OPTIONS EVALUATION REPORT (OER)

Line 29-26 - Refurb

OER- N2525 revision 1.0

Ellipse project no(s):
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Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Replacement

Approvals

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Change history

Revision	Date	Amendment
0	13/10/2021	Initial Issues
1	15/11/2021	Minor Formatting

Executive summary

Line 29/26 is a double circuit steel tower 330kV transmission line between Vineyard and Sydney West Substations, with a route length of 21km. The transmission line is a key link between generation on the Central Coast and the Sydney metropolitan area. There are 85 structures on the transmission line, which traverses through urban areas in western and north-western Sydney. There are several major road and rail crossings as well as numerous local road crossings along its route.

Detailed analysis of asset condition information has identified that 64 of the 85 structures on line 29/26 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	3.75	0.35	4.10	2.62	1
Option B	Refurbish all asset components that have been identified as having condition issues	4.16	0.38	4.54	2.49	2

Whilst Option A provides slightly higher Weighted NPV of the technically and commercially feasible options which were considered, the preferred option is option B. 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.

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 2024/2025.

[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

Line 29/26, between Vineyard and Sydney West Substations, forms a key link between generation on the Central Coast and the Sydney metropolitan area. There are 85 structures on the transmission line, which traverses through urban areas in western and north-western Sydney. The line has widespread condition issues on various line components, all of which increase the probability of asset failure.

Detailed analysis of asset condition information has identified that 64 of the 85 structures on line 29/26 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 the condition of the steel towers. Corrosion has been identified in tower base members and at the tower footings. One structure also has its footings submerged in water, which create conditions that will accelerate corrosion of the steel. As these are critical load bearing members of the tower, the towers cannot be easily remediated if the member condition passes a stage where rectification work is no longer possible.

Another issue is that the insulators have reached the end of their expected lives. A number of installed insulators are of the pre-1965 vintage, which has experienced deterioration of insulation performance Failure of an insulator may result in a fallen conductor which can present bushfire and safety risk.

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

- Condition deterioration of conductor fittings due to corrosion – failure of the fitting attachment can result in a fallen conductor
- Ineffective earthwire vibration dampers – can accelerate conductor fatigue
- Deterioration on asset components relating to public safety such as earthing, anti-climbers and signage

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.’
- Provide an economic benefit to consumers through reductions in safety and bushfire risks. The direct impact of asset failure can result in a conductor drop event with potential fire ignition and/or safety hazard consequences to the general public, as evaluated in the associated modelling.

If the condition issues on the line are not addressed in sufficient time, then the asset will operate with increasing risk of failure as it continues to deteriorate. The level of reactive corrective maintenance needed to keep the line operating within required standards may also increase, particularly when asset failures ultimately occur.

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.

Appendix B provides a summary of the number of structures with condition issues within each asset component category. The figures for each (Option A and Option B) are based on the Transmission Line Refurbishment Criteria document.

2. Related needs/opportunities

- Need 000000001350: Line 25/26 and 26 (Single Circuit Section) Refurbishment

3. Options

The base case for this assessment is a 'do nothing' scenario, where the assets are left in service until they fail and require replacement. In addition to the base case, two remediation options have been considered. The first, Option A involves a targeted program to address components which have experienced the greatest deterioration. The second, Option B, involves addressing all identified condition issues on 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 inspections will not rectify them.

The base case will instead be defined as a 'do nothing' scenario, where the assets are left in service until they fail and require replacement.

The replacement cost has been captured in the NPV assessment under financial risk cost.

3.2 Options evaluated

Option A — Remediate identified condition issues for line components that have experienced greater deterioration and/or reached the end of their functional lives [NOSA N2525, OFS N2525A]

Detail of scope can be found in Appendix B.

It is estimated that this option would cost $4.10 million ± 25% ($2020-21). This option is expected to be completed within 24 months following DG1.

Option B — Remediate all identified condition issues for line components [NOSA N2525, OFS N2525B].

Detail of scope can be found in Appendix B.

It is estimated that this option would cost $4.54 million ± 25% ($2020-21). This option is expected to be completed within 24 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.
Elimination of all associated risk	This can only be achieved through retirement and decommissioning of the associated assets which is not feasible.
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

Option	Reason for not progressing
	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 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 used in the NPV evaluation

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 0 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	3.40	2.06	-1.00	7.36	2.62	1
Option B	3.77	1.90	-1.31	7.45	2.49	2

Whilst Option A provides slightly higher Weighted NPV of the technically and commercially feasible options which were considered, the preferred option is option B. 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. 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 factor4, 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	**0.29**	**0.24**	**Y**
B	**0.29**	**0.27**	**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] 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

Whilst Option A provides slightly higher Weighted NPV of the technically and commercially feasible options which were considered, the preferred option is option B. 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.

Option B also meets the ALARP threshold. The optimal delivery date for this option is 2024/2025 based on an optimal timing analysis (see Section 5).

Capital and Operating Expenditure

The required capex expenditure is $4.10 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 2024/2025.

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 risk costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The optimal timing assessment considers the delivery requirements of the project and the estimated delivery timeline of 24 months in the OFS.

The commencement year is determined based on the required project disbursement to meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

- Optimal commissioning year: 2024/2025
- Commissioning year annual benefit: $0.35 million
- Annualised cost: $0.24 million

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

6. Recommendation

Whilst Option A provides slightly higher Weighted NPV of the technically and commercially feasible options which were considered, the preferred option is option B. 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.

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 $4.54 million including an amount of $0.5 million to progress the project from DG1 to DG2.

Appendix A – Option Summaries [6]

Project Description	Line 29-26 Refurbishment		
Option Description	Option A - Refurbish components that meet primary condition criteria only		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	2.06	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.24
NPV @ Lower Bound Scenario (PV, $m)	-1.00	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.29
NPV @ Higher Bound Scenario (PV, $m)	7.36	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	2.62	Optimal Timing	Optimal timing (Business Case) 2025
Cost (Central Scenario)			
Total Capex ($m)	4.10	Cost Capex (PV,$m)	3.40
Terminal Value ($m)	1.06	Terminal Value (PV,$m)	0.27
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.53	Reliability Risk (Post) 0.16	Pre – Post 0.37
Financial (PV,$m)	Financial Risk (Pre) 0.69	Financial Risk (Post) 0.18	Pre – Post 0.51
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 2.93	Safety Risk (Post) 0.73	Pre – Post 2.20
Environmental (PV,$m)	Environmental Risk (Pre) 2.81	Environmental Risk (Post) 0.74	Pre – Post 2.07
Reputational ($m)	Reputational Risk (Pre) 0.07	Reputational Risk (Post) 0.02	Pre – Post 0.05
Total Risk (PV,$m)	Total Risk (Pre) 7.02	Total Risk (Post) 1.83	Pre – Post 5.19
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 5.19

Commissioning year annual benefit ($k): 342.91

[6] Figures may not add due to rounding

Project Description	Line 29-26 Refurbishment		
Option Description	Option B - Refurbish all asset components identified as having condition issues		
Project Summary			
Option Rank	*2*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	1.90	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.27
NPV @ Lower Bound Scenario (PV, $m)	-1.31	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.29
NPV @ Higher Bound Scenario (PV, $m)	7.45	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	2.49	Optimal Timing	Optimal timing (Business Case) 2025
Cost (Central Scenario)			
Total Capex ($m)	4.54	Cost Capex (PV,$m)	3.77
Terminal Value ($m)	1.17	Terminal Value (PV,$m)	0.30
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.53	Reliability Risk (Post) 0.11	Pre – Post 0.42
Financial (PV,$m)	Financial Risk (Pre) 0.69	Financial Risk (Post) 0.16	Pre – Post 0.53
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 2.93	Safety Risk (Post) 0.73	Pre – Post 2.20
Environmental (PV,$m)	Environmental Risk (Pre) 2.81	Environmental Risk (Post) 0.64	Pre – Post 2.17
Reputational ($m)	Reputational Risk (Pre) 0.07	Reputational Risk (Post) 0.02	Pre – Post 0.05
Total Risk (PV,$m)	Total Risk (Pre) 7.02	Total Risk (Post) 1.66	Pre – Post 5.37
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 5.37

Commissioning year annual benefit ($k): 351.28

Appendix B – Structure with Condition Issues by Asset Category

Asset Component Category	Cause	Effect	Consequence	No. of Structures	
				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	2	2
Earthwire Bonding	Damaged connection.	Possible transfer potential, earth current and voltage gradient issues	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1	1
Earthwire Dampers	Old spiral dampers requiring removal. Ineffective vibration damping can lead to accelerated conductor fatigue.	Damaged earthwire	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	4	4
Earthwire Fittings	Loose fitting connections.	Fallen earthwire	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	2	2
Foundations	Footings covered in soil and showing signs of corrosion. Failure of critical members can compromise structural integrity.	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	4	4
Groundline steel	Footing steelwork submerged in water, and susceptible to corrosion. Failure of critical members can compromise structural integrity.	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	0	1
Insulator	Porcelain insulators have reached end of serviceable life. Broken insulator discs.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential	15	18

Asset Component Category	Cause	Effect	Consequence	No. of Structures	
				Option A	Option B
			network reliability impacts		
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	4	4
Public Safety – Climbing Deterrent	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	22	22
Public Safety – Danger Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	44	44
Public Safety – Structure ID Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	14	14
Structure Earthing	Poor connection.	Possible transfer potential, earth current and voltage gradient issues	Safety incident resulting in potential injury or death	3	3
Tower Base	Corrosion of members	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	2	2
Tower Fasteners	Corrosion of nuts and bolts	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	2	2