

Summary: Meeting system strength requirements in NSW

RIT-T Project Assessment Draft Report (PADR)

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Summary

Transgrid is responsible for ensuring sufficient system strength services are available to maintain the stability of the NSW power system. This Project Assessment Draft Report (PADR) represents the second step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for meeting system strength requirements in New South Wales.

Identified need: meeting system strength requirements in NSW

Transgrid is responsible for ensuring sufficient system strength services are available to maintain the stability of the NSW power system. We are applying the Regulatory Investment Test for Transmission (RIT-T) to options that meet our National Electricity Rule (NER) obligations, specifically:

1. Clause 11.143.15 to address a system strength Shortfall in the transmission network at Newcastle and Sydney West, forecasted to arise from 1 July 2025 and continue until 1 December 2025; and
2. Clause S5.1.14 to deliver system strength services to the NSW power system to meet standards set by AEMO from 2 December 2025, including for the safe and secure operation of the power system (minimum level) and to facilitate the stable voltage waveform ('efficient' level) of new inverter-based resources (IBRs).

This RIT-T examines non-network and network options to ensure compliance with system strength requirements in the National Electricity Rules (NER) and to maximise the present value of net economic benefit to the National Electricity Market (NEM) and ultimately to the consumers.

The PADR has benefited from stakeholder submissions

Publication of this PADR is the second step in the RIT-T process. It follows publication of the Project Specification Consultation Report (PSCR) on 16 December 2022, which received five submissions. In addition, Transgrid's Expression of Interest (EOI) process resulted in non-network option submissions from 25 parties, covering over 60 individual potential technology solutions. Transgrid also developed 40 unique network solutions to meet the need.

Our approach to identifying the preferred 'portfolio of solutions'

While it is common for RIT-Ts to identify a 'preferred option' (i.e., singular) to meet the need, the scale and complex nature of NSW's system strength requirements necessitated a preferred 'portfolio of solutions'. This was because:

- the need for system strength must be co-optimised across six system strength 'nodes' in NSW and at the connection points of all future IBRs;
- no single solution can meet the need – in fact, dozens of solutions across NSW will be required at any one time;
- we assessed over 60 individual non-network solutions and 40 unique network solutions to meet the need – resulting in billions of combinations of possible solutions; and
- the system strength contribution of each asset to each system strength node (and points of IBR connections) is dynamic and non-linear, changing at any one time depending on the combination of solutions online and the impedance of the network.

Our methodology integrates system strength constraints into market modelling software (PLEXOS) and uses its Long-Term capacity expansion capabilities to optimise and trade-off the deployment of new build options that provide system strength, with a change in the operating patterns for existing synchronous machines. The process finds the optimal ‘portfolio of solutions’ which maximise net market benefits while meeting system strength requirements. It does this in a similar way to what AEMO does in its ISP, to identify the optimal timing and mix of generation assets, storage and transmission.

In addition, in order to tune system strength ‘coefficients’ used within PLEXOS, and to validate that the output of PLEXOS’ portfolio optimisation met the power system’s needs, PLEXOS results were automatically analysed within PSS@E, with a full network topology including geographically dispersed IBR locations. This process meant tens of thousands of power system modelling simulations occurred to validate the portfolios of solutions.

Four portfolios of solutions have been developed and assessed in this PADR

The four portfolio options developed can be summarised as follows:

- **Portfolio option 1:** synchronous condensers able to be commissioned in 2028/29; and
- **Portfolio option 2:** synchronous condensers able to be commissioned a year earlier in 2027/28 (i.e., ‘accelerated’); and
- **Portfolio option 3:** portfolio option 1 assumptions plus the confidential proposal *is* assumed to be technically feasible; and
- **Portfolio option 4:** portfolio option 1 assumptions but with the addition of a restriction on the number of gas units we can contract with.

At this stage, only portfolio option 1 and portfolio option 4 are considered credible options. This is because our current best available information suggests that:

- the earliest timing that synchronous condensers could be commissioned is in 2028/29. Acceleration (to 2027/28) is expected to only be feasible if we commence procurement of synchronous condensers prior to the conclusion of the RIT-T and AER’s approval of a contingent project application (CPA);
- the technical feasibility of a confidential proposal to provide synchronous condenser services in the vicinity of Newcastle and Sydney West has not yet been demonstrated by the project proponent.

However, insights from our market modelling show that if these two options were proven to be feasible, there would be significant additional benefits for consumers. As such, we will work over the course of this RIT-T to clarify and resolve the uncertainties associated with the possible acceleration of synchronous condensers and the technical feasibility of the confidential proposal.

Composition of the four portfolio options

Portfolio option 1 is made-up of:

- fourteen synchronous condensers required by the end of the next regulatory period (2032/33), with eight of these required by 2028/29;
- modifications to synchronous hydro generators and the addition of clutches to the Broken Hill compressed air energy storage facility in order to facilitate system strength provision even when the units are not generating, pumping or compressing, in total contributing over 550 MW of generation assets;

- re-dispatching¹ a range of existing hydro generators to ensure they can switch on or operate in synchronous condenser mode where necessary to fill gaps in system strength, as well as a smaller number of gas and black coal units also being re-dispatched; and
- 4.8 GW of new build grid-forming BESS by 2032/33, comprising primarily of upgrading committed and anticipated grid-following BESS with grid-forming capability and ISP 'modelled' BESS included in AEMO's IBR forecasts also upgrading to grid-forming capability.

Under portfolio option 1, our modelling results show that there are gaps in system strength that cannot be filled in 2027/28. These gaps occur at or surrounding Armidale, Wellington, Newcastle, Sydney West and Darlington Point nodes during times when there are low numbers of synchronous machines online due to synchronous generator maintenance or outages (occurring for up to 3% of time in the year).

Portfolio options 2 – 4

All portfolio options contain a blend of non-network (e.g. coal, hydro, gas, grid-forming batteries) and network (e.g. synchronous condensers) system strength solutions. Portfolio options 2 to 4 represent variations on portfolio option 1, as a result of varying a key assumption within the portfolio optimisation process.

The table below compares the composition of portfolio options 2 to 4, compared to portfolio option 1.

Table 1 – Composition of portfolio options 2-4, compared to portfolio option 1

Option component	Portfolio option 2 – synchronous condensers in 2027/28	Portfolio option 3 – confidential proposal assumed to be technically feasible	Portfolio option 4 – restricting the number of gas units
Synchronous condensers	Brings forward five synchronous condensers by one year, from 2028/29 to 2027/28. Identical build path of synchronous condensers from 2028/29 onwards (14 required by 2032/33).	Requires four less synchronous condensers by 2032/33. No synchronous condensers required at Sydney West and Newcastle, as well as deferred requirements for synchronous condensers at Tamworth, and within the New England REZ and the CWO REZ.	Brings forward two synchronous condensers by one year, from 2029/30 to 2028/29 and adjusts the timing of two other synchronous condensers between 2031/32 and 2034/35. The same number of synchronous condensers is required over the modelling period (26 in total).
Modifications to synchronous generators	Identical levels of modifications to existing or future synchronous machines are required.		
Redispatch of synchronous machines	A smaller amount of gas and coal units are re-dispatched, particularly in 2027/28.		Re-dispatches a smaller amount of gas and coal units (although, there is more gas re-dispatched at the start of the period).
Grid-forming BESS	Effectively the same levels of grid-forming BESS are required (i.e., only minor changes for these three portfolio options).		

¹ The word 're-dispatching' or 're-dispatched' has been used to represent system strength solutions (typically existing or future synchronous generators) which are 'enabled' or 'scheduled-on' by AEMO for the purpose of providing system strength services.

With regards to gaps in system strength observed in portfolio option 1, the following options contribute towards removing these gaps:

- Portfolio option 2 (if synchronous condensers are available one year prior, in 2027/28) closes the system strength gaps that our model shows in 2027/28; and
- Portfolio option 3 (if the confidential proposal is proven to be technically feasible) closes the system strength gaps in nearby locations (Sydney West and Newcastle regions) but does not close the gaps at the further locations (Armidale, Wellington and Darlington Point).

Costs of the four portfolio options

Table 2 summarises the total capital and operating costs² for each option over the full 20-year assessment period, in aggregate across the difference components (please note that these costs are shown in *undiscounted 2023/24 dollars*).

Table 2 – Summary of the costs of the four portfolio options over the 20-year assessment period – undiscounted 2023/24 dollars, \$m

	1 – Synchronous condensers available from 2028/29	2 – Synchronous condenser delivery accelerated to 2027/28	3 – Confidential proposal technically feasible	4 – Restricting the number of gas units
<i>New synchronous condensers</i>				
Capex	\$2,023	\$2,023	Confidential*	\$2,023
Opex	\$144	\$147		\$144
Total	\$2,167	\$2,170		\$2,167
<i>Unit upgrades to allow synchronous condenser mode operation</i>				
Capex	\$25	\$25	Confidential*	\$25
Opex	\$0	\$0		\$0
Total	\$25	\$25		\$25
<i>Grid-forming BESS</i>				
Capex	\$360	\$357	Confidential*	\$352
Opex	\$28	\$28		\$28
Total	\$388	\$384		\$380
Total costs (excl. redispatch)				
Capex	\$2,408	\$2,404	Confidential*	\$2,399
Opex	\$172	\$175		\$172
Total	\$2,580	\$2,579		\$2,571

* Portfolio option 3's costs have been redacted given it includes the confidential proposal to provide synchronous condenser services in the vicinity of Newcastle and Sydney West.

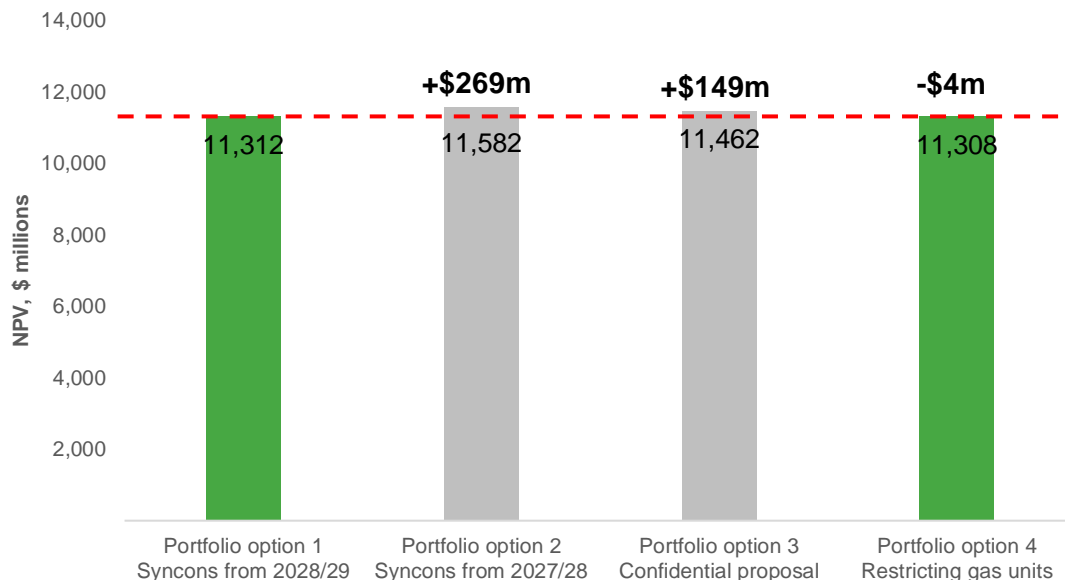
Note, costs may not add due to rounding.

² In preparing this PADR, Transgrid has used the best available information on the timing and costs of non-network and network solutions, as established in mid-2023 following the PSCR consultation and expressions of interest phase, and detailed proponent and Original Equipment Manufacturer (OEM) discussions. Transgrid is continuing to engage with proponents and OEMs on the lead times and costs of all proposed solutions. Market modelling for the PACR stage of the RIT-T will incorporate latest information as it arises.

Preferred portfolio option(s)

The Net Present Value (NPV) results demonstrate that the ultimately preferred option for this RIT-T will depend on what can be confirmed as feasible through the PADR consultation process. The figure below summarises the NPV results for each of the portfolio options.

Figure 1 – Headline NPV results for each of the portfolio options. Green indicates currently credible portfolio option; grey indicates a portfolio option where investigation will continue over the course of the RIT-T to see whether credibility can be confirmed.



Portfolio option 1 is found to generate substantial estimated net benefits over the assessment period – approximately \$11.3 billion in present value terms.³ However, there are still gaps in system strength that cannot be filled in 2027/28 under this option, which presents risks to outcomes for the power system and consumers (including expected unserved energy).

Importantly, while portfolio option 1 is currently the most credible option, the PADR analysis finds that:

- if the delivery of synchronous condensers can be accelerated by one year (i.e., under portfolio option 2), gaps in system strength are eliminated and the expected net market benefits *increase* by approximately \$269 million (in present value terms) over the assessment period;
- if the confidential proposal to provide synchronous condenser services in the vicinity of Newcastle and Sydney West was in fact technically feasible (i.e., under portfolio option 3), the expected net market benefits *increase* by approximately \$149 million (in present value terms) over the assessment period compared to portfolio option 1. Note that this proposal closes the system strength gap in nearby locations (Sydney West and Newcastle regions) but does not close the gap at the further locations (Armidale, Wellington and Darlington Point).
- if we restrict the number of gas units assumed to be contracted with for system strength, then the expected net market benefits decrease by approximately \$4 million (in present value terms) over the

³ Net market benefits of each portfolio option are assessed against a 'do nothing' base case (or counterfactual scenario), in line with RIT-T requirements. A 'do nothing' scenario would mean that Transgrid does not procure any system strength solutions to meet its need, which would ultimately lead to significant system strength violations, and ultimately unserved energy for consumers.

assessment period compared to portfolio option 1. This is driven in part by a slight increase in system strength gaps that occur in 2027/28, compared to portfolio option 1.

Next steps

While portfolio option 1 is currently the most credible and preferred portfolio option at this stage of the RIT-T, there is significant merit in continuing to investigate whether the key uncertainties involved with each portfolio option can be resolved over the course of this RIT-T, individually or in combination, given the potential of increased market benefits.

Specifically, between now and the PACR, we will:

- investigate the advancement the procurement and commissioning of 'no-regret' synchronous condensers. This would require commencement of procurement of synchronous condensers prior to the conclusion of the RIT-T and AER's approval of a contingent project application (CPA);
- confirm the technical feasibility of the confidential proposal to provide synchronous condenser services in the vicinity of Newcastle and Sydney West. We will work with the proponent of this solution following this PADR to determine this;
- identify credible approaches to minimise expected network support payments without materially impacting the optimal portfolio of solutions (e.g., contracting with less gas, coal or hydro units);
- identify additional non-network solutions that can contribute to meeting system strength gaps at Armidale, Sydney West, Newcastle, Wellington and Darlington Point in 2027/28 such as new synchronous condensers, new synchronous generators or modifications to existing units; and
- assess the technical feasibility of each proposed grid-forming battery project via a request for PSCAD models (which is considered necessary before each project can be considered part of the optimal portfolio of solutions at the final PACR stage).

Submissions

We welcome written submissions on materials contained in this PADR.

Submissions are due on 2 August 2024.

Submissions should be emailed to our Regulation team via regulatory.consultation@transgrid.com.au. In the subject field, please reference 'Meeting system strength requirements in NSW RIT-T PADR'.

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