TransGrid

Reinforcing the New South Wales Southern Shared Network to increase transfer capacity to the state's demand centres

Project Specification Consultation Report
25 June 2019

01 Executive Summary

The National Electricity Market (NEM) is undergoing rapid change as demand for electricity continues to grow, the retirement of existing coal-fired generation draws closer and the sector transitions to greater reliance on renewable generation and new technologies.

With increasing focus on putting downward pressure on wholesale electricity prices and on ensuring security of supply into the future, the Australian Energy Market Operator (AEMO) consulted widely and released the Integrated System Plan (ISP) in July 2018.

The ISP demonstrated the economic value of transmission investment to lowering costs, providing energy security and efficiently supporting the transition to a lower emissions system.

The ISP outlined 10 transmission investments, including the expansion of transmission capacity between the Snowy Mountains, Sydney and other demand centres.

Expanded transmission capacity from southern NSW to major demand centres was also listed as a priority in the New South Wales (NSW) Transmission Infrastructure Strategy, released in November last year.

Final approval for the proposed Snowy 2.0 generation development occurred in February 2019.

TransGrid, as the jurisdictional planning body for NSW, is commencing formal consultation under the Regulatory Investment Test for Transmission (RIT-T) on investments that can reinforce the Southern Shared Network to increase transfer capacity between southern NSW and major demand centres in the State.

The Southern Shared Network includes existing transmission capacity and planned interconnectors, connections to the existing Snowy Hydro Scheme and other regional generation assets. It provides transfer capacity to demand centres and allows for interstate and regional transfers.

RIT-T commenced to examine reinforcing the Southern Shared Network to increase transfer capacity to demand centres

TransGrid operates and maintains the transmission network in NSW. The shared transmission network between the Snowy Mountains and Bannaby carries power from all generation across southern NSW to the major load centres of Sydney, Newcastle and Wollongong. It also carries all electricity that is imported from Victoria (VIC) to the major load centres in NSW. The main transmission lines in this area are heavily congested at times of high demand, and will become more congested as new generation connects in southern NSW.

Snowy Hydro's existing generation capacity connects to the Southern Shared Network at Upper Tumut, Lower Tumut, and Murray.

Existing congestion at times of high demand limits access to the existing generation capacity of the Snowy Mountains Scheme at times of peak demand. Access to the additional 2,000 MW capacity of Snowy 2.0 and other new generation in southern NSW would, therefore, be severely limited, without reinforcement to the Southern Shared Network. Snowy Hydro Limited will connect Snowy 2.0 to the Southern Shared Network via a cut-in to the existing Upper Tumut to Lower Tumut transmission line and a new substation at Maragle. These connection works are outside the scope of this RIT-T.

In NSW, where the existing coal-fired generators are retiring progressively from 2022, there is a pressing need for new sources of supply to meet the community's growing energy demand.

Snowy 2.0 will provide a new source of generation to meet future demand in the major load centres of NSW and 'firm' supply from new renewable generation which is anticipated in southern NSW. This includes renewables projects in construction or under development totaling 1,900 MW. Reinforcement of the Southern Shared Network will be required to allow the transfer of energy to demand centres.

The RIT-T will consider investments for reinforcing the Southern Shared Network for the most efficient outcome compared to alternative options including maintaining the status quo

The RIT-T must demonstrate that there is an overall net market benefit to the NEM from increasing the transfer capacity of the transmission network – the Southern Shared Network - between southern NSW and the major demand centres of Sydney, Newcastle and Wollongong.

Increasing access to generation capacity from the Snowy Mountains Scheme and other sources of generation in southern NSW has the potential to benefit the market and consumers through lowering the overall dispatch and investment costs required to meet the demand from households and businesses in NSW for reliable and safe electricity.

In addition, the investments to be considered in this RIT-T have the potential to:

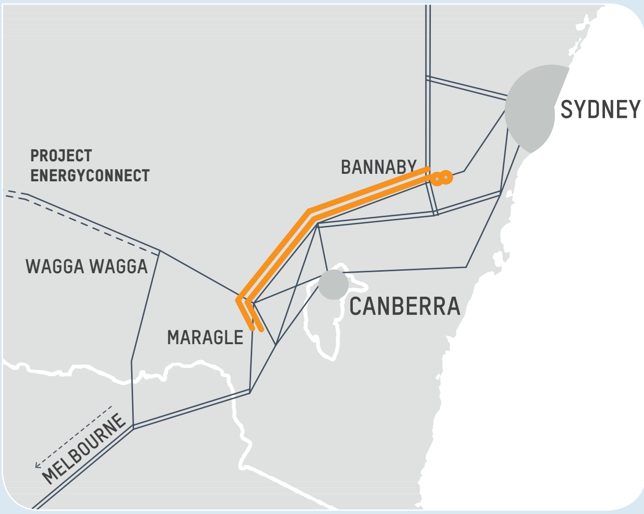
- open up additional capacity for new generation (primarily renewable generation) in areas of southern NSW, which has recognised high-quality wind and solar resources;
- increase the transfer capacity between VIC and NSW, which would provide NSW with access to additional generation from VIC; and
- allow the additional transfer capacity between South Australia (SA) and NSW provided by the proposed SA–NSW interconnector, Project EnergyConnect, to flow to Sydney

The RIT-T will test the opportunity to realise additional market benefits through further reducing dispatch costs and deferring or avoiding investment in generation and storage in areas with lower quality resources.

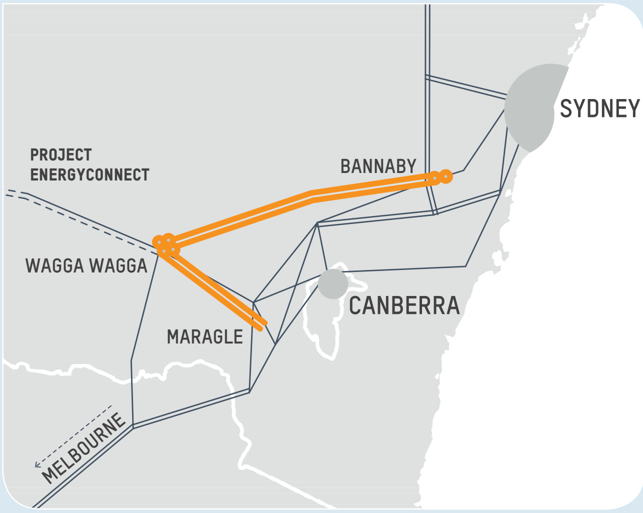
In the absence of investment under this RIT-T, alternative investment by market participants in peaking plants, other generation technologies or utility-scale storage in NSW would be needed to continue to meet the State's demand and system stability requirements, as existing dispatchable generation in NSW retires.

The RIT-T will test whether the net cost to the market, (and therefore ultimately to consumers), is to be higher under the 'do nothing' path, than if investment under this RIT-T proceeds.

Option 1



Option 2



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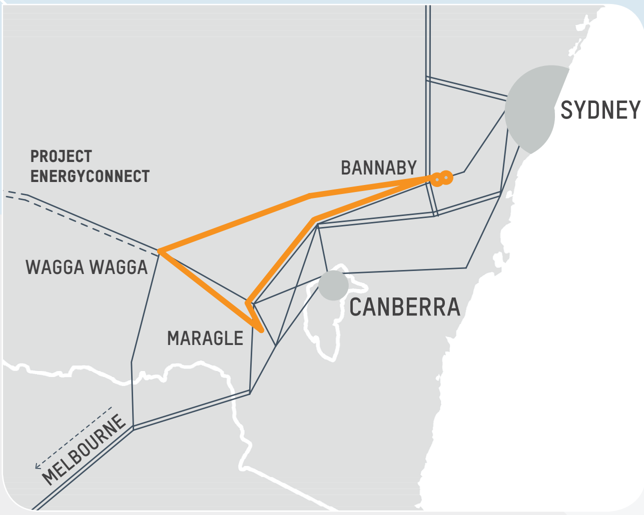

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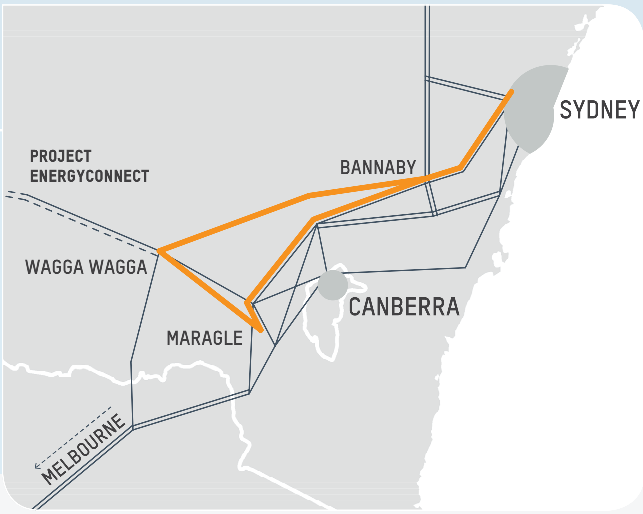


1 Cost estimates are indicative and based on preliminary desktop estimates. TransGrid will further refine these estimates in the PADR.
2 Maragle is approximately 85 km south of Tumut, in the Snowy Mountains.

Four options for transmission network investment considered in this RIT-T

An increase in transmission capacity between the Snowy Mountains and Sydney of 2,000 MW could be provided under a range of options with indicative construction costs between $790 million and $1.9 billion[1]

Options with higher capacity, or a wider footprint in southern NSW, may provide greater economic benefits by opening access to additional capacity from new renewable generation proposed to be built around and west of Wagga Wagga, which has been identified as an area with very high quality renewable resources.

TransGrid therefore intends to consider through this RIT-T, four transmission network options:

Option 1: Lines running directly from Maragle[2] to Bannaby

Option 2: Lines running from Maragle[2] to Bannaby via Wagga Wagga

Option 3: A triangle linking Maragle, Wagga Wagga and Bannaby - which would unlock new renewable energy resources in the region and,

Option 4: A variant on Option 3, which further extends the new lines back to Sydney.

All four options include the construction of new single-circuit lines on diverse paths, designed to mitigate bushfire and extreme weather risks and ensure the reliable supply of electricity to major demand centres. TransGrid intends to consider variants for all four options of 330 kV, 500 kV and a flexible option with transmission built to enable 500 kV operation, though initially operated at 330 kV.

Submissions sought from proponents of non-network options

This RIT-T will also consider non-network options which address the limitations on transfer capacity between southern NSW and Sydney and which may therefore contribute to meeting the identified need, either individually or in combination with other non-network and/or network options.

This Project Specification Consultation Report (PSCR) provides information on the technical characteristics required from non-network options, which could include load reduction or load shifting, new generation or storage, or participation in a Wide Area Special Protection Scheme.

Proponents of non-network options are encouraged to contact TransGrid directly to discuss their options, and to make submissions on these options which will be assessed in the Project Assessment Draft Report (PADR).

Next steps

Submissions are sought in particular on the four options cited above, and from potential proponents of non-network options.

Submissions are due not later than 19 September 2019.

Submissions should be emailed to: regulatory.consultation@transgrid.com.au

The next formal stage of this RIT-T process is the development and finalisation of the PADR which will include quantitative analysis of the network and non-network options identified.

The PADR is expected to be published in the second half of 2019.

01 Introduction

The National Electricity Market (NEM) is currently undergoing rapid change as the sector transitions to a lower carbon emissions and greater uptake of new technologies.

The inaugural Integrated System Plan (ISP), released by the Australian Energy Market Operator (AEMO) in July 2018, demonstrated the economic value of network investment to efficiently support the transition to a lower emissions power system, including in response to the expansion of generation and storage capacity at the Snowy Mountains Hydroelectric Scheme ('Snowy 2.0').

Snowy 2.0 is a project to install new pumped hydro generation using existing dams in the Snowy Mountains for storage. The Snowy 2.0 expansion is proposed to have peak generation and pumping capacity of 2,000 MW, and total storage of 350 GWh.

There have been a number of key developments since the release of the 2018 ISP:

- In November 2018 the NSW Government released its Transmission Infrastructure Strategy[5], which also supports augmentation of the shared transmission network between the Snowy Mountains and Sydney to unlock existing firm generation supply and enable efficient investment and use of generation and storage; and
- In December 2018, the Board of Snowy Hydro Limited approved a final investment decision to proceed with Snowy 2.0. This was followed by shareholder approval from the Federal Government on 26 February 2019. The first energy is expected to be generated in late 2024-25.[3]
- In April 2019, Snowy Hydro entered into an EPC Contract with Future Generation JV for the construction of Snowy 2.0, and commenced exploratory works.

In light of AEMO's 2018 ISP assessment and these more recent developments, TransGrid is commencing formal consultation under the Regulatory Investment Test for Transmission (RIT-T) on investments that increase transfer capacity of the shared network between southern NSW and the major load centres in NSW.

1.1 The investment decision process

The current regulatory framework requires that in order to initiate transmission projects, including those identified in AEMO's ISP, a transmission network service provider (TNSP) must conduct a RIT-T.[4]

In order to secure funding for a project that passes a RIT-T, the TNSP may then apply to the Australian Energy Regulator (AER) to trigger a 'contingent project' (unless the project is already included in a revenue determination).

1.1.1 The Regulatory Investment Test for Transmission (RIT-T)

The RIT-T is a limited economic test that is designed to maximise the net present value (NPV) of the total net benefit (or minimise the NPV of the total net cost) to all those who 'produce, consume and transport electricity'[5] in the NEM.

The RIT-T identifies and evaluates credible options to meet an identified need, in order to identify the most efficient investment. It provides an opportunity for consultation with interested parties, including non-network providers, to promote efficient investment.

Because the RIT-T considers the costs and benefits to the NEM as a whole, it does not directly take into account changes in electricity price outcomes. However, it does take into account reductions in the overall costs of meeting electricity demand, such as reductions in dispatch and investment costs as a result of higher cost generation being displaced with lower cost generation.

3 Snowy Hydro, Snowy 2.0, project and business case overview, February 2019, p. 8.
4 TransGrid is required to apply the RIT-T to this investment, as none of the exemptions listed in the National Electricity Rules (NER) clause 5.16.3(a) apply.
5 AEMC, National Electricity Rules, Clause 5.16.1(b) and AER, Regulatory investment test for transmission, June 2010, p3.

In addition, because the focus of the RIT-T is limited to the NEM, it does not take into account economic benefits outside of the NEM, such as:

- Regional economic benefits from investment in generation and transmission in regional areas;
- Benefits to gas consumers from a reduction in gas consumption in the NEM; and
- Benefits from the electricity sector reducing emissions in greater proportion than other sectors of the Australian economy.

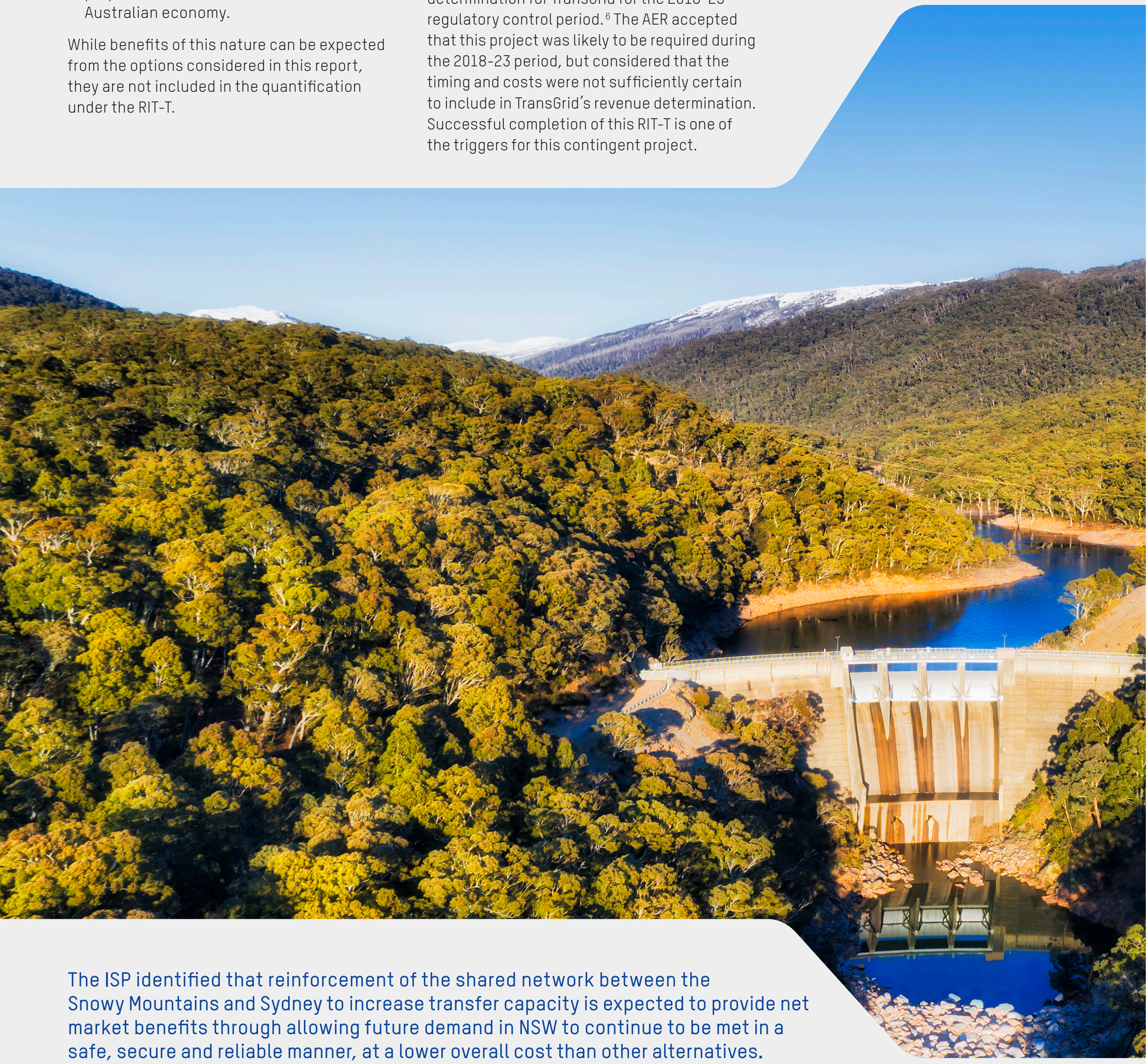
While benefits of this nature can be expected from the options considered in this report, they are not included in the quantification under the RIT-T.

Unlike TNSPs, market participants (such as generators) and governments are not bound by the limitations of the RIT-T, and are able to more completely account for the range of benefits associated with these developments in their strategy and business case documents.

1.1.2 Subsequent stages of the process

The Australian Energy Regulator (AER) has determined that this project is a contingent project ('reinforcement of Southern Network in response to Snowy 2.0') in its revenue determination for TransGrid for the 2018-23 regulatory control period.[6] The AER accepted that this project was likely to be required during the 2018-23 period, but considered that the timing and costs were not sufficiently certain to include in TransGrid's revenue determination. Successful completion of this RIT-T is one of the triggers for this contingent project.

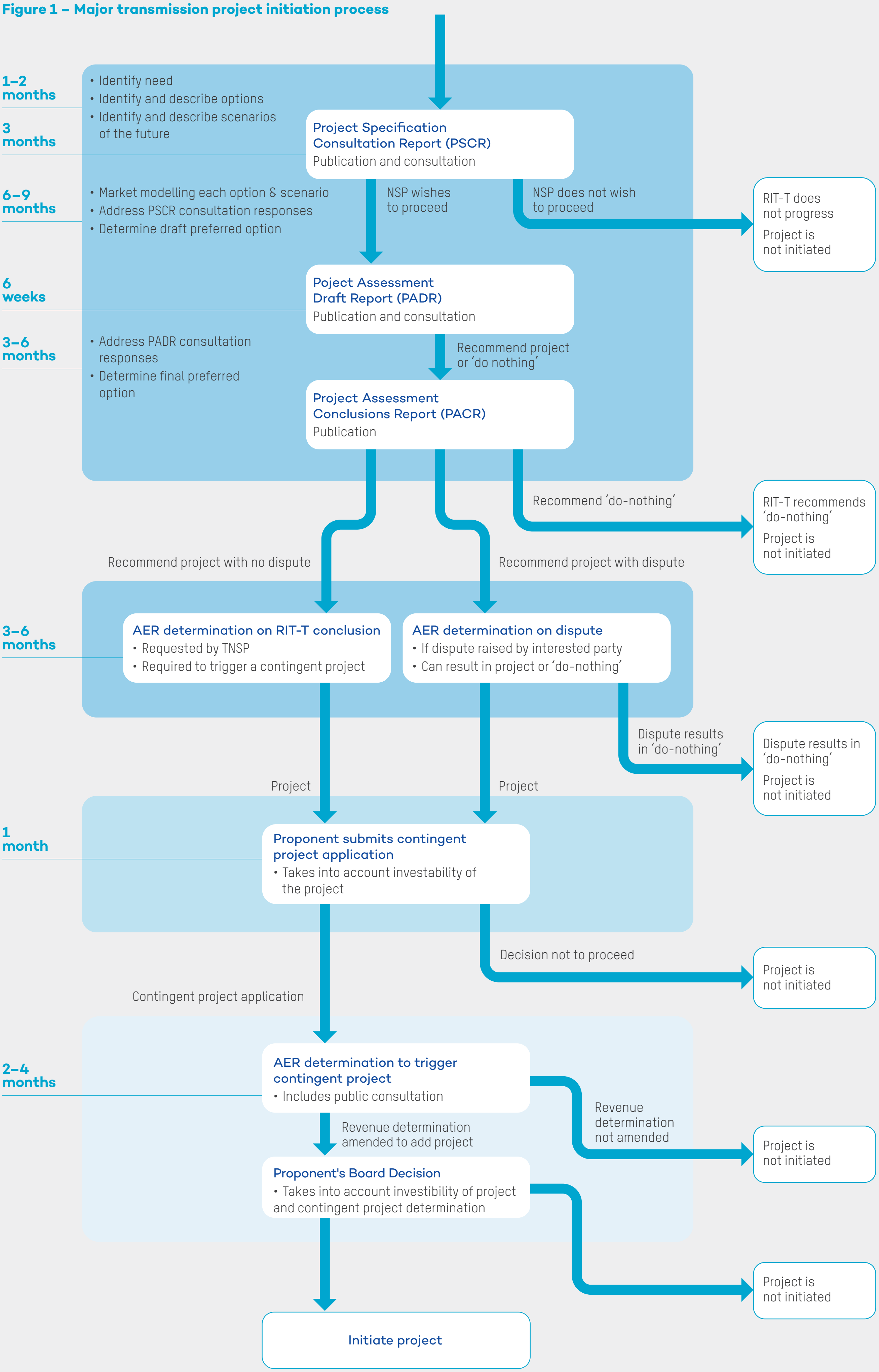
Following the RIT-T, the AER will therefore make a determination on whether the RIT-T has been applied correctly in order for TransGrid to subsequently trigger a 'contingent project'.[7]



The ISP identified that reinforcement of the shared network between the Snowy Mountains and Sydney to increase transfer capacity is expected to provide net market benefits through allowing future demand in NSW to continue to be met in a safe, secure and reliable manner, at a lower overall cost than other alternatives.

6 AER, Final Decision, TransGrid transmission determination 2018 to 2023, Attachment 6 – Capital expenditure, May 2018, p.6-139.
7 The process for this determination differs slightly depending whether a dispute is raised with AER on the conclusion of the RIT-T.

Figure 1 – Major transmission project initiation process



Following the RIT-T, TransGrid will also make its Final Investment Decision (FID) on whether to proceed with the project.

If the AER determination on the RIT-T and TransGrid's FID are favourable, TransGrid can then apply to the AER to trigger a 'contingent project'. The contingent project mechanism is used to amend TransGrid's revenue determination to include the project, once the scope and cost are sufficiently certain. This provides funding to TransGrid to undertake the project.

The existing process, including the statutory timeframes set out in the National Energy Rules (NER) and reasonable expected time frames for supporting analysis, is shown in Figure 1.

In December 2018, the Energy Security Board (ESB) published an Integrated System Plan Action Plan with recommendations to streamline regulatory processes for some ISP projects.[8] The COAG Energy Council has further tasked the ESB to consider how these reforms could be applied to other priority projects in the ISP.[9] If these reforms result in changes to the process to initiate projects identified in the ISP, the process and time frames shown in Figure 1 may change.

1.2 The role of this report

This Project Specification Consultation Report (PSCR) is the first step in the RIT-T process.

The purpose of the PSCR is to:

- set out the reasons why TransGrid proposes that action be undertaken (that is, the 'identified need');
- present credible network options that can address the identified need; and
- provide details as to what non-network solutions would need to be delivered in order to help address the identified need, and invite submissions from proponents of potential non-network options to be included in the RIT-T assessment.

TransGrid is also publishing an accompanying Inputs and Methodology Consultation Paper, which provides further information in relation to the market modelling assumptions proposed, approach and parameters intended to be adopted in the quantitative analysis for this RIT-T assessment. This consultation paper is published in addition to the NER requirements for a RIT-T and provides greater transparency and an opportunity to obtain earlier stakeholder feedback on the quantitative modelling, ahead of the Project Assessment Draft Report (PADR).

1.2.1 Interaction with the 2020 ISP

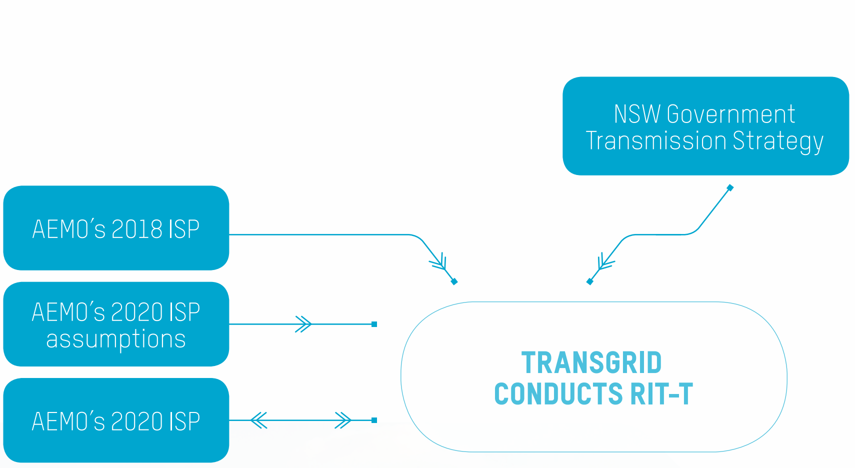
AEMO's 2018 ISP identified augmentation of the existing shared transmission network between the Snowy Mountains and Sydney as a project that would have net market benefits, following the Snowy 2.0 expansion, and form part of the overall optimal network development plan for NEM transition.

AEMO has flagged that in the 2020 ISP it will consider the latest information that becomes available through active RIT-T processes.[10] AEMO has also flagged that it intends to re-evaluate all transmission projects that are still under active assessment by TNSPs at the time at which it prepares its next ISP. TransGrid expects that this will include investments to augment transfer capacity between the Snowy Mountains and Sydney.

The interaction between this RIT-T and AEMO's 2020 ISP process is shown in Figure 2. In particular, TransGrid intends to adopt the same assumptions as AEMO for the 2020 ISP, except where it has more recent information, or where departure from the ISP assumptions is appropriate to adequately test the robustness of the conclusions reached in this RIT-T.

TransGrid intends to consult closely with AEMO as it undertakes this RIT-T analysis to ensure effective coordination of the shared network between the RIT-T and ISP processes.

Figure 2: Interaction between RIT-T process and AEMO's ISP process



1.3 Submissions and next steps

TransGrid welcomes written submissions on this PSCR. Submissions are due on or before 19 September 2019. 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 should be emailed to regulatory.consultation@transgrid.com.au.

Submissions will be published on the TransGrid website. If you do not wish for your submission to be made publicly available, please clearly specify this at the time of lodgement.

The next formal stage of this RIT-T is the PADR. The PADR will include the full quantitative analysis of both network and non-network options, and is expected to be published in the second half of 2019.

8 Energy Security Board, Integrated System Plan: Action Plan, December 2018.
9 COAG Energy Council, Meeting Communique, 19 December 2018.
10 AEMO, 2019 Planning and Forecasting Consultation Paper, February 2019, p. 48.

02 The 'Identified Need'

This section discusses the drivers for potential investment under this RIT-T ('the identified need'), and why TransGrid considers that material market benefits will arise as a result of this potential investment.

The expectation that investment to increase transfer capacity of the shared network between the Snowy Mountains and major NSW load centres will increase net market benefits is consistent with AEMO's findings in its 2018 ISP. In particular, the 2018 ISP analysis included a scenario that assumed that the Snowy 2.0 expansion went ahead (i.e. the 'neutral with storage' scenario). AEMO's analysis found that under this scenario 'a new link from Tumut (in the Snowy Mountains) to Bannaby (SnowyLink North) and associated works between Bannaby and Sydney West would provide system benefits'.

2.1 Investment under this RIT-T will contribute to meeting future NSW demand and emissions reduction targets to be met at lowest cost

The identified need for this RIT-T is to deliver a net market benefit by:

- increasing the transfer capacity and stability limits between the Snowy Mountains and major load centres of Sydney, Newcastle and Wollongong,
- this will enable greater access to lower cost generation to meet demand in these major load centres; and
- facilitate the development of renewable generation in high quality renewable resource areas in southern NSW, which will further lower the overall investment and dispatch costs in meeting NSW demand whilst also ensuring that emissions targets are met at the lowest overall cost to consumers.

The planned expansion of generation in the Snowy Mountains through the Snowy 2.0 project provides a source of generation that can be used to meet demand in the major load centres of NSW as existing New South Wales coal-fired generation retires. However, access to existing capacity from the Snowy Mountains Hydroelectric Scheme is currently limited by constraints on the transmission network between the Snowy Mountains and Sydney, Newcastle and Wollongong at times of peak demand. Access to additional Snowy 2.0 capacity would be similarly limited under the existing network configuration.

Investment to increase the transfer capacity between the Snowy Mountains and these major load centres would both relieve constraints that currently limit the use of existing generation capacity at Snowy Hydro to supply these load centres and enable greater access to increased generation from Snowy.

In addition, the dispatchable generation that can be provided via the expanded storage capacity at Snowy Hydro can be used to 'firm' renewable generation and is to support the development of additional renewable generation in both NSW and VIC, as the NEM transitions to low-emission generation technologies.

Depending on the route adopted, the investments being considered in this RIT-T also have the potential to:

- open up additional capacity for new generation (primarily renewable generation) in areas of southern NSW, which has recognised high-quality wind and solar resources;
- increase the transfer capacity between VIC and NSW, which would provide NSW with access to additional generation in VIC; and
- allow the additional transfer capacity between SA and NSW which will be provided by the proposed new SA–NSW interconnector (which is proposed to terminate at Wagga), to also flow to Sydney.

Opening up additional capacity in areas of the NEM for renewable generation investment will facilitate geographical diversity in renewable generation and lead to less variability in output as a result of local weather effects.

Within the context of the RIT-T assessment, greater output from renewable generation can be expected to primarily deliver the following classes of market benefit:

- Further reductions in total dispatch costs, by enabling lower cost renewable generation to displace higher cost conventional generation; and
- Reduced generation investment costs, resulting from more efficient investment and retirement decisions, due to high quality wind, solar and pumped-hydro generation being able to locate at optimal locations rather than inferior locations limited by congestion on the existing transmission system.

Under the existing regulatory framework, this RIT-T is the means by which further consideration of options identified in the ISP is undertaken.

2.2 Assumptions underpinning the identified need

This section provides background and more information on the key assumptions underpinning the identified need for this investment, in particular:

- The committed expansion of generation and storage capacity in the Snowy Mountains ('Snowy 2.0');
- The strength of the renewable energy resources in southern NSW and western VIC;
- The limitations on the existing NSW transmission network that would limit northwards flows from the Snowy Mountains to the major NSW load centres; and
- AEMO's ISP analysis that identified transmission augmentation of the shared network between the Snowy Mountains and Sydney as part of the optimal network development plan that would deliver net market benefits as dispatchable generation in NSW retires.

The following section summarises the key assumptions that TransGrid intends to reflect in its scenarios for the market modelling analysis in this RIT-T. Further details of the modelling assumptions are provided in a separate Inputs and Methodology Consultation Paper being released alongside this PSCR.

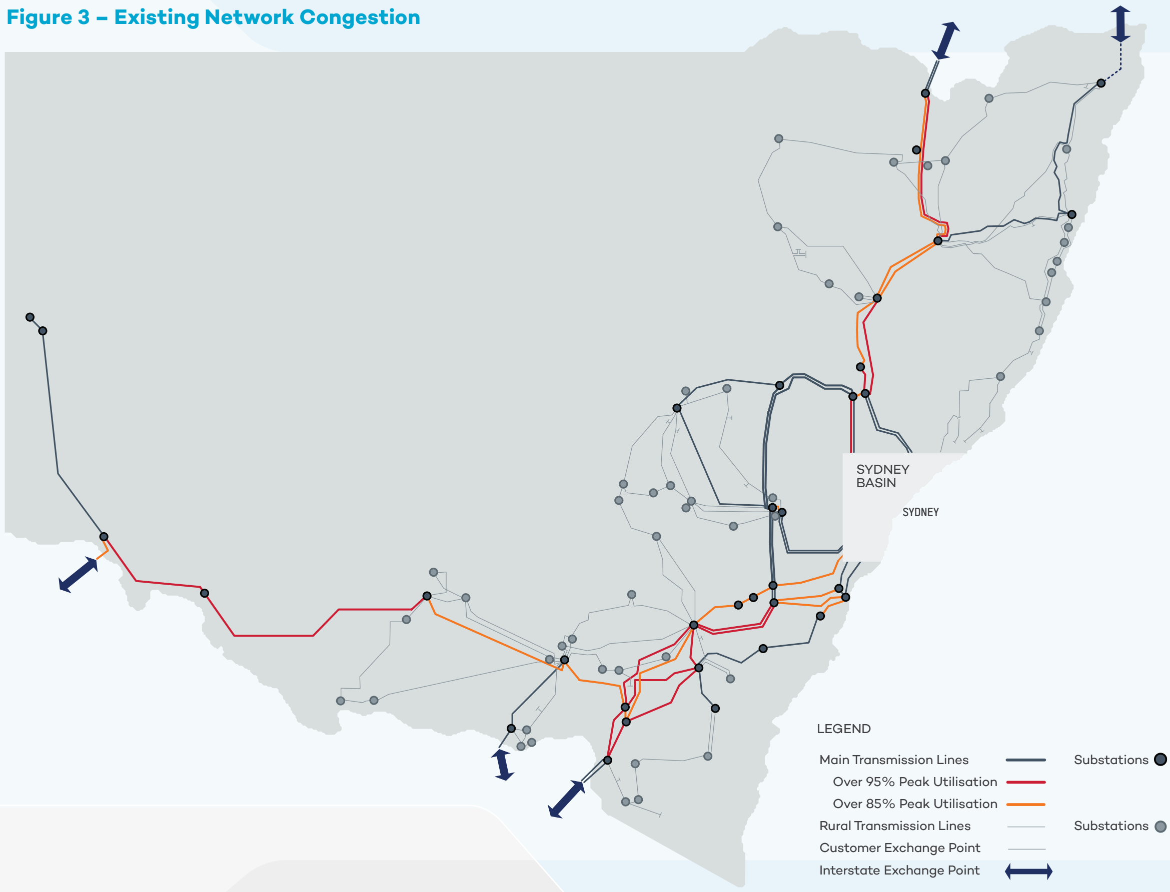
2.2.1 Expansion of generation and storage capacity in the Snowy Mountains ('Snowy 2.0')

The current Snowy Hydro Scheme (Scheme) is an integrated water and hydro-electric power utility located in Australia's Southern Alps which is operated and maintained by Snowy Hydro Limited. The Scheme diverts the headwaters of the Snowy, Eucumbene and Murrumbidgee Rivers westward through the Great Dividing Range, releasing water into the Murray and Murrumbidgee Rivers.

In March 2017, the Federal Government announced a feasibility study to add 2,000 MW of pumped storage (known as "Snowy 2.0") to the Scheme. Snowy 2.0 is proposed to link the two existing reservoirs of Tantangara and Talbingo through underground tunnels and an underground power station with pumping capabilities.

Pumped hydro works like a conventional hydro-electric scheme. However, a pumped hydro scheme can 'recycle' or pump water back to the upper reservoirs to be used again. The ability to pump and store water means Snowy 2.0 will be able to provide storage by absorbing, storing and dispatching energy.

Figure 3 – Existing Network Congestion



A feasibility study was completed in December 2017, and concluded that Snowy 2.0 is both technically and financially feasible. Following consideration of the study and further detailed works, Snowy Hydro's Board of Directors approved a final investment decision to proceed with Snowy 2.0 on 12 December 2018. The Australian Government gave shareholder approval on 26 February 2019.

Environmental Impact Statement (EIS) approval has been given for exploratory works. It is expected that the first energy generation from Snowy 2.0 will be in late 2024-25.

2.2.2 Renewable energy potential in southern NSW and western VIC

Australia's COP21[13] commitment to reduce carbon emissions by 26 to 28 per cent below 2005 levels by 2030 has significant implications for the future operation of the NEM. Meeting this commitment is expected to necessitate replacement of some of Australia's emissions intensive generators with lower emissions alternatives, such as renewable energy.[14]

As part of the 2018 ISP, AEMO undertook an extensive investigation of the renewable energy resources in, and near, existing NEM infrastructure. The 2018 ISP identified potential renewable energy zones including three in southern NSW.

These renewable zones have been updated in AEMO's 2019 Planning and Forecasting Consultation Paper and include zones 11 (southern NSW Tablelands), 13 (Tumut) and 14 (South West NSW), as shown in Figure 5.

The southern NSW area has some of highest quality renewable energy resources in Australia including wind, solar and pumped-hydro potential.

In addition, there are a number of renewable generation developments currently underway in western VIC (zone 17 in Figure 5), and which are expected to be supported by developments resulting from AEMO's current Western VIC integration RIT-T.[15]

Strengthening the southern NSW network will provide capacity to link the high quality solar and wind resources in southern NSW and additional generation in VIC to the major load centres of Sydney, Newcastle and Wollongong.

2.2.3 The nature of constraints on the existing NSW shared transmission network

The existing shared transmission capacity between southern NSW (including the Snowy Mountains) and major load centres of Sydney, Newcastle and Wollongong is heavily utilised at times of peak demand. The peak utilisation has ranged between 90% and 110% over the last three years, and transmission constraints are expected to become more frequent as new renewable generation connects in southern NSW.

While low-cost projects have been initiated to maximise utilisation of the existing assets using power flow control devices, these only provide small increases in capacity.

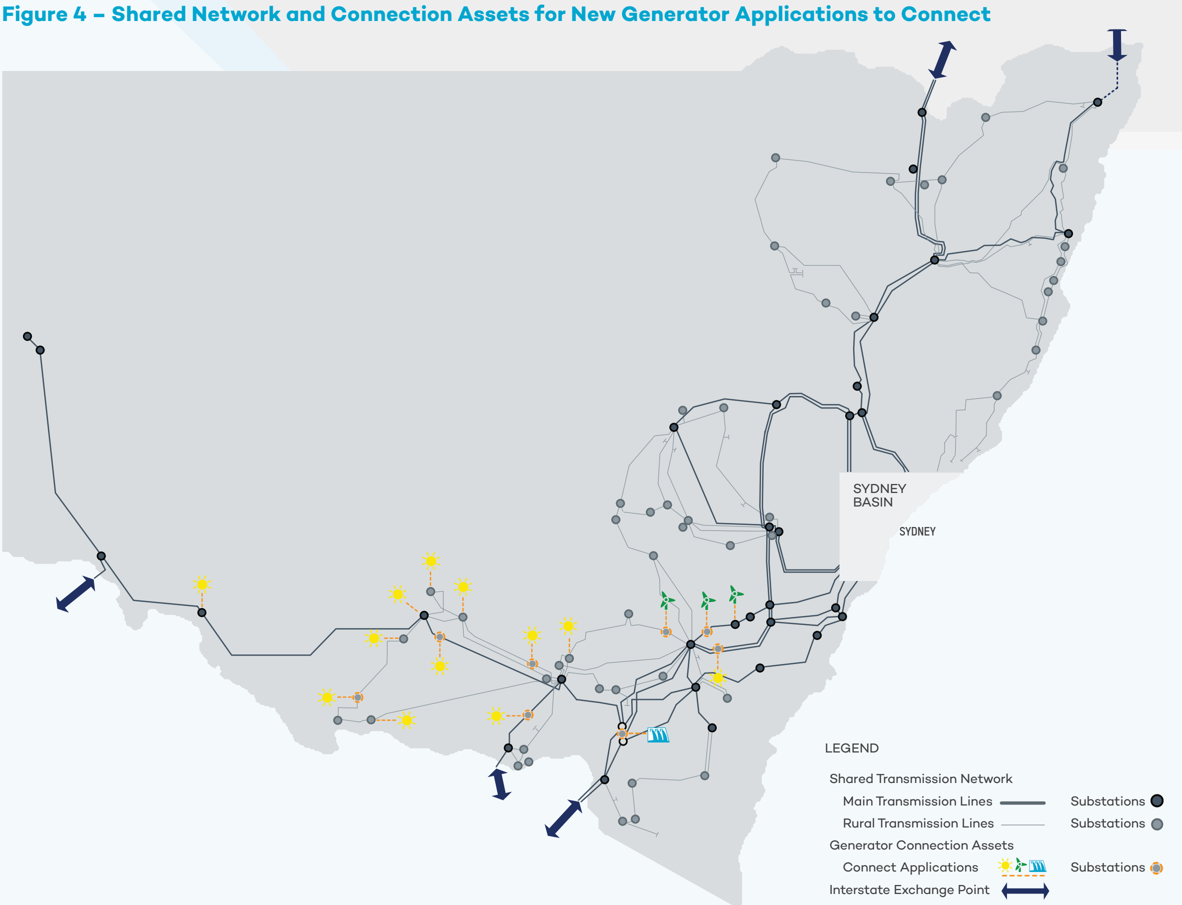
The following elements in southern NSW pose limitations, depending on the generation profile in southern NSW and import level from VIC to NSW:

- Line between Murray – Upper Tumut / Lower Tumut
- Line between Lower Tumut – Yass
- Line between Lower Tumut - Canberra
- Line between Canberra - Yass
- Lines between Yass - Marulan
- Line between Kangaroo Valley – Dapto
- Line between Bannaby – Gullen Range
- Line between Bannaby – Sydney West

The addition of 2,000 MW of new generation at Snowy 2.0 and wind and solar generation in southern NSW will severely constrain the southern NSW network, in the absence of a development that increases transfer capacity.

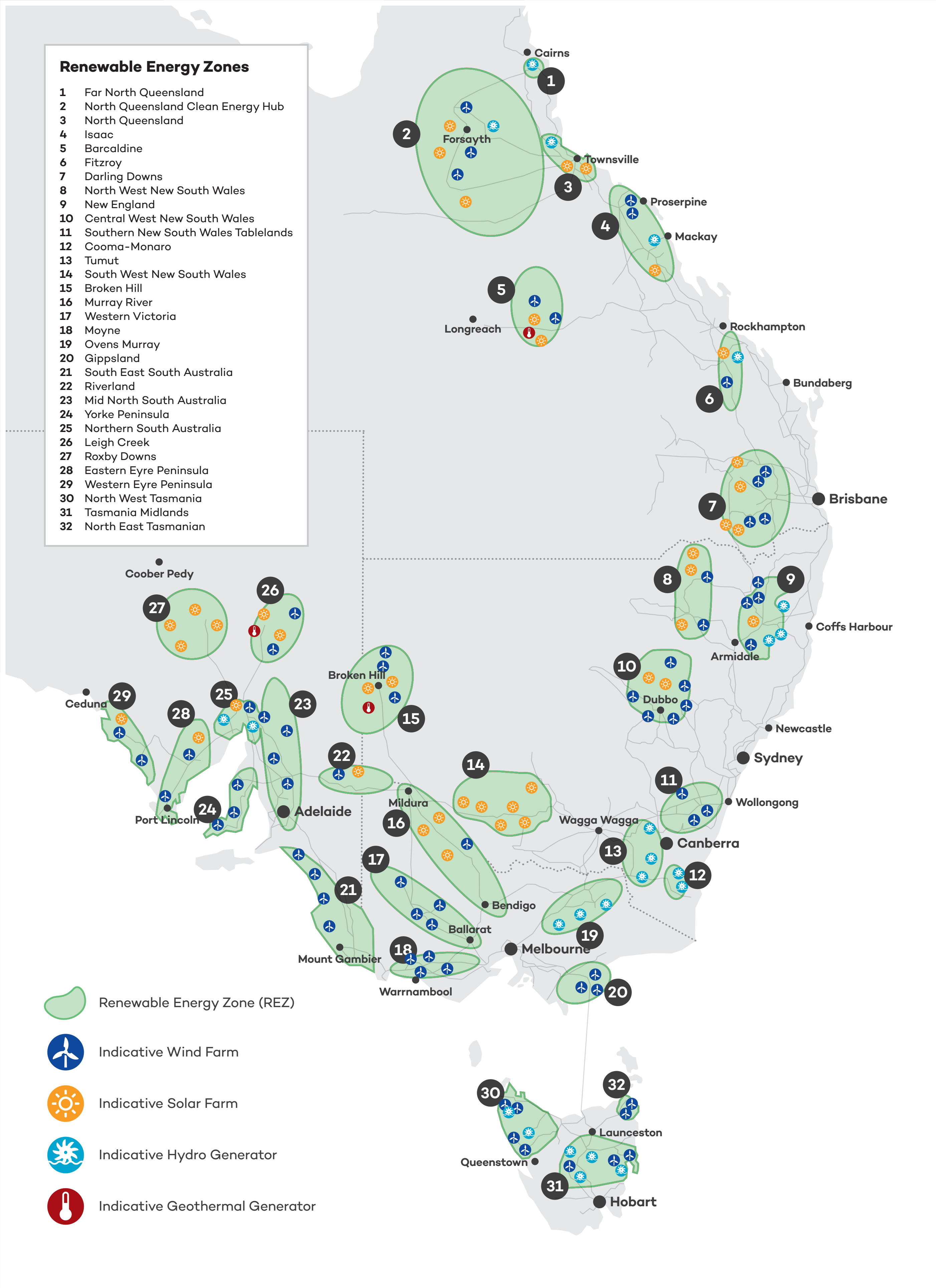
Figure 4 shows the Shared Southern network, the existing Snowy Hydro scheme, and new connecting renewables in southern NSW.

Figure 4 – Shared Network and Connection Assets for New Generator Applications to Connect



13 The 2015 United Nations Climate Change Conference (also known as 'COP 21' or 'CMP 11') was held in Paris, France, from 30 November to 12 December 2015.
14 COAG Energy Council, Review of the Regulatory Investment Test for Transmission, Consultation Paper, Energy Project Team, 30 September 2016, p. 13.
15 AEMO, Western VIC Renewable Integration, Project Assessment Draft Report, December 2018.

Figure 5 – AEMO Potential Renewable Energy Zones (2019 Modelling Assumptions)



Source: AEMO, 2019 Planning and Forecasting Consultation Paper, February 2019, p. 43.

2.2.4 AEMO's 2018 ISP

The inaugural Integrated System Plan (ISP), released by AEMO in July 2018, demonstrates the economic value of network investment to efficiently support the transition to a lower emissions power system, including in response to the development of Snowy 2.0 and the expected retirement of conventional coal-fired generation in NSW.

The ISP identified that augmentation of the shared transmission network between the Snowy Mountains and Sydney would provide net market benefits and forms part of the optimal future network development path to support the long-term interests of consumers for safe, secure and reliable electricity, at the least cost.[16]

In particular, AEMO noted that:[17]

> "When a final decision is made on the commitment of Snowy 2.0, a new link from Tumut to Bannaby (SnowyLink North) and associated works between Bannaby and Sydney West would provide system benefits."

The retirement of Liddell Power Station and the projected retirement of the other, ageing NSW coal-fired stations (including Vales Point, Eraring and Bayswater), are expected to necessitate further dispatchable generation capacity to maintain supply adequacy.

AEMO's 2018 ISP directly considered the optimal NEM-wide investment path across both shared transmission and generation in light of these projected retirements, and found that a new transmission development between the Snowy Mountains and Sydney:[18]

> "provides route diversity to harden the grid against extreme climate conditions, and unlocks high quality renewable energy resources, reducing connection costs for new renewable generation needed once the majority of the coal fleet retires. Without this interconnection, AEMO's modelling indicates that more balancing services (such as GPG or energy storage) would be required to address the lack of diversity that arises from concentrating renewable generation in clusters."

2.3 ISP-based modelling assumptions

The assumptions TransGrid proposes to use to assess the market benefits in the PADR are based on the 2019 planning and forecasting assumptions currently being consulted on by AEMO for the 2020 ISP, published in February 2019.[19] Where updated assumptions are not available from AEMO by the time the modelling for this RIT-T commences, TransGrid will use the most recent assumptions that are available (eg, electricity demand forecasts sourced from the 2018 ESOO), either from AEMO or from alternative sources.

TransGrid proposes to modify assumptions where required either to reflect factors that are most relevant to this particular assessment, or in response to stakeholder feedback, as part of the scenario and sensitivity testing.

In conjunction with this PSCR, TransGrid is publishing an Inputs and Methodology Consultation Paper on the proposed market modelling approach. The consultation paper provides more detail in relation to the modelling approach and parameters we intend to adopt in the quantitative analysis. This separate report is not required under the NER but provides greater transparency and an opportunity to obtain stakeholder feedback on the proposed approach to quantitative modelling, ahead of the PADR.

2.3.1 Summary of proposed scenarios

TransGrid notes the importance of ensuring that the outcome of this RIT-T assessment is robust to different assumptions about how the energy sector may develop in the future. Transmission investments are long-lived assets, and it is important that the market benefits associated with these investments do not depend on a narrow view of potential future outcomes, given that the future is inherently uncertain.

Uncertainty is captured under the RIT-T framework through the use of scenarios, which reflect different assumptions about future market development and other factors that are expected to affect the relative market benefits of the options being considered.

We are intending to construct four 'core' scenarios that we consider reflect a sufficiently broad range of potential outcomes across the key uncertainties that are expected to affect the future market benefits of the investment options being considered. The proposed scenarios are summarised in Table 1, which focuses on the key variables that are expected at this stage to have the greatest influence on the net market benefits of the options considered.

The scenarios are primarily based on AEMO's proposed 2020 ISP scenarios. At this stage TransGrid is not intending to adopt AEMO's proposed high Distributed Energy Resources (DER) scenario as one of the core scenarios for this RIT-T. However, TransGrid will test the impact of assuming higher uptake of DER as part of our sensitivity testing.

Instead, TransGrid intends to include a fourth "Neutral with Stronger Share of Emission Reduction Target" scenario. This reflects feedback from TransGrid's NSW and ACT Transmission Planning Forum in November 2018, which suggested that there may be value in including a scenario that incorporates higher emissions reductions in the electricity sector even under a neutral outlook, to investigate the impact that any future policy change may have on the assessment of policy options under this RIT-T. This scenario may also be an effective proxy for the impact of any future policies that increase the likelihood of additional renewable generation locating in NSW.

Table 1 also summarises the coincident network developments TransGrid proposes to reflect in the market modelling analysis. TransGrid notes that some options under consideration in the VIC to NSW interconnector upgrade (ISP Group 1) project would bring forward part of the development being considered in this RIT-T. We will take this interaction into account in undertaking the market modelling assessment for this RIT-T.

16 Integrated System Plan July 2018, Australian Energy Market Operator, page 3 and page 9.
17 Integrated System Plan July 2018, Australian Energy Market Operator, page 9.
18 Integrated System Plan July 2018, Australian Energy Market Operator, page 9.
19 2019 Planning and Forecasting Consultation Paper, February 2019, Australian Energy Market Operator.

Table 1 – Summary of scenarios proposed to be modelled

VARIABLE	FAST CHANGE SCENARIO	NEUTRAL SCENARIO	NEUTRAL WITH STRONGER EMISSION REDUCTION TARGET SCENARIO	SLOW CHANGE SCENARIO
Electricity demand	AEMO 2018 ESOO strong demand forecasts	AEMO 2018 ESOO neutral demand forecasts	AEMO 2018 ESOO neutral demand forecasts	AEMO 2018 ESOO weak demand forecasts
Coal and gas prices	AEMO ISP strong forecast	AEMO ISP neutral forecast	AEMO ISP neutral forecast	AEMO ISP slow forecast
Emission reduction renewables policy (reflected in coal plant retirement trajectories)	52% reduction from 2005 by 2030	28% reduction from 2005 by 2030	52% reduction from 2005 by 2030	28% reduction from 2005 by 2030
Jurisdictional emissions targets	VRET 25% by 2020 and 40% by 2025 QRET 50% by 2030			
COINCIDENT NETWORK DEVELOPMENTS				
SA to NSW interconnector	The proposed SA to NSW interconnector is assumed constructed by 2023			
VIC to NSW Interconnector Upgrade	The preferred ISP option is assumed constructed by 2020 and the timing will be tested as a sensitivity			
Western VIC Renewable Integration RIT-T	The preferred Western VIC RIT-T option is assumed constructed by 2023 and the timing will be tested as a sensitivity			
QNI expansions	The preferred ISP option is assumed to be constructed by 2020 (Stage 1) and 2023 (Stage 2), or as updated by concurrent QNI RIT-T process. Timing will be tested as a sensitivity			
SnowyLink South	The preferred ISP option is assumed constructed by 2034 and the timing will be tested as a sensitivity			
MarinusLink and Battery of the Nation	The preferred option is assumed constructed by 2033 and the timing will be tested as a sensitivity	Not included	Not included	Not included

2.3.2 Sensitivity analysis

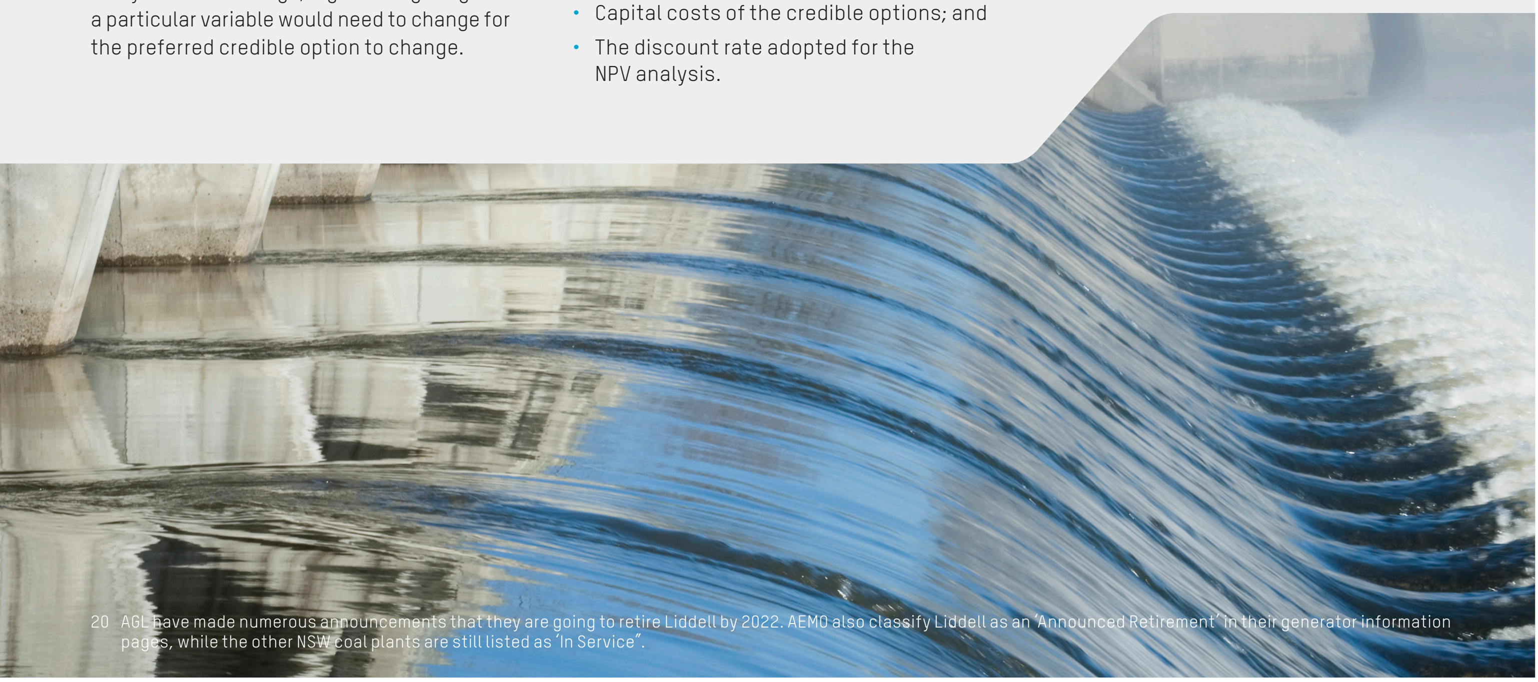
In addition to the use of scenarios to capture key uncertainties in relation to the future 'state-of-the-world', the robustness of the economic assessment presented in the PADR will also be investigated through the use of sensitivity analysis in relation to key input assumptions.

In particular, TransGrid intends to identify the key factors driving the outcome of this RIT-T through this sensitivity testing and will seek to identify the 'boundary value' for these factors, beyond which the outcome of the analysis would change, e.g. investigating what a particular variable would need to change for the preferred credible option to change.

At this stage, based on the 2018 ISP assessment and preliminary modelling undertaken by TransGrid, we consider that the following are candidates for this detailed sensitivity testing:

- Retirement dates of coal generators (particularly Vales Point, Eraring and Bayswater in NSW);
- The timing of potential coincident, and/or subsequent, network developments (e.g., other ISP 'Group 1', 'Group 2' projects and 'Group 3' projects, including SnowyLink South);
- Higher than anticipated DER uptake (to align with AEMO's 2019 modelling scenario);
- Capital costs of the credible options; and
- The discount rate adopted for the NPV analysis.

While the retirement of Liddell is expected to be a key driver of market benefits for the credible options considered (as highlighted in the ISP), we consider there to be less uncertainty around the retirement date of Liddell than other NSW coal plants.[20] We are therefore not intending to test a sensitivity on the assumed retirement date of Liddell in the PADR.



20 AGL have made numerous announcements that they are going to retire Liddell by 2022. AEMO also classify Liddell as an 'Announced Retirement' in their generator information pages, while the other NSW coal plants are still listed as 'In Service'.

03 Network Options

This section presents the network options that TransGrid has identified to increase transfer capability between the Snowy Mountains and Sydney, Newcastle and Wollongong. The following section presents the technical characteristics that non-network options would need to meet in order to provide similar net market benefits, either on a stand-alone basis, or coupled with a network option.

TransGrid is considering 12 network options to provide additional transfer capacity on the NSW Southern Shared Network between the major load centres of Sydney, Newcastle and Wollongong.

3.1 Overview of network options

TransGrid is currently considering 12 network options to provide additional transfer capacity on the NSW Southern Shared Network between the Snowy Mountains and the major load centres of Sydney, Newcastle and Wollongong.

The network options considered reflect four alternative topologies for greenfield developments, reflecting:

1. A 'direct' path between Maragle[21] and Bannaby;
2. A path between Maragle and Bannaby via Wagga Wagga that would open up additional capacity for new renewable generation in southern NSW which may provide greater market benefits;
3. A wider footprint via Wagga Wagga, that would open up both direct and additional capacity for new renewable generation in southern NSW, which may provide greater market benefits; and
4. A wider Maragle-Wagga-Bannaby footprint *plus* additional capacity between Bannaby and Sydney, to further relieve constraints on that portion of the network.

Each topology is being considered across three voltages:

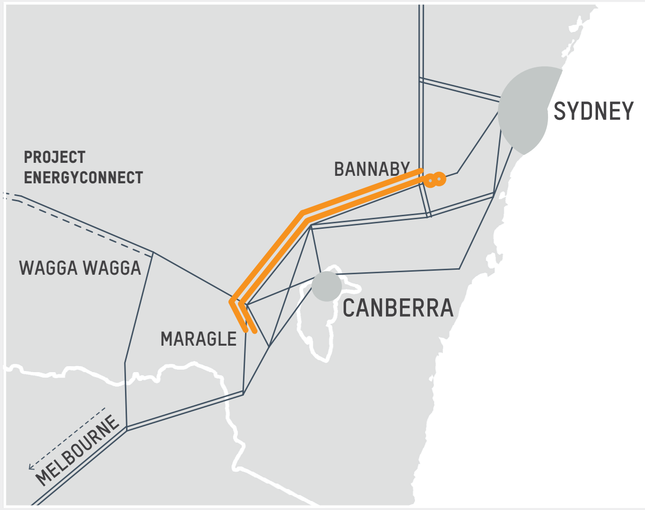
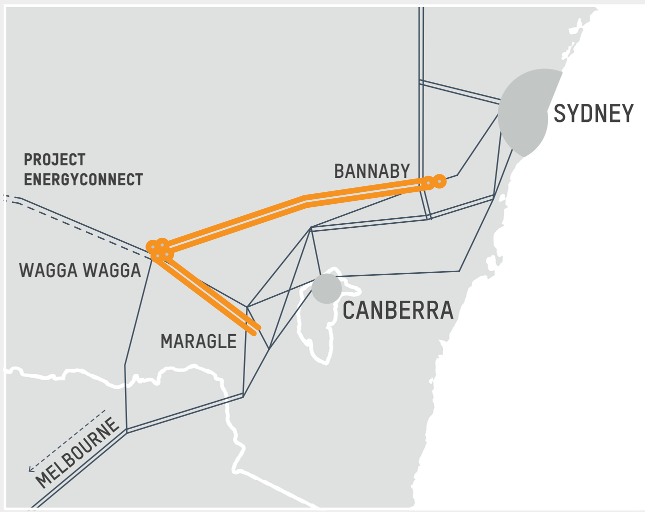
- A Construction and operation at 330kV with high capacity conductor;
- B Construction to 500kV and initial operation at 330kV, with the optionality to augment substation equipment in the future to operate to 500kV; and
- C Construction and operation at 500kV.

These network options are summarised in Table 2, which shows the additional network capacity that each provides between southern NSW and the major load centres of Sydney, Newcastle and Wollongong.

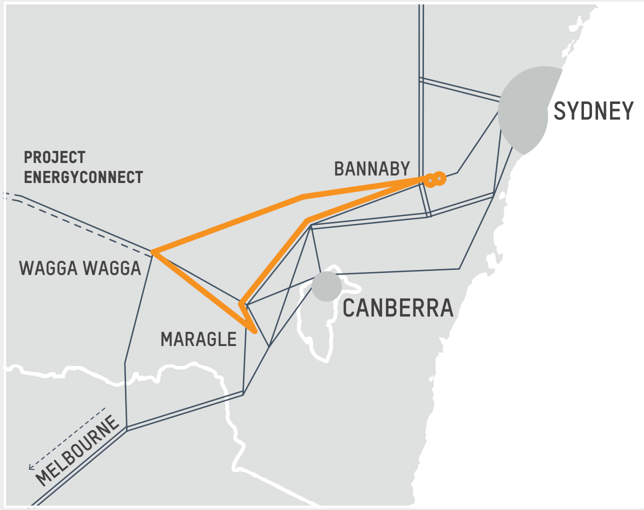
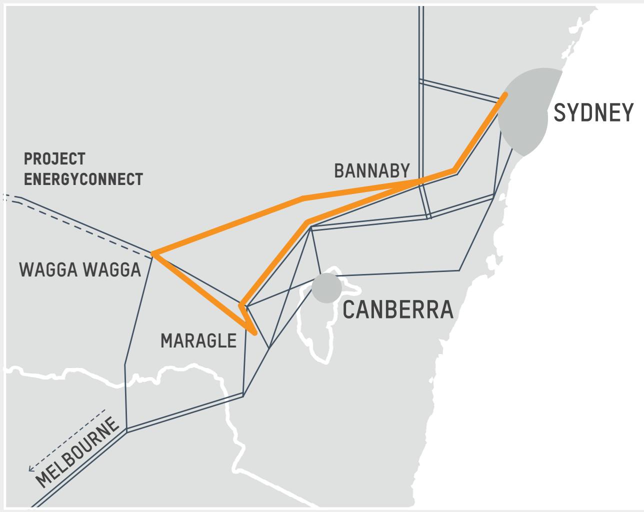
The remainder of this section provides further detail on each of these options. It also outlines a number of network options that have been considered but not progressed (together with the reasons why). In addition, there would be connection works not a part of this RIT-T.

21 Maragle is approximately 85 km south of Tumut, in the Snowy Mountains. This is the connection point to the shared network for Snowy 2.0.

Table 2 – Summary of credible network options

TOPOLOGY / VOLTAGE	A. 330KV HIGH CAPACITY CONDUCTOR	B. 500KV BUILD 330KV INITIAL OPERATION	C. 500KV
1 Two new single circuit transmission lines from Maragle directly to Bannaby (and power flow control between Bannaby and Sydney where needed to provide 2,000 MW capacity) 	**OPTION 1A** Two new 330 kV high capacity transmission lines, switchgear and phase shifting transformer **Additional firm capacity** 2,050 MW[22] **Indicative capital cost** $790m[23]	**OPTION 1B** Two new 500 kV transmission lines operated at 330 kV, switchgear and phase shifting transformer **Additional firm capacity** 2,170 MW **Indicative capital cost** $950m	**OPTION 1C** Two new 500 kV transmission lines, tie transformers and switchgear **Additional firm capacity** 2,510 MW **Indicative capital cost** $1,060m
2 New single circuit transmission lines from Maragle to Wagga Wagga and Wagga Wagga to Bannaby (and power flow control between Bannaby and Sydney where needed to provide 2,000 MW capacity) 	**OPTION 2A** Four new 330 kV high capacity transmission lines, switchgear and phase shifting transformers **Additional firm capacity** 2,000 MW[22] **Indicative capital cost** $1,240m	**OPTION 2B** Four new 500 kV transmission lines operated at 330 kV, switchgear and phase shifting transformers **Additional firm capacity** 2,000 MW[22] **Indicative capital cost** $1,420m	**OPTION 2C** Four new 500 kV transmission lines, tie transformers and switchgear **Additional firm capacity** 2,500 MW[22] **Indicative capital cost** $1,380m

22 The additional firm capacities in this table assume an average level of import from VIC to NSW of 200 MW and average wind generation in southern NSW of 265 MW.
23 Cost estimates are indicative and based on preliminary desktop estimates. TransGrid will further refine these estimates in the PADR.

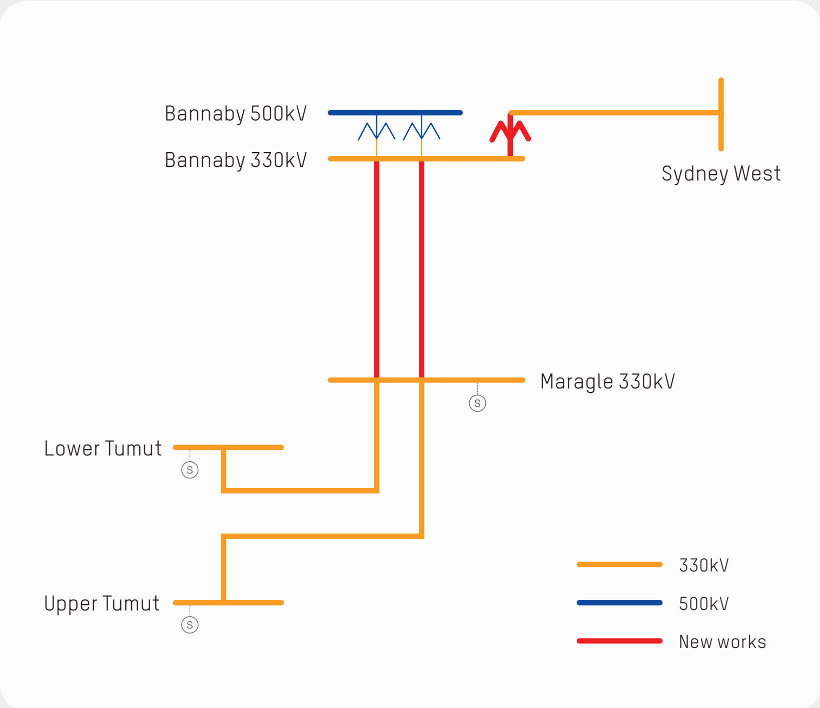
TOPOLOGY / VOLTAGE	A. 330KV HIGH CAPACITY CONDUCTOR	B. 500KV BUILD 330KV INITIAL OPERATION	C. 500KV
3 New single circuit transmission lines from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby (and power flow control between Bannaby and Sydney where needed to provide 2,000 MW capacity)  	**OPTION 3A** Three new 330 kV high capacity transmission lines, switchgear and phase shifting transformer **Additional firm capacity** 2,000 MW **Indicative | capital cost** $1,010m	**OPTION 3B** Three new 500 kV transmission lines operated at 330 kV, switchgear and phase shifting transformer **Additional firm capacity** 2,030 MW **Indicative capital cost** $1,220m	**OPTION 3C** Three new 500 kV transmission lines, tie transformers and switchgear **Additional firm capacity** 2,570 MW **Indicative capital cost** $1,350m
4 New single circuit transmission lines from Maragle to Bannaby, Maragle to Wagga, Wagga to Bannaby and Bannaby to Sydney  	**OPTION 4A** Four new 330 kV high capacity transmission lines and switchgear **Additional firm capacity** 2,000 MW **Indicative capital cost** $1,330m	**OPTION 4B** Four new 500 kV transmission lines operated at 330 kV and switchgear **Additional firm capacity** 2,030 MW **Indicative capital cost** $1,570m	**OPTION 4C** Four new 500 kV transmission lines, tie transformers and switchgear **Additional firm capacity** 3,100 MW **Indicative capital cost** $1,890m

Cost estimates specified in these Options have been prepared from the desktop studies based on cost data available at the date of preparation. Data used in the Options is consistent for the purposes of inter-Option comparison. The specific route will only be confirmed during preparation of the PACR. An extensive range of factors may affect the project cost including (but not limited to) environmental factors affecting line route, land acquisition or easement cost, construction cost implications arising from route dynamics, currency fluctuations and construction contractor costs in the proposed construction period. As such the nominal costs specified are indicative only at this stage and will be subject to further refinement.

3.2 Credible network options

3.2.1 **Option 1A** – Two new single circuit 330 kV route diverse lines from Maragle to Bannaby using high capacity conductor

This option involves constructing two new single circuit 330 kV route diverse lines from Maragle to Bannaby using a high capacity conductor and a phase shifting transformer on Bannaby – Sydney West 330 kV line to control power flows on existing transmission lines between Bannaby and Sydney. The new 330 kV circuits have route diverse paths to mitigate the risk of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting both lines simultaneously.



The high level scope includes:

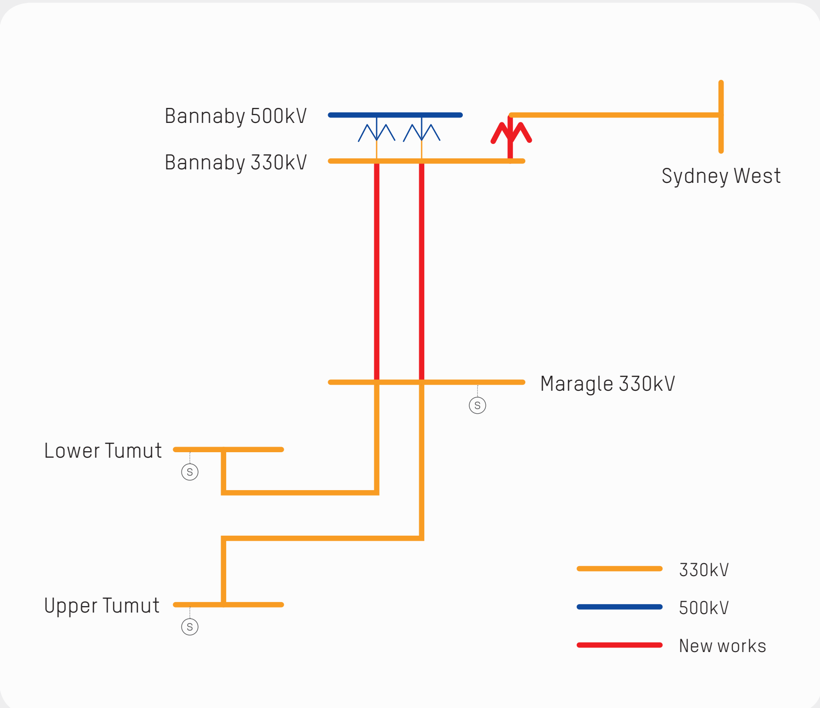
- Constructing two 330 kV single circuit transmission lines using high capacity conductor:
  - From Maragle Substation to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Bannaby Substation to accommodate the additional transmission lines and phase shifting transformer

Preliminary modelling indicates that an additional 2,050 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $790 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.2 **Option 1B** – Two new single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby

This option involves constructing two new single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby and a phase shifting transformer on Bannaby – Sydney West 330 kV line. The new circuits have route diverse paths to mitigate the risk of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting both lines simultaneously.



The high level scope includes:

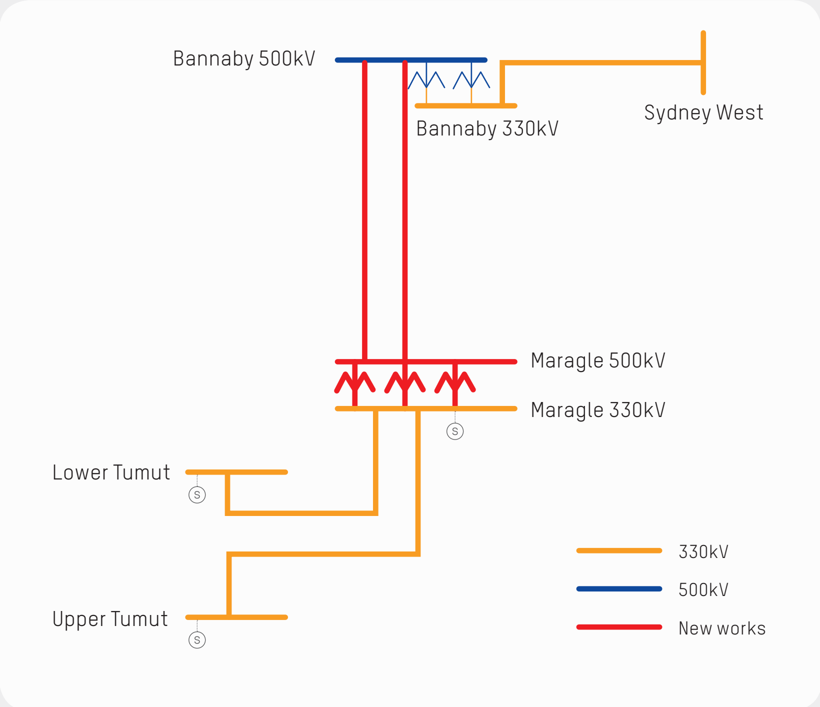
- Construct two 500 kV single circuit transmission lines to be initially operated at 330 kV:
  - From Maragle Substation to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Bannaby Substation to accommodate the additional transmission lines and phase shifting transformer

Preliminary modelling indicates that additional 2,170 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $950 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.3 Option 1C – Two new single circuit 500 kV route diverse lines from Maragle to Bannaby

This option involves constructing two new single circuit 500 kV route diverse lines from Maragle to Bannaby. The new circuits have route diverse paths to mitigate the risks of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting both lines simultaneously.



The high level scope includes:

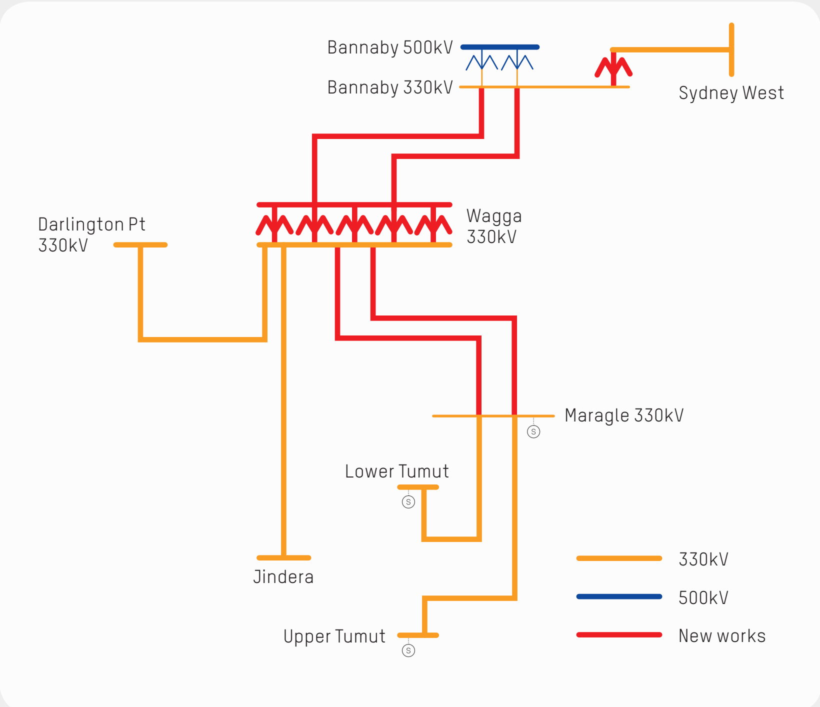
- Construct two 500 kV single circuit transmission lines:
  - From Maragle Substation to Bannaby 500 kV Substation (260km)
- Three new 500/330/33 kV 1,500 MVA transformers at Maragle Substation
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Bannaby Substation to accommodate the additional transmission lines

Preliminary modelling indicates that additional 2,510 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,060 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.4 Option 2A – New single circuit 330 kV route diverse lines from Maragle to Wagga Wagga and Wagga Wagga to Bannaby using high capacity conductor

This option involves constructing two new single circuit 330 kV route diverse lines from Maragle to Wagga Wagga and Wagga Wagga to Bannaby using a high capacity conductor and a phase shifting transformer on Bannaby – Sydney West 330 kV line. The new 330 kV circuits have route diverse paths to mitigate the risks of high impact events (such as lightening strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

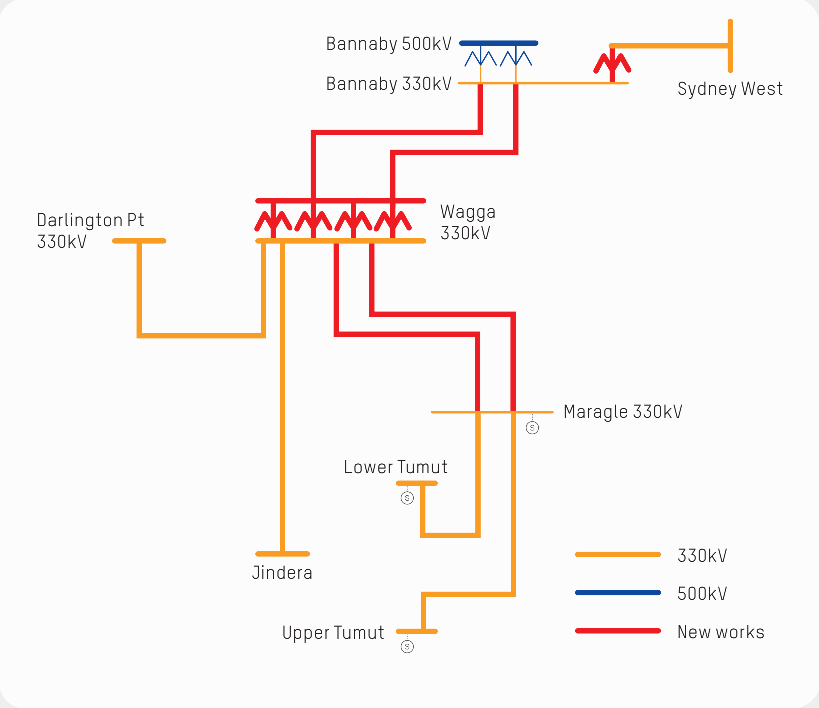
- Constructing four 330 kV single circuit transmission lines using high capacity conductor:
  - Two single circuit lines from Maragle Substation to Wagga 330 kV Substation (110km); and
  - Two single circuit lines from Wagga Substation to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Phase shifting transformers on Wagga–Bannaby 330 kV line
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines

Preliminary modelling indicates that an additional 2,000 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,240 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.5 **Option 2B** – New single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Wagga Wagga and Wagga Wagga to Bannaby

This option involves constructing new single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby via Wagga and a phase shifting transformer on Bannaby – Sydney West 330 kV line. The new circuits have route diverse paths to mitigate the risks of high impact events (such as lightening strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

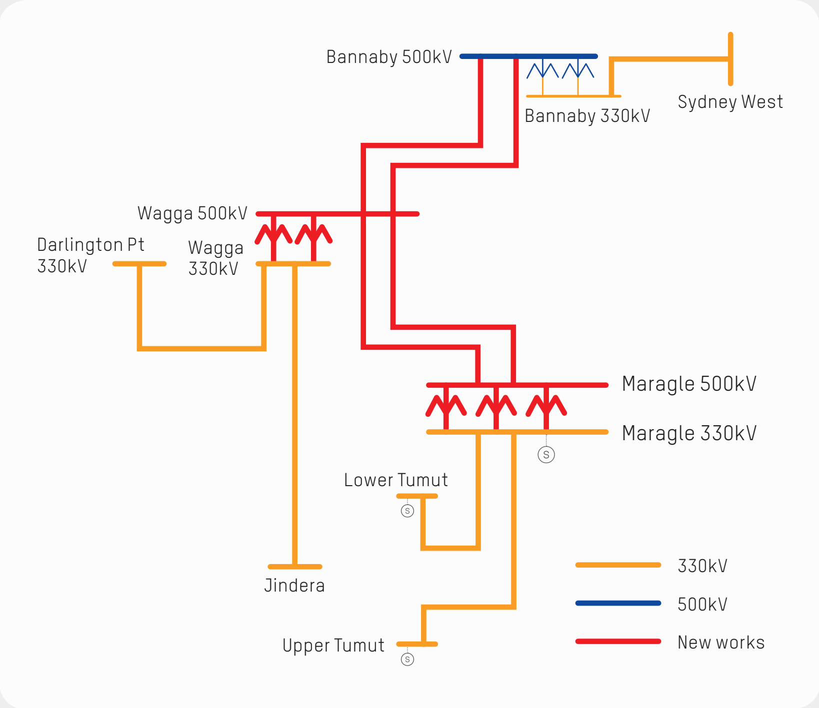
- Construct four 500 kV single circuit transmission lines to be initially operated at 330 kV:
  - Two single circuit lines from Maragle Substation to Wagga 330 kV Substation (110km); and
  - Two single circuit lines from Wagga Substation to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Phase shifting transformers on Wagga–Bannaby 330 kV lines
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines

Preliminary modelling indicates that an additional 2,000 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,420 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.6 **Option 2C** – New single circuit 500 kV route diverse lines from Maragle to Wagga Wagga and Wagga Wagga to Bannaby

This option involves constructing new single circuit 500 kV route diverse lines from Maragle to Wagga Wagga and Wagga Wagga to Bannaby. The new circuits have route diverse paths to mitigate the risks of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

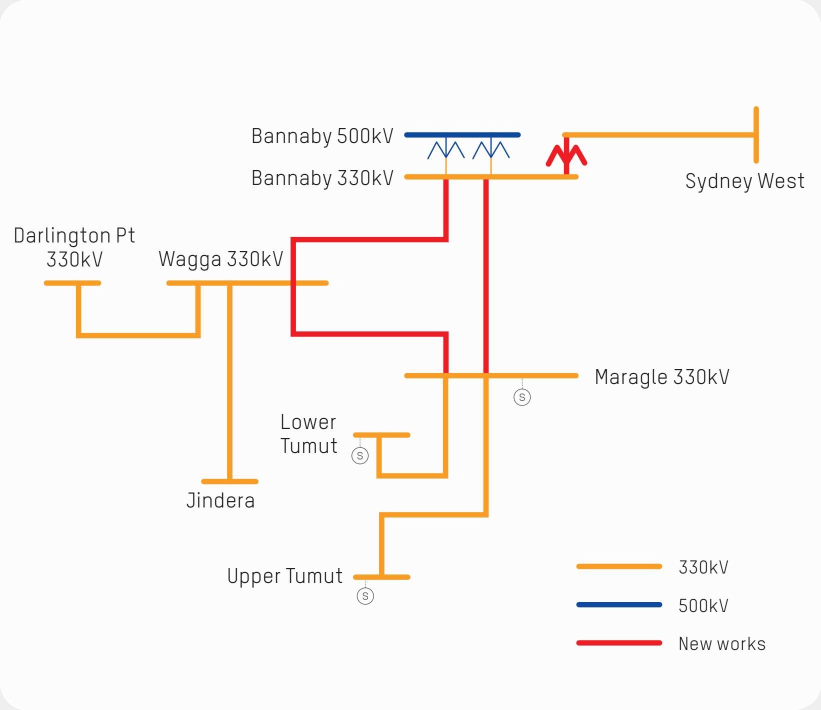
- New Wagga 500 / 330 kV Substation and 330 kV connection to the existing Wagga Substation
- Construct four 500 kV single circuit transmission lines:
  - Two single circuit lines from Maragle Substation to Wagga 500 kV Substation (110km); and
  - Two single circuit lines from Wagga Substation to Bannaby 500 kV Substation (260km)
- Three new 500 / 330 / 33 kV 1,500 MVA transformers at Maragle Substation and two new 500 / 330 / 33 kV 1,500 MVA transformers at Wagga Substation
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines / transformers

Preliminary modelling indicates that an additional 2,500 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,380 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.7 Option 3A – New single circuit 330 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby using high capacity conductor

This option involves constructing new single circuit 330 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby using high capacity conductor and a phase shifting transformer on Bannaby – Sydney West 330 kV line. The new 330 kV circuits have route diverse paths to mitigate the risks of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

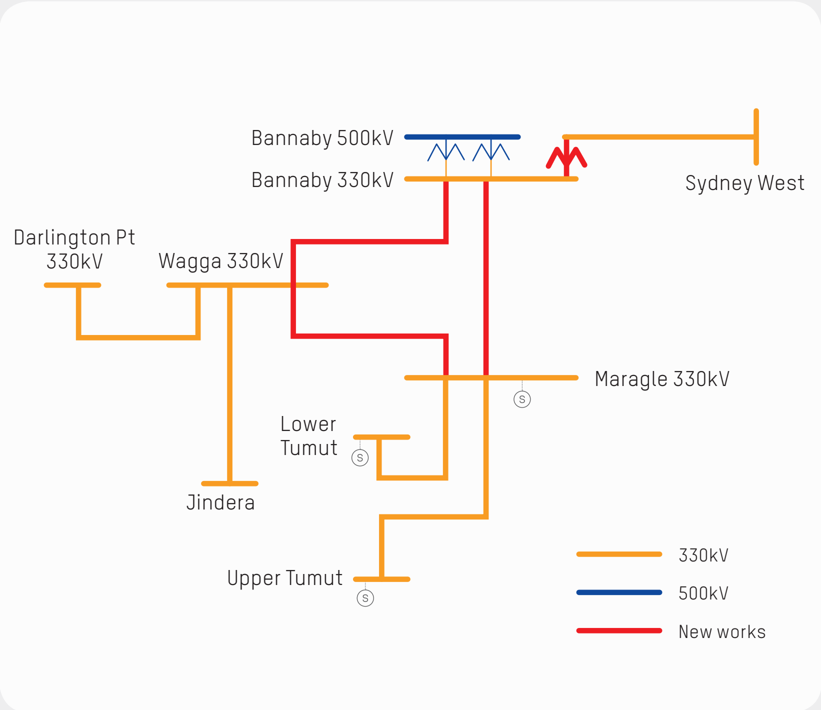
- Construct three 330 kV single circuit transmission lines using high capacity conductor:
  - From Maragle to Bannaby 330 kV Substation (260km);
  - From Maragle to Wagga 330 kV Substation (110km); and
  - From Wagga to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines.

Preliminary modelling indicates that additional 2,000 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,010 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.8 Option 3B – New single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby

This option involves constructing new single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby, and a phase shifting transformer on Bannaby – Sydney West 330 kV line. The new circuits have route diverse paths to mitigate the risks of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

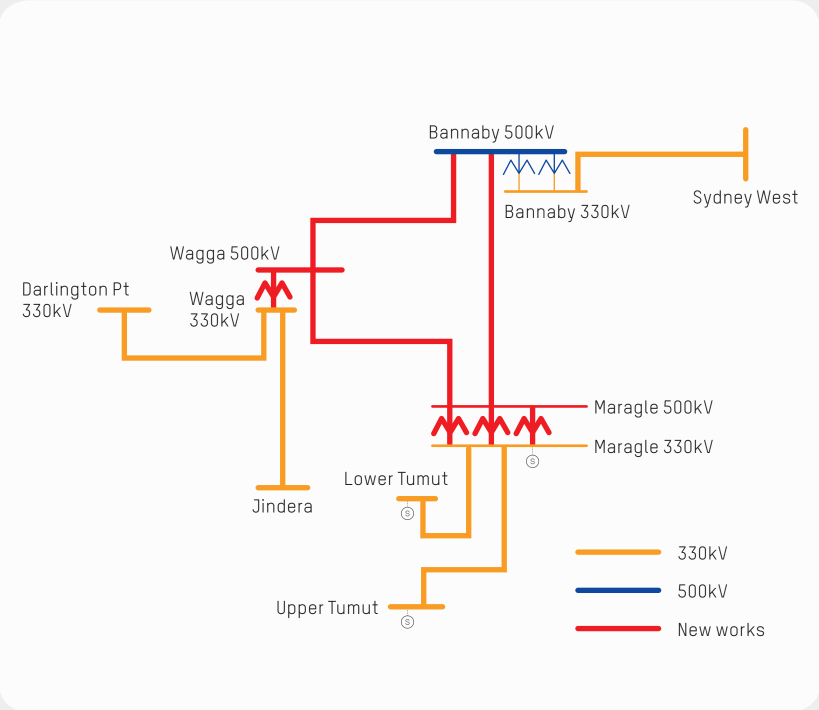
- Construct three 500 kV single circuit transmission lines:
  - From Maragle to Bannaby 330 kV Substation (260km);
  - From Maragle to Wagga 330 kV Substation (110km); and
  - From Wagga to Bannaby 330 kV Substation (260km)
- Phase shifting transformer on Bannaby-Sydney West 330 kV line
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines.

Preliminary modelling indicates that additional 2,030 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,220 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.9 Option 3C – New single circuit 500 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby

This option involves constructing new single circuit 500 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga and Wagga to Bannaby. The new circuits have route diverse paths to mitigate the risks of high impact events (such as lightning strikes, bushfires or extreme wind events) affecting multiple lines simultaneously.



The high level scope includes:

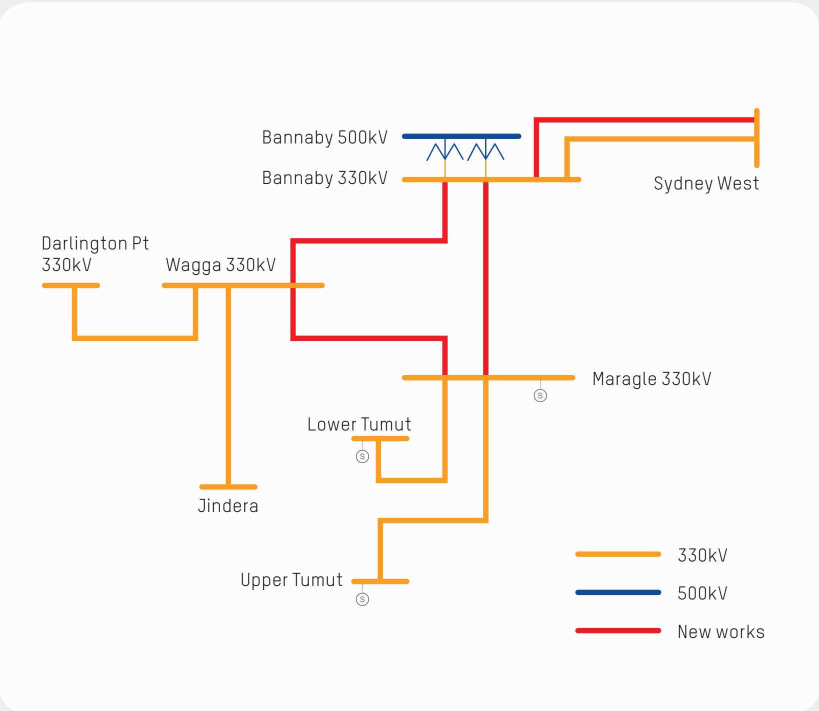
- New Wagga 500 / 330 kV Substation and 330 kV connection to the existing Wagga Substation
- Construct three 500 kV single circuit transmission lines:
  - From Maragle to Bannaby 500 kV Substation (260km);
  - From Maragle to Wagga 500 kV Substation (110km); and
  - From Wagga to Bannaby 500 kV Substation (260km)
- Three new 500/330/33 kV 1,500 MVA transformers at Maragle Substation and one new 500/330/33 kV 1,500 MVA transformer at Wagga Substation
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga and Bannaby to accommodate the additional transmission lines/transformers.

Preliminary modelling indicates that additional 2,570 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,350 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.9 Option 4A – New single circuit 330 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga, Wagga to Bannaby and Bannaby to Sydney West via South Creek

This option involves constructing new single circuit 330 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga, Maragle to Wagga and Wagga to Bannaby and a new single circuit 330 kV line from Bannaby to Sydney West. The new circuits other than Bannaby to Sydney West have route diverse paths to mitigate the risk of high impact events (such as lightning strikes, bushfires and extreme wind events) affecting multiple circuits.



The high level scope includes:

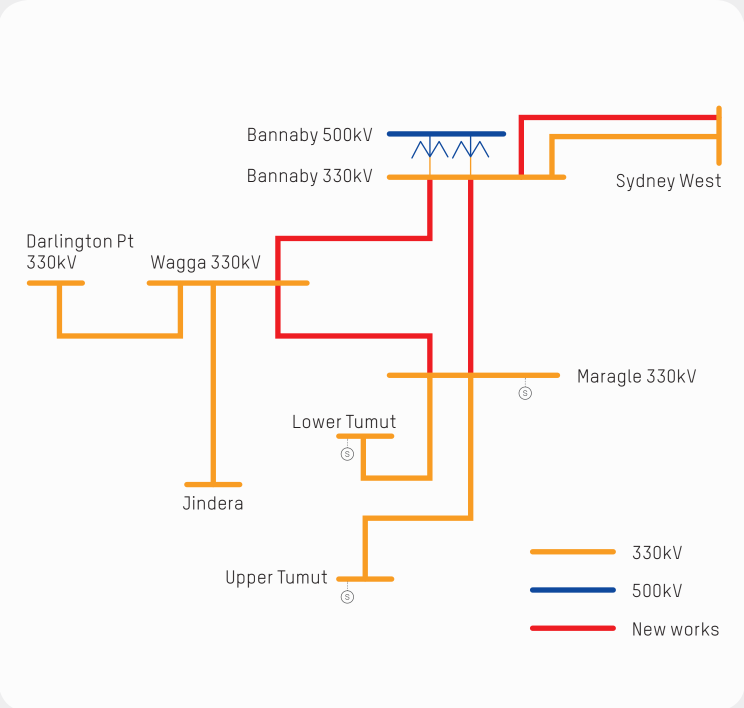
- Construct three 330 kV single circuit transmission lines using high capacity conductor:
  - from Maragle to Bannaby 330 kV Substation (260km);
  - from Maragle to Wagga 330 kV Substation (110km); and
  - from Wagga to Bannaby 330 kV Substation (260km);
- Construct one 330 kV single circuit transmission line:
  - from Bannaby to Sydney West 330 kV Substation (110km)
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle connection Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga, Bannaby and Sydney West to accommodate the additional transmission lines.

Preliminary modelling indicates that an additional 2,000 MW generation could be accommodated at times of average import from VIC and average renewable generation output in southern NSW.

The estimated capital cost of this option is approximately $1,330 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals

3.2.10 Option 4B – New single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby, Maragle to Wagga, Wagga to Bannaby and Bannaby to Sydney West via South Creek

This option involves constructing new single circuit 500 kV route diverse lines initially operated at 330 kV from Maragle to Bannaby, Maragle to Wagga, and Wagga to Bannaby, and a new single circuit 330 kV line from Bannaby to Sydney West. The new circuits other than Bannaby to Sydney West have route diverse paths to mitigate the risk of high impact events (such as lightning strikes, bushfires and extreme wind events) affecting multiple circuits.



The high level scope includes:

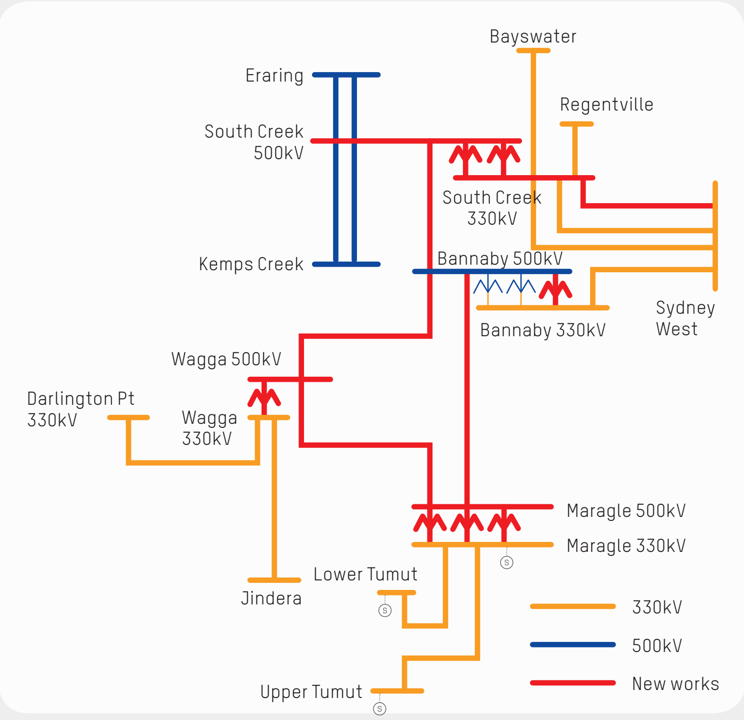
- Construct three 500 kV single circuit transmission lines to be initially operated at 330 kV:
  - From Maragle to Bannaby 330 kV Substation (260km);
  - From Maragle to Wagga 330 kV Substation (110km); and
  - From Wagga to Bannaby 330 kV Substation (260km);
- Construct 330 kV single circuit transmission line:
  - From Bannaby to Sydney West 330 kV Substation 110km
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle connection Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga, Bannaby and Sydney West to accommodate the additional transmission lines.

Preliminary modelling indicates that an additional 2,030 MW generation could be accommodated at times of average import from VIC and average renewable generation output in southern NSW.

The estimated capital cost of this option is approximately $1,570 million. Construction is expected to take 3-4 years, with commissioning commencing in 2024, subject to obtaining necessary environmental and development approvals.

3.2.11 Option 4C – New single circuit 500 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga, Wagga to Bannaby and Bannaby to Sydney via South Creek

This option involves constructing new single circuit 500 kV route diverse lines from Maragle to Bannaby, Maragle to Wagga, Wagga to Bannaby and Bannaby to South Creek. The new circuits other than Bannaby to Sydney via South Creek have route diverse paths to mitigate the risk of high impact events (such as lightning strikes, bushfires and extreme wind events) affecting multiple circuits.



The high level scope includes:

- New Wagga 500 / 330 kV Substation and 330 kV connection to the existing Wagga Substation
- New 500 / 330 kV South Creek Substation connecting existing 330 kV lines 32/38 and 500 kV lines 5A1/5A2
- Construct four 500 kV single circuit transmission lines:
  - From Maragle to Bannaby 500 kV Substation (260km);
  - From Maragle to Wagga 500 kV Substation (110km);
  - From Wagga to Bannaby 500 kV Substation (260km); and
  - From Bannaby to South Creek 500 kV Substation (102km)
- Construct one 330 kV single circuit transmission line:
  - From South Creek to Sydney West Substation (8km)
- Seven new 500/330/33 kV 1,500 MVA transformers: three transformers at Maragle Substation, one transformer at Wagga Substation, one transformer at Bannaby Substation and two transformers at South Creek Substation
- Upgrade equipment at Lower Tumut and Upper Tumut Substations to accommodate increased fault levels
- Augment the Maragle Substation to accommodate the additional transmission lines
- Augment the existing Substations at Wagga, Bannaby and Sydney West to accommodate the additional transmission lines/transformers.

Preliminary modelling indicates that additional 3,100 MW generation could be accommodated at times of average import from VIC and average renewable generation in southern NSW.

The estimated capital cost of this option is approximately $1,890 million. Construction is expected to take 4-5 years, with commissioning commencing in 2024 and progressing throughout 2025 subject to obtaining necessary environmental and development approvals.

3.3 Network options considered but not progressed

TransGrid has also considered a range of other potential options but ceased to progress these on the grounds that they are not considered technically and/or economically feasible, and therefore are not credible options.

3.3.1 Brownfield options

TransGrid has considered options that re-use existing transmission line routes ("brownfield" options). These options may be, for example:

- replacement of existing single circuit transmission lines with double circuit transmission lines; and
- replacement of existing standard conductor transmission lines with high capacity conductor transmission lines.

The scope of "brownfield" options includes demolition of existing transmission lines and construction of new single circuit high capacity or double circuit transmission lines on multiple existing transmission line routes.

The removal of several existing transmission lines for their demolition and construction periods would remove capacity from the transmission system and significantly increase constraints on generation and inter-regional transfers within the NEM.

For these reasons, TransGrid does not consider developments that are significantly brownfield represent credible options, and does not propose to consider those options further as part of this RIT-T. TransGrid will consider re-use of existing corridors where practical and cost-effective, where the impact of outages on the market is manageable.

3.3.2 HVDC options

TransGrid has also considered HVDC options following the topologies set out in options 1, 2, 3 and 4.[24] These would require the installation of two or three new HVDC transmission lines, tie transformers and switchgear.

Preliminary estimation has found that HVDC options would be substantially more expensive than other potential greenfield options and would not provide materially higher capacities. The HVDC options considered are show in Table 3.

These options have costs that are between 50% and 100% higher than other options with comparable capacity. These options are therefore not considered economically feasible, as the higher costs are not expected to be outweighed by materially higher market benefits, and are proposed not to be considered further as part of this RIT-T.[25]

Table 3 – Options considered but not progressed

TOPOLOGY	HVDC
1	**Option 1D:** Two new 330kV or 400kV HVDC transmission lines, four converter stations and phase shifting transformer **Additional firm capacity:** 2,000 MW **Indicative capital cost:** approx. \$1,200m
2 or 3	**Option 2-3D:** Three new 330kV HVDC transmission lines, six converter stations and phase shifting transformer **Additional firm capacity:** 2,000 MW **Indicative capital cost:** approx. \$2,100m
4	**Option 4D:** Three new 330kV HVDC transmission lines and six converter stations[24] **Additional firm capacity:** 2,000 MW **Indicative capital cost:** approx. \$2,370m

24 The topology of option 3D differs from the other options, with transmission lines from Snowy 2.0 to Wagga and Wagga to Sydney, to minimise the number of HVDC converter stations required.
25 AER, Regulatory Investment Test for Transmission Application Guidelines, December 2018, p13.

3.3.3 Summary of other network options considered and not progressed

A summary of all the options considered but not progressed is provided in Table 4. TransGrid does not propose to consider these options further in this RIT-T.

Table 4 – Options considered but not progressed

OPTION	OVERVIEW	REASON(S) NOT PROGRESSED
HVDC between Maragle and Bannaby / Sydney	HVDC options between Maragle and Bannaby / Sydney, using one of the three topologies in options 1, 2 or 3.	These options are more expensive than other potential greenfield options with the same additional capacities. There options are therefore not considered economically feasible.
Use the existing 330 kV network with minor line upgrades	Cut Maragle into the existing line 01 and 2 and upgrade the southern NSW lines	This option would significantly limit generation in the Snowy Mountains due to thermal capability, voltage stability and transient stability limits. This option is therefore not considered technically feasible as it would not increase transfer capacity.
Rebuild existing 330 kV lines	Cut Maragle into the existing line 01 and 2, rebuild the sections from Maragle to Canberra on line 01 and from Maragle to Yass on line 2 as double circuit 330 kV lines, rebuild line 9 Canberra to Yass as double circuit 330 kV lines, and build new double circuit 330 kV lines from Yass to Bannaby.	This option would require significant outages of existing transmission lines to rebuild existing single circuit 330 kV lines between Maragle and Bannaby as double circuit lines, removing significant transmission capacity from this area during demolition and construction and creating significant impacts to the wholesale electricity market. This option is therefore not considered economically feasible.
New 330 kV or 500 kV double circuit transmission line from Maragle to Bannaby	Build new 330 kV or 500 kV double circuit transmission line from Maragle to Bannaby	This option introduces the risk of a single high impact event (such as lightning strikes, bushfires or extreme wind events) affecting both circuits simultaneously. The likely consequences include widespread blackouts due to both voltage collapse in southern NSW and under frequency load shedding. These consequences for the power system have been experienced previously, including recently due to a double circuit lightning strike on the Queensland to NSW interconnector on 25 August 2018. This option is therefore not considered technically feasible.

3.4 Material inter-network impact

TransGrid has considered whether the credible options above are expected to have a material inter-network impact.[26] A 'material inter-network impact' is defined in the NER as:

"A material impact on another Transmission Network Service Provider's network, which may include (without limitation): (a) the imposition of power transfer constraints within another Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."

The credible options outlined above are near VIC - NSW interconnectors and will therefore have a material inter-network impact. These options do not meet AEMO's screening criteria for investments that do not have a material inter-network impact.[27]

We will request that AEMO produce an augmentation technical report in relation to the options being considered in this RIT-T.[28] As part of the augmentation technical report, AEMO will:[29]

- consult with and take into account the recommendations of the jurisdictional planning representatives in relation to the proposed augmentation; and
- make a determination as to: (i) the performance requirements for the equipment to be connected; and (ii) the extent and cost of augmentations and changes to all affected transmission networks; and (iii) the possible material effect of the new connection on the network power transfer capability including that of other transmission networks. We will publish the augmentation technical report with the PACR.[30]

26 NER clause 5.16.4(b)(6)(ii).
27 The screening test is set out in Appendix 3 of the Inter-Regional Planning Committee's Final Determination: Criteria for Assessing Material Inter-network Impact of Transmission Augmentations, Version 1.3, October 2004.
28 NER clause 5.21(d)(1)-(3).
29 NER 5.16.4 (k)(9)(iii).
30 As required by NER 5.16.4 (k)(9)(iii).

04 Non-network Option Information

This section describes the technical characteristics that a non-network option would need in order to address the identified need.[37]

Non-network options, either individually or combined with network solutions, may also be able to relieve transmission constraints between the Snowy Mountains and Sydney on the NSW Southern Shared Network, therefore contributing to the identified need.

In particular, this section sets out both:

- general information on how non-network options can assist with increasing transfer capacity (section 4.1);
- specific information on the use of a potential Wide Area System Integrity Protection Scheme (section 4.2); and
- the information requested from potential non-network proponents (section 4.3).

Proponents of non-network options are encouraged to make submissions on any non-network option they believe can address, or contribute to addressing, the identified need. Moreover, we encourage proponents to reach out and contact us as soon as practicable about potential solutions, ahead of preparing a formal submission. Overall, this process will enable credible non-network options to be assessed in the PADR.

4.1 Technical characteristics required for non-network options

At a high level, credible non-network options need to be able to help relieve constraints on the shared transmission network between the Snowy Mountains and Sydney, Newcastle and Wollongong, in order to increase overall transfer capacity. These constraints are anticipated to worsen in future, once Liddell retires, and will be further impacted by the development of Snowy 2.0 and renewable generation in southern NSW.

In the first instance, non-network options would need to be able to reduce load in central or northern NSW at times of high power transfer between the Snowy Mountains and Sydney, Newcastle and Wollongong.

TransGrid has set out a number of potential non-network technologies in Table 5 that could assist with meeting the identified need.

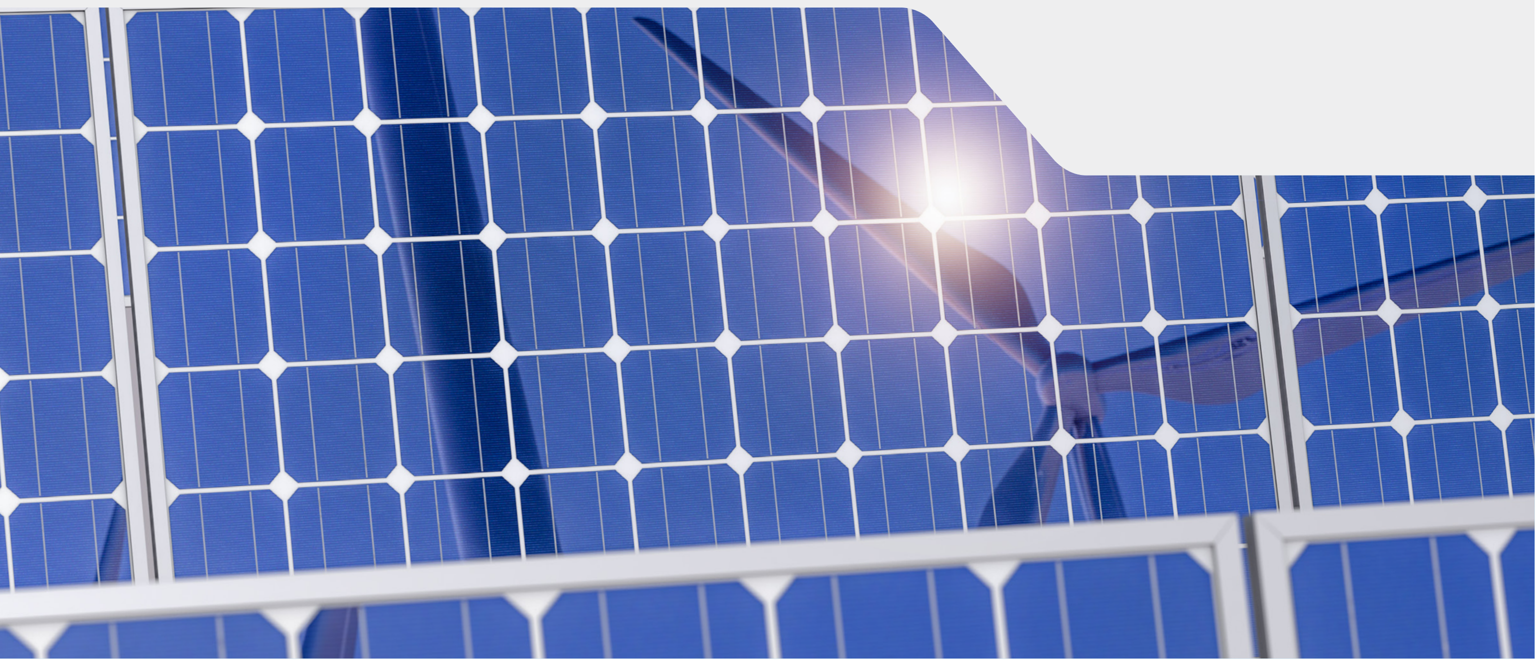
Given a desire to not be prescriptive at this early stage of the RIT-T regarding the role of non-network options, we have not specified minimum quantities and operating profiles for these solutions.

We are interested to hear from parties regarding the potential for non-network options to satisfy, or contribute to satisfying, the identified need, and from potential proponents of such non-network options.

37 In accordance with NER clause 5.16.4(b)(3).

Table 5 – How non-network technologies can assist in delivering key market benefits

	REDUCING/DEFERRING THE GENERATION COST	ASSISTANCE WITH LOWERING GENERATOR FUEL CONSUMPTION	FACILITATING THE CONNECTION OF HIGH-QUALITY RENEWABLE GENERATION
Overview of how non-network technologies may be able to assist with providing each key market benefit	A non-network option would need to increase transfer capacity to defer the need for more expensive generation development in NSW	A non-network option would need to be able to reduce load in central or northern NSW at times of high power transfer north from the Snowy Mountains so as to provide a fast response in the event of contingencies, in order to relieve the current operational constraints in southern NSW	A non-network option would need to support development of renewable energy in additional geographical areas of the NEM
POSSIBLE TECHNOLOGIES			
Peak load reduction in NSW	✓	—	—
Shifting of load to alternative time periods	✓	✓	
Energy storage that uses any surplus or low cost generation to be released at appropriate times	✓	✓	✓
Improved utilisation of existing generating plant	✓	—	—
Pre-emptive load reduction to reduce the loading on transmission lines in southern NSW at constraining time	—	✓	—
Post-contingent load reduction and generator shedding to counteract the stability limitations	—	(These actions would need to be very high speed (within a few cycles of a contingency))	—
Improve system strength to accommodate more renewable generation	—	—	✓



4.2 Information regarding a potential Wide Area System Integrity Protection Scheme

TransGrid is interested in understanding the potential to leverage flexibility in generation and demand to extend the capacity of the transmission network between the Snowy Mountains and Sydney.

In particular, Snowy Mountains to Sydney transfer capacity could be increased if, immediately following:

- A critical network contingency, generation could be tripped or runback in the Snowy Mountains or south of the Snowy Mountains, and a corresponding amount of load could be tripped or run-back north of Bannaby, within the same time frame;
- A critical NSW generation trip, a corresponding amount of load could be tripped or run-back in NSW.

The tripped or run-back generation and load would need to remain in this state until AEMO is able to re-secure the power system (i.e. within 30 minutes) but would then be free to resume normal operation within the new secure envelope.

For such a Wide Area System Integrity Protection Scheme to function it would require the participation of generators and loads – specifically:

- Generators which can be run-back very quickly or tripped without adverse consequences:
  - this may be particularly applicable to large inverter-connected generators which can operate flexibly; and
  - the level of run-back which could be offered at a specific point in time would be limited by the level at which the generation is operating (i.e. without storage, a solar generator would be unable to provide a run-back service overnight).
- Loads which could be run-back very quickly or tripped without adverse consequences:
  - It is anticipated that this may be most appropriate for industrial loads that have a high degree of controllability and/or have energy storage incorporated into the process (e.g., heat); and
  - the level of run-back would be limited by the size of the load, and any variations in consumption over time.
- Energy storage such as large-scale battery installations could respond quickly in either direction:
  - their capacity to respond would be limited by the headroom between their power capacity and the current level of output, and how much energy is presently stored (i.e. the state-of-charge for a battery).

For all proponents, consideration would also need to be given to complementarity between this service and other ancillary services that the proponent may be providing (e.g. Frequency Central Ancillary Services (FCAS)) during such contingencies.

Consideration would also need to be given to whether the response could exacerbate constraints elsewhere in the NEM. The risk of additional local constraints limiting participation would generally increase with distance from the Snowy Mountains, but would need to be considered on a case by case basis.

The nature of thermal limitations that often limit transfer capacity between the Snowy Mountains and Sydney call for a rapid response (in the order of less than 2 minutes), from the transmission fault commencing to the completion of the ramping and/or tripping of participants. This would necessitate the use of dedicated and secure communications and would likely limit participants to those which are connected at a transmission level.

A Wide Area System Integrity Protection Scheme would facilitate and coordinate the response of multiple participants, and may operate as follows:

- proponents would need to advise their ability to respond in real-time (given that this may fluctuate over time);
- the scheme would need to aggregate overall availability of demand and generator response – AEMO's market dispatch system would need to be provided this information to enable the additional secure capability to be realised;
- on detection of a monitored contingency event, signals would be initiated requiring the agreed response;
- if ramp-back does not occur within the design time frame the generator/load would be tripped; and
- the signal would be cleared once AEMO had re-secured the power system (which they are required to do under the NER within 30 minutes) and given permission for participants to resume normal operation – participants may be notified of the possibility to return to normal operation in a staggered fashion over several minutes to minimise subsequent disturbances to the power system.

Compensation would be offered to participants through a combination of availability and operation payments.

It is not expected that the scheme would need to operate very frequently since:

- Historical fault rates are low
- Even when a fault occurs, power transfers would need to be beyond existing limits to necessitate demand or generator action in order to keep the power system stable;
- The scheme would be designed and operated in a manner to minimise the risk of mal-operation or fails-safely; and
- Testing would be needed during commissioning, and periodically thereafter to verify the functionality of the scheme but would be designed and coordinated to minimise its impact.

The impact of being part of such a scheme on participants is expected to be modest. Nevertheless, participants would need to be prepared to reliably respond when called upon to do so.

We consider that such a non-network solution could be considered in conjunction with the network options put forward, could be scaled over time in response to changing market needs and could also be used to address other intra-regional limitations.

In order to evaluate the practicality and viability of such a scheme, TransGrid calls upon interested generators and loads to submit a non-binding expression of interest in response to this PSCR. This information will assist TransGrid in determining how to progress the concept in the PADR.

4.3 Information to be provided by proponents of a non-network option

The table below sets out the indicative parameters that we request parties nominate in responses to this PSCR.

TransGrid is not initiating a formal tender for non-network solutions at this stage. However, we strongly encourage proponents of potential non-network solutions to make a submission to this PSCR and/or contact us, as any non-network solutions considered under this RIT-T will require indicative costs and timings to be evaluated alongside the other options in the next stage of this RIT-T assessment (i.e. the PADR).

Should the RIT-T assessment identify a non-network solution(s) as part or all of the preferred option then we would seek binding offers from the proponent(s) prior to completing the PACR.

Table 6 – Information requested from non-network proponents

	PARAMETER
1	Organisational information
2	Relevant experience
3	Details of the service, including location of relevant technologies. Technical characteristics, such as: • Detection method • Actuation time • Characteristics of the response • Inertia capability • Scalability of the service Demonstration of ability to deliver utility scale solution in a reasonable time frame
4	Cost of service, separating capital and operational expenditure
5	Confirmation of timelines in providing the service, i.e. speed of response
6	Indicative establishment charge
7	Indicative standby charges
8	Indicative operational charges
9	Responsibility and liability arising directly or indirectly from the operation or failure of the non-network solution
10	Indicative demonstration of the proponent's financial viability position

05 Materiality of Market Benefits

The NER requires that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material in relation to the RIT-T assessment for a specific option.[31]

5.1 Categories of market benefit expected to be material

Table 7 below summarises the key components of the identified need, and the associated market benefit categories under the RIT-T, as set out in the NER, as well as the other consequential market benefit categories that may be material for this RIT-T.

The table also summarises TransGrid's proposed approach to considering each of these benefit categories in this RIT-T.

Table 7: Categories of market benefit expected to be material

COMPONENT OF IDENTIFIED NEED	NER PRESCRIBED MARKET BENEFIT – NER 5.16.1(C)(4)	PROPOSED CONSIDERATION IN THIS RIT-T
Meeting NSW demand at lowest cost	i Changes in fuel consumption arising from different patterns of generation dispatch ii Changes in voluntary load curtailment iii Changes in involuntary load shedding iv changes in costs for parties, other than the RIT-T proponent, due to differences in the timing of new plant, capital costs and operating and maintenance costs[32] viii Competition benefits ix Option value	Benefit categories quantified through market modelling.[33] Option value considered through inclusion of flexible options (1B, 2B, 3B, 4B). Potential for competition benefits to materially affect the identification of preferred option to be further considered.
Facilitating the transition to lower carbon emissions	iv Change in costs for parties, other than the RIT-T proponent, due to differences in the timing of new plant, capital costs and operating and maintenance costs ix Option value	Benefit categories quantified through market modelling. Option value considered through inclusion of flexible options (1B, 2B, 3B, 4B).
Consequential market benefits	vi Changes in network losses v Differences in the timing of transmission expenditure	Losses quantified through market modelling. Interaction between options and other transmission developments to be explicitly taken into account.

31 NER clause 5.16.1(c)(6).

32 TransGrid notes that benefits regarding changes in costs for third parties will reflect both benefits in meeting NSW demand at lowest cost and benefits in facilitating a transmission to lower emissions. They will enter the RIT-T analysis as a single benefit category (and so will not be double-counted).

33 TransGrid notes that the AER's RIT-T includes an additional benefit category relating to the penalty paid for not meeting the renewable energy target (AER Regulatory Investment Test for Transmission, June 2010, (5)(j)). This benefit category is not expected to be material for this RIT-T, but it is typically incorporated into the wholesale market modelling.

The majority of the market benefit categories for this RIT-T will be quantified through the use of wholesale market modelling, including the assessment of dispatch cost benefits and investment deferral benefits associated with the generation and storage investment that would otherwise be needed to meet NSW demand and Australia's carbon emission reduction commitments. TransGrid is publishing an accompanying Inputs and Methodology Consultation Paper alongside this PSCR, which provides further information on the proposed modelling approach and assumptions.

TransGrid intends to further investigate as part of the PADR whether there is significant option value associated with flexible options which would readily and cost-effectively increase the transfer capacity between the Snowy Mountains and Sydney, and in particular those option variants (1B, 2B, 3B, 4B) that would be built at 500 kV but initially operated at 330 kV.

These options provide flexibility to 'scale up' transfer capacity at a later date, in response to changes in demand and/or the expansion of generation capacity along the transmission corridor, whilst avoiding upfront investment associated with higher capacity. TransGrid currently envisages that an upgrade to 500 kV operation may be justified on the basis of the resulting market benefits once the amount of new generation connecting exceeds 400 MW. However, since these options have a higher initial cost than options which are constructed at 330 kV, they would only be justified if the value of this flexibility (i.e. the 'option value' is provides) is greater than the increase in initial cost.

TransGrid also intends to investigate other examples of incremental scope that may deliver option value benefits including the construction of transmission lines as double circuit towers strung on one side, rather than single circuit towers, to provide options to more cost-effectively string additional circuits (for example, as future renewable generation and storage is developed in southern NSW).

Finally, TransGrid considers that there is the potential for competition benefits from relieving current constraints on transmission capacity between the major New South Wales load centres and the Snowy Mountains and unlocking new Renewable Energy Zones (REZs) in southern NSW. The options considered in this RIT-T have the potential to affect constraints between competing generation centres where there is currently potential for strategic bidding, and may therefore lead to a change in bidding behaviour and resulting changes in wholesale market outcomes.

The assessment of competition benefits is complex and requires additional market modelling, reflecting assumptions about future generator bidding behaviour and how this is expected to be affected by the different options being considered. TransGrid therefore intends to undertake an initial 'fit-for-purpose' exercise to understand whether the size of potential competition benefits may differ substantially between options, to assess whether consideration of competition benefits is likely to be material to the identification of the preferred option under this RIT-T.

5.2 Classes of market benefit not expected to be material – changes in ancillary services costs

The PSCR is also required to set out the classes of market benefit that the TNSP considers are not likely to be material for a particular RIT-T assessment. At this stage, TransGrid considers that all categories of market benefit identified in this RIT-T have the potential to be material, with the exception of changes in ancillary services costs.

Ancillary service costs currently make up a relatively small proportion of total energy supply costs. TransGrid recognises that this may not be the case going forward as renewable penetration in the NEM increases. However, there is a large degree of uncertainty around how ancillary services requirements may develop, and currently TransGrid has no reason to consider that any increase in ancillary services costs will be different between the credible options being considered in this RIT-T.

While the cost of FCAS may change as a result of changed generation dispatch patterns and changed generation development following expanded transfer capacity between the Snowy Mountains and Sydney, FCAS costs are relatively small compared to the total market benefits that TransGrid's initial assessment (and the 2018 ISP analysis) indicates may be realised by the investment options being considered. Changes in FCAS costs are also not likely to be materially different between options, and so are therefore not considered to be material in the selection of the preferred option.

There is no expected change to the costs of Network Control Ancillary Services (NCAS), or System Restart Ancillary Services (SRAS) as a result of the options being considered. These costs are therefore not material to the outcome of the RIT-T assessment.

Given the complexity of modelling ancillary services requirements going forward, and the expectation that differences in ancillary services costs will not be material to the identification of the preferred option, TransGrid is not proposing to quantify ancillary services costs as part of this RIT-T assessment.

Appendix A

Appendix A Checklist of compliance clauses

This section sets out a compliance checklist which demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the National Electricity Rules version 122.

RULES CLAUSE	SUMMARY OF REQUIREMENTS	RELEVANT SECTION(S) IN THE PSCR
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 or 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 NTNDP;	2
	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, alternative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3
	6 for each credible option identified in accordance with subparagraph (5), information about: i the technical characteristics of the credible option; ii whether the credible option is reasonably likely to have a material inter-network impact; iii the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.1(c)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefits 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

TransGrid