Transgrid

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Maintaining voltage levels in Northern NSW

RIT-T Project Assessment Conclusions Report

Issue date: 1 February 2024

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Executive summary

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining voltage levels in the Moree and Inverell area in Northern New South Wales (NSW). Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Transgrid and the Australian Energy Market Operator (AEMO) forecasts that minimum demand in NSW will rapidly decline over the next 10 years due to ongoing growth in distributed solar (PV) generation.[1] In Northern NSW, growth in small to large scale embedded generation connecting to the Essential Energy network is forecast to continue, driving declining minimum demand in this region.

The Northern NSW region is supplied by a series of 132 kV transmission lines which form a link between Glen Innes, Armidale and Tamworth. Our power system studies show that the declining minimum demand in these areas mean that the electricity transmission system in these areas is at risk of exceeding allowable voltage levels during times of low demand and in particular when nearby generators are unable to provide reactive power support.

We are required to manage the risk of system voltages exceeding their allowable limits as set out in the National Electricity Rules (NER)[2] and the NSW Electricity Reliability and Performance Standards 2017.This RIT-T therefore examines various network and non-network options to address the excess voltage levels to ensure compliance with the requirements of the NER and provide the greatest net benefit to the market.

Identified need: maintaining voltage levels in Northern NSW in compliance with NER requirements

The identified need for this RIT-T is to maintain voltage levels in Northern NSW by managing the risk of excess voltage levels due to declining minimum demand. There is an increasing likelihood of non-compliance with the NER and NSW reliability standards without investment to address the need.

We are required to maintain compliance with Schedule 5.1.4 of the NER and the NSW Electricity Reliability and Performance Standards 2017. Consequently, we consider this 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.

No submissions received in response to the Project Specification Consultation Report

We published a Project Specification Consultation Report (PSCR) on 26 July 2023 and invited written submissions on the material presented within the document. No submissions were received in response to the PSCR.

No material developments since publication of the PSCR

No additional credible options were identified during the consultation period following publication of the PSCR. The discount rate and Value of Customer Reliability (VCR) used has been updated to align with the Australian Energy Market Operator's (AEMO's) 2023 Inputs, Assumptions and Scenarios Report. No

[1] AEMO, 2023 Electricity Statement of Opportunities, August 2023.

[2] Schedule 5.1.4 of the NER requires us to plan and design equipment for voltage control to maintain voltage levels within 10 per cent of normal voltage. We expect non-compliance with this requirement will occur without remedial action.

material developments have occurred since publication of the PSCR and Option 2 remains the preferred option at this stage of the RIT-T process.

We note that, since the PSCR was released, there has been a law change to introduce an emissions reduction objective into the national energy objectives[3] and that the National Electricity Rules are currently being updated to add a new category of market benefit to the RIT-T reflecting changes in Australia's greenhouse gas emissions.[4] While we acknowledge this important change to the RIT-T, we note that there is not expected to be a difference in greenhouse gas emission levels between the two options assessed in this PACR since the options are not expected to affect the dispatch of generation in the wholesale market. This new category of market benefit is therefore not expected to be material for this RIT-T and so has not been estimated.

Credible options considered

We consider there are two credible options that would meet the identified need from a technical, commercial, and project delivery perspective.[5] These are summarised in Table E-1.

Table E-1 Summary of credible options, $2021/22

Option	Description	Capital costs, $m	Operating costs (per year), $	Remarks
Option 1	Install a 66 kV 10 MVAr reactor at Moree and a 66 kV 15 MVAr reactor at Inverell	7.64	76,400	Provides the same benefits as Option 2, but at a higher cost
Option 2	Install a 132 kV 25 MVAr reactor at Inverell	5.41	54,100	Most economical and preferred option

No submissions received in relation to non-network options

In the PSCR we noted that we considered non-network options may be able to assist with meeting the identified need, specifically non-network technologies that are able to provide reactive support. We invited parties to make written submissions regarding the potential of non-network options to satisfy, or contribute to satisfying, the identified need for this RIT-T. No submissions were received in response to the PSCR in relation to non-network options.

[3] On 12 August 2022, Energy Ministers agreed to fast track the introduction of an emissions reduction objective into the national energy objectives, consisting of the National Electricity Objective (NEO), National Gas Objective and National Energy Retail Objective. On 21 September 2023, the *Statutes Amendment (National Energy Laws) (Emissions Reductions Objectives) Act 2023* (the Act) received Royal Assent.

[4] AEMC, *Harmonising the electricity network planning and investment rules and AER guidelines with the updated energy objectives (electricity)*, draft determination, 26 October 2023, p. i.

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

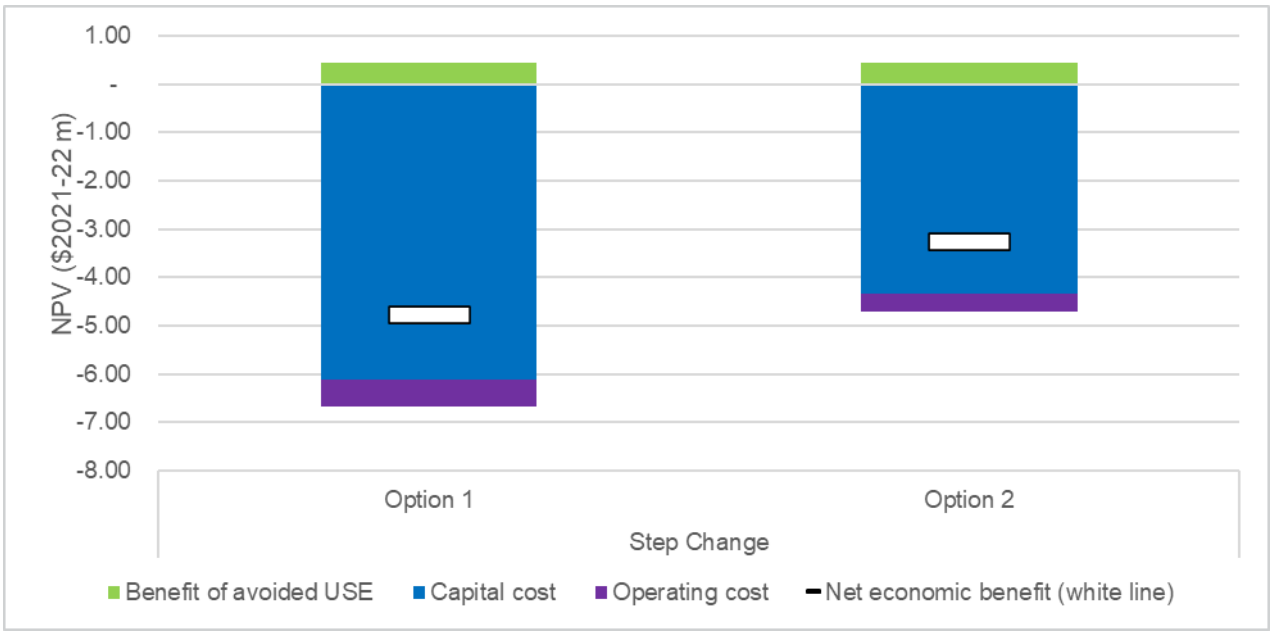
Conclusion: installation of a 132 kV 25 MVAr reactor at Inverell is optimal

Implementing Option 2 by 2025/26 will meet the relevant regulatory obligations set out in the NER and NSW reliability standards, maintaining voltage levels in Northern NSW in the long term.

Option 2 delivers the highest net economic benefits in all scenarios, meeting the identified need and avoiding expected unserved energy in the long term at a lower cost than Option 1. This makes Option 2 the preferred option.

Under all scenarios, the costs of mitigating the risks under both options are found to be significantly outweighed by the expected benefit of avoiding the risks. Option 2 provides the greatest estimated net benefit of the two options considered – with net benefits that are approximately 47 per cent greater than Option 1.

Figure E-1 Net economic benefits ($m, PV)



The optimal commercially and technically feasible option presented in this PSCR – Option 2 (Install a 132 kV 25 MVAr reactor at Inverell) – is the preferred option to meet the identified need and maintain voltage levels in Northern NSW.

Moving forward with this option is the most prudent and economically efficient solution to ensure the NER requirements and NSW reliability standards are met in the long term, while avoiding expected unserved energy.

The estimated capital expenditure associated with this option is $5.41 million. +/- 25 per cent. Routine operating and maintenance costs relating to planned activities are approximately $54,100 per year.

This preferred option, Option 2, is not found to have positive net benefits under the Step Change scenario, however, since this RIT-T is a reliability corrective action, the top-ranked option is permitted to have a negative market benefit.

We also conducted sensitivity analysis on the net economic benefit to investigate the robustness of the conclusion to key assumptions. Our analysis concluded that Option 2 remains the preferred option under all sensitives studied.

The works will be undertaken between 2023/24 and 2025/26, with final commissioning of the solution expected in 2026/27.

All works will be completed in accordance with the relevant standards by 2025/26 with minimal modification to the wider transmission assets. Necessary outages of in-service equipment will be planned appropriately in order to complete the works with minimal impact on the network.

Next steps

This PACR represents the final step of the consultation process in relation to the application of the Regulatory Investment Test for Transmission (RIT-T) process undertaken by Transgrid.

The second step of the RIT-T process, 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 due to:

- the estimated capital cost of the preferred option being less than $46 million;
- the PSCR stating:
    - the proposed preferred option, together with the reasons for the proposed preferred option;
    - the RIT-T is exempt from producing a PADR; and
    - the proposed preferred option and any other credible options will not have a material market benefit for the classes of market benefit specified in clause 5.15A.2(b)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding;
- 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 (noting that no issues have been raised).

Parties wishing to raise a dispute notice with the AER may do so prior to 5 March 2024 (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 regulatory.consultation@transgrid.com.au. In the subject field, please reference 'Maintaining voltage levels in Northern NSW PACR'.

Contents

1. Introduction

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options which manage excessive voltage levels to maintain reliable supply around Narrabri, Inverell and Moree in Northern New South Wales (NSW). Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Our power system studies show that declining minimum demand in the Narrabri, Inverell and Moree areas mean that there is a need to manage the risk of system voltages exceeding their allowable limit. Schedule 5.1.4 of the National Electricity Rules (NER) requires us to plan and design equipment for voltage control to maintain voltage levels within 10 per cent of normal voltage. We expect non-compliance with this requirement will occur without remedial action.

This RIT-T therefore examines various network and non-network options to address the excess voltage to ensure compliance with the requirements of the NER and provide the greatest net benefit to the market. Consequently, it is considered a reliability corrective action under the RIT-T.

1.1. Purpose of this report

The purpose of this PACR[6] is to:

- describe the identified need;
- describe and assess credible options to meet the identified need;
- describe the assessment approach used; and
- provide details of the proposed preferred option to meet the identified need.

Overall, this report provides transparency into the planning considerations for investment options to ensure continuing reliable supply to our customers. A key purpose of this PACR is to provide interested stakeholders the opportunity to review the analysis and assumptions and have certainty and confidence that the preferred option has been robustly identified as optimal.

1.2. No submissions received in response to the Project Specification Consultation Report and there have been no material developments

We published a Project Specification Consultation Report (PSCR) on 26 July 2023 and invited written submissions on the material presented within the document. No submissions were received in response to the PSCR.

No additional credible options were identified during the consultation period following publication of the PSCR. The Value of Customer Reliability (VCR) used has been updated to align with the Australian Energy Market Operator's (AEMO's) 2023 Inputs, Assumptions and Scenarios Report. This VCR has been converted to $2021-22.

[6] See Appendix A for the National Electricity Rules requirements.

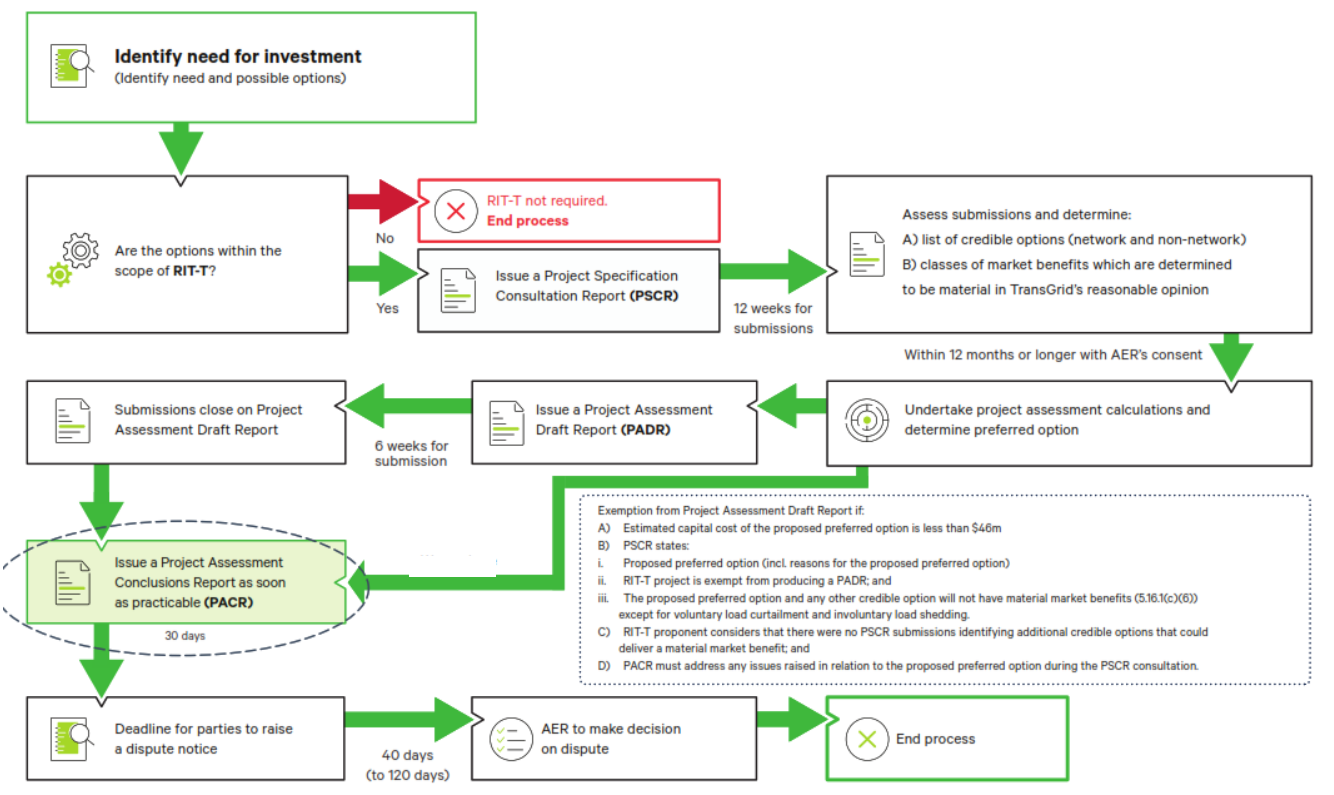
We note that, since the PSCR was released, there has been a law change to introduce an emissions reduction objective into the national energy objectives[7] and that the National Electricity Rules are currently being updated to add a new category of market benefit to the RIT-T reflecting changes in Australia's greenhouse gas emissions.[8] While we acknowledge this important change to the RIT-T, we note that there is not expected to be a difference in greenhouse gas emission levels between the two options assessed in this PACR since the options are not expected to affect the dispatch of generation in the wholesale market. This new category of market benefit is therefore not expected to be material for this RIT-T and so has not been estimated.

No material developments have occurred since publication of the PSCR and Option 2 remains the preferred option at this stage of the RIT-T process.

1.3. Next steps

This PACR represents the final step of the consultation process in relation to the application of the RIT-T process undertaken by Transgrid.

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



[7] On 12 August 2022, Energy Ministers agreed to fast track the introduction of an emissions reduction objective into the national energy objectives, consisting of the National Electricity Objective (NEO), National Gas Objective and National Energy Retail Objective. On 21 September 2023, the *Statutes Amendment (National Energy Laws) (Emissions Reductions Objectives) Act 2023* (the Act) received Royal Assent.

[8] AEMC, *Harmonising the electricity network planning and investment rules and AER guidelines with the updated energy objectives (electricity)*, draft determination, 26 October 2023, p. i.

[9] Australian Energy Market Commission. "*Replacement expenditure planning arrangements, Rule determination*". Sydney: AEMC, 18 July 2017.

Parties wishing to raise a dispute notice with the AER may do so prior to 5 March (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 regulatory.consultation@transgrid.com.au . In the subject field, please reference 'Maintaining voltage levels in Northern NSW PACR'.

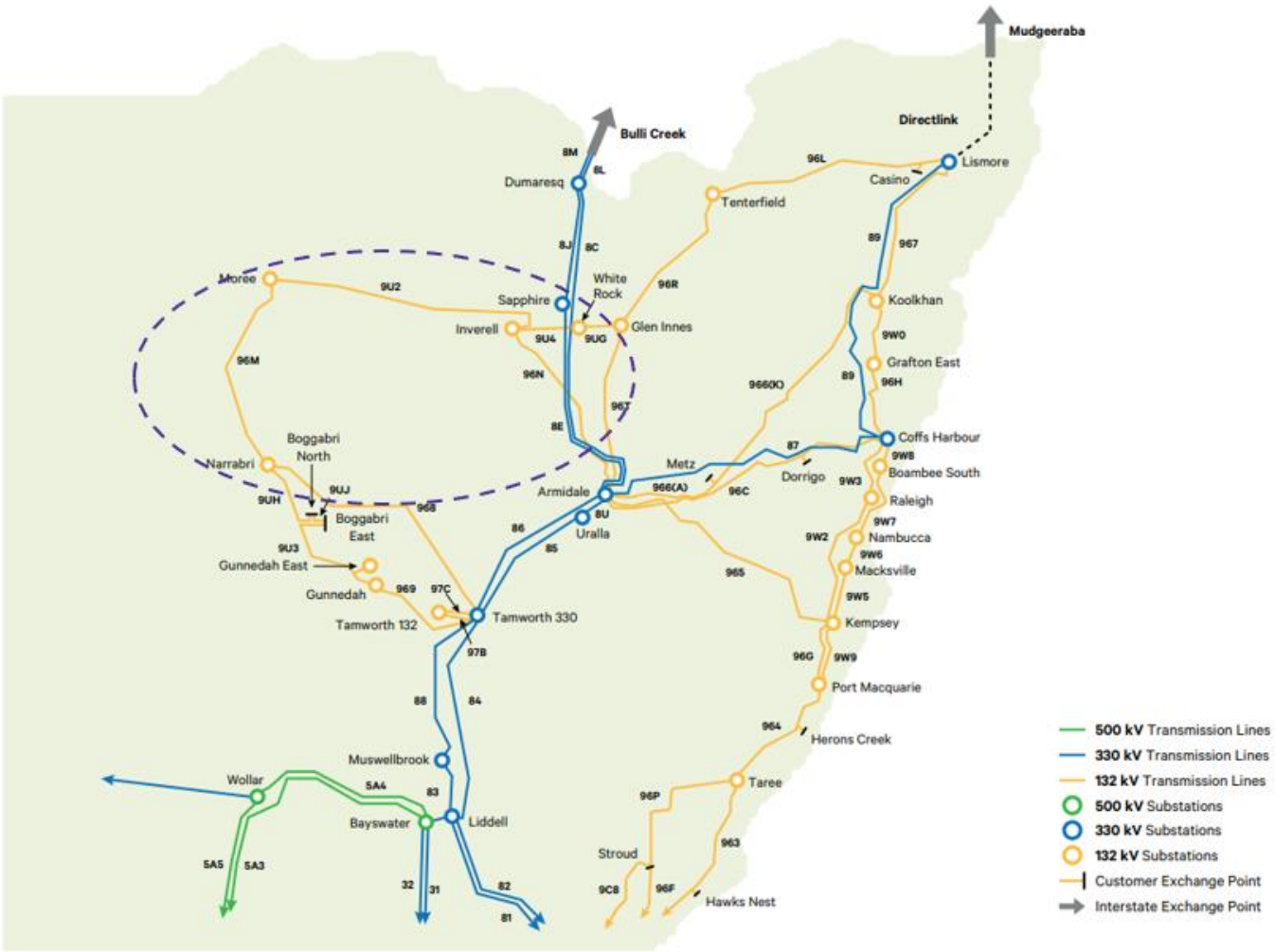
2. The identified need

This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it.

2.1. Background to the identified need

The current Northern NSW electricity transmission network is shown in Figure 2-1. The Narrabri, Moree and Inverell areas are supplied by a series of 132 kV transmission lines which form a link between Glen Innes, Armidale and Tamworth. These are circled in Figure 2-1 below.

Figure 2-1 Northern NSW transmission network



The latest demand forecasts show that the minimum demand in NSW will be steadily declining over the next 20 years due to gradual and continued growth in distributed solar generation capacity.[10] In Northern

[10] AEMO, 2023 Electricity Statement of Opportunities, August 2023.

NSW the expected growth in embedded generation is contributing to the falling minimum demand in the Moree and Inverell areas into the future.

This declining minimum demand is leading to excessive voltage levels, particularly when renewable generators in the region are not providing sufficient reactive support and demand is low.

2.2. Description of the identified need

Schedule 5.1.4 of the NER requires us to plan and design equipment for voltage control to maintain voltage levels within 10 per cent of normal voltage.[11] The NER also requires the power system to be operated in a satisfactory operating state, which requires voltages to be maintained within these levels, both in normal operation and following any credible contingency event.[12]

Our power system studies show that the declining minimum demand in Northern NSW, specifically in the Moree and Inverell areas, means that there is an immediate need to manage the risk of excessive voltage levels leading to non-compliance with the NER under a single credible contingency. Excessive voltages have already been encountered during a contingency event at Inverell. During this event, operational measures were implemented to manage the voltage levels in the short term. In the longer-term remedial solutions are required to maintain compliance with the NER and NSW Electricity Reliability and Performance Standard 2017.

We have commenced this RIT-T to assess options to ensure the above NER requirements continue to be met in the longer term in Northern NSW considering the declining minimum demand. We consider this a 'reliability corrective action' under the RIT-T, as the proposed investment is for the purpose of meeting externally-imposed regulatory obligations and service standards, i.e., Schedule 5.1.4 of the NER and the NSW Electricity Reliability and Performance Standard 2017.

2.3. Assumptions underpinning the identified need

This RIT-T has been initiated in response to declining minimum demand in Northern NSW. The demand forecasts underpinning the identified need for this RIT-T reflect the expected continued growth in embedded and distributed generation which will continue to reduce minimum demand in the region.

We have undertaken planning studies with a number of operating scenarios (day and night times) to assess the impact of the decreasing minimum demand. These studies shows that the voltage at the following busbars will exceed acceptable levels during a credible contingency:

- Moree 132 kV; and
- Inverell 132 kV.

This is expected to occur during both day time and night time periods when the demand is low and sufficient reactive power support is unavailable from renewable generators in the region.

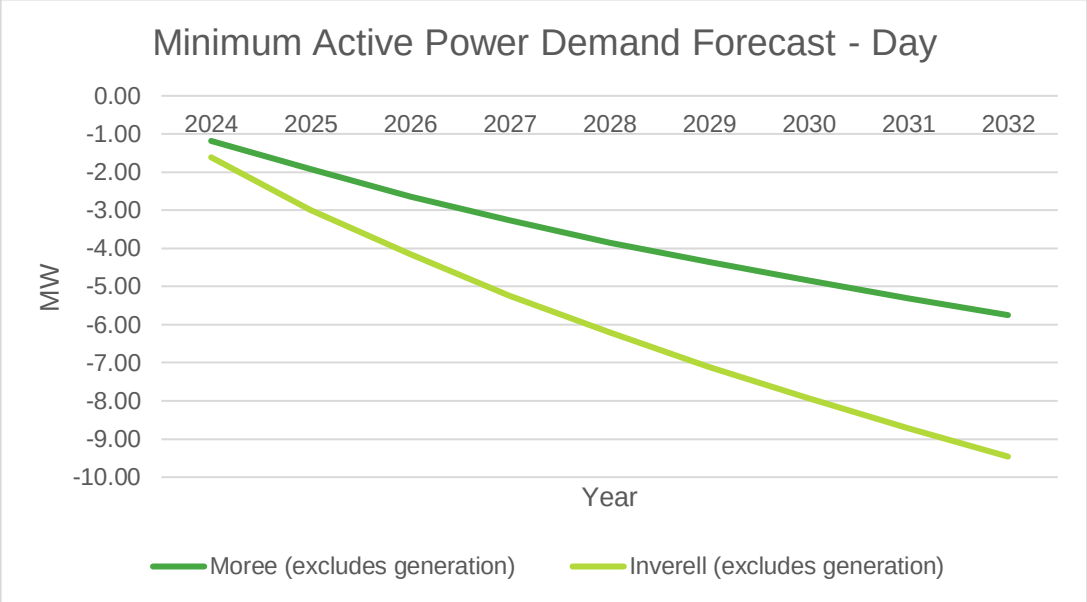
Figure 2-2 and Figure 2-3 below illustrate the latest available POE50 minimum active (MW) and reactive (MVAr) power demand forecast at the Moree and Inverell 132 kV substations for day and night,

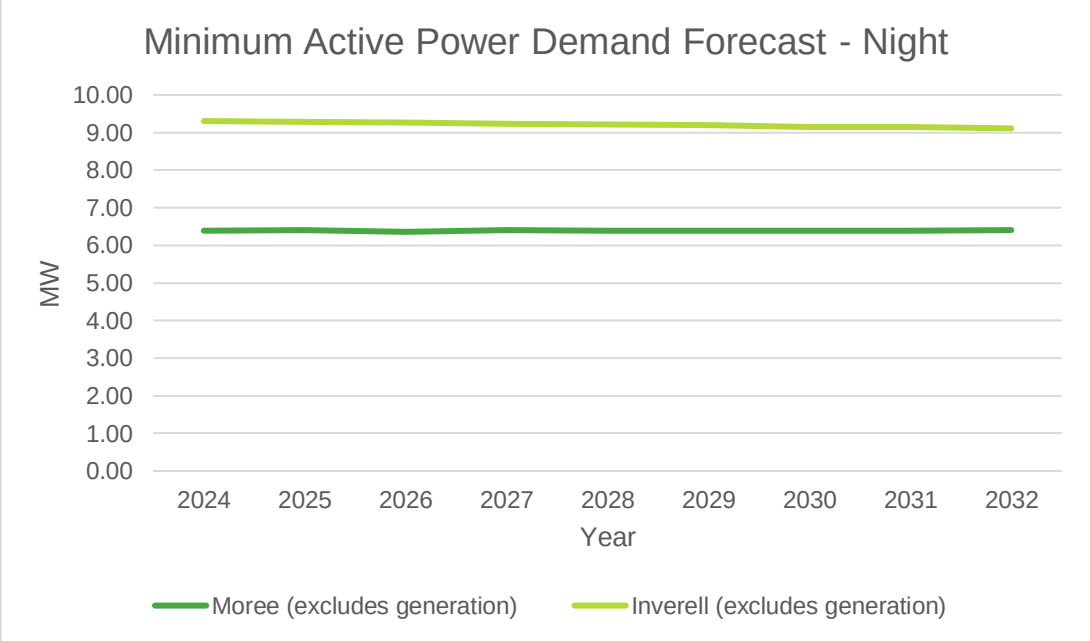
[11] These levels are specified in Clause S5.1a.4. of the system standards

[12] These requirements are set out in Clauses 4.2.6, 4.2.4 and 4.2.2(b) of the NER. The requirement for secure operation of the power system in Clause 4.2.4 requires the power system to be in a satisfactory operating state following any credible contingency event, that is, to maintain voltage within 10 per cent of normal voltage following the first credible contingency event.

respectively.[13] The demand forecasts show that the day time minimum demand is declining at a rapid rate compared to the night time minimum demand forecasts. This results in more pronounced over voltages for the day time scenarios during a credible contingency when reactive support is not available from renewable generators in the region and demand is low. Additionally, the capacitive (injecting) reactive power forecast at Moree and Inverell contributes to the excessive voltages at these locations.

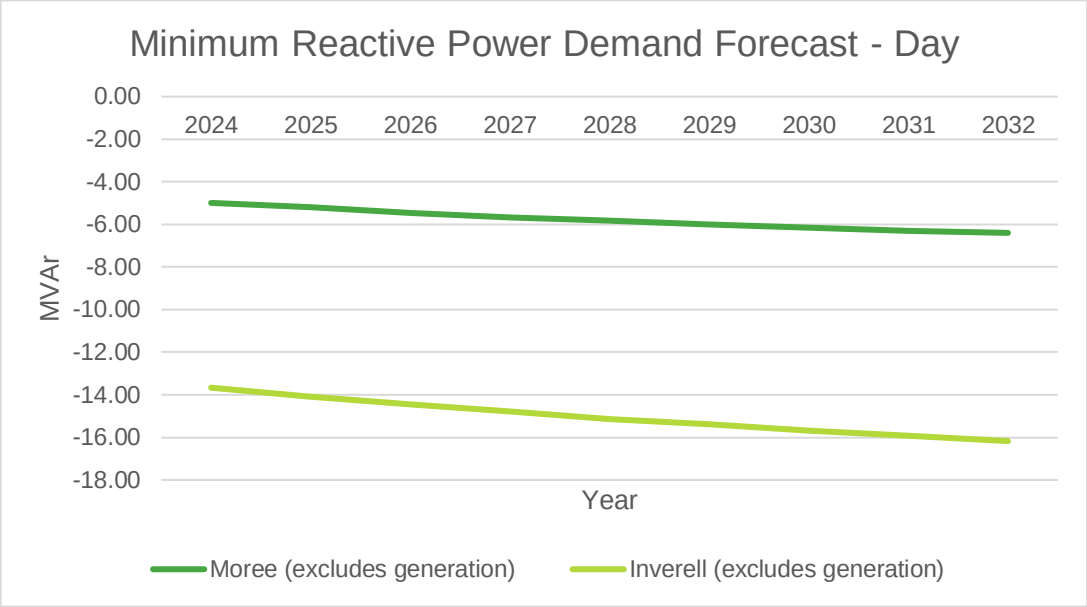
Figure 2-2 Moree and Inverell BSP POE50 minimum demand forecasts (Active Power Day/Night)

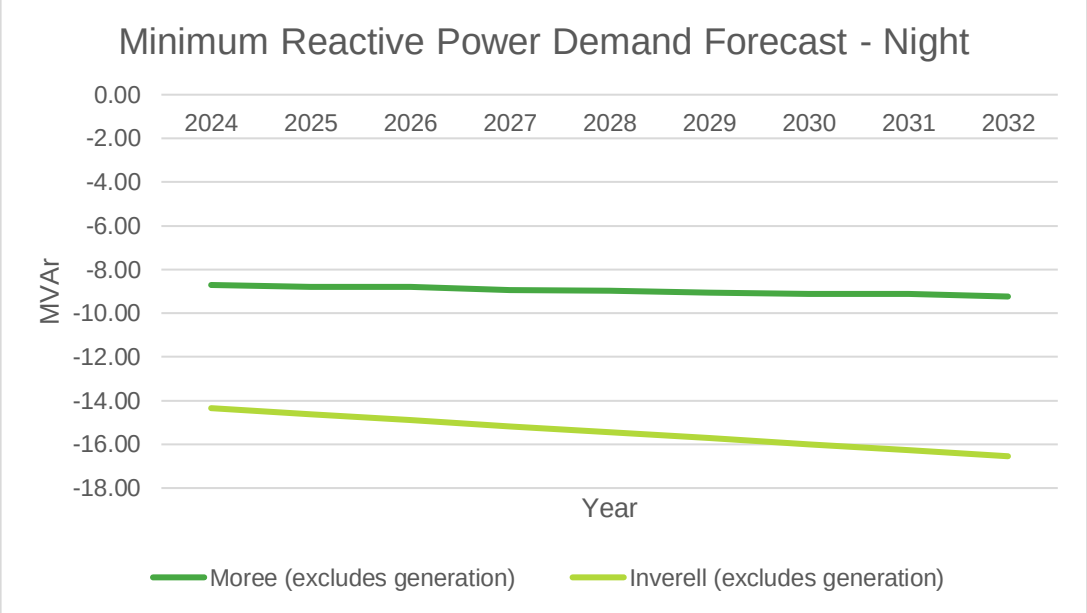




[13] Positive MVAr means Inductive (absorbing) reactive power whereas negative MVAr means Capacitive (injective) reactive power.

Figure 2-3 Moree and Inverell BSP POE50 minimum demand forecasts (Reactive Power Day/Night)





The analysis used the central (POE 50) demand forecast provided by Essential Energy. Essential Energy do not produce a low (POE 90) or high (POE10) forecasts for minimum demand. However, as outlined in section 4.1, each of the credible options avoids exactly the same level of unserved energy and so the underlying demand forecasts are not considered material to the outcome of this RIT-T.

Figure 2-4 shows the voltage at the Moree and Inverell 132 kV bulk supply points (BSP) in the event of a contingency event using the central minimum demand forecast during the day time. Figure 2-5 shows these same voltages at night time. The figures show that the voltages are presently exceeding or will soon exceed 1.10 pu under a single credible contingency event. The highest over voltages are expected to occur during the day (when reactive power support is not available from nearby renewable generation).

Figure 2-4: Day time post-contingent voltage at Moree and Inverell

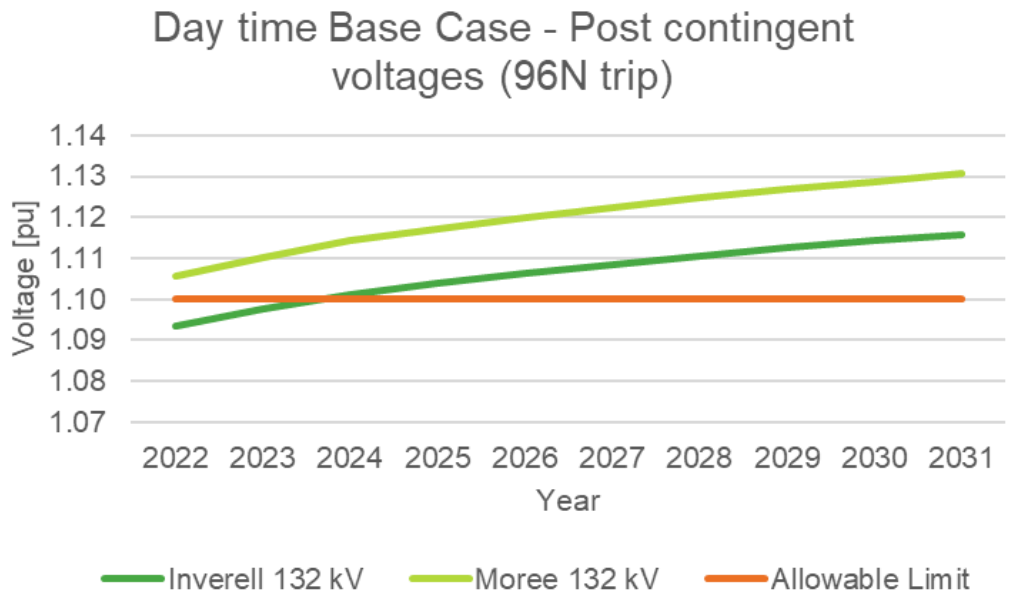
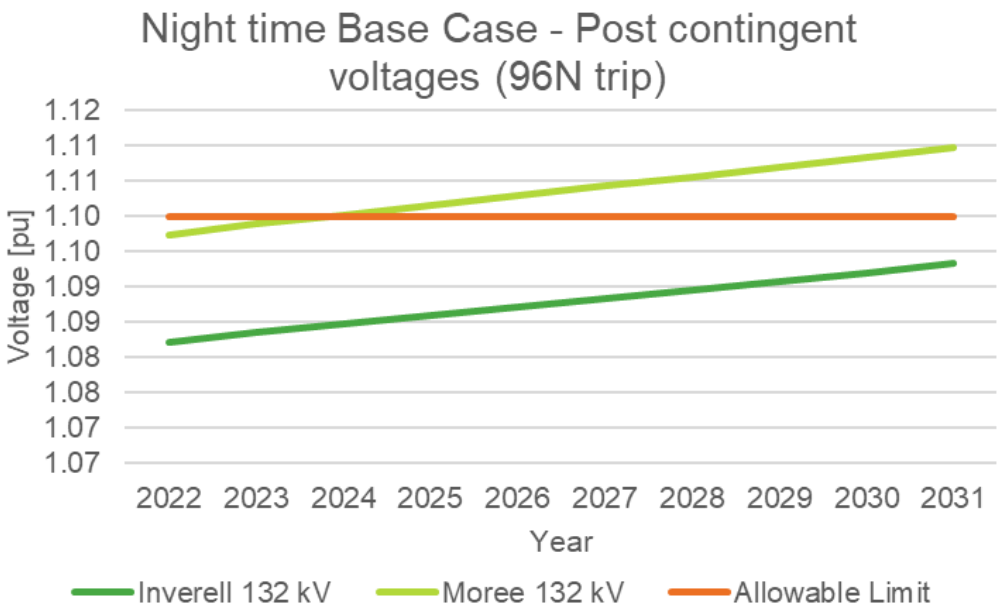


Figure 2-5: Night time post-contingent voltage at Moree and Inverell



This assessment highlights that the identified need must be addressed as soon as possible in order to ensure compliance with the NER.

3. Potential credible options

This section describes the options we have explored to address the need, including the scope of each option and the associated costs.

We consider that there are two feasible options from a technical, commercial, and project delivery perspective that can be implemented in sufficient time to meet the identified need. One other option was considered but not progressed for reasons that are outlined in Table 3-4.

Additionally, we noted in the PSCR that we considered non-network options may be able to assist with meeting the identified need, specifically non-network technologies that are able to provide reactive support. We invited parties to make written submissions regarding the potential of non-network options to satisfy, or contribute to satisfying, the identified need for this RIT-T. No submissions were received in response to the PSCR in relation to non-network options.

The credible network options for this RIT-T focus on reactors at Moree and/or Inverell substation. The options differ in terms of the busbars that any new reactor connect into and the rating of any new reactor.

Table 3-1 summarises each of the credible options we currently consider can meet the identified need.

Table 3-1: Summary of the credible options

Option	Description	Estimated capex ($2021-22)	Expected commission date
1	Install a 66 kV 10 MVAr reactor at Moree and a 66 kV 15 MVAr reactor at Inverell	$7.64 million	2026/27
2	Install a 132 kV 25 MVAr reactor at Inverell	$5.41 million	2026/27

All costs and benefits presented in this PACR are in 2021-22 dollars, unless otherwise stated.

3.1. Base case

The costs and benefits of each option in this PACR are compared against those of a base case.[14]

Under the base case, where the excessive voltage levels due to declining minimum demand are unresolved, there is expected to be a reduction in supply reliability. This is expected to result in non-compliance with the NSW Electricity Reliability and Performance Standard 2017 at Moree. This is expected to result in unserved energy of 1.25 MWh per year, increasing to 1.4 MWh per year by 2043.

While this is not a situation we plan to encounter, and this RIT-T has been initiated specifically to avoid it, the assessment is required to use this base case as a common point of reference when estimating the net benefits of each credible option.

[14] Transgrid notes that the August 2020 AER RIT-T Guidelines (p. 21) state that the base case is where the RIT–T proponent does not implement a credible option to meet the identified need, but rather continues its 'BAU activities'. The AER define 'BAU activities' as ongoing, economically prudent activities that occur in the absence of a credible option being implemented.

3.2. Option 1 – Install a 66 kV 10 MVAr reactor at Moree and a 66 kV 15 MVAr reactor at Inverell

Option 1 involves installing a 66 kV 10 MVAr reactor at the existing Moree 132/66 kV substation and a 66 kV 15 MVAr reactor at the existing Inverell 132/66 kV substation.

This involves extending the existing switchyard (within the existing property boundary) to accommodate installation of the reactors and their associated switchbays. As part of the desktop feasibility study, normal soil conditions were assumed for the extension of the switchyard. As all works are occurring at an in-service substation, no additional access work is anticipated to be required.

The estimated capital expenditure associated with this option is $7.64 million. The estimated capital cost of this option is approximately $6.11m (June $2022) +/-25 per cent.

Routine operating and maintenance cost are estimated at approximately $76,400/annum.

Table 3-2 Breakdown of capital cost and operating cost for Option 1 ($M, 2021-22)below provides a breakdown of the capital expenditure and operating expenditure for Option 1.

Table 3-2 Breakdown of capital cost and operating cost for Option 1 ($M, 2021-22)

Years	Capital cost ($m)	Operating cost ($m)
2023	-	-
2024	$0.58	-
2025	$4.09	-
2026	$2.97	-
2027	-	$0.08
2028	-	$0.08
2029	-	$0.08
2030	-	$0.08
2031	-	$0.08
2032	-	$0.08
2033	-	$0.08
2034	-	$0.08
2035	-	$0.08
2036	-	$0.08
2037	-	$0.08
2038	-	$0.08
2039	-	$0.08
2040	-	$0.08
2041	-	$0.08
2042	-	$0.08
Total	**$7.64m**	**$1.22m**

We estimate that it will take 32 months from this RIT-T commencement to complete Option 1 with commissioning possible in 2026/27.

This option will manage the excess network voltages in the region at times of low demand and therefore meet the compliance requirements.

All works would be completed in accordance with the relevant standards with minimal modification to the wider transmission assets. Necessary outages of affected line(s) in service would be planned appropriately in order to complete the works with minimal impact on the network.

3.3. Option 2 – Remediate all identified condition issues on the line

Option 2 involves installing a 25 MVAr 132 kV reactor at the existing Inverell 132/66 kV substation.

This involves extending the existing switchyard (within the existing property boundary) to accommodate installation of the reactors and their associated switchbays.

The estimated capital expenditure associated with this option is $5.41 million. The estimated capital cost of this option is approximately $4.33m (June $2022) +/-25 per cent.

Routine operating and maintenance cost are estimated at approximately $54,100/annum.

Table 3-3 below provides a breakdown of the capital expenditure and operating expenditure for the base case.

Table 3-3 Breakdown of capital cost and operating cost for Option 2 ($M, 2021-22)

Years	Capital cost ($m)	Operating cost ($m)
2023	-	
2024	$0.40	
2025	$2.90	
2026	$2.11	
2027	-	$0.05
2028	-	$0.05
2029	-	$0.05
2030	-	$0.05
2031	-	$0.05
2032	-	$0.05
2033	-	$0.05
2034	-	$0.05
2035	-	$0.05
2036	-	$0.05
2037	-	$0.05

2038	-	$0.05
2039	-	$0.05
2040	-	$0.05
2041	-	$0.05
2042	-	$0.05
Total	**$5.41m**	**$0.87m**

We estimate that it will take 34 months from this RIT-T commencement to complete Option 2 with commissioning possible in 2026/27

This option will manage the excess network voltages in the region at times of low demand and therefore meet the compliance requirements.

All works would be completed in accordance with the relevant standards with minimal modification to the wider transmission assets. Necessary outages of affected line(s) in service would be planned appropriately in order to complete the works with minimal impact on the network.

3.4. Options considered but not progressed

We considered several additional options to meet the identified need in this RIT-T. Table 3-4 summarises the reasons the following options were not progressed further.

Table 3-4 Options considered but not progressed

Description	Reason(s) for not progressing
Installing a Static VAr Compensator (+25/-25 MVAr) at Inverell substation	This option is expected to cost significantly more than the two options considered and will not provide any additional benefits, therefore is not considered commercially feasible.

3.5. No material inter-network impact is expected

We have considered whether the credible options listed above is expected to have material inter-regional impact[15]. A 'material inter-network impact' is defined in the NER as:

> "*A material impact on another Transmission Network Service Provider's network, which impact may include (without limitation): (a) the imposition of power transfer constraints within another 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[16]:

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

[16] 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 23 June 2021. https://aemo.com.au/-/media/files/electricity/nem/network_connections/transmission-and-distribution/170-0035-pdf.pdf

- a decrease in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3 per cent 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 per cent 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; and
- the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

We consider that each credible option satisfies these conditions as it does not modify any aspect of transmission assets and will only have localised effects around the Northern region of NSW. By reference to AEMO's screening criteria, there is no material inter-network impacts associated with any of the credible options considered.

4. Materiality of market benefits

This section outlines the categories of market benefits prescribed in the National Electricity Rules (NER) and whether they are considered material for this RIT-T.[17]

We note that, since the PSCR was released, there has been a law change to introduce an emissions reduction objective into the national energy objectives[18] and that the NER are currently being updated to add a new category of market benefit to the RIT-T reflecting changes in Australia's greenhouse gas emissions.[19] While we acknowledge this important change to the RIT-T, we note that there is not expected to be a difference in greenhouse gas emission levels between the two options assessed in this PACR since the options are not expected to affect the dispatch of generation in the wholesale market. This new category of market benefit is therefore not expected to be material for this RIT-T and so has not been estimated.

4.1. Avoided unserved energy has been estimated (but is not considered material to the RIT-T outcome)

We have estimated the expected unserved energy if action is not taken to address the identified need.

Each credible option considered in this RIT-T is expected to avoid all of this expected unserved energy from 2024/25. Given there is no difference in avoided expected unserved energy across the options, the level of unserved energy does not have any material impact on the identification of the preferred option under the RIT-T.

Other categories of market benefits prescribed in the NER have not been estimated and are not considered material for this RIT-T, as outlined below.

4.2. Wholesale 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.[20]

The credible options considered in this RIT-T will not address network constraints between competing generating centres and are therefore not expected to result in any change in dispatch outcomes and

[17] The NER requires that all classes of market benefits identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific class (or classes) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.15A.2(5). See Appendix A for requirements applicable to this document.

[18] On 12 August 2022, Energy Ministers agreed to fast track the introduction of an emissions reduction objective into the national energy objectives, consisting of the National Electricity Objective (NEO), National Gas Objective and National Energy Retail Objective. On 21 September 2023, the *Statutes Amendment (National Energy Laws) (Emissions Reductions Objectives) Act 2023* (the Act) received Royal Assent.

[19] AEMC, *Harmonising the electricity network planning and investment rules and AER guidelines with the updated energy objectives (electricity)*, draft determination, 26 October 2023, p. i.

[20] Australian Energy Regulator. "*Application guidelines Regulatory Investment Test for Transmission - August 2020*." Melbourne: Australian Energy Regulator. https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

wholesale market prices. We therefore consider 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; and
- competition benefits.

4.3. No other classes of market benefits are material

In addition to the classes of market benefits listed above, NER clause 5.15A.2(4) requires that we consider the following classes of market benefits, listed in Table 4-1, arising from each credible option. We consider that none of the classes of market benefits listed are material for this RIT-T assessment for the reasons in Table 4-1.

Table 4-1 Reasons non-wholesale electricity market benefits are considered immaterial

Market benefits	Reason
Differences in the timing of unrelated network expenditure	The credible options considered are all designed to meet the required reliability requirements and are unlikely to affect decisions to undertake unrelated expenditure in the network. Consequently, material market benefits will neither be gained nor lost due to changes in the timing of expenditure from any of the options considered.
Option value	None of the credible options considered possess the flexibility required for there to be any option value.
Changes in network losses	There is not expected to be any material difference in transmission losses between options.

5. Overview of the assessment approach

This section outlines the approach that we have applied in assessing the net benefits associated with each of the credible options against the base case.

5.1. Description of the base case

As outlined in section 3.1, all costs and benefits considered have been measured against a base case where the excessive voltage levels associated with declining minimum demand in Northern NSW remain unresolved and as a result may become non-compliant with the NER and NSW reliability standards.

5.2. Assessment period and discount rate

The RIT-T analysis considers a 20-year assessment period from 2022/23 to 2041/42. A 20-year period takes into account the size, complexity and expected asset life of the circuit breakers and provides a reasonable indication of the costs and benefits over a long outlook period.

Where the capital components of the credible options have asset lives extending beyond the end of the assessment period, the NPV modelling includes a terminal value to capture the remaining asset life. This ensures that the capital cost of long-lived options over the assessment period is appropriately captured, and that all options have their costs and benefits assessed over a consistent period, irrespective of option type, technology or asset life. The terminal values have been calculated based on the undepreciated value of capital costs at the end of the analysis period and expected operating and maintenance cost for the remaining asset life. As a conservative assumption, we have effectively assumed that there are no additional cost and benefits after the analysis and period.

A real, pre-tax discount rate of 7 per cent has been adopted as the central assumption for the NPV analysis presented in this PACR, consistent with AEMO's Inputs Assumptions and Scenarios Consultation Report[21] and the assumptions adopted in AEMO's Draft 2024 Integrated System Plan (ISP).[22] The RIT-T requires that sensitivity testing be conducted on the discount rate and that the regulated weighted average cost of capital (WACC) be used as the lower bound. We have therefore tested the sensitivity of the results to a lower bound discount rate of 3 per cent.[23] We have also adopted an upper bound discount rate of 10.5 per cent (ie, AEMO's 2023 Inputs Assumptions and Scenarios Report).[24]

5.3. Approach to estimating option costs

We have estimated the capital costs of the options based on the scope of works necessary together with costing experience from previous projects of a similar nature.

The cost estimates are developed using our 'MTWO' cost estimating system. This system utilises historical average costs, updated by the costs of the most recently implemented project with similar scope. All

[21] AEMO '2023 Inputs, Assumptions and Scenarios Report', July 2023, p 123.
[22] AEMO, *2024 Draft Integrated System Plan, December 2023*, p 91.
[23] This is equal to WACC (pre-tax, real) in the latest final decision for a transmission business in the NEM (Transgrid) as of the date of this analysis, see: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/transgrid-determination-2023%E2%80%9328/final-decision
[24] AEMO '2023 Inputs, Assumptions and Scenarios Report', July 2023, p 123.

estimates in MTWO are developed to deliver a 'P50' portfolio value for a total program of works (i.e., there is an equal likelihood of over- or under-spending the estimate total).[25]

We estimate that actual costs will be within +/- 25 per cent of the central capital cost estimate. An accuracy of +/-25 per cent for cost estimates is consistent with industry best practice and aligns with the accuracy range of a 'Class 4' estimate, as defined in the Association for the Advancement of Cost Engineering (AACE) classification system.

All cost estimates are prepared in real, 2021-22 dollars based on the information and pricing history available at the time that they were estimated. The cost estimates do not include or forecast any real cost escalation for materials.

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

5.4. Value of customer reliability

We have applied a NSW-wide VCR value based on the estimates developed and consulted on by the AER[26]. The options considered involve the replacement of capacitor banks across our network. As a result, we consider that a state-wide VCR is likely to reflect the weighted mix of customers that will be affected by these options.

5.5. One scenario has been modelled

The RIT-T must include any of the ISP scenarios from the most recent IASR that are relevant unless[27]:

- the RIT-T proponent demonstrates why it is necessary to vary, omit or add a reasonable scenario to what was in the most recent IASR, and
- the new or varied reasonable scenarios are consistent with the requirements for reasonable scenarios set out in the RIT-T instrument.

The AER's RIT-T Guidelines clarifies that the number and choice of reasonable scenarios must be appropriate to the credible options under consideration, and that the choice of reasonable scenarios must reflect any variables or parameters that are likely to affect the ranking or sign of the net benefit of any credible option[28].

For the purposes of this RIT-T, we have only modelled outcomes under the Step Change IASR scenario. This scenario was selected because it is the most likely scenario under AEMO's latest IASR[29]. Adoption of this scenario is also consistent with the minimum demand forecasts provided by Essential Energy, which are POE50 forecasts and therefore also represent the most likely forecast.

We do not consider it necessary to model the other ISP scenarios (i.e., Progressive Change, and Green Energy Exports scenarios). The Progressive Change and Green Energy Exports scenarios differ from the

[25] For further detail on our cost estimating approach refer to section 7 of our Augmentation Expenditure Overview Paper submitted with our 2023-28 Revenue Proposal.
[26] AEMO '2023 Inputs, Assumptions and Scenarios Report', July 2023, p 124.
[27] AER, Regulatory investment test for transmission: Application guidelines, October 2023, p.33
[28] AER, Regulatory investment test for transmission: Application guidelines, October 2023, p.43.
[29] AEMO '2023 Inputs, Assumptions and Scenarios Report', July 2023, p 124. In the 2022 ISP, the Step Change scenario is assigned a probability of 50% (See: AEMO, 2022 Integrated System Plan, June 2022, p. 34)

Step Change scenario on the basis of a range of parameters, including forecast demand and the approach to decarbonisation. As discussed in section 4.1, the credible options considered in this RIT-T avoid the same amount of unserved energy. This means that the underlying demand forecasts are not considered material to the outcome of this RIT-T. We do not consider that other assumptions or parameters underpinning the alternative scenarios will affect the ranking of the credible options.

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

Table 5-1 Summary of step change scenario

Parameter	Step Change
Discount rate	7%
Network capital costs	Base estimate
Operating and maintenance costs	Base estimate
Value of Customer Reliability (VCR) ($2021-22)[30]	$46.43/kWh
Minimum demand forecast	Central demand forecast (POE50)

[30] This VCR is aligned with AEMO's 2023 Inputs, Assumptions and Scenarios Report and has been converted to $2021-22.

6. Assessment of credible options

This section outlines the assessment we have undertaken of the credible network options. The assessment compares the costs and benefits of each credible option to the base case. The benefits of each credible option are represented by a reduction in costs or risks compared to the base case.

All costs and benefits presented in this PACR are in 2021/22 dollars.

6.1. Estimated gross benefits

Table 6-1 summarises the present value of the gross benefit estimates for each credible option relative to the base case. The only benefit category included in this assessment is avoided involuntary load shedding. The gross benefit is the same for each credible option since, as discussed in section 5.1, the credible options are expected to avoid the same amount of unserved energy.

Table 6-1 Estimated gross benefits from credible options relative to the base case ($m, PV)

Option	Step Change ($m)
Option 1	$0.45
Option 2	$0.45

6.2. Estimated costs

Table 6-2 below summarises the costs of the options, relative to the base case, in present value terms. The cost includes the direct capital and routine operating costs of each option, relative to the base case, and is the same for each option in all scenarios given nothing that affects the direct costs is varied between scenarios.

Table 6-2 Costs of credible options relative to the base case and breakdown of the preferred option ($m, PV)

Option	Components considered	Cost	Total Cost
Option 1	Labour	1.59	7.05
	Expenses	3.28	
	Materials	2.18	
Option 2 (preferred option)	Labour	1.22	5.41
	Expenses	2.52	
	Materials	1.67	

6.3. Estimated net economic benefits

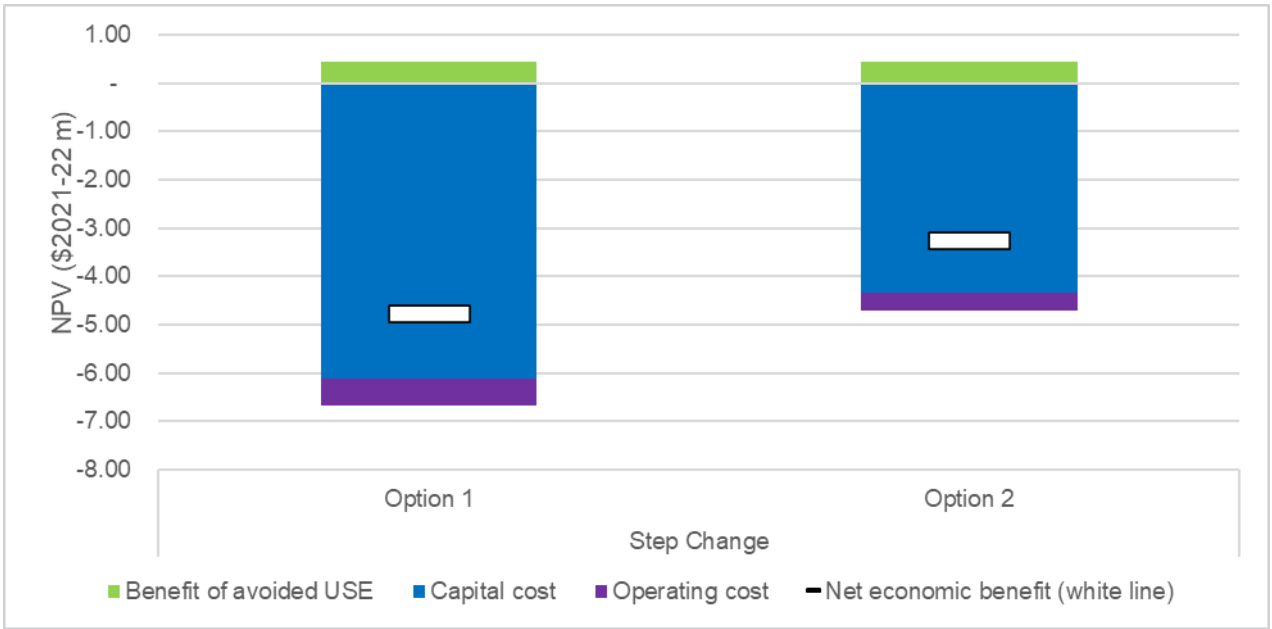
The net economic benefits are the differences between the estimated gross benefits less the estimated costs. Table 6-3 below summarises the present value of the net economic benefits for each credible option across the three scenarios and the weighted net economic benefits.

Table 6-3 Net economic benefits for credible options relative to the base case ($m, PV)

Option	Step Change
Option 1	-$4.76
Option 2	-$3.24

While both options yield negative net economic benefits, Option 2 provides approximately $1.52 million more than Option 1 (an approximate 32% increase). Since gross benefits are the same for both Option 1 and Option 2, the key factor driving this result is that Option 2 can be delivered at a lower estimated cost than Option 1. Since this RIT-T is a reliability corrective action, the top-ranked option is permitted to have a negative market benefit.

Figure 6-1 Net economic benefits ($m, PV)



6.4. Sensitivity testing

We have undertaken sensitivity testing to examine how the net economic benefit of the credible options changes with respect to changes in key modelling assumptions. The factors tested as part of the sensitivity analysis in this PSCR are:

- Higher or lower VCRs
- Higher or lower network capital costs of the credible options
- Alternate commercial discount rate assumptions

The sensitivity testing was undertaken as against the sole Step Change scenario. Specifically, we individually varied each factor identified above and estimated the net economic benefit in the scenario relative to the base case while holding all other assumptions under the Step Change scenario constant. The results of the sensitivity tests are set out in the sections below.

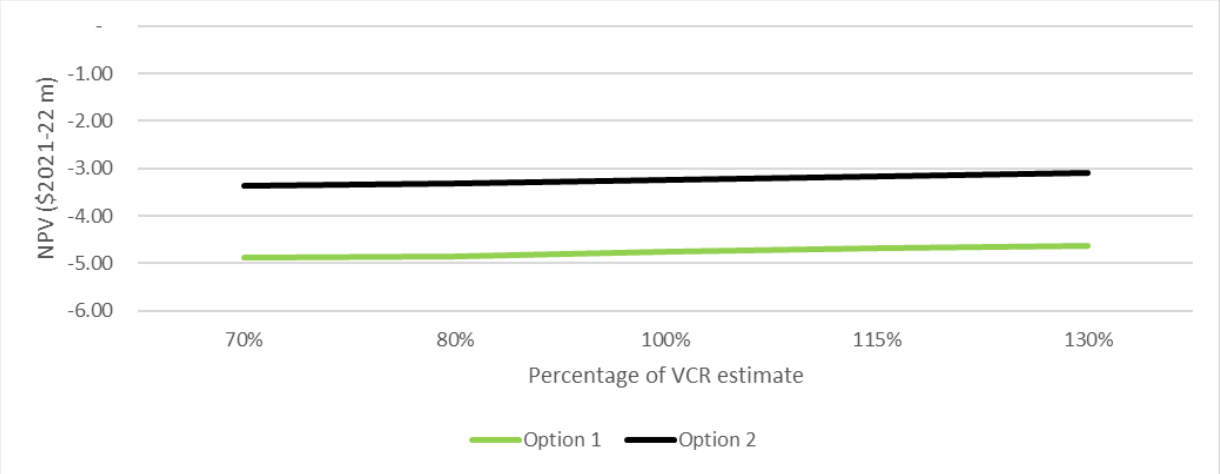
6.4.1. Sensitivity analysis on the VCR

The table and figure below set out the net economic benefits estimated for each credible option relative to the base case by adopting a VCR that is 30% higher (the 'High VCR' scenario) and 30% lower (the 'Low VCR' scenario) than the estimate of VCR adopted in our Step Change scenario. The option ranking for each sensitivity does not change compared to the main results presented above, i.e., Option 2 is always ranked first.

Table 6-4: Net economic benefits relative to the base case under a lower and higher VCR, PV ($M, real 2021-22)

Option/scenario	Low VCR	High VCR	Ranking
Sensitivity	*Step Change estimate -30%*	*Step change estimate + 30%*	
Option 1	-$4.89	-$4.62	2
Option 2	-$3.37	-$3.10	1

Figure 6-2 Net economic benefits relative to the base case with lower and higher VCR, PV ($M, real 2021-22)



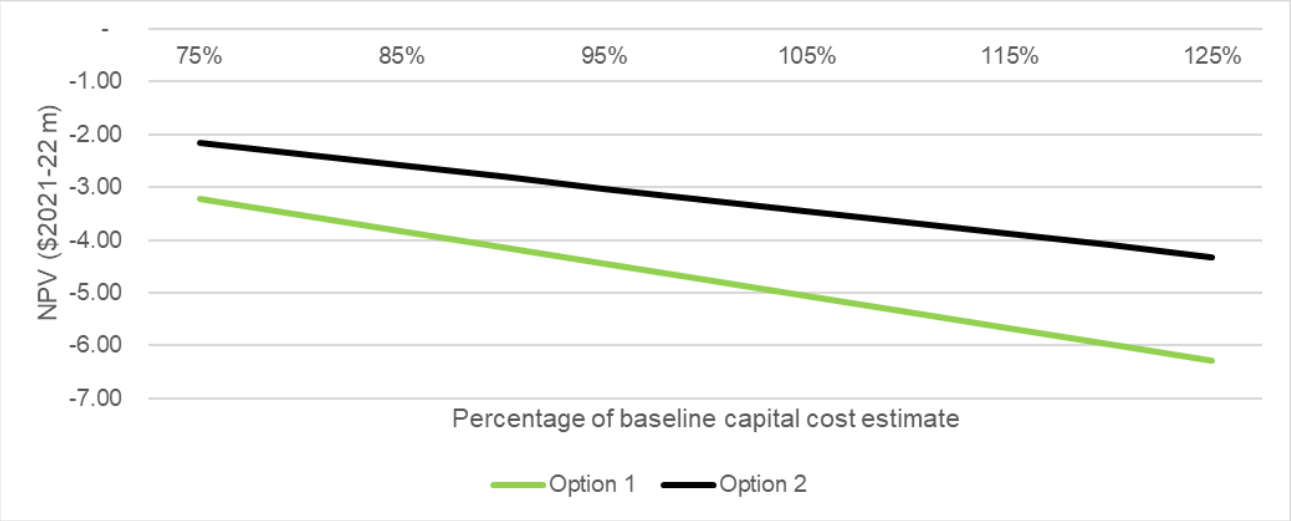
6.4.2. Sensitivity analysis on the network capital costs

The table and figure below set out the net economic benefits estimated for each credible option relative to the base case by adopting a capital costs that are 25% higher (the 'High capex' scenario) and 25% lower (the 'Low capex' scenario) than the estimate of capital costs adopted in our Step Change scenario. The option ranking for each sensitivity does not change compared to the main results above, i.e., Option 2 is always ranked first.

Table 6-5: Net economic benefits relative to the base case under a lower and higher capital costs, PV ($M, real 2021-22)

Option/scenario	Low capex	High capex	Ranking
Sensitivity	*Step Change estimate -25%*	*Step Change estimate +25%*	
Option 1	-$3.23	-$6.29	2
Option 2	-$2.16	-$4.32	1

Figure 6-3 Net economic benefits relative to the base case with lower and higher capital costs, PV ($M, real 2021-22)



We have also undertaken a threshold analysis to identify whether a change in capital cost estimates would change the RIT-T outcome. Specifically, we assess the extent to which Option 2's capital expenditure would need to increase by for it to no longer be the preferred option. Our findings show that Option 2's capex would need to increase by more than 35.12% of its current baseline capex estimates for it to no longer be the preferred option within this RIT-T.

6.4.3. Sensitivity analysis on the discount rate

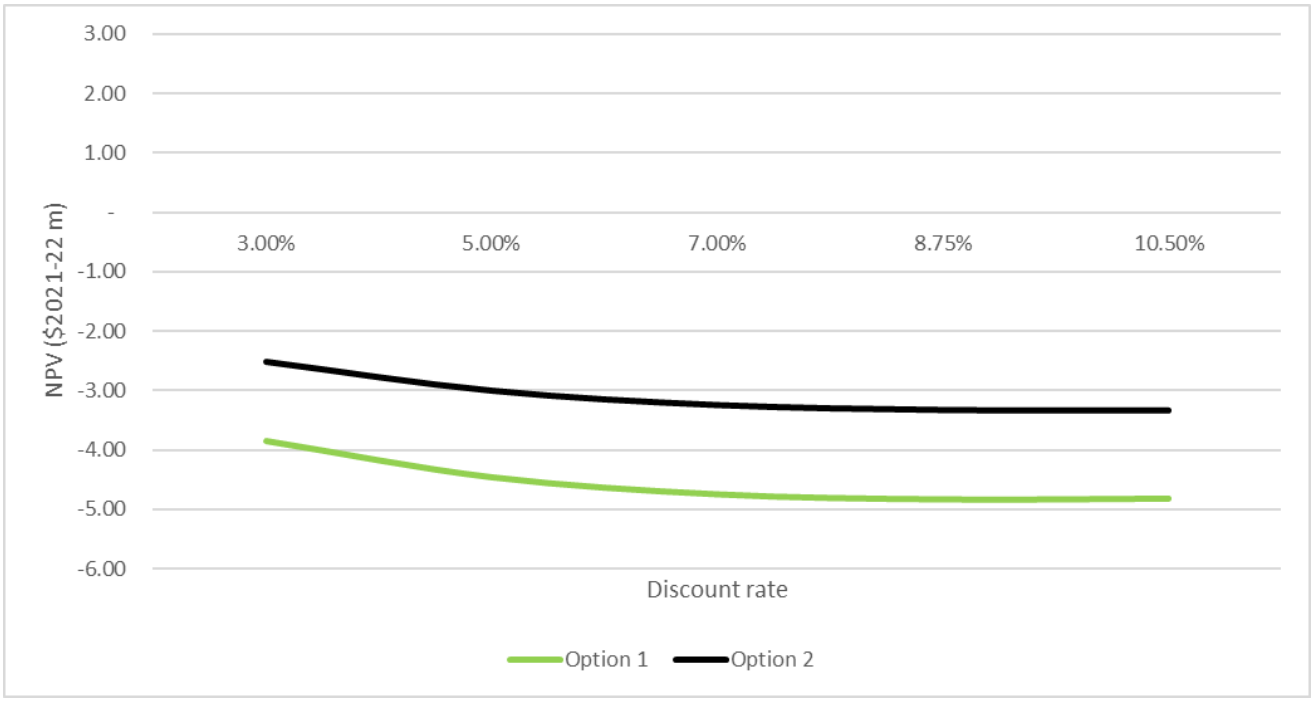
The table and figure below set out the net economic benefits estimated for each credible option relative to the base case by adopting alternative discount rates. Specifically, we considered a low discount rate of 3% and a high discount rate of 10.5%. These discount rates were chosen because they align with the low and high discount rate scenarios in the 2023 IASR.[31] The option ranking for each sensitivity does not change compared to the main results above, i.e., Option 2 is always ranked first.

Table 6-6: Net economic benefits relative to the base case under lower and higher discount rates, PV ($M, real 2022-23)

Option/scenario	Low discount rate	High discount rate	Ranking
Sensitivity	3%	10.5%	
Option 1	-3.84	-4.83	2
Option 2	-2.52	-3.33	1

[31] AEMO July 2023 2023 Inputs, Assumptions and Scenarios Report

Figure 6-4 Net economic benefits relative to the base case with lower and higher discount rates, PV ($M, real 2022-23)



We have also undertaken a threshold analysis to identify whether a change in the discount rate would change the RIT-T outcome. Our approach involved solving for the discount rate that would result in Option 2 not being the preferred option. Our results suggest that there is no reasonable discount rate that would change the RIT-T outcome.

7. Final conclusion on the preferred option

The optimal commercially and technically feasible option presented in this PACR – Option 2 (Install a 132 kV 25 MVAr reactor at Inverell) – is the preferred option to meet the identified need and maintain voltage levels in Northern NSW.

Moving forward with this option is the most prudent and economically efficient solution to ensure the NER requirements and NSW reliability standards are met in the long term, while avoiding expected unserved energy.

The estimated capital expenditure associated with this option is $5.41 million +/- 25 per cent. Routine operating and maintenance costs relating to planned activities are approximately $54,100 per year.

This preferred option, Option 2, is not found to have positive net benefits under the Step Change scenario, however, since this RIT-T is a reliability corrective action, the top-ranked option is permitted to have a negative market benefit.

We also conducted sensitivity analysis on the net economic benefit to investigate the robustness of the conclusion to key assumptions. Our analysis in this PACR has concluded that Option 2 remains the preferred option under all sensitives studied.

The works will be undertaken between 2023/24 and 2025/26, with final commissioning of the solution expected in 2026/27.

All works will be completed in accordance with the relevant standards by 2026/27 with minimal modification to the wider transmission assets. Necessary outages of in-service equipment will be planned appropriately in order to complete the works with minimal impact on the network.

In considering this option, normal soil conditions were assumed for the civil works within the substation and as part of the bench extension. As all works are occurring at an in-service substation, no additional access work is anticipated to be required.

Option 2 is the preferred option in accordance with NER clause 5.15A.2(b)(12) because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. The analysis undertaken and the identification of Option 2 as the preferred option satisfies the RIT-T.

Appendix A Compliance checklist

This appendix sets out a checklist which demonstrates the compliance of this PACR with the requirements of the National Electricity Rules version 204.

Rules clause	Summary of requirements	Relevant section(s) in the PACR
5.16.4(v)	The project assessment conclusions report must set out:	–
	(1) the matters detailed in the project assessment draft report as required under paragraph (k); and	See below.
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought under paragraph (q).	NA
5.16.4(k)	The project assessment draft report must include:	–
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	NA
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	3 & 6
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	4 & 5
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	4
	(6) the identification of any class of market benefit estimated to arise outside the region of the Transmission Network Service Provider affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	6
	(8) the identification of the proposed preferred option;	7
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a material inter-network impact and if the Transmission Network Service Provider affected by the RIT-T project has received an augmentation technical report, that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission.	3 & 7
	(10) if each of the following apply to the RIT-T project: (i) if the estimated capital cost of the proposed preferred option is greater than $100 million (as varied in accordance with a cost threshold determination); and (ii) AEMO is not the sole RIT-T proponent,	N/A

	The RIT-T reopening triggers applying to the RIT-T project.	