

OPTIONS EVALUATION REPORT (OER)



Line 8C-8E - Refurb

OER- N2497 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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Date submitted for approval	12 November 2021	

Change history

Revision	Date	Amendment
0	13/10/2021	Original Issue
1	12/11/2021	Minor Update

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Executive summary

Line 8C/8E is a double circuit, steel tower 330kV transmission line with a route length of 113.5km, and connects Sapphire and Armidale 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 to as part of the interconnector between New South Wales and Queensland transmission networks, and consists of 284 structures. It mainly traverses rural agricultural land, bushland areas, and crosses the Gwydir Highway south of Sapphire Substation and the New England Highway and Waterfall Way north of Armidale 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 280 of the 284 structures on Line 8C/8E 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 assessment of the options considered to address the need/opportunity appears in Table 1.

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.

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	Remediate all identified condition issues for line components which have experienced deterioration and/or reached the end of their functional lives	17.17	1.59	18.76	334.39	1

The preferred option is Option A as it has positive weighted NPV result of the technically and commercially feasible option. Options considered and not progressed are stated in section 3.3.

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.

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 2026/2027.

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

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1. Need/opportunity

Line 8C/8E is a double circuit, steel tower 330kV transmission line with a route length of 113.5km, and connects Sapphire and Armidale 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 to as part of the interconnector between New South Wales and Queensland transmission networks, and consists of 284 structures. It mainly traverses rural agricultural land, bushland areas, and crosses the Gwydir Highway south of Sapphire Substation and the New England Highway and Waterfall Way north of Armidale 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 (i.e. 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.

The majority of the line has NCI insulators 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.

The most recent inspection data and detailed asset condition analysis have identified that 280 of the 284 structures on Line 8C/8E have condition issues which require rectification to address its health and maintain appropriate risk levels across the network.

Other issues on the line include:

- > Deterioration of public safety – Danger signs, which could lead to unauthorised access to the structures.
- > Deterioration on tower components relating to public safety such as marker balls, climbing deterrents and signage.
- > Broken strands on earthwire bonding – failure of bond can result in uncontrolled discharge or contact with electricity.

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.

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 N2425: Transmission Line Public Safety Compliance
- > Need N2496: Line 8C/8J Refurbishment
- > Need N2498: Line 8L/8M Refurbishment

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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, one refurbishment option has been considered.

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 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 all identified condition issues for line components which have experienced deterioration and/or reached the end of their functional lives. [\[NOSA-N2497, OFSN2497A\]](#)

Detail of scope can be found in Appendix B.

It is estimated that this option would cost \$18.76 million \pm 25% in \$2020-21.

This project is expected to be completed within the 2024 – 2028 regulatory period and within 43 months of DG1.

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 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

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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 Scenarios

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

Parameters used in this commercial evaluation are set out in the table below:

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 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	14.35	295.15	133.88	613.37	334.39	1

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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	14.10	1.12	Y

Option A meets the ALARP threshold.

4.4 Preferred option

Option A is the preferred option for the remediation of Line 8C-8E as it has positive weighted NPV result. Option A also meets the ALARP threshold. The optimal delivery date for this option is 2026/2027 based on the optimal timing analysis (see Section 5).

Capital and Operating Expenditure

The required capex expenditure is \$18.76 million.

Regulatory Investment Test

A regulatory investment test for transmission (RIT-T) is 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 economic benefit NPV analysis for the need, its optimal timing is 2026/2027.

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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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 43 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: 2026/2027
- > Commissioning year annual benefit: \$15.6 million
- > Annualised cost: \$1.12 million

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

6. Recommendation

The preferred option is Option A, as it has the highest weighted NPV result of all the technically and commercially feasible options 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 \$18.76 million including an amount of \$0.5 million to progress the project from DG1 to DG2.

Appendix A – Option Summaries⁶

Project Description		Line 8C-8E Refurbishment	
Option Description		Option A - Refurbish all asset components that have been identified as having condition issues	
Project Summary			
Option Rank	1	Investment Assessment Period	25
Asset Life	35	NPV Year	2020/2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, \$m)	295.15	Annualised CAPEX @ Central Benefit Scenario (\$m)	Annualised Capex - Standard (Business Case) 1.12
NPV @ Lower Bound Scenario (PV, \$m)	133.88	Network Safety Risk Reduction (\$m)	Network Safety Risk Reduction 14.10
NPV @ Higher Bound Scenario (PV, \$m)	613.37	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, \$m)	334.39	Optimal Timing	Optimal timing (Business Case) 2026/2027
Cost (Central Scenario)			
Total Capex (\$m)	18.76	Cost Capex (PV,\$m)	14.35
Terminal Value (\$m)	4.82	Terminal Value (PV,\$m)	1.13
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) 38.42	Financial Risk (Post) 10.35	Pre – Post 28.07
Operational/Compliance (PV,\$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,\$m)	Safety Risk (Pre) 0.03	Safety Risk (Post) 0.01	Pre – Post 0.02
Environmental (PV,\$m)	Environmental Risk (Pre) 381.00	Environmental Risk (Post) 102.66	Pre – Post 278.34
Reputational (\$m)	Reputational Risk (Pre) 2.66	Reputational Risk (Post) 0.72	Pre – Post 1.94
Total Risk (PV,\$m)	Total Risk (Pre) 422.10	Total Risk (Post) 113.74	Pre – Post 308.36
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 308.36

Commissioning year annual benefit (\$k):

15624.2

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
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	6
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	5
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	280
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	26
Public Safety – Climbing Deterrents	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	91
Public Safety – Danger Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	254
Public Safety – Structure ID Signs	Deteriorated.	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1

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