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Maintaining voltage levels in Northern NSW

RIT-T Project Specification Consultation Report

Region: Northern NSW

Date of issue: 26 July 2023

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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 Specification Consultation Report (PSCR) represents the first step in the RIT-T process.

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.

Two credible network options have been identified

We have identified two credible network options that would meet the identified need from a technical, commercial, and project delivery perspective.[3] These options are summarised in Table E-1 below.

1 AEMO, 2021 Electricity Statement of Opportunities, August 2021.
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.
3 As per clause 5.15.2(a) of the NER.

Table E-1: Summary of the credible options

Option	Description	Estimated capex ($2021-22 +/- 25%)	Operating costs ($2021-22, $ 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 million	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 million	54,100	Most economical and preferred option

Non-network options may also be able to form credible options for this RIT-T

We consider that non-network options may be able to assist with meeting the identified need, specifically non-network technologies that are able to provide reactive support. At this stage we consider that possible solutions include, but are not limited to:

- battery energy storage systems (BESS), and
- generators in the region who are able to provide reactive power support.

However, we note that the cost of the network options may act to effectively bound the cost available for any non-network options to be considered commercially feasible.

We encourage 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.

Option 2 delivers highest net economic benefits and will meet relevant regulatory obligations

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.

Draft Conclusion

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 $7.64 million +/- 25 per cent. Routine operating and maintenance costs relating to planned activities are approximately $76,400 per year.

This preferred option, Option 2, is not found to have positive net benefits under the weighted 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 22025/26, with final commissioning of the solution expected in 2025/26.

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.

Exemption from preparing a Project Assessment Draft Report

Subject to additional credible options being identified during the consultation period, publication of a Project Assessment Draft Report (PADR) is not required for this RIT-T as we consider its investment in relation to the preferred option to be exempt from that part of the process under NER clause 5.16.4(z1). Production of a PADR is not required due to:

- the estimated capital cost of the proposed preferred option being less than $46 million[4];
- the PSCR states:
  - 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 option 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 except for voluntary load curtailment and involuntary load shedding;
- the RIT-T proponent considers that there were no PSCR submissions identifying additional credible options that could deliver a material market benefit; and
- the PACR must address any issues raised in relation to the proposed preferred option during the PSCR consultation.

Submissions and next steps

The purpose of this PSCR is to set out the reasons we propose that action be taken, 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.

We welcome 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 25 October 2023.

[4] Varied from $43m to $46m based on the AER Final Determination: Cost threshold review November 2021.

Submissions should be emailed to Transgrid's Regulation team via regulatory.consultation@transgrid.com.au.[5] In the subject field, please reference 'Maintaining voltage levels in Northern NSW PSCR'.

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

Should we consider that no additional credible options were identified during the consultation period, we intend to produce a Project Assessment Conclusions Report (PACR) that addresses all submissions received including any issues in relation to the proposed preferred option raised during the consultation period. Subject to additional credible options being identified, we anticipate publication of a PACR by December 2023.

[5] 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 Privacy Notice within the Disclaimer for more details.

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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 Specification Consultation Report (PSCR) represents the first 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.

1.1. Purpose of this report

The purpose of this PSCR[6] is to:

- set out the reasons why Transgrid proposes that action be taken (the 'identified need')
- present the options that Transgrid currently considers to address the identified need
- outline the technical characteristics that non-network options would need to provide
- summarise how we have assessed the options for addressing the identified need
- present the cost benefit assessment of all options for meeting the identified need
- identify the preferred option under the RIT-T assessment, and
- allow interested parties to make submissions and provide input to the RIT-T assessment.

1.2. Exemption from producing a Project Assessment Draft Report

Subject to additional credible options being identified during the consultation period, publication of a Project Assessment Draft Report (PADR) is not required for this RIT-T as we consider its investment in relation to the preferred option to be exempt from that part of the process under NER clause 5.16.4(z1). Production of a PADR is not required due to:

- the estimated capital cost of the proposed preferred option being less than $46 million[7];
- the PSCR states:
  - 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 option 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 except for voluntary load curtailment and involuntary load shedding;
- the RIT-T proponent considers that there were no PSCR submissions identifying additional credible options that could deliver a material market benefit; and

[6] See Appendix A for the National Electricity Rules requirements.
[7] Varied from $43m to $46m based on the AER Final Determination: Cost threshold review November 2021.

- the PACR must address any issues raised in relation to the proposed preferred option during the PSCR consultation.

If an additional credible option that could deliver a material market benefit is identified during the consultation period, then we will produce a Project Assessment Draft Report (PADR) that updates the NPV assessment presented in this PSCR.

If no additional credible options with material market benefits are identified during the consultation period, then the next step in this RIT-T process will be the publication of a PACR that addresses all submissions received, including any issues in relation to the proposed preferred option raised during the consultation period.

1.3. Submissions and next steps

We welcome 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 25 October 2023.

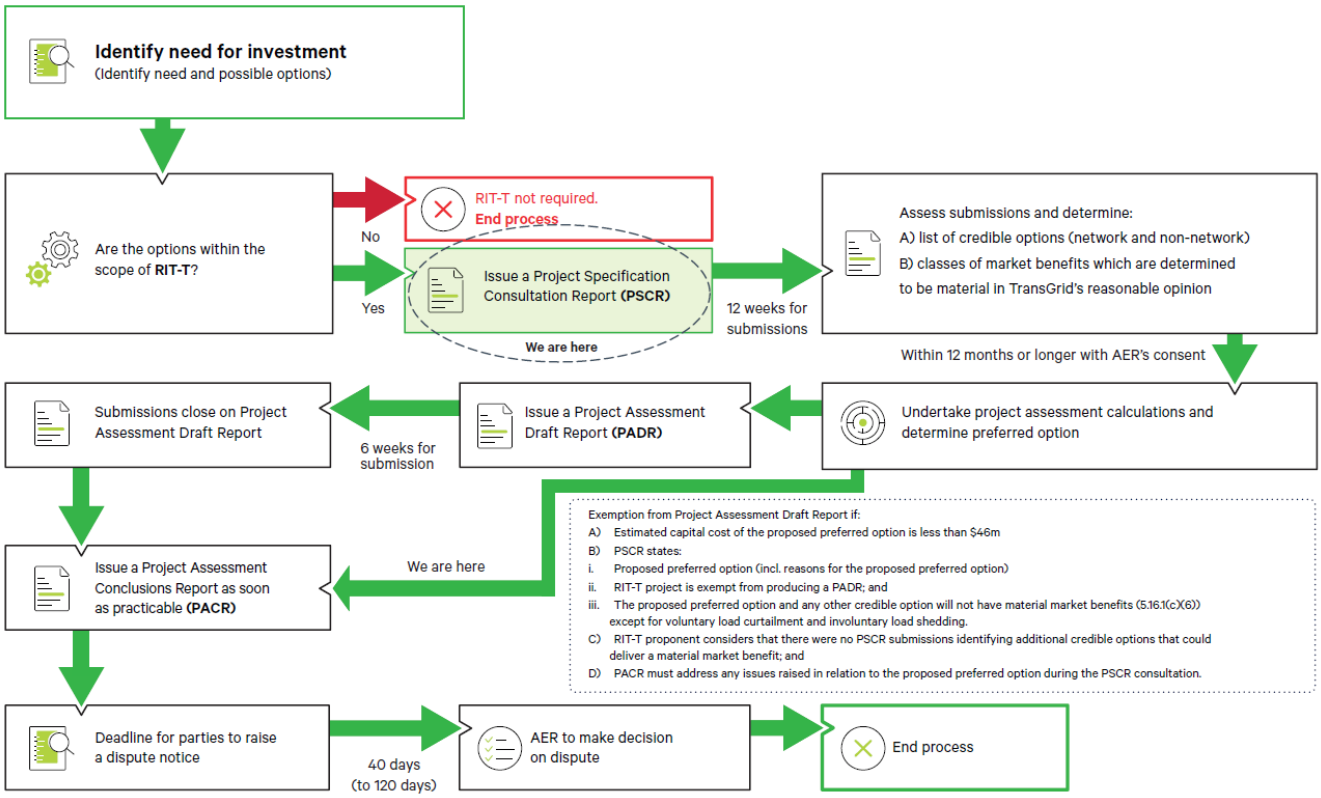
Submissions should be emailed to Transgrid's Regulation team via regulatory.consultation@transgrid.com.au.[8] In the subject field, please reference 'Maintaining voltage levels in Northern NSW PSCR.'

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

Should we consider that no additional credible options were identified during the consultation period, we intend to produce a Project Assessment Conclusions Report (PACR) that addresses all submissions received including any issues in relation to the proposed preferred option raised during the consultation period. Subject to additional credible options being identified, we anticipate publication of a PACR by December 2023.

[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 Privacy Notice within the Disclaimer for more details.

Figure 1-1 This PSCR is the first stage of the RIT-T process

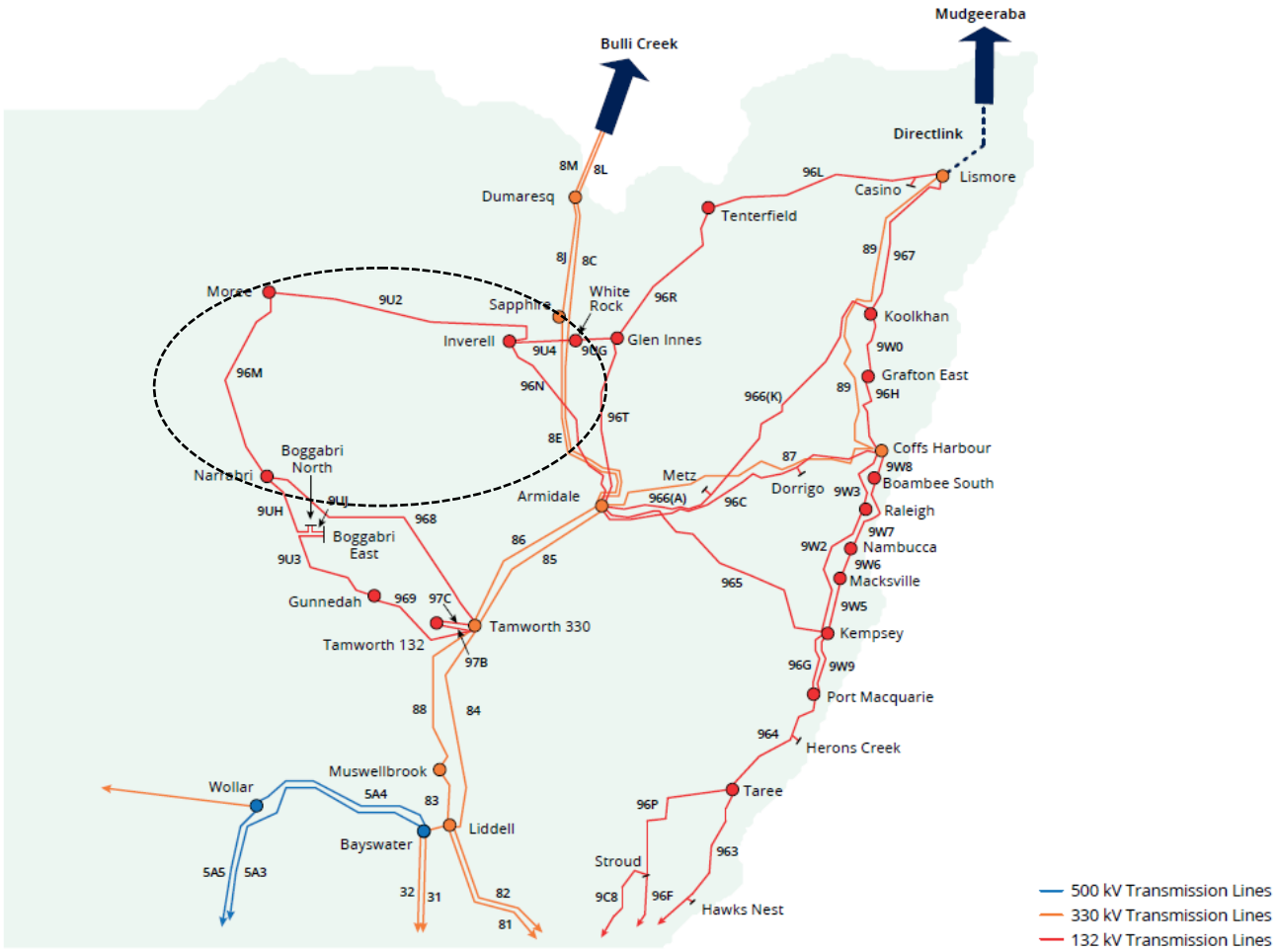


2. The identified need

2.1. Background to the identified need

The current Northern NSW electricity transmission network is shown in 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.[9] In Northern 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.

9 AEMO, Electricity Statement of Opportunities (ESOO) 2021, August 2021

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.[10] 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.[11]

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 system normal and 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 POE50 minimum active (MW) and reactive (MVAr) power demand forecast at the Moree and Inverell 132 kV substations respectively.[12] 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

[10] These levels are specified in Clause S5.1a.4.

[11] 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.

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

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)

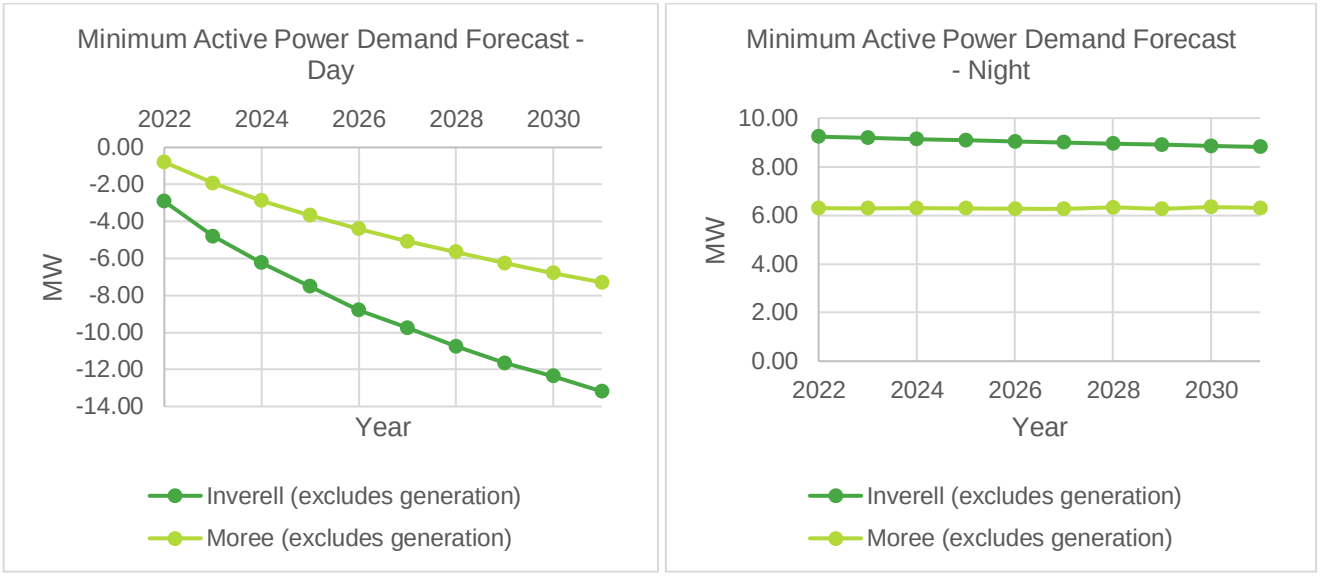
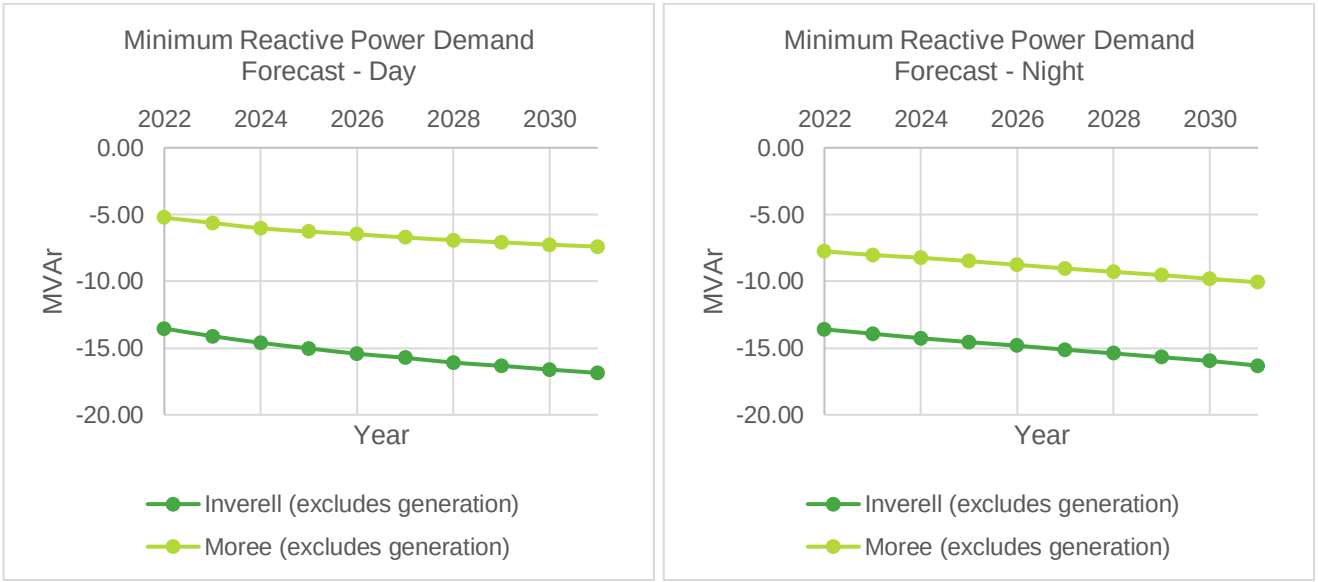


Figure 2-3 Moree and Inverell BSP POE50 minimum demand forecasts (Reactive Power Day/Night)



The analysis in this PSCR uses 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 5.1, 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

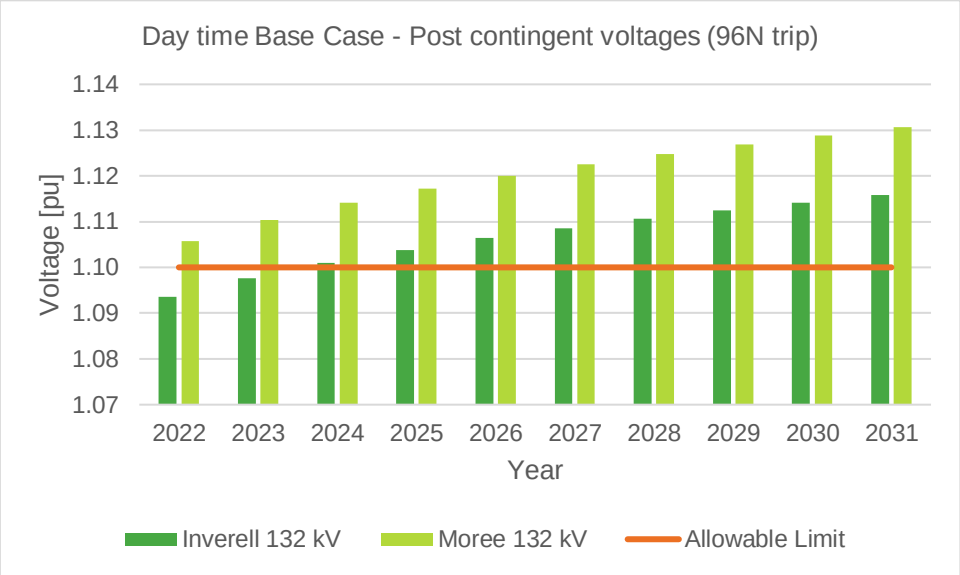
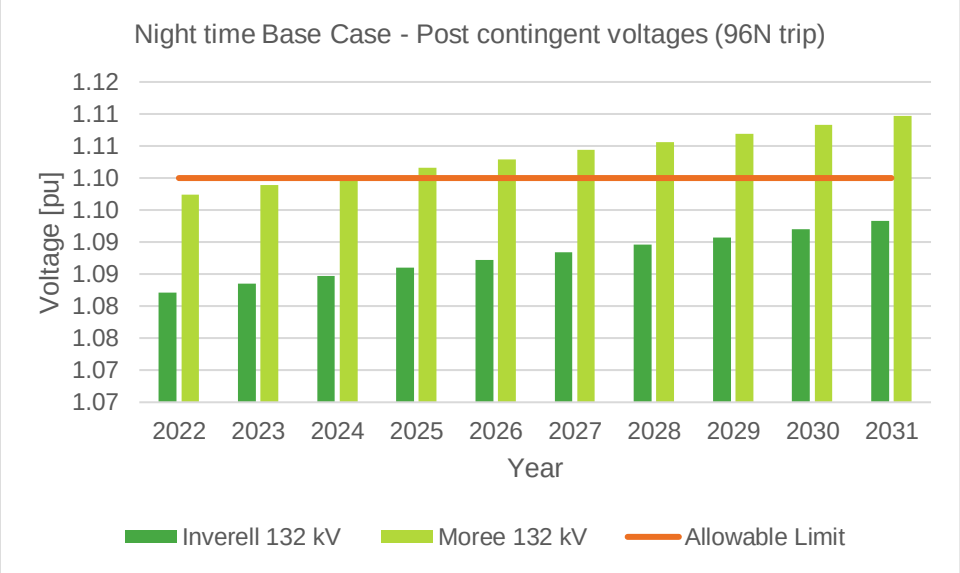


Figure 2-5: Night time post-contingent voltage at Moree and Inverell



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

3. Options that meet the identified need

We consider credible options in this RIT-T assessment as those that would meet the identified need from a technical, commercial, and project delivery perspective.[13] This will include any credible options that are put forward by proponents in response to this PSCR.

The credible network options for this RIT-T all 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 timing
1	Install a 66 kV 10 MVAr reactor at Moree and a 66 kV 15 MVAr reactor at Inverell	$7.64 million	2025/26
2	Install a 132 kV 25 MVAr reactor at Inverell	$5.41 million	2025/26

In addition, we consider that non-network solutions may be able to form credible options for this RIT-T. Section 4 provides details on the technical information that proponents of non-network options need to provide in order to enable their option to be considered in this RIT-T.

None of the credible options listed above are expected to have a material inter-regional impact.

3.1. Base case

Consistent with the RIT-T requirements, the assessment undertaken in this PSCR compares the costs and benefits of each option to a base case 'do nothing' option. The base case is the (hypothetical) projected case if no action is taken, ie:[14]

> "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'. 'BAU activities' are ongoing, economically prudent activities that occur in absence of a credible option being implemented"

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.

[13] As per clause 5.15.2(a) of the NER.
[14] AER, *Regulatory Investment Test for Transmission Application Guidelines,* August 2020, p. 21.

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.

The estimated capital cost of Option 1 is approximately as set out in Table 3-2.

Table 3-2 Option 1 Capital Cost ($M, real 2021-22)

Capital cost	FY2023-24	FY2024-25	FY2025-26
Option 1	0.58	4.09	2.97

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

We estimate that it will take 32 months from this RIT-T commencement to complete Option 1 with commissioning possible in 2025/26.

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

3.3. Option 2 – Install a 132 kV 25 MVAr reactor at Inverell

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 cost of Option 2 is approximately $ 5.41 million as set out in Table 3-3.

Table 3-3 Option 2 Capital Cost ($M, real 2021-22)

Capital cost	FY2023-24	FY2024-25	FY2025-26
Option 2	0.40	2.90	2.11

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

We estimate that it will take 34 months from this RIT-T commencement to complete Option 2 with commissioning possible in 2025/26.

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

3.4. Options considered but not progressed

We have also considered whether other options could meet the identified need. The reasons these options were not progressed are summarised in Table 3-4.

Table 3-4: Options considered but not progressed

Option	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]:

- 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.

[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

4. Technical characteristics for non-network options

We consider that non-network options may be able to assist with meeting the identified need, specifically non-network technologies that are able to provide absorbing reactive support. At this stage we consider that possible solutions include but are not limited to:

- battery energy storage systems (BESS); and
- generators in the region who are able to provide reactive power support.

However, we note that the cost of the network options may act to effectively bound the cost available for any non-network options to be considered commercially feasible. We are interested in hearing from proponents on their individual solutions and costs.

This section describes the technical characteristics that a non-network option would need to deliver to address the identified need consistent with the NER.

The following table outlines the size, location, and nature of the required non-network option have been determined based on the power system studies carried out by Transgrid for a period of 10 years. Further, the size of the reactive power requirement has been estimated for the worst case scenario which is the day time minimum demand forecast for the critical contingency when nearby generation is out of service or not providing sufficient reactive support.

Table 5 - Reactive power requirement for the non-network options

Year	Size – MVAr (absorbing)	Location	Time of the Day
2025	2	Moree or Inverell 132 kV	Overnight
2027	6		
2029	8		
2031	10		
2023	12		Day
2025	15		
2027	18		
2029	21		
2031	24		

The prevailing conditions will require the non-network option to operate in the day time during low NSW demand.

Like the network option, the switching of the non-network option must not exceed the voltage step limits (<3%) on the network. We note dynamic reactive support technologies are capable of providing reactive support to not exceed this voltage limit.

We welcome submissions to this PSCR from potential providers of non-network solutions.

5. Materiality of market benefits

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

5.1. 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.

5.2. Wholesale electricity market benefits are not material

The AER has recognised that if the credible options 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.[18]

The credible options considered in this PSCR do not address network constraints between competing generators and so will not have an impact on generation dispatch outcomes and the wholesale electricity market. Therefore, we 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 price-responsive voluntary load curtailment (since there is no significant impact on pool price);
- changes in costs for parties, other than for TransGrid (since there will be no deferral of generation investment);
- changes in ancillary services costs;
- competition benefits; and
- Renewable Energy Target penalties.

5.3. 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 us to consider the following classes of market benefits, listed in Table 5-1, arising from each credible option. The same

[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] AER, *Regulatory Investment Test for Transmission Application Guidelines*, August 2020, p. 29

table sets out the reasons we consider these classes of market benefits to be immaterial for this RIT-T assessment.

Table 5-1: Reasons non-wholesale electricity market benefits categories are considered not material

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.

6. Overview of the assessment approach

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

6.1. 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.

6.2. 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 reflects the timeframe for which demand forecasts for the area are available. It also takes into account the size, complexity and expected lives of the options 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 as the undepreciated value of capital costs at the end of the analysis period and can be interpreted as a conservative estimate for benefits (net of operating costs) arising after the analysis period.

A real, pre-tax discount rate of 5.50 per cent has been adopted as the central assumption for the NPV analysis presented in this PADR, consistent with the assumptions adopted in the 2021 IASR. The RIT-T also 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 3.21%,[19] and an upper bound discount rate of 7.50 per cent (i.e., the upper bounds in the 2021 IASR[20]).

6.3. Approach to estimating option costs

We have estimated the capital and operating 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 estimates in MTWO are developed to deliver a 'P50' portfolio value for a total program of works (ie, there is an equal likelihood of over- or under-spending the estimate total).[21]

[19] This is equal to WACC (pre-tax, real) in the latest final decision for a transmission business in the NEM, see: AER, *Transgrid 2023-28 – Final Decision – PTRM – April 2023.xlsx*), 'WACC' sheet, cell R23.
[20] AEMO, 2021 Inputs, Assumptions and Scenarios Report, July 2021, p. 105.
[21] 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.

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

6.4. Value of customer reliability

We have applied a NSW-wide VCR value based on the estimates developed and consulted on by the AER. 41 As outlined in section 5.1, each option is expected to avoid the same amount of unserved energy and so the value of this is not considered material for this RIT-T, i.e., it does not have any impact on the identification of the preferred option under the RIT-T.

6.5. One scenario has been modelled

The RIT-T must include any of the ISP scenarios from the most recent IASR that are relevant unless[22]:

- 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[23].

For the purposes of this RIT-T, we have only modelled outcomes under the Step Change ISP scenario. This scenario was selected because it is the most likely scenario under AEMO's latest ISP[24]. 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., Slow Change, Progressive Change, and Hydrogen Superpower scenarios). AEMO has identified that the Slow Change scenario has a very low probability of occurring (approximately 4%). We have excluded this scenario as it does not have a reasonable likelihood of arising. The Progressive Change and Hydrogen Superpower scenarios differ from the 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

[22] AER, Regulatory investment test for transmission, August 2020, clause 20(b)
[23] AER, Regulatory investment test for transmission: Application guidelines, August 2020, p.41.
[24] In the 2022 ISP, the Step Change scenario is assigned a probability of 50% (See: AEMO, 2022 Integrated System Plan, June 2022, p. 34)

considered material to the outcome of this RIT-T. We do not consider that other assumptions or parameters underpinning the alternative ISP 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 6-1 Summary of step change scenario

Parameter	Step Change
Discount rate	5.50%
Network capital costs	Base estimate
Operating and maintenance costs	Base estimate
Value of Customer Reliability (VCR) ($2021-22)	$46.86/kWh
Minimum demand forecast	Central demand forecast (POE50)

7. Assessment of credible options

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

7.1. Estimated gross benefits

The table below 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 7-1: NPV of gross benefits relative to the base case ($M, real 2021-22)

Option	Step Change
Option 1	0.53
Option 2	0.53

7.2. Estimated costs

The table below summarises the present value of capital costs, and operating and maintenance costs, of each credible option relative to the base case. We consider that Option 2 can be delivered at a lower cost than Option 1 (in NPV terms).

Table 7-2: Costs relative to the base case, PV ($M, real 2021-22)

Option/scenario	Step Change
Option 1	7.05
Option 2	4.99

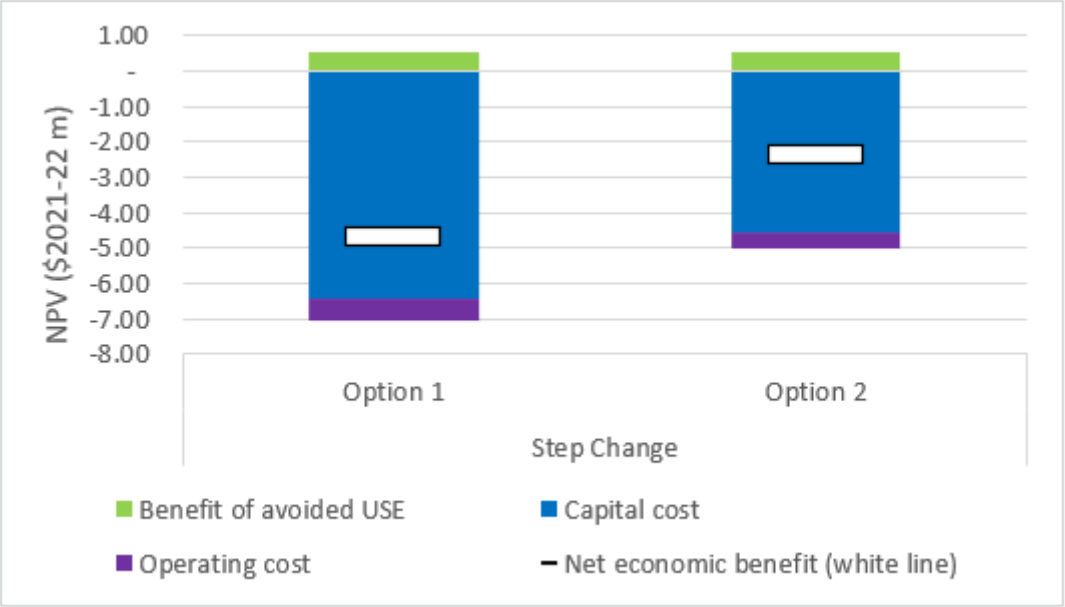
7.3. Estimated net market benefits

The table below summarises the present value of the net economic benefits for each credible option. The net economic benefits are calculated as the estimated gross benefits less the estimated costs. The results shows that Option 2 has the greatest net market benefit of all the options considered. Since gross benefits are the same across the credible options, the key factor driving this result is that Option 2 can be delivered at a lower estimated cost than Option 1 (in NPV terms). Since this RIT-T is a reliability corrective action, the top-ranked option is permitted to have a negative market benefit.

Table 7-3: Net benefits relative to the base case, PV ($M, real 2021-22)

Option/scenario	Step Change	Ranking
Option 1	-4.69	2
Option 2	-2.39	1

Figure 7-1 Net benefits relative, PV ($M, real 2021-22)



7.4. 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 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.

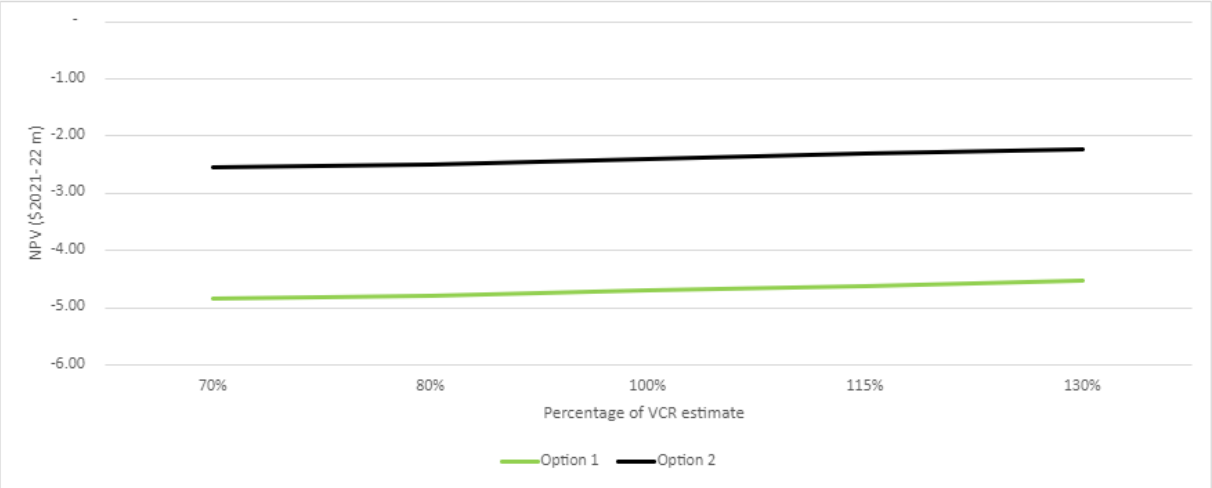
7.4.1. Sensitive analysis on the VCR

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 7-4: 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	-4.85	-4.54	2
Option 2	-2.55	-2.23	1

Figure 7-2 Net economic benefits relative to the base case with lower and higher VCR, PV ($M, real 2021-22)



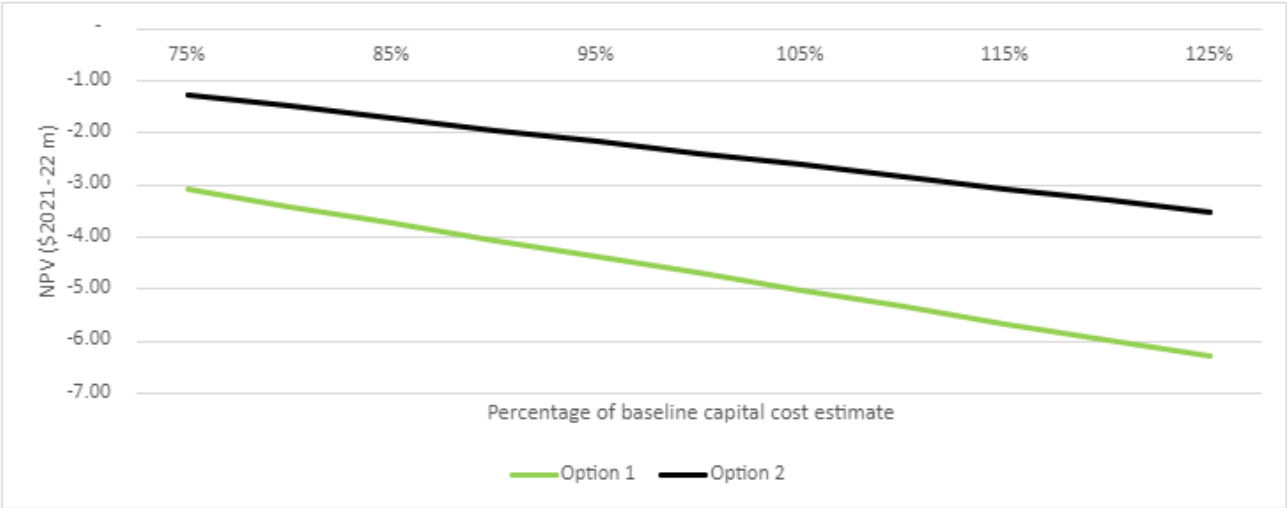
7.4.2. Sensitivity analysis on network capital costs

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 7-5: 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	-3.09	-6.29	2
Option 2	-1.26	-3.52	1

Figure 7-3 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 considered whether an increase or decrease in the capital costs of one option (while holding the capital costs of the other options constant) would change the RIT-T outcome. Our findings show that Option 2's capex would need to increase by more than 50.79% of its current baseline capex estimates in order to change the RIT-T outcome i.e., for Option 2's NPV net economic benefit to be less than Option 1's. Similarly, we found that Option 1's capex would need to decrease by more than 35.96% in order to change the RIT-T outcome.

7.4.3. 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 3.21% which is consistent with the AER's latest final determination for a TNSP (the 'Low discount rate' scenario),[25]and a high discount rate of 7.5% which aligns with the high discount rate scenario in the 2022 IASR (the 'High discount rate' scenario).[26] The option ranking for each sensitivity does not change compared to the main results above, i.e., Option 2 is always ranked first.

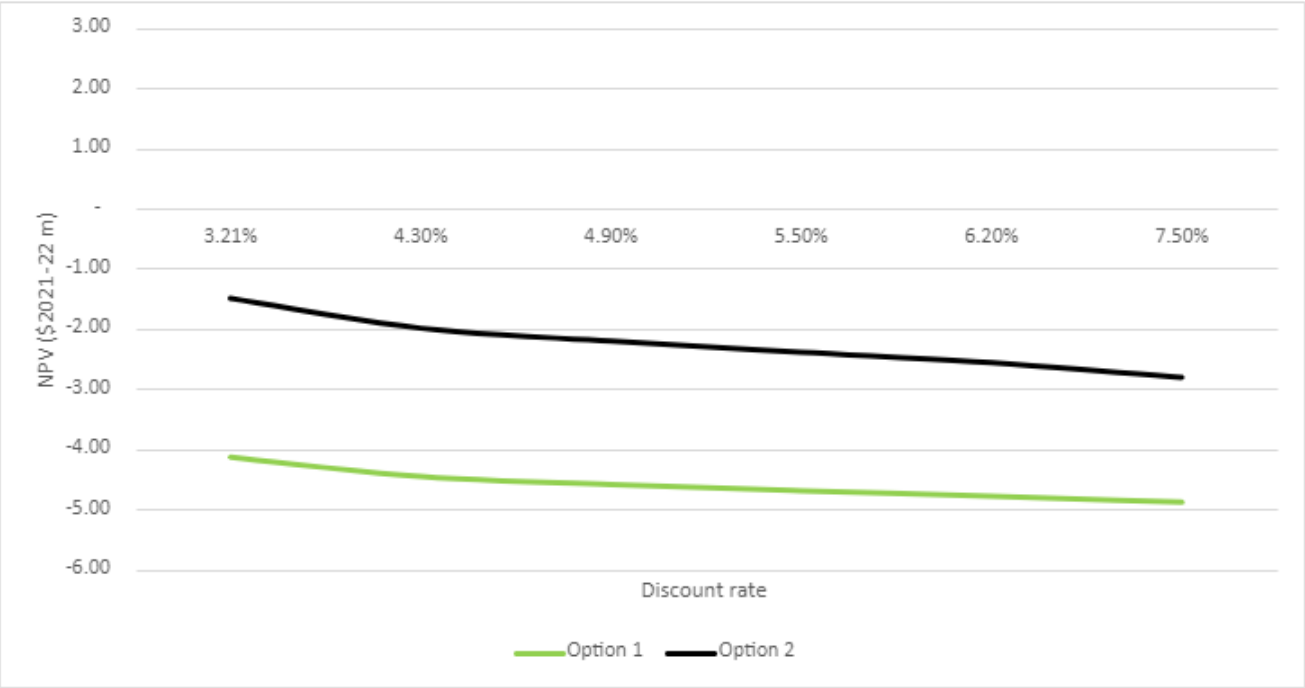
Table 7-6: Net economic benefits relative to the base case under lower and higher discount rates, PV ($M, real 2022-23)

Option/scenario	Low discount rate	High discount rate	Ranking
Sensitivity	3.21%	7.5%	
Option 1	-4.14	-4.88	2
Option 2	-1.50	-2.81	1

[25] 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

[26] AEMO July 2021 2021 Inputs, Assumptions and Scenarios Report

Figure 7-4 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 Option 2 not being the preferred option. Our results suggest that there is no reasonable discount rate that would change the RIT-T outcome.

8. Draft conclusion and exemption from preparing a PADR

Option 2 is the preferred option at this draft stage and involves installing a new 25 MVAr reactor at Inverell to the 132 kV bus.

The estimated capital cost of Option 2 is approximately $5.41 million. Routine operating and maintenance cost are estimated at approximately $54,100/annum.

We estimate that it will take 34 months to complete Option 2 with commissioning in 2025/26.

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:

- if the estimated capital cost of the preferred option is less than $46 million;
- 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
- 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 benefit specified in clause 5.15A.2(b)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding.

We consider that investment in relation to Option 2 is exempt from the requirement to publish a PADR under NER clause 5.16.4(z1).

This exemption would no longer apply if an additional credible option that we consider could deliver a material market benefit is identified during the consultation period. In that case, we will produce a PADR which includes an NPV assessment of the net market benefit of each additional credible option.

If we consider that no additional credible options have been identified during the consultation period that have material market benefits, the next step in this RIT-T process will be the publication of a PACR that addresses all submissions received, including any issues in relation to the proposed preferred option raised during the consultation period.[27]

[27] In accordance with NER clause 5.16.4(z2).

Appendix A Compliance checklist

This appendix sets out a checklist which demonstrates the compliance of this PSCR with the requirements of the National Electricity Rules version 200.

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;	4
	(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 Integrated System 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, system strength services, 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 5.15A.2(b)(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 [preparing a PADR] (paragraphs (j) to (s)) if:	8

	1. the estimated capital cost of the proposed preferred option is less than $35 million[28] (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 5.15A.2(b)(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 5.15A.2(b)(4) except those classes specified in clauses 5.15A.2(b)(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.	

[28] Varied to $46m based on the AER Final Determination: Cost threshold review November 2021.