OPTIONS EVALUATION REPORT (OER)

Line 8L-8M - Refurb

OER- N2498 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	27/10/2021	Initial Issue
1	12/11/2021	Minor Update

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Executive summary

Line 8L/8M is a double circuit, steel tower 330kV transmission line with a route length of 48.7km, and connects Texas and Dumaresq Substations. The transmission line is a key link in the east coast network and is on the QNI transmission path which links the NSW and QLD regions of the National Electricity Market.

The line was constructed in 2000 as part of the interconnector between New South Wales and Queensland transmission networks, and consists of 122 structures. It mainly traverses rural agricultural land, bushland areas, and crosses the Bruxner Highway just south of Texas Substation.

The line was amongst the first constructed utilising Non-Ceramic Insulators (NCI) within the TransGrid network and these are now approaching the end of their service life. The sample test results have shown a large reduction in hydrophobicity (ie ability of the insulator to resist the ingress of moisture), reduction in rod to housing adhesion and corona activity at the end fitting to housing interface, due to degradation and older design of this interface, after 21 years in service.

Majority of the line has Non Ceramic Insulators (NCIs) installed, and a health assessment predicts that these will reach end of life at around 2025. This is consistent with current industry practise to restrict service life of NCIs at Extra High Voltage to 25 years due to corona ageing effects on the silicone housing.

Recent inspection data and existing asset condition records have identified that 117 of the 121 structures on Line 8L/8M have condition issues which require rectification. These have been set out based on the criteria set out in the Transmission Line Refurbishment Criteria document.

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

> Provide an economic benefit to consumers through reductions in reliability, safety and bushfire risks. The direct impact of asset failure can reduce the power follow capacity of the interconnector resulting in a substantial increase in the wholesale market price of New South Wales and/or Queensland.

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 all asset components that have been identified as having condition issues	6.00	0.52	6.52	14.24	1

The preferred option is Option A, as it has a positive weighted NPV result, is optimally timed and is considered to be technically and commercially feasible. Other options considered (as per Table 2) were not progressed as they were deemed to be technically and commercially unfeasible. It is therefore recommended that Option A 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.

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1. Need/opportunity

Line 8L/8M is a double circuit, steel tower 330kV transmission line with a route length of 48.7km, and connects Texas and Dumaresq Substations. The transmission line is a key link in the east coast network and is on the QNI transmission path which links the NSW and QLD regions of the National Electricity Market.

The line was amongst the first constructed utilising Non-Ceramic Insulators (NCI) within the TransGrid network and these are now approaching the end of their service life. The sample test results have shown a large reduction in hydrophobicity (ie ability of the insulator to resist the ingress of moisture), reduction in rod to housing adhesion and corona activity at the end fitting to housing interface, due to degradation and older design of this interface, after 21 years in service.

Majority of the line has Non Ceramic Insulators (NCIs) installed, and a health assessment predicts that these will reach end of life at around 2025. This is consistent with current industry practise to restrict service life of NCIs at Extra High Voltage to 25 years due to corona ageing effects on the silicone housing.

Recent inspection data and existing asset condition records have identified that 117 of the 121 structures on Line 8L/8M have condition issues which require rectification. These have been set out based on the criteria set out in the Transmission Line Refurbishment Criteria document.

Other issues on the line include:

- Deterioration on asset components relating to public safety such as climbing deterrents and signage;
- Deterioration of tower foundations – failure of which can compromise structural integrity;
- Broken strands on earthwire bonding – failure of bond can result in uncontrolled discharge or contact with electricity.

The main driver of the need to remediate these issues is:

- Provide an economic benefit to consumers through reductions in reliability, safety and bushfire risks. The direct impact of asset failure can reduce the power follow capacity of the interconnector resulting in a substantial increase in the wholesale market price of New South Wales and/or Queensland.

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 are based on the Transmission Line Refurbishment Criteria document.

2. Related needs/opportunities

- Need N2496: Line 8C/8J Refurbishment
- Need N2497: Line 8C/8E 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, a refurbishment option has been considered. This option A involves refurbishing all asset components that have been identified as having condition issues on the line.

3.1 Base case

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 deteriorating conditions is not a viable option.

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 cost of replacing failed assets has been included as part of risk cost on the asset under this option.

3.2 Options evaluated

Option A — Refurbish all asset components that have been identified as having condition issues [NOSA N2498, OFS N2498A]

Detail of scope can be found in Appendix B.

It is estimated that this option would cost $6.52 million ± 25% ($2020-21). This option is expected to be completed within 29 months following DG1.

3.3 Options considered and not progressed

The following options were considered but not progressed:

Table 2 Options considered and not progressed

Option	Reason for not progressing
Increased inspections and maintenance	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 may lead to reliability issue. Therefore, it is considered not technically 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 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 parameters

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

Parameters used in this commercial evaluation:

Table 4 Key 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 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	6.52	12.22	2.92	29.61	14.24	1

Based on the commercial analysis, Option A is the preferred option as it yields the highest weighted NPV and is technically and commercially feasible. The main driver of the benefit in the NPV is market 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 + 3 or 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	0.02	0.39	N

The result of the ALARP evaluation is that the option does not meet the ALARP threshold.

4.4 Preferred option

The preferred option is Option A, as it has a positive weighted NPV result and is technically and commercially feasible. Option A does not meet the ALARP criteria. 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 $6.52 million.

Regulatory Investment Test

A regulatory investment test for transmission (RIT-T) will be required, as the estimated capital cost for the preferred option is above the threshold of $6 million.

5. Optimal Timing

In consideration of the delivery requirements and the 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:

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[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.

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- Optimal commissioning year: 2025/2026
- Commissioning year annual benefit: $0.89 million
- Annualised cost: $0.39 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 A, as it has the highest weighted NPV result and is technically and commercially feasible option considered as part of this need. 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 $6.52 million including an amount of $0.5 million to progress the project from DG1 to DG2.

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Appendix A – Option Summaries[6]

Project Description	8L-8M		
Option Description	Option A - Refurbish asset components that meet the 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, $m)	12.22	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.39
NPV @ Lower Bound Scenario (PV, $m)	2.92	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.02
NPV @ Higher Bound Scenario (PV, $m)	29.61	ALARP	ALARP Compliant? No
NPV Weighted (PV, $m)	14.24	Optimal Timing	Optimal timing (Business Case) 2026
Cost (Central Scenario)			
Total Capex ($m)	6.52	Cost Capex (PV,$m)	5.21
Terminal Value ($m)	1.68	Terminal Value (PV,$m)	0.41
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,$m)	Financial Risk (Pre) 20.92	Financial Risk (Post) 5.29	Pre – Post 15.63
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 0.00	Safety Risk (Post) 0.00	Pre – Post 0.00
Environmental (PV,$m)	Environmental Risk (Pre) 0.40	Environmental Risk (Post) 0.10	Pre – Post 0.30
Reputational ($m)	Reputational Risk (Pre) 1.45	Reputational Risk (Post) 0.37	Pre – Post 1.08
Total Risk (PV,$m)	Total Risk (Pre) 22.77	Total Risk (Post) 5.75	Pre – Post 17.01
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 17.01

Commissioning year annual benefit ($k): 898.3

[6] Figures may not add due to rounding

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Appendix B Structure with Condition Issues by Asset Category

Asset Component Category	Cause	Effect	Consequence	No. of Structures with condition issues
Earthwire Bonding	Minor repair required, earth bond has broken strands.	Uncontrolled discharge or contact with electricity	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	8
Foundations	Structure legs covered with soil. 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	1
Insulator	Non-ceramic insulators (NCI) have reached end of serviceable life.	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	117
Public Safety – Aerial Marker Balls	Deteriorated.	Uncontrolled discharge or contact with electricity	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	5
Public Safety – Climbing Deterrents	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	14
Public Safety – Danger Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	112
Public Safety - Structure Earthing	Erosion of ground has exposed earth strap.	Uncontrolled discharge or contact with electricity	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death	1

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