Transgrid

People. Power. Possibilities.

# Summary: Maintaining compliance with performance standards applicable to Broken Hill substation secondary systems

RIT-T Project Assessment Conclusions Report

Region: South Western NSW

Date of issue: 15 November 2021

# Disclaimer

This suite of documents comprises Transgrid's application of the Regulatory Investment Test for Transmission (RIT-T) which has been prepared and made available solely for information purposes. It is made available on the understanding that Transgrid and/or its employees, agents and consultants are not engaged in rendering professional advice. Nothing in these documents is a recommendation in respect of any possible investment.

The information in these documents reflect the forecasts, proposals and opinions adopted by Transgrid at the time of publication, other than where otherwise specifically stated. Those forecasts, proposals and opinions may change at any time without warning. Anyone considering information provided in these documents, at any date, should independently seek the latest forecasts, proposals and opinions.

These documents include information obtained from the Australian Energy Market Operator (AEMO) and other sources. That information has been adopted in good faith without further enquiry or verification. The information in these documents should be read in the context of the Electricity Statement of Opportunities, the Integrated System Plan published by AEMO and other relevant regulatory consultation documents. It does not purport to contain all of the information that AEMO, a prospective investor, Registered Participant or potential participant in the National Electricity Market (NEM), or any other person may require for making decisions. In preparing these documents it is not possible, nor is it intended, for Transgrid to have regard to the investment objectives, financial situation and particular needs of each person or organisation which reads or uses this document. In all cases, anyone proposing to rely on or use the information in this document should:

1. Independently verify and check the currency, accuracy, completeness, reliability and suitability of that information
2. Independently verify and check the currency, accuracy, completeness, reliability and suitability of reports relied on by Transgrid in preparing these documents
3. Obtain independent and specific advice from appropriate experts or other sources.

Accordingly, Transgrid makes no representations or warranty as to the currency, accuracy, reliability, completeness or suitability for particular purposes of the information in this suite of documents.

Persons reading or utilising this suite of RIT-T-related documents acknowledge and accept that Transgrid and/or its employees, agents and consultants have no liability for any direct, indirect, special, incidental or consequential damage (including liability to any person by reason of negligence or negligent misstatement) for any damage resulting from, arising out of or in connection with, reliance upon statements, opinions, information or matter (expressed or implied) arising out of, contained in or derived from, or for any omissions from the information in this document, except insofar as liability under any New South Wales and Commonwealth statute cannot be excluded.

## Privacy notice

Transgrid is bound by the *Privacy Act 1988 (Cth)*. In making submissions in response to this consultation process, Transgrid will collect and hold your personal information such as your name, email address, employer and phone number for the purpose of receiving and following up on your submissions.

Under the National Electricity Law, there are circumstances where Transgrid may be compelled to provide information to the Australian Energy Regulator (AER). Transgrid will advise you should this occur.

Transgrid's Privacy Policy sets out the approach to managing your personal information. In particular, it explains how you may seek to access or correct the personal information held about you, how to make a complaint about a breach of our obligations under the Privacy Act, and how Transgrid will deal with complaints. You can access the Privacy Policy here (https://www.transgrid.com.au/Pages/Privacy.aspx).

# Summary

Transgrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining reliable secondary systems at Broken Hill substation. Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Broken Hill 220/22kV substation is a customer connection point supplying the Essential Energy networks in the area. Silverton Wind Farm also connects at Broken Hill substation, as well as Broken Hill Solar Plant. It forms part of the wider South Western NSW network which supports renewable energy zone development and will continue to play a central role in supporting the flow of energy to the Far West region of NSW.[1]

Transgrid has identified that the secondary systems at Broken Hill substation have reached a condition that reflects the end of serviceable life. As it is superseded by new technology at the manufacturer level and the existing technology becomes obsolete, spare parts become scarce and the ability of any primary asset connected to the substation to reliably operate will be at risk.

The 220kV and 22kV secondary systems need has been considered in the context that the associated 22kV primary equipment is also reaching a condition that reflects the end of serviceable life.

The outcome of this RIT-T is not influenced by the outcome of the active "Maintaining a reliable supply to Broken Hill" RIT-T.

## Identified need: meet the service level required under the National Electricity Rules for protection schemes

Secondary systems are used to control, monitor, protect and secure communication to facilitate safe and reliable network operation.[2] They are necessary to operate the transmission network and prevent damage to primary assets when adverse events occur.

Provision of redundant protection schemes to ensure the transmission system is adequately protected is a Network Performance Requirement under Schedule 5.1 of the National Electricity Rules (NER), therefore the condition issues affecting the secondary systems at Broken Hill substation must be addressed.

The Network Performance Requirements, set out in Schedule 5.1 of the NER, place an obligation on Transmission Network Service Providers (TNSPs) to provide redundant protection schemes to ensure the transmission system is adequately protected. Schedule 5.1.9(c) of the NER requires a TNSP to provide sufficient primary and back-up protection systems, including any communications facilities and breaker fail protection systems, to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.

Additionally, TNSPs are required to disconnect the unprotected primary systems where secondary systems fault lasts for more than eight hours (for planned maintenance) or 24 hours (for unplanned outages). TNSPs must also ensure that all protection systems for lines at a voltage above 66 kV are well-maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance

[1] There is over 5GW of potential wind and solar generation connections in South Western NSW and the Barrier Ranges. Transgrid. "*Transmission Annual Planning Report 2021*." Sydney: Transgrid, 2021. 69. Accessed 2 September, 2021. https://www.transgrid.com.au/news-views/publications/Documents/TAPR_2021.pdf

[2] As per Schedule 5.1 of the NER.

of protection systems is being carried out.[3] In the event of an unplanned outage, AEMO's Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours.[4]

Furthermore, as per clause 4.11.1 of the NER, remote monitoring and control systems are required to be maintained in accordance with the standards and protocols determined and advised by AEMO.

A failure of the secondary systems would involve replacement of the failed component or taking the affected primary assets, such as lines and transformers, out of service.

Though replacement of failed secondary systems component is a possible interim measure, the approach is not sustainable as the stock of spare components will deplete due to the technology no longer being manufactured or supported. Once all spares are used, replacement will cease to be a viable option to meet performance standards stipulated in clause 4.6.1 of the NER.

If the failure to provide functional secondary systems due to technology obsolescence is not addressed by a technically and commercially feasible credible option in sufficient time (by 2022/23), the likelihood of not recovering from secondary systems faults and not maintaining compliance with NER performance requirements will increase.

The proposed investment will enable Transgrid to continue to meet the standards for secondary systems availability set out in the NER, and to avoid the impacts of taking primary assets out of service. Consequently, it is considered a reliability corrective action under the RIT-T.

A reliability corrective action differs from a 'market benefits'-driven RIT-T in that the preferred option is permitted to have negative net economic benefits on account of it being required to meet an externally imposed obligation on the network business.

## Submissions received in response to the Project Assessment Draft Report

Transgrid published a Project Assessment Draft Report (PADR) on 16 March 2021 and invited written submissions on the material presented within the document. One formal submission was received on the PADR and with permission from the submitter — the Public Interest Advocacy Centre — it is available on Transgrid's website.

The submission covered two topics regarding the efficiencies when considering the secondary and primary systems, specifically for Transgrid to ensure that the proposed timing of the works is in the interests of consumers and to provide more clarity regarding cost comparison between the credible options presented in the PADR to demonstrate that Option 4 is the most efficient and prudent way to achieve these efficiencies.

Transgrid values the feedback raised in the submission and met with representatives from PIAC to better understand and discuss these topics in more detail ahead of preparing this PACR. Feedback from the submission has been taken into account in undertaking the PACR analysis and in preparing this report.

[3] As per S5.1.2.1(d) of the NER.

[4] Australian Energy Market Operator. "*Power System Security Guidelines, 7 April 2021*." Melbourne: Australian Energy Market Operator, 2021.35. Accessed 22 June 2021. https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en

## No material developments since publication of the PADR

Transgrid published a Project Specification Consultation Report (PSCR) on 17 December 2019 which presented four credible options that would meet the Identified Need from a technical, commercial, and project delivery perspective[5].The options included: complete replacement with Secondary Systems Buildings (SSBs) (Option 1); complete in-situ replacement (Option 2); strategic asset replacement (Option 3); and a complete upgrade and renewal with 22 kV switchroom and 220 kV Secondary Systems Building (SSBs) (Option 4). No submissions were received on the PSCR.

Following publication of the PSCR, Transgrid identified a need to re-scope one of the credible options (Option 4- complete upgrade and renewal with 22 kV switchroom and 220 kV in-situ secondary systems replacement), and identified one additional credible option (Option 5- complete in-situ secondary systems and 22 kV AIS replacement). Consequently, as a result of this material change, Transgrid re-ran the NPV analysis including Options 1, 2 and 3[6], Option 4 (re-scoped) and the new Option 5. In the NPV analysis, Transgrid used updated costs where applicable, as well as the latest inflation and discount rates.

Transgrid presented this analysis and revised assessment, including identification of Option 4 as the proposed preferred option, in a Project Assessment Draft Report (PADR) on 16 March 2021. Transgrid invited written submissions on the materials contained within the PADR and received one submission from the Public Interest Advocacy Centre. The submission highlighted some opportunities to improve the clarity of this PACR, specifically regarding the efficiencies provided by the timing of the works and clearer cost comparison of all credible options to better demonstrate that Option 4 (preferred option) is the most efficient and prudent way forward. Further detail in relation to these points is provided in Section 3 of this PACR.

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

The following changes have occurred since the PADR which have not made an impact on the preferred option:

- updated the substation primary equipment investment cost in the base case and Options 1, 2, 3 and 5 to include remediating fault level limitations on the busbar to allow comparable assessment with Option 4,
- updated operations and maintenance costs,
- updated phasing of risk cost benefits to align with the timing of substation primary equipment investment; and
- removed unserved energy benefits from the NPV analysis.

Option 4 remains the preferred option at this stage of the RIT-T process.

## Complete replacement with 22 kV switchroom and 220 kV in-situ secondary systems remains the most prudent and economically efficient option to meet regulatory obligations

In the PADR Transgrid put forward for consideration five technically and commercially feasible options:

- Option 1 – Complete replacement with Secondary Systems Building

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

[6] Including $12.1m of investment costs in 2025 to allow comparable assessment of the base case, Option 1, 2 and 3 with the revised Option 4 and new Option 5.

- Option 2 – Complete in-situ replacement
- Option 3 – Strategic asset replacement
- Option 4 – Complete replacement with 22 kV switchroom and 220 kV in-situ secondary systems
- Option 5 – Complete in-situ secondary systems and 22 kV AIS replacement

Option 4 remains the most prudent and economically efficient option to address the identified need. Implementation of Option 4 will enable Transgrid to continue meeting its regulatory obligations set out in clauses 4.11.1, 4.6.1(b),[7] and Schedule 5.1 of the NER. Consequently, it will ensure the performance standards applicable to Broken Hill substation secondary systems are met and is therefore the preferred option for this RIT-T.

Transgrid expects coronavirus (COVID-19) to impact suppliers and disrupt their supply chains, 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 1 Options considered

| Option | Description | Capital cost ($m 2020/21) | Operating costs ($ per year) | Remarks |
|---|---|---|---|---|
| Option 1 | Complete replacement with Secondary Systems Building | 13.8 (+/- 25%) by 2022/23 (additional $12.1 million by 2024/25*) | ~ 172,000 | Technically and commercially feasible but less efficient. |
| Option 2 | Complete in-situ replacement | 8.0 (+/- 25%) by 2022/23 (additional $12.1 million by 2024/25*) | ~ 172,000 | Technically and commercially feasible but less efficient. |
| Option 3 | Strategic asset replacement | 6.2 (+/- 25%) by 2024/25 and ~ 1.6 in 2029/30 (additional $12.1 million by 2024/25*) | ~ 172,000 | Technically and commercially feasible but does not address technological obsolescence beyond 2023. |
| Option 4 | Complete replacement with 22 kV switchroom and 220 kV in-situ secondary systems | 18.3 (+/- 25%) by 2022/23 | ~ 23,000 | Preferred option, provides efficiencies in combining primary works with secondary works and provides the most benefit to consumers. |

[7] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

| Option | Description | Capital cost ($m 2020/21) | Operating costs ($ per year) | Remarks |
|---|---|---|---|---|
| Option 5 | Complete in-situ secondary systems and 22 kV AIS replacement | 18.2 (+/- 25%) by 2022/23 | ~ 169,000 | Provides efficiencies in combining primary works with secondary works but does not address unique site conditions. |

* Future expenditure for 22kV primary plant renewal.

Renewal of the 22kV primary plant has been included in the upfront capital cost of Options 4 and 5 to allow efficiencies to be achieved by combining the replacement of both the secondary and primary assets as an integrated solution by 2022/23. Options 1, 2 and 3 only include the secondary systems renewal in their upfront capital cost by 2022/23, but have included subsequent expenditure in 2024/25 for the 22kV primary system renewal as part of the economic assessment to allow 'life-for-like' assessment of all options.

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

Transgrid does not consider non-network options to be commercially and technically feasible to assist with meeting the identified need for this RIT-T. Non-network options are not able to meet NER obligations to provide redundant secondary systems and ensure that the transmission system is adequately protected.

### Option 4 delivers highest net economic benefits

In all scenarios, highest net economic benefits result from implementing Option 4. Option 4 is the most efficient option to ensure reliability of the secondary systems at Broken Hill substation and mitigate its risks of prolonged failure while also considering the efficiency and benefits achieved through delivering it as an integrated renewal with the primary system. Sensitivity testing finds that Option 4 delivers the most net economic benefits under all sensitivities undertaken by Transgrid.

### Option 4 delivers the most benefit to consumers

In this PACR Transgrid has considered five credible options which have been assessed relative to the base case. Of the credible options considered, Option 4 delivers the most benefit to consumers. This includes renewal of 22 kV switchgear which, although not part of the secondary systems need being addressed by this RIT-T, has been discussed in some sections of this PACR as it maximises the benefit to consumers when considered as an integrated solution.

While all options consider renewal of the 220kV and 22kV secondary systems, the renewal of the 22kV primary systems are considered as either future expenditure scheduled by 2024/25 for Options 1, 2 and 3, or undertaken at the same time as the secondary systems renewal by 2022/23 in Options 4 and 5. Options 4 and 5 consider the efficiency achieved through bundling the renewal works given the remote location challenges of Broken Hill.

Option 4 offers an additional benefit as the 22kV secondary and primary systems are renewed using a 'switchroom' solution, whereby the secondary and primary systems are integrated. This solution represents

the modern day practice for this type of equipment, such as would be seen at new renewable generator sites. This 'switchroom' solution will also have lower operational expenditure associated with responding to supply reliability interruptions caused by birds and vermin which is a known issue at Broken Hill substation. It will also provide an unserved energy benefit by addressing this issue, which has not been included in the analysis as it is within the reliability standard.

The efficiency and risk benefits offered by Option 4 result in it having the highest net economic benefit, making it the preferred option.

## Conclusion: complete replacement with 22 kV switchroom and 220 kV in-situ secondary systems is optimal

The optimal commercially and technically feasible option presented in the PACR – Option 4 (complete replacement with 22 kV switchroom and 220 kV in-situ secondary systems at the Broken Hill substation) – remains the preferred option to meet the identified need.

Option 4 addresses the identified secondary systems need and scheduled primary system renewals in an efficient manner with additional reliability benefits. This option offers the most benefit to consumers (highest net economic benefits) and can be implemented in sufficient time to meet the identified need by 2022/23. It is therefore the preferred option presented in this PACR.

Moving forward with this option is the most prudent and economically efficient solution to enable Transgrid to continue meeting its regulatory obligations set out in clauses 4.11.1, 4.6.1(b),[8] and Schedule 5.1 of the NER. Consequently, it will ensure the performance standards applicable to Broken Hill substation secondary systems are met.

This option results in efficient renewal of the primary systems as an integrated solution with the secondary systems, maximising the benefit to consumers. This has been assessed through the assessment of Options 1, 2 and 3 whereby the secondary systems are renewed by 2022/23 and the primary systems separately by 2024/25. Option 4 has the highest net economic benefit, making it the preferred option.

The estimated capital cost of this option is approximately $18.3 million. Routine operating and maintenance costs are approximately $23,000 per year.

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 2021/22 with procurement and delivery of the identified assets planned to occur during 2021/22. All works will be completed by 2022/23.

Necessary outages of relevant existing assets will be planned appropriately in order to complete the works with minimal impact on the network.

The analysis undertaken and the identification of Option 4 as the preferred option satisfies the RIT-T. Option 4 is the preferred option in accordance with NER clause 5.16.1(b) because it is the credible option

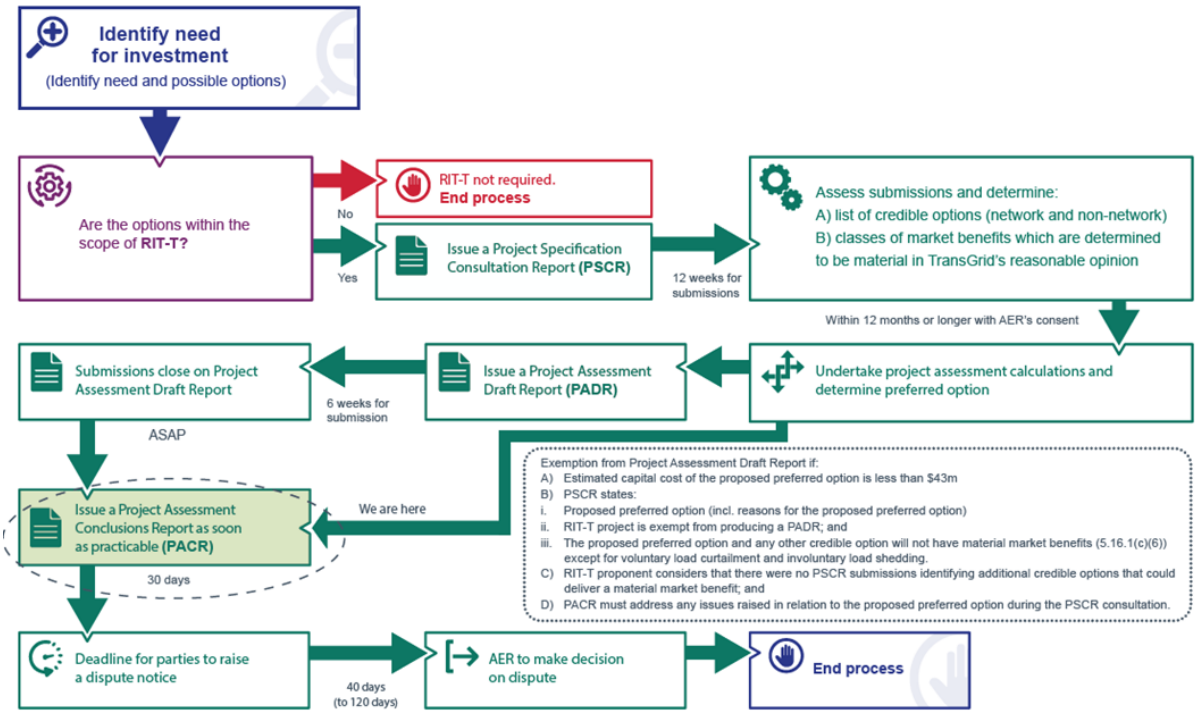
[8] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. This preferred option, Option 4, was found to have the highest net economic benefit while also maintaining compliance with regulatory and safety obligations. 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, Option 4 delivers the most net benefit.

## 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) and Project Assessment Draft Report (PADR) published in December 2019 and March 2021, respectively.

Figure 1 This PACR is the third stage of the RIT-T process[9]




Parties wishing to raise a dispute notice with the AER may do so prior to 14 December 2021 (30 days after publication of this PACR). 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 'Broken Hill Secondary Systems PACR'.

To read the Project Assessment Conclusions Report visit Transgrid's website

[9] Australian Energy Market Commission. "*Replacement expenditure planning arrangements, Rule determination*". Sydney: AEMC, 18 July 2017.65. Accessed 14 May 2020. https://www.aemc.gov.au/sites/default/files/content/89fbf559-2275-4672-b6ef-c2574eb7ce05/Final-rule-determination.pdf