OPTIONS EVALUATION REPORT (OER)

Line 992 - Refurb

OER- N2604 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	13/10/2021	Initial Issue
1	15/11/2021	Minor Formatting

Executive summary

Line 992 is a 132kV transmission line between Burrinjuck and Tumut. It was originally commissioned in 1963 as the link between Wagga and Burrinjuck. The line was cut into Tumut 132kV Substation in 1973 (~850m deviation) and Gadara Substation in circa 2000 (~1000m deviation). The line has a route length of 52.7km and a total of 195 structures, 163 of which are wood pole structures.

Detailed analysis of the asset condition information indicates that the line has several condition issues which require refurbishment to address its health and maintain appropriate risk levels across the network. These issues primarily concern the wood pole structures on the line. Also it is noted that other line components are also approaching an end of life condition.

The scope of work involves replacement of all wood pole structures with concrete or steel poles. The total number of structures expected to be replaced is 163.

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

> Provide economic benefit to the consumers through safety and bushfire risks reductions. 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.

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] ($m)	Weighted NPV ($m)	Rank
Option A	Replace the deteriorated wood pole structures with concrete or steel poles, including all associated attachments e.g. insulators and fittings.	5.52	0.54	6.06	19.92	2
Option B	Replace all wood pole structures with concrete or steel poles, including all associated attachments e.g. insulators and fittings.	22.34	1.60	23.94	21.92	1

[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.

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[1] ($m)	Weighted NPV ($m)	Rank
Option C	Replace the all wood pole structures with concrete or steel poles, including all associated attachments. The existing Panther conductor is to be replaced with Lemon ACSR/GZ, the modern equivalent.	30.18	2.18	32.36	18.02	3

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 2029/2030.

Whilst Option B provides the highest weighted NPV results, optimal timing for option A is in 2026/2027. Hence, it is recommended that the delivery of option B to be phased into two Regulatory Period. 55 structures (targeted wood pole replacement under option A - $6.06 million) to be replaced in 2024-2028 Regulatory Period and the remaining 198 structures ($17.9 million) to be replaced in 2029-2033 Regulatory Period.

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

1. Need/opportunity

Line 992, between Burrinjuck and Tumut, is a single circuit section with a route length of 52.7 km and a total of 195 structures, 163 of which are wood pole structures. The line has widespread condition issues on various line components, all of which increase the probability of asset failure. These issues present a bushfire and safety risk which TransGrid is obligated to manage.

Wood Pole Structures

The most significant element of concern is the condition of the wood pole structures on the line. Line 992 was first placed into service in 1963, and the wood poles are approaching 60 years of age and toward the end of their nominal lives. The defect rate on the line has increased from 2015 onwards, which is in line with the expected condition of the asset based on its original design parameters.

Available recent inspection data and existing asset condition records have identified that 31 structures, or 16% of the line are currently having deteriorating condition issues. A further 6 structures will have decayed to the point of requiring replacement by 2028, based on the average defect rates of structures assessed to require additional monitoring due to their condition (also known as “conditionally serviceable”) over the past 10 years on this line.

Other Line Condition Issues

Given the age of the asset, it is also noted that other line components are in a deteriorating condition that is reflective of them approaching the end of their serviceable lives. These other condition issues impact 153 of the 195 structures on Line 992, and cover multiple line components, including:

- A large number of structures (153) on the line still have the original insulators installed that are of pre-1965 vintage. These insulators have reached the end of their serviceable lives. Recent laboratory testing undertaken on a sample of pre-1965 porcelain insulators indicated a deterioration in insulation resistance performance. Further, the porcelain mixture in these insulators is no longer in use, and the manufacturer has recommended their replacement. Failure of the insulator can result in a fallen conductor, as recently experienced on another 132kV transmission line.
- Flying angle and tension structures have insulators connected directly to the wood pole via eyebolts. Where timber is defective, these bolts are known to “pull through” the pole – there have been three failure incidents resulting in conductor drop since 1998. Due to the design of these structures is not possible to assess the condition of the poles in this area without altered practices. A wider programme to replace these attachments is in place. There are 14 structures on Line 992 which are impacted.
- Deterioration of conductor fittings, guys, earthwire dampers and earthwire spans – failure of these components can lead to a fallen conductor.
- Deterioration of components related to public safety including earthing and bonding, aerial marker balls and signage.

There is a need to remediate condition issues in order to:

- Provide economic benefit to the consumers through safety and bushfire risks reductions. 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 avoidable cost savings from unserved energy penalties, reduced in bushfire and safety risk, and maintenance costs that would otherwise occur without refurbishment.

2. Related needs/opportunities

> Nil.

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, three other options have been considered. The Option A involves a targeted replacement of wood pole structures that experience the greatest deterioration with steel or concrete poles. Option B and C involves rebuilding of the entire 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 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 — Replace known wood pole structures exhibiting ground line degradation with steel or concrete pole structures only. [NOSA N2604, OFS N2604A]

The Option A involves a targeted replacement of wood pole structures that experience the greatest deterioration with steel or concrete poles including the bushfire impacted wood poles. The total number of structures expected to be replaced for this option is 37. This option is expected to be completed within the 2024 – 2028 regulatory period with optimal timing in 2026/2027.

It is estimated that this option would cost $6.06 million ± 25% ($2020-21). This option is expected to be completed within 24 months following DG1.

Option B — Replace all wood pole structures with concrete or steel poles, including all associated attachments e.g. insulators and fittings. [NOSA N2604, OFS N2604B]

This option will address the wood pole condition issues and other line condition issues including fitting and insulator.

The scope of work covers replacement of 163 wood pole structures. It is estimated that this option would cost $23.94 million ± 25% ($2020-21). This option is not expected to be completed within the 2024 – 2028 regulatory period with optimal timing in 2029/2030. Works for the project would be completed within 31 months following DG1.

Option C — Replace the all wood pole structures with concrete or steel poles, including all associated attachments. The existing Panther conductor is to be replaced with Lemon ACSR/GZ, the modern equivalent. [NOSA N2604, OFS N2604C]

This option will address the wood pole condition and other line condition issues including fitting, insulator and conductor. The existing Panther conductor is to be replaced with Lemon ACSR/GZ including all components, hardware and fittings, and all insulators.

The scope of work covers replacement of 163 wood pole structures, 52.7 km of conductor, and 105.4 km of earthwire. It is estimated that this option would cost $32.36 million ± 25% ($2020-21). This option is not expected to

be completed within the 2024 – 2028 regulatory period with optimal timing in 2031/2032. Works for the project would be completed within 38 months following 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 is not technically 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 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 benefit	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

Parameter	Parameter Description	Value used for this evaluation
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	50 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	5.03	16.67	4.20	42.14	19.92	2
Option B	19.01	16.98	-3.88	57.60	21.92	1
Option C	18.02	12.77	-9.94	56.49	18.02	3

Based on the commercial analysis, Option B 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 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.

[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.

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	0.28	0.32	N
B	1.16	1.27	N
C	1.52	1.72	N

The result of the ALARP evaluation is that all options do not meet the ALARP threshold.

4.4 Preferred option

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. The optimal delivery date for this option is 2029/2030 based on an optimal timing analysis (see Section 5).

Whilst Option B provides the highest weighted NPV results, optimal timing for option A is in 2026/2027. Hence, it is recommended that the delivery of option B to be phased into two Regulatory Period. 55 structures (targeted wood pole replacement under option A - $6.06 million) to be replaced in 2024-2028 Regulatory Period and the remaining 198 structures ($17.9 million) to be replaced in 2029-2033 Regulatory Period.

Capital and Operating Expenditure

The required capex expenditure is $23.94 million with $6.06 million to be delivered in 2024-2028 Regulatory Period and $17.9 million to be delivered in 2029-2033 Regulatory Period.

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 2029/2030.

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 31 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:

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

- Optimal commissioning year: 2029/2030
- Commissioning year annual benefit: $1.33 million
- Annualised cost: $1.27 million

Based on the optimal timing, the project is expected to commence in the 2024-2028 Regulatory Period and completed in 2029-2033 Regulatory Period.

6. Recommendation

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.

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 $23.94 million including an amount of $1 million to progress the project from DG1 to DG2.

Whilst Option B provides the highest weighted NPV results, optimal timing for option A is in 2026/2027. Hence, it is recommended that the delivery of option B to be phased into two Regulatory Period. 55 structures (targeted wood pole replacement under option A - $6.06 million) to be replaced in 2024-2028 Regulatory Period and the remaining 198 structures ($17.9 million) to be replaced in 2029-2033 Regulatory Period.

Appendix A – Option Summaries[6]

Project Description	Line 992 Refurbishment		
Option Description	Option A - Replace the deteriorated wood pole structures with concrete or steel poles, including all associated attachments e.g. insulators and fittings.		
Project Summary			
Option Rank	*2*	Investment Assessment Period	*25*
Asset Life	*50*	NPV Year	2020/2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	16.67	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 0.32
NPV @ Lower Bound Scenario (PV, $m)	4.20	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 0.28
NPV @ Higher Bound Scenario (PV, $m)	42.14	ALARP	ALARP Compliant? No
NPV Weighted (PV, $m)	19.92	Optimal Timing	Optimal timing (Business Case) 2026/2027
Cost (Central Scenario)			
Total Capex ($m)	6.06	Cost Capex (PV,$m)	5.03
Terminal Value ($m)	2.91	Terminal Value (PV,$m)	0.75
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 1.16	Reliability Risk (Post) 0.34	Pre – Post 0.82
Financial (PV,$m)	Financial Risk (Pre) 3.97	Financial Risk (Post) 1.63	Pre – Post 2.34
Operational/Compliance (PV,$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) 34.77	Environmental Risk (Post) 17.27	Pre – Post 17.50
Reputational ($m)	Reputational Risk (Pre) 0.47	Reputational Risk (Post) 0.19	Pre – Post 0.28
Total Risk (PV,$m)	Total Risk (Pre) 40.37	Total Risk (Post) 19.43	Pre – Post 20.95
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 20.95

Commissioning year annual benefit ($k): **333.4**

[6] Figures may not add due to rounding

Project Description	Line 992 Refurbishment		
Option Description	Option B - Replace all wood pole structures with concrete or steel poles, including all associated attachments e.g. insulators and fittings..		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*50*	NPV Year	2020/2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	16.98	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 1.27
NPV @ Lower Bound Scenario (PV, $m)	-3.88	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 1.16
NPV @ Higher Bound Scenario (PV, $m)	57.60	ALARP	ALARP Compliant? No
NPV Weighted (PV, $m)	21.92	Optimal Timing	Optimal timing (Business Case) 2029/2030
Cost (Central Scenario)			
Total Capex ($m)	23.94	Cost Capex (PV,$m)	19.01
Terminal Value ($m)	11.97	Terminal Value (PV,$m)	3.07
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 1.16	Reliability Risk (Post) 0.20	Pre – Post 0.96
Financial (PV,$m)	Financial Risk (Pre) 3.97	Financial Risk (Post) 0.66	Pre – Post 3.31
Operational/Compliance (PV,$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) 34.77	Environmental Risk (Post) 6.52	Pre – Post 28.25
Reputational ($m)	Reputational Risk (Pre) 0.47	Reputational Risk (Post) 0.08	Pre – Post 0.39
Total Risk (PV,$m)	Total Risk (Pre) 40.37	Total Risk (Post) 7.45	Pre – Post 32.92
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 32.92

Commissioning year annual benefit ($k): **1327.54**

Project Description	Line 992 Refurbishment		
Option Description	Option C - Replace the all wood pole structures with concrete or steel poles, including all associated attachments. The existing Panther conductor is to be replaced with Lemon ACSR/GZ, the modern equivalent.		
Project Summary			
Option Rank	*3*	Investment Assessment Period	*25*
Asset Life	*50*	NPV Year	2020/2021
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	12.77	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 1.72
NPV @ Lower Bound Scenario (PV, $m)	-9.94	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 1.52
NPV @ Higher Bound Scenario (PV, $m)	56.49	ALARP	ALARP Compliant? No
NPV Weighted (PV, $m)	18.02	Optimal Timing	Optimal timing (Business Case) 2031/2032
Cost (Central Scenario)			
Total Capex ($m)	32.36	Cost Capex (PV,$m)	25.64
Terminal Value ($m)	16.83	Terminal Value (PV,$m)	4.32
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 1.16	Reliability Risk (Post) 0.10	Pre – Post 1.06
Financial (PV,$m)	Financial Risk (Pre) 3.97	Financial Risk (Post) 0.55	Pre – Post 3.42
Operational/Compliance (PV,$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) 34.77	Environmental Risk (Post) 5.56	Pre – Post 29.21
Reputational ($m)	Reputational Risk (Pre) 0.47	Reputational Risk (Post) 0.07	Pre – Post 0.40
Total Risk (PV,$m)	Total Risk (Pre) 40.37	Total Risk (Post) 6.28	Pre – Post 34.10
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 34.10

Commissioning year annual benefit ($k): **1747.26**