OPTIONS EVALUATION REPORT (OER)

Transformer Compound Wall Renewal

OER- N2601 revision 3.0

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

Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Replacement

Approvals

Author	Jeremy Culberg	Substations Asset Strategist
Endorsed	Evan Lamplough	Substations Asset Manager
	Debashis Dutta	Asset Analytics & Insights Manager
Approved	Andrew McAlpine	A/Head of Asset Management
Date submitted for approval	13 November 2021	

Change history

Revision	Date	Amendment
0	28/10/2021	Initial revision
1	10/11/2021	Minor wording updates
2	12/11/2021	Formatting corrections
3	13/11/2021	Minor formatting corrections

Executive summary

Transformer compound walls are installed around oil transformers and reactors to manage noise compliance and to prevent fire from spreading to adjacent assets in the event of a catastrophic failure.

The earliest implementation of the Transformer compound wall designs are now showing signs of failing and vertical sections of the wall have fallen off which presents a risk to workers and damage to the associated transformer or reactor. There are 21 locations across the network that have been identified as requiring renewal.

The identified compound walls were installed in the early to mid 2000s and have heights ranging from 5 meters to 9.3 meters. The length of any given wall is typically the length of the transformer or reactor plus a few meters to allow for access around the transformer and reactor. Wall lengths of up to 20m are common for the power transformers and larger reactors and a few meters only for auxiliary transformers.

This need is an economic benefits need with the following benefits if it is addressed:

The key economic benefits associated with addressing this need are summarised as:

> Reduction of risk valued as a direct impact to TransGrid associated with safety hazards associated with failure.
> Avoided operating expenditure related to corrective maintenance.

The only identified option is the renewal of the compound walls. The assessment of the options considered to address the need/opportunity appears in Table 1.

Table 1 - Evaluated options ($ million)

Option	Description	Direct capital cost	Network and corporate overheads	Total capital cost[1]	Weighted NPV	Rank
Option A	Renewal of Transformer and Reactor Compounds walls	2.43	0.44	2.87	5.26	1

It is recommended to proceed with Option A, at a total cost of $2.87 million, as this option is technically feasible and provides a positive net present value.

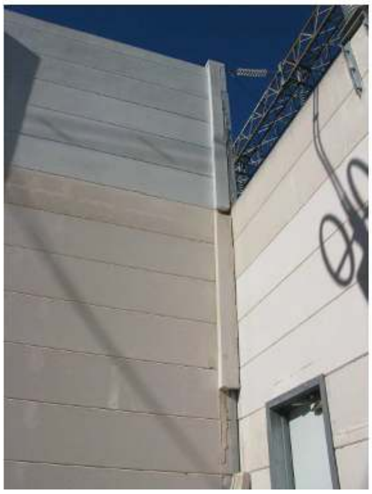
[1] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

1. Need/opportunity

Compound wall panels are installed in numerous sites with transformers and reactors to help with reducing sounds levels and to act as a barrier in the event of a fire to protect adjacent assets.

The first generation of Transgrid wall panels are inadequately attached and some of the vertical panel members have started to fail and break away from the steel columns. The broken sections are dense and heavy and represent a safety risk to Transgrid workers and contractors. The following photos are representative of the overall condition, and give indication as to the height of the compound walls:

Figure 1 Compound wall representative issues



Sydney South No. 6 transformer - entrance to the compound

Sydney South No.6 transformer - wall joint cracking

Orange No.1 transformer – fallen brickwork

Barricades to prevent workers being under areas identified as at immediate risk of failure have been put in place. However, these barricades do not address the risk of fire spread, nor prevent parts of the wall hitting the equipment. In addition, the barricades make routine maintenance on the transformers and reactors more onerous and a long term solution is required.

The affected sites have undergone inspections to confirm the level of degradation and the required remediation to address the issues.

This will ensure the transformer enclosures are safe for workers and contractors to carry out inspections and maintenance. The risk associated with damage to the transformers or reactors in the event of failure will be mitigated through this action..

The key economic benefits associated with addressing this need are summarised as:

- Reduction of risk valued as a direct impact to TransGrid associated with safety hazards associated with failure.
- Avoided operating expenditure related to corrective maintenance.

Additional benefits related to avoided unserved energy due to parts of the wall hitting equipment and causing outages or fire damage to other assets due to ineffective walls. However these have not been quantified as a benefit in this options evaluation report.

2. Related needs/opportunities

Initial investigation and condition assessments for this issue were performed under N2250.

3. Options

3.1 Base case

In the event that major remediation is not undertaken, all the transformer compound walls would require significant and more permanent barricading / repairs. In the following years, the initial repair and mitigation measures would require inspection and as required further work to ensure that personnel and equipment are not exposed to parts of the transformer compound wall falling on people or equipment.

If the walls are not repaired, a transformer or reactor catastrophic failure may also lead to additional damage to other assets (however this has been excluded from the economic assessment).

3.2 Options evaluated

Option A — Remediate transformer and reactor compound walls, [NOSA-N2601, OFS-N2601A]

Sites with identified condition issues which require rectification work outlined in Table 2. Scope also includes renewal of the sites to the latest design, ensuring the longevity of existing cladding.

Table 2 – Identified Rectification Works

Site	Assets (see note)	Rectification Work
Sydney South	TX1, TX5, TX6, RX2	> Existing Compound wall fire cladding shows signs of failing.
Sydney South	All Auxiliary Transformer	> Existing Compound wall fire cladding shows signs of failing.
Liverpool	TX3	> Existing Compound wall blocking is falling. > Refit / replace fallen blocking.
Waratah West	TX1	> Existing Compound wall fire cladding has failed and has all been removed. > Fire cladding to be reinstated to the internal side (transformer side) of all steel columns as per current standard designs.
Kemps Creek	RX6	> Existing Compound wall blocking is falling. > Refit / replace fallen blocking.
Orange	TX3, TX1	> Existing Compound wall fire cladding shows signs of failing.
Macarthur	TX3	> Fire protection to fire wall steel columns is a spraycrete type product (not Compound wall). Fire protection shows signs of failing.
Armidale	RX3, RX4	> Existing Compound wall fire cladding shows signs of failing.
Koolkhan	TX2	> Existing Compound wall fire cladding shows signs of failing.
Lismore	RX1, RX3	> Areas of Compound wall roof panels are showing signs of spalling on the underside.

Note: TX and RX and the following number refers to the power transformer or oil filled reactor respectively and its identifying number.

The project is anticipated to take 31 months, with the construction time of 13 weeks, and is dependent on outages on the relevant assets. The overall cost is $2.87 million.

3.3 Options considered and not progressed

The following options were considered but not progressed:

Table 3 – Options not progressed

Option	Reason for not progressing
Increased maintenance or inspections	The condition issues have already been identified and cannot be rectified through increased maintenance or inspections, and therefore is not technically feasible to address the need.
Elimination of all associated risk	This can only be achieved by retiring the assets, which is not technically feasible. The assets are required by Australian and Transgrid design standards to mitigate fire and noise risk and the decommissioning is expected to be equal or more expensive than the identified option.
Non-network solutions	It is not technically feasible for non-network solutions to provide the functionality of the equipment under this need.

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 for this project are set out in table 4.

Table 4 – Commercial evaluation assumptions

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	4.8%	7.37%	2.23%
Capital cost	100%	125%	75%
Operating expenditure	100%	75%	125%
Risk costs	100%	75%	125%
Benefits	Not applicable		
Scenario weighting	**50%**	**25%**	**25%**

Parameters used in this commercial evaluation are shown in Table 5.

Table 5 – Commercial evaluation parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2020/21
Base year	The year that dollar value outputs are expressed in real terms	2020/21
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
ALARP disproportionality (repex only)	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 6. Details appear in Appendix A.

Table 6 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	2.07	4.42	0.97	11.22	5.26	1

Individual site analysis is provided in Appendix B.

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.[2]

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor[3], 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.

---

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

[3] 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 + 3 or 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction.

Results of the ALARP evaluation are set out in Table 7.

Table 7 - Reasonably practicable test ($ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable?[4]
A	0	0.18	No

The result of the ALARP evaluation is that the option does not satisfy the ALARP criteria.

4.4 Preferred option

The preferred option is Option A, which is to remediate the transformer compound Walls, as it is technically feasible and has a high positive NPV.

Capital and Operating Expenditure

Opex cost benefits associated reduced corrective expenditure has been allowed for in economic evaluation and optimal timing evaluation.

There are no capex to opex trade-offs considered in this evaluation.

Regulatory Investment Test

A regulatory investment test is not required as the preferred option is below $6m.

5. Optimal Timing

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: 2025/26
- Commissioning year annual benefit: $0.63 million
- Annualised cost: $0.18 million

Based on the optimal timing, the project is expected to commence in the 2023-2028 Regulatory Period.

6. Recommendation

It is recommended to proceed with Option A with a total value of $2.87 million, which includes a $0.3 million allowance to progress the project from Decision Gate 1 to Decision Gate 2 (DG2).

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

Appendix A – Option Summaries

Project Description	**Transformer & Reactor Compound Wall Remediation**		
Option Description	Option A – Rectification of Transformer & Reactor Compound Walls		
Project Summary			
Option Rank	*[Option Rank] 1*	Investment Assessment Period	[Project Useful Life] 25
Asset Life	[Asset Useful Life] 30	NPV Year	*[NPV Year] 2021*
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	*[Net Present Value (Standard – OER)] 4.42*	Annualised CAPEX ($m)	Annualised Capex - Standard (Business Case) *0.18*
NPV @ Lower Bound Scenario (PV, $m)	*[Net Present Value (Upper Bound)] 0.97*	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction *0.00*
NPV @ Higher Bound Scenario (PV, $m)	[Net Present Value (Lower Bound)] *11.22*	ALARP	ALARP Compliant? *No*
NPV Weighted (PV, $m)	[Net Present Value (Weighted)] *5.26*	Optimal Timing	Optimal timing (Business Case) *2025/26*
Cost			
Direct Capex ($m)	*2.43*	Network and Corporate Overheads ($m)	*0.44*
Total Capex ($m)	*2.87*	Cost Capex (PV,$m)	*2.07*
Terminal Value ($m)	*0.38*	Terminal Value (PV,$m)	*0.09*
Risk (central scenario)	Pre	Post	Benefit
Reliability (PV,$m)	Reliability Risk (Pre) *0.00*	Reliability Risk (Post) *0.00*	Pre – Post *0.00*
Financial (PV,$m)	Financial Risk (Pre) *4.66*	Financial Risk (Post) *0.00*	Pre – Post *4.66*
Operational/Compliance (PV,$m)	Operational Risk (Pre) *1.73*	Operational Risk (Post) *0.00*	Pre – Post *1.73*
Safety (PV,$m)	Safety Risk (Pre) *0.01*	Safety Risk (Post) *0.00*	Pre – Post *0.01*
Environmental (PV,$m)	Environmental Risk (Pre) *0.00*	Environmental Risk (Post) *0.00*	Pre – Post *0.00*
Reputational ($m)	Reputational Risk (Pre) *0.00*	Reputational Risk (Post) *0.00*	Pre – Post *0.00*
Total Risk Benefit (PV,$m)	Total Risk (Pre) *6.40*	Total Risk (Post) *0.00*	Pre – Post *6.40*
OPEX Benefit (PV,$m)			OPEX Benefit *0.39*
Other benefit (PV,$m)			Incremental Net Benefit *0.00*
Total Benefit (PV,$m)			Business Case Total Benefit *6.40*

Appendix B – Individual Site NPV

Site	Equipment	Optimal Timing	NPV ($, million)
Sydney South	Transformer No 1	2024/25	0.23
	Transformer No 5	2024/25	0.22
	Transformer No 6	2024/25	0.22
	Reactor No 2	2024/25	0.21
	Auxiliary Transformer No 1	2024/25	0.17
	Auxiliary Transformer No 2	2024/25	0.17
	Auxiliary Transformer No 3	2024/25	0.17
	Auxiliary Transformer No 4	2024/25	0.17
	Auxiliary Transformer No 5	2024/25	0.17
	Auxiliary Transformer No 6	2024/25	0.17
Liverpool	Transformer No 3	2023/24	0.29
Koolkhan	Transformer No 2	2023/24	0.27
Armidale	Reactor No 3	2025/26	0.34
	Reactor No 4	2025/26	0.34
Kemps Creek	Reactor No 6	2025/26	0.29
Orange	Transformer No 1	2024/25	0.27
	Transformer No 3	2024/25	0.31
Macarthur	Transformer No 3	2023/24	0.23
Lismore	Reactor No 1	2023/24	0.36
	Reactor No 1	2023/24	0.36
Waratah West	Transformer No 1	2025/26	0.18

TransGrid