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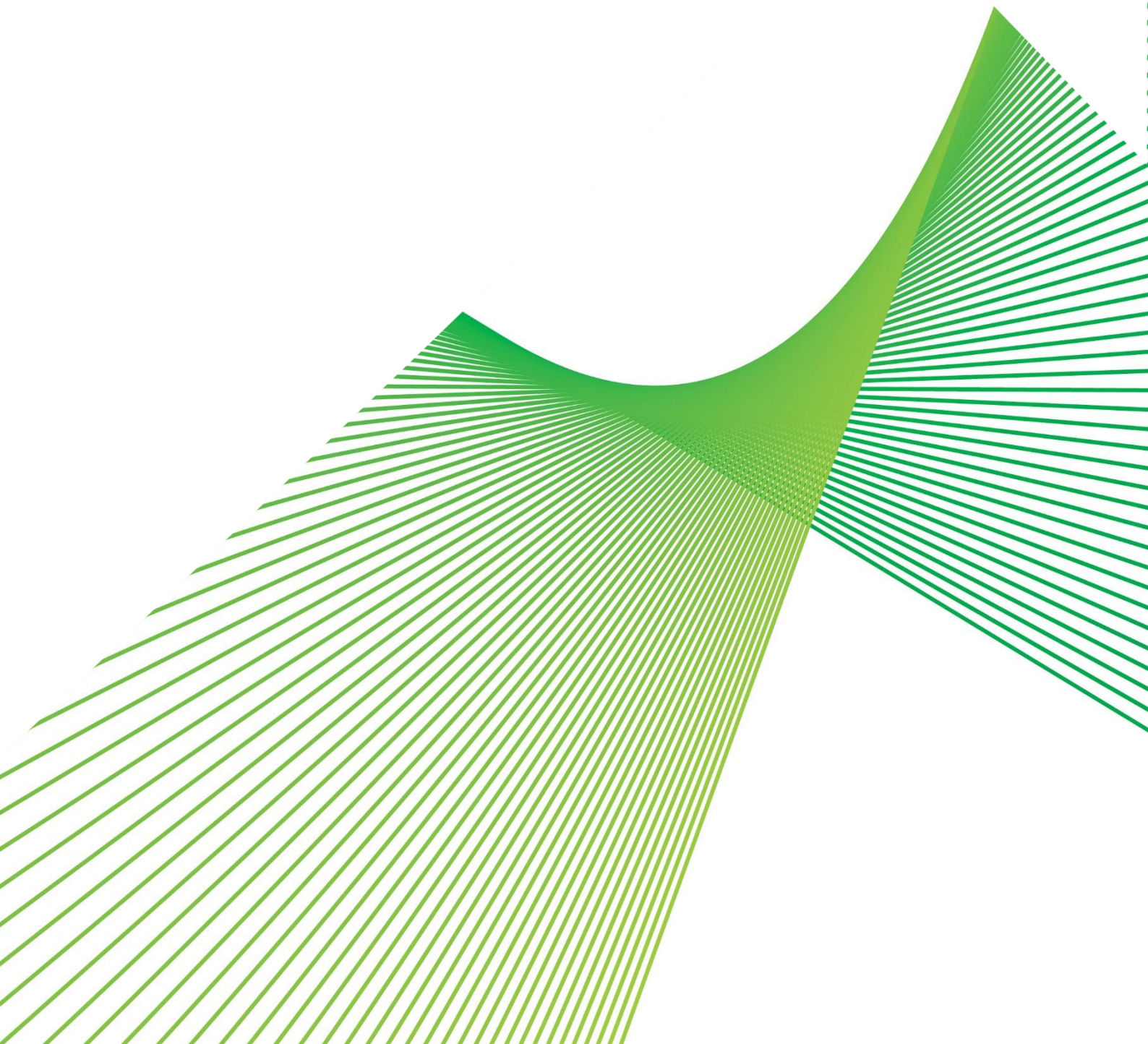
Managing increased fault levels in southern New South Wales

RIT-T Project Assessment Conclusions Report

Region: Southern New South Wales

Date of issue: 21 March 2025



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Executive summary

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for ensuring increased fault levels in southern New South Wales (NSW) are managed appropriately and in the most efficient manner. This Project Assessment Conclusions Report (PACR) is the final step in the application of the RIT-T and follows the Project Assessment Draft Report (PADR) published on 19 December 2024.

The expected commissioning of three actionable ISP projects in southern NSW in coming years (Project EnergyConnect, HumeLink and VNI West), as well as full commercial operation of Snowy 2.0 in December 2028,[1] is expected to result in fault levels that exceed the existing fault level ratings of existing transmission assets at four of our substations in southern NSW if action is not taken. Without action, (i.e., under the base case), this would cause equipment failure and likely significant unserved energy to end consumers in the National Electricity Market (NEM).

The four affected substations are:

- Lower Tumut 330 kV substation;
- Upper Tumut 330 kV substation;
- Murray 330 kV substation; and
- Wagga 330 kV substation.

We are therefore undertaking this RIT-T to assess the options available for managing the expected increased fault levels at these substations, to avoid these consequences and to continue to maintain compliance with the relevant equipment standards under the National Electricity Rules (NER).

The scope of work covered by this RIT-T is necessarily separate to that included as part of the three actionable ISP projects mentioned above. Specifically, the assessment of fault level impacts involves complex network-wide considerations, and these impacts can only be accurately calculated after the design parameters and equipment specifications of the ISP projects have been fully identified (i.e., after the RIT-Ts for those projects have been completed). Further, due to the interconnected nature of the transmission network and the combined effects of multiple major projects, it would be very difficult to attribute the costs to any single project at the time of their respective RIT-Ts.

The separate nature of the scope of works covered by this RIT-T is consistent with the AER approving the 'managing increased fault levels in southern NSW' contingent project with a value of $54.3 million (in 2021/22 dollars) in its determination for our current regulatory control period.[2]

The AER accepting that we have completed a RIT-T to address this identified need is one of the four triggers for this contingent project. A further trigger is that Transgrid has a connection agreement in place with Snowy 2.0. We note that we will not formally commence the investment identified in this RIT-T unless the associated revenue is approved by the AER and will not proceed until the connection agreement is in place. We intend

[1] Snowy Hydro, *Securing the Future of Critical Energy Transformation Projects*, 31 August 2023, available at: https://www.snowyhydro.com.au/news/securing-the-future-of-critical-energy-transformation-resets/. We note that this timing is consistent with the latest (January 2025) AEMO generator information as at the time of finalising this PACR (see: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information), as well that assumed in the 2024 ISP (see: https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios).

[2] AER, *Final decision Transgrid transmission determination 1 July 2023 to 30 June 2028, Attachment 5 – Capital expenditure*, April 2023, p 39.

to undertake early works and development activities on the project before submission of the Contingent Project Application (CPA).

Identified need: ensuring fault levels at four substations comply with regulatory requirements

The system standards set out in Schedule 5.1a of the NER stipulate fault clearance times that we have to meet. Specifically, Schedule 5.1a.8(a)(3) requires that faults anywhere within the power system should be cleared sufficiently rapidly such that consequential equipment damage is minimised.

If action is not taken (i.e., under a 'do nothing' base case), the connection of Project EnergyConnect, HumeLink and VNI West, as well as full commercial operation of Snowy 2.0, will lead to increased fault levels at the above mentioned four substations in southern NSW and consequent equipment failure that would breach our requirements under Schedule 5.1a.8(a)(3) of the NER, as well likely significant unserved energy to end consumers in the NEM.

While in reality, we would not 'do nothing' and would instead reduce the fault level by disconnecting some generator units from the grid in the region (including Snowy 2.0) to avoid these consequences, this is not considered a sustainable long-term solution and would be out-of-step with industry standards for substation equipment design

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

No submissions received in response to the PADR and no material developments since the PADR

We published a PADR on 19 December 2024 and invited written submissions on the material presented within the document. No submissions were received in response to the PADR.

In addition, no additional credible options were identified during the consultation period following publication of the PADR, and no material changes have since occurred.

On 21 November 2024, the requirements set out in the Australian Energy Regulator's Regulatory Investment Test for Transmission (RIT-T) Application Guidelines were amended. The amended guidelines now expect a RIT-T proponent to explicitly consider community engagement and social licence during the RIT-T process.

The amended guidelines mean that Transgrid must consider social licence principles in the identification of credible options. Transgrid considers that through early engagement we can begin to build relationships and trust to gain communities input into the planning of a project during the early design phase as part of the RIT-T. When considering an option, Transgrid will involve community in this decision to determine the most likely cost and delivery timeline for the option and uncover opportunities that can deliver sustainable social legacy outcomes, informed by community engagement.

Transgrid is a strong supporter of involving community in the option design process to better gain community acceptance for the option and reduce the risk of delay to project timelines due to community disagreement.

Through earlier engagement we can quantify prudent and efficient social licence initiatives and mitigate impacts on project timing.

The new guideline requirements do not apply to any RIT-T project where a PSCR was published prior to 21 November 2024. As the PSCR for this RIT-T was published prior to 21 November 2024, this RIT-T does not need to consider the new requirements.

Further, Transgrid will be engaging with communities post the RIT-T through other approval processes.

Upgrading existing substation switchgear and earth grid at the four affected substations is the preferred option

We consider that there is only one option from a technical, commercial, and project delivery perspective that can be implemented in sufficient time to meet the identified need for this RIT-T.

Option 1 involves upgrading certain existing substation switchgear and earth grid at the four affected substations to meet the increased fault levels in the network. The upgraded equipment will ensure that equipment failure does not occur and there is no breach of the requirements under Schedule 5.1a.8(a)(3) of the NER (or a need to significantly constrain generation in the region).

The equipment to be upgraded at each site will comprise all equipment that is rated below the expected fault levels at that site. This equipment will be upgraded to fault level ratings greater than or equal to the ultimate fault levels expected at each site.

The scope of works is expected to be carried out between 2024/25 and 2027/28, with commissioning in 2027/28 (when both Project EnergyConnect and HumeLink are expected to have been commissioned and ahead of full commercial operation of Snowy 2.0 in December 2028).

All works would be completed in accordance with the relevant equipment standards with minimal modification to the wider transmission assets.

The estimated capital expenditure associated with Option 1 is $52.1 million (in 2024/25 dollars).

Conclusion

This PACR finds that Option 1 is the preferred option to manage the expected increased fault levels at the four affected substations and to continue to maintain compliance with the relevant equipment standards. This is consistent with the draft conclusion in the earlier PADR.

The estimated capital expenditure associated with Option 1 is $52.1 million (in 2024/25 dollars). Routine operating and maintenance costs are expected to be $260,000 per year. The works are estimated to take two years to complete and be commissioned in 2027/28.[3]

[3] Timing of the works, and consequently commissioning, is subject to the trigger events outlined in the Executive Summary and Chapter 1 of this PACR.

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.

Parties wishing to raise a dispute notice with the AER may do so prior to 27 April 2025 (30 days after publication of this PACR). Any dispute notices raised during this period will be addressed by the AER within 40 to 100 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 'Managing southern NSW fault levels PACR'.

Contents

Disclaimer **1**

Privacy notice 1

Executive summary **3**

1. Introduction **8**

1.1. Purpose of this report 9

1.2. Next steps 9

2. The identified need **10**

2.1. Background to the identified need 10

2.2. Description of the identified need 12

2.3. Assumptions underpinning the identified need 13

3. Credible options that meet the identified need **14**

3.1. Base case 14

3.2. Option 1 – Upgrade fault ratings at each substation 14

3.3. Options considered but not progressed 16

4. Overview of the assessment approach **18**

4.1. Assessment period and discount rate 18

4.2. Approach to estimating costs 18

4.3. No market benefits are material for this RIT-T 19

4.4. One scenario has been assessed 19

5. Assessment of credible options **20**

5.1. Net economic benefit 20

6. Conclusion **21**

Appendix A Compliance checklist **22**

1. Introduction

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for ensuring increased fault levels in southern New South Wales (NSW) are managed appropriately and in the most efficient manner. This Project Assessment Conclusions Report (PACR) is the final step in the application of the RIT-T and follows the Project Assessment Draft Report (PADR) published on 19 December 2024.

The expected commissioning of three actionable ISP projects in southern NSW in coming years (Project EnergyConnect, HumeLink and VNI West), as well as full commercial operation of Snowy 2.0 in December 2028,[4] is expected to result in fault levels that exceed the existing fault level ratings of existing transmission assets at four of our substations in southern NSW if action is not taken. Without action, (i.e., under the base case), this would cause equipment failure and likely significant unserved energy to end consumers in the National Electricity Market (NEM).

We have therefore commenced this RIT-T to assess the options available for managing the expected increased fault levels to avoid these consequences and to continue to maintain compliance with the relevant equipment standards under the National Electricity Rules (NER). Consequently, we consider this to be a reliability corrective action under the RIT-T.

The scope of work covered by this RIT-T is necessarily separate to that included as part of the three actionable ISP projects mentioned above. Specifically, the assessment of fault level impacts involves complex network-wide considerations, and these impacts can only be accurately calculated after the design parameters and equipment specifications of the ISP projects have been fully identified (i.e., after the RIT-Ts for those projects have been completed). Further, due to the interconnected nature of the transmission network and the combined effects of multiple major projects, it would be very difficult to attribute the costs to any single project at the time of their respective RIT-Ts.

The separate nature of the scope of works covered by this RIT-T is consistent with the AER approving the 'managing increased fault levels in southern NSW' contingent project in its determination for our current regulatory control period with a value of $54.3 million (in 2022/23 dollars).[5] The AER accepting that we have completed a RIT-T to address this identified need is one of the four triggers for this contingent project. Importantly it demonstrates that the proposed network investment is the most efficient option to ensure fault current ratings of equipment at Lower Tumut, Upper Tumut, Wagga 330 kV and Murray are not exceeded. A further trigger is that Transgrid has a connection agreement in place with Snowy 2.0.

While we will not formally commence the investment identified in this RIT-T unless the associated revenue is approved by the AER and the connection agreement is in place given its importance, we intend to undertake early works and development activities on the project before submission of the Contingent Project Application (CPA).

[4] Snowy Hydro, *Securing the Future of Critical Energy Transformation Projects*, 31 August 2023, available at: https://www.snowyhydro.com.au/news/securing-the-future-of-critical-energy-transformation-resets/. We note that this timing is consistent with the latest (October 2024) AEMO generator information as at the time of finalising this PACR (see: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information), as well that assumed in the 2024 ISP (see: https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios).

[5] AER, *Final decision Transgrid transmission determination 1 July 2023 to 30 June 2028, Attachment 5 – Capital expenditure*, April 2023, p 39.

1.1. Purpose of this report

The purpose of this PACR[6] is to:

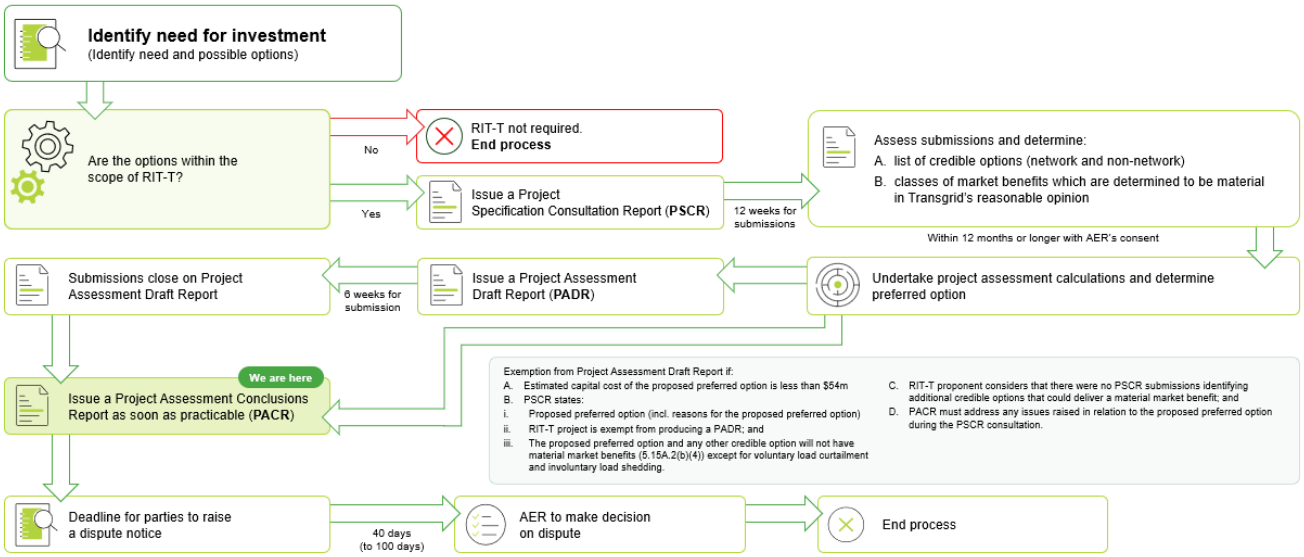
- describe the identified need;
- describe and assess the credible option to meet the identified need;
- describe the assessment approach used; and
- provide details of the proposed preferred option to meet the identified need.

Overall, this report provides transparency into the planning considerations for investment options to address the expected increase in fault levels. A key purpose of this PACR, and the RIT-T more broadly, 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. 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.

Figure 1-1 This PACR is the final stage of the RIT-T process[7]



Parties wishing to raise a dispute notice with the AER may do so prior to 27 April 2025 (30 days after publication of this PACR). Any dispute notices raised during this period will be addressed by the AER within 40 to 100 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 'Managing southern NSW fault levels PACR'.

[6] See Appendix A for the NER requirements.
[7] Australian Energy Market Commission. "*Replacement expenditure planning arrangements, Rule determination*". Sydney: AEMC, 18 July 2017.

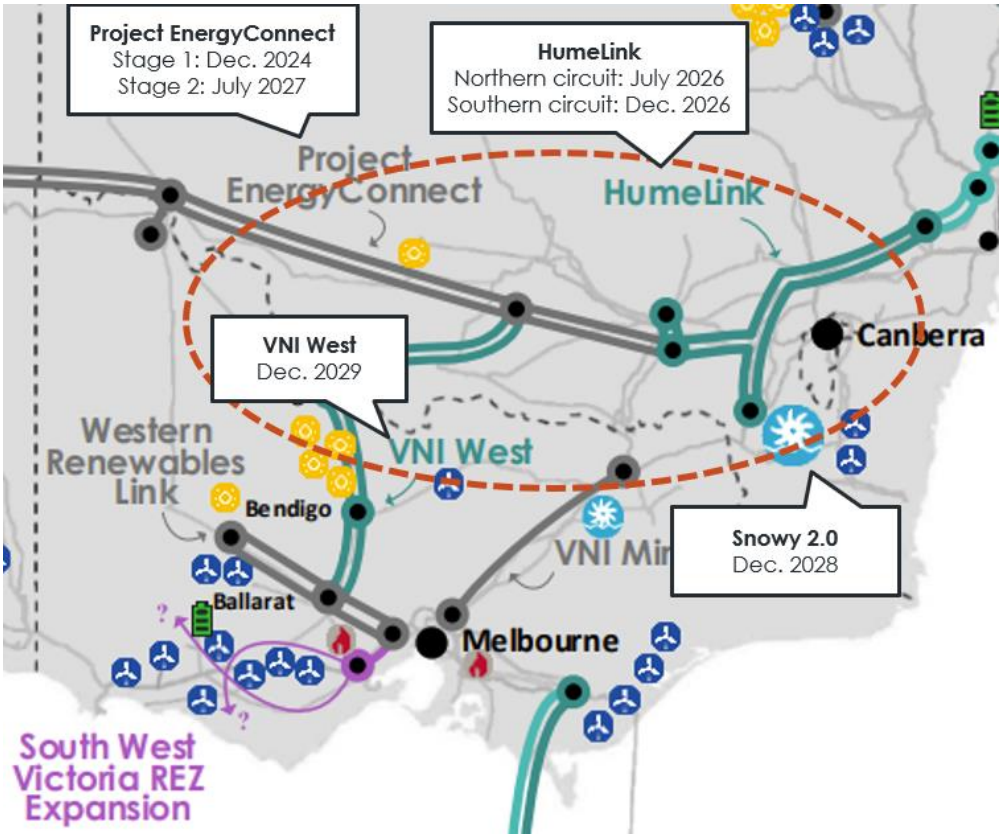
2. The identified need

This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it. It first sets out background information related to the southern NSW transmission network and the expected key developments in coming years.

2.1. Background to the identified need

The identified need for this RIT-T is driven by the expected commissioning of three actionable ISP projects in southern NSW in coming years, as well as the full commercial operation of Snowy 2.0 in December 2028. These key developments are shown in Figure 2-1 below.

Figure 2-1 Key developments in southern NSW



Source: Developed from the Final 2024 ISP, see: AEMO, 2024 Integrated System Plan, 26 June 2024, p. 14.

The three actionable ISP projects can be summarised as follows:

- Project EnergyConnect – a new interconnector between NSW and South Australia that provides the eastern states with greater access to low-cost renewable energy from South Australia. It will also allow lower-cost baseload generation in the eastern states to displace higher cost gas-fired generation in South Australia when variable renewable generation in South Australia is low.
- HumeLink – reinforcement of the southern NSW transmission network to provide access to renewable and peaking generation in southern NSW and Victoria to meet demand in the major load centres of Sydney, Newcastle and Wollongong.
- VNI West – additional interconnection between NSW and Victoria to help maintain reliability of supply in Victoria, as Victorian coal-fired generators are scheduled to retire in the late 2020s and the 2030s. It is also expected to provide a significant increase in capacity for low-cost renewable generation in south-western NSW and north-western Victoria.

Snowy 2.0 is a committed pumped hydro generator that involves linking two existing dams, Tantangara and Talbingo, and building a new underground power station. Full commercial operation is expected by December 2028.[8]

All three actionable ISP projects are integral to realising the full benefits of Snowy 2.0 and ensuring that its 2,000 MW of dispatchable capacity can be used flexibly across the NEM to supply end users in major load centres. All four projects are considered essential to the fundamental, rapid and complex change the power system in eastern Australia is undergoing as it transitions to net zero emissions.

We note that AEMO's final 2024 ISP, which was released following the PSCR for this RIT-T, includes a delay to the full capacity timing for both stage one and stage two of Project EnergyConnect of six months and one year, respectively, compared with the draft 2024 ISP. Stage one is now expected to be complete in December 2024 and stage two in July 2027 (as shown in the figure above). We do not consider that this has resulted in a delay in the identified need for this RIT-T, and continue to consider that the fault level remediation needs to be complete by 2027/28 (when both Project EnergyConnect and HumeLink are both expected to have been commissioned and ahead of full commercial operation of Snowy 2.0 in December 2028).

In light of these developments, we have undertaken system studies to determine the effect that they are expected to have on our transmission network. These studies show that, without action, the expected commissioning of the three actionable ISP projects in southern NSW, as well as the full commercial operation of Snowy 2.0, is expected to result in fault levels that exceed the existing fault level ratings of existing transmission assets at four of our substations in southern NSW. This would cause equipment failure and likely significant unserved energy to end consumers in the NEM.

The four affected substations are:

- Lower Tumut 330 kV substation;
- Upper Tumut 330 kV substation;
- Murray 330 kV substation; and
- Wagga 330 kV substation.

[8] See the latest (January 2025) AEMO generator information database: https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information.

We are therefore undertaking this RIT-T to assess the options available for managing the expected increased fault levels at these substations, to avoid these consequences.

The scope of work covered by this RIT-T is necessarily separate to that included as part of the three actionable ISP projects mentioned above. Specifically, the assessment of fault level impacts involves complex network-wide considerations, and these impacts can only be accurately calculated after the design parameters and equipment specifications of the ISP projects have been fully identified (i.e., after the RIT-Ts for those projects have been completed). Further, due to the interconnected nature of the transmission network and the combined effects of multiple major projects, it would be very difficult to attribute the costs to any single project at the time of their respective RIT-Ts.

The separate nature of the scope of works covered by this RIT-T is consistent with the AER approving the 'managing increased fault levels in southern NSW' contingent project in its determination for our current regulatory control period.[9]

2.2. Description of the identified need

The system standards set out in Schedule 5.1a of the NER stipulate fault clearance times that we have to meet. Specifically, Schedule 5.1a.8(a)(3) requires that faults anywhere within the power system should be cleared sufficiently rapidly such that consequential equipment damage is minimised.

If action is not taken (i.e., under a 'do nothing' base case), the connection of Project EnergyConnect, HumeLink and VNI West, as well as full commercial operation of Snowy 2.0, will lead to increased fault levels at the abovementioned four substations in southern NSW and consequent equipment failure that would breach our requirements under Schedule 5.1a.8(a)(3) of the NER, as well likely significant unserved energy to end consumers in the NEM.

While, in reality, we would reduce the fault level by disconnecting some generator units from the grid in the region (including Snowy 2.0) to avoid these consequences, this is not considered a sustainable long-term solution and would be out-of-step with industry standards. Specifically, section 8.4.4.2 of the Australian Standard 'AS2067-2016' – covering substations and high voltage installations exceeding 1 kV AC – states that the design of equipment should take into consideration expected fault levels in the future. We consider a situation in which generation is consistently constrained (likely significantly) to be unrealistic and inconsistent with this standard. We note also that all four substations in question were commissioned in the 1970s and were not designed to accommodate the increase in fault levels expected from the significant projects soon to be commissioned in the region.

The proposed investment will enable us to manage the expected increased fault levels to avoid these consequences and to continue to maintain compliance with the relevant equipment standards under the NER. Consequently, the identified need is considered a 'reliability corrective action' under the RIT-T. A reliability corrective action differs from a 'market benefits'-driven RIT-T in that the preferred option is permitted to have negative net economic benefits on account of it being required to meet an externally imposed obligation on the network business.

[9] AER, *Final decision Transgrid transmission determination 1 July 2023 to 30 June 2028, Attachment 5 – Capital expenditure*, April 2023, p 39.

2.3. Assumptions underpinning the identified need

Preliminary fault level calculations have been performed using a Root Mean Square (RMS) model of the NSW network. This includes detailed modelling of synchronous generators for all coal-fired, gas-fired, and hydro power stations in NSW, and considers the contribution from interconnectors to assess fault level calculations. Modelling of inverter-based resources is also included when calculating the maximum fault level requirements.

The table below summarises the results of this assessment, in terms of the increasing (3-phase) fault levels following each expected key development. Specifically, it shows the projected rating as key developments come online (and how they increase at each location).

Table 2-1 Increasing 3-phase fault level (KA) for each stage based on the projects commissioning date.

Substation	3-phase			
	PEC + HumeLink	CWO REZ	Snowy 2.0	VNI-West
Lower Tumut	31.30	31.45	36.32	37.00
Upper Tumut	28.10	28.23	33.60	34.09
Wagga	23.12	23.21	24.20	23.78
Murray	28.01	28.06	29.54	29.70

The estimated fault levels above have not been updated from the PADR, and we do not consider that doing so is a proportionate exercise for this PACR assessment (i.e., it will not affect the preferred option identified).

The Central-West Orana (CWO) Renewable Energy Zone (REZ) has been included in this table because its development, which will occur around the same time as the commissioning of the other major projects mentioned in this RIT-T, will increase the fault levels in southern NSW. That said, it is not considered a key determinant of the identified need in this RIT-T because it does not significantly affect the fault levels in the southern area, being in Central West NSW.

We also undertook this analysis for all other substations in the area, but the fault level impact was found to be relevant only for the four substations subject to this RIT-T.

3. Credible options that meet the identified need

This section describes the credible option that we currently consider addresses the need, including its scope and the associated costs.

We consider that there is only one option from a technical, commercial, and project delivery perspective that can be implemented in sufficient time to meet the identified need for this RIT-T. Three other options were considered but not progressed for reasons that are outlined in table 3-3.

Transgrid is progressing system studies in parallel with this RIT-T to refine the exact scope of work required under Option 1. This work has progressed significantly since the PSCR and PADR. We are currently studying equipment rating at each of the four substations to determine the exact scope of work expected to be required. While the work has not been finalised, we do not anticipate the costs exceeding the current estimates. Once the exact scope of work is defined, Transgrid will apply appropriate steps in the regulatory process to notify stakeholders and the AER of any material changes.

All costs and benefits presented in this PACR are in 2024/25 dollars, unless otherwise stated.

3.1. Base case

Under the base case, no proactive capital investment is undertaken to address the increased fault levels, which means that they will exceed the ratings of the existing assets at the four substations, leading to equipment failure.

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

However, for this RIT-T, we note that the base case definition (e.g., how unserved energy is expected to occur) for this RIT-T is not considered material. This is due to there only being one credible option (as outlined below) and the identified need being a reliability corrective action (as outlined in section 2.2).

3.2. Option 1 – Upgrade fault ratings at each substation

Option 1 involves upgrading certain existing substation switchgear and earth grid at the four affected substations to meet the increased fault levels in the network. The upgraded equipment will ensure that equipment failure does not occur and there is no breach of the requirements under Schedule 5.1a.8(a)(3) of the NER (or a need to reduce the fault level by disconnecting some generator units from the grid in the region).

The equipment to be upgraded at each site will comprise all equipment that is rated below the expected fault levels at that site. This equipment will be upgraded to fault level ratings to withstand the ultimate fault levels expected at each site

The scope of this option is currently expected to include:

- extension of the existing earth grid at the Lower Tumut 330 kV substation to comply with the allowable touch/step voltage limit;

- 77 sets of 3 phase 330 kV disconnectors, including:
  - 36 at the Lower Tumut 330 kV substation;
  - 16 at the Upper Tumut 330 kV substation;
  - 14 at the Murray 330 kV substation;
  - 11 at the Wagga 330 kV substation;
- 29 sets of 3 phase 330 kV post insulators with new footings, including:
  - 4 at the Lower Tumut 330 kV substation;
  - 14 at the Upper Tumut 330 kV substation;
  - 5 at the Murray 330 kV substation; and
  - 6 at the Wagga 330 kV substation; and
- 6 sets of 2 phase 330 kV wave traps reusing existing footings;
- 6 sets of 3 phase 330 kV capacitive voltage transformers reusing existing footings;
- reshaping of 330 kV conductors to reduce terminal loading forces in the following substations, including:
  - 10 sets at the Lower Tumut 330 kV substation;
  - 5 sets at the Upper Tumut 330 kV substation;
  - 10 sets at the Murray 330 kV substation;
  - 1 set at the Wagga 330 kV substation; and
- Transmission line earth wire replacement near affected substations and associated structure strengthening.

The scope of works is expected to be carried out between 2024/25 and 2027/28, with commissioning in 2027/28 (when both Project EnergyConnect and HumeLink are expected to have been commissioned and ahead of full commercial operation of Snowy 2.0 in December 2028). All works would be completed in accordance with the relevant equipment standards with minimal modification to the wider transmission assets.

The estimated capital expenditure associated with this option is $52.1 million, which is comprised of:

- $10.6 million in labour costs;
- $8.2 million materials costs; and
- $33.2 million in expenses (which includes expenses in relation to contractors, design consultants etc).

The capital expenditure estimated is the same as that stated in the PADR.

Table 3-1 below provides a breakdown of the expected capital expenditure by substation and transmission line categories and expense types.

Table 3-1 Breakdown of capital expenditure by substation and driver, $m

	Transmission Line	Upper Tumut	Lower Tumut	Wagga	Murray	Total
Labour	1.8	2.2	3.6	1.1	1.9	10.6
Material	0.8	1.8	3.0	1.3	1.3	8.2
Expenses	5.9	6.9	11.2	2.7	6.5	33.2
Total	8.5	10.9	17.8	5.1	9.8	52.1

Table 3-2 below shows the expected expenditure profile of this option.

Table 3-2 Annual breakdown of Option 1's expected capital cost, $m

	2024/25	2025/26	2026/27	2027/28
Capital expenditure	3.4	11.7	19.8	17.2

There is not expected to be a material increase in operating and maintenance costs for Option 1 given all equipment installed will replace similar equipment with the same standard maintenance schedules. Operating expenditure has been estimated at $260,000 per year (0.5 per cent of total capital expenditure).

3.3. Options considered but not progressed

We have considered three additional network options to meet the identified need in this RIT-T. Table 3-3 summarises the reasons these options were not progressed further.

Table 3-3 Options considered but not progressed

Description	Reason(s) for not progressing
Staged version of Option 1	We considered a variant of Option 1 that stages the work at each substation according to when fault level issues are expected to arise at each. However, the increased mobilisation costs associated with staging are considered to outweigh the benefits associated with delaying capital expenditure. In addition, staging would not result in an increase in estimated gross benefits as compared to Option 1, given that both options would result in the works for each substation being completed in time to address the expected increase in fault levels (and thereby have the same expected gross benefits). This variant is therefore not considered commercially feasible and has not been progressed. Further, we note that there will be a level of 'organic' staging with Option 1, as it is not possible to undertake the works at all four substations simultaneously. The work plan for Option 1 will prioritise the work at each substation according to a condition assessment.
Using fault limiters to reduce the associated fault levels.	This option is not considered technically feasible as fault limiters have not been comprehensively tested and proven in the context of the NEM. Fault limiters are also expected to affect network flows in this context and give rise to other network issues such as rising voltage drop during normal condition, increasing the time constant of the system during the fault, and compromising the system transient stability.
Contracting generators to disconnect (or not connect)	This option is considered not commercially feasible. While the fault level issues could be avoided through contracting with generators to either disconnect or not connect (e.g., for Snowy 2.0), this is not considered realistic as this is not expected to be in the interest of these parties.
Non-network solutions	We do not consider non-network options to be commercially and technically feasible to assist with meeting the identified need. Non-network options would need to replace the functionality of the substations affected by increasing fault level capacity or increasing the fault level ratings of the affected transmission assets (as outlined in more detail in section 4 of the PSCR). No non-network options were proposed in response to the PSCR.

Due to the nature of the identified need, the only technically and commercially feasible option identified by Transgrid is to upgrade fault level ratings for associated transmission network equipment. Consequently, no other options have been identified or considered to address the identified need.

4. Overview of the assessment approach

This section outlines the approach that we have applied in assessing the net benefit associated with the credible option against the base case as part of the PACR.

4.1. Assessment period and discount rate

A 20-year assessment period from 2024/25 to 2043/44 has been adopted for this RIT-T analysis. This period takes into account the size, complexity and expected asset life of the assets.

Where the capital components have asset lives extending beyond the end of the assessment period, the NPV modelling includes a terminal value to capture the remaining functional asset life. This ensures that the capital cost of long-lived assets over the assessment period is appropriately captured, and that all assets have their costs assessed over a consistent period, irrespective of type, technology or serviceable asset life. The terminal values will be calculated as the undepreciated value of capital costs at the end of the analysis period.

A real, pre-tax discount rate of 7 per cent is adopted as the central assumption for the NPV analysis, consistent with AEMO's latest Input Assumptions and Scenarios Report (IASR).[10]

4.2. Approach to estimating costs

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

All costs estimated by Transgrid's project development team use the estimating tool 'MTWO'. The MTWO cost estimating database reflects actual outturn costs built up over more than 10 years from:

- period order agreement rates and market pricing for plant and materials;
- labour quantities from recently completed project; and
- construction tender and contract rates from recent projects.

The MTWO estimating database is reviewed annually to reflect the latest outturn costs and confirm that estimates are within their stated accuracy range and represent the most likely expected cost of delivery (P50 costs)[11]. As part of the annual review, Transgrid benchmarks the outcomes against independent estimates provided by various engineering consultancies.[12]

Transgrid does not generally apply the Association for the Advancement of Cost Engineering (AACE) international cost estimate classification system to classify cost estimates. Doing so for this RIT-T would involve significant additional costs, which would not provide a corresponding increase in benefits compared with the use of MWTO estimates.

We estimate that actual costs will be within +/- 25 per cent of the central capital cost estimate. While we have not explicitly applied the AACE cost estimate classification system, we note that an accuracy of +/- 25

[10] AEMO, 2023 Inputs, Assumptions and Scenarios Report | Final report, July 2023, p 123.
[11] i.e., there is an equal likelihood of over- or under-spending the estimate total.
[12] 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.

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 AACE classification system.

The cost estimate is prepared in real, 2024/25 dollars based on the information and pricing history available at the time that they were estimated. The cost estimate does not include or forecast any real cost escalation for materials.

4.3. No market benefits are material for this RIT-T

In light of there only being one credible option and the identified need for this RIT-T being a reliability corrective action (which enables the preferred option to have negative net market benefits), we do not consider any of the categories of market benefits prescribed in the NER to be material for this RIT-T.[13] We therefore have not estimated any market benefits as part of the NPV assessment in this PACR.

This also applies to estimating the benefits of avoiding the expected various risk costs under the base case (e.g., the safety, bushfire and financial risks). While we expect these benefits to accrue to the investment being contemplated in this RIT-T, given that there is only a single credible option, quantifying these benefits will not affect the identification of the preferred option. We therefore have not estimated any of these avoided risk cost benefits as part of the NPV assessment.

4.4. One scenario has been assessed

In light of market benefits (and avoided risk cost benefits) not being considered material for this RIT-T (as there is only one credible option), we modelled one reasonable scenario. This scenario is summarised in the table below.

Table 4-1 Summary of the scenario

Variable / Scenario	Central
Scenario weighting	*100%*
Discount rate	7.0%
Network capital costs	Base estimate
Operating and maintenance costs	Base estimate

This scenario implicitly assumes the expected most likely scenario for the 2024 ISP (i.e., the 'Step Change' scenario).

We have not undertaken sensitivity testing on account of it not being proportionate, i.e., given we only have one credible option for this reliability corrective action, sensitivity testing will not inform the identification of the preferred option.

[13] 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(b)(6). See Appendix A for requirements applicable to this document.

5. Assessment of credible options

This section outlines the assessment we have undertaken of the credible network option.

5.1. Net economic benefit

Table 5-1 below summarises the present value of the net economic benefit of the credible option relative to the base case, under the single scenario investigated (as outlined in section 4.4).

Table 5-1 PV of net economic benefit for Option 1 relative to the base case ($m, 2024/25)

Option/scenario	Central
Scenario weighting	100%
Option 1	-39.6

In this instance, the net economic benefit is negative, as it only reflects the costs of the option.

6. Conclusion

This PACR finds that Option 1 is the preferred option to manage the expected increased fault levels at the four affected substations and to continue to maintain compliance with the relevant equipment standards. This is consistent with the draft conclusion in the earlier PADR.

Option 1 involves upgrading certain existing substation switchgear and earth grid at the four affected substations. The upgraded equipment will ensure that equipment failure does not occur and there is no breach of the requirements under the NER (or need to significantly constrain generation in the region).

The equipment to be upgraded at each site will comprise all equipment that is rated below the expected fault levels at that site. The equipment will be upgraded to fault level ratings greater than or equal to the ultimate fault levels expected at each site.

The estimated capital expenditure associated with Option 1 is $52.1 million (in 2024/25 dollars). Routine operating and maintenance costs are expected to be $260,000 per year. The works are estimated to take two years to complete and be commissioned in 2027/28.[14]

Option 1 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.

Transgrid considers this conclusion to be robust to changes in capital cost inputs, estimated risk costs and underlying discount rates, noting that there would need to be unrealistic changes to these key assumptions to change the ranking of the options (as shown via the boundary testing at the end of section 6). Transgrid will however continue to monitor these key assumptions and will notify the AER if such changes do occur (or appear likely), which would constitute a material change in circumstance.

[14] Timing of the works, and consequently commissioning, is subject to the trigger events outlined in the Executive Summary and Chapter 1 of this PACR.

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 225.

Rules clause	Summary of requirements	Relevant section(s)
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).	N/A
5.16.4(k)	The assessment draft report, which must include:	-
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the PSCR;	N/A
	(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, 4 & 5
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	4
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	4.3
	(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;	5
	(8) the identification of the proposed preferred option;	6
	(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 & 6

In addition, the table below outlines a separate compliance checklist demonstrating compliance with the binding guidance in the latest AER RIT-T guidelines.

Guidelines section	Summary of the requirements	Relevant section(s)
3.2.5	A RIT-T proponent must consider social licence issues in the identification of credible options. A RIT proponent should include information in its RIT reports about when and how social licence considerations have affected the identification and selection of credible options.	N/A[15]
3.4.3	The value of emissions reduction (VER), reported in dollars per tonne of emissions (CO2 equivalent), is used to value emissions within a state of the world. A RIT-T proponent is required to use the then prevailing VER under relevant legislation or, otherwise, in any administrative guidance.	N/A[15]
3.5A.1	Where the estimated capital costs of the preferred option exceeds $103 million (as varied in accordance with a cost threshold determination), a RIT-T proponent must, in a RIT-T application: • outline the process it has applied, or intends to apply, to ensure that the estimated costs are accurate to the extent practicable having regard to the purpose of that stage of the RIT-T • for all credible options (including the preferred option), either – apply the cost estimate classification system published by the AACE, or – if it does not apply the AACE cost estimate classification system, identify the alternative cost estimation system or cost estimation arrangements it intends to apply, and provide reasons to explain why applying that alternative system or arrangements is more appropriate or suitable than applying the AACE cost estimate classification system in producing an accurate cost estimate	NA
3.5A.2	For each credible option, a RIT-T proponent must specify, to the extent practicable and in a manner which is fit for purpose for that stage of the RIT-T: • all key inputs and assumptions adopted in deriving the cost estimate • a breakdown of the main components of the cost estimate	3.2 & 4.2

[15] These are new requirements stipulated in revised RIT-T Application Guidelines released by the AER, which came into effect on 21 November 2024. For compliance purposes, the AER only have regard to the guidance that was in effect when Transgrid initiated the RIT-T in question. In this context, initiated means from the publication of a project specification consultation report (PSCR). As the PSCR was published prior to 21 November 2024, these new requirements are not applicable to this RIT-T.

	• the methodologies and processes applied in deriving the cost estimate (e.g. market testing, unit costs from recent projects, and engineering-based cost estimates) • the reasons in support of the key inputs and assumptions adopted and methodologies and processes applied the level of any contingency allowance that have been included in the cost estimate, and the reasons for that level of contingency allowance	
3.5	In the RIT-T, costs must include the following classes: • Costs incurred in constructing or providing the credible option • Operating and maintenance costs over the credible option's operating life • Costs of complying with relevant laws, regulations and administrative requirements For, asset replacement projects or programs, there are costs resulting from removing and disposing of existing assets, which a RIT-T assessment should recognise. RIT-T proponents should include these costs in the costs of all credible options that require removing and disposing of retired assets. For completeness, the RIT-T proponent would exclude these costs from the 'BAU' base case.	3
3.5.3	The RIT-T proponent is required to provide the basis for any social licence costs in its RIT-T reports and may choose to refer to best practice from a reputable, independent and verifiable source.	N/A[15]
3.6	RIT-T proponents are required to apply classes of market benefits consistently across all credible options.	N/A[15]
3.7.3	When calculating the benefit from changes in Australia's greenhouse gas emissions, a RIT-T proponent is required to: • include the following emissions scopes, unless the change relative to the base case can be demonstrated to be immaterial to the RIT outcome: – direct emissions from generation – direct emissions other than from generation estimate the change in annual emissions (once identified in accordance with this Guideline) between the base case and the credible option, and multiplying this change by the annual VER to arrive at the annual benefit from changes in Australia's greenhouse gas emissions	N/A[15]
3.8.2	Where the estimated capital cost of the preferred option exceeds $103 million (as varied in accordance with an applicable cost threshold determination), a RIT-T proponent must undertake sensitivity analysis on all credible options, by varying one or more inputs and/or assumptions.	NA
3.9.4	If a contingency allowance is included in a cost estimate for a credible option, the RIT-T proponent must explain:	N/A

	• the reasons and basis for the contingency allowance, including the particular costs that the contingency allowance may relate to, and • how the level or quantum of the contingency allowance was determined.	
3.11.2	Where a concessional finance agreement is included, the RIT-T proponent is required to provide sufficient detail about the concessional finance agreement to justify an agreement's inclusion and such that it can articulate how the value of the concession is to or would be shared with consumers. If a proponent seeks to include an unexecuted concessional finance agreement in the RIT-T, they must undertake sensitivity testing for the scenario the agreement doesn't eventuate.	N/A[15]
4.1	RIT-T proponents are required to describe in each RIT-T report • how they have engaged with local landowners, local council, local community members, local environmental groups or traditional owners and sought to address any relevant concerns identified through this engagement • how they plan to engage with these stakeholder groups, or • why this project does not require community engagement.	NA[15]