Victoria to New South Wales Interconnector Upgrade

November 2018

Regulatory Investment Test for Transmission Project Specification Consultation Report

Important notice

PURPOSE

AEMO and TransGrid have prepared this document to provide information about network limitations and potential options to address these limitations, as at the date of publication, in accordance with clause 5.16 of the National Electricity Rules.

DISCLAIMER

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Executive summary

The Regulatory Investment Test for Transmission (RIT-T) is an economic cost-benefit test used to assess and rank different electricity transmission investment options that address an identified need. Its purpose is to identify the investment option which maximises the present value of net economic benefit to all those who produce, consume, and transport electricity in the market.

AEMO's 2018 Integrated System Plan (ISP) recommended several investments in transmission which should be undertaken and completed as soon as practicable (called "group 1 developments")[1]. These recommendations included investment to increase Victorian transfer capacity to New South Wales, to capture positive net market benefits through more efficient sharing of generation resources between states. This stronger interconnection will also help improve the reliability and resilience of the power system.

This ISP recommendation aligns with the conclusions of the 2018 Victorian Annual Planning Report (VAPR)[2] and the 2018 TransGrid Annual Planning Report (TAPR)[3].

The identified need considered by this RIT-T is to alleviate current and projected limitations on power transfer capacity from Victoria to New South Wales, caused by both thermal and stability limitations. These limitations result in market costs through less efficient sharing of generation resources between states.

AEMO and TransGrid are undertaking this joint RIT-T to assess network and non-network options that are considered technically and commercially feasible to address the identified need. From the credible options, the RIT-T process will select a preferred option and its optimal timing. Several feasible options may also provide market benefits beyond the identified need, such as increased system strength, voltage support, or the ability to optimise fuel costs over time with storage devices. These market benefits will also be considered in this RIT-T.

This Project Specification Consultation Report (PSCR) is the first stage of the RIT-T process, and includes:

1. A description of the identified need.
2. A description of the network options being considered to meet the identified need.
3. The technical characteristics that a non-network option would need to address the identified need.
4. Specific categories of market benefit and their applicability to this RIT-T.

Next steps

The second stage of the RIT-T process is a full options analysis, followed by publication of a Project Assessment Draft Report (PADR) in accordance with clause 5.16.4 of the National Electricity Rules (NER).

Submissions

AEMO and TransGrid welcome written submissions on this PSCR, particularly in relation to the credible network and non-network options presented, and other issues addressed in this report.

Submissions should be emailed to Planning@aemo.com.au and are due on or before 15 February 2019.

Submissions will be published on the AEMO and TransGrid websites. If you do not want your submission to be publicly available, please clearly stipulate this at the time of lodgement.

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[1] Section 6.3.1 of AEMO's 2018 ISP, available at http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf.

[2] Section 3.8 of AEMO's 2018 VAPR, available at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/VAPR/2018/2018-Victorian-Annual-Planning-Report.pdf.

[3] Section 2.1.3 of TransGrid's 2018 TAPR, available at https://www.transgrid.com.au/news-views/publications/Documents/Transmission%20Annual%20Planning%20Report%202018%20TransGrid.pdf.

Contents

1. Introduction

This Project Specification Consultation Report (PSCR) has been prepared in accordance with the requirements of clause 5.16.4 of the National Electricity Rules (NER), for a Regulatory Investment Test for Transmission (RIT-T).

In line with these requirements, this PSCR describes:

1. The identified need that is being addressed, and the assumptions used in identifying the need.
2. The technical characteristics that a non-network option would be required to deliver to meet the identified need.
3. All credible options that AEMO and TransGrid consider can reasonably address the identified need.
4. The classes of market benefit that are likely not to be material.

The next stage of the RIT-T process is a full option analysis , followed by publication of a Project Assessment Draft Report (PADR), in accordance with the requirements of clause 5.16.4 of the NER.

The PADR will include information on which credible option returns the highest net market benefit, details on its technical characteristics, estimated commissioning date, and analysis showing that the preferred option satisfies the RIT-T.

2. Identified need

2.1 Background

The power system is undergoing a transformational change, with an unprecedented increase in renewable generation, changes in consumption patterns, and the withdrawal of several existing conventional generation sources across the National Electricity Market (NEM). These changes, coupled with the intermittent nature of the renewable generation, will likely necessitate increased utilisation of gas-powered generation (GPG), or additional interconnector capacity to enable more efficient sharing of generation resources between states.

AEMO's 2018 Integrated System Plan (ISP) recommended several investments in transmission which should be undertaken and completed as soon as practicable (called "group 1 developments"). These developments included investment to increase Victorian transfer capability to New South Wales by approximately 170 megawatts (MW), as this could capture positive net market benefits through more efficient sharing of generation resources between states to meet the identified need. This stronger interconnection will also help improve the reliability and resilience of the power system. From the credible options, the RIT-T process will select a preferred option and its optimal timing.

As recommended by the ISP, AEMO and TransGrid are undertaking this RIT-T to assess network and non-network options that are considered technically and economically feasible to increase Victorian transfer capacity to New South Wales. Consistent with the ISP, VNI options that can be implemented quickly, and at modest cost, are likely to deliver the highest net market benefits when cooptimised with other network augmentation across the NEM. However, several larger and longer term options are also feasible and will be tested as required by the current RIT-T process.

From the credible options, the RIT-T will identify the preferred option and its optimal timing for implementation.

2.2 Description of the identified need

The identified need considered by this RIT-T is to alleviate current and projected limitations on power transfer capacity from Victoria to New South Wales. These limitations result in market costs through less efficient sharing of generation resources between states.

In the Victorian transmission network, the identified need arises due to the transfer capability to New South Wales being currently limited by:

- Thermal capacity of the 500/330 kilovolt (kV) transformer at South Morang.
- Thermal capacity of the 330 kV transmission circuits between South Morang and Dederang.
- A transient stability limitation on transfers to provide for the potential loss of a Hazelwood to South Morang line.

In addition, there is also a new voltage stability limitation which can restrict transfers from Victoria to New South Wales. This limitation was identified after the publication of the 2018 ISP and VAPR, and its market impact will be investigated through the next stage of the RIT-T process.

In the New South Wales transmission network, output from existing and new generation assets in southern New South Wales will compete with imports from Victoria for access to the transmission capacity between Snowy and Sydney. The identified need arises due to the following key limiting element:

- Thermal capacity of the 330 kV transmission circuit between Canberra and Upper Tumut.

In addition, this RIT-T will consider other transmission lines in the New South Wales transmission network between Snowy and Sydney which can also be a limitation, depending on the generation profiles in southern New South Wales.

2.3 Classes of market benefit relevant to the RIT-T

The purpose of a RIT-T is to identify an option that addresses the identified need and maximises the present value of the net economic benefit to all those who produce, consume, and transport electricity in the market[4].

To satisfy the RIT-T, there must be positive net market benefits associated with implementing the preferred option. Several feasible options may also provide market benefits beyond the identified need, such as increased system strength, voltage support, or the ability to optimise fuel costs over time with storage devices. These market benefits will also be considered in this RIT-T.

The classes of market benefits considered most relevant to this RIT-T are:

- Reduced variable operating costs.
  - Increasing transfer capacity is expected to promote more efficient sharing of generation resources between states. This represents an increase in productive efficiency, through better utilisation of low-cost fuel sources, and reductions in variable operating and maintenance costs.
  - In addition, some option components (such as storage devices), may also allow inter-temporal optimisation between times where fuel costs are high and other times where fuel costs are low.
- Reduced investment costs to other parties due to better utilisation of existing plant.
  - Increasing the transfer capacity will allow more efficient sharing of generation resources between states, which may avoid (or defer) the need for new investment to maintain the same level of reliability.

[4] Refer to Clause 5.16.1 (b) of the NER.

  - In addition, some option components (such as synchronous condensers) can provide voltage control and system strength services, which reduce the need for investments by other parties.
- Reduced investment costs in other transmission assets or services.
  - The implementation of options that increase transfer capacity from Victoria to New South Wales may also relieve other transmission network limitations, and therefore defer other transmission investments.
- Reduced voluntary load curtailment and involuntary load shedding.
  - Increasing transfer capacity will improve the availability of supply at times of high demand in New South Wales and therefore help meet reliability requirements. This is expected to reduce voluntary load curtailment and involuntary load shedding.
- Others.
  - Greater interconnection will improve the power system's resilience to manage non-credible contingencies, changing operating patterns, and other possible market changes (such as early withdrawal of existing generating units). Such high-impact, low probability events can carry significant cost implications directly, or occur without sufficient notice to allow efficient and timely corrective action.

3. Assumptions made in identifying the need

The ISP recommended increasing transfer capacity from Victoria to New South Wales as soon as practical, to capture net market benefits through more efficient sharing of generation resources between states. This recommendation was based on extensive market modelling of possible future scenarios, and allowed for co-optimised investment in generation and network assets across the NEM over a 20-year period.

This section provides a high-level summary of the key assumptions used in ISP market modelling. Chapter 2 and Appendix F of the ISP[5], as well as the associated ISP Assumptions Workbook[6], provide more information on the modelling and assumptions used.

3.1 Scenarios and policy inputs

The ISP modelled seven scenarios/sensitivities, as described in Section 2.7 of the ISP report. These scenarios included two base cases (Neutral, and Neutral with storage initiatives[7]), three additional economic scenarios (Slow change, Fast change, and High penetration of distributed energy resources), and two sensitivities to explore key issues (Increased role for gas, and Early exit of coal-fired generation).

The ISP modelled all policies considered committed, including the Commonwealth Government's policy on emissions reductions, and the Victorian and Queensland Governments' renewable energy policies[8].

[5] AEMO, Integrated System Plan, available at http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/ISP/2018/Integrated-System-Plan-2018_final.pdf.

[6] AEMO, Integrated System Plan Assumptions Workbook, available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-andforecasting/Integrated-System-Plan.

[7] Because the Snowy 2.0 and Tasmanian Battery of the Nation projects had not met the commitment criteria, these projects were modelled separately in the Neutral with storage initiatives base case scenario.

[8] See sections 2.3.1 and 2.7 of the ISP for more information on the policy inputs used in the modelling.

3.2 Consumption forecast

Underlying demand for power is projected to increase, due to population and economic growth. However, much of this growth is forecast to be met by distributed energy resources (DER), such as rooftop photovoltaic (PV), and energy efficiency measures.

As a result, demand for grid-supplied energy is projected to remain relatively flat over the ISP outlook period, and load growth is not the primary driver of the identified need in this RIT-T.

3.3 Projected generation and transmission development

The 2018 ISP developed generation expansion (and withdrawal) plans for each scenario based on modelling which minimised the overall system costs while meeting consumer demand.

The modelling also considered a wide range of potential upgrades to the national transmission grid, including intra-regional developments to connect renewable energy zones (REZs), and inter-regional developments to facilitate resource sharing and reliability. As a result, the modelling identified that increasing the export capability from Victoria to New South Wales is likely to be a source of positive market benefits from 2020.

Refer to Section 2.4 and Chapter 3 of the ISP for more information on anticipated coal-fired generation retirements, the future energy resource mix, and projected REZs. Refer to Chapter 4 of the ISP for information on the full set of recommended transmission development options and their indicative timings.

4. Credible options to address the need

4.1 Description of possible credible network options

As described in Section 2.2, there are four key limitations to be addressed through this RIT-T. AEMO and TransGrid are considering options to address each of these limitations as described below:

- To provide additional thermal capacity to the existing 500/330 kV transformation at South Morang:
  - Additional 500/330 kV transformer(s) in parallel with the existing South Morang F2 transformer.
  - Replacing the existing South Morang F2 transformer with a transformer with higher capacity.
- To provide additional thermal capacity to the existing 330 kV circuits from South Morang to Dederang:
  - Uprating the South Morang – Dederang 330 kV lines by conductor re-tensioning and associated works (including uprating of series capacitors) to allow the line to run to thermal rating.
  - Additional 330 kV circuit(s) in parallel with the existing 330 kV South Morang – Dederang lines.
  - Replacing the existing 330 kV South Morang – Dederang lines with higher capacity conductors.
- To improve stability:
  - Installing a braking resistor at a selected location[9].
  - Installing dynamic reactive plant (FACT device), at selected locations, including batteries, Static Var Compensation (SVC), STACOM, synchronous condensers, and any other equivalents.

[9] Possible options include Hazelwood, South Morang, and Dederang, with the exact location to be confirmed in the PADR.

  - Installing fast-acting protection relays and circuit breakers to allow fast protection clearance times.
- To provide additional thermal capacity between Snowy and Sydney:
  - Uprating the existing Canberra – Upper Tumut 330 kV line.
  - Uprating the existing 330 kV lines between Snowy and Sydney (and Canberra – Upper Tumut).
  - Additional 500 kV single circuit line between Snowy and Bannaby, bringing forward part of a Group 2 project in the ISP. This is an alternative to uprating existing 330 kV lines between Snowy and Sydney.

4.2 Credible network options and cost estimates

Due to the number of possible combined permutations of the options listed in Section 4.1, it is impractical and ineffective to consider all combinations in detail. As such, it is proposed that the RIT-T will consider those combinations of network options which are considered to be credible in terms of the criteria in clause 5.15.2 of the NER (with respect to, among other things, cost and timing).

Three primary options are being considered, with several additional sensitivity variants for each. Option 1 is consistent with the scope of augmentation recommended by the ISP. It represents a near-term and modest cost option with the potential to capture market benefits from as early as 2022. Option 2 and Option 3 represent larger options, which are also capable of meeting the identified need, however may need to deliver significant additional benefits to cover their higher costs and longer lead times.

Cost estimates (±50%) and typical component lead times are presented in the tables below. These cost estimates may differ from the ISP, VAPR, and TransGrid Annual Planning Report (TAPR) cost estimates, because they have been refined and developed using the latest available information. These cost estimates, including further detail such as operation and maintenance costs, construction and commissioning timelines, and additional site-specific requirements, will be further refined through the PADR stage of the RIT-T.

Option 1 – ISP base case

	Description	Estimated cost ($M)	Estimated lead time (months)
1	Installation of a new 500/330 kV transformer at South Morang	29	36
	Re-tensioning the South Morang – Dederang 330 kV lines and associated works (including uprating of series capacitors) to allow the line to run to thermal rating	17	30
	Installation of a braking resistor *	13	24
	Uprating of the Canberra – Upper Tumut 330 kV line	28	27
Total		87	

* Three alternative stability variations are being considered in Option 1, as outlined below.

	Description	Estimated cost ($M)	Estimated lead time (months)
1a	Installation of a synchronous condenser with inertia support *	20	30
1b	Installation of SVC *	19	30
1c	Installation of batteries with fast response inverters	TBA **	24

* This is an average cost and will be reviewed and updated as part of the PADR stage.
** The cost of battery technology is heavily dependent on technical characteristics and will be investigated through the PADR.

Option 2 – Additional higher capacity upgrades in New South Wales

	Description	Estimated cost ($M)	Estimated lead time (months)
2	Installation of a new 500/330 kV transformer at South Morang	29	36
	Re-tensioning the South Morang – Dederang 330 kV lines and associated works (including uprating of series capacitors) to allow the line to run to thermal rating	17	30

	Description	Estimated cost ($M)	Estimated lead time (months)
	Installation of a braking resistor (or preferred option to address stability limitation)	13	24
	Uprating of the Canberra – Upper Tumut 330 kV line	28	27
	Uprating selected existing 330 kV lines between Snowy and Sydney (in addition to the Canberra – Upper Tumut 330 kV line) *	36-112 **	44-63 ***
Total		123-199	

* This option is being considered with a 500 kV variant as outlined below.
** The cost will depend on the number of lines considered for uprating.
*** This is a high-level lead time estimate. The construction components would need to be staggered due to outage constraints, which will be further reviewed and updated as part of the PADR stage.

	Description	Estimated cost ($M)	Estimated lead time (months)
2a	Bring forward a new 500 kV single circuit line between Snowy and Bannaby * (part of a Group 2 Project in the ISP)	520	47

* Significant outages may be required to uprate the existing 330 kV lines between Snowy and Sydney, potentially incurring an associated market cost. As such, sensitivity studies will be performed to investigate the net benefits of a new greenfield 500 kV line as an alternative with a lower outage impact.

Option 3 – Additional higher capacity upgrades in Victoria and NSW

	Description	Estimated cost ($M)	Estimated lead time (months)
3	Installation of a new 500/330 kV transformer at South Morang	29	36
	Replace the existing South Morang – Dederang 330 kV lines with higher capacity conductors and associated work (including uprating of series capacitors) to allow the line to run to thermal rating.	TBA *	
	Installation of a braking resistor (or preferred option to address stability limitation)	13	24
	Uprating of the Canberra – Upper Tumut 330 kV line	28	27
	Uprating selected existing 330 kV lines between Snowy and Sydney (in addition to the Canberra – Upper Tumut 330 kV line) **	36-112 ***	44-63 ****
Total			

* Note that the cost and timing is heavily dependent on associated works and will be investigated through the PADR.
** Note that this option is being considered with 330 kV and 500 kV variants as outlined below.
*** The cost will depend on the number of lines considered for uprating.
**** This is a high-level lead time estimate. The construction components would need to be staggered due to outage constraints, which will be further reviewed and updated as part of the PADR stage.

	Description	Estimated cost ($M)	Estimated lead time (months)
3a	Bring forward a new 500 kV single circuit line between Snowy and Bannaby * (part of a Group 2 Project in the ISP)	520	47
3b	New single circuit line (with series compensation) in parallel with the existing South Morang – Dederang 330 kV lines	370	60

* Significant outages may be required to uprate the existing 330 kV lines between Snowy and Sydney, potentially incurring an associated market cost. As such, sensitivity studies will be performed to investigate the net benefits of a new greenfield 500 kV line as an alternative with a lower outage impact.

4.3 Non-network options

Non-network options may be available to address or partially address the identified limitations. For example, the use of an automatic load, generation, and/or battery response could minimise the impact of thermal limitations by allowing for the use of short-term five-minute ratings.

In Victoria, this could take the form of a combined demand and generation/battery response with adequate demand response located north of Dederang and a generation or battery response located south of South Morang. Such demand and generation/battery responses would need to work in combination to reduce loading on the South Morang – Dederang 330 kV line.

In New South Wales, a combination of demand and generation/battery response could prevent post-contingent thermal overloads on the lines from Snowy to Sydney. Adequate demand response would need to be located in Sydney or north of Sydney, with generation/battery response located near Snowy. The demand and generation/battery responses would need to work in combination to reduce loading on the lines from Snowy to Sydney.

In addition, a battery-based solution could help to address stability limitations in Northern Victoria. To be effective, such batteries would likely require inverters capable of a fast response (less than 200-300 milliseconds).

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

The above is not an exhaustive list of potential non-network services. AEMO and TransGrid would welcome potential non-market service providers making submissions on potential non-network options they believe can address the identified need outlined in this PSCR.

Submissions should include details on:

- Organisational information.
- Relevant experience.
- Technical details of the service.
- Cost of service, separating capital and operational expenditure.
- Confirmation of timelines in providing the service.

5. Materiality of benefits

The NER require that the categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the transmission network service provider (TNSP) can demonstrate that:

- A specific class of market benefit is unlikely to affect materially the outcome of the RIT-T assessment of the credible options; or
- The estimated cost of undertaking the analysis to quantify that market benefit is likely to be disproportionate to the "scale, size and potential benefits of each credible option being considered in the report".

The following classes of market benefits are not considered to be material to this RIT-T assessment:

- Changes in ancillary services costs.
  - There is no expected change to the costs of frequency control ancillary services (FCAS), network support and control ancillary services (NSCAS), and system restart ancillary services (SRAS) as a result of the augmentation options being considered. These costs are therefore not expected to be material to the outcome of the RIT-T assessment.
- Competition benefits.

  - While increasing the ability for resource sharing between states is likely to increase competition and therefore provide a competition benefit, the estimated cost of the modelling and analysis to estimate this benefit is considered to be disproportionate to the size of the potential benefit itself.
- Option value.
  - For this RIT-T, estimating any option value benefit over and above that already captured via the scenario analysis and ISP modelling would require a disproportionate level of investigation having regard to the cost of the analysis and the potential benefits. As such, additional option value market benefit estimates are not proposed as part of this RIT-T assessment.