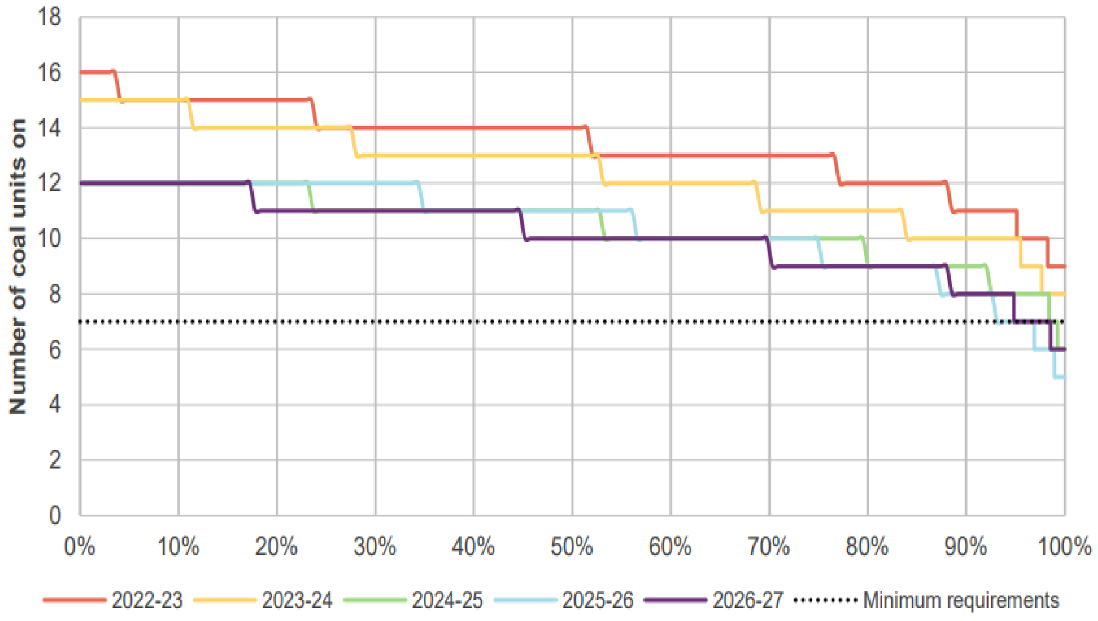
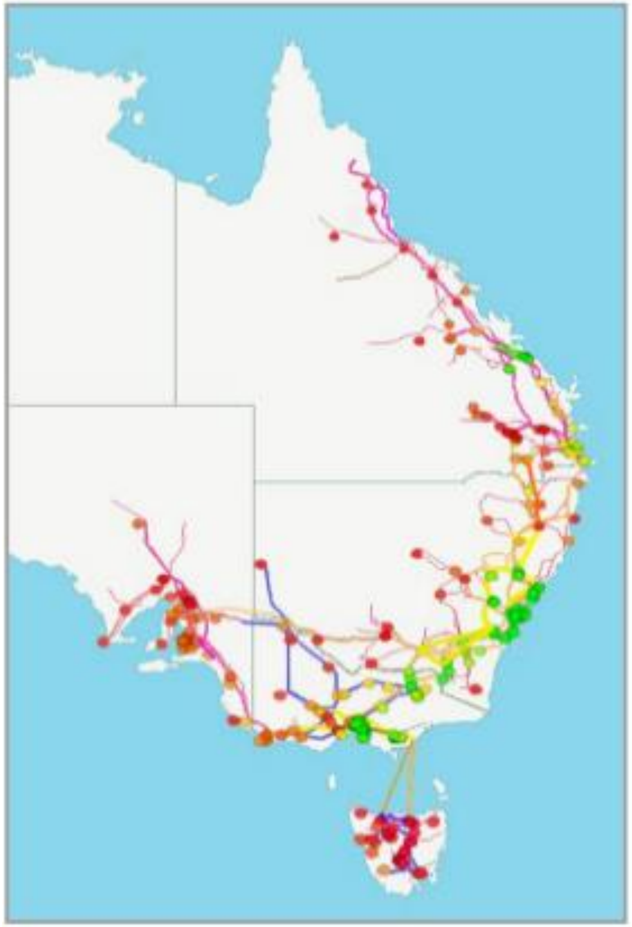
Efficient management of system strength during the power system transition

AUSTRALIAN ENERGY MARKET OPERATOR

Inverter-based renewable energy uptake and declining synchronous generation commitment is driving urgent need for more system strength services in Australia



Number of coal units projected to be online under a 'progressive change' scenario in the New South Wales jurisdiction over the coming five years, shown against the minimum threshold. Since publication, a scenario with higher renewable uptake, 'step change', has been identified as more likely and a major coal-fired power station has announced early retirement. [AEMO, 2021 System Security Reports]



System strength outlook for the Eastern seaboard in 2031-32. Assumes 'backbone' system strength services are met and shows where additional support is needed to accommodate more inverter-based renewable energy generation. [AEMO, Draft 2022 Integrated System Plan]

Significant regulatory changes have been made to secure system strength services

Existing framework	Incoming framework
• AEMO sets minimum fault level requirements for each region. • Local transmission network secures 'shortfall' services against fault level projection. • Newly-connecting generators self-remediate system strength impact.	• AEMO sets system strength standard for each region, including fault level requirement and voltage waveform stability criteria. • Local transmission network secures services to meet the full standard. • Newly-connecting generators can pay to access the centralised service, or self-remediate.

AEMC, Efficient management of system strength on the power system

AEMO combines three modelling techniques to plan for system strength

Market modelling	Steady state loadflow	Electromagnetic transient analysis
• Long-term capacity outlook for generation resources and new generator planting. • Optimal development pathway for generation and network developments. • Time-sequential results projecting generator commitment and decommitment across the day and through the year.	• Holistic network planning to account for thermal limits, voltage management, and fault level projections. • Calculate long-term projections for fault level, to be compared against minimum values as a proxy for system strength.	• Assess power system stability for key power system snapshots, based on market modelling. • Study inverter interactions and generator performance pre- and post-contingency. • Derive a requirement for fault level (MVA) at key network nodes, to be used as a proxy for system strength needs. • Assess proposed system strength services from transmission networks.

A variety of system strength services have been implemented or are being explored

- Synchronous condensers
- Operation of hydro in synchronous condenser mode
- Agreements with synchronous generators to remain online
- Grid-forming inverters coupled with batteries
- Tuning the inverters of existing variable renewable energy
- Temporary constraints on number of inverters online for existing variable renewable energy
- New network augmentations

Synchronous condensers can mitigate post-disturbance oscillations through injection of fault current

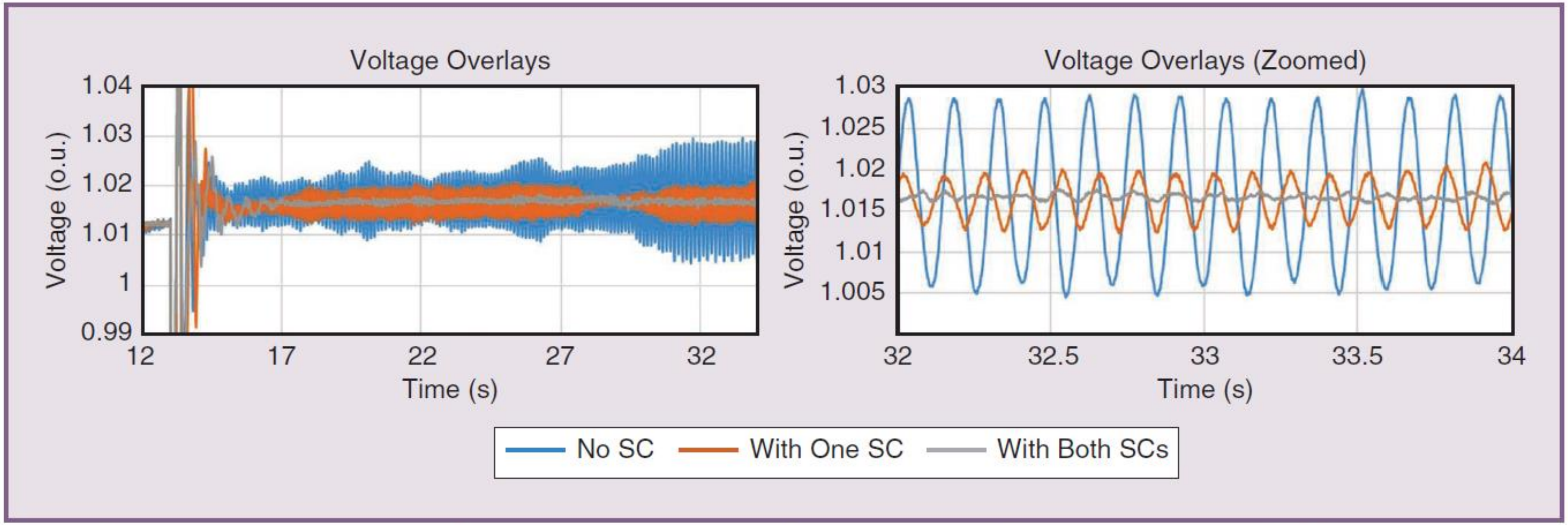


figure 6. The contribution of synchronous condensers on mitigating sustained postdisturbance oscillations.

[IEEE, Power system operation with a high share of inverter-based resources: The Australian experience]

Inverter tuning for variable renewable energy sources can prevent voltage waveform distortion

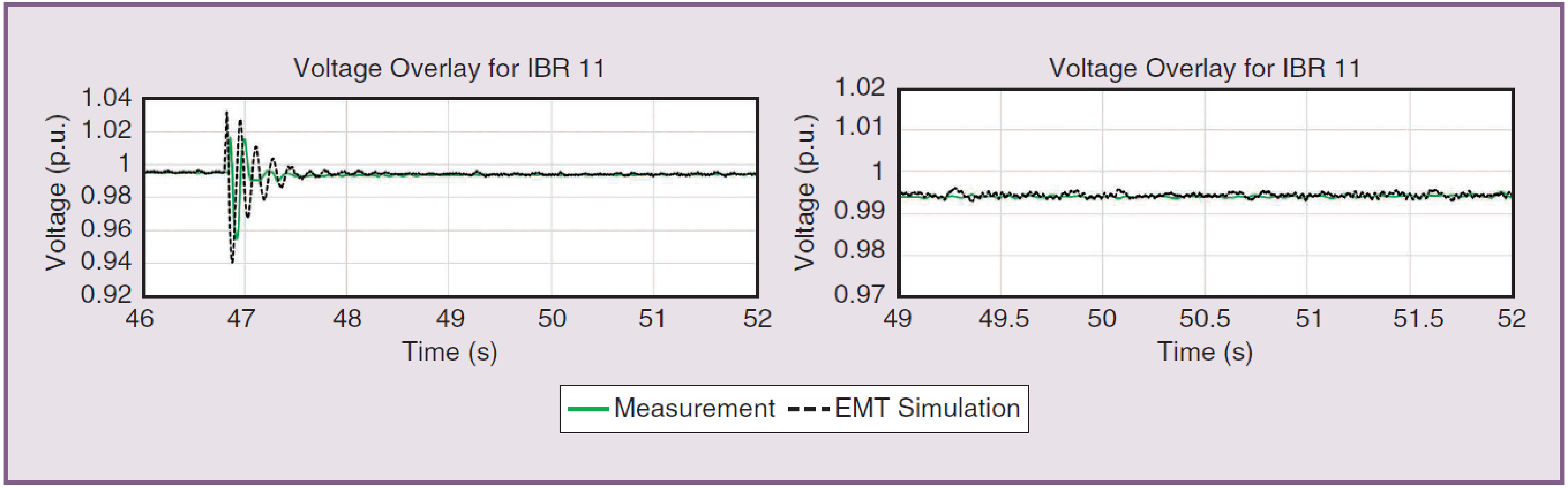
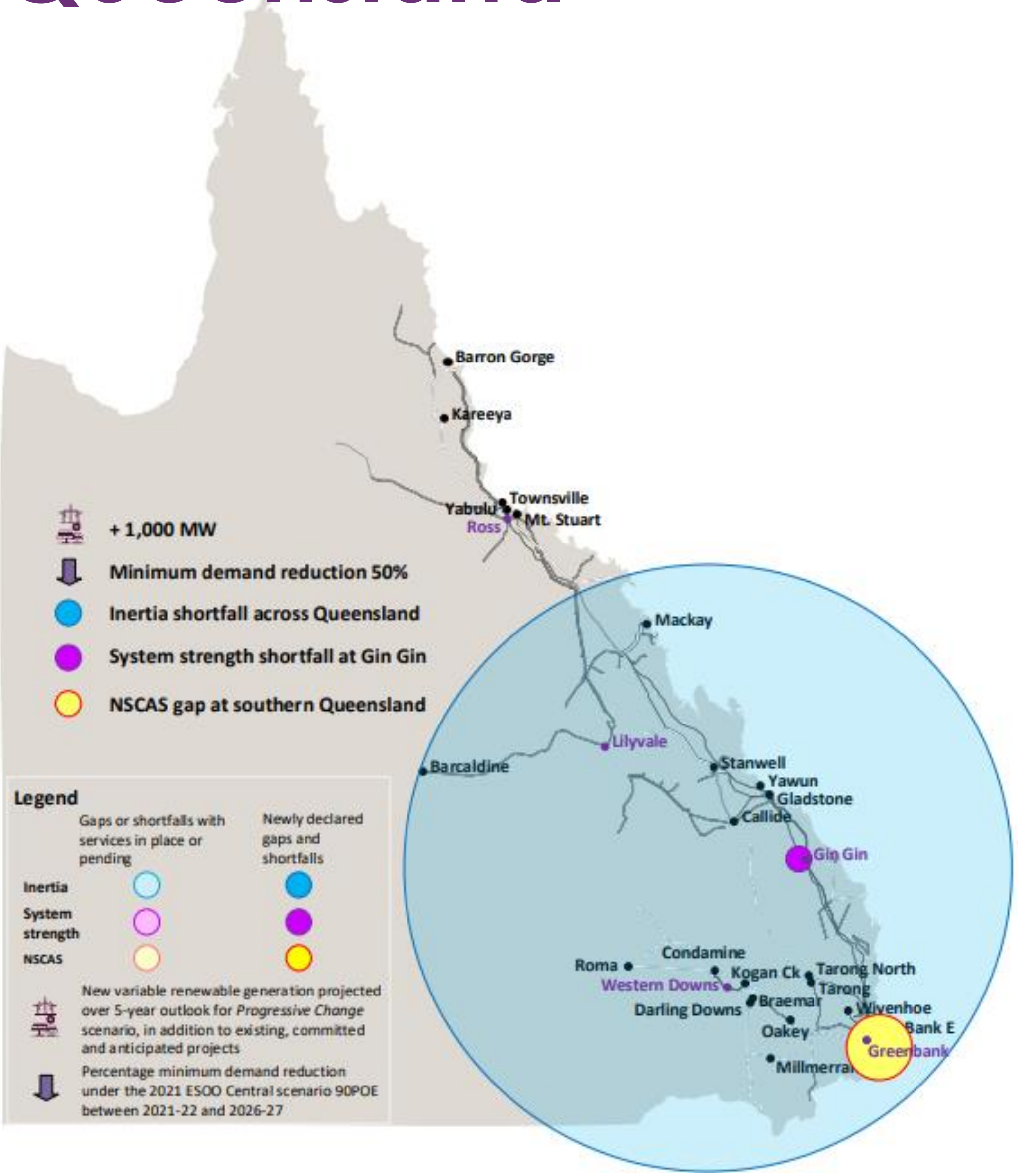


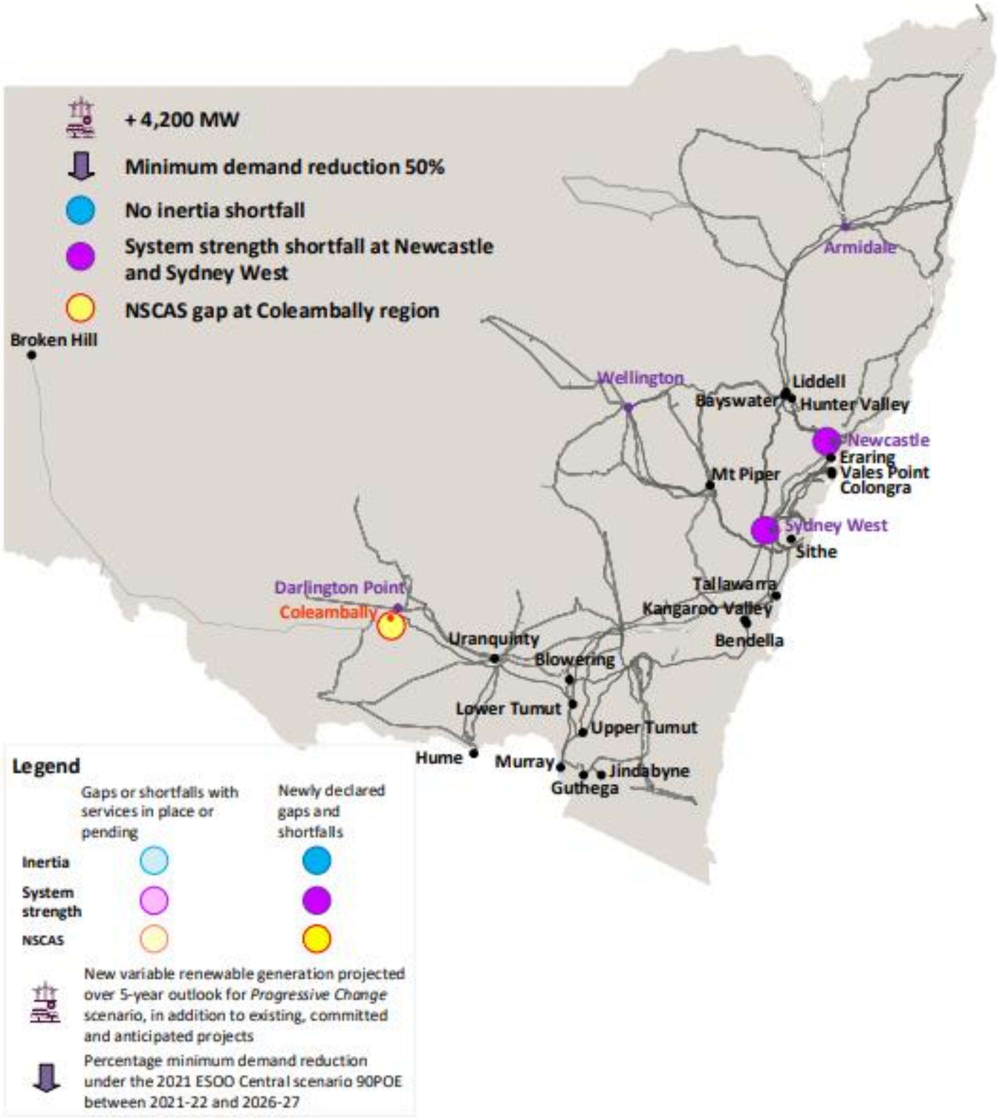
figure 7. Overlays of measured and simulated responses following IBR tuning.

[IEEE, Power system operation with a high share of inverter-based resources: The Australian experience]

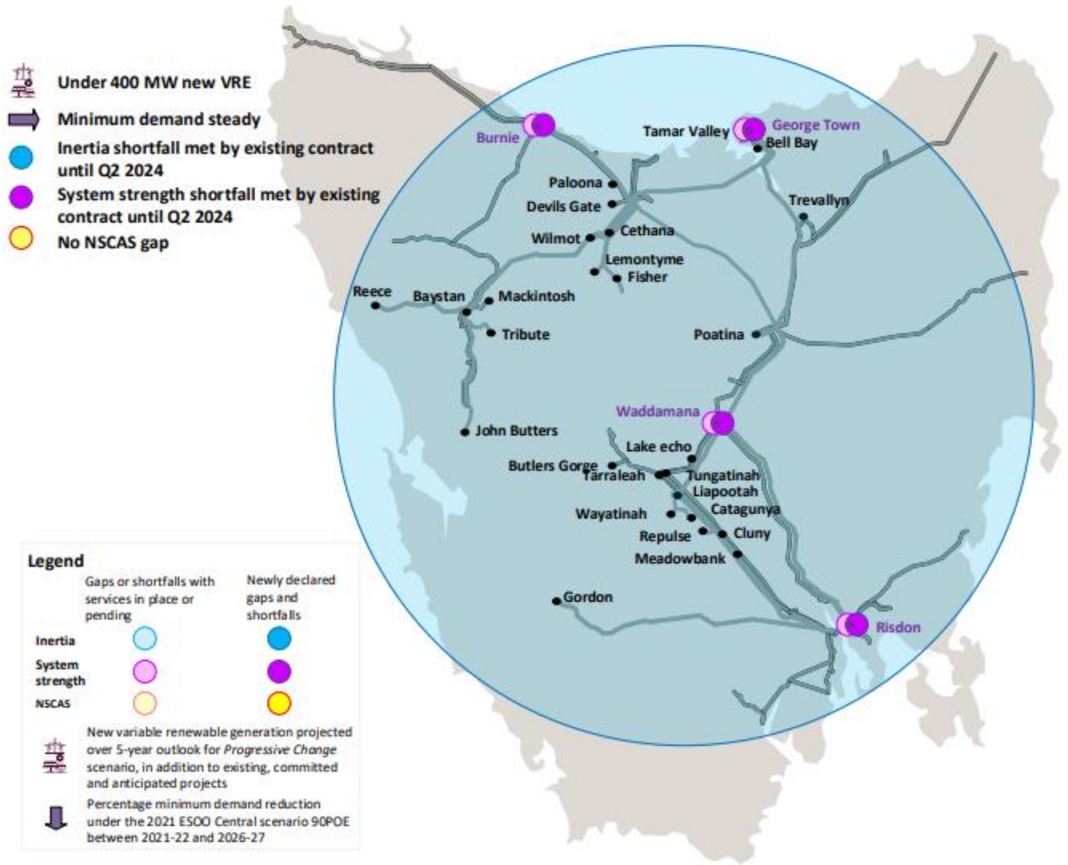
Queensland



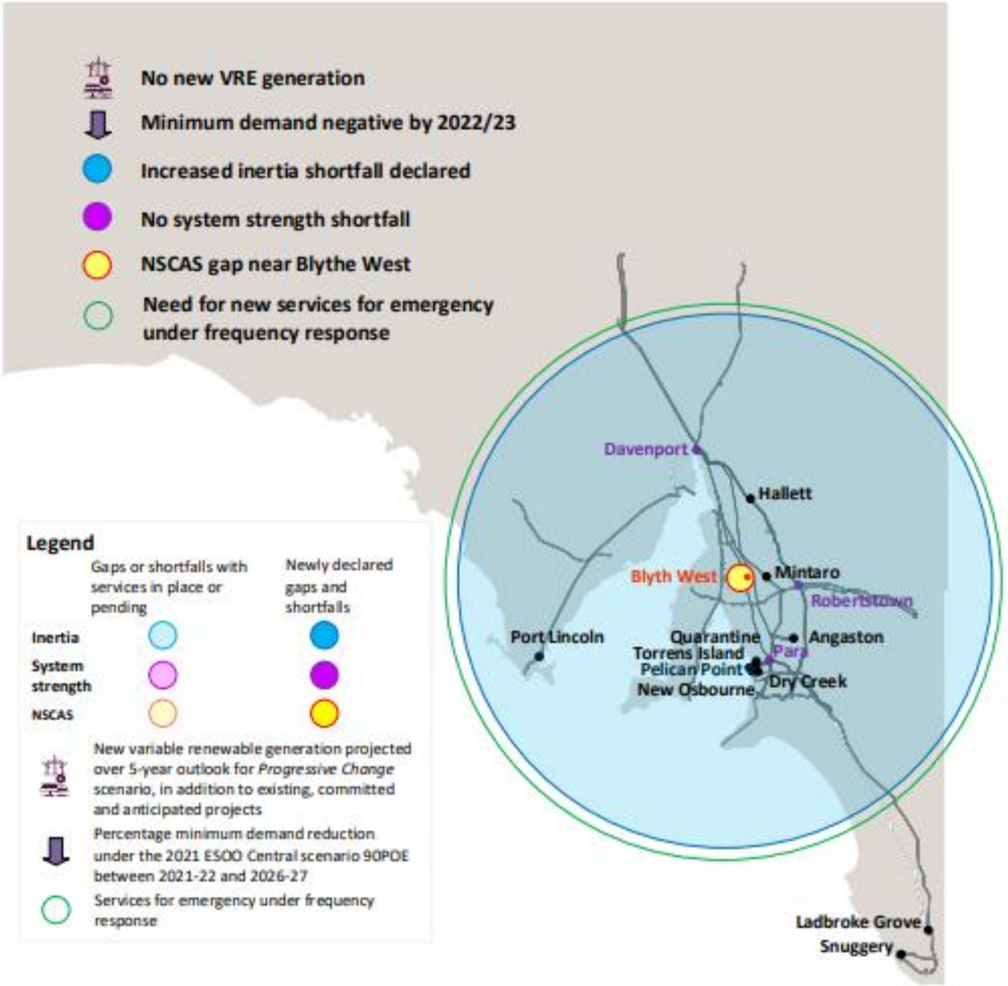
New South Wales



Tasmania



South Australia



AEMO

AUSTRALIAN ENERGY MARKET OPERATOR

For more information visit

aemo.com.au