Improving stability in south-western NSW

RIT-T – Project Specification Consultation Report

Region: South Western New South Wales

Date of issue: 31 July 2020

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Executive summary

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for improving stability in the south-western New South Wales (NSW) power system. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process.

The main power system in south-western NSW consists primarily of one 330 kV transmission line from Darlington Point to Wagga Wagga (Line 63) and 220 kV transmission lines west of Darlington Point (including Line X5). Smaller underlying 132 kV transmission lines supply regional towns.

This area has seen significant growth in renewable connections to the transmission network as part of the wider energy market transition. Approximately 560 MW of renewable generation has connected in the area since December 2015, with a further 800 MW expected to connect by 2021. This is having an impact on how this part of the power system operates. In particular, while power has historically primarily flowed west from Darlington Point to supply rural and mine loads, this is expected to reverse with the increase in renewable generation in the area, particularly during daytime when there is an abundance of solar generation.

These changes in power flows are expected to lead to an increasing risk of power system instability going forward. Currently, the only way of managing this risk is to constrain generation in south-western NSW. In recognition of the risks to future power system stability, the Australian Energy Market Operator (AEMO) recently implemented an operational constraint in the NEM Dispatch Engine (NEMDE) to limit power flows and prevent this occurring.

TransGrid has identified the opportunity to strengthen the transmission network to relieve this constraint and realise net market benefits. This RIT-T has therefore been initiated to progress and consult on the assessment of investment options. The investments considered in this RIT-T are not expected to form part of AEMO's final 2020 Integrated System Plan (ISP), and so are being progressed outside of the ISP framework.

TransGrid's revenue determination for the 2018-2023 regulatory control period includes a contingent project to support South Western NSW for renewables. This contingent project is to reinforce the transmission network in the area to enable additional renewable generation and provide net market benefits to NSW as well as the wider National Electricity Market.[1]

The 'identified need' is to provide net benefits to the market through relieving the recently imposed generation constraint in the south-western NSW power system

The identified need for this RIT-T is to increase overall net market benefits in the National Electricity Market (NEM) through relieving existing and forecast constraints on generation connecting to the transmission network in south-western NSW. Doing so will enable greater output from renewable generation in this region of the NEM.

Within the context of the RIT-T assessment, greater output from renewable generation is expected to deliver market benefits primarily through:

- reductions in total dispatch costs (including fuel costs), by enabling low cost renewable generation to displace higher cost conventional generation elsewhere; and
- reducing the need for new investment in generating plant, or a deferral of generation investment.

It is expected that the market benefits from relieving these constraints will exceed the cost of doing so.

[1] TransGrid, *Revised Regulatory Proposal 2018/19-2022/23*, available at: https://www.aer.gov.au/system/files/TransGrid%20-%20Revenue%20Proposal%2018_19%20to%2022_23%20-%20January%202017.pdf

Three types of credible options have been identified

TransGrid considers there are three types of credible options that have the potential to meet the identified need from a technical, commercial, and project delivery perspective.

These options cover:

> a new or rebuild transmission line between Darlington Point and the new Dinawan substation being constructed for EnergyConnect (Option 1A (new line) and Option 1B (rebuild));
> a new transmission line between Darlington Point and Wagga Wagga (Option 2); and
> a static synchronous compensator (STATCOM) solution (Option 3).

Table E-1 summarises the credible options TransGrid proposes be assessed in the Project Assessment Draft Report (PADR).

TransGrid notes that a STATCOM solution may not be able to relieve the constraint in full, due to the fast-acting nature of voltage collapse and the low system strength in the area. The benefits from this option are therefore likely to be less than those for the network options. Whether this option remains a credible option (or becomes non-economic) will be evaluated as part of the PADR.

Section 4 of this PSCR provides detail on the technical characteristics that a non-network solution would need to have in order to assist with meeting the identified need for this RIT-T. TransGrid would be interested in hearing from proponents that provide these solutions.

Table E-1: Summary of the credible options, $2019-20

Option	Description	Estimated capital cost	Expected delivery time
1A	Establish a new Darlington Point to Dinawan 330 kV transmission line	$145-225 million	4-5 years
1B	Rebuild the existing 99T Darlington Point to Coleambally and 99L Coleambally to Deniliquin as 330 kV to Dinawan	$180-280 million	4-5 years
2	Establish a new Wagga Wagga to Darlington Point 330 kV transmission line	$220-340 million	4-5 years
3	STATCOM	$30-50 million for a 100 MVar STATCOM	3-4 years

All options are assumed at this stage to have annual operating and maintenance costs equal to approximately one per cent of their capital costs. However, TransGrid is continuing to investigate these costs for each option and expects to report more detailed estimates in the PADR.

Wholesale market modelling reflecting the 2020 ISP assumptions will be used to identify the preferred option

Given that the benefits of the investments considered in this RIT-T relate to reduced constraints on generation, TransGrid intends to adopt market modelling in identifying the preferred option.

Given the long-lived nature of transmission investments, it is important that the outcome of the RIT-T assessment is robust to different assumptions about how the energy sector may develop in the future.

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.

TransGrid intends to model the market benefits of the credible options across three 'core' scenarios using wholesale market modelling in the PADR. These scenarios will be based on those used by AEMO in the forthcoming 2020 ISP and will 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.

TransGrid also plans to investigate a range of sensitivity tests on key assumptions in the PADR to further test the robustness of the preferred option to the underlying assumptions. These may be informed by submissions to this PSCR.

Submissions and next steps

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

TransGrid welcomes written submissions on the material contained in this PSCR. Submissions are particularly sought on the credible options presented and from potential proponents of non-network options that could meet the technical requirements set out in this PSCR. Submissions are due on 26 October 2020.

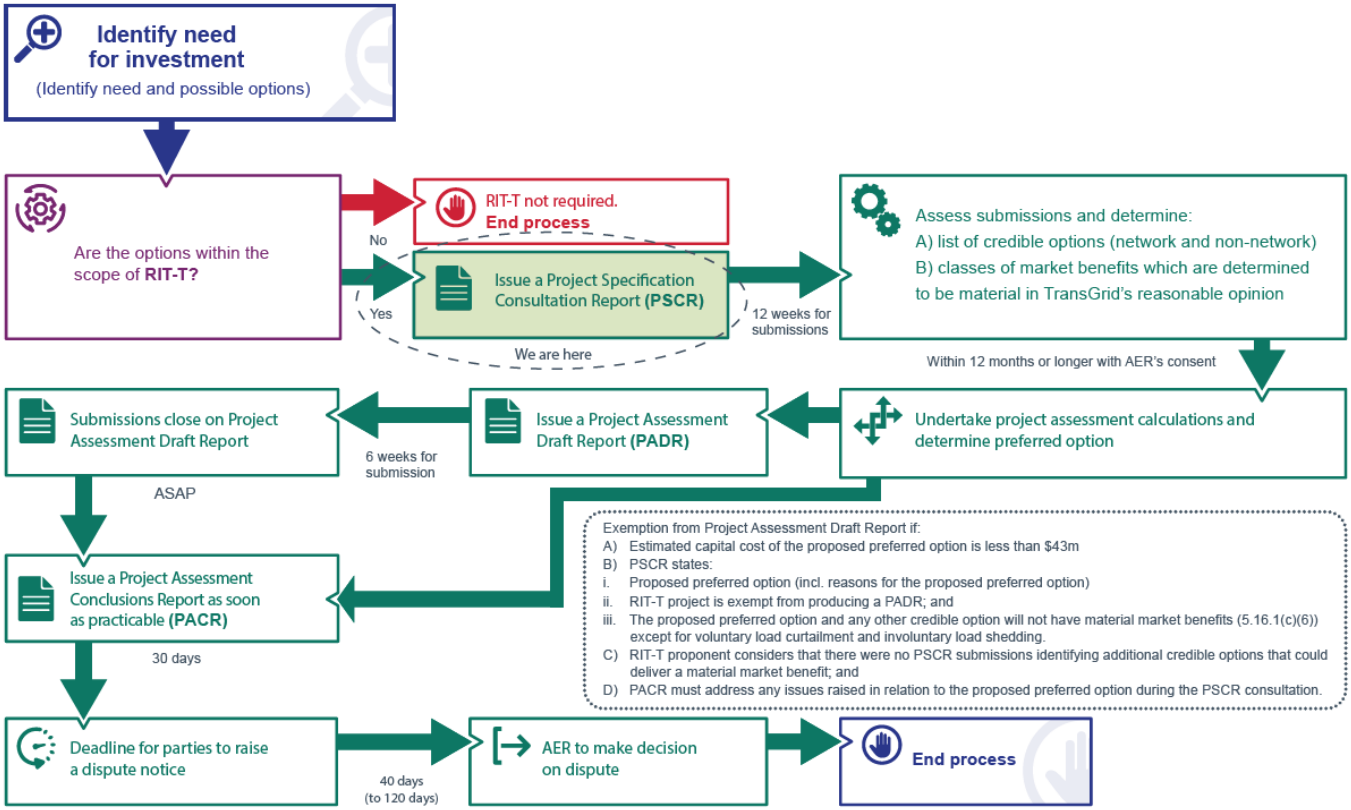
Submissions should be emailed to TransGrid's Regulation team via regulatory.consultation@transgrid.com.au.[2] In the subject field, please reference 'PSCR Improving stability in south-western NSW.'

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

The next formal stage of this RIT-T is the publication of a PADR. The PADR will include the full quantitative analysis of all credible options and is expected to be published in late 2020.

[2] TransGrid is bound by the Privacy Act 1988 (Cth). In making submissions in response to this consultation process, TransGrid will collect and hold your personal information such as your name, email address, employer and phone number for the purpose of receiving and following up on your submissions. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement. See section 1.2 for more details.

Figure E-1: This PSCR is the first stage of the RIT-T process[3]



[3] AER, *Final determination on the 2018 cost thresholds review for the regulatory investment tests*, available at: https://www.aer.gov.au/communication/aer-publishes-final-determination-on-the-2018-cost-thresholds-review-for-the-regulatory-investment-tests

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1. Introduction

The National Electricity Market (NEM) is currently undergoing rapid change as the sector transitions to a world with lower carbon emissions and greater uptake of emerging technologies. Renewable energy is making up an increasing proportion of the national energy mix.

South-western New South Wales (NSW) has seen significant growth in renewable connections to the transmission network as part of this wider energy market transition, which is having an impact on how this part of the power system operates (and is expected to operate going forward). In particular, while power has historically primarily flowed west from Darlington Point to supply rural and mine loads, this is expected to reverse going forward with the increase in renewable generation in the area, particularly during daytime when there is an abundance of solar generation.

These changes in power flows are expected to lead to an increasing risk of power system instability going forward. Currently, the only way of managing this risk is to constrain generation in south-western NSW. In recognition of the risk to future power system stability, the Australian Energy Market Operator (AEMO) recently implemented an operational constraint in the NEM Dispatch Engine (NEMDE) from 8 May 2020, to limit power flows and prevent this occurring.

TransGrid has identified the opportunity to strengthen the transmission network to relieve this constraint and realise net market benefits. This Regulatory Investment Test for Transmission (RIT-T) has therefore been initiated to progress and consult on the assessment of investment options.

This RIT-T process will be undertaken in consultation with consumers, AEMO, Registered Participants and other interested parties regarding the investment options under consideration. The investments considered in this RIT-T are not expected to form part of AEMO's final 2020 Integrated System Plan (ISP), and so are being progressed outside of the ISP framework.

TransGrid's revenue determination for the 2018-2023 regulatory control period includes a contingent project to support South Western NSW for renewables. This contingent project is to reinforce the transmission network in the area in order to enable additional renewable generation and provide net market benefits to NSW as well as the wider National Electricity Market.[4]

1.1 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 the technical characteristics non-network solutions would need to deliver 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.

[4] TransGrid, *Revised Regulatory Proposal 2018/19-2022/23*, available at: https://www.aer.gov.au/system/files/TransGrid%20-%20Revenue%20Proposal%2018_19%20to%2022_23%20-%20January%202017.pdf

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TransGrid welcomes written submissions on the material contained in this PSCR. Submissions are due on 26 October 2020.

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2. The identified need

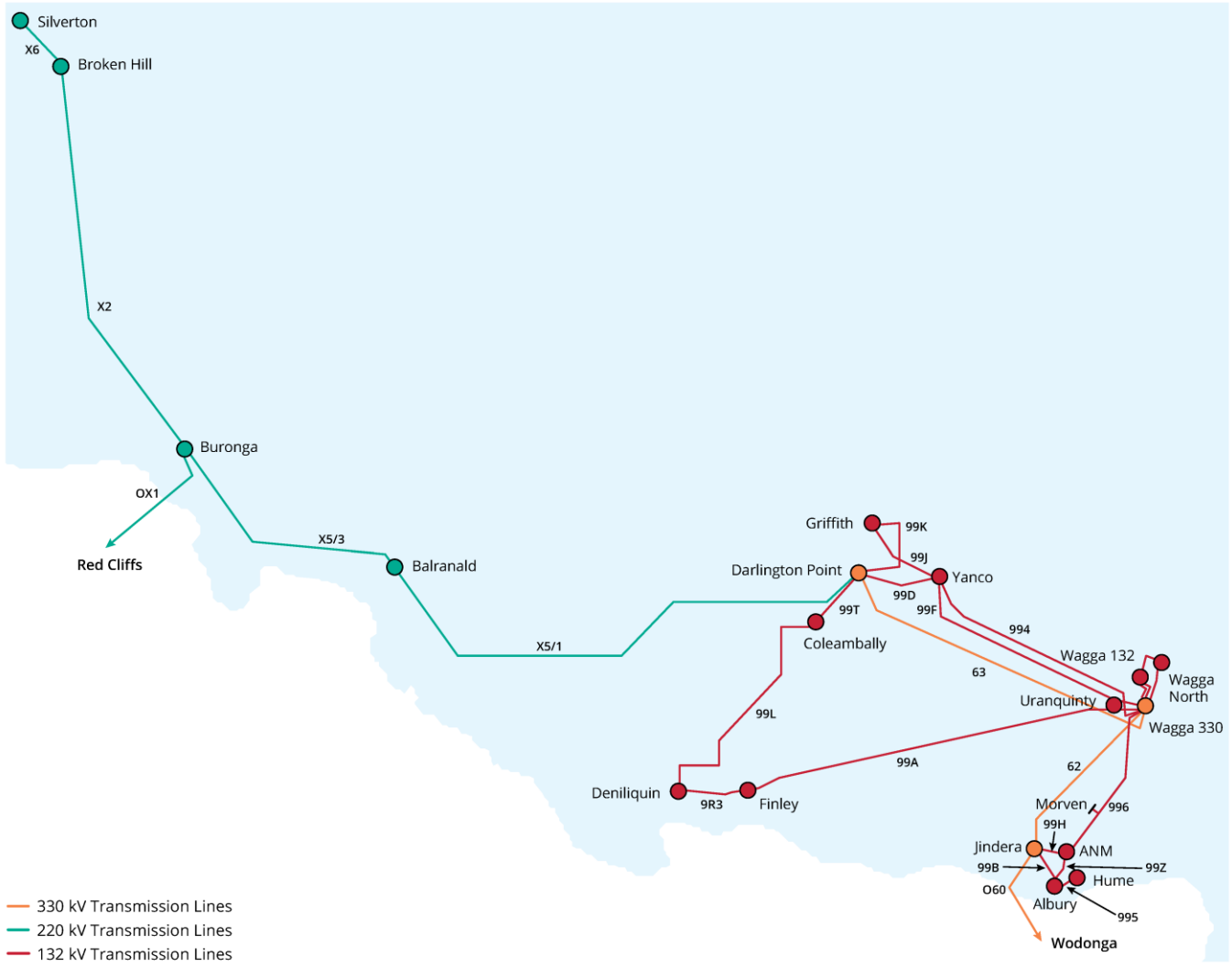
This section outlines the identified need for this RIT-T, as well as the assumptions underlying the identified need. It first sets out background on the current south-western NSW electricity supply arrangements.

2.1 Background to the identified need

The main power system in south-western NSW consists primarily of one 330 kV transmission line from Darlington Point to Wagga Wagga (Line 63) and 220 kV transmission lines west of Darlington Point (including Line X5). Smaller underlying 132 kV transmission lines supply regional towns.

The current electricity network supplying south-western NSW is shown in Figure 2-1 below.

Figure 2-1: South western NSW transmission network



South-western NSW has attracted a lot of interest from investors in renewable energy due to the high quality of renewable energy resources. In particular, the Broken Hill Solar Plant (53 MW) and the Silverton Wind Farm (200 MW) connected at Broken Hill in December 2015 and May 2017, respectively. More recently, new solar farms have been connected at Coleambally (150 MW) in November 2018, Griffith (29.9 MW) in April 2018 and Finley (133 MW) in late 2019.

Further connections are progressing with commissioning scheduled during 2020 for the Darlington Point Solar Farm (275 MW), Limondale 1 Solar Farm (220 MW), Sunraysia Solar Farm (200 MW) and Limondale 2 Solar Farm (29 MW).

In summary, there has been approximately 560 MW of renewable generation connect in this area since December 2015 with a further 800 MW to be connected by 2021.

2.2 Description of the 'identified need'

The power system in the NEM must be planned and operated to remain stable during an outage of any single transmission line. Schedule 5.1 of the National Electricity Rules (NER) sets out the default planning, design and operating criteria that must be applied by all TNSPs in operating their networks and includes minimum standards for network stability.

TransGrid's system studies have highlighted that the 132 kV system in south-western NSW can experience significant stability issues during an outage of Line 63, including thermal overloads and under-voltage. These are particularly likely during high power flows west from Wagga Wagga and are currently managed operationally through measures such as:

- power flow constraints;
- transfer tripping Line X5 for a trip of Line 63; and
- splitting 132kV parallels to Line 63 pre-contingency.

Power flows east towards Wagga Wagga have not been high enough to-date to cause stability issues during an outage of Line 63. Operational measures have therefore not been put in place to manage high easterly flows.

The commissioning of new generation in south-western NSW is expected to result in high power flows east towards Wagga Wagga from mid-2020. Under these conditions, the 132 kV system will experience even more significant stability issues during an outage of Line 63, including fast voltage collapse, thermal overloads and under-voltage. There is a particular risk of fast voltage collapse that would result in power electronics based renewable generation becoming unstable.

New measures are therefore required to maintain power system stability during high easterly power flows. Considering the very fast timeframe of voltage collapse, the only feasible operational solution identified in the short term is a pre-contingent constraint to limit power flows east from Darlington Point to Wagga Wagga.

Based on advice from TransGrid, on 8 May 2020, AEMO implemented a new system normal constraint in the NEMDE to limit power flows on Line 63. This constraint has been developed to minimise the risk of voltage collapse at Darlington Point and the constraint equation includes generators in south-western NSW and north-west Victoria as well as Murraylink.[6] The existing operational measures outlined above for when there are high power flows west are not able to be expanded to resolve the voltage collapse issues when there are high easterly flows.

The limit going forward for power flows east is expected to be approximately 300 MW, although it will vary slightly with power system conditions. Power flows east presently peak at approximately 200 MW and a further 724 MW of generation is due to be commissioned in south-western NSW over 2020. This will result in material constraints to some generators in the region.

TransGrid is therefore investigating alternate options for providing the requisite power system stability in south-western NSW and alleviating, or modifying, the existing constraints.

[6] https://aemo.com.au/market-notices/?marketNoticeQuery=&marketNoticeFacets=SYSTEM+RECONFIGURATION%2cCONSTRAINTS%2cINTER-REGIONAL+TRANSFER%2cPROTECTED+EVENT%2cLOR2+ACTUAL&MarketNoticeList=5

The identified need for this RIT-T is to increase overall net market benefits in the NEM through relieving existing and forecast constraints on generation connecting to the transmission network in south-western NSW. Initial assessment indicates that the market benefits from relieving these constraints are expected to exceed the cost of doing so.

2.3 Nearby network developments

There are two notable network developments expected in south-western NSW in coming years, namely:

- EnergyConnect, which will increase power transfer capability between South Australia, New South Wales, and Victoria by developing a new 330 kV interconnector from Robertstown in mid-north South Australia via Buronga and through to Wagga Wagga in New South Wales and includes an augmentation between Buronga in New South Wales and Red Cliffs in Victoria.
  - The draft 2020 AEMO Integrated System Plan (ISP) assumes that EnergyConnect is commissioned in 2023-24.[7]
- the Victoria to New South Wales Interconnector West (VNI West), which is a proposed longer-term investment to strengthen bi-directional interconnection between Victoria and New South Wales to deliver fuel cost savings, facilitate efficient connection of new renewable generation, and provide greater access to hydro energy storage plant in the Snowy Mountains.
  - The draft 2020 AEMO ISP assumes that VNI West is commissioned by 2026-27.[8]

While both of these network developments are expected to affect the development of generation in the area, they are not expected to affect the specific constraints this RIT-T is aiming to relieve. The market benefits expected from the options considered in this RIT-T are therefore expected to be incremental to both of these major network developments.

[7] AEMO, *Draft 2020 ISP*, 12 December 2019, p. 11.

[8] AEMO, *Draft 2020 ISP*, 12 December 2019, p. 11.

2.4 Assumptions underpinning the identified need

There is a direct relationship between the new generation expected to locate in south-western NSW and how severe the effects of the constraint AEMO has imposed are (and so the expected market benefits from relieving it). The extent and timing of this new generation is therefore a key assumption underlying the identified need.

Table 2-1 summarises the various new generation developments expected to connect in south-western NSW.

Table 2-1: Summary of new generation developments in south-western NSW

Development	Expected timing	Size (MW)
Darlington Point Solar Farm	Q3 2020	275
Limondale 1 Solar Farm	Registration effective 30/06/2020	220
Sunraysia Solar Farm	Q3 2020	200
Limondale 2 Solar Farm	Registration effective 24/12/2019	29
Hillston Solar Farm	2021	85
Riverina Solar Farm	2021	30
Additional submitted connection applications	2021-2022	475

More broadly, TransGrid is intending to model the market benefits of the credible options using wholesale market modelling in the PADR. The assumptions will be based on those used by AEMO in the forthcoming 2020 ISP and will 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. Section 6.3 below outlines how wholesale market modelling is intended to be applied for estimating the net market benefits of the credible options in the PADR.

TransGrid also plans to investigate a range of sensitivity tests on key assumptions in the PADR to further test the robustness of the preferred option to the underlying assumptions. These may be informed by submissions to this PSCR.

3. Options that meet the identified need

TransGrid has identified three 'types' of credible options that have the potential to meet the identified need from a technical, commercial, and project delivery perspective.

These options cover:

> a new or rebuilt transmission line between Darlington Point and the new Dinawan substation being constructed for EnergyConnect (Option 1A (new) and Option 1B (rebuilt));

> a new transmission line between Darlington Point and Wagga Wagga (Option 2); and

> a static synchronous compensator (STATCOM) solution (Option 3).

Table 3-1 below summarises each of the credible options.

Table 3-1: Summary of the credible options, $2019-20

Option	Description	Estimated capital cost	Expected delivery time
1A	Establish a new Darlington Point to Dinawan 330 kV transmission line	$145-225 million	4-5 years
1B	Rebuild the existing 99T Darlington Point to Coleambally and 99L Coleambally to Deniliquin as 330 kV to Dinawan	$180-280 million	4-5 years
2	Establish a new Wagga Wagga to Darlington Point 330 kV transmission line	$220-340 million	4-5 years
3	STATCOM	$30-50 million for a 100 MVar STATCOM	3-4 years

All options are assumed at this stage to have annual operating and maintenance costs equal to approximately one per cent of their capital costs. However, TransGrid is continuing to investigate these costs for each option and expects to report more detailed estimates in the PADR.

While TransGrid has provided indicative cost estimates for some of the network options above, more accurate figures will be developed as part of the PADR and may be informed by responses to this PSCR. In addition, while the network options include an indicative route for new lines, TransGrid intends to further investigate the routing of these options as part of the PADR.

The remainder of this section provides further detail on each of these options. It also outlines a further option that has been considered but not progressed (and the reasons why).

A a network diagram for each credible option has been included, which shows the existing network configuration (in black) with works and new elements for each option (in red).

Section 4 outlines the technical characteristics that a non-network option would need to provide in order to assist with meeting the identified need for this RIT-T.

While each of the options are expected to have an inter-regional impact through relieving the existing constraint and allowing more efficient generation in the NEM, the extent of this impact will be determined via the market modelling in the PADR.

3.1 Option 1A – New Darlington Point to Dinawan 330 kV transmission line

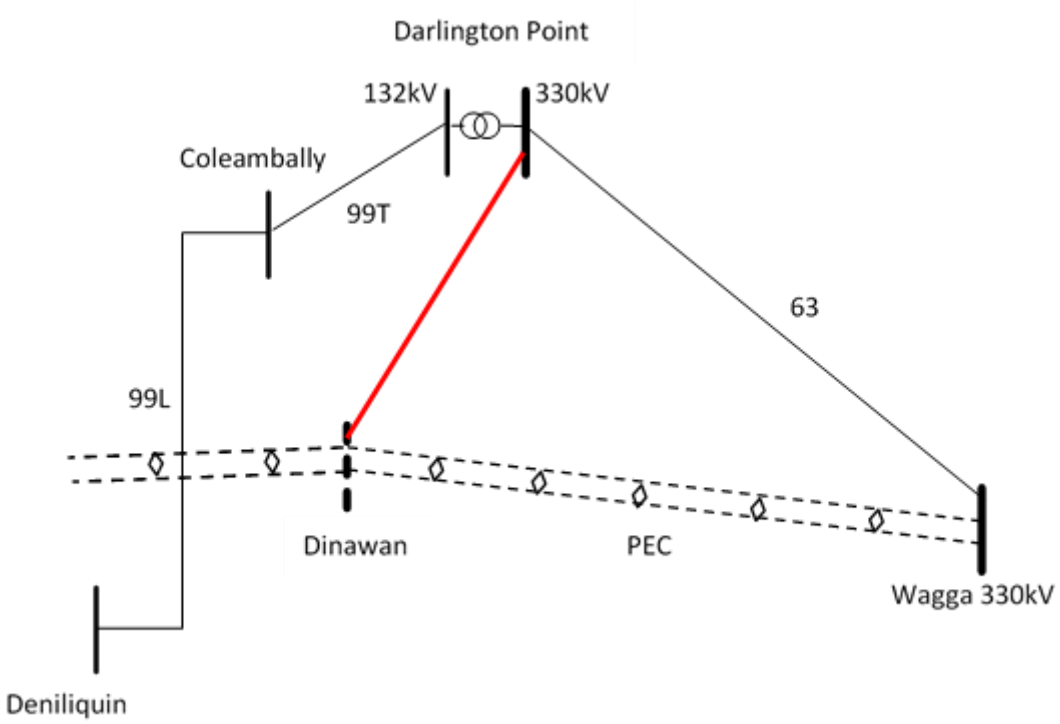
Option 1A involves the establishment of a greenfield transmission line between Darlington Point and the proposed Dinawan substation.

The high-level scope of this option includes:

> construct a single circuit 330 kV transmission line from Darlington Point to Dinawan (approximately 90 km); and
> install new 330 kV switchbays at Darlington Point and Dinawan substations.

Figure 3-1 provides a network diagram for Option 1A, which highlights the new network elements in red.

Figure 3-1: Option 1A network diagram



The estimated capital cost of Option 1A is $145-225 million. Delivery is expected to take 4-5 years, with commissioning possible in late 2024, subject to obtaining necessary environmental and development approvals.

3.2 Option 1B – New Darlington Point to Dinawan 330 kV transmission line

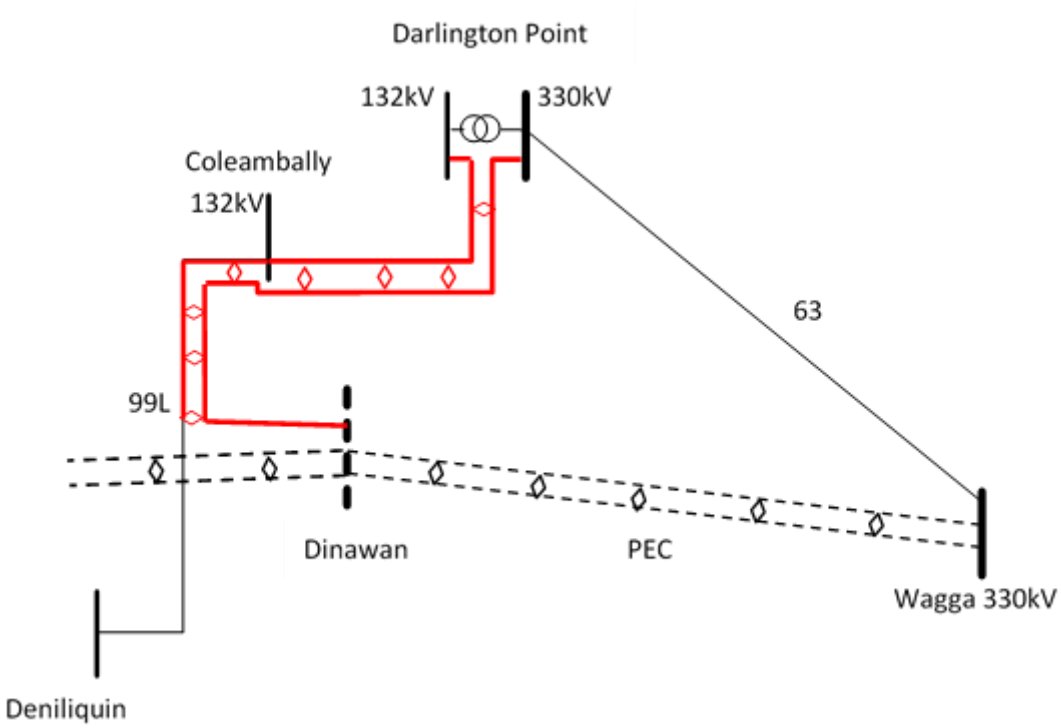
Option 1B involves the rebuild of existing 132 kV transmission lines to establish a 330 kV connection between Darlington Point and the proposed Dinawan substation.

The high-level scope of this option includes:

> rebuild the existing 99T Darlington Point to Coleambally 132 kV circuit as a 330 kV double circuit transmission line (approximately 13 km), with one side to be operated at 132 kV;
> rebuild a section of the existing 99L Coleambally to Deniliquin 132 kV circuit (from Coleambally to where it crosses the proposed EnergyConnect interconnector) as a 330 kV double circuit transmission line (approximately 40 km), with one side to be operated at 132 kV;
> build a new 330 kV single circuit from where the 99L line crosses the proposed EnergyConnect interconnector to the proposed Dinawan substation (approximately 35 km); and
> install new 330 kV switchbays at Darlington Point and Dinawan substations.

Figure 3-2 provides a network diagram for Option 1B, which highlights the new network elements in red.

Figure 3-2: Option 1B network diagram



The estimated capital cost of Option 1B is $180-280 million. Delivery is expected to take 4-5 years, with commissioning possible in late 2024, subject to obtaining necessary environmental and development approvals.

3.3 Option 2 – New Wagga Wagga to Darlington Point 330 kV transmission line

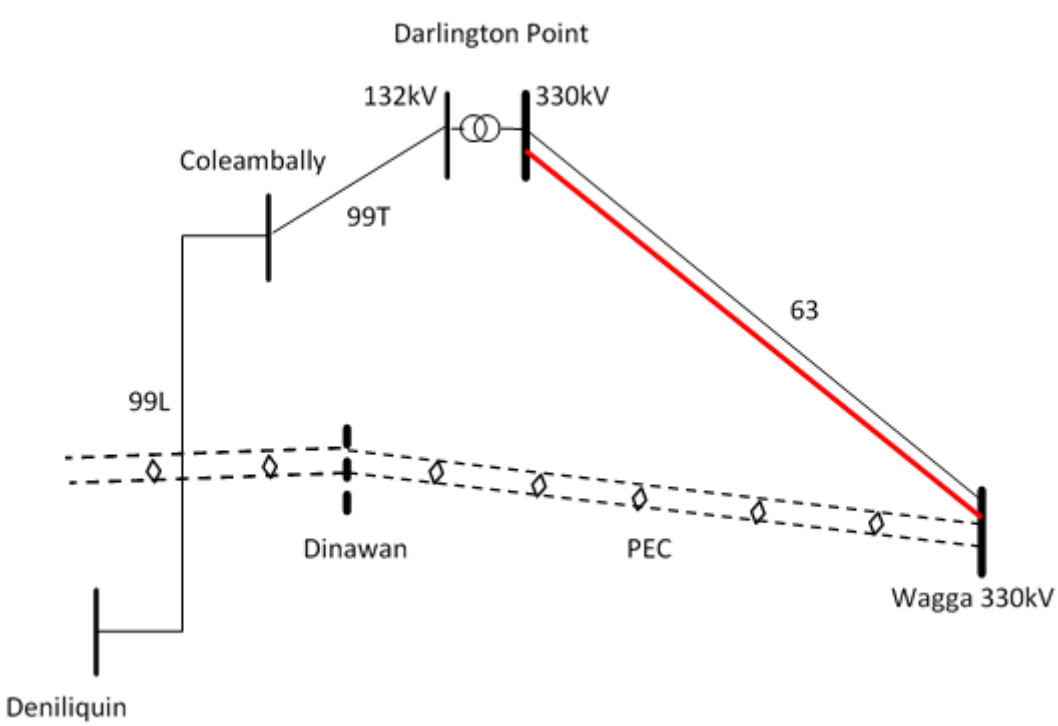
Option 2 involves the establishment of a new 330 kV single circuit transmission line between Wagga Wagga 330/132 kV substation and Darlington Point substation.

The high-level scope of this option includes:

- construct a single circuit 330 kV transmission line from Wagga Wagga to Darlington Point (approximately 150 km); and
- install new 330 kV switchbays at Wagga Wagga 330/132 kV substation and Darlington Point substation.

Figure 3-3 provides a network diagram for Option 2, which highlights the new network elements in red.

Figure 3-3: Option 2 network diagram



The estimated capital cost of Option 2 is $220-340 million. Delivery is expected to take 4-5 years, with commissioning possible in late 2024, subject to obtaining necessary environmental and development approvals.

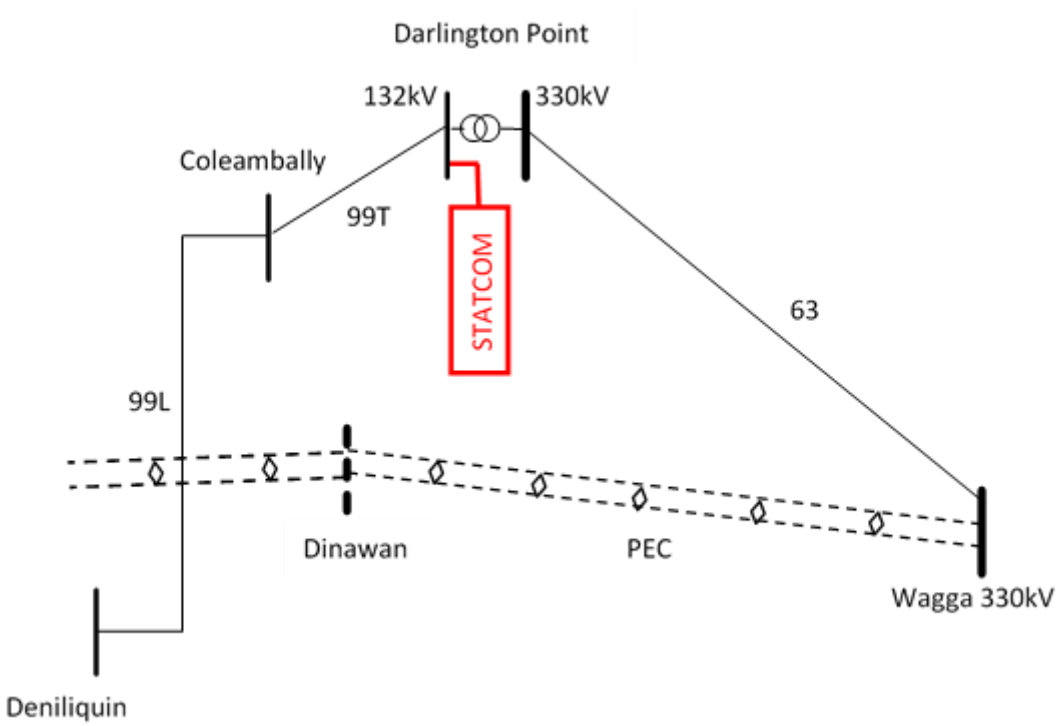
3.4 Option 3 – STATCOM

Option 3 involves the use of a STATCOM to assist in meeting the constraint.

At this stage, TransGrid considers that a STATCOM may not actually be able to fully alleviate the constraint but, instead, may enable the constraint to be modified to be less severe and thus still provide market benefits.

TransGrid is intending to undertake further analysis as part of the PADR, focussed on assessing the trade-off between different capacities for a STATCOM solution, their impact on the constraints and whether these options are economic.

Figure 3-4: Option 3 network diagram



3.5 Options considered but not progressed

TransGrid has also considered whether one other network option would meet the identified need. The reasons this option has not been progressed any further are summarised in Table 3-2.

Table 3-2: Options considered but not progressed

Option	Reason(s) for not progressing
Rebuild Line 63 as double circuit 330 kV transmission line	This option would be considerably more expensive than the other network options outlined above (due to it being double-circuit and also requiring significant demolition costs) and would require extended outage of Line 63 (which would exacerbate the effects of the generation constraints in the area). This option is therefore considered inferior to the credible network options outlined above and not commercially feasible under the RIT-T.
Synchronous condensers	Synchronous condensers are not considered able to respond fast enough to meet the identified need. They are therefore not considered technically feasible since they cannot meet the identified need.
Batteries	TransGrid considers that batteries would require coupling with a STATCOM and so would always be more expensive than a STATCOM solution like Option 3, without providing commensurately greater market benefits. A battery solution is therefore not considered commercially feasible under the RIT-T.

4. Non-network option information

This section describes the technical characteristics that a non-network option would be required to deliver in order to assist in addressing the identified need of relieving existing and forecast congestion on the transmission network in south-western NSW over the short and medium term.

In particular, we set out both:

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

Proponents of non-network options are encouraged to make submissions on any non-network option they believe can address, or contribute to, the identified need.

Proponents are encouraged to reach out and contact TransGrid as soon as practicable about potential solutions, ahead of preparing a formal submission. Overall, this process will best enable these options to be assessed alongside the network options in the PADR.

The final part of this section presents the form of information to be provided by non-network proponents looking to assist with relieving existing and forecast congestion on the transmission network in south-western NSW.

4.1 General information for non-network options

At a high-level, credible non-network options for assisting with relieving existing and forecast constraints on generation in south-western NSW need to either:

> provide estimated net market benefits in-line with those estimated for the credible network options; or
> be able to be coupled with a network option in order to increase its estimated net market benefit overall.

TransGrid notes that the key drivers of market benefits for the network options stem from alleviating constraints on renewable generation in south-western NSW. Within the context of the RIT-T assessment, greater output from renewable generation is expected to deliver market benefits primarily through:

> reductions in total dispatch costs (including fuel costs), by enabling low cost renewable generation to displace higher cost conventional generation; and
> reducing the need for new investment in generating plant, or a deferral of generation investment.

To achieve similar market benefits, non-network options would need to be able to mitigate the risk of fast voltage collapse for a Line 63 contingency. We consider this would need to be a fast acting control scheme to either:

> reduce generation to the west of Darlington Point; or
> reduce load to the east of Darlington Point.

Given the nature of the identified need, and the yet to be quantified estimated market benefits from relieving the existing constraint, as well as 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.

TransGrid is 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.

The sections below provide information to assist non-network proponents formulate responses to this PSCR.

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 mitigate the risk of fast voltage collapse for a Line 63 contingency.

In particular, TransGrid considers that the risk can be mitigated if, immediately following a Line 63 contingency, generation could be tripped west of Darlington Point and/or load could be tripped to the east of Darlington Point.

The tripped 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 that can be tripped without adverse consequences;
- loads that can be 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);
- energy storage, such as large-scale battery installations, could respond quickly in either direction:
  - the 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 how the service offered fits with other ancillary services that it may be providing (e.g. FCAS) during such contingencies.

The nature of the voltage stability limitations affecting the south-western NSW network call for a very rapid response, faster than 100 ms from the transmission fault commencing to the completion of tripping of participants. This would necessitate the use of dedicated fast and secure communications and would likely limit participants to those that are connected at a transmission level to a circuit equipped with fibre-optic ground wire. TransGrid consider that the required speed of this response may prove challenging for loads.

To facilitate and coordinate the response of multiple participants will require a Wide Area System Integrity Protection Scheme. This 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;
- on detection of a monitored contingency event, trip signals would be initiated requiring the agreed response; and
- the signal would be cleared once AEMO had re-secured the power system (which is required to be done 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 frequently since:

- historical fault rates are low;
- even when a fault occurs, power transfers on Line 63 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.

It is also possible that there are other generator control schemes that can respond in very fast timeframes that may allow an increase in the pre-contingent constraint on Line 63 to be applied. Such solutions could include the adoption of the Q(V) function for inverter control schemes that provides quick reactive power adjustment based on the inverter output voltage.

In order to evaluate the 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 to evaluate the practical and economic viability of such a scheme and inform how to progress the concept in the PADR.

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

Table 4-1 sets out the indicative parameters that we request parties to nominate in any response to this PSCR.

TransGrid notes that a formal tender for non-network solutions is not being initiated at this stage. However, proponents of potential non-network solutions are strongly encouraged to make a submission to this PSCR and to get in contact with TransGrid as soon as possible, as any non-network solutions considered potential options 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.

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

Table 4-1: Indicative parameters that non-network proponents should provide

	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

	Parameter
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

5. 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.

The PSCR is 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 the RIT-T have the potential to be material with the exception of changes in ancillary services costs, option value and competition benefits. That is, TransGrid expects the following six categories to be material for this RIT-T and thus be estimated in the wholesale market modelling exercise as part of the PADR:

- changes in fuel consumption arising through different patterns of generation dispatch;
- changes in price-responsive voluntary load curtailment;
- changes in involuntary load shedding;
- changes in costs for parties, other than for TransGrid, due to differences in the timing of new plant, capital costs and operating and maintenance costs;
- differences in the timing of expenditure; and
- changes in network losses.

A discussion of the three categories of market benefit TransGrid considers are not material for this RIT-T assessment is provided in the section below.

5.1 Changes in ancillary service costs

While the cost of Frequency Control Ancillary Services (FCAS) may change as a result of changed generation dispatch patterns and changed generation development following removal, or modification, of the existing constraint in south-western NSW, TransGrid consider that FCAS costs are relatively small compared to the total market benefits. It is therefore considered that changes in the cost of FCAS are not likely to be materially different between options and are 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 considered material to the outcome of the RIT-T assessment.

While ancillary service costs make up a relatively small proportion of total energy supply costs currently, this may not be the case going forward as renewable penetration in the NEM increases. However, TransGrid note that there is a large degree of uncertainty around how this may develop and do not consider that any increase in ancillary services costs will be different between the credible options considered.

5.2 Option value

TransGrid notes that option value is likely to arise in a RIT-T assessment where there is uncertainty regarding future outcomes, the information that is available is likely to change in the future, and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[9]

[9] This is consistent with the AER's view, see: AER, Regulatory Investment Test for Transmission Application Guidelines, December 2018, available at: https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%2014%20December%202018_0.pdf

The credible options outlined in this PSCR do not exhibit flexibility in terms of how they can be developed. TransGrid does not therefore consider at this stage that option value to be a material category of market benefit for this RIT-T.

Additionally, a significant modelling assessment would be required to estimate any option value benefit and it is currently considered disproportionate to any potential additional benefits for this RIT-T.

5.3 Competition benefits

Competition benefits under the RIT-T relate to net changes in market benefits arising from the impact of the credible option on the bidding behaviour of market participants in the wholesale market.

While each of the credible options considered are designed to address network constraints between competing generating centres, TransGrid consider that competition benefits are unlikely to be material and do not intend to estimate them as part of this RIT-T. This is due to all options being expected to have a similar effect on the wholesale market through relieving the existing constraint in south-western NSW, as well as the relatively minor impact this is expected to have on wholesale electricity prices in the NEM.

In addition, the calculation of competition benefits requires substantial additional market modelling. TransGrid consider that this modelling exercise would be disproportionate to any competition benefits that may be identified for this specific RIT-T assessment, particularly the difference between options in terms of competition benefits.

6. Overview of the assessment approach

This section outlines the approach that TransGrid is proposing to apply in assessing the net benefits associated with each of the credible options.

6.1 Assessment period and discount rate

The RIT-T will consider a 25-year period, from 2020/21 to 2044/45. TransGrid considers that this takes into account the size, complexity and expected lives of the options and provide a reasonable indication of the costs and benefits over a long outlook period.

Since the capital components have asset lives greater than 25 years, TransGrid will take a terminal value approach to ensure that the capital costs of long-lived assets are appropriately captured in the assessment period.

TransGrid will adopt a central real, pre-tax 'commercial'[10] discount rate of 5.9 per cent as the central assumption for the NPV analysis presented in this report. TransGrid considers that this is a reasonable contemporary approximation of a commercial discount rate, consistent with the RIT-T.

TransGrid will also test the sensitivity of the results to discount rate assumptions. A lower bound real, pre-tax discount rate of 2.23 per cent equal to the latest AER Final Decision for a TNSP's regulatory proposal at the time of preparing this PSCR,[11] and an upper bound discount rate of 9.57 per cent (a symmetrical adjustment upwards) will be investigated.

6.2 Approach to estimating project costs

TransGrid's initial cost estimates presented in this PSCR have been at a high level based on experience from previous projects involving similar options or based on publicly available information.

It is intended that cost estimates will be further refined in the PADR stage and this process may be informed by responses to the PSCR. TransGrid's objective is to achieve costs that are estimated to be within +/- 25 per cent of the actual cost as part of the PADR.

6.3 The wholesale market modelling will be based on the 2020 ISP assumptions

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.

TransGrid is intending to model the market benefits of the credible options across three 'core' scenarios using wholesale market modelling. These scenarios will be based on those used by AEMO in the forthcoming 2020 ISP and will 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.

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

[11] See Directlink's Post-tax Revenue Model (PTRM) for the 2020-25 period, available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/directlink-determination-2020-25

Appendix A – Compliance checklist

This appendix sets out a compliance checklist which demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the Rules version 143.

Rules clause	Summary of requirements	Relevant section(s) in 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);	2.4
	(3) the technical characteristics of the identified need that a non- network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	4
	(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent National Transmission Network Development Plan;	NA
	(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alterative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3 & 4
	(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, 4 & 5