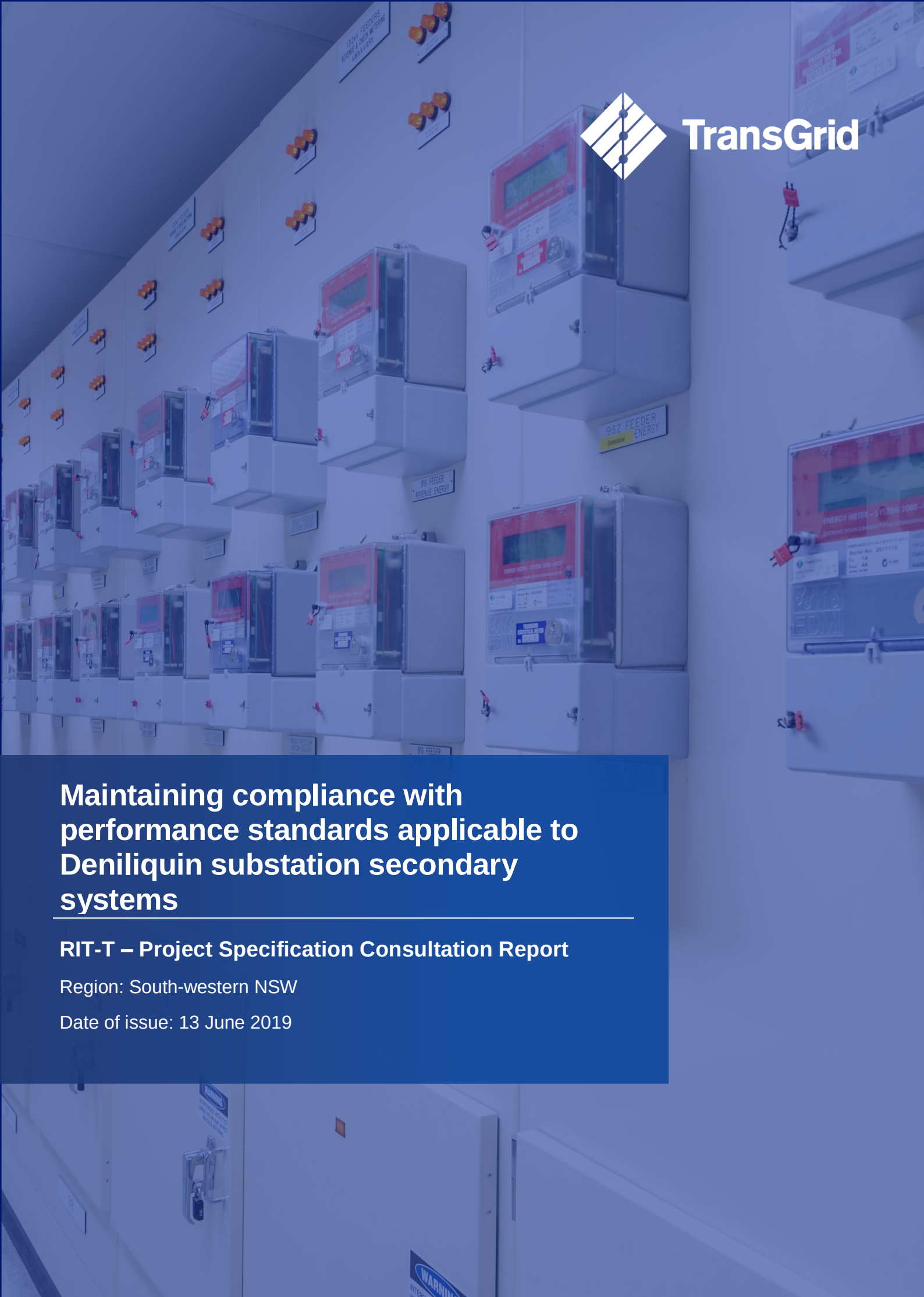


Maintaining compliance with performance standards applicable to Deniliquin substation secondary systems

RIT-T – Project Specification Consultation Report

Region: South-western NSW

Date of issue: 13 June 2019

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 as at 13 June 2019 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 those 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).

Executive summary

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining reliable secondary systems at Deniliquin substation. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process.

TransGrid has identified that the secondary systems at Deniliquin 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 the any primary asset connected to the substation to reliably operate will be at risk.

Deniliquin substation will continue to play a central role in supporting the flow of energy to the Riverina region of New South Wales. It forms part of the wider south-western NSW network which supports renewable energy zone development.

Identified need: continue meeting network performance rules requirements

Secondary systems are used to control, monitor, protect and secure communication to facilitate safe and reliable network operation.[1] They are necessary to operate the transmission network and prevent damage to primary systems when adverse events occur.

The Network Performance Requirements, Schedule 5.1 of the National Energy Rules (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 Rules specifically 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 of a protection systems is being carried out.[2] 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.[3]

Furthermore, as per clause 4.11.1 of the NER, remote control and monitoring systems are required to be maintained in accordance with the standards and protocols determined and advised by the Australian Energy Market Operator (AEMO).[4]

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

Though repair of a failed secondary systems is a possible interim measure, the approach is not sustainable as spare components will deplete due to the technology no longer being manufactured or supported. Once all spares are used, repair will cease to be a viable option to meet performance standards applicable to Deniliquin substation secondary systems.

---

1 As per Schedule 5.1 of the NER.

2 As per S5.1.2.1(d) of the NER.

3 Australian Energy Market Operator. *"Power System Security Guidelines, 31 December 2018."* Melbourne: Australian Energy Market Operator, 2018. Accessed 20 March 2019. https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715---Power-System-Security-Guidelines.pdf

4 As per clause 4.11.1 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 (that is by 2022/23), the likelihood of not recovering from secondary systems faults and not maintaining compliance with the Rules' performance requirements will increase.

Continued deterioration of the secondary systems at Deniliquin substation will accelerate the depletion of spares which will lead to a situation where TransGrid is unable to operate the secondary system in accordance with clause 4.6 of the NER. [5]

Categorised as a reliability corrective action under the RIT-T, 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.

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.

There are also economic benefits from reduction of reliability, safety and environmental risks by implementing a replacement option.

Credible options considered

In this PSCR, TransGrid has put forward for consideration credible options that would meet the identified need from a technical, commercial, and project delivery perspective.[6]

These are summarised in the following table.

Table E-1 – Summary of the credible options

Option	Description	Capital cost	Operating cost and maintenance	Remarks
Option 1	Secondary systems building replacement	$10.4 million	$4,000 per year	Most economically beneficial and preferred option
Option 2	Complete in situ (on-site) replacement	$4.4 million	$4,000 per year	Less efficient
Option 3	Strategic asset replacement	$2.84 million by 2022/23 and $532,000 between 2023/24 and 2037/38	$4,000 per year	Less efficient

Non-network options are not able to assist in 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 as non-network options will not enable TransGrid to continue meeting its Rules obligation to provide redundant secondary systems and ensure that the transmission system is adequately protected.

5 As per clause 4.6.1 of the NER.

6 As per clause 5.15.2(a) of the NER.

Options assessed under three different scenarios

TransGrid has considered three alternative scenarios – a low net economic benefits scenario, a central scenario, and a high net economic benefits scenario – all involve a number of assumptions that results in the lower bound, the expected, and the upper bound estimates for present value of net economic benefits respectively.

Table E-2 – Summary of the scenarios

Variable/Scenario	Central	Low net economic benefit	High net economic benefit
Scenario weighting	*50%*	*25%*	*25%*
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Discount rate	5.9%	7.2%	4.6%
Unserved energy	Base estimates	Base estimate - 25%	Base estimate + 25%

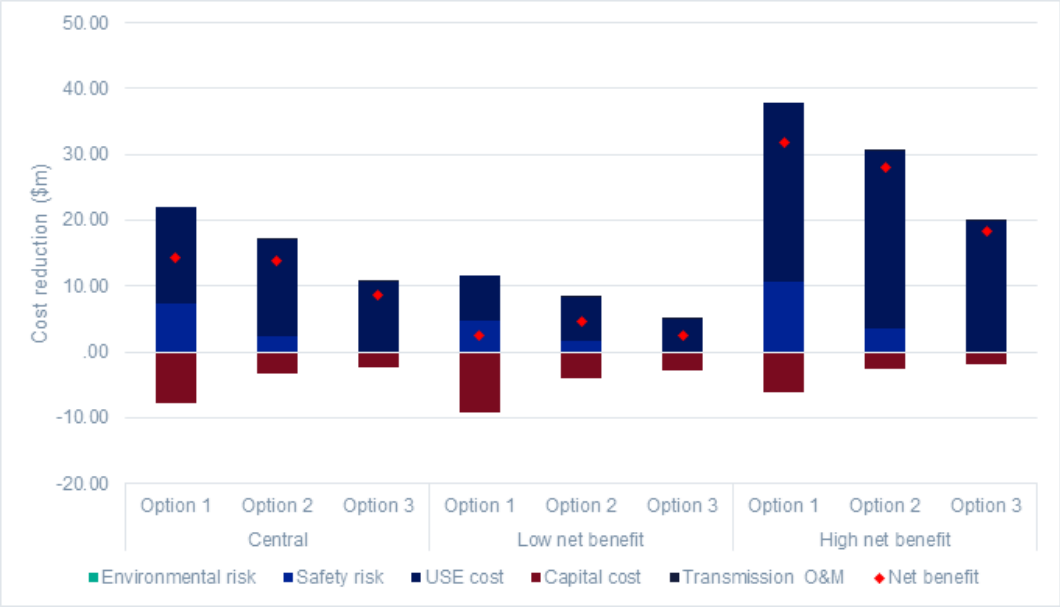
Implementing Option 1 will meet relevant regulatory obligations

Implementation of Option 1 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 also ensure the performance standards applicable to Deniliquin substation secondary systems are met.

Option 1 delivers highest net economic benefits

In all scenarios, highest net economic benefits result from implementing Option 1. The gross economic benefits are mostly composed of improvement in reliability and reduction in safety risks.

Figure E-1 – Breakdown of net economic benefits relative to the base case, present value 2017/18 $m



[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.

The figures below illustrate that for all sensitivity tests, the estimated net economic benefits of Option 1 are positive.

Figure E-2 – Sensitivity of the net economic benefits from Option 1

Draft conclusion

The implementation of Option 1, a complete upgrade and renewal of secondary systems at Deniliquin by using modular Secondary Systems Building (SSB) and installing new cable throughout the substation, is the most efficient technically and commercially feasible option at this draft stage of the RIT-T process. Option 1 can be implemented in sufficient time to meet the identified need by 2022/23, and is therefore the preferred option presented in this PSCR.

The estimated capital cost of this option is approximately $10.4 million. The total capital cost for this option has a weighted present value of $7.7 million. Routine and operating maintenance costs are approximately $38,000 per year – the same as the base case.

The work will be undertaken over the three-year period until 2022/23, with all works expected to 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.

Submissions and next steps

The purpose of this PSCR is to set out the reasons TransGrid proposes that action be undertaken, present the options that address the identified need, outline the technical characteristics that non-network options will need to provide, and allow interested parties to make submissions and provide input to the RIT-T assessment.

TransGrid welcomes written submissions on materials contained in this PSCR. Submissions are particularly sought on the credible options presented and from potential proponents of non-network options that could meet the technical requirements set out in this PSCR. Submissions are due on 5 September 2019.

Submissions should be emailed to TransGrid's Prescribed Revenue & Pricing team via RIT-TConsultations@transgrid.com.au.[8] In the subject field, please reference 'PSCR Deniliquin secondary systems project.'

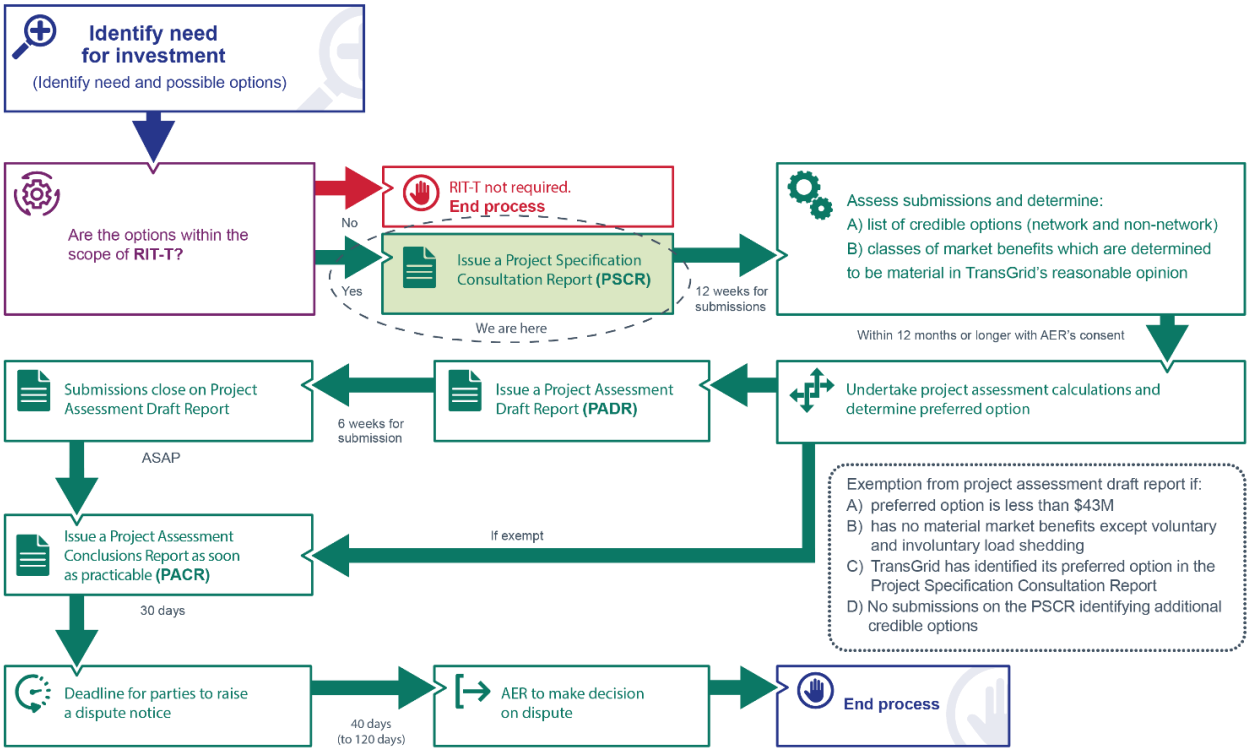
At the conclusion of the consultation process, all submissions received will be published on the TransGrid's website. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement.

Publication of a Project Assessment Draft Report (PADR) is not required for this RIT-T as TransGrid considers its investment in relation to the preferred option to be exempt from that part of the process as per NER clause 5.16.4(z1). Therefore, the next step in this RIT-T, following consideration of submissions received via the 12-week consultation period and any further analysis required, will be publication of a Project Assessment Conclusions Report (PACR). TransGrid anticipates publication of a PACR by 5 October 2019.

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. Accordingly, if TransGrid considers that any additional credible options are identified, TransGrid will produce a PADR which includes a net present value (NPV) assessment of the net economic benefits of each additional credible option.

[8] 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. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement. See section 1.2 for more details.

Figure E-3: This PSCR is the first stage of the RIT-T process[9]



[9] Australian Energy Regulator, *"Final determination on the 2018 cost thresholds review for the regulatory investment tests,"* accessed 15 March 2019. https://www.aer.gov.au/communication/aer-publishes-final-determination-on-the-2018-cost-thresholds-review-for-the-regulatory-investment-tests

Contents

List of Tables

List of Figures

1. Introduction

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining a reliable secondary systems at Deniliquin substation. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process.

TransGrid has identified that the secondary systems at Deniliquin 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 the any primary asset connected to the substation to reliably operate will be at risk. The deterioration of the secondary systems must be addressed to support a functional substation.

Deniliquin substation forms part of the wider south-western NSW network and will continue to play a central role in supporting renewable energy zone development and the flow of energy to the Riverina region of New South Wales.

TransGrid has commenced this RIT-T to examine and consult on options to mitigate and alleviate the deterioration of the secondary systems at Deniliquin substation and the risk from technology obsolescence. As investment is intended to maintain compliance with Rules requirement, TransGrid considers this a reliability corrective action RIT-T.

1.1 Purpose of this report

The purpose of this PSCR is to:

- set out the reasons why TransGrid proposes that action be undertaken (that is, the 'identified need')
- present the options that TransGrid currently considers to address the identified need
- outline how non-network options are unlikely to contribute to meeting the identified need for this RIT-T
- allow interested parties to make submissions and provide inputs to the RIT-T assessment.

2. The identified need

Deniliquin 132/66 kV substation was commissioned in early 1970s and forms part of TransGrid's network that serves the Riverina region in south-western NSW. A customer connection point supplying Essential Energy in the Deniliquin area, it supports the flow of electricity to nearby agricultural industries which mainly consist of irrigation and rice farming,[10] as well as a residential population of more than 7,000[11].

Deniliquin substation is supplied by Wagga 330 kV substation and Darlington Point substation, via two 132 kV transmission lines which connect at Coleambally (Line 99L) and Finley (Line 9R3).

A further five feeders at 66 kV, all owned by Essential Energy, run between Deniliquin substation and Essential Energy substations in the surrounding area. These substations include: Moama (Line 84Y); Moulamein, tees Deniliquin Town and Murgha (Line 822); Deniliquin Town (Line 845); Barham, tee Deniliquin Town (Line 844); and Moama, tee Deniliquin Town (Line "No.6").

In addition to these feeders, Deniliquin substation comprises two 132/66/11 kV transformers and three 66 kV capacitors.

The secondary systems components at Deniliquin were installed between 1970 and 2007 to further support the safe and reliable operation of the substation. This arrangement is necessary to ensure that all electricity users in south-western NSW, whether they be large industrial directly connected to TransGrid's network or residential consumers connected via Essential Energy's distribution network, are able to receive the level of support they require.

Deniliquin substation will continue to play a central role in supporting the flow of energy to the Riverina region of NSW. It forms part of the wider south-western NSW network which supports renewable energy zone development.[12]

The load for Deniliquin substation is predominantly agricultural and residential[13] which was approximately 54 MW in the summer of 2018/19.[14]

An overview of the south-western transmission network is provided in Figure 2-1 below.

---

10 It is estimated that every $1 of rice production equates to $4 in flow on economic activity. Deniliquin is capable of producing significant tonnage of rice and is home to the largest rice mill in the southern hemisphere. Rice Growers' Association of Australia, "*Rice Community*", accessed 4 April, 2019. http://www.rga.org.au/the-rice-industry/rice-community.aspx

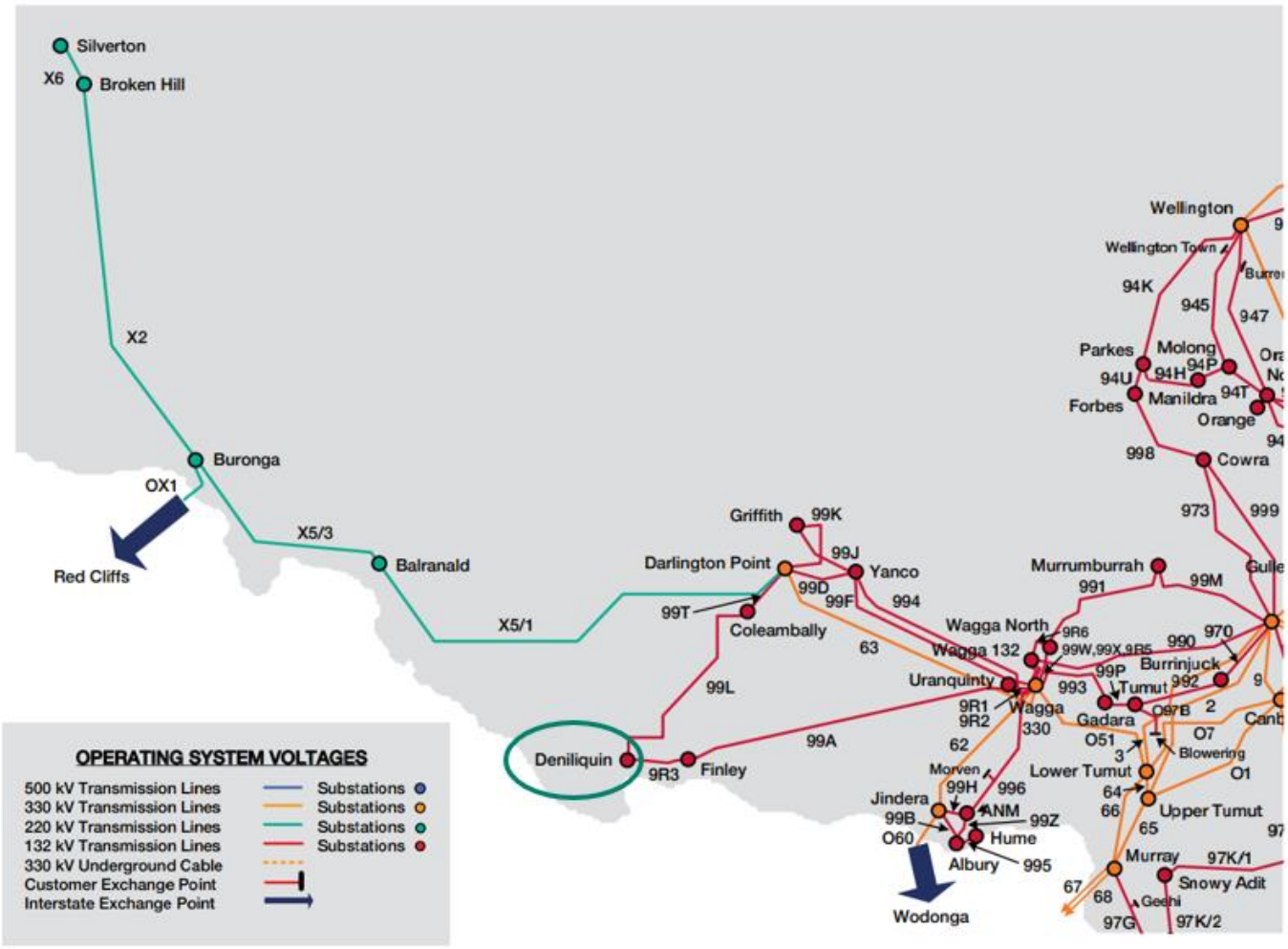
11 Australian Bureau of Statistics, "*2016 Census QuickStats*", accessed 4 April, 2019. https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/SSC11237

12 South-western NSW has potential capacity for 5GW of wind generation and >5GW of solar generation. TransGrid. "*Transmission Annual Planning Report 2018*." Sydney: TransGrid, 2018. 53. Accessed 5 April, 2019. https://www.transgrid.com.au/news-views/publications/Documents/Transmission%20Annual%20Planning%20Report%202018%20TransGrid.pdf

13 Australian Energy Market Operator, *"AEMO Visualisations Map,"* accessed 3 April, 2019. http://www.aemo.com.au/aemo/apps/visualisations/map.html

14 TransGrid's internal analysis.

Figure 2-1 – Transmission network supplying Deniliquin



2.1 Description of the identified need

Secondary systems are used to control, monitor, protect and secure communication to facilitate safe and reliable network operation.[15] They are necessary to operate the transmission network and prevent damage to primary assets when adverse events occur.

The Network Performance Requirements, set out in Schedule 5.1 of the National Energy Rules (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 Rules 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 of protection

[15] As per Schedule 5.1 of the NER.

systems is being carried out.[16] 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.[17]

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 the Australian Energy Market Operator (AEMO).[18]

TNSPS, as per clause 4.11.2 of the NER, are also required to provide and maintain necessary primary and back-up communications facilities for control, operational metering and indication from the relevant local sites to the appropriate interfacing termination as nominated by AEMO.[19]

In general, failures are becoming more difficult to diagnose and rectify due to obsolescence of equipment and supporting tools, leading to longer recovery times. TransGrid estimates that the amount of time it takes to recover from secondary systems failure (eg malfunction of the 132 kV low impedance busbar protection relays) once spares are depleted, is estimated to exceed 16 hours – longer than acceptable.[20] During this period, the failed component of the secondary systems would need to be replaced with a new design and primary assets such as the lines or transformers connected to the substation would have to be taken out of service.

Though replacement of failed secondary systems component is a possible interim measure, the approach is not sustainable as spare components will deplete due to the technology no longer being manufactured or supported. Sourcing spares will continue to be a challenge as the technology and its supporting software has become obsolete. Cybersecurity risk from using unsupported and un-patchable configuration and diagnostic software are also present.

TransGrid considers spare parts will be exhausted by 2023. However, continued deterioration of the secondary systems at Deniliquin substation will accelerate the depletion of spares. Once all spares are used and the asset becomes unserviceable, repair will cease to be a viable option to meet performance standards applicable to Deniliquin substation secondary systems.

Therefore, a technically and commercially feasible credible option must be implemented in sufficient time (ie by 2022/23) to maintain compliance with the NER requirement.

Categorised as a reliability corrective action under the RIT-T, 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.

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.

2.2 Assumptions underpinning the identified need

2.2.1 Depletion of available spares due to no manufacturer support for technologically obsolete components

Though repair of a failed secondary systems at Deniliquin substation is possible as an interim measure, the approach is not sustainable as spare components will deplete due to the technology no longer being

16 As per S5.1.2.1(d) of the NER.

17 Australian Energy Market Operator. *"Power System Security Guidelines, 31 December 2018."* Melbourne: Australian Energy Market Operator, 2018. Accessed 20 March 2019. https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715---Power-System-Security-Guidelines.pdf

18 As per clause 4.11.1 of the NER.

19 Australian Energy Market Operator. "Power System Data Communication Standard." Melbourne: Australian Energy Market Operator, 2018. Accessed 20 March 2019. https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/AEMO-Standard-for-Power-System-Data-Communications.pdf

20 As per S5.1.2.1(d) of the NER.

manufactured or supported. Once all spares are used, repair will cease to be a viable option and will not enable performance standards applicable to Deniliquin substation secondary systems to be met.

2.2.2 Deterioration of control systems increases the risk of substation failure

TransGrid has identified several critical issues with the secondary systems at Deniliquin substation. The issues are outlined in Table 2-1 are expected to escalate until the asset is fully inoperable.

Table 2-1 – Identified condition of Deniliquin substation secondary systems

Asset components	Issues	% of services at site
Line/Feeder Protection Relays	> Component technology obsolescence resulting in a lack of spares and no manufacturer support > Inaccurate measurement of fault angles due to deteriorated internal components > End of asset life	100% of all line/feeder protection relays on site
Transformer Protection Relays	> Component technology obsolescence resulting in a lack of spares and no manufacturer support > Faulty harmonic bias circuitry due to component failure > Internal wiring connection problems	100% of all transformer protection relays on site
Busbar Protection Relays	> Degradation of plastic components causing mechanical failure of the pickup adjusting mechanism > Component technology obsolescence resulting in a lack of spares and no manufacturer support	100% of all busbar protection relays on site
Capacitor Protection Relays	> Prone to excessive mechanical wear under certain situations, potentially causing a slow rest > Component technology obsolescence resulting in a lack of spares and no manufacturer support	100% of all capacitor protection relays on site
EDMI MK3 Energy Meters	> Microprocessor Energy Meters failing as they approach 15 years of life > Component technology obsolescence resulting in a lack of spares and no manufacturer support	100% of all market meters on site

3. Options that meet the identified need

TransGrid considers credible network options that would meet the identified need from a technical, commercial, and project delivery perspective.[21]

In identifying credible options, TransGrid has taken the following factors into account: energy source; technology; ownership; the extent to which the option enables intra-regional or intra-regional trading of electricity; whether it is a network option or a non-network option; whether the credible option is intended to be regulated; whether the credible option has proponent; and any other factor which TransGrid reasonably considered should be taken into account.[22]

3.1 Base case

The costs and benefits of each option in this PSCR are compared against those of a base case. Under this base case, no proactive capital investment is made to remediate the technological obsolescence, spares unavailability, manufacturer non-support, and components deterioration of the secondary systems. The asset will continue to operate and be maintained under the current regime.

The majority of protection relays, remote control and monitoring devices at this site have limited spares, no manufacturer support, and will reach end of serviceable life by 2022/23. Repairs will become more difficult due to limited spares and this will lead to periods of unavailability. As a result, the likelihood of a hazardous event will increase.

Annual maintenance costs are approximated at $38,000 per year. However, increases to the regular maintenance regime will not be able to mitigate the risk of substation failure.

3.2 Option 1 – Secondary Systems Building replacement

Option 1 involves a complete upgrade and renewal of secondary systems at Deniliquin substation by using modular Secondary Systems Buildings (SSB) and installing new cable throughout. This option will modernise the automation philosophy to current design standards and practices.

This option assumes that the new secondary systems will be designed to be accommodated within a similar panel arrangement as the existing installation. Redundant panels and tunnel boards in the Auxiliary Services Building's (ASB) relay room will need to be progressively decommissioned and removed as the new secondary systems are cut-over and commissioned.

The estimated capital costs for the option total $10.4 million. Routine operating and maintenance costs are approximately $38,000 per year.

The work will be undertaken over the three-year period until 2022/23, with all works expected to be completed by 2022/23.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network.

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

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

[22] As per clause 5.15.2(b) of the NER.

3.3 Option 2 – Complete in situ (on-site) replacement of protection and control systems

Option 2 involves replacement of all secondary systems assets at Deniliquin substation. This option will modernise the automation philosophy to current design standards and practices. This option also includes replacement of Direct Current (DC) supplies to account for an increase in secondary systems power requirements and remediation of the 415V Alternating Current (AC) distribution in the building and the switchyard.

The estimated capital costs for the option total $4.4 million. Routine operating and maintenance costs are approximately $4,000 per year.

The work will be undertaken over the three-year period until 2022/23, with all works expected to be completed by 2022/23.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network.

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

3.4 Option 3 – Strategic asset replacement

Option 3 involves individual replacements of identified assets up to 2023. The option is based on a like-for-like approach whereby the assets is replaced by its modern equivalent. Additional system modifications or additional functionalities would not be deployed under this option. This option will lock TransGrid to a system architecture that cannot be expanded to match modern technology capabilities into the future.

The estimated capital costs for the option total $2.84 million by 2022/23. A further $532,000 between 2023/24 and 2037/38. Routine operating and maintenance costs are approximately $4,000 per year.

The work will be undertaken over the three-year period until 2022/23, with all works expected to be completed by 2022/23.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network.

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

3.5 Options considered but not progressed

At this draft stage of the RIT-T process, TransGrid determines that there is no other commercially and technically feasible option to meet the identified need.

3.6 No material inter-network impact is expected

TransGrid has considered whether the credible options listed above is expected to have material inter-regional impact.[23] A 'material inter-network impact' is defined in the NER as:

> *"A material impact on another Transmission Network Service Provider's network, which may include (without limitation): (a) the imposition of power transfer constraints within another*

[23] As per clause 5.16.4(b)(6)(ii) of the NER.

Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."

AEMO's suggested screening test to indicate that a transmission augmentation has no material inter-network impact is that it satisfies the following:[24]

- a decrease in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in fault level by less than 10 MVA at any substation in another TNSP's network
- the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

TransGrid notes that each credible option satisfies these conditions as it does not modify any aspect of electrical or transmission assets. By reference to AEMO's screening criteria, there is no material inter-network impacts associated with any of the credible options considered.

[24] Inter-Regional Planning Committee. *"Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations."* Melbourne: Australian Energy Market Operator, 2004. Appendix 2 and 3. Accessed 15 March 2019. https://www.aemo.com.au/-/media/Files/PDF/170-0035-pdf.pdf

4. Non-network options

TransGrid does not consider non-network options to be commercially and technically feasible to assist with meeting the identified need for this RIT-T as non-network options will not be enable TransGrid to continue meeting its Rules obligation under Schedule 5.1 and clause 4.11 of the NER to provide redundant secondary systems and ensure that the transmission system is adequately protected.

5. Materiality of market benefits

5.1 All credible options are expected to reduce involuntary load shedding

Involuntary load shedding is where a customer's load is interrupted from the network without their agreement or prior warning. TransGrid has quantified the expected involuntary load shedding by estimating the chances of widespread load shedding due to the assets failure and mean time to repair. A reduction in involuntary load shedding relative to the base case is expected under each option.

5.2 Wholesale electricity market benefits are not material

The AER has recognised that if the credible options considered will not have an impact on the wholesale electricity market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated.[25]

TransGrid determines that the credible options considered in this RIT-T will not have an impact on the wholesale electricity market, therefore considers that the following classes of market benefits are not material for this RIT-T assessment:

- changes in fuel consumption arising through different patterns of generation dispatch
- changes in voluntary load curtailment (since there is no impact on pool price)
- changes in costs for parties other than the RIT-T proponent
- changes in ancillary services costs
- changes in network losses
- competition benefits
- Renewable Energy Target (RET) penalties.

5.3 No other categories of market benefits are material

In addition to the classes of market benefits listed above, NER clause 5.16.1(c)(4) requires TransGrid to consider the following classes of market benefits, listed in Table 5-1, arising from each credible option.

The same table sets out the reasons TransGrid considers these classes of market benefits to be immaterial.

Table 5-1 – Reasons non-wholesale electricity market benefits are considered immaterial

Market benefits	Reason
Differences in the timing of expenditure	Either option is being undertaken to mitigate, in isolation, the rising risk caused by the existing asset nearing its end of serviceable life.
Option value	TransGrid notes the AER's view that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available is likely to change in the future, and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[26]

[25] Australian Energy Market Operator. *"Power System Security Guidelines, 31 December 2018."* Melbourne: Australian Energy Market Operator, 2018. Accessed 20 March 2019. https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3715---Power-System-Security-Guidelines.pdf

[26] Australian Energy Regulator. *"Application guidelines Regulatory Investment Test for Transmission - December 2018."* Melbourne: Australian Energy Regulator, 2018. Accessed 15 March 2019. https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%2014%20December%202018_0.pdf

Market benefits	Reason
	TransGrid also notes the AER's view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. TransGrid notes that no credible option is sufficiently flexible to respond to change or uncertainty. Additionally, a significant modelling assessment would be required to estimate the option value benefit but it would be disproportionate to potential additional benefits for this RIT-T. Therefore, TransGrid has not estimated any additional option value benefit.

6. Overview of the assessment approach

As outlined in section 3.1, all costs and benefits considered have been measured against a base case.

The analysis presented in this RIT-T considered a 20-year period, from 2018/19 to 2038/39. TransGrid considers that a 20-year period takes into account the size, complexity and expected lives of the options and provide a reasonable indication of the costs and benefits over a long outlook period. Since the capital components have asset lives greater than 20 years, TransGrid has taken a terminal value approach to ensure that the capital costs of long-lived assets is appropriately captured in the 20-year assessment period.

TransGrid has adopted a central real, pre-tax 'commercial'[27] discount rate of 5.9%[28] as the central assumption for the NPV analysis presented in this report. TransGrid considers that this is a reasonable contemporary approximation of a commercial discount rate, consistent with the RIT-T.

TransGrid has also tested the sensitivity of the results to discount rate assumptions. A lower bound real, pre-tax discount rate of 4.60% equal to the latest AER Final Decision for a TNSP's regulatory proposal at the time of preparing this PSCR,[29] and an upper bound discount rate of 7.2% (a symmetrical adjustment upwards) are investigated.

6.1 Approach to estimating project costs

TransGrid has estimated the capital costs of the options by using scope from similar works. TransGrid considers the central capital costs estimates to be within ± 25% of the actual costs.

Routine operating and maintenance costs are based on similar to works of similar nature.

Reactive maintenance costs under the base case considers the:

> level of corrective maintenance required to restore assets to working order following a failure
> probability and expected level of network asset faults.

6.2 Three different scenarios have been modelled to address uncertainty

RIT-T assessments are based on cost-benefit analysis that includes assessment under reasonable scenarios which are designed to test alternate sets of key assumptions and their impact on the ranking and feasibility of options.

TransGrid has considered three alternative scenarios, summarised in Table 6-1, to address uncertainty – namely:

> a 'low net economic benefits' scenario, involving a number of assumptions that gives a lower bound and conservative estimates of net present value of net economic benefits
> a 'central' scenario which consists of assumptions that reflect TransGrid's central set of variable estimates that provides the most likely scenario
> a 'high net economic benefits' scenario that reflects a set of assumptions which have been selected to investigate an upper bound of net economic benefits.

---

27 The use of a 'commercial' discount rate is consistent with the RIT-T and is distinct from the regulated cost of capital (or 'WACC') that applies to network businesses like TransGrid.

28 Electricity Networks Association. *"RIT-T Economic Assessment Handbook."* Melbourne: Electricity Networks Association, 2019. Accessed 15 March 2019. https://www.energynetworks.com.au/sites/default/files/ena_rit-t_handbook_15_march_2019.pdf

29 See TransGrid's Post-tax Revenue Model (PTRM) for the 2018-23 period, available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/transgrid-determination-2018-23

Table 6-1 – Summary of the scenarios

Variable/Scenario	Central	Low net economic benefit	High net economic benefit
Scenario weighting	*50%*	*25%*	*25%*
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Discount rate	5.9%	7.2%	4.6%
Unserved energy	Base estimates	Base estimate - 25%	Base estimate + 25%

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

7. Assessment of credible options

7.1 Estimated gross economic benefits

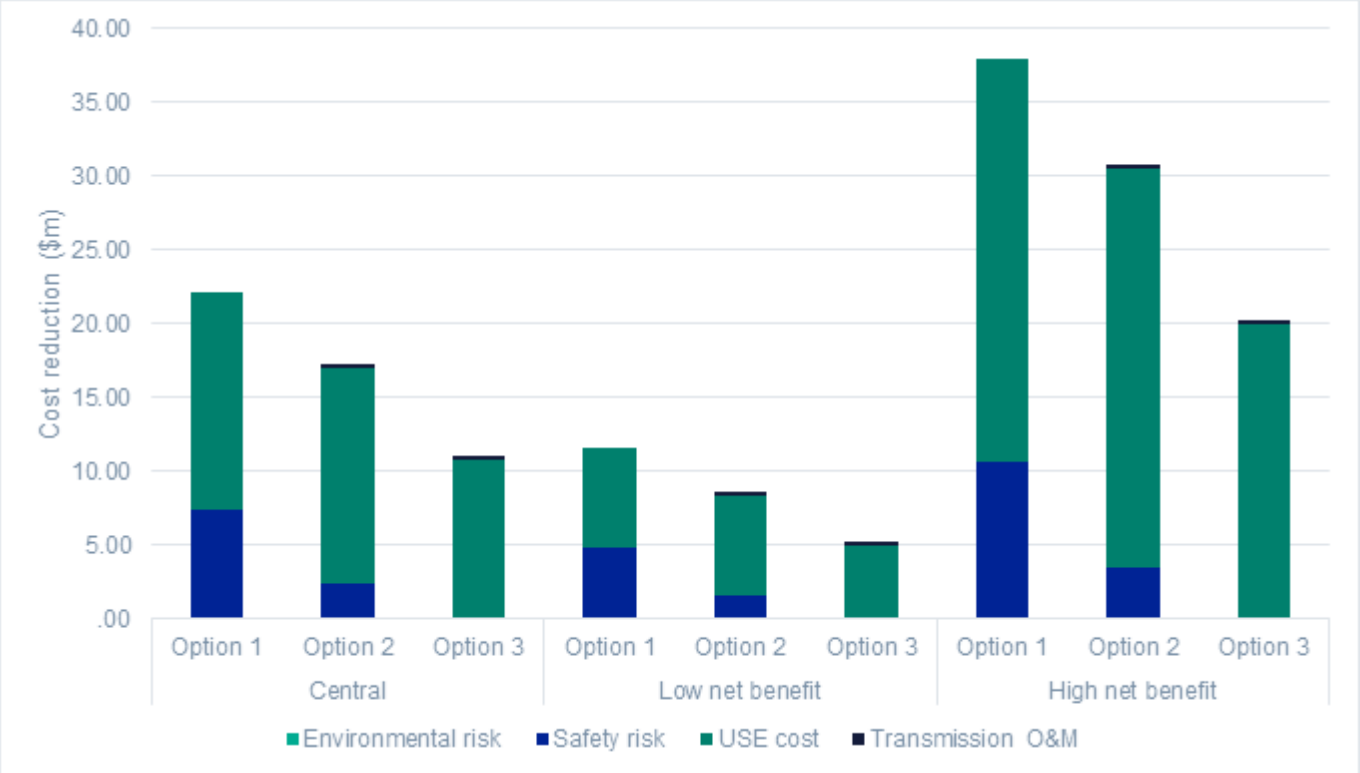
Table 7-1 below summarises the present values of gross economic benefits estimated for each credible option under the three scenarios.

Table 7-1 – Gross economic benefits from credible options relative to the base case, present value 2017/18 $m

Option/scenario	Central	Low net economic benefits	High net economic benefits	Weighted value
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	22.0	11.6	37.9	23.4
Option 2	17.2	8.6	30.7	18.4
Option 3	10.9	5.2	20.2	11.8

Figure 7-1 provides a breakdown of estimated benefits for each credible option.

Figure 7-1 – Components of gross economic benefits, present value 2017/18 $m



7.2 Estimated costs

Table 7-2 summarises the present value of costs of all options relative to the base case under the three scenarios.

Table 7-2 – Present value of costs of all options relative to the base case, PV 2017/18 $m

Option	Central	Low net economic benefit	High net economic benefit	Weighted value
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	7.8	9.1	6.3	7.7
Option 2	3.3	3.8	2.6	3.3
Option 3	2.3	2.7	1.9	2.3

7.3 Meeting relevant regulatory obligations

As per clause 4.11.1, secondary systems are required to be maintained in accordance with the standards and protocols determined and advised by AEMO. They are also needed to meet the Network Performance Requirements imposed on Transmission Network Service Providers (TNSPs) as per Schedule 5.1 of the National Energy Rules (NER).

Implementation of Option 1 is the cheapest option to ensure reliability of the secondary systems at Deniliquin substation, mitigate its risks of prolonged failure, and enable TransGrid to continue to meet the regulatory obligations set out in clause 4.6.1(b)[30] and Schedule 5.1 of the NER.

7.4 Estimated net economic benefits

Table 7-3 summarises the present value of the net economic benefits for each credible option across the three scenarios and the weighted net economic benefits. These net economic benefits are the differences between the estimated gross economic benefits less the estimated costs.

Option 1 has the highest net economic benefit while also maintaining compliance with TransGrid's rules and safety obligations.

Table 7-3 – Net economic benefits for each credible option relative to the base case, present value 2017/18 $m

Option	Central	Low net economic benefits	High net economic benefits	Weighted value
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	14.2	2.4	31.7	15.6
Option 2	13.9	4.6	28.1	15.1

[30] 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	Central	Low net economic benefits	High net economic benefits	Weighted value
Option 3	8.6	2.5	18.3	9.5

7.5 Sensitivity of the economic tests

TransGrid has undertaken thorough sensitivity testing exercise to understand the robustness of the conclusion to underlying assumptions about key variables. The figures below illustrate Option 1 always has the highest net economic benefits while also maintaining compliance with TransGrid's rules and safety obligations.

Figure 7-2 – Sensitivity of the net economic benefits

8. Draft conclusion and exemption from preparing a PADR

The implementation of Option 1, a complete upgrade and renewal of secondary systems at Deniliquin substation by using modular SSB and installing new cable throughout, is the most efficient technically and commercially feasible option to continue meeting Rules requirements at this draft stage of the RIT-T process. Option 1 can be implemented in sufficient time to meet the identified need by 2022/23, and is therefore the preferred option presented in this PSCR.

The estimated capital cost of this option is approximately $10.4 million. This option has a weighted present value of $7.7 million. Routine and operating maintenance costs are approximately $38,000 per year.

The work will be undertaken over the three-year period until 2022/23, with all works expected to 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.

Publication of a Project Assessment Draft Report (PADR) is not required for this RIT-T as TransGrid considers its investment in relation to the preferred option to be exempt from that part of the process as per NER clause 5.16.4(z1). Therefore, the next step in this RIT-T, following consideration of submissions received during the 12-week consultation period and any further analysis required, will be publication of a Project Assessment Conclusions Report (PACR). TransGrid anticipates publication of a PACR by 5 October 2019.

As the investments are intended to continue meeting Rules obligations and will not have material market benefit, TransGrid is exempt from producing a PADR for this RIT-T.

TransGrid welcomes written submissions on material contained in this PSCR. Submissions are due on or before 5 September 2019. Submissions should be emailed to TransGrid's Prescribed Revenue & Pricing team via RIT-TConsultations@transgrid.com.au. In the subject field, please reference 'PSCR Deniliquin secondary systems project.'

NER clause 5.16.4(z1) provides for a TNSP to be exempt from producing a PADR for a particular RIT-T application, in the following circumstances:

(a) if the estimated capital cost of the preferred option is less than $43 million;
(b) if the TNSP identifies in its PSCR its proposed preferred option, together with its reasons for the preferred option and notes that the proposed investment has the benefit of the clause 5.16.4(z1) exemption; and
(c) if the TNSP considers that the proposed preferred option and any other credible options in respect of the identified need will not have a material market benefit for the classes of market benefits specified in clause 5.16.1(c)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding.

TransGrid considers that the preferred option is exempt from producing a PADR under NER clause 5.16.4(z1).

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.

Accordingly, if TransGrid considers that any additional credible options are identified, TransGrid will produce a PADR which includes an NPV assessment of the net economic benefits of each additional credible option.

Should TransGrid consider that no additional credible options were identified during the consultation period, TransGrid intends to produce a PACR that addresses all submissions received including any issues in relation to the proposed preferred option raised during the consultation period.[31]

[31] As per clause 5.16.4(z2) of the NER.

Appendix A – Compliance checklist

This appendix sets out a compliance checklist which demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the Rules version 111.

Rules clause	Summary of requirements	Relevant section
5.16.4 (b)	A RIT-T proponent must prepare a report (the project specification consultation report), which must include:	–
	(1) a description of the identified need;	2
	(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	2
	(3) the technical characteristics of the identified need that a non- network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	NA
	(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent National Transmission Network Development Plan;	NA
	(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alterative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3
	(6) for each credible option identified in accordance with subparagraph (5), information about: (i) the technical characteristics of the credible option; (ii) whether the credible option is reasonably likely to have a material inter-network impact; (iii) the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.1(c)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefit are not likely to be material; (iv) the estimated construction timetable and commissioning date; and (v) to the extent practicable, the total indicative capital and operating and maintenance costs.	3 & 5

5.16.4(z1)	A RIT-T proponent is exempt from paragraphs (j) to (s) if: 1. the estimated capital cost of the proposed preferred option is less than $35 million (as varied in accordance with a cost threshold determination); 2. the relevant Network Service Provider has identified in its project specification consultation report: (i) its proposed preferred option; (ii) its reasons for the proposed preferred option; and (iii) that its RIT-T project has the benefit of this exemption; 3. the RIT-T proponent considers, in accordance with clause 5.16.1(c)(6), that the proposed preferred option and any other credible option in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4) except those classes specified in clauses 5.16.1(c)(4)(ii) and (iii), and has stated this in its project specification consultation report; and 4. the RIT-T proponent forms the view that no submissions were received on the project specification consultation report which identified additional credible options that could deliver a material market benefit.	8

Appendix B – Risk cost framework

This appendix summarises the key assumptions and data from the risk assessment methodology that underpin the identified need for this RIT-T and the assessment undertaken for the Revenue Proposal.[32]

As part of preparing its Revenue Proposal for the current regulatory control period, TransGrid developed the Network Asset Risk Assessment Methodology to quantify risk for replacement and refurbishment projects. The risk assessment methodology:

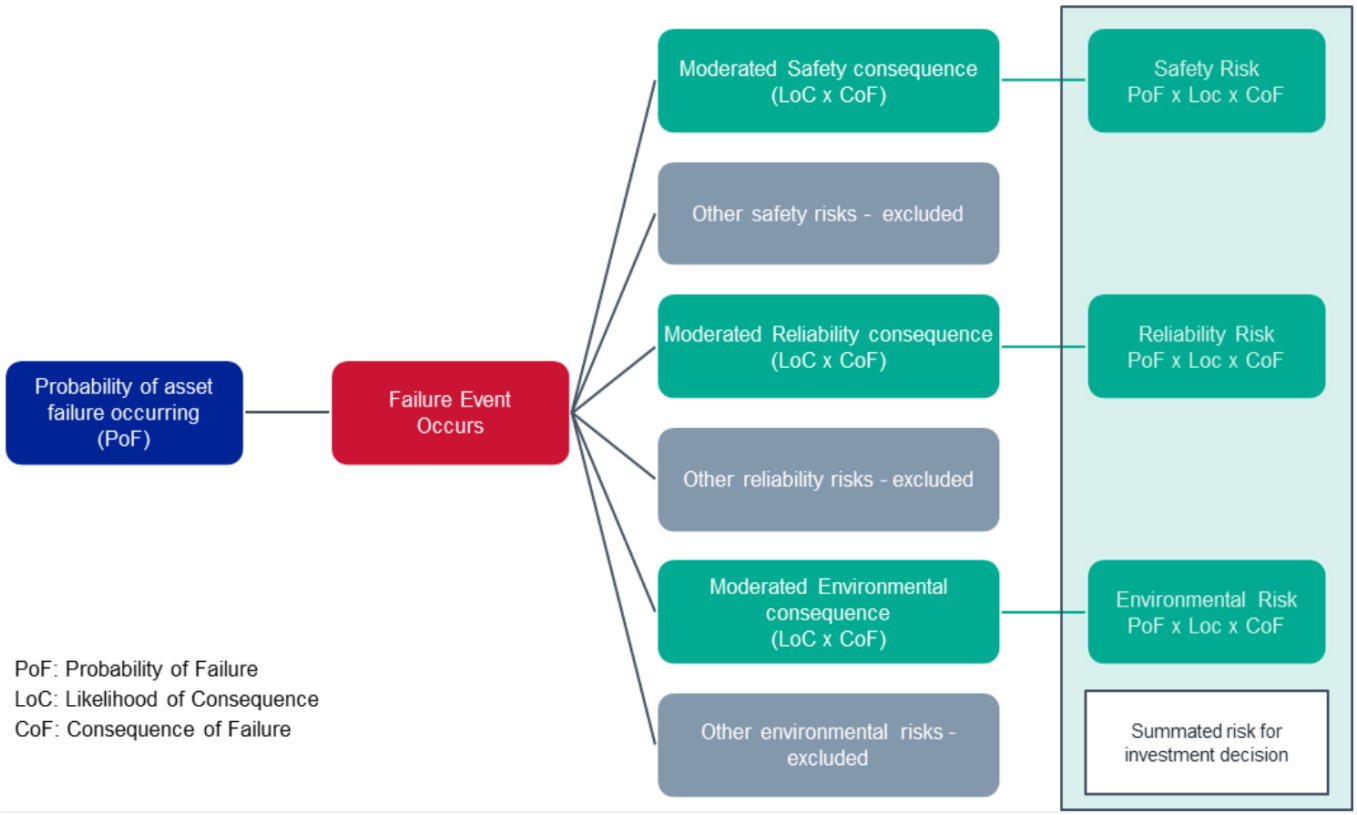
- uses externally verifiable parameters to calculate asset health and failure consequences
- assesses and analyses asset condition to determine remaining life and probability of failure
- applies a worst-case asset failure consequence and significantly moderates this down to reflect the likely consequence in a particular circumstance
- identifies safety and compliance obligations with a linkage to key enterprise risks.

B.1 Overview of risks assessment methodology

A fundamental part of the risk assessment methodology is calculating the 'risk costs' or the monetised impacts of the reliability, safety, environmental and other risks.

Figure below summarises the framework for calculating the risk costs, which has been applied on TransGrid's asset portfolio considered to need replacement or refurbishment.

Figure B-1 – Overview of TransGrid's 'risk cost' framework



The 'risk costs' are calculated based on the Probability of Failure (PoF), the Consequence of Failure (CoF),

[32] TransGrid. *"Revised Regulatory Proposal 2018/19-2022/23."* Melbourne: Australian Energy Regulator, 2017. 63-69. Accessed 15 March 2019. https://www.aer.gov.au/system/files/TransGrid%20-%20Revised%20Revenue%20Proposal%20-%201%20December%202017.pdf

and the corresponding Likelihood of Consequence (LoC).

In calculating the PoF, each failure mode that could result in significant impact is considered. For replacement planning, only life-ending failures are used to calculate the risk costs. PoF is calculated for each failure mode base on ‘conditional age’ (health-adjusted chronological age), failure and defect history, and benchmarking studies. For ‘wear out’ failures, a Weibull curve may be fitted; while for random failures, a static failure rate may be used.

In calculating the CoF, LoC and risks, TransGrid uses a moderated ‘worst case’ consequence. This is an accepted approach in risk management and ensures that high impact, low probability (HILP) events are not discounted. But it excludes the risk costs of low impact, high probability (LIHP) which would results in lower calculated risk.