TransGrid

Summary: Managing asset risks at Forbes substation

RIT-T – Project Assessment Conclusions Report

Region: Central

Date of issue: 30 November 2020

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Summary

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating the risks caused by the deteriorating condition of transformers at Forbes substation. Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Forbes 132/66 kV substation is located on TransGrid's Central NSW network. It connects two of TransGrid's 132 kV transmission lines — Line 94U to Parkes and Line 998 to Cowra. It also connects the Essential Energy distribution network and supports approximately 200 MW of existing renewable generation in the area[1].

Forbes substation will continue to play a central role in the safe and reliable operation of the power system. The substation is located within an area of interest for new renewable connections.

There are two transformers at Forbes substation (No.1 Transformer and No.2 Transformer), which are used to change the voltages levels. Different voltages are used for generation, high voltage transmission and local distribution. The transformers at Forbes substation are essential for the safe and reliable transmission of electricity to the Central NSW network. The transformers were both commissioned in 1969 and have now reached the end of serviceable life. Both transformers are showing signs of deterioration attributable to ageing. Table 1 outlines the condition issues on Transformer 1 and 2 at Forbes substation, the impact of those condition issues if not remediated, and the consequences if no action is taken.

Table 1 Condition issues at Forbes substation, their potential impacts and consequences

Issue	Potential impact	Consequence
Carbon particle contamination	Carbon is a conductor and there can be a tendency for the individual particles to accumulate in areas of strong high electric fields. This could lead to electrical breakdown resulting in a catastrophic failure of the transformer.	Increased risk of prolonged and frequent involuntary load shedding
Paper insulation moisture	The transformer insulation system is based on special papers impregnated with insulating oil. Moisture acts to increase the rate of degradation of the paper insulating system. At high levels, it may compromise the insulation. The papers provided insulation and also support the structure of the transformer winding. Over time and with load and the presence of moisture, the paper becomes embrittled. This may progress to the point where a mechanical shock caused by a	

[1] Summation of approximate load from Molong Solar Farm, Manildra Solar Farm, Parkes Solar Farm, and Goonumbla Solar Farm.

	through fault can result in electrical failure.	
Corrosion resulting in loss of oil due to leaks	Corrosion resulting in leaks or leaking gaskets can cause loss of oil within the Transformer resulting in a catastrophic failure. Moisture and oxygen can also enter the transformer resulting in accelerated aging of the insulation resulting in failure.	
Mechanical failure of the tap changer	The tapchanger switches the voltage ratio on the transformer while it is under load. It is a mechanical device and in the case of failure, large amounts of energy are expected to be released and transformer loss is likely.	Lack of voltage control at Forbes substation

These condition issues, if not remediated, will increase the risk of failures at Forbes substation resulting in prolonged and frequent involuntary load shedding on the Central NSW network.

Identified need: avoid prolonged and frequent involuntary load shedding in Central NSW attributed to deteriorating asset condition at Forbes substation

The transformers at Forbes substation play a central role in supplying electricity to TransGrid's Central NSW transmission network.

If the deteriorating asset condition at Forbes substation is not addressed by a technically and commercially feasible credible option in sufficient time (by 2022/23), the likelihood of prolonged and involuntary load shedding in the Central West will increase.

In addition to the market benefit of avoided prolonged and frequent involuntary load shedding, the proposed investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from continued deterioration of asset condition. Rectifying the worsening condition of the transformers will reduce safety risks, as well as lower planned and unplanned corrective maintenance costs. However, these costs are of small magnitude compared to the cost of prolonged and frequent involuntary load shedding and do not affect the preference amongst the options[2].

No submissions received in response to Project Specification Consultation Report

TransGrid published a Project Specification Consultation Report (PSCR) on 14 August 2020 and invited written submissions on the material presented within the document. No submissions were received in response to the PSCR.

[2] TransGrid manages and mitigates safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with TransGrid's obligations under the New South Wales *Electricity Supply (Safety and Network Management) Regulation 2014* and TransGrid's Electricity Network Safety Management System (ENSMS). In particular, risks for TransGrid and its consumers are mitigated unless it is possible to demonstrate that the cost involved in further reducing the risk would be grossly disproportionate to the benefit gained.

No developments since publication of the PSCR

No additional credible options were identified during the consultation period following publication of the PSCR.

Option 1 remains the preferred option at this stage of the RIT-T process.

Replacement of both transformers with new assets remains the most prudent and economically efficient option to avoid prolonged and frequent involuntary load shedding

In the PSCR, TransGrid put forward for consideration two credible options that would meet the identified need from a technical, commercial, and project delivery perspective.[3]

- **Option 1** – Replace Transformer No.1 and No.2 with new assets; and
- **Option 2** – Replace Transformer No.1 with a new asset and replace Transformer No.2 with a redeployed asset

The implementation of Option 1, replacing No.1 and No.2 transformers with new 132/66 kV 60 MVA transformers at Forbes substation, remains the most efficient technically and commercially feasible option at this stage of the RIT-T process. Option 1 addresses the identified need, offers the most benefit to consumers, and can be implemented in sufficient time to meet the identified need (by 2022/23). The investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from continued deterioration of asset condition. It is therefore the preferred option presented in this PACR.

TransGrid expects coronavirus (COVID-19) to impact its suppliers and disrupt their supply chains. TransGrid has preliminary advice that this is already occurring, although at this time the extent of the current or future impact is unknown. Consequently, some of the costs associated with the works outlined in this document may be affected.

All costs presented in this PACR are in 2020/21 dollars. The options are summarised in the table below.

Table 2 Summary of credible options

Option	Transformer No.1	Transformer No.2	Capital cost ($m 2020/21)	Operating costs ($ per year)	Remarks
Option 1	**Replace with new asset**	**Replace with new asset**	**~9.1 (+/- 25%)**	**~1,000**	**Preferred option, would maintain regulatory obligations and provide highest net economic benefits**
Option 2	Replace with new asset	Replace with redeployed asset	~8.1 (+/- 25%) Additional 3.6m in 2036/37 to replace redeployed asset	~1,100	Would maintain regulatory obligations but provide less net benefits to consumers.

[3] As per clause 5.15.2(a) of the NER.

TransGrid also considered whether there are other credible options that would meet the identified need. Other options that are not considered credible include:

- As both transformers are of similar age and condition, replacing one transformer and leaving the other unit in service would result in increasing risk over time to an unacceptable level. TransGrid proposes to remediate both transformers in order to mitigate the risks associated with catastrophic failure as they approach end of life.
- Refurbishment of the Forbes transformers would provide no improvement to their underlying condition and therefore risk of failure. This is because of the inherent nature of the issues are affecting the oil, main tank and tap changer.
- Replacing one transformer and decommissioning the other is also not feasible as TransGrid must maintain reliability standards for the Forbes bulk supply point (BSP) under the IPART - Electricity transmission reliability standards[4].

Non-network options are not able to assist in this RIT-T

TransGrid does not consider non-network options to be commercially feasible to assist with meeting the identified need for this RIT-T. Although technically feasible, TransGrid does not consider non-network options are able to cost-effectively defer the need for a second transformer replacement. Specifically, to be considered equal to or cheaper than Option 1, non-network solutions would need to cost below $8/kW for a minimum of 37 MW.

For non-network options to efficiently reduce the risk of unserved energy, non-network solutions would need to have higher economic net benefits than the incremental network option.

Notwithstanding the above, TransGrid set out the required technical characteristics for non-network options in the PSCR, consistent with the requirements of the RIT-T and invited interested parties to make submissions regarding non-network options that satisfy, or contribute to satisfying, the identified need.

No non-network submissions were received in response to the PSCR.

Net economic benefits have been assessed under three different scenarios

The assessment was conducted under three net economic benefits scenarios. These are plausible scenarios which reflect different assumptions about the future market development and other factors that are expected to affect the relative economic benefits of the options being considered. All scenarios (low, central and high) involve a number of assumptions that result in the lower bound, the expected, and the upper bound estimates for present value of net economic benefits respectively.

A key expected driver of the net economic benefits is the Value of Customer Reliability (VCR) and the underlying demand forecast since avoided EUE is the primary market benefit. TransGrid has applied a VCR estimate of $42.90/kWh in the central scenario and +/-30 per cent for the other two scenarios, which is consistent with the AER's VCR review released in December 2019[5].

A summary of the key variables in each scenario is provided in the table below.

[4] IPART Electricity transmission reliability standards Final Report, August 2016, Appendix B Recommended reliability standards, Section 8 Table of Values.

[5] The central estimate of $42.90/kWh reflects an inflation adjustment to the load weighted VCR estimate for NSW and ACT ($42.12/kWh). The confidence interval selected is also drawn from the AER's VCR review. AER, *Value of Customer Reliability Review – Final report*, December 2019, pp 71 (Table 5.22) & 84. https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20Report%20-%20December%202019.pdf.

Table 3 Summary of scenarios

Variable / Scenario	Central	Low benefit scenario	High benefit scenario
Scenario weighting	*50%*	*25%*	*25%*
Discount rate	5.90%	9.57%	2.23%
Costs			
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Benefits (negative benefits)			
Reduction in operating and maintenance costs	Base estimate	Base estimate - 25%	Base estimate + 25%
Reduction in safety and environmental risk costs	Base estimate	Base estimate - 25%	Base estimate + 25%
Reduction in financial risks	Base estimate	Base estimate - 25%	Base estimate + 25%
Demand forecasts	Based on POE50 demand forecasts	Based on POE90 demand forecasts	Based on POE10 demand forecasts
Value of Customer Reliability (VCR)	The AER's VCR	The AER's VCR - 30%	The AER's VCR + 30%

TransGrid consider that the central scenario is most likely since it is based primarily on a set of expected assumptions. TransGrid have therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being weighted equally with 25 per cent each.

Option 1 delivers the highest net economic benefits

In the central and high benefit scenarios, as well as on a weighted basis, positive net economic benefits result from implementing Option 1 as demonstrated in the table below.

Table 4 Estimated net economic benefits from credible options relative to the base case, present value ($m 2020/21)

Option	Central	Low benefit scenario	High benefit scenario	Weighted	Ranking
Scenario weighting	*50%*	*25%*	*25%*		
Option 1 – Replace both transformers with new transformers	35.9	11.6	77.2	40.2	1
Option 2 – Replace No.1 transformer with a new transformer and replace No.2 transformer with a redeployed transformer from another site	35.0	11.5	75.1	39.1	2

Sensitivity testing finds that, while the results are most sensitive to the assumed discount rate and adjustments to expected unserved energy estimates, Option 1 is still found to deliver strongly positive net benefits over a range of alternate assumptions regarding key parameters. Option 1 delivers the most benefit under all scenarios and sensitivities.

Conclusion: replacement of both transformers with new assets is optimal

The implementation of Option 1, replacing No.1 and No.2 transformers with new 132/66 kV 60 MVA transformers at Forbes substation, is the most efficient technically and commercially feasible option at this draft stage of the RIT-T process. Option 1 addresses the identified need, offers the most benefit to consumers and can be implemented in sufficient time to meet the identified need (by 2022/23). The investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from continued deterioration of asset condition. It is therefore the preferred option presented in this PACR.

This preferred option, Option 1, is found to have positive net benefits under all scenarios investigated and on a weighted basis will deliver $40.2 million in net economic benefits. TransGrid also conducted sensitivity analysis on the net economic benefit to investigate the robustness of the conclusion to key assumptions. TransGrid finds that under all sensitivities, positive net benefits are expected from new transformers at Forbes.

The estimated capital cost of this option is approximately $9.1 million. Routine and operating maintenance costs are approximately $1,000 per year on average.

The works will be undertaken between 2020/21 and 2022/23. Planning (including commencement of the RIT-T) commenced in 2019/20 and is due to conclude in 2020/21.The detailed design will commence in 2020/21 with procurement and delivery of the identified assets planned to occur in 2021/22. All works will be completed by 2022/23. Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

Next steps

This PACR represents the third and final step of the consultation process in relation to the application of the Regulatory Investment Test for Transmission (RIT-T) process undertaken by TransGrid. It follows a Project Specification Consultation Report (PSCR) released in August 2020. No submissions were received in response to the PSCR.

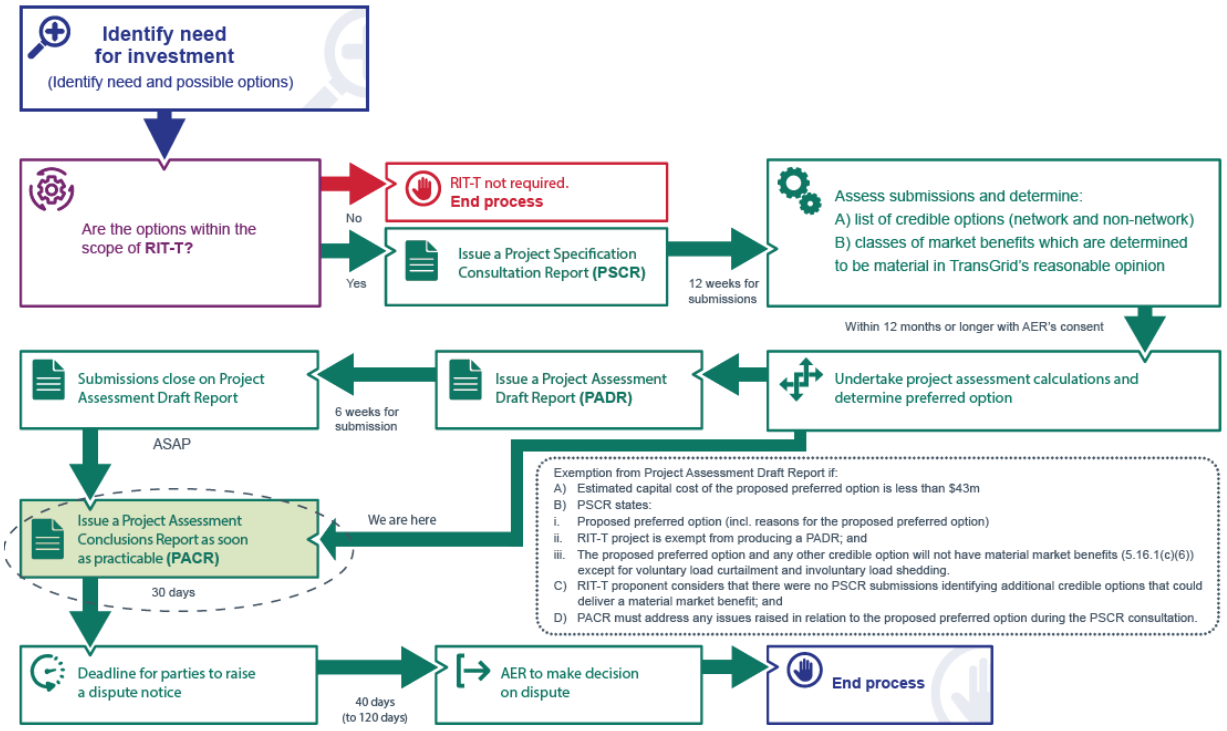
The second step, production of a Project Assessment Draft Report (PADR), was not required as TransGrid considers its investment in relation to the preferred option to be exempt from that part of the RIT-T process under NER clause 5.16.4(z1). Production of a PADR is not required[6] due to:

- the estimated capital cost of the proposed preferred option being less than $43 million;
- the PSCR stating:
  - the proposed preferred option (including reasons for the proposed preferred option)
  - the RIT-T is exempt from producing a PADR
  - the proposed preferred option and any other credible option will not have material market benefits[7] except for voluntary load curtailment and involuntary load shedding
- the RIT-T proponent considers that there were no PSCR submissions identifying additional credible options that could deliver a material market benefit; and
- the PACR addressing any issues raised in relation to the proposed preferred option during the PSCR consultation.

[6] In accordance with NER clause 5.16.4(z1)(4), the exemption from producing a PADR will no longer apply if TransGrid considers that an additional credible option that could deliver a material market benefit is identified during the consultation period. No additional credible options were identified.

[7] As per clause 5.16.1(c)(6)

Figure 1 This PACR is the third stage of the RIT-T process[8]



Parties wishing to raise a dispute notice with the AER may do so prior to 4 January 2021 (30 days after publication of this PACR[9]). Any dispute notices raised during this period will be addressed by the AER within 40 to 120 days, after which the formal RIT-T process will conclude.

Further details on the RIT-T can be obtained from TransGrid's Regulation team via RIT-TConsultations@transgrid.com.au. In the subject field, please reference 'Forbes substation transformer PACR'.

To read the full Project Assessment Conclusions Report visit the Regulatory Investments Test page on TransGrid's website.

[8] Australian Energy Market Commission. "*Replacement expenditure planning arrangements, Rule determination*". Sydney: AEMC, 18 July 2017.65. Accessed 19 November 2019. https://www.aemc.gov.au/sites/default/files/content/89fbf559-2275-4672-b6ef-c2574eb7ce05/Final-rule-determination.pdf

[9] Additional days have been added to cover public holidays