Managing the energy transformation in an open-access energy-only Market

Future Directions for Market Operation and System Planning

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Agenda

1. Australia's electricity networks
2. The National Electricity Market
3. Transmission and Reliability Planning
4. Energy transformation
5. Power system technical requirements

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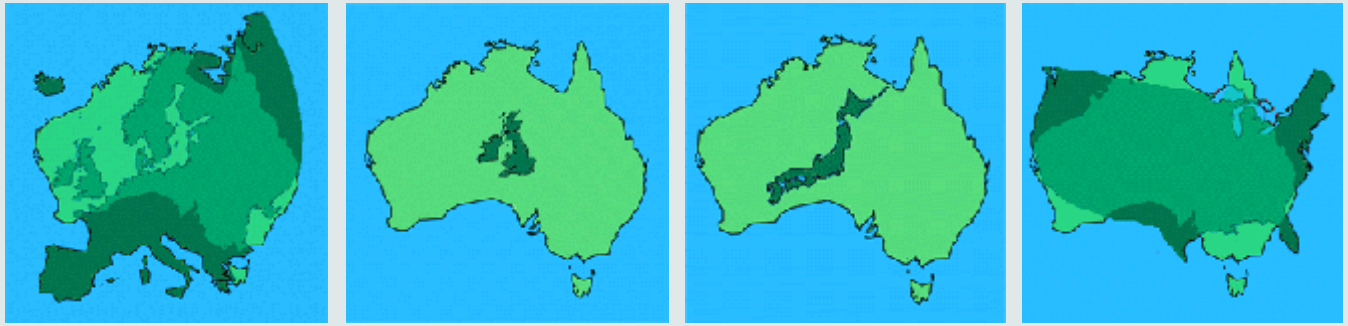
Australian electricity networks



- Eastern interconnection (NEM) approx. 4500 km long
- 190 TWh annual energy, 15 – 35 GW demand
- 47 GW installed capacity (incl. 6 GW LS wind & PV)
- 8 GW of domestic solar PV installed.
- Rapid growth of domestic solar PV (200 MW / month)
- 5 minute energy only market
- AEMO the ISO / IMO for this interconnection

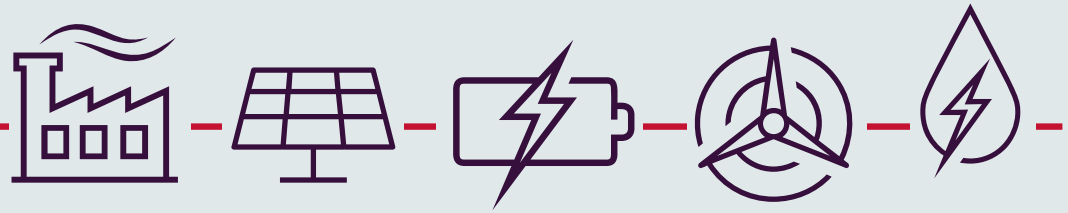
Australia's Energy-only Market

- The NEM is an energy only market dispatched by AEMO in 5 minute intervals and settled in 30 minute blocks
- The NEM operates around a common energy pool (spot market) for wholesale trading.
- AEMO also manages a FCAS market for 8 different frequency services.
- Energy and FCAS dispatch is co-optimised every market interval by an economic dispatch engine based on generator bids, network congestion, system stability limits and marginal loss factors.
- There are 5 separate price regions between which electricity is transmitted, each with it's own regional reference node.
- There is no day-ahead market or unit commitment dispatch. Pre-dispatch schedules forecast expected lack of reserves
- While prices bid by generators may not vary, the generator may rebid available capacity and energy constraints
- Renewable forecasts are provided by AEMO through ASEFS and AWEFS, although some generators have commenced self forecasting

Transmission and Reliability Planning

- Transmission Annual Planning Report (TNSP)
- Integrated System Plan (AEMO)
- Regulatory Investment Tests for Transmission (TNSP)
- Power System Frequency Risk Review (AEMO)
- Planner of Last Resort (AEMC)

- Reliability Standards
- Electricity Statement of Opportunity (AEMO)
- Reliability Retailer Obligation
- Reliability and Emergency Reserve Trader (AEMO)



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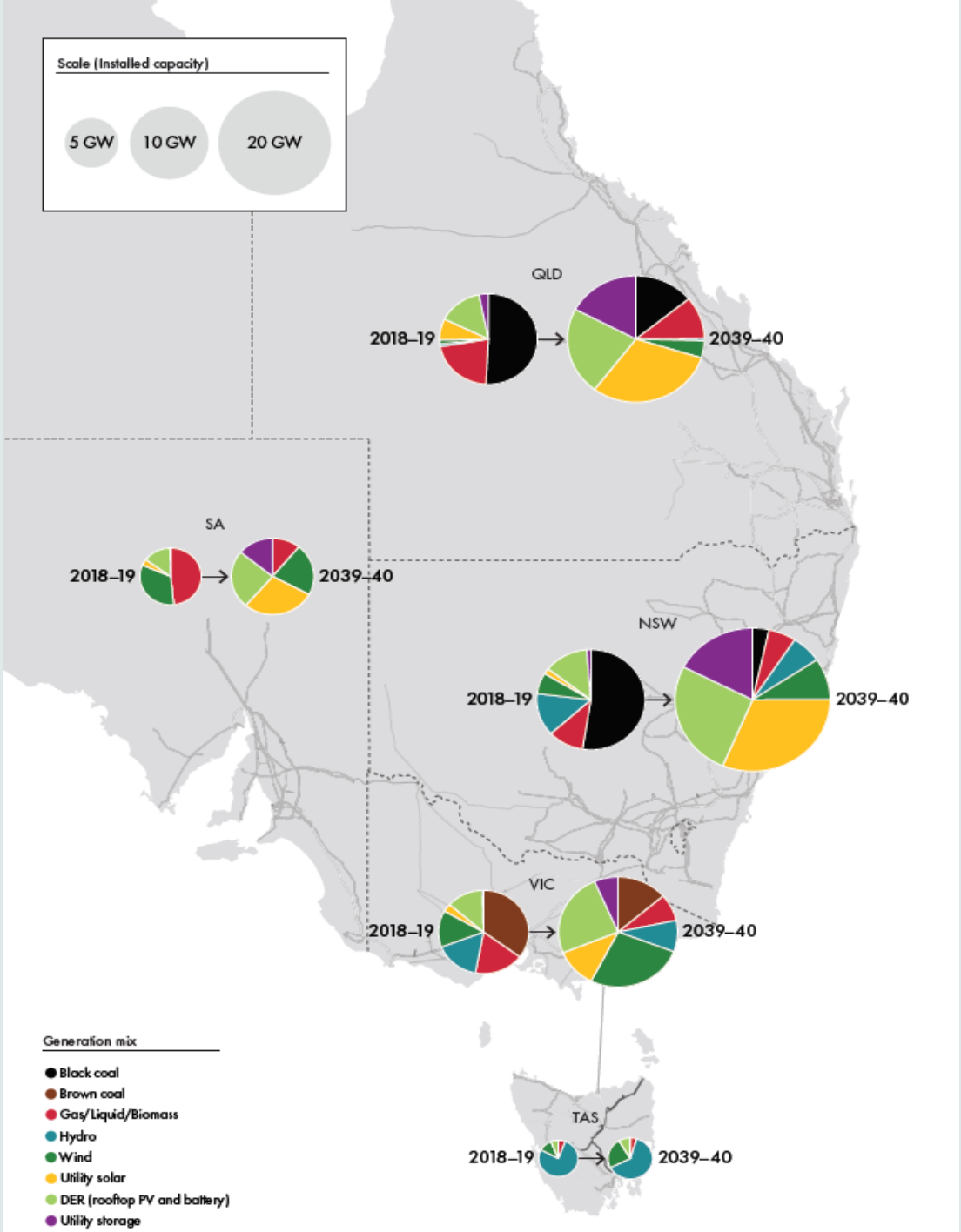
Reliability Planning

- Energy requirements are governed by the reliability standard
- Reliability Standard of the NEM limits forecast USE to <0.002% annual demand
- RRO will help ensure a reliable energy system by requiring companies to hold contracts or invest directly in generation or demand response to support reliability in the National Electricity Market (NEM).
- The ESOO forecasts supply reliability in the NEM over a 10-year period to inform market participants, new investors and policy makers as they assess future development opportunities.
- With the introduction of the Retailer Reliability Obligation (RRO), from 2019 the ESOO specifically includes a five year reliability forecast with the remaining five years being the indicative reliability forecast.
- It may trigger obligations for market participants under the RRO, if a material reliability gap is forecast for any region for either:
  - T-3 (3 years out) – In the 2019 ESOO this relates to the financial year 2022-23.
  - T-1 (1 year out) – In the 2019 ESOO this cannot be triggered, as the rules require that a T-3 reliability instrument must previously have been declared for that year.
- Reliability and Emergency Reserve Trader facilitates out of market energy procurement by AEMO if the ES is expected to be exceeded
- of last resort (AEMC) is an oversight mechanism to complement TNSP and AEMO planning roles

Projected change in resource mix

Installed capacity by NEM region over the 20-year plan horizon



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Generation projects in the pipeline

Technical Requirements

System attribute	Requirement	Service(s) needed to meet requirement
Resource adequacy and capability	Provision of sufficient supply to match demand from consumers	Bulk Energy
		Strategic Reserves
	Capability to respond to large continuing changes in energy requirements	Operating Reserves
	Network transport capability	Transmission and distribution services
Frequency management	Ability to set frequency	Grid formation
	Frequency within limits	Inertial response Primary frequency control Secondary frequency control Tertiary frequency control
Voltage management	Voltage within limits	Slow response voltage control Fast response voltage control
		System Strength
System restoration	Ability to restore the system	System restart services

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