation remaining.	Fallen structure	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	0	3
Steel Pole Crossarm	Corrosion of collars on pole crossarms.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	4	4
Structure Earthing	Earth straps exposed and/or rusty.	Possible transfer potential, earth current and voltage gradient issues	Safety incident involving electric shock resulting in potential injury or death	27	27