

Energy storage in the National Electricity Market

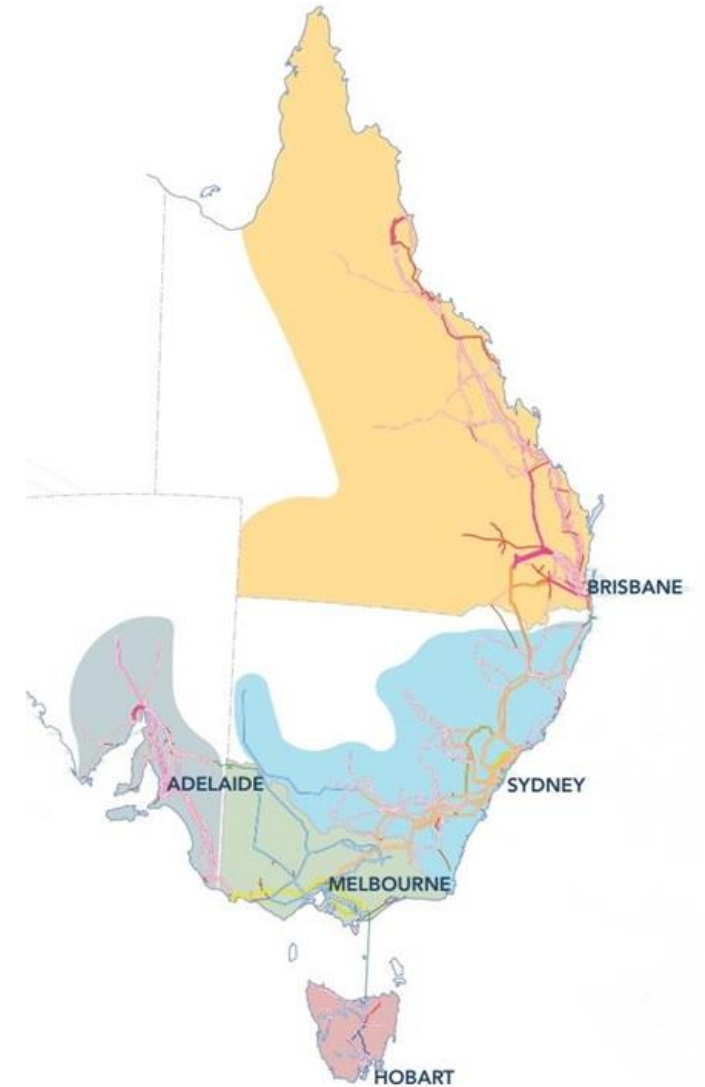
Farhad Billimoria, Strategy and Markets Group
Australian Energy Market Operator

Storage Systems in the Electrical Sector, 8th January 2019, Santiago - Chile

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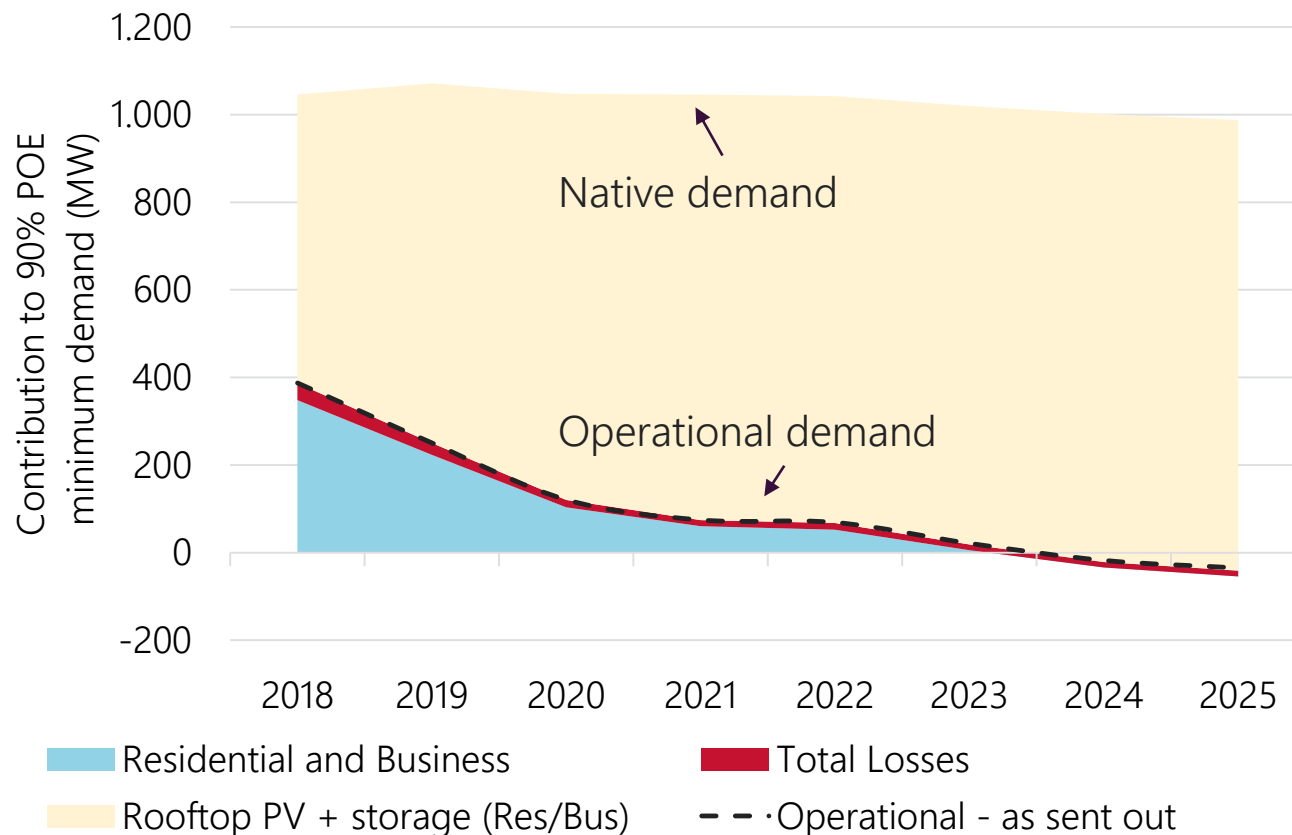
Agenda

1. The role of storage in the NEM
2. Current storage developments
3. Operational and system integration
4. Market dynamics
5. Conclusions



An electricity market in transition...

Minimum Operational Demand Projection
– South Australia



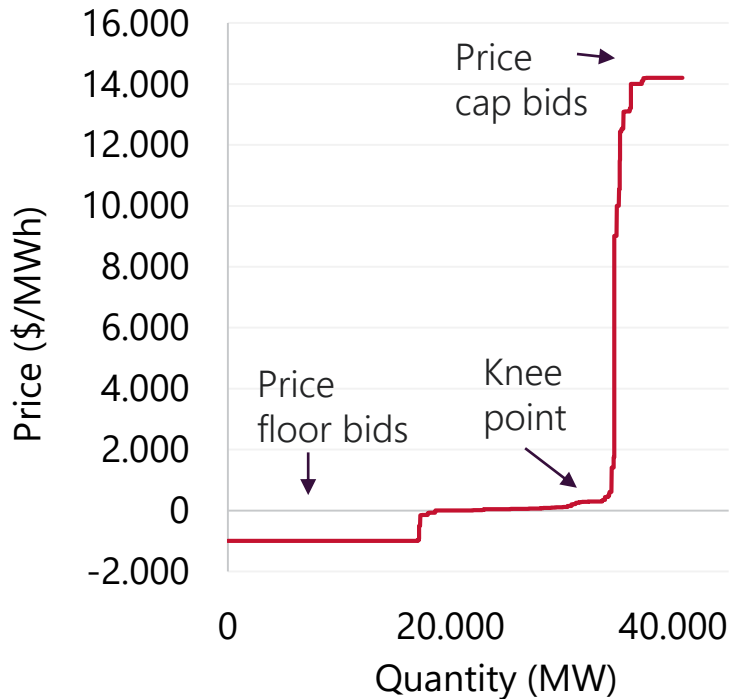
Summary

- A Electricity market overview:**
 - Wholesale – competitive RT gross pool
 - Regulated networks
 - Retail – competitive, vertical integration
 - Environmental – 2030 renewable target
- B Transformational growth in DER with ~ 8GW of rooftop PV.**
- C Over 10GW of utility-scale renewable projects committed since 2012**
- D Retirement of large thermal generators ~5.2GW retired since 2012**

The rationale for BESS in the NEM

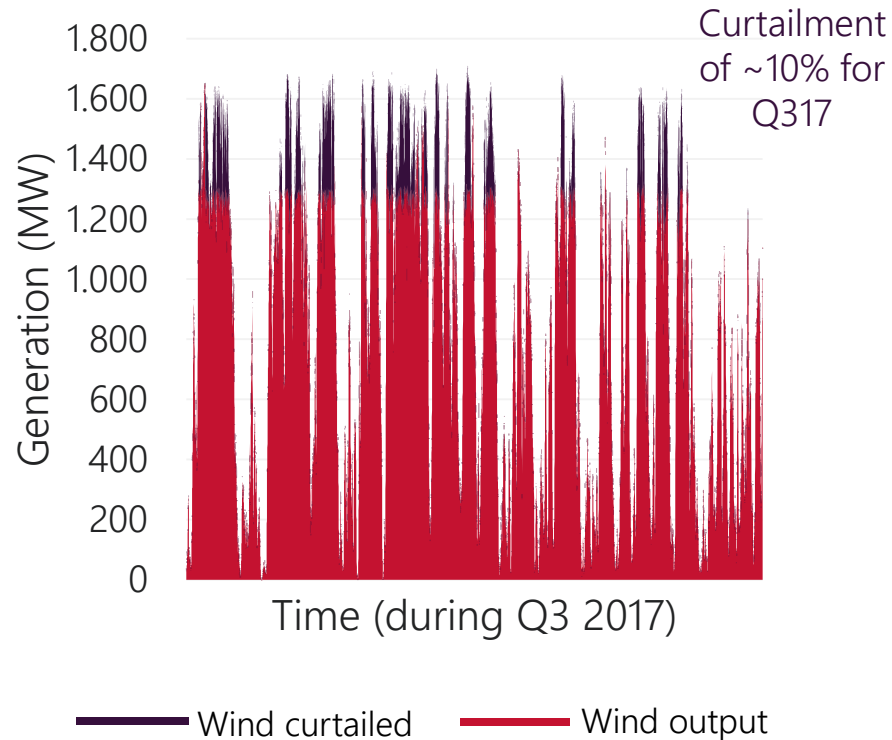
High price cap and low price floor

Sample NEM bid stack for Energy



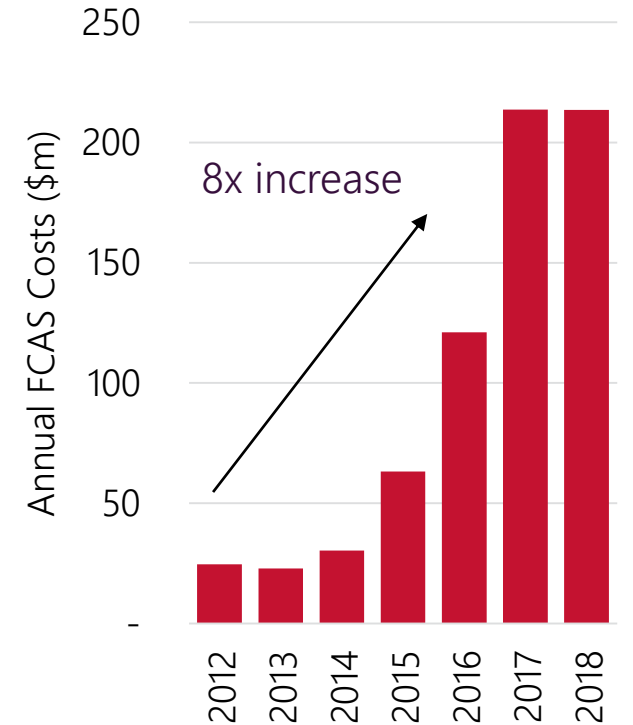
Prevalence of renewable curtailment

SA wind generation and curtailments (Q3-2017)



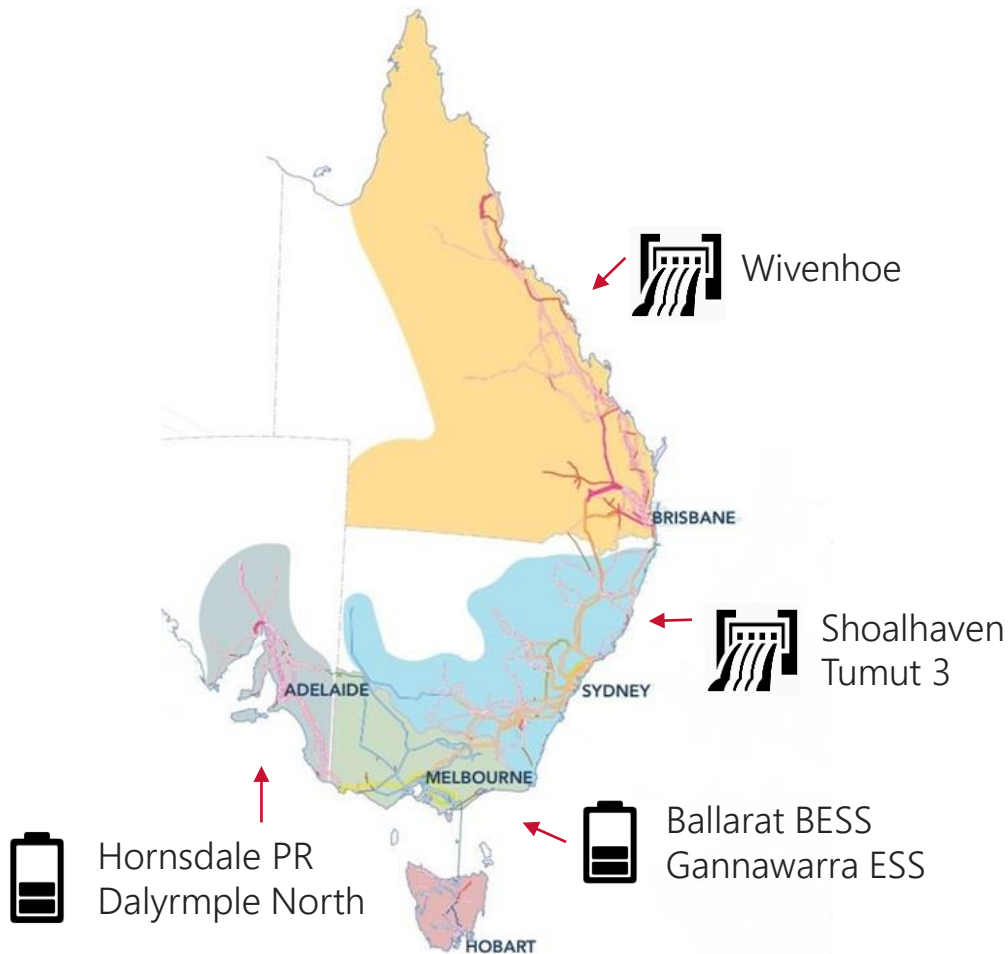
Growing costs of ancillary services

Annual Costs of Frequency Control Ancillary Services



Storage developments in the NEM

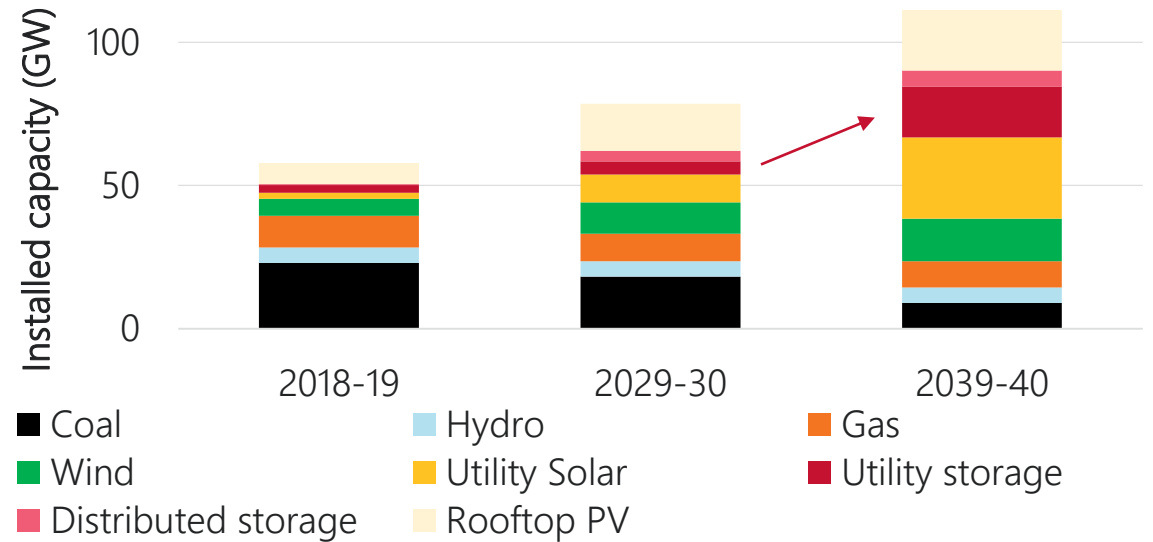
Operating Energy Storage Assets



Energy storage in the NEM

- A Operating ~ 1.6GW (with 180MW BESS) plus 1.7GW proposed
- B Integrated System Plan: Storage ~ 21% of capacity by 2040
- C Strategic projects: Snowy Hydro 2.0, Battery of the Nation

Integrated System Plan – Capacity (Neutral case)

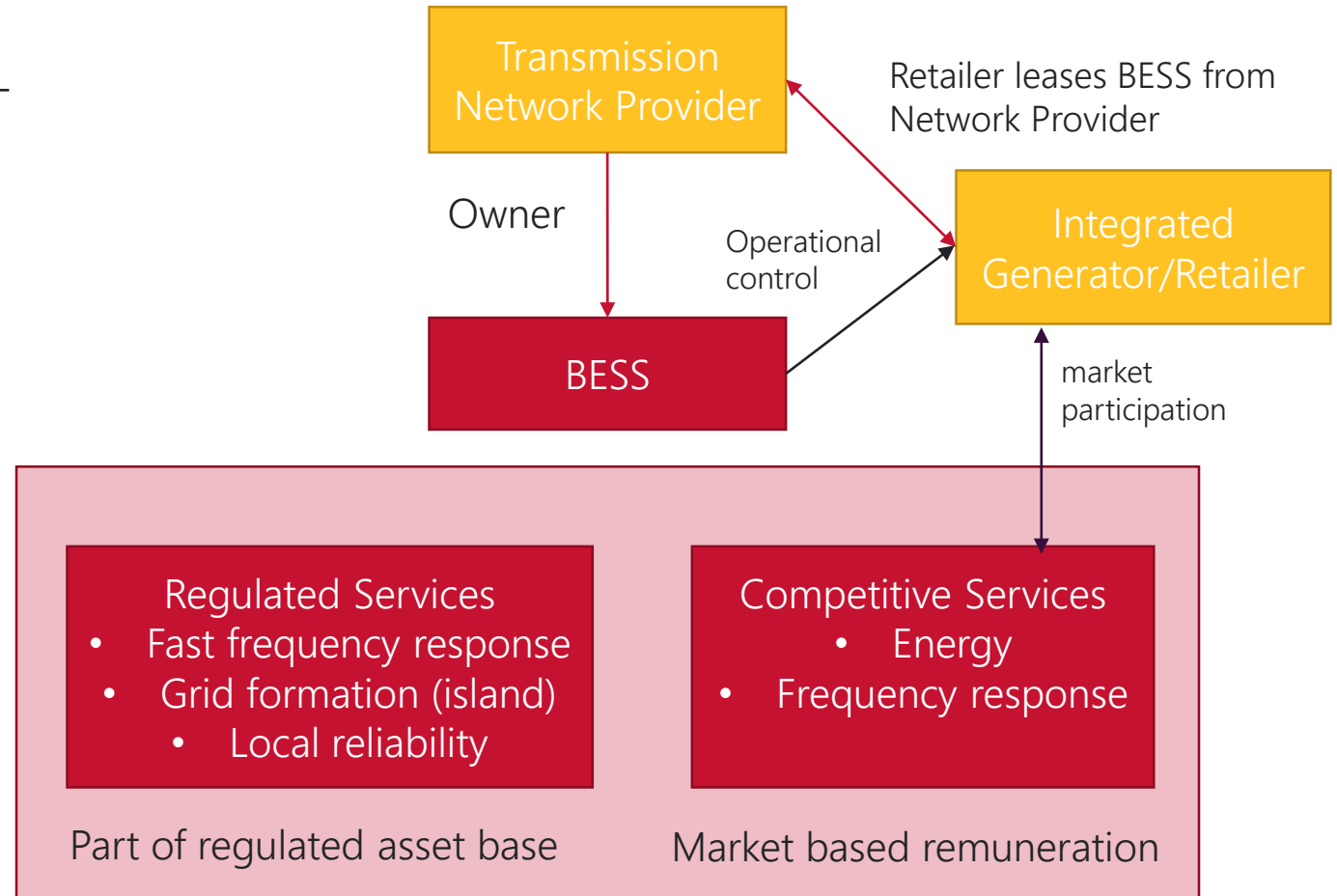


Source: AEMO

Implementing the 'value stack'

Value stack	Services
Energy	Merchant arbitrage Contracts
Ancillary Services	Frequency response (FCAS) Fast frequency response Voltage control System restart
System	Control schemes Grid formation
Network	Local reliability Network voltage control Avoided/deferred investment
Other	Causer-pays mitigation
Consumer	Retail charge avoidance Virtual power plant

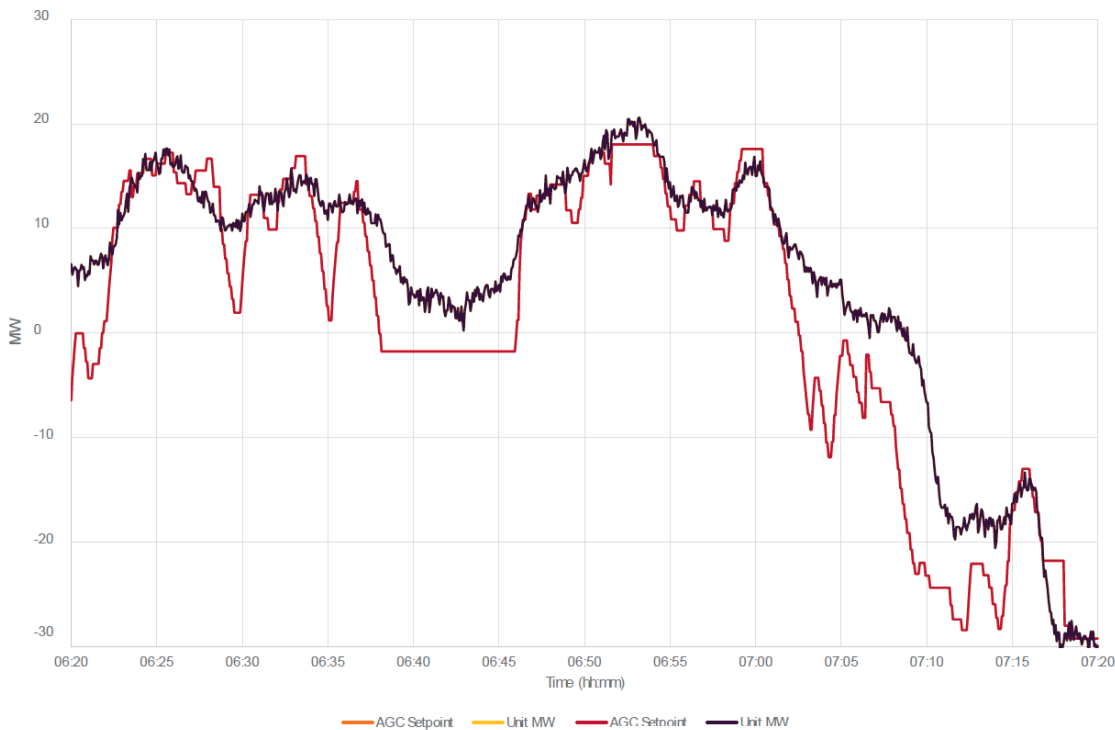
Case study: Dalrymple Battery Project



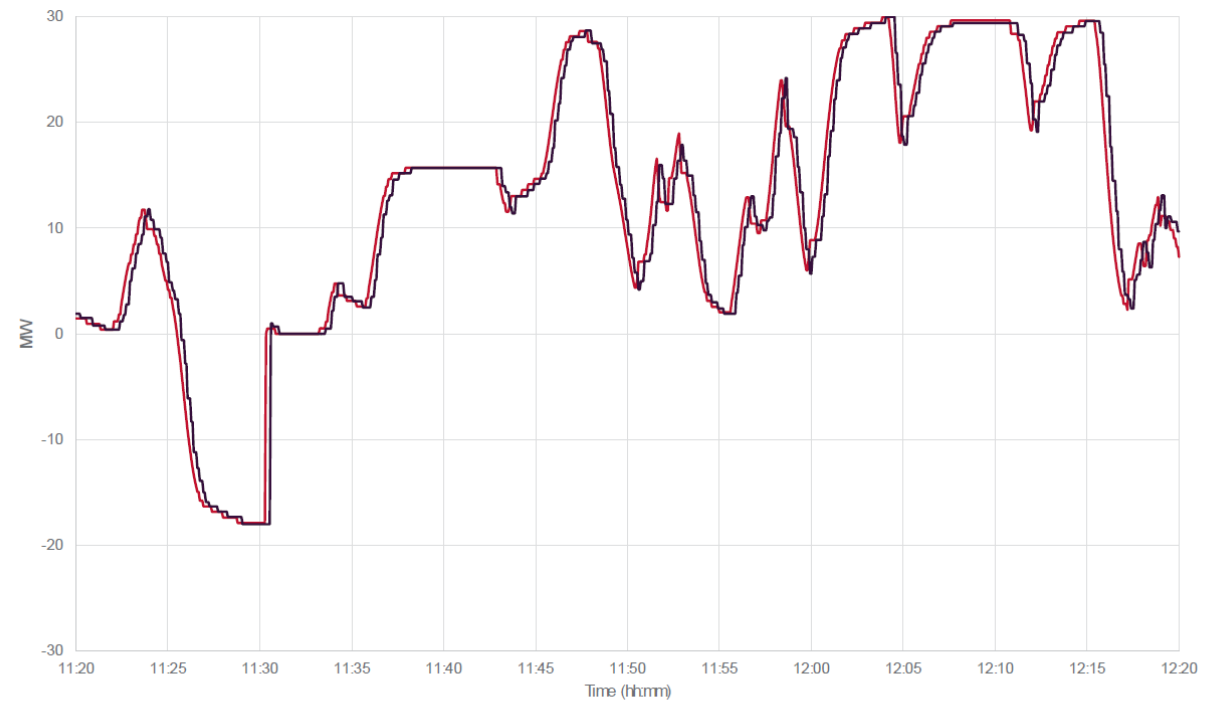
Quality of regulation delivery

Accuracy and speed of regulation FCAS response

Large conventional steam turbine



Hornsedale Power Reserve battery

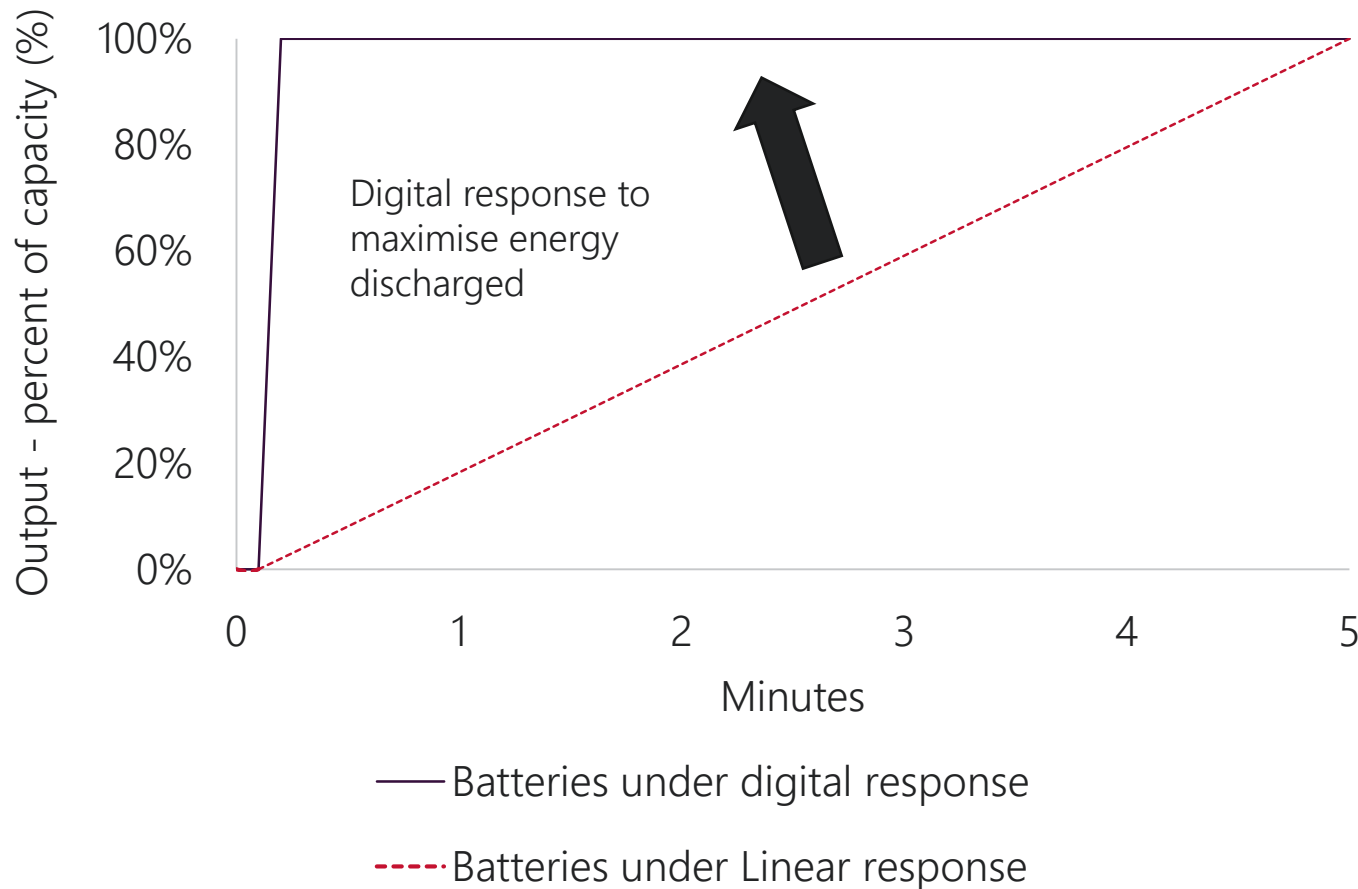


— AGC setpoint

— Unit MW

System implications need to be managed

Ramping incentives for Battery Storage

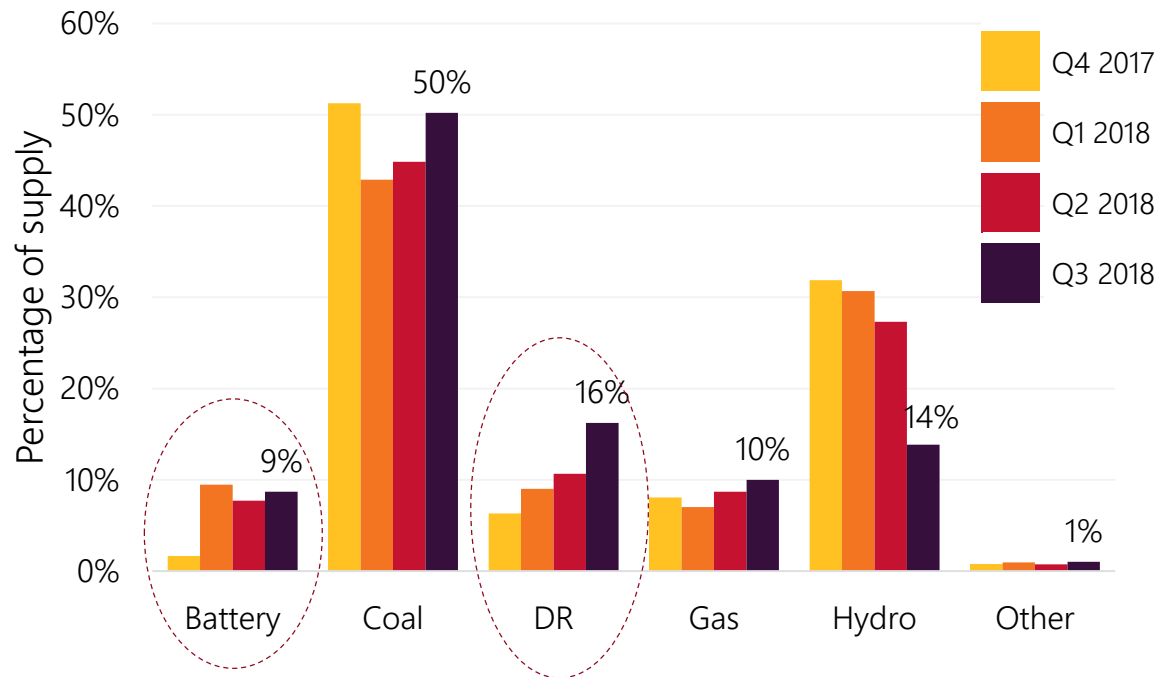


Key operational issues

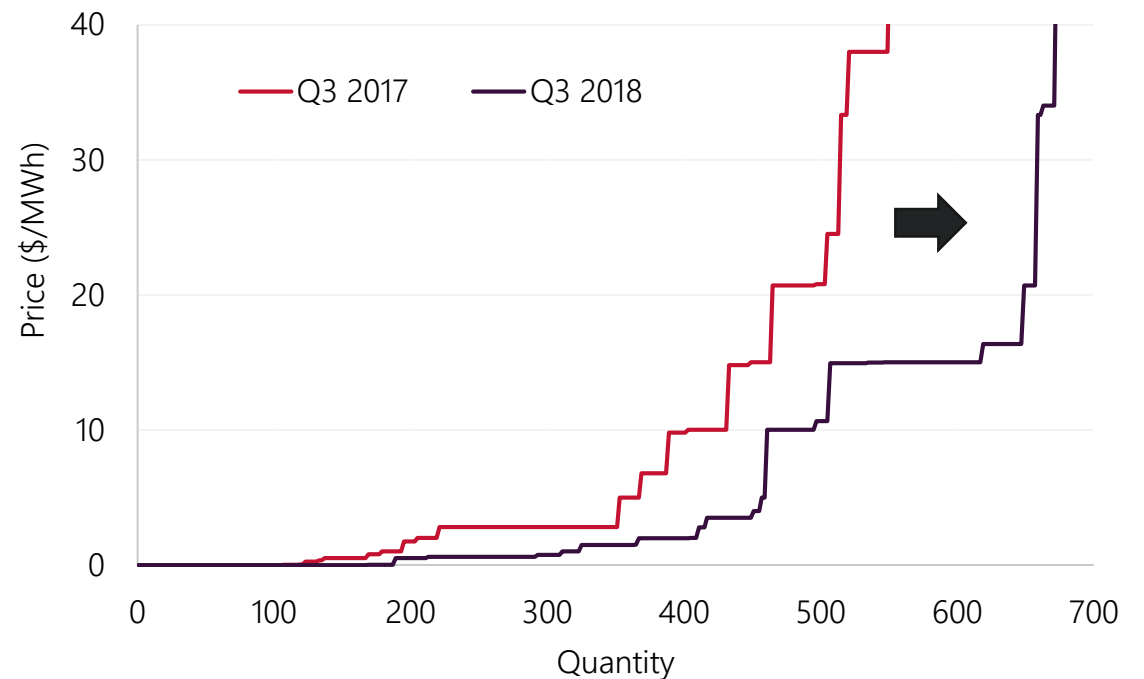
- A System security - incentives for digital response from fast-ramping technology
- B System security issues with increased non-synchronous penetration (e.g. inertia).
- C Visibility and predictability of the flexible fleet – especially DER / distributed storage.
- D Enablement of correct service mix

Impact of new technologies on frequency response markets

Raise FCAS enabled by fuel type – Q3 18



Raise FCAS 6 sec offer curve



Adding new technologies and providers to the supply mix has altered market dynamics

Key takeaways

1. Access to value is multi-faceted → via organized and bilateral/multilateral mechanisms
2. New technologies and participants have shifted market dynamics
3. System and operational impacts need careful management

Appendix

Key regulatory developments

Regulatory developments affecting BESS

Completed initiatives

- Five minute settlement
- Ancillary services unbundling
- Reliability frameworks review
- Frequency control frameworks review
- Future power systems security program
- Co-ordination of generation and transmission

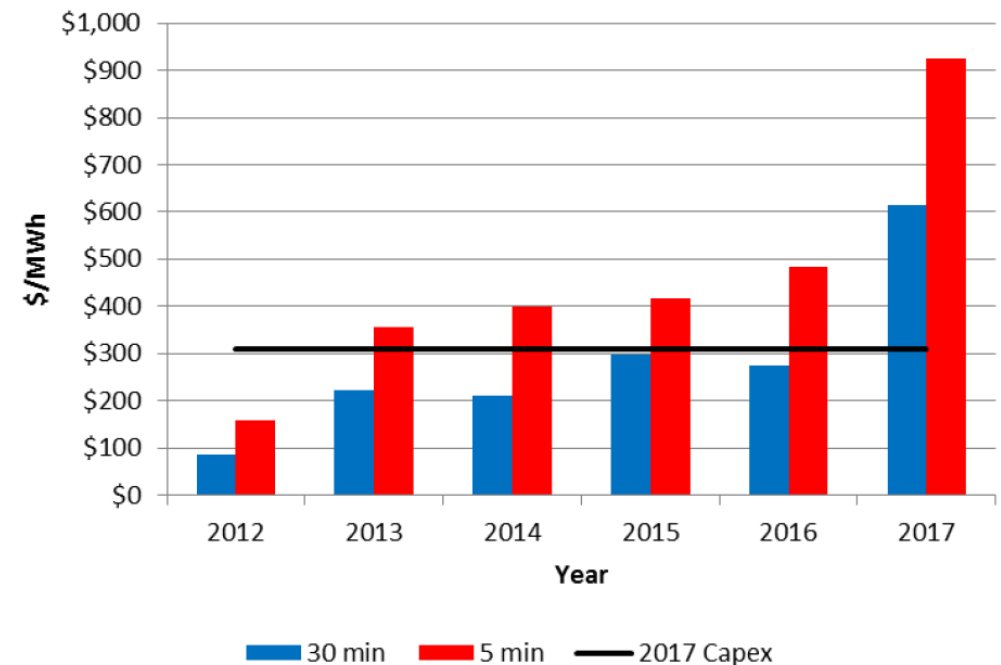
Current initiatives

- Virtual Power Plant Demonstration Program
- Emerging Generation and Energy Storage
- Wholesale demand response mechanism

The Future

- Frequency control and reserve frameworks
- Operational security frameworks
- Reliability frameworks.

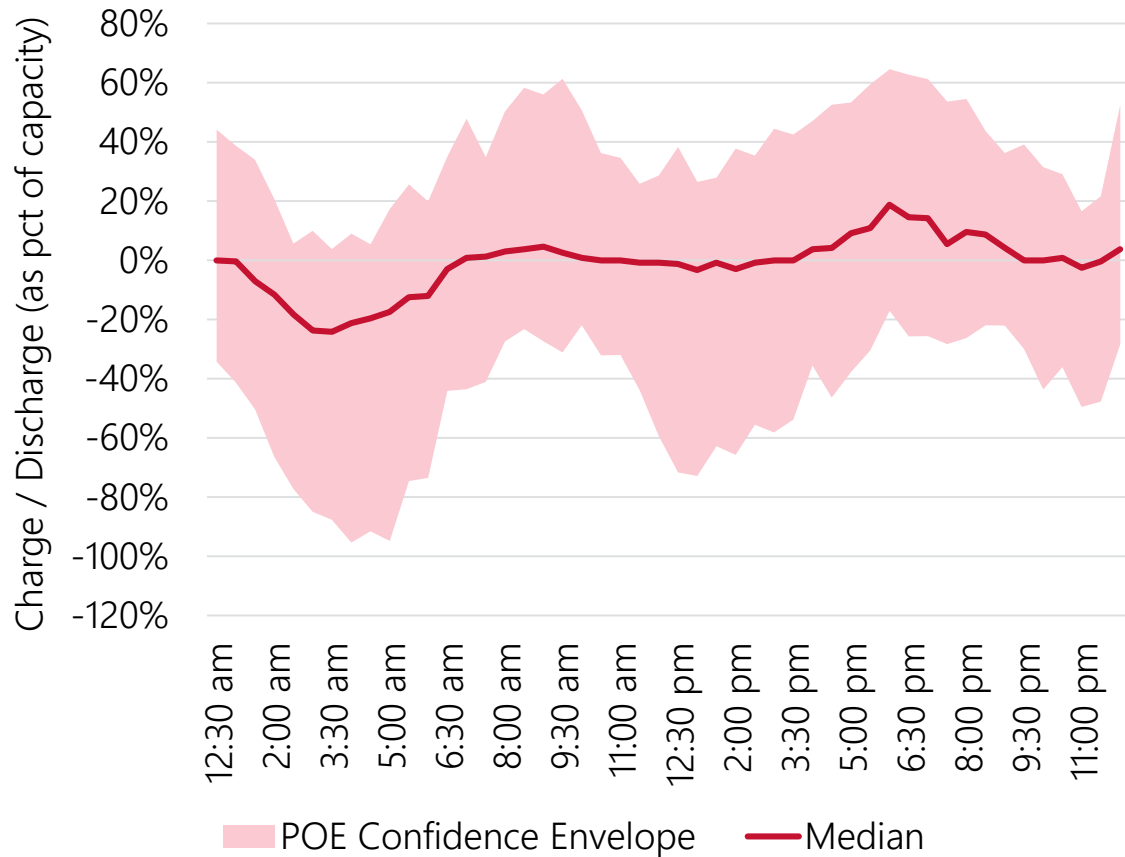
Battery net arbitrage value – Queensland (2012-17)



Source: AEMC

Generation patterns

BESS energy dispatch - 2018



Pumped hydro energy dispatch - 2018

