AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Update to the 2023 Electricity Statement of Opportunities

May 2024

An updated report for the National Electricity Market

Important notice

Purpose

The Electricity Statement of Opportunities provides technical and market data that informs the decision-making processes of market participants, new investors, and jurisdictional bodies as they assess opportunities in the National Electricity Market over a 10-year outlook period. AEMO publishes this May 2024 Update to the 2023 Electricity Statement of Opportunities in accordance with clause 3.13.3A of the National Electricity Rules. This publication is generally based on information available to AEMO as at 16 April 2024 unless otherwise indicated.

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Executive summary

New information has become available since AEMO released the 2023 *Electricity Statement of Opportunities* (ESOO) in August 2023 that warrants reassessment of the supply and demand outlook in the National Electricity Market (NEM). New information includes new commissioning dates for Project EnergyConnect, mothballed gas generators in South Australia, and approximately 4.6 gigawatts (GW) of new generation and storage projects.

While these changes to various existing and new developments across the power system change the reliability outlook in some market regions, this Update to the 2023 ESOO reinforces that urgent investments in capacity in the NEM are needed to manage reliability risks. Continued investment in transmission, generation, storage and consumer energy resources (CER), supported by existing federal and state policies, is forecast to lower reliability risks, yet additional opportunities remain for market investments to reduce reliability risks to below the relevant reliability standard over the next 10 years.

This Update to the 2023 ESOO includes:

- Updated reliability assessments on three sensitivities that featured in the 2023 ESOO, applying the updated information which has become available.
- New information on generation and storage development locations in the NEM that have the potential to improve regional reliability risks. Without further transmission development, this analysis in **Section 4.3** shows that there are limited locations in each mainland region that can support new generation and storage that will benefit power system reliability.
- Information on the investments necessary to maintain power system security as thermal generators retire and are replaced by inverter-based resources (IBR). As explained in **Section 4.4**, these accompanying investments are necessary to support power system security so new sources of supply can be operated securely and deliver reliable outcomes.

Reliability gaps continue to be forecast over the 10-year outlook in all mainland NEM regions when considering only those developments that meet AEMO's commitment criteria

The **ESOO Central scenario** includes committed, in commissioning, and anticipated generation, storage and transmission projects, according to AEMO's commitment criteria[1], as well as committed investments in demand flexibility and consumer batteries that are orchestrated to minimise grid requirements.

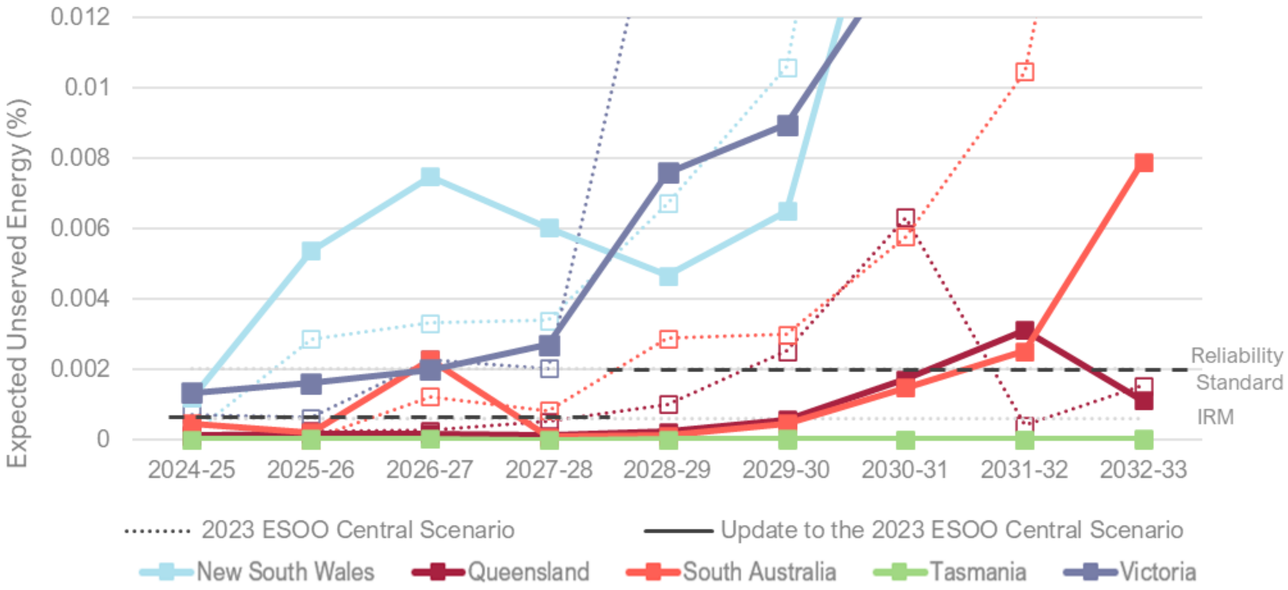
Reliability gaps are forecast in all mainland NEM regions in the next decade in the ESOO Central scenario, signalling a need for further commitment and delivery of generation, transmission, demand side participation (DSP) and consumer assets such as batteries that can be orchestrated to minimise grid requirements.

As **Figure 1** shows, reliability risks in the Central scenario, relative to the 2023 ESOO, have:

[1] Commitment criteria relate to land, contracts, planning, finance, and construction, and are explained in each update on AEMO's Generation Information web page at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information and Transmission Augmentation information web page at https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

- Increased in New South Wales between 2024-25 and 2027-28 due to advised delays to previously considered battery projects and revised assumptions for demand allocation within New South Wales.
- Increased in Victoria until 2027-28 due to mothballed generators in South Australia and transmission limitations affecting flows into Melbourne.
- Increased in South Australia in 2026-27 due to the advised delay of Project EnergyConnect Stage 2 to after the previously advised closure timings of the Torrens Island B and Osborne Power Stations, resulting in a newly identified reliability gap.
- Decreased in Victoria and South Australia from 2028-29 when Yallourn Power Station retires, due to a newly advised transmission configuration planned for the Latrobe Valley transmission network.

Figure 1 Updated ESOO Central scenario, all regions, 2024-25 to 2032-33, expected unserved energy (%)



As a result of the reliability gaps forecast in the ESOO Central scenario, AEMO will tender for Interim Reliability Reserves (IRR) which support New South Wales and Victoria to minimise the consumer impact of reliability risks should low reserve conditions emerge over summer 2024-25.

Federal and state government programs, actionable transmission developments, orchestrated consumer investments and demand flexibility have the potential to address the majority of forecast reliability risks

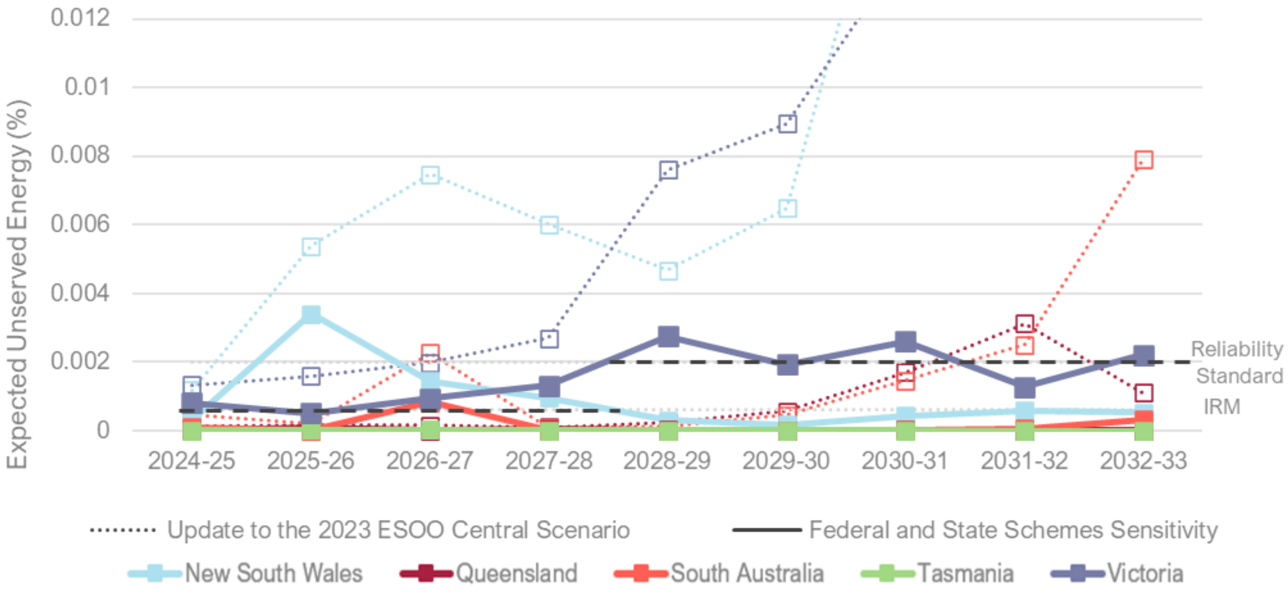
The ***Federal and state schemes* sensitivity** includes all developments in the ESOO Central scenario as well as:

- Actionable transmission investments and forecast potential growth in consumer investments (orchestrated CER and DSP).
- Firming and renewable energy developments that have specific funding, development or contracting arrangements under federal, state and territory government schemes and programs.

These schemes have the potential to significantly improve the outlook if they progress as projected.

Figure 2 shows that these additional investments in renewable generation, dispatchable capacity, transmission and CER are forecast to reduce reliability risks to below the relevant reliability standard in most regions in most years of the 10-year horizon if they progress as advised. Additional investments are required to further reduce reliability risks. Existing policies, such as future tenders for the capacity investment scheme, and various renewable energy and storage targets of state governments, will contribute to supporting these investments and will be assessed as more information on the actual projects become available.

Figure 2 *Federal and state schemes* sensitivity, expected unserved energy, 2024-25 to 2032-33 (%)



Development opportunities for providing power system reliability vary by technology and available capacity in the power system, and require further system security investments.

To address reliability risks new supply developments will be needed and will also need to connect in locations that can service loads, which at times may be geographically distant. This Update to the 2023 ESOO provides new insights on locations that can provide reliability benefits within existing transmission capabilities and as new transmission developments are completed and transfer capability confirmed. Without further transmission development, this analysis shows that there are limited locations that will benefit power system reliability, and that technologies that have greatest capacity to operate continuously through a potential reliability event (such as deeper storage technologies and other dispatchable technologies) will provide greatest reliability benefit.

The power system also requires sufficient security and stability services to ensure that it remains both stable and resilient. As existing synchronous generators decommission and transmission augmentations are developed, provision of alternative essential system services are required. For example, a need for new system strength services has been identified equivalent to approximately 22 synchronous condensers distributed in optimal locations across the NEM.

Contents

1 Updating the 2023 Electricity Statement of Opportunities

National Electricity Rules (NER) 3.13.3A(b) requires AEMO to publish updates to the Electricity Statement of Opportunities (ESOO) for the National Electricity Market (NEM) as soon as practicable when new information becomes available that materially changes the supply or demand projections, including plant retirements. Since the publication of the 2023 ESOO[2] in August 2023 and subsequent update in September 2023, material updates have been announced, triggering this update. Specifically, these material updates are:

- Revised commissioning dates for transmission, generation and storage projects, particularly in the first three years of the horizon. This includes Project EnergyConnect, now advised to release full capacity in July 2027, which was previously advised for July 2026.
- Advised mothballing and retirement of generators.

In processing this update, AEMO has also included new information on generation and storage developments, being approximately 4.6 gigawatts (GW) of new capacity which has advanced sufficiently to be considered.

Unless specified otherwise, all inputs and assumptions used in this reliability forecast align with the Central scenario published for Retailer Reliability Obligation (RRO) purposes in the 2023 ESOO.

1.1 Reliability measures and the Retailer Reliability Obligation (RRO)

The ESOO measures power system reliability using expected unserved energy (USE). Factors that influence when and how USE occurs include occurrences of generator outages and high demand at the same time as low wind and solar generation conditions combined with transmission capacity. AEMO's forecasts of expected USE are compared against:

- The **Interim Reliability Measure** (IRM) of 0.0006% of the total energy demanded in a region for a financial year, which applies for the purposes of the RRO until 30 June 2028[3]. When reliability is forecast consistent with the IRM, consumers should expect larger USE events (on average 10% of average regional demand for five hours) at a frequency of one in every 10 years.
- The **reliability standard** of 0.002% of the total energy demanded in a region for a financial year, which applies for the purposes of the RRO when the IRM does not apply. When reliability is forecast consistent with the reliability standard, consumers should expect larger USE events (on average 12% of average regional demand for eight hours) at a frequency of one in every five years.

[2] At https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo.

[3] NER 11.132.2

For the RRO[4], components of any reliability forecast or indicative reliability forecast[5] must indicate whether there is a forecast reliability gap. Details on the reliability forecast are included in **Chapter 3**.

[4] For more information on the RRO, see https://www.energy.gov.au/sites/default/files/retailer_reliability_obligation_factsheet.pdf.

[5] At https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/rsig/reliability-forecast-guidelines.pdf.

2 Updated information and assumptions

This reliability forecast incorporates all updated information from developers and market participants from AEMO's latest Generation Information, published 16 April 2024[6], and AEMO's latest Transmission Augmentation Information, published 17 May 2024[7]. In addition to existing power system assets, the reliability forecast considers all generation, storage, and transmission developments that have progressed sufficiently to be considered by AEMO as anticipated, committed, or in commissioning.

2.1 Updated transmission information

The following updates have been received regarding transmission elements since the 2023 ESOO:

- **Transgrid** has advised revisions to the expected commissioning dates of **Project EnergyConnect**, a committed transmission development between New South Wales and South Australia.
  - Stage 1 (release of 150 MW transfer capacity) is expected for November 2024 (previously July 2024).
  - Stage 2 (release of 800 MW transfer capacity) is expected for July 2027 (previously July 2026).
- **Energy Co** has advised revisions to the expected commissioning dates of the **Central West Orana Renewable Energy Zone (REZ) Link**, an anticipated transmission development in New South Wales. The release of this capacity is expected for August 2028 (previously September 2027).
- **APA** has advised a new Cable Load Prediction System (CLPS) for **Basslink**, that allows for dynamic capacity on this existing cable between Tasmania and Victoria, increasing peak transfer capacity to its original design transfer capacity (594 MW towards Victoria and 478 MW towards Tasmania), which is above the capacity provided in recent years.
  - Short-term dynamic capacity is only available operationally where a sufficient period of cable cooling has occurred. ESOO modelling accounts for this short-term dynamic behaviour through application of static daily energy limits[8].
  - APA has advised that this system is in the final stages of commissioning and associated higher short-term power flows will be enabled by 1 July 2024.
- **AEMO Victorian Planning** has advised a new network configuration for Latrobe Valley transmission networks is planned to follow the retirement of the Yallourn Power Station in 2028. This new configuration better utilises existing 220 kilovolts (kV) and 500 kV assets, reducing generator curtailment and consequently improving the reliability outlook. As this reconfiguration utilises existing assets and is expected to be relatively low cost to develop, this reconfiguration has been applied to the Central scenario.

[6] At https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information.

[7] At https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

[8] As this functionality is not available in the Medium Term Projected Assessment of System Adequacy (MT PASA), APA has advised that they will continue to submit the long-term sustained capability of the cable for MT PASA purposes.

2.2 Distribution of regional consumer demand in the ESOO

Every year AEMO publishes new demand forecasts for each region of the NEM within the ESOO. AEMO distributes this load across the region through detailed power system constraints that seek to ensure all components of the power system remain within technical limits.

Historically, the distribution of regional demand has been derived from snapshots of NEM maximum demand events. As part of the analysis of locational reliability benefits published in **Section 4.3**, it was identified that the previously applied approach was leading to inappropriate locational signals in the two largest NEM regions, New South Wales and Queensland. As a result, the proportion of demand in these regions in this Update to the 2023 ESOO has been updated to represent proportions consistent with the independent maximum demand events for these regions.

For example, **Figure 3** shows a scatter plot of the demand proportion for the Sydney, Newcastle, Wollongong sub-region relative to New South Wales regional demand for the 2022-23 summer. Intervals where demand in New South Wales exceeded 11,000 megawatts (MW), highlighted in purple, indicate that high demand periods in New South Wales are typically associated with higher proportions of demand in this sub-region.

The 2023 ESOO proportion is shown to be lower than average intervals, while the revised proportion used in this update aligns with high demand intervals for the New South Wales region. Proportions that apply at time of maximum demand ensure that the model reflects the reliability outlook for summer maximum demand events, when the majority of reliability risk is currently forecast to occur for both regions.

Figure 3 Scatter plot of Sydney, Newcastle, Wollongong sub-regional demand proportion relative to New South Wales regional demand, summer 2022-23

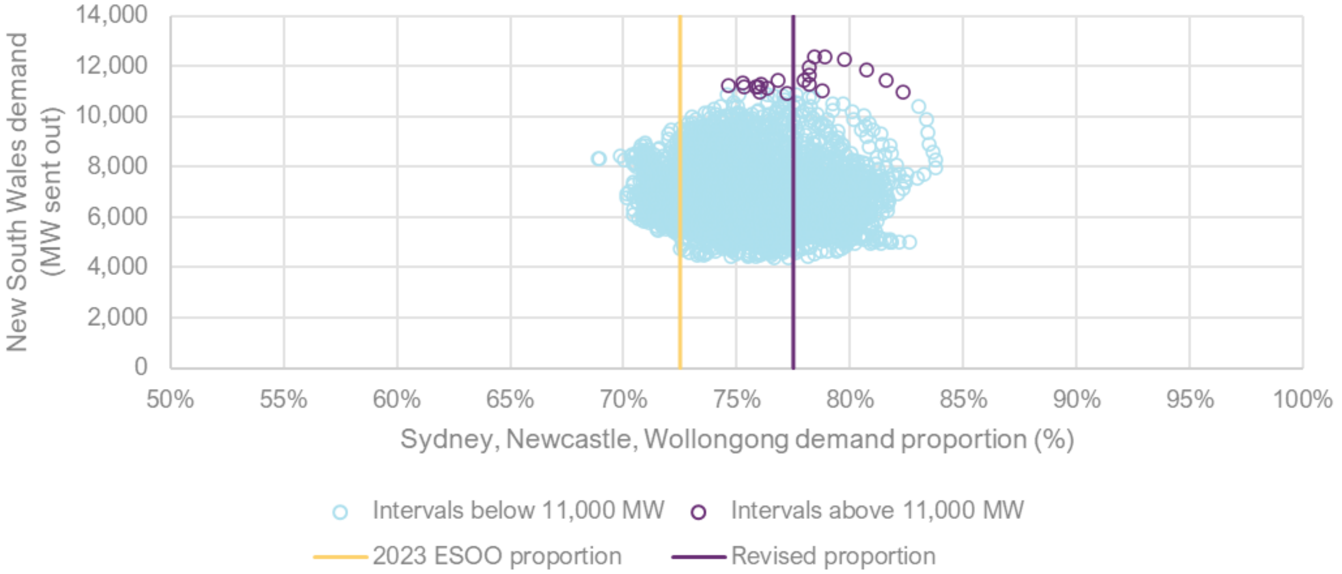
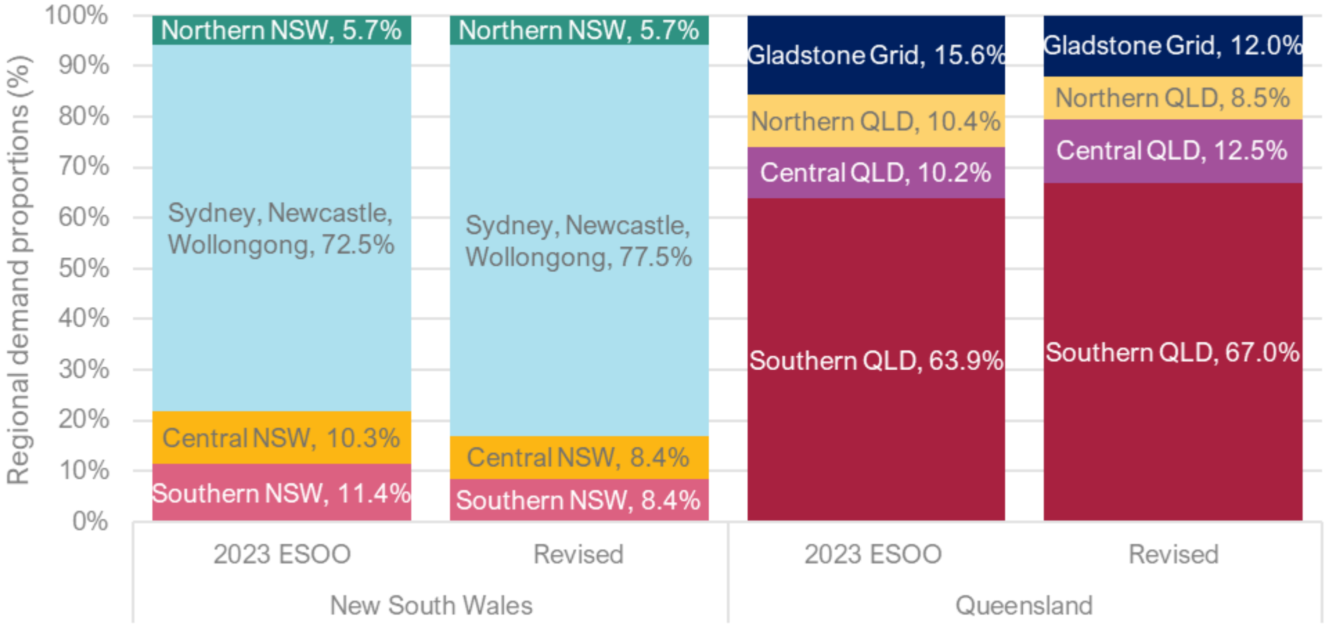


Figure 4 shows the revised demand proportions applied in this update relative to the 2023 ESOO. In both New South Wales and Queensland regions, the revised proportions place higher demand within the capital city than was previously allocated. In New South Wales, the location of generation and storage in combination with transmission capability for flows into Sydney, Newcastle, Wollongong means that reliability risks are more likely

with greater demand observed in this sub-region. In Queensland, the revised regional demand distribution results in a relative decrease in reliability risks, as the overall Queensland power system of generation, storage and transmission can serve the additional flows towards South Queensland.

Figure 4 Demand proportions applied in this update relative to the 2023 ESOO



2.3 Updated generation information

The following updates have been received regarding generators since the 2023 ESOO:

- **AGL** had previously advised its intention to return the 200 MW **Torrens Island B unit 1** in South Australia back from mothballing in advance of summer 2024-25. In September 2023, AGL advised that that it was no longer its intention to return this unit from mothballing[9] up until its expected retirement in 2026.
- **Engie** has advised its intention to mothball[9] its **Port Lincoln** (73.5 MW) and **Snuggery** (84 MW) power stations in South Australia from 1 July 2024 until their expected closure date of 1 January 2028 (previously 2030).
- In September 2023, **Snowy Hydro** revised the expected commissioning date of **Snowy 2.0** to December 2028 from December 2029, with a revised capacity of 2,200 MW, up from 2,000 MW.

Approximately 4.6 GW of new generation and storage capacity has advanced sufficiently[10] to be considered in this ESOO update since the 2023 ESOO, published in August 2023. **Figure 5** shows the capacity outlook utilised for the reliability forecast in this ESOO Update, where the labels show the change in capacity for each forecast year relative to the previous year. **Figure 6** shows the capacity variation from the 2023 ESOO, where the labels show the change in capacity relative to the 2023 ESOO.

[9] While these mothballed generators are not formally retired, the operator has advised that it is not its current intent or expectation to operate these units.

[10] Projects classified by AEMO as ‘in service’, ‘in commissioning’, ‘committed’, or ‘anticipated’.

Key points from this updated outlook are:

- Only minor variations in seasonal capacity availability for coal generators are noted between the 2023 ESOO and this ESOO Update, however many continue to advise expected closure within the next 10 years.
- The announcements from AGL and Engie have reduced gas and diesel generation availability over the horizon relative to the 2023 ESOO. A new 204 MW hydrogen-powered generator in South Australia is now considered from summer 2026-27, increasing availability.
- Many hydro and battery storage developments are noted to be sufficiently progressed for inclusion in this update, with over 3 GW of battery projects newly considered. Despite this, numerous delays to the development and commissioning of committed and anticipated battery and hydro storage projects have been advised, reducing forecast availability in some years of the horizon for some jurisdictions.
- Many wind and solar developments are noted to be sufficiently progressed for inclusion in this update, with approximately 1 GW of projects newly considered. Despite this, numerous delays to the development and commissioning of committed and anticipated wind and solar projects have also been advised, reducing forecast availability in 2025-26 to 2027-28 relative to the 2023 ESOO.
- In applying AEMO's reliability forecasting methodology[11] to this reliability assessment, AEMO has allowed for potential delays to committed and anticipated projects that are yet to reach final commissioning milestones. This methodology was applied to 4.6 GW of developments across a range of technologies (1,625 MW wind, 1,236 MW / 2,200 MWh battery, 742 MW solar, 250 MW pumped hydro, and 750 MW gas turbine) which have been advised to be commissioned immediately preceding or during the 2024-25 summer period, including the Hunter Power Station[12]. In some cases, this results in less capacity forecast to be available in summer 2024-25 than was considered in the 2023 ESOO.

Beyond in-commissioning, committed, and anticipated projects, there remains a strong pipeline of publicly announced generation and storage projects that have the potential to reduce projected reliability risks if developed in the required timeframes, but these are not considered in this Update to the 2023 ESOO. For example, some projects that been awarded contracts as part of federal or state schemes are not considered in this forecast, because they have not yet advised sufficient development and planning progress to be considered.

AEMO applied its consulted-on ESOO reliability assessment methodology[13] that reflects commissioning uncertainty for projects that are committed and anticipated but have not yet met certain commissioning milestones. As established with stakeholders when consulting on this methodology, AEMO considers this approach balances the risks appropriately that consumers are exposed to development delays for new projects. If these projects are commissioned to the schedules provided by each developer, reliability risks may reduce relative to those evaluated in the reliability forecast and indicative reliability forecast that applied this methodology.

[11] ESOO & Reliability Forecast methodology is available at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo

[12] This Snowy Hydro generator development has previously been referred to as 'Kurri Kurri' or 'Hunter Power Project'.

[13] ESOO & Reliability Forecast methodology is available at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo

Figure 5 Assumed capacity available for the Central scenario during typical summer conditions, by generation type, 2023-24 to 2032-33 (MW)

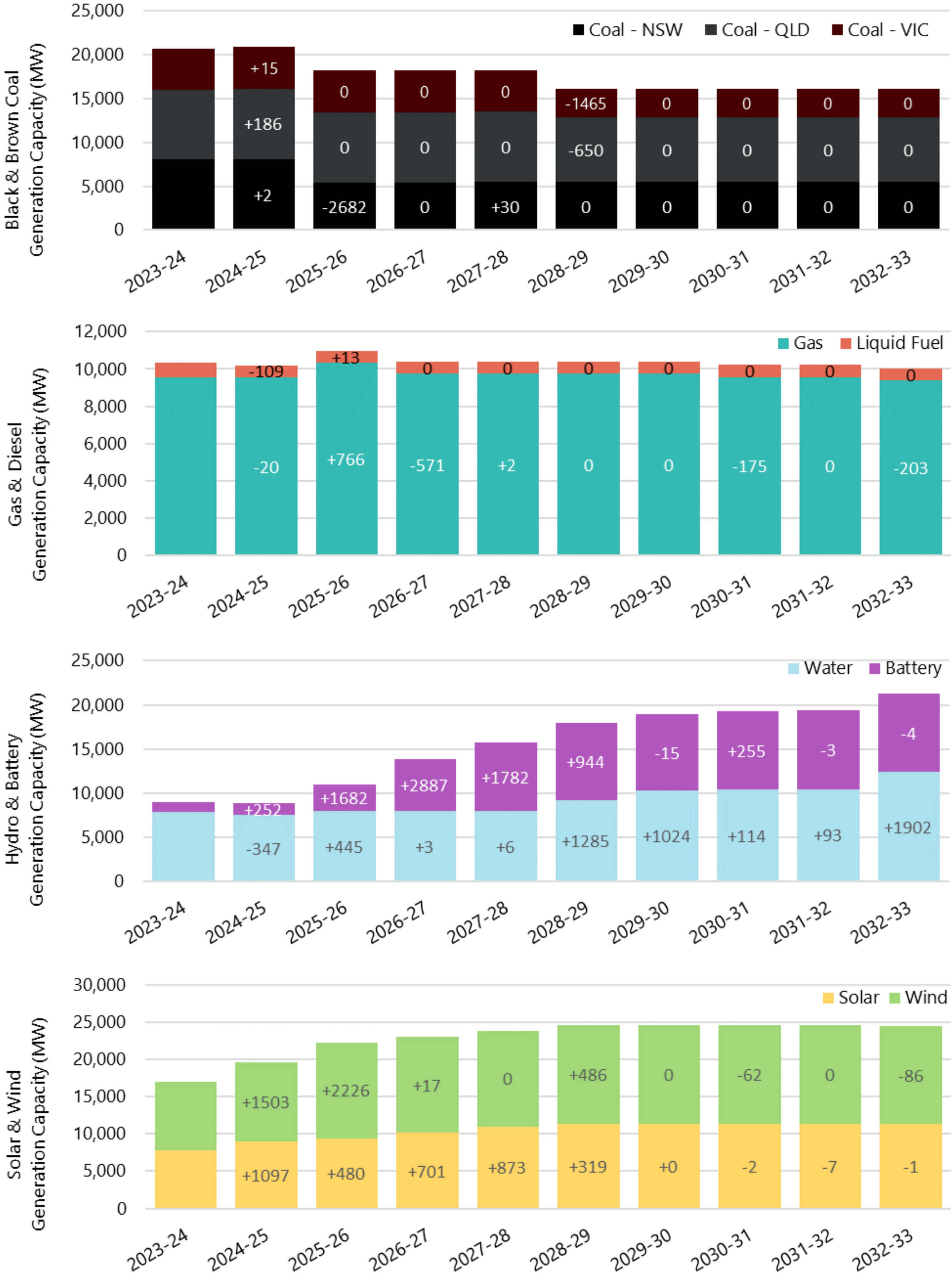
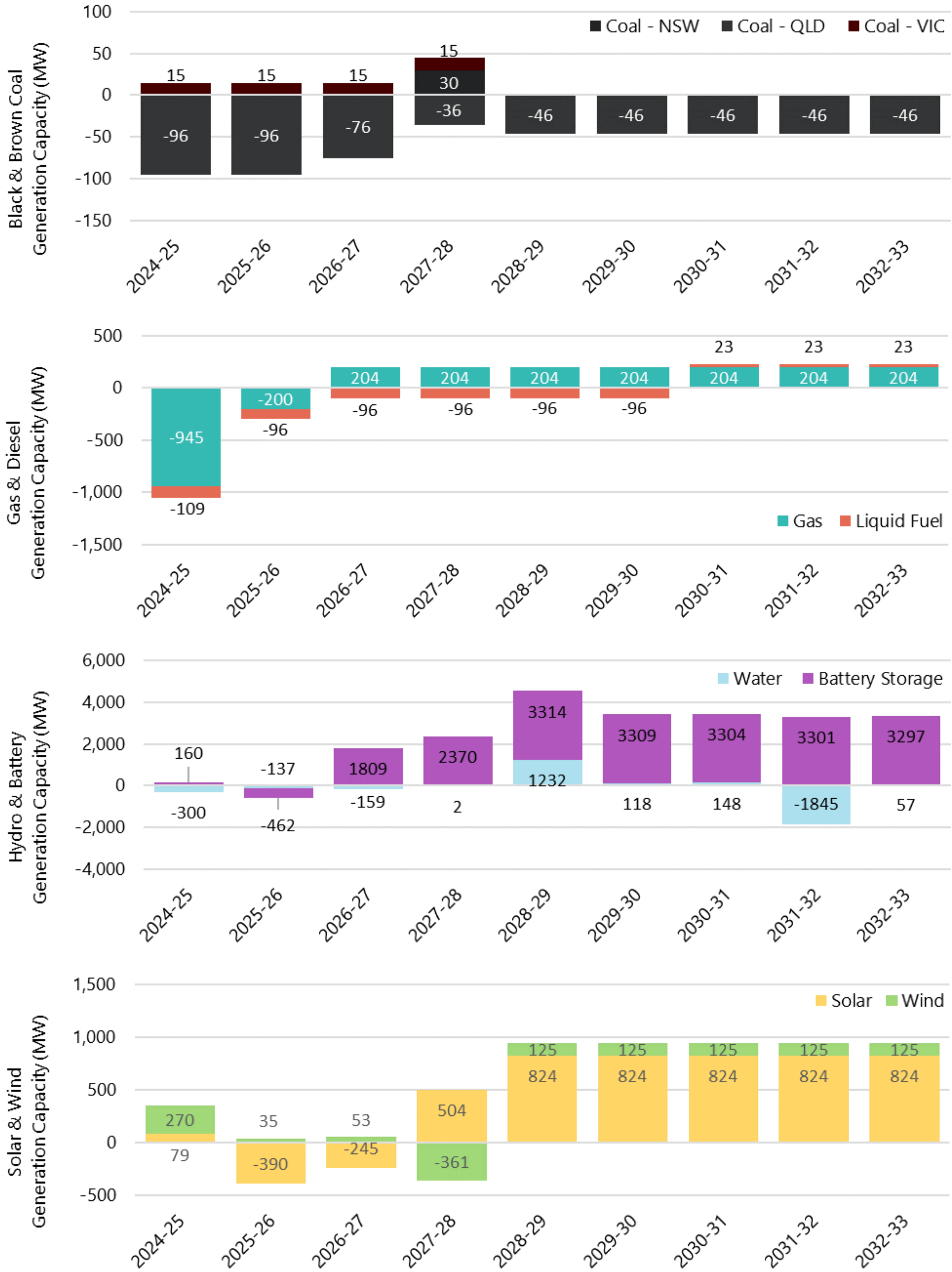


Figure 6 Change between 2023 ESOO and this May 2024 Update to the 2023 ESOO, Central scenario capacity outlook under summer typical conditions, 2024-25 to 2032-33 (MW)



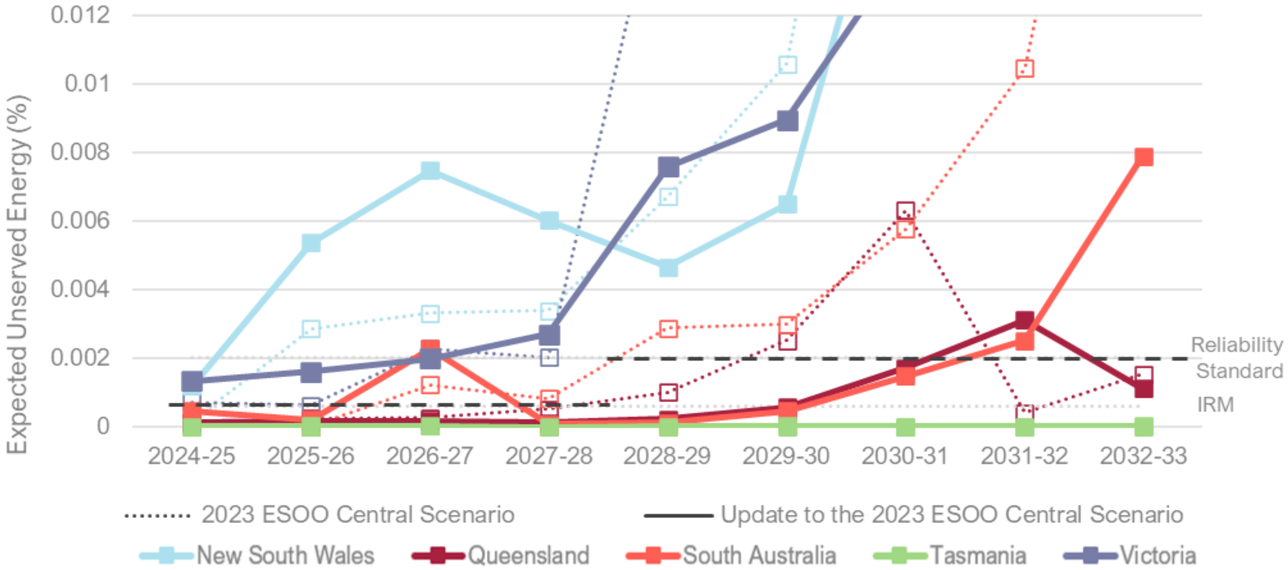
3 Reliability forecast

This ESOO Central scenario incorporates the reliability forecast (2024-25 to 2027-29) and the indicative reliability forecast (2028-29 to 2032-33). It has been developed consistent with AEMO's Reliability Forecast Guidelines and AEMO's ESOO and Reliability Forecast Methodology[14] and is used to trigger measures that seek to manage reliability risks, such as the RRO, Interim Reliability Reserves (IRR) and the Reliability and Emergency Reserve Trader (RERT).

This forecast includes all in service, in commissioning, committed and anticipated generation, storage and transmission projects, according to AEMO's commitment criteria, as well as committed investments in demand flexibility and consumer batteries that are orchestrated to minimise grid requirements. Projects yet to reach final commissioning phases have been assumed to progress according to typical development, approval and commissioning timelines, which may be later than the dates advised by project developers (as described in the previous section).

Figure 7 shows the updated ESOO Central scenario, relative to the Central scenario published in the 2023 ESOO. While this updated forecast signals a need for further capacity development, many additional developments are sought by various state and federal schemes; the impact of these additional schemes is considered in **Section 4.2**.

Figure 7 Updated ESOO Central scenario, all regions, 2024-25 to 2032-33, expected unserved energy (%)



New South Wales

- Reliability risks are forecast higher than the 2023 ESOO between 2025-26 – when Eraring Power Station is advised to retire – and 2027-28, due to advised delays to previously considered battery projects, and revisions

[14] Both documents are available at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo.

to assumed demand distributions across key New South Wales load centres at times of summer supply scarcity.

- The remainder of the reliability assessment (2028-29 to 2032-33) generally shows slightly less reliability risk than that published in the 2023 ESOO, predominantly due to the consideration of various battery storage and variable renewable energy (VRE) developments, many of which have been awarded long-term energy supply agreements (LTESAs) from the New South Wales Government. Despite these developments, reliability risks remain above the reliability standard.
- In applying AEMO's reliability forecasting methodology (as described in **Section 2.3** above), delays to committed and anticipated projects were assumed in the reliability assessment to projects that are yet to reach final commissioning milestones. As a result, this Update to the 2023 ESOO identifies greater reliability risks for the 2024-25 financial year than was identified in the 2023 ESOO (in addition to the increased risks associated with updated information as described in **Chapter 2**).
  - The application of this methodology does not represent specific information or guidance that these projects will or are expected to be delayed, rather that it remains a prudent consideration in assessing reliability risks given observed development challenges in recent years.
  - As reflected by the reliability gaps that are shown in **Table 1** below, if projects across the NEM that are committed and anticipated, including the Hunter Power Station, are delivered ahead of peak demand periods in the upcoming summer, and with all else being equal, then AEMO estimates that the reliability forecast for New South Wales would also be below the IRM.

Queensland

- Reliability risks are forecast to remain within the relevant standard until 2031-32, which reflects an improved outlook since the 2023 ESOO. The improved outlook is driven by the consideration of additional storage and generation developments, and revisions to the assumed demand distributions within Queensland at time of summer supply scarcity.
- The commissioning advice for the Borumba pumped hydro generator has been updated since the 2023 ESOO, with the expected full commercial use date now advised to be available ahead of the 2031-32 summer. Considering the application of AEMO's reliability forecasting methodology for anticipated projects, this results in the slower reduction in reliability risks in Queensland.

South Australia

- Since the 2023 ESOO, Torrens Island B1, Port Lincoln and Snuggery power stations, all of which are in South Australia, have advised that they will no longer be available in 2024-25 onwards. This reduction in peak generation capacity has increased reliability risks from 2024-25 onwards jointly in South Australia and Victoria, which are often tightly interconnected regions for reliability purposes.
- In 2026-27, Torrens Island B and Osborne power stations have advised closure, as was assumed in the 2023 ESOO, Project EnergyConnect Stage 2 is no longer expected to commission in this year, and a 204 MW hydrogen-powered generator as part of the South Australian Hydrogen Jobs Plan is now anticipated to

commission in this year. Collectively these factors result in increased reliability risks above the reliability standard in South Australia in 2026-27.

- In 2027-28, Project EnergyConnect Stage 2 is advised to release the full 800 MW transfer capacity, decreasing reliability risks below the relevant reliability standard until 2031-32 when further gas generator retirements worsen the outlook (as was forecast in the 2023 ESOO). This includes Mintaro and Dry Creek gas turbine retirements in 2030, and Hallett gas turbine retirements in 2032.

Tasmania

- Consistent with the 2023 ESOO, expected USE is forecast to be less than the IRM for the ESOO horizon.

Victoria

- As described in the section above regarding South Australia, the advised withdrawal of South Australian gas generators has increased reliability risks from 2024-25 onwards jointly in South Australia and Victoria, which are often tightly interconnected regions for reliability purposes. Similar to the 2023 ESOO, reliability risks in Victoria are forecast above the relevant reliability standards over the entire horizon, although a revised network configuration in the Latrobe Valley following the closure of Yallourn in 2028 has reduced risks.
- From 2024-25 onwards, new transmission constraints are included in the projection, consistent with new constraints which have been applied in the NEM dispatch engine (NEMDE)[15] and have been observed to bind operationally. Numerous power system limitations, including these new constraints, restrict energy flows into the local Melbourne 220 kV network from the broader Victorian 500 kV and 220 kV transmission networks during periods of high demand and/or reliability risk.
- In 2028-29, expected USE increases when Yallourn Power Station is advised to retire, as was also advised for the 2023 ESOO. Reliability risks are, however, lower than previously forecast, due to the consideration of a new network configuration that is advised to apply to the 500 kV and 220 kV transmission networks in the Latrobe Valley. AEMO Victorian Planning has advised that this new configuration is planned to be in place coincident with the retirement of the Yallourn power station in 2028.

3.1 RRO reliability gaps

A reliability gap for RRO purposes is forecast if expected USE in a region:

- Exceeds 0.0006% of the total energy demanded in that region for a given financial year (the IRM) between 2024-25 and 2027-28.
- Exceeds 0.002% of the total energy demanded in that region for a given financial year (the reliability standard) between 2028-29 and 2032-33.

Table 1 shows the reliability gap assessments against the IRM and **Table 2** shows assessments against the reliability standard, with purple columns in each table highlighting the years relevant to each standard for RRO

[15] A new constraint has been added to NEMDE in December 2023 for the overload of Moorabool – Geelong 220 kV line for an outage of a parallel Moorabool – Geelong 220 kV line.

purposes. The relevant reliability standard is coloured in purple for each relevant year, while values for other years are provided for information purposes.

This additional capacity assessment:

- Considers each region separately and does not consider the inter-regional benefits of new capacity. Actual capacity requirements may therefore be lower for some regions considering developments in neighbouring regions.
- Identifies firm capacity that is assumed to be fully unconstrained and continuously available throughout the entire year. Actual capacity requirements may therefore be greater considering potential generator outages, energy limits, storage duration and power system constraints.

Table 1 Reliability gaps and equivalent gaps against the IRM, 2024-25 to 2032-33 (MW)

Region	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33
New South Wales	270	1040	1230	1135	1050	1285	2590	2865	3055
Queensland	0	0	0	0	0	0	400	640	255
South Australia	0	0	305	0	0	0	240	390	750
Tasmania	0	0	0	0	0	0	0	0	0
Victoria	245	335	400	530	1585	1760	2085	2405	2835

Table 2 Reliability gaps and equivalent gaps against the reliability standard, 2024-25 to 2032-33 (MW)

Region	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33
New South Wales	0	510	695	595	480	695	1800	2110	2295
Queensland	0	0	0	0	0	0	0	170	0
South Australia	0	0	35	0	0	0	0	75	455
Tasmania	0	0	0	0	0	0	0	0	0
Victoria	0	0	0	120	885	975	1365	1705	2190

Note: for the purposes of this Update to the 2023 ESOO, the reliability gaps and equivalent gaps shown are calculated as the additional capacity required, if unconstrained and continuously available throughout the entire financial year, to reduce the forecast of expected USE to the relevant reliability metric.

To better illustrate the contributions of various technologies to reducing expected USE, indicative technology combinations that are forecast to reduce reliability risks to the reliability standard and IRM are shown in **Table 3** and **Table 4**. These technology combinations have been forecast for New South Wales and Victoria in 2027-28 (the T-3 period for RRO purposes). This extended analysis of the additional capacity required:

- Does not consider any reliability improvements that could be achieved with transmission developments, CER orchestration or DSP developments, or the impact of transmission limits on future generation development.
- Considers each region separately and does not consider the inter-regional benefits of new capacity. Actual capacity requirements may therefore be lower for some regions considering developments in neighbouring regions.
- Identifies the capacity required assuming adequate transmission connectivity with fully unconstrained access to supply the major demand centres within each region. Actual capacity requirements may therefore be greater

considering power system constraints. **Section 4.3** includes more detail on the variation in locational reliability benefits across the NEM.

- Considers the reliability needs of the region for the year of study in isolation, without consideration for the long-term requirements of the region and the impact of over-use of stored energy on future supply conditions. Over the longer term, longer duration storages, or energy generating plant may prove more effective at mitigating reliability risks that emerge less frequently, but require prolonged dispatch.
- Does not identify an optimal development path, or recommend a particular solution.

Table 3 Additional capacity required, considering a variety of technology combinations (in MW) to reduce expected USE to the reliability standard and IRM, New South Wales 2027-28

Combination	Technology type	Reliability standard of 0.002% USE	IRM of 0.0006% USE
1	**Firm, unlimited capacity**	595 MW	1,135 MW
2	**Open cycle gas turbine (OCGT)[A]**	650 MW	1,235 MW
3	**2 hour storage[B]**	1,840 MW/3,680 MWh	4,015 MW/8,030 MWh
4	**4 hour storage[B]**	825 MW/3,300 MWh	1,700 MW/6,800 MWh
5	**6 hour storage[B]**	665 MW/3,990 MWh	1,290 MW/7,740 MWh
6	**8 hour storage[B]**	620 MW/4,960 MWh	1,190 MW/9,520 MWh
7	**Wind**	990 MW	1,940 MW
	4 hour storage	495 MW/1,980 MWh	970 MW/3,880 MWh
8	**Solar**	1,210 MW	2,520 MW
	4 hour storage	605 MW/2,420 MWh	1,260 MW/5,040 MWh
9	**Wind**	930 MW	1,840 MW
	Solar	235 MW	460 MW
	4 hour storage	465 MW/1,860 MWh	920 MW/3,680 MWh

A. Assuming there is sufficient gas to operate the generator throughout potential USE periods.
B. Assuming there is sufficient energy and/or water to charge/pump ahead of potential USE periods.

Table 4 Additional capacity required, considering a variety of technology combinations (in MW) to reduce expected USE to the reliability standard and IRM, Victoria 2027-28

Combination	Technology type	Reliability standard of 0.002% USE	IRM of 0.0006% USE
1	**Firm, unlimited capacity**	120 MW	530 MW
2	**Open cycle gas turbine (OCGT)[A]**	130 MW	580 MW
3	**2 hour storage[B]**	285 MW/570 MWh	1,500 MW/3,000 MWh
4	**4 hour storage[B]**	145 MW/580 MWh	665 MW/2,660 MWh
5	**6 hour storage[B]**	125 MW/750 MWh	570 MW/3,420 MWh
6	**8 hour storage[B]**	120 MW/960 MWh	545 MW/4,360 MWh
7	**Wind**	190 MW	890 MW
	4 hour storage	95 MW/380 MWh	445 MW/1,780 MWh
8	**Solar**	180 MW	850 MW
	4 hour storage	90 MW/360 MWh	425 MW/1,700 MWh
9	**Wind**	170 MW	800 MW
	Solar	45 MW	200 MW

Combination	Technology type	Reliability standard of 0.002% USE	IRM of 0.0006% USE
	4 hour storage	85 MW/340 MWh	400 MW/1,600 MWh

A. Assuming there is sufficient gas to operate the generator throughout potential USE periods.
B. Assuming there is sufficient energy and/or water to charge/pump ahead of potential USE periods.

Interim Reliability Reserves, reliability forecast components and RRO requests

In the reliability forecast, forecast reliability gaps occur against the IRM in New South Wales and Victoria (2024-25 to 2027-28) and in South Australia (2026-27). As a result of the reliability gaps forecast in the ESOO Central scenario in 2024-25, AEMO will tender for IRR which support New South Wales and Victoria to minimise the consumer impact of reliability risks should low reserve conditions emerge over summer 2024-25

AEMO must also request the Australian Energy Regulator (AER) to consider making an RRO reliability instrument should it forecast a reliability gap within very specific timeframes at the time of publishing an ESOO or Update to an ESOO. No reliability gap meets the required criteria[16], and AEMO will not therefore request the AER to consider making new reliability instruments as a result of this Update to the 2023 ESOO. AEMO however will re-assess forecast reliability gaps in the 2024 ESOO to be published in August 2024. AEMO will request AER consideration of any relevant reliability instruments at that time that will support appropriate responses under the RRO to any reliability gaps identified.

To support the market's capacity to respond to reliability gaps forecast across the next five years, AEMO provides the following reliability forecast components, including the reliability gap period, and likely trading intervals associated with these forecast reliability gaps, as summarised in **Table 5**. For the purposes of this Update to the 2023 ESOO, AEMO confirms no change to the one-in-two year demand forecasts published in the 2023 ESOO.

Table 5 Reliability forecast components against the IRM (2024-25 to 2027-28)

Region	Financial year	Reliability gap period	Likely trading intervals [A]	Expected USE for the gap period (GWh)	Reliability gap (MW)
New South Wales	2024-25	1 December 2024 – 28 February 2025	3:00 pm – 8:00 pm, working weekdays	0.64	270
	2025-26	1 December 2025 – 31 March 2026	2:00 pm – 10:00 pm, working weekdays	2.83	1,040
		1 June 2026 – 30 June 2026	5:00 pm – 9:00 pm, working weekdays	0.28	
	2026-27	1 July 2026 – 31 July 2026	5:00 pm – 9:00 pm, working weekdays	0.47	1,230
		1 December 2026 – 28 February 2027	3:00 pm – 10:00 pm, working weekdays	3.26	
		1 June 2027 – 30 June 2027	5:00 pm – 9:00 pm, working weekdays	0.37	
	2027-28	1 July 2027 – 31 July 2027	5:00 pm – 10:00 pm, working weekdays	0.53	1,135

[16] Forecast reliability gap periods in 2025-26 either start later than the one year and six month maximum lead time from the publication of this ESOO Update required for a T-1 instrument request (New South Wales); or are not associated with a related T-3 reliability instrument (New South Wales and Victoria).
Forecast reliability gap periods in 2027-28, either start sooner than the three years and three months minimum lead time from the publication of this ESOO Update required for a T-3 instrument request (New South Wales); or start later than the three years and six months maximum lead time from the publication of this ESOO Update required for a T-3 instrument request (New South Wales and Victoria).

Region	Financial year	Reliability gap period	Likely trading intervals [A]	Expected USE for the gap period (GWh)	Reliability gap (MW)
		1 December 2027 – 29 February 2028	2:00 pm – 11:00 pm, working weekdays	2.63	
		1 June 2028 – 30 June 2028	5:00 pm – 9:00 pm, working weekdays	0.30	
South Australia	2026-27	1 December 2026 – 28 February 2027	2:00 pm – 10:00 pm, working weekdays	0.27	305
Victoria	2024-25	1 January 2025 – 28 February 2025	4:00 pm – 8:00 pm, working weekdays	0.45	245
	2025-26	1 January 2026 – 28 February 2026	4:00 pm – 9:00 pm, working weekdays	0.89	335
	2026-27	1 January 2027 – 28 February 2027	4:00 pm – 9:00 pm, working weekdays	0.71	400
	2027-28	1 January 2028 – 31 March 2028	3:00 pm – 9:00 pm, working weekdays	1.00	530

A. NEM time.

4 Development opportunities

The 2023 ESOO included various alternate development sensitivities that demonstrated a reduced need for utility-scale supply solutions should:

- Demand side solutions such as the orchestration of CER and growth of DSP occur at scale as forecast.
- Actionable transmission developments progress as planned and scheduled.
- Committed and anticipated generation projects develop as planned and scheduled by developers (without delay).
- Federal and state generation development schemes deliver the expected volumes of new capacity as scheduled.

Two sensitivities have been updated as part of this May 2024 Update to the 2023 ESOO:

- the *Actionable transmission* sensitivity, and
- the *Federal and state schemes* sensitivity.

Consistent with the Central scenario, all inputs and assumptions remained consistent with those advised in the 2023 ESOO unless specified otherwise.

This chapter also includes new additional information on the technology and geographic opportunities that exist in the NEM to improve reliability, and an overview of forecast gaps in system security requirements over the ESOO horizon.

4.1 Actionable transmission developments significantly improve the reliability outlook

The Central scenario included only transmission developments that are considered committed or anticipated, as classified by AEMO's Transmission Augmentation Information page[17]. The Draft 2024 ISP[18] identified numerous other transmission projects that were defined as 'Actionable', meaning that they should progress as soon as possible. The *Actionable transmission* sensitivity demonstrates the potential reliability improvement of these actionable transmission developments, where:

- Committed and anticipated generation and storage projects are applied at the full commercial use date as advised by the project developer (not applying the delays of the 2023 ESOO Central scenario).
- Committed, anticipated and actionable transmission projects are included at the full commercial use date advised by the project developer.

[17] At https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information.

[18] At https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp.

- CER orchestration and demand flexibility growth in DSP, virtual power plants (VPP) and Vehicle to Grid (V2G) projections are applied, in addition to the existing and committed DSP, VPP and V2G developments considered in the ESOO Central scenario.
- Projects identified in Transmission Annual Planning Reports that are material to reliability outcomes, and are likely to be progressed through a RIT-T in the next year are considered:
  - Emerging limitations within Victoria that are driven primarily by demand growth are assumed to be addressed by two upcoming projects, which will be subject to regulatory investment tests for transmission (RIT-Ts) – Western Melbourne metro, where limits are assumed to be addressed by mid-2029 and Eastern Melbourne metro and any residual Latrobe Valley 220 kV network constraints where limits are assumed to be addressed by mid-2031.

The actionable projects from the Draft 2024 ISP and their applied dates are listed in **Table 6.**

Table 6 Projects considered actionable as part of the draft 2024 ISP

Project	Capacity release date	Description
HumeLink	July – December 2026	A new 500 kV transmission line which will connect Wagga Wagga, Bannaby and Maragle, increasing the transfer capacity between southern New South Wales and major load centres within New South Wales (Sydney, Newcastle and Wollongong)
New England REZ Link Part 1	September 2028[A]	New transmission lines and energy hubs to service the New England REZ
Hunter Transmission Project	December 2028	A new 500 kV transmission line of around 115 kilometres between Bayswater in the Upper Hunter and Eraring in the Lower Hunter
Gladstone Grid Reinforcement	March 2029	Upgrading the existing transmission network in Gladstone, Queensland by constructing a 275 kV line, upgrading existing lines and constructing a new transformer at Calliope River
Victoria – New South Wales Interconnector West (VNI West)	December 2029	A new high capacity 500 kV interconnector between Victoria and New South Wales
Marinus Link Stage 1	December 2030	An initial 750 MW link as part of a proposed undersea and underground electricity and telecommunications interconnector between North West Tasmania and the Latrobe Valley in Victoria
Queensland SuperGrid South	September 2031	New 500 kilovolt transmission lines to connect Borumba Pumped Hydro Project into the NEM in Central Queensland
Marinus Link Stage 2	December 2032	An additional 750 MW link as part of a proposed undersea and underground electricity and telecommunications interconnector between North West Tasmania and the Latrobe Valley in Victoria

A. On 14 May 2024, Energy Co advised a revised scope and expected capacity release date of June 2031. All modelling and commentary included in this Update to the ESOO incorporates the previously advised scope and date of September 2028.

Figure 8 shows the results of the *Actionable transmission* sensitivity relative to the updated Central scenario.

Key insights from this sensitivity are:

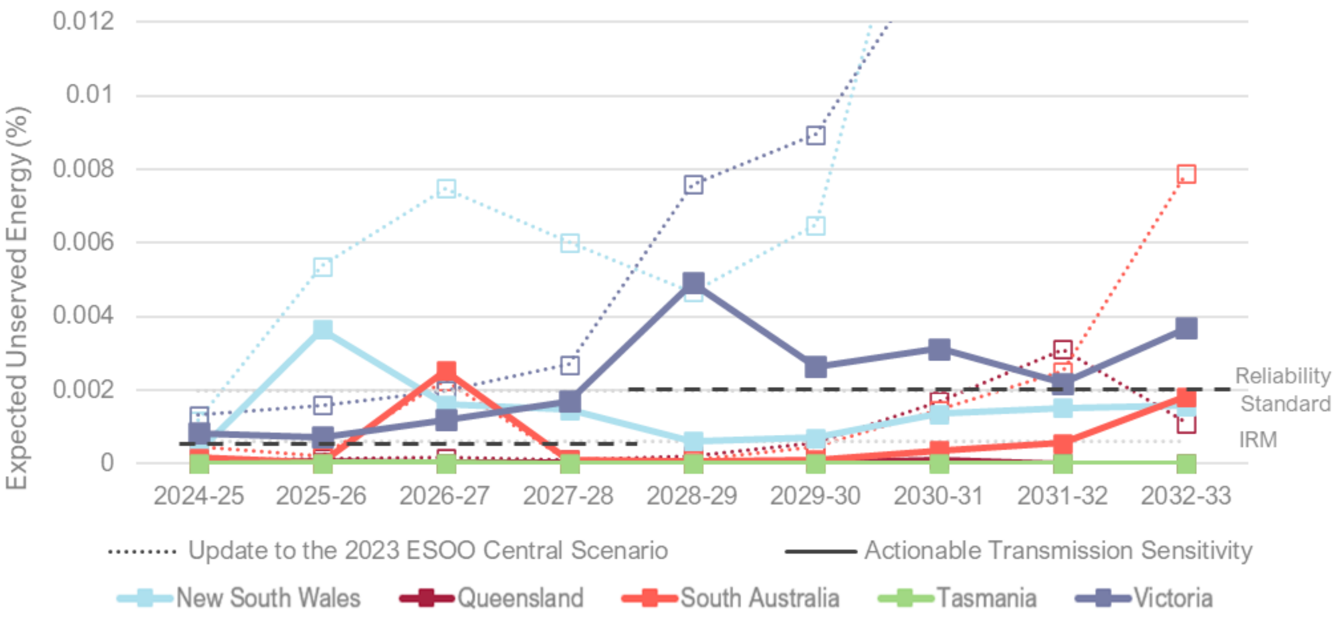
- Forecast expected USE is lower than the Central scenario in all regions, due to the earlier commissioning of committed and anticipated generation and storage projects, the increase in transmission capacity, and the additional demand flexibility.

- Consistent with the findings from the Draft 2024 ISP and the 2023 ESOO Central scenario, additional generation and storage investments, beyond those that are committed or anticipated, are required to ensure reliability.
- In New South Wales, the sensitivity shows significantly lower reliability risks over the ESOO horizon, although the risk is above the IRM from 2025-26 to 2027-28 and also above the reliability standard in 2025-26.
  - Reliability risks are lower relative to the Central scenario, due to the inclusion of additional CER orchestration and the modelled on-time delivery of all included generation and storage projects.
  - In 2026-27 and 2027-28, the HumeLink and Hunter Transmission Project developments commission respectively, reducing expected USE considerably relative to the Central scenario, as increased transmission capacity allows generation and storage projects already considered in the Central scenario to gain access to the major demand centres of Sydney, Newcastle and Wollongong.
  - In 2027-28 and 2028-29, Snowy 2.0 is expected to progressively commission, further reducing expected USE relative to the Central scenario, to be within the reliability standard when fully commissioned.
- In Victoria, the sensitivity shows reliability risks under the reliability standard until (and including) 2027-28, with risks lower than the Central scenario over the entire horizon.
  - Between 2024-25 and 2027-28, reliability risks are lower relative to the Central scenario, due to the inclusion of additional CER orchestration, and the modelled on-time delivery of all included generation and storage projects.
  - From 2028-29, when Yallourn Power Station is expected to retire, reliability risks increase but are considerably lower than in the Central scenario.
  - In 2029-30, Victoria – New South Wales Interconnector West (VNI West) is assumed to release full capacity and to be accompanied by the Western Melbourne metro RIT-T projects that seek to address limitations arising from demand growth within Melbourne. VNI West provides greater connectivity with New South Wales, which also improves reliability outcomes in Victoria. While VNI West was included in this sensitivity, additional generation and storage along the line corridor were not assumed. The sensitivity may therefore understate the potential reliability impact of this transmission development as further generation developments would improve the outlook if developed.
  - In 2030-31 and 2032-33, Stage 1 and Stage 2 of Marinus Link commission respectively. Marinus Link provides greater connectivity with Tasmania, improving reliability outcomes in Victoria. While the new transmission link is included in this sensitivity, additional generation and storage in Tasmania is not assumed. The sensitivity may therefore understate the potential reliability impact of this transmission development as further generation developments in Tasmania would improve the outlook if developed.
  - In 2031-32, the Eastern Melbourne metro RIT-T projects were assumed, relaxing limitations on the eastern side of Melbourne arising from demand growth. These assumed projects allow further flows into Melbourne, improving the reliability outlook.
- In South Australia, the sensitivity shows lower levels of expected USE than the Central scenario, that remain within the reliability standard apart from 2026-27. In that year, Torrens Island B and Osborne power stations

are advised to be decommissioned, and Project EnergyConnect Stage 2 is no longer advised to be available. Reliability risks are considerably lower than in the Central scenario, due to the on-time delivery of all committed and anticipated generation and storage projects, and the additional inter-regional capacity sharing enabled by a more interconnected NEM.

- In Queensland, the sensitivity shows USE within the reliability standard over the entire horizon, significantly lower than the Central scenario. The lower reliability risk is forecast due to the on-time delivery of all included generation and storage projects, increased orchestrated CER developments, and additional interregional capacity sharing enabled by a more interconnected NEM.

Figure 8 ***Actionable transmission*** **sensitivity, expected unserved energy, 2024-25 to 2032-33 (%)**



4.2 Federal and State generation development schemes have the potential to address the majority of long-term risks

Numerous federal, state and territory government schemes and programs are being deployed to further incentivise or directly fund additional generation and storage developments in the NEM. Schemes typically focus on dispatchable capacity needs, or renewable energy developments. The *Federal and State schemes* sensitivity includes the following federal and state schemes in addition to all developments considered in the *Actionable transmission* sensitivity described in **Section 4.1**:

- The **New South Wales Infrastructure Investment Objectives (IIO) Report**[19], which includes an implementation plan for conducting competitive tenders for the IIO Development Pathway.

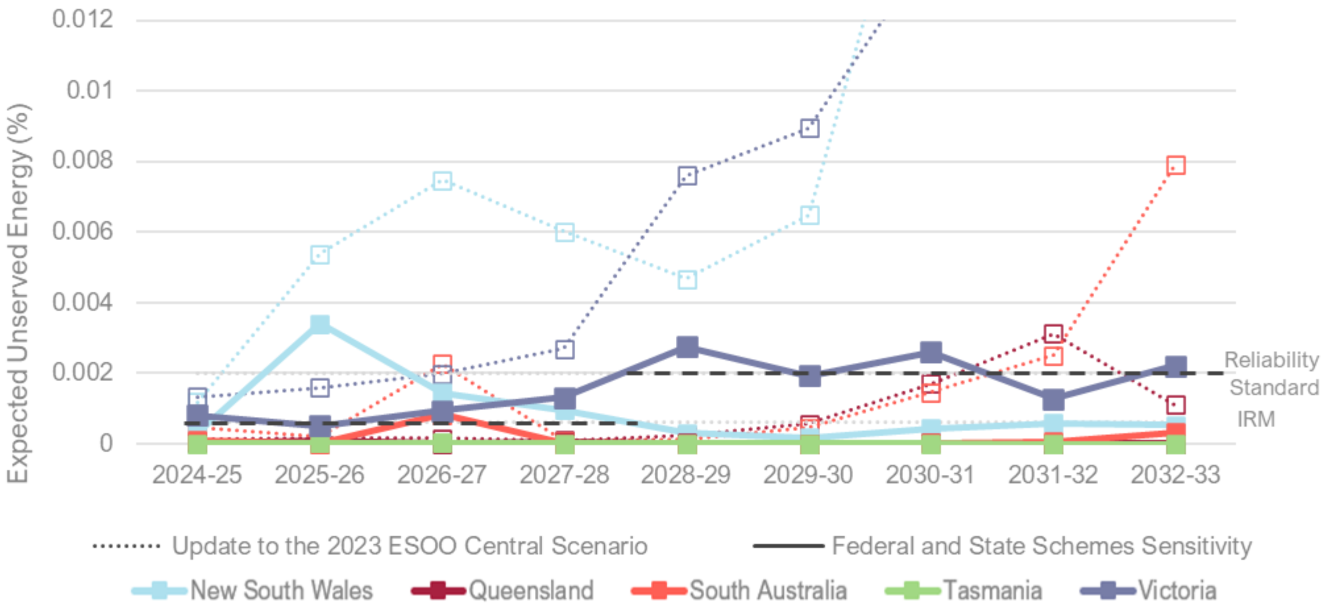
[19] See https://aemoservices.com.au/publications-and-resources/infrastructure-investment-objectives-report.

  – The pathway includes the construction of 2 GW of long-duration (eight or more hours) storage by 2030. The draft 2023 IIO report assumes the majority of this capacity will be commissioned in 2028 and 2030.
  – While the IIO Development Pathway includes further development of VRE generators, these are not included in this sensitivity.
- All projects that have been awarded funding as part of an **Australian Renewable Energy Agency (ARENA), New South Wales IIO**, or **Victorian Renewable Energy Target Auction 2** scheme, that is not yet already considered committed or anticipated by AEMO.
- The **Queensland Energy and Jobs Plan**, which will fund new dispatchable investments including the Swanbank BESS and the Borumba Pumped Hydro Project (both of which were already considered in the Central outlook), and a hydrogen-ready gas peaking power station at Kogan Creek to be commissioned by June 2026.
- The first stage tender of the **Capacity Investment Scheme in South Australia and Victoria**, which will fund the development of an indicative amount of 2,400 megawatt hours (MWh) of storage, with an indicative duration of four hours. For the purposes of this sensitivity, 300 MW/1,200 MWh is assumed in each region.

Other schemes – such as further stages of the Capacity Investment Scheme, renewable developments as part of the IIO Pathway, and jurisdictional renewable energy targets – were not included in this sensitivity as there is yet insufficient detail available for these schemes to be appropriately modelled.

Figure 9 shows the results of the *Federal and state schemes* sensitivity, relative to the updated ESOO Central scenario.

Figure 9 Federal and state schemes sensitivity, expected unserved energy, 2024-25 to 2032-33 (%)



Key insights from this sensitivity are:

- Forecast expected USE is lower in all regions due to the earlier commissioning of committed and anticipated generation and storage projects, the increase in transmission, generation and storage capacity, and the additional demand flexibility.
- Consistent with the findings from the Draft 2024 ISP and the ESOO Central scenario, additional generation and storage investments, beyond those that are committed or anticipated, are required to ensure reliability to adequately replace announced retirements.
- In **New South Wales**, the sensitivity shows reliability risk within the reliability standard, apart from in 2025-26 when Eraring Power Station is advised to have retired.
  - In 2024-25, reliability risks are lower relative to the Central scenario, due to the modelled on-time delivery of all included transmission, generation and storage projects, and projects funded by the first IIO tender.
  - In 2025-26, there is a benefit from additional firming infrastructure from the firming infrastructure tender and additional Capacity Investment Scheme support, alongside the Waratah Super Battery project. However, the additional risks from the retirement of Eraring Power Station and revised distribution of demand across New South Wales load centres mean that the risk exceeds the reliability standard.
  - Between 2026-27 and 2032-33, the HumeLink and Hunter Transmission Project developments commission, as well as Snowy 2.0, the IIO long duration storage projects and the firming infrastructure tender, reducing USE for the remainder of the horizon.
- In **Victoria**, the sensitivity shows reliability risks to be lower than that forecast in the ESOO Central scenario, however risks are still forecast above the reliability standard in some periods from 2028-29.
  - In 2024-25 to 2027-28, reliability risks are lower relative to the Central scenario due to the modelled on-time delivery of all included transmission, generation and storage projects, and projects funded by the Victorian Renewable Energy Target Auction 2 and the federal Capacity Investment Scheme.
  - In 2028-29 to 2032-33, some reliability risks exceed the reliability standard, but risks are reduced relative to the Central scenario due to the development of Actionable and other considered transmission projects, and the included schemes.
- In **South Australia**, reliability risks are forecast within the reliability standard over the horizon. Reliability improvements arise relative to the Central scenario, due to the modelled on-time delivery of all included generation and storage projects, the federal Capacity Investment Scheme and the enhanced ability of neighbouring regions to provide additional capacity in times of supply scarcity.
- In **Queensland**, reliability risks are forecast within the reliability standard over the horizon. Reliability improvements arise relative to the Central scenario, due to the modelled on-time delivery of all included generation and storage projects, the development of the Kogan Creek gas turbine, and the enhanced ability of available generation in New South Wales to provide additional capacity in times of supply scarcity following actionable ISP transmission developments.

While the sensitivity demonstrates that there is potential to address the majority of the forecast reliability risks for many jurisdictions over the ESOO horizon with existing schemes, additional development opportunities remain, and delivery challenges will exist. Project commissioning delays are emerging as a material risk to the delivery of transmission, generation and storage projects. Delays to the delivery of projects, relative to the dates envisioned by the schemes and proponents, has the potential to result in periods of high risk throughout the horizon.

The pipeline of known generation and storage projects[20] is more than 4.5 times larger than the size of the current NEM, indicating that there are sufficient projects at various stages of consideration to resolve any residual reliability risks.

There remain numerous other government schemes in development that have the potential to bring forward this pipeline of proposed projects, which will further address the residual reliability risks forecast. These schemes include:

- Further developments as part of the federal Capacity Investment Scheme, which seeks to unlock at least 9 GW of dispatchable power (the first stage tenders are included in the sensitivity).
- Further developments as part of the New South Wales Electricity Infrastructure Roadmap.
- Further developments as part of the Queensland Energy and Jobs Plan.
- Further developments as part of the Victorian Renewable Energy Target, Storage Target, Offshore Wind Policy, or State Electricity Commission (SEC) investments.
- Developments to meet the Tasmanian Renewable Energy Target.
- Further developments to support the Federal Government's *Powering Australia Plan* commitment to increase renewable energy generation to 82% of supply by 2030.

4.3 The opportunity to improve power system reliability in the NEM varies by technology and location

Reliability gaps calculated for the ESOO Central scenario, as shown earlier in **Table 1** and **Table 2,** are calculated as the additional capacity required, if unconstrained and continuously available throughout the entire financial year, to reduce the forecast of expected USE to the relevant reliability metric. While these values are useful to understand the scale of the development response required, no generator or storage technology is ever actually unconstrained and continuously available – each unit is subject to unplanned outages, energy limitations, and power system constraints.

This section provides an assessment of the indicative reliability benefit, assessed as the reduction in expected USE of:

- Different generation technologies, relative to an unconstrained, always available, energy unlimited generator, per mainland region.
- Different NEM connection points, relative to an unconstrained, always available, energy unlimited generator, assessing reliability benefits per mainland region.

[20] Committed, anticipated or publicly announced projects as per the April 2024 Generation Information.

To assess the reliability benefit *of different generation technologies*, 200 MW of each generation technology was added to each mainland region to assess the change in expected USE relative to the USE improvement expected from a 200 MW addition that was both unconstrained and energy unlimited. The reliability benefit was assessed against the ESOO Central scenario only, in the year 2029-30. This assessment:

- Did not consider the inter-regional benefits of new capacity.
- Assessed the reliability needs of the region for the year of study in isolation; the reliability needs of other years were not considered, and therefore the best technology or location in the selected year may not be best over the longer term, as the energy system and customer demand evolves over time.
- Considered the reliability needs of the region without consideration for likely developments that may occur beyond what is already considered committed or anticipated. Wind and solar reliability contribution factors may decline over time, as further developments in wind and solar may not increase the resource diversity if not widely distributed geographically.

To assess the reliability benefit of generators *at different connection points* within the NEM, 200 MW of an energy unlimited generator was separately added to a large number of connection points to assess the change in expected USE relative to a 200 MW unconstrained, energy unlimited generator at the regional reference node for each NEM region. The assessment was conducted for both the ESOO Central scenario and the *Actionable transmission* sensitivity for the year 2029-30.

This assessment:

- Identified the relative reliability benefit assuming the generator is always available and energy unlimited.
- Considered only higher level power system level limitations that have the potential to impact power system reliability. Limitations relating to local transmission or distribution networks, or connection points were not considered, and could reduce the reliability contribution of a given development opportunity[21].
- Assessed reliability benefits only, and does not reflect all of the opportunities and costs a project proponent should consider when choosing a development location in the NEM.
- For the ESOO Central scenario, considered only the generation, storage and transmission developments and retirements as modelled in the scenario. Any changes to the developments or retirements considered may change the locational opportunities across the NEM.
- For the *Actionable transmission* sensitivity, considered only the generation and storage developments as modelled in that sensitivity. Additional generator retirements are however applied to this analysis to ensure there is sufficient reliability risk to study. For each region, the next generator to retire in terms of expected closure date was selected, being Mt Stuart, Gladstone, Vales Point B, Loy Yang A, Mintaro and Dry Creek. Their retirement is assumed for the functionality of this study only and does not represent a view on the

[21] Power system models do not consider all transmission elements, and do not consider any distribution or connection point limitations. For example, a lower voltage connection point modelled with a high reliability factor may be subject to local network congestion not modelled by AEMO. Project proponents must engage with network service providers (NSPs) and undertake their own studies to determine the potential benefits of any development.

likelihood of the earlier retirement of these generators. Any changes to the developments or retirements considered may change the locational opportunities across the NEM.

For each mainland region, maps are provided that indicate the relative reliability benefit of connection points in that region and in neighbouring NEM regions. For example, connection points coloured dark green are modelled to have 100% relative reliability benefit, while those coloured dark red are modelled to have 0% reliability benefit. Each connection point is further differentiated by size, whereby larger points represent the extra high voltage transmission network (275 kV, 330 kV and 500 kV) connection points, and smaller points reflect lower voltage sites.

New South Wales

Figure 10 shows the relative reliability benefits of various generation and storage technologies in New South Wales for 2029-30, relative to a fully unconstrained, always available, energy unlimited generator.

Gas turbines, six- and eight-hour batteries, and 12-hour pumped hydro projects are shown to have the highest relative reliability benefit, with the main difference attributable to the expected level of unplanned outages. Wind and solar generators are found to have low relative reliability benefits, which are likely to decline further, as reliability risks are increasingly concentrated outside of periods with wind or solar availability. Two-hour and four-hour batteries in New South Wales have lower relative reliability benefits compared to other regions due to the extended nature of USE periods in New South Wales in this year.

Figure 10 Reliability benefit of various generation technologies relative to an unconstrained, energy unlimited generator, New South Wales 2029-30

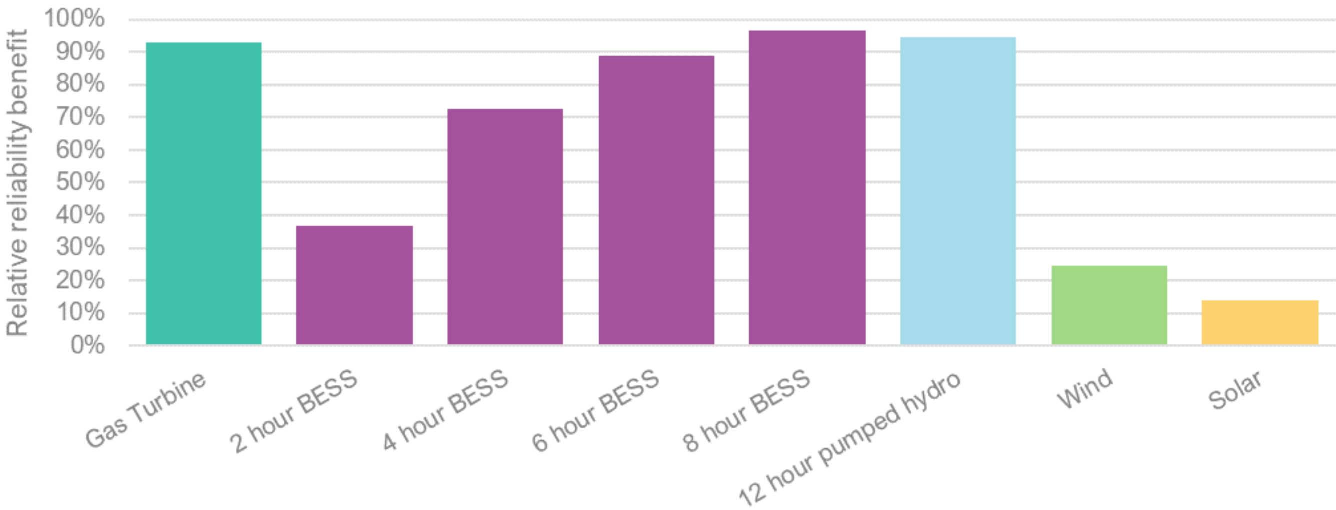


Figure 11 shows the relative reliability benefits of generators located at various connection points across New South Wales and the NEM for the ESOO Central scenario in 2029-30.

Key points are:

- Connection points in the Sydney and Newcastle areas are shown to have a 100% relative benefit, while those further south, west, and coastal north are shown to have reduced reliability benefits due to periods of congestion on transmission networks at time of New South Wales reliability risk.
- Connection points on the Queensland – New South Wales Interconnector (QNI) corridor in the north of New South Wales, and further north in Queensland, are shown to have no reliability benefit, indicating that transmission capacity towards Sydney is fully utilised at time of New South Wales reliability risk.
- Connection points south and west of Canberra, and those in Victoria, South Australia and Tasmania, are shown to have no reliability benefit, indicating that transmission capacity towards Sydney is fully utilised at time of New South Wales reliability risk.

For comparison, **Figure 12** shows the relative reliability benefits of generators located at various connection points across New South Wales and the NEM for the *Actionable transmission* sensitivity in 2029-30.

Key points are:

- Additional transmission developments, including HumeLink and Hunter Transmission Project, significantly increase transfer capacity within New South Wales to service major load centres in this sensitivity.
- However, generator projects that are already considered committed and anticipated, including Snowy 2.0, fully take up this additional capacity.
- As such, the relative reliability benefits of connection points around the NEM remain similar to, and in some cases lower than, those identified for the ESOO Central scenario, due to additional congestion arising from increased flows from Southern New South Wales. While these developments significantly improve the capability for existing, committed and anticipated projects in southern locations in New South Wales to service major load centres, the opportunity for further developments in these locations beyond those commitments is limited without additional transmission investment.
- While considered after the study year of 2029-30, the development of the actionable transmission project New England REZ Part 2 transmission link (2033) has the potential to increase benefits further for locations in the New England REZ area.

Figure 11 ESOO Central scenario, locational reliability factors for New South Wales USE, 2029-30

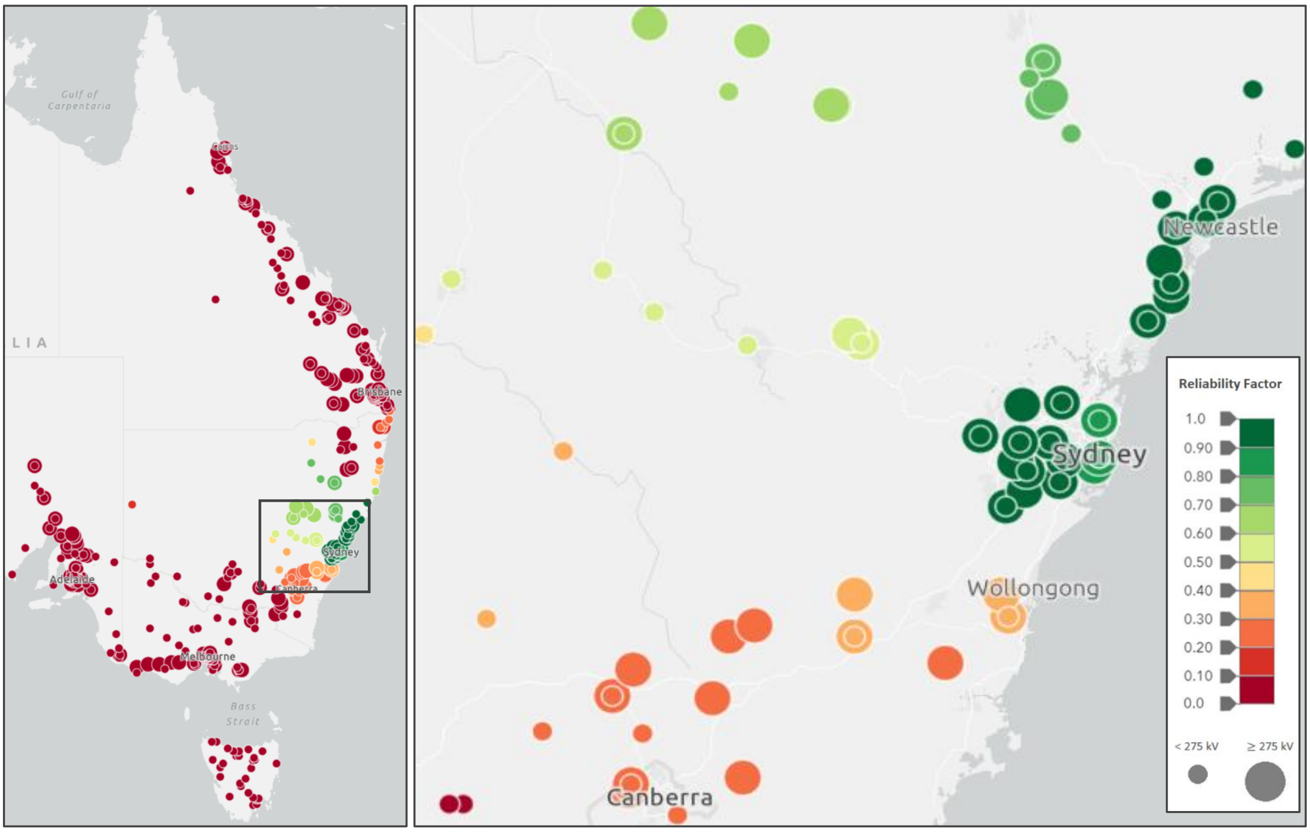
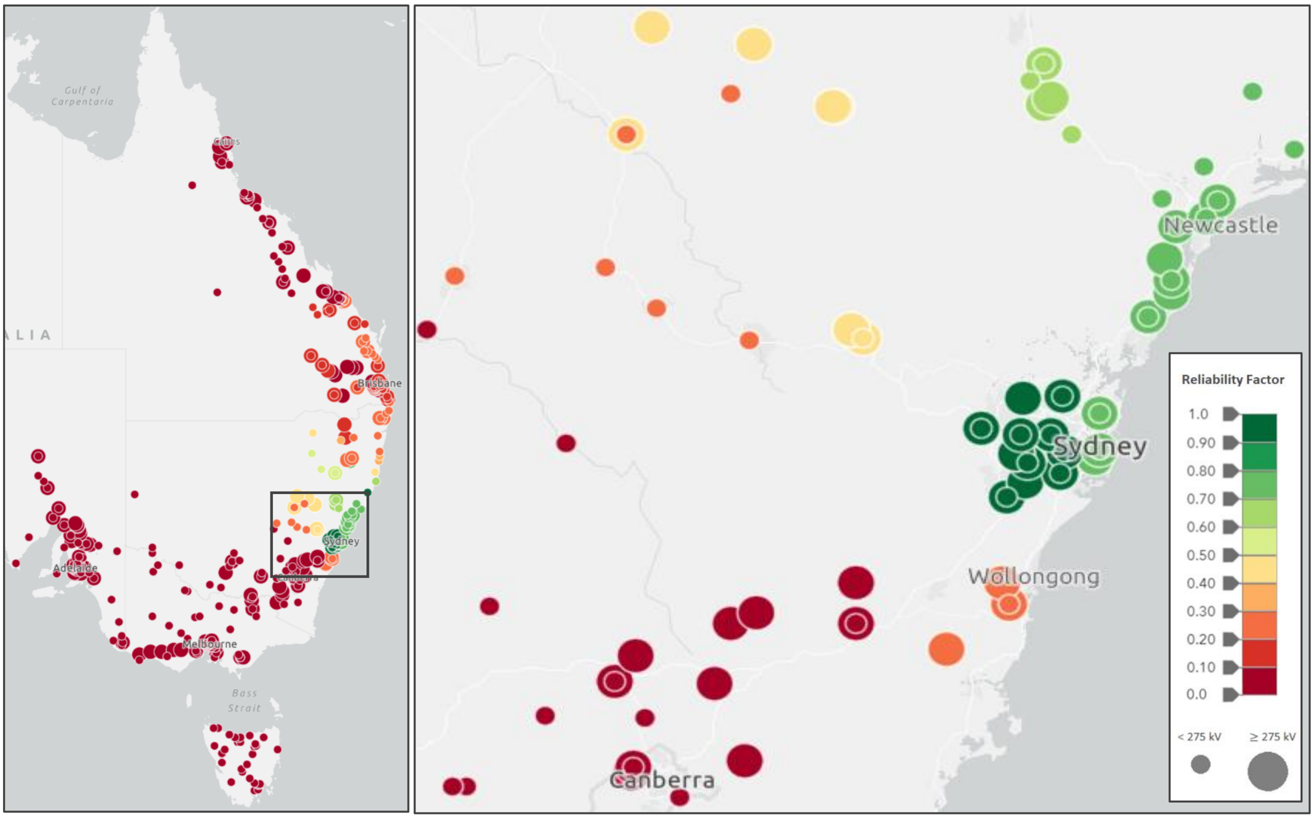


Figure 12 *Actionable transmission* sensitivity, locational reliability factors for New South Wales USE, 2029-30



Queensland

Figure 13 shows the relative reliability benefits of various generation and storage technologies in Queensland for 2029-30, relative to a fully unconstrained, always available, energy unlimited generator.

Gas turbines, four-hour, six-hour and eight-hour batteries, and 12-hour pumped hydro projects are shown to all have a high relative benefit, while relatively low benefits occur from wind and solar. There is a slightly lower relative reliability benefit from solar compared to other regions, as periods of reliability risk in Queensland are predominantly forecast to occur during low solar generation periods.

Figure 13 Reliability benefit of various generation technologies relative to an unconstrained, energy unlimited generator, Queensland 2029-30

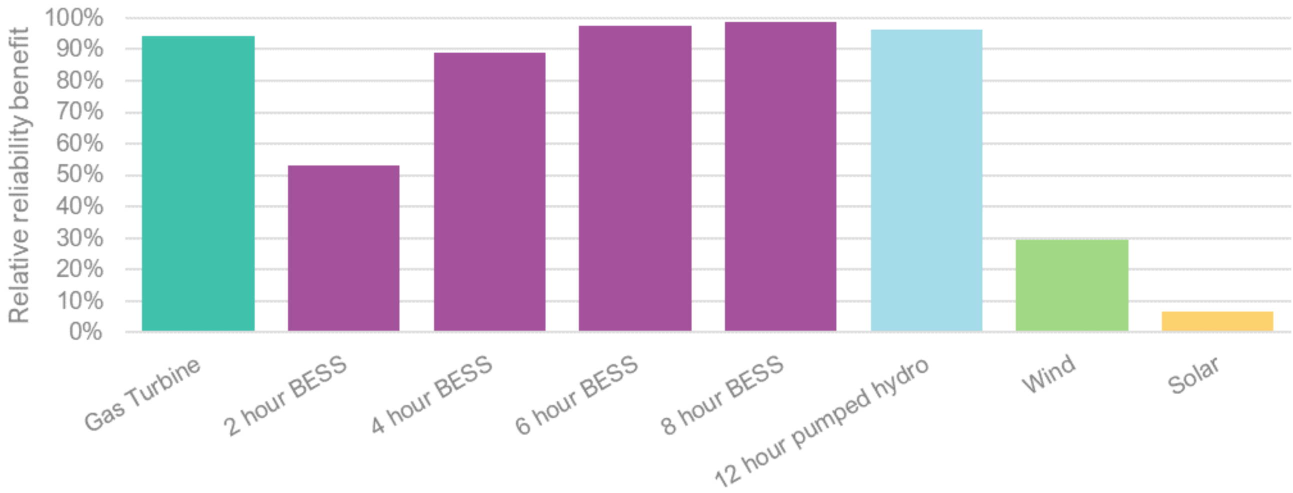


Figure 14 shows the relative reliability benefits of generators located at various connection points across Queensland and the NEM for the ESOO Central scenario in 2029-30.

Key points are:

- Connection points between the Gold Coast and Gladstone are shown to have a 100% relative reliability benefit, while those west of Brisbane are shown to have reduced reliability benefits due to congestion in transmission networks at time of Queensland reliability risk.
- North of Gladstone, and all connection points in southern regions, show only low levels of reliability benefit, indicating that transmission capacity towards south east Queensland is subject to congestion at time of Queensland reliability risk.

Figure 15 shows the relative reliability benefit of generators located at various connection points across Queensland and the NEM for the *Actionable transmission* sensitivity in 2029-30.

Key points are:

- This sensitivity includes the Gladstone Grid reinforcement, and the assumed earlier retirement of the Gladstone Power Station, to ensure there is sufficient reliability risk for the purposes of this study.
- As a result of the reinforcement and earlier assumed retirement, connection points in the Central Queensland sub-region are shown to have increased reliability benefits as they are no longer competing with the Gladstone Power Station for access to southern loads, and to support load in central Queensland.
- Developments in north and far north Queensland are no longer shown to have reliability benefits in this sensitivity, despite the assumed retirement of the Mt Stuart generator. This occurs as system strength limitations prevent the dispatch of these assumed inverter based resources. While not modelled, the development of synchronous generators, or the remediation of system strength issues would improve the capability of these locations to provide reliability benefits to Queensland.
- While not considered in this analysis of 2029-30, the development of the actionable transmission project Queensland SuperGrid South (advised capacity release in 2031) has the potential to increase the reliability contribution potential for Central Queensland locations regardless of the assumed retirement of Gladstone Power Station by strengthening the connection between central and southern Queensland.

Figure 14 ESOO Central scenario, locational reliability factors for Queensland USE, 2029-30

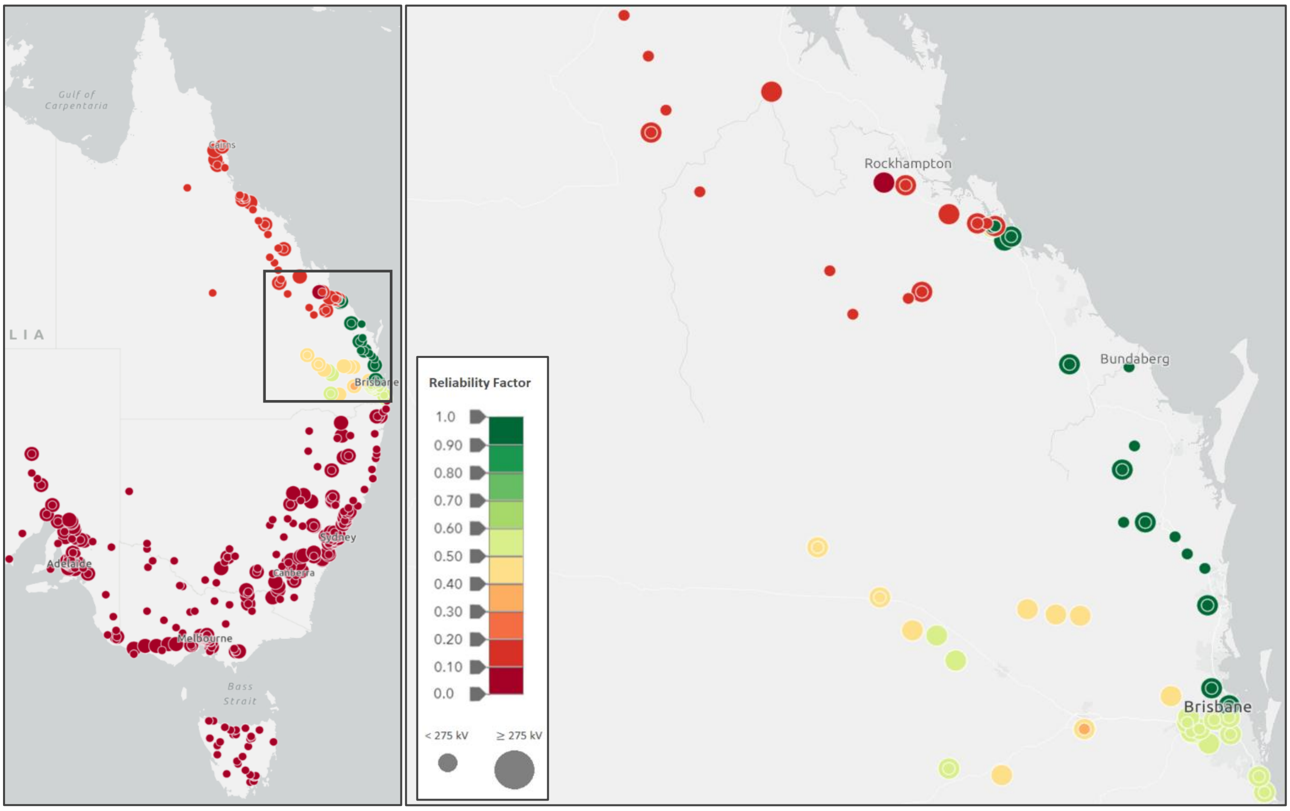
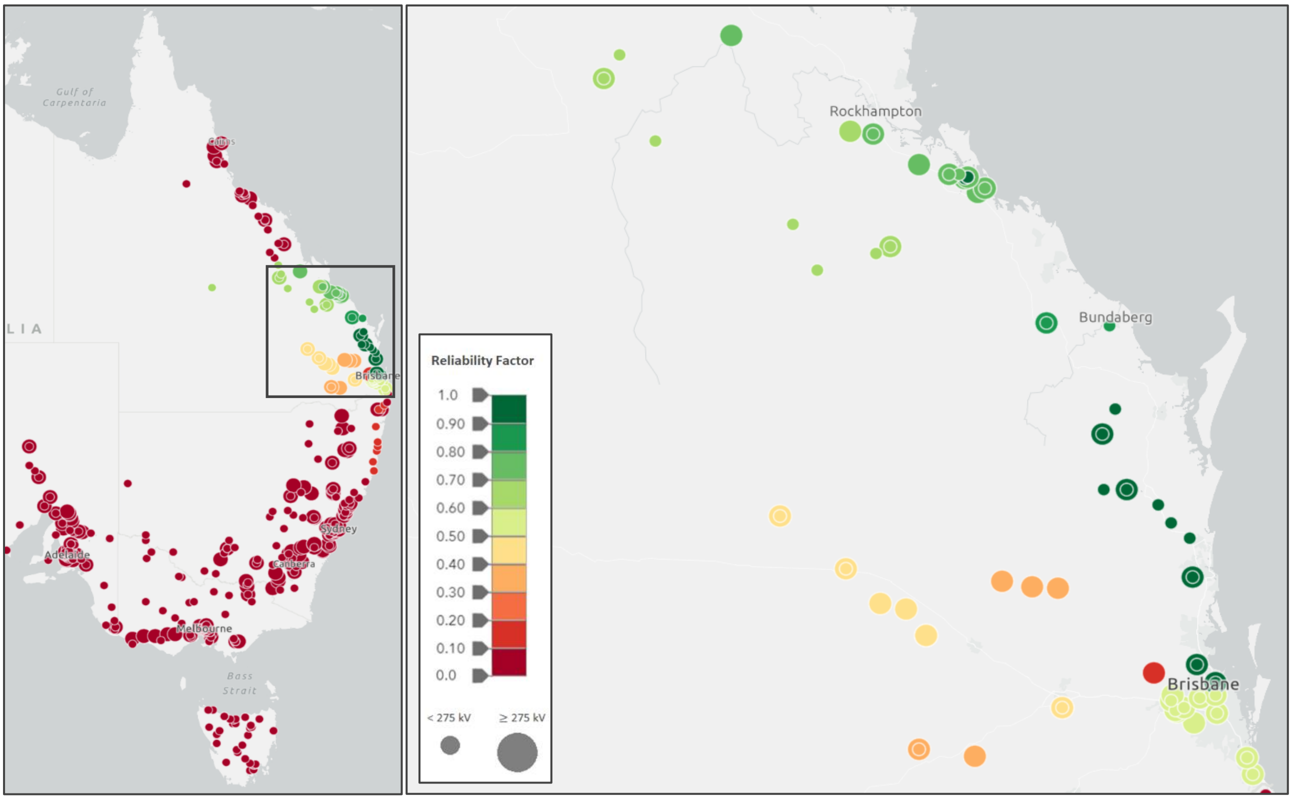


Figure 15 *Actionable transmission* sensitivity, locational reliability factors for Queensland USE, 2029-30



South Australia

Figure 16 shows the relative reliability benefits of various generation and storage technologies in South Australia for 2029-30, relative to a fully unconstrained, always available, energy unlimited generator.

Gas turbines, four-hour to eight-hour batteries, and 12-hour pumped hydro projects are shown to all have a high relative benefits, while wind and solar generators are found to have lower relative benefits. Because USE is likely to occur in periods with low wind and solar resources, new wind and solar build has a decreasing contribution given the high level of existing capacity of these technologies.

Figure 16 Reliability benefit of various generation technologies relative to an unconstrained, energy unlimited generator, South Australia 2029-30

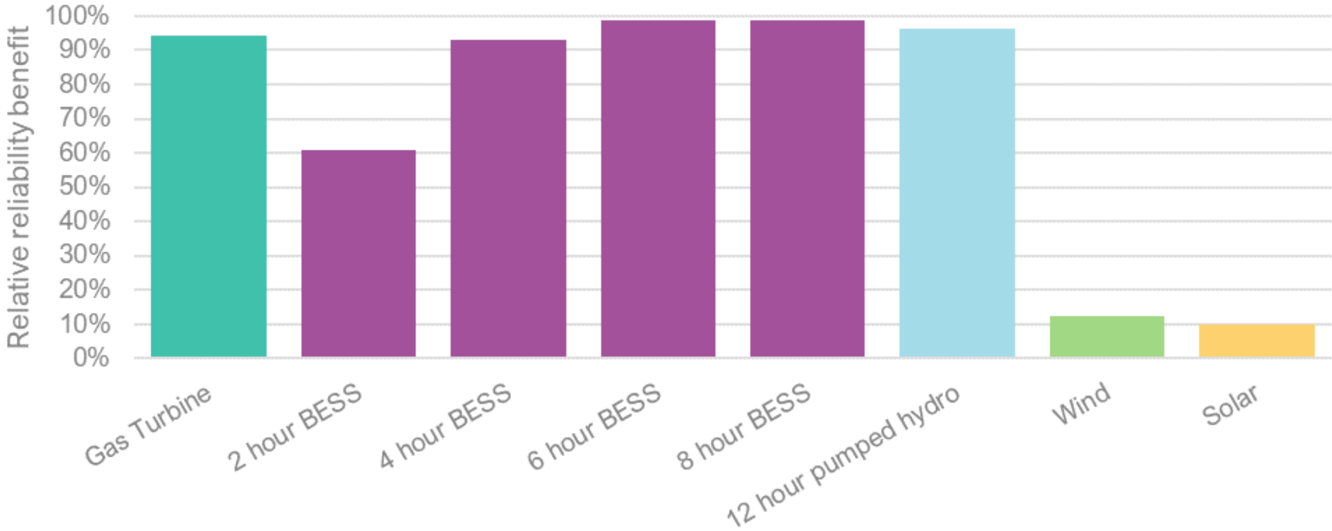


Figure 17 shows the relative reliability benefits of generators located at various connection points across South Australia and the NEM for the ESOO Central scenario in 2029-30.

Key points are:

- The majority of locations within South Australia are shown to have a high reliability benefit, with only those on the Yorke and Eyre peninsulas shown to have reduced reliability benefits.
- Locations within southern New South Wales, particularly those along the Project EnergyConnect corridor, and various locations in Victoria are also shown to contribute favourably to reliability risks in South Australia.
- Connection points in northern New South Wales, Queensland and Tasmania are shown to have no reliability benefits towards South Australia.

Figure 18 shows the relative reliability benefit of generators located at various connection points across South Australia and the NEM for the *Actionable transmission sensitivity* in 2029-30.

Key points are:

- Additional transmission developments – including VNI West, the Melbourne West metro RIT-T, HumeLink and the Hunter Transmission Project – significantly increase transfer capacity across southern Australia in this sensitivity.
- While additional reliability benefits are noted throughout Tasmania, Victoria and New South Wales, those in Southern New South Wales have reduced factors as the development of HumeLink allows existing, committed and anticipated generators throughout New South Wales to utilise Project EnergyConnect capacity towards South Australia.

Figure 17 ESOO Central scenario, locational reliability factors for South Australian USE, 2029-30

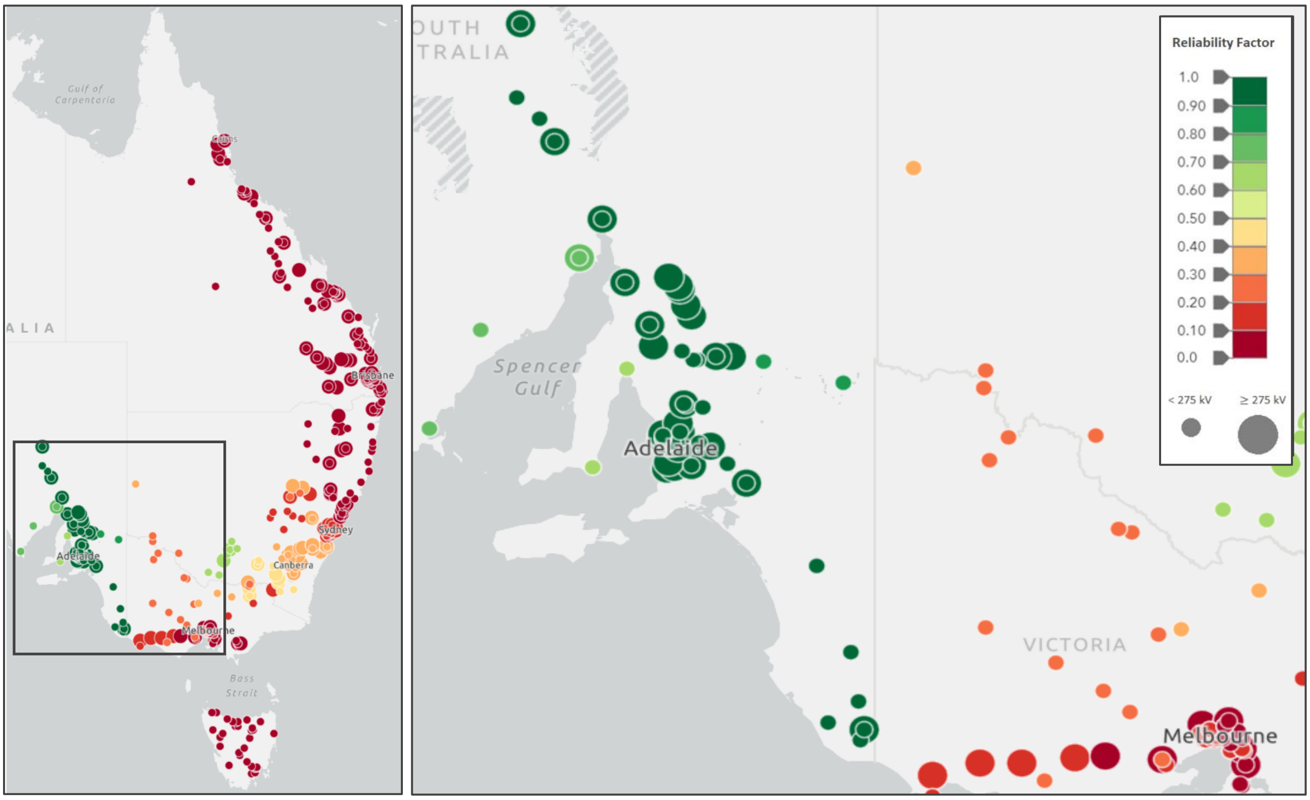
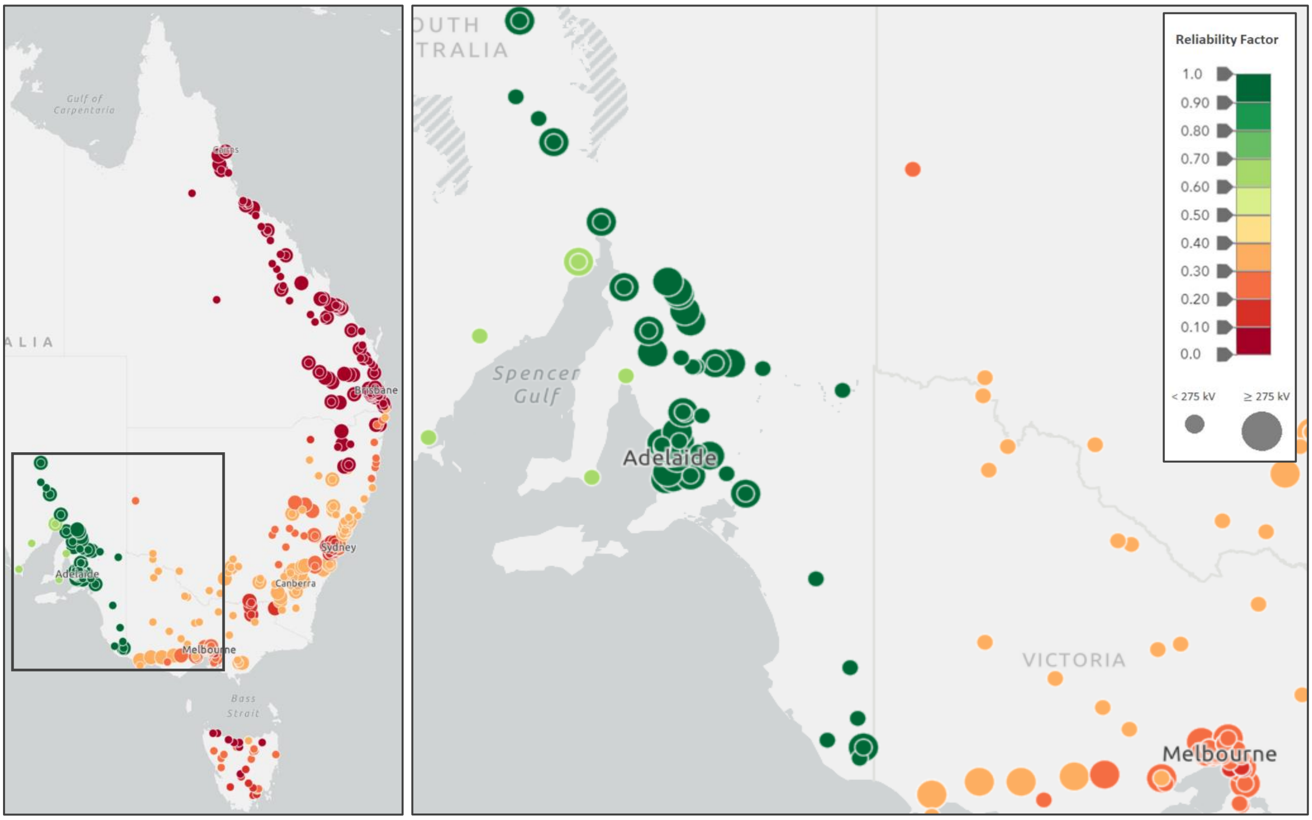


Figure 18 *Actionable transmission sensitivity*, locational reliability factors for South Australian USE, 2029-30



Victoria

Figure 19 shows the relative reliability benefits of various generation and storage technologies in Victoria for 2029-30, relative to a fully unconstrained, energy unlimited generator.

Gas turbines, four-hour, six-hour and eight-hour hour batteries, and 12-hour pumped hydro projects are shown to all have a high relative benefits, while two-hour batteries and wind and solar generators are found to have lower relative reliability benefits. As USE is likely to occur in periods with low wind and solar resources, additional developments of these technologies will likely have a decreasing contribution.

Figure 19 Reliability benefit of various generation technologies relative to an unconstrained, energy unlimited generator, Victoria 2029-30

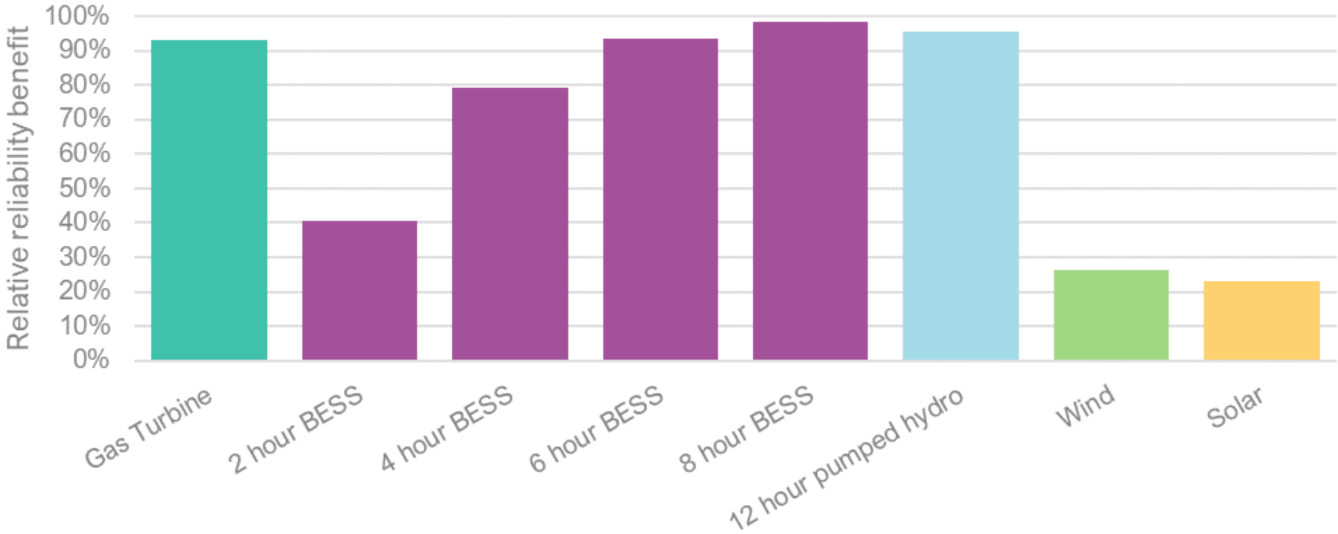


Figure 20 shows the relative reliability benefits of generators located at various connection points across Victoria and the NEM for the ESOO Central scenario in 2029-30.

Key points are:

- Many connection points within the Melbourne 220 kV network are shown to have a 100% relative reliability benefit, while those on the 500 kV network are shown to have approximately half the benefit, indicating that transmission capacity into Melbourne through the 500/330/220 kV networks is subject to congestion at time of Melbourne reliability risk. This confirms that further network investment in Victoria, such as the Melbourne metro RIT-Ts, should be progressed to support demand growth, as identified in the *Victorian Annual Planning Report* and currently being progressed by AEMO Victorian Planning.
- Connection points in regional Victoria and South Australia are shown to have reduced reliability benefits relative to those in the Melbourne 220 kV network, while those in New South Wales, Tasmania and Queensland are shown to have no or low reliability benefits, indicating that the relevant transmission networks are fully utilised at time of Victorian reliability risk.

Figure 21 shows the relative reliability benefits of generators located at various connection points across Victoria and the NEM for the *Actionable transmission* sensitivity in 2029-30.

Key points are:

- Additional transmission developments, including VNI West and the Western Melbourne metro RIT-T, significantly increase transfer capacity across Victoria and South Australia in this sensitivity.
- As a result, connection points in Victoria, South Australia and Tasmania are shown to have significantly more benefit than in the Central scenario. This demonstrates that these transmission developments enable reliability risks to be resolved by generation and storage developments outside the Melbourne 220 kV network, including the Melbourne 500 kV network and VNI West corridor.
- Due to forecast demand growth in Tasmania, Basslink is no longer to be fully utilised, and in this sensitivity some limits between the Latrobe Valley and Melbourne have been reduced, hence additional capacity in Tasmania has a reliability benefit to Victoria under some conditions.
- While not considered in this analysis of 2029-30, the development of Marinus Link 1, Marinus Link 2 and the Melbourne East metro RIT-T (with target development timeframes after 2030) have the potential to increase benefits further for locations in regional Victoria and Tasmania.

Figure 20 ESOO Central scenario, locational reliability factors for Victorian USE, 2029-30

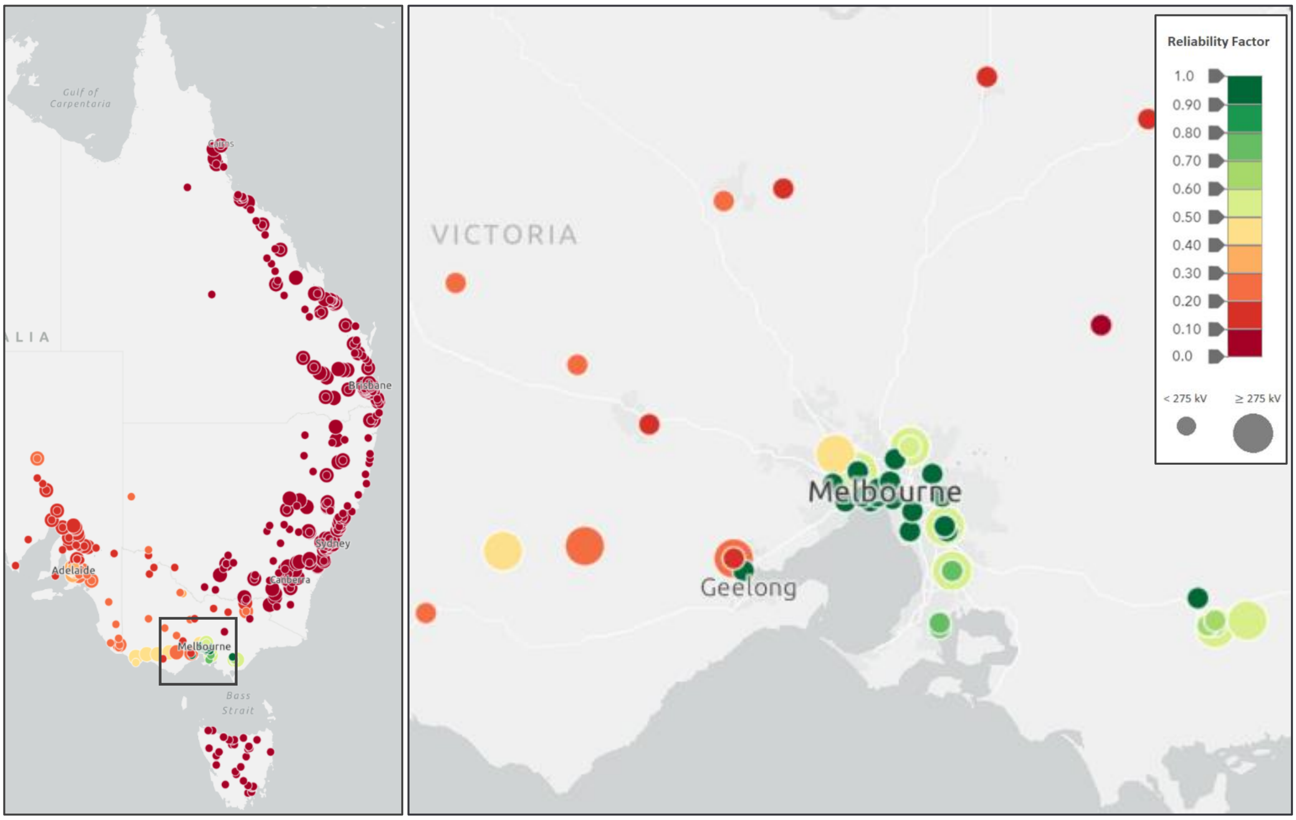
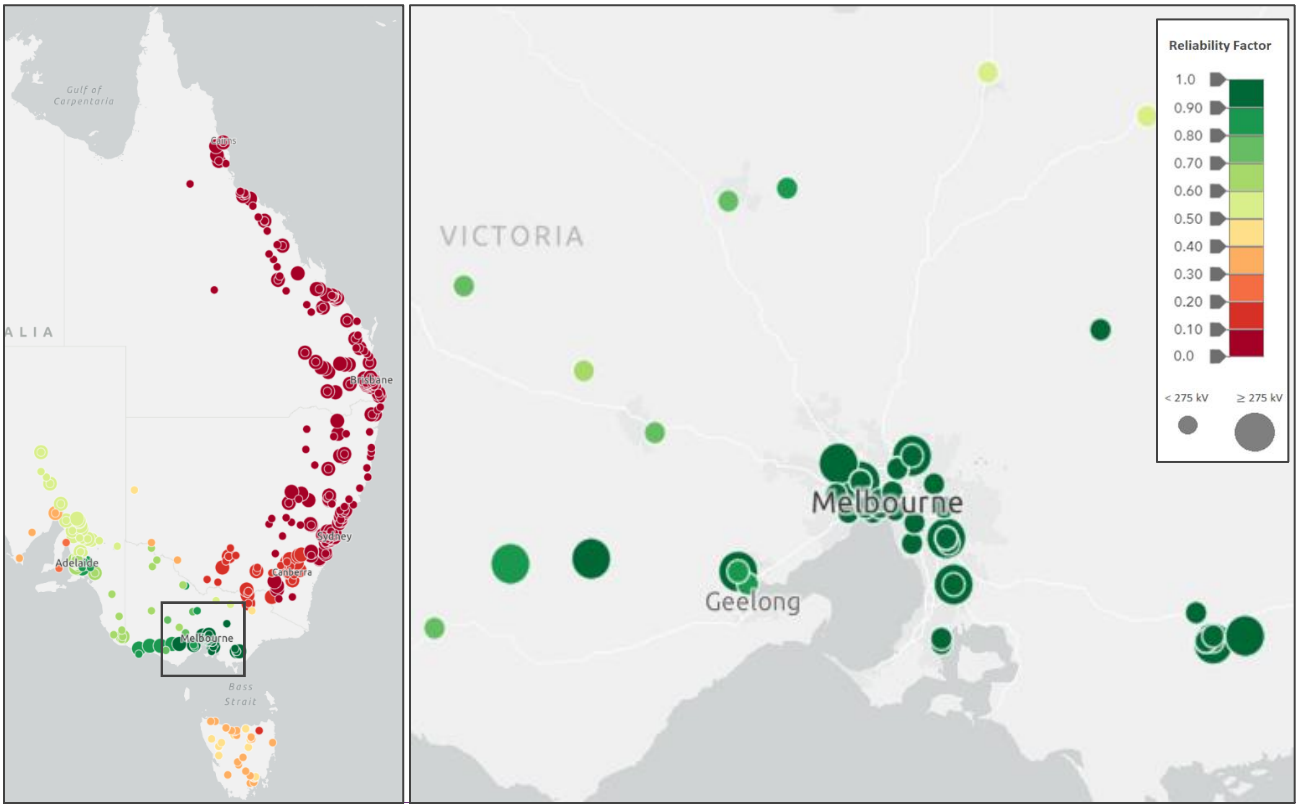


Figure 21 Actionable transmission sensitivity, locational reliability factors for Victorian USE, 2029-30



4.4 Reliability and power system security

A reliable power system requires more than just sufficient levels of installed capacity and available energy supplies. The system must also maintain an underlying set of security and stability services to ensure that it remains both stable and resilient under normal operating conditions, and following disturbances.

Over the coming decade, the rapid energy transition will result in a significant need for new assets and providers of these essential system services, including for system strength, frequency management, voltage control, ramping capability, and system restoration services.

The timing and magnitude of these emerging requirements are influenced by:

- **Retiring thermal generation** – historically, thermal generation has been the source of much of the system strength, inertia, and system restart services in the NEM, and a significant source of voltage control and ramping capability. Replacement services will be needed as these units withdraw.
- **Increases in inverter-based resources (IBR) development** – adequate system strength, voltage control, and ramping capability will be needed to ensure that future levels of IBR can operate stably, and transfer energy to where it is needed.
- **Major network augmentations** – network upgrades can help reduce system security requirements by lowering system impedance and allowing better sharing of existing services across multiple locations. They can also impact the likelihood of regions becoming islanded and reduce the impact of credible network events, putting downward pressure on security needs.

AEMO and network service providers (NSPs) must act in advance to procure the assets and services necessary to meet all system security needs. However, these investments can be subject to regulatory delays and extended lead times, limiting their flexibility to adapt to rapid changes in the short term. When security services are inadequate in operational timeframes, AEMO may reduce the output of specific generators or limit network transfers to re-secure the system.

This represents both a risk and an opportunity for new proponents, as existing sources of these services withdraw, and new providers are sought to meet these needs.

Projected system security outlook and opportunities

Analysis undertaken by AEMO as part of the 2023 annual system security reports[22] and Draft 2024 *Integrated System Plan* (ISP)[23] confirms the following:

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[22] 2023 System Strength Report, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/2023-system-strength-report.pdf?la=en, 2023 Network Support and Control Ancillary Services (NSCAS) Report, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/2023-nscas-report.pdf?la=en, and 2023 Inertia Report, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/2023-inertia-report.pdf.

[23] At https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/draft-2024-isp.pdf.

- **System strength** – this is likely to be the most onerous emerging requirement in all regions, and is projected to require new system strength assets or services strategically timed, and distributed in optimal locations across the NEM.
  - Of this, approximately 22 equivalent synchronous condensers are needed to meet minimum fault level requirements and must be delivered by devices that can provide protection-quality levels of fault current – such as new synchronous condensers, service contracts with existing hydro or thermal units, or through the retrofit of those existing units themselves. Much of this investment is needed by 2029-30 to allow for extended periods with limited thermal generators online, even before they formally retire.
  - The remaining system strength services are needed to accommodate future IBR and could be met by a variety of existing or new technologies with the ability to stabilise their local voltage waveforms, including grid-forming inverters.
- **Inertia** – available inertia levels will fall sharply alongside declining thermal generator utilisation and unit retirements. If no new investment in inertia occurs, typically availability is projected to fall from 63,000 megawatt seconds (MWs) in 2024-25 to as low as 21,000 MWs by 2029-30. These needs could be partially met by investments for system strength capable of delivering both services at once, highlighting the importance of co-optimised investment decisions, and versatile asset types.
- **Voltage control** – these needs are largely met by the additional reactive capabilities provided by IBR investment, particularly when IBR is installed in sufficient volumes to meet maximum demand conditions. However, increasing system volatility will place greater emphasis on the system's dynamic reactive capabilities.
- **Ramping** – system ramping events continue to grow in magnitude alongside growth in distributed solar generation and increasing penetration of weather-dependant resources such as grid-scale solar and wind. While typical events are not yet sufficient to create system normal security risks, this is changing rapidly, and will increasingly present opportunities for new flexible plant and battery energy storage systems (BESS).
- **System restoration** – several major thermal generating units provide system restart ancillary services (SRAS) in the form of trip to house load capability. In addition, restart of major thermal generating units from smaller restart services is generally an early step in the process of restoring the power system following a black system event. Retirement of these units will require careful case-by-case monitoring and open opportunities for new service providers. AEMO is currently undertaking an SRAS procurement process[24].

While these needs are all expected to emerge and grow over the coming decade, AEMO's 2023 system security reports identify that service gaps have already emerged in all regions. In particular:

- System strength shortfalls of 1,420 megavolt amperes (MVA) and 1,165 MVA are forecast at Newcastle and Sydney West respectively from 1 July 2025, with an immediate shortfall of 64 MVA already present at Gin Gin in Queensland, and at all system strength nodes in Tasmania.
- Inertia shortfalls are already being managed in South Australia and Tasmania, with a new 1,660 MWs shortfall projected to emerge in Queensland from 2027-28. The Victorian region is forecast to fall below its secure

[24] See https://www.aemo.com.au/consultations/tenders/sras-procurement.

operating level in over 90% of periods by 2028-29, however strong interconnection with other regions means it is not considered sufficiently likely to island.

- Existing voltage control gaps in Queensland and New South Wales closed in the 2023 calendar year, with a new immediate voltage control gap declared for South Australia, and new thermal and voltage control risks identified near Deer Park and Melbourne in Victoria.

List of tables and figures

Tables

Figures