

Is bigger really better?

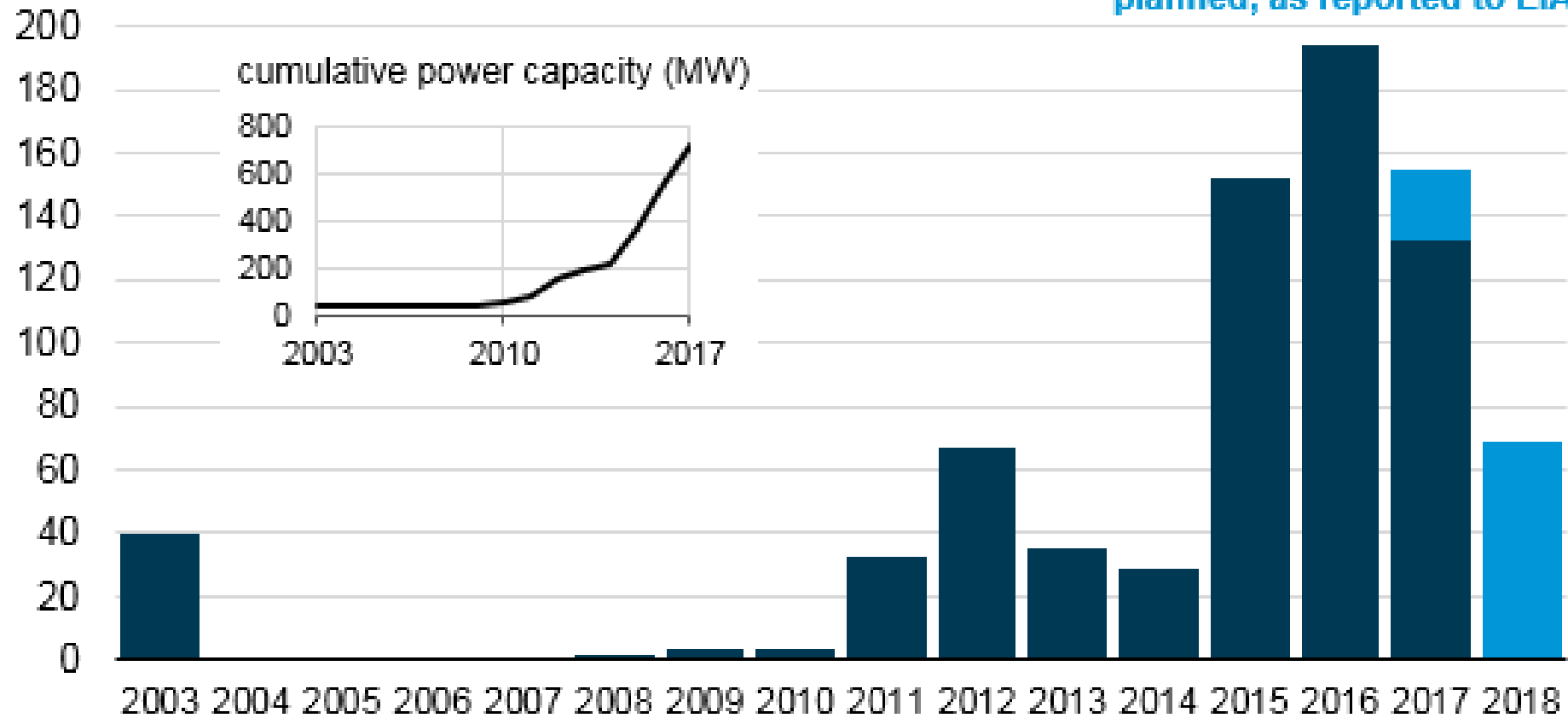
The outlook for utility-batteries in Australia

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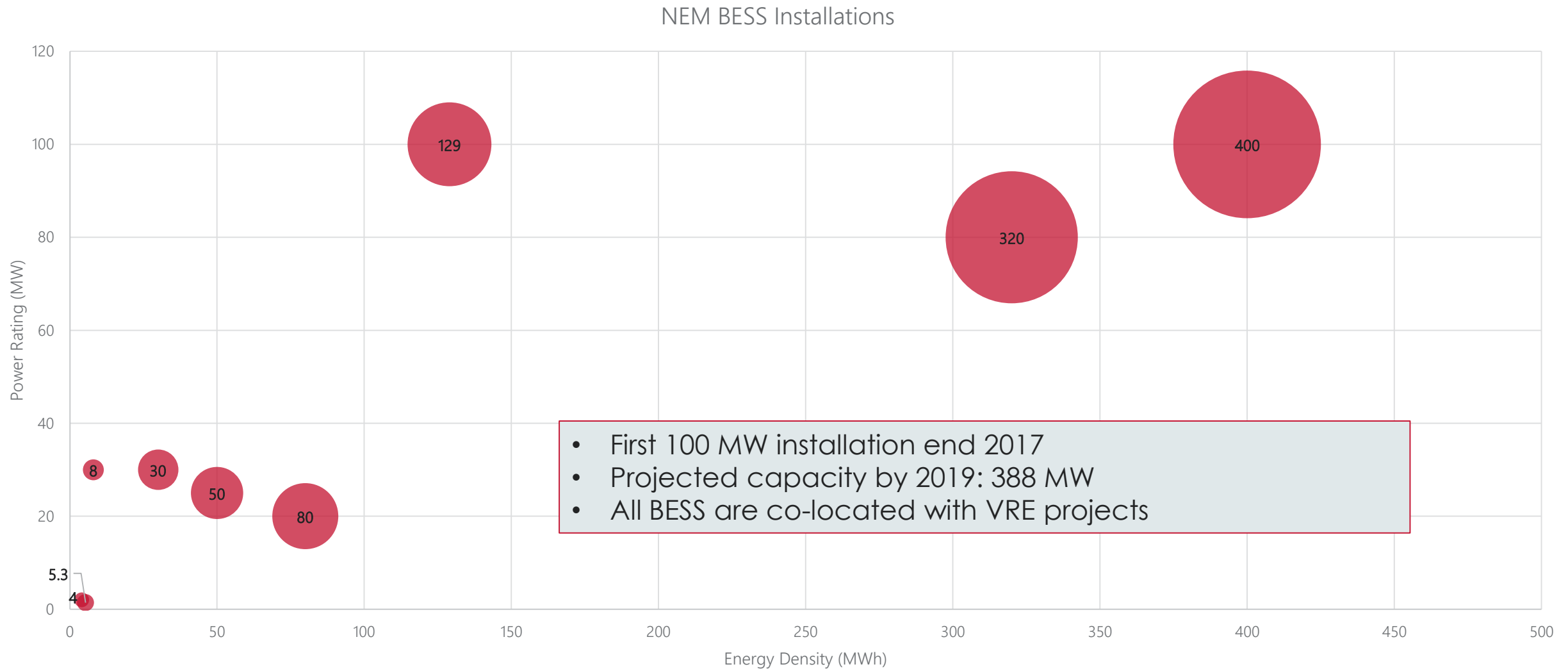
Utility Battery Energy Storage System – an overview

U.S. utility-scale annual battery installations, 2003-2018
power capacity, megawatts (MW)

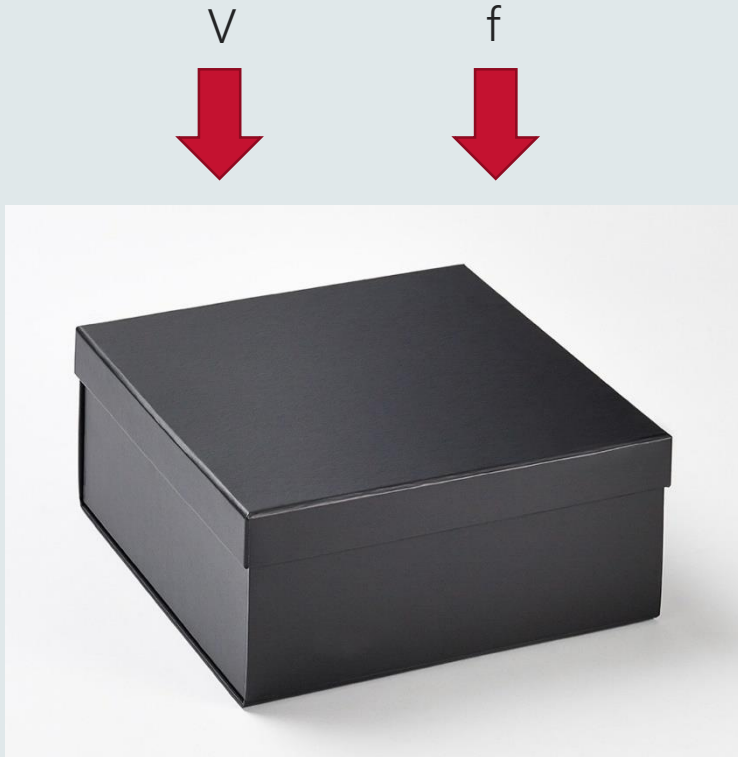
operating, as of October 2017
planned, as reported to EIA



Utility Battery Energy Storage System – an overview

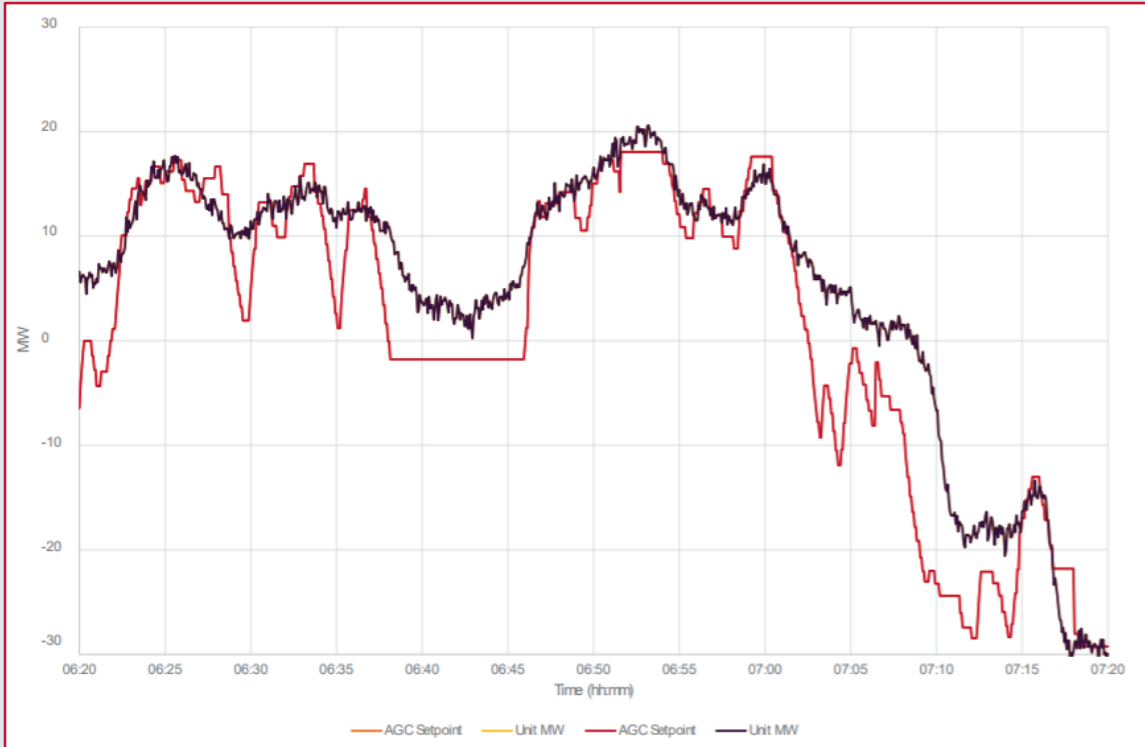


What services could batteries provide?

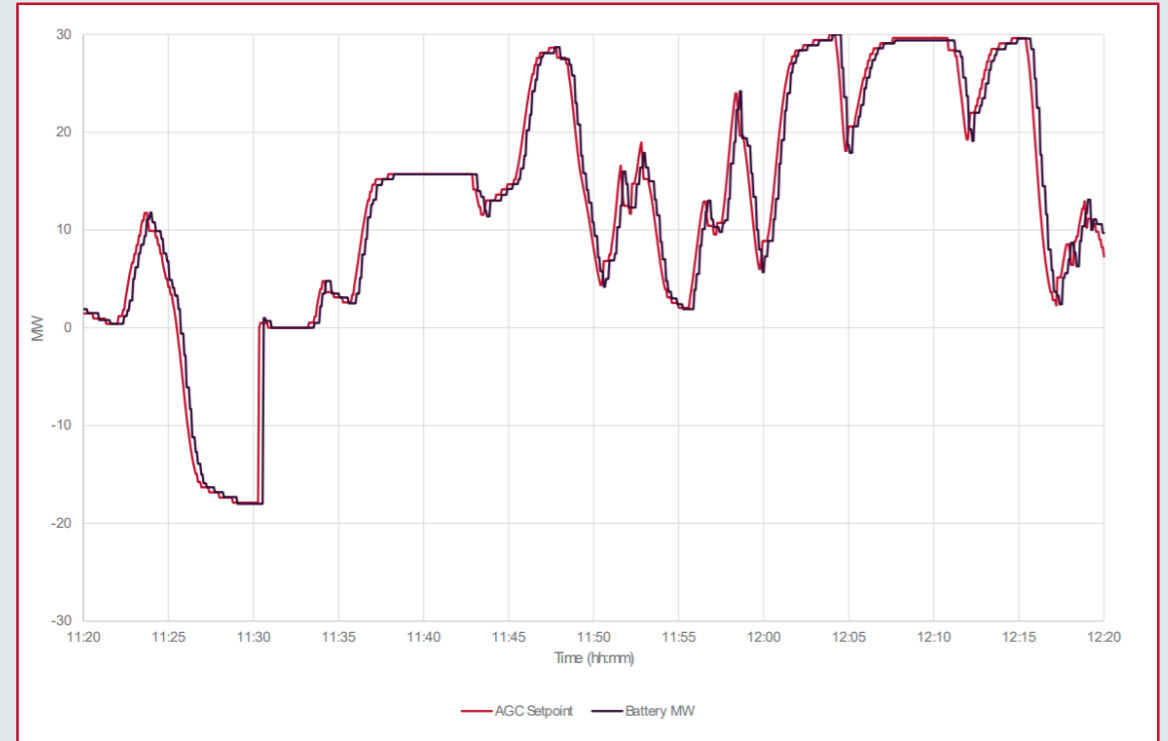


Potential Services	Power Capacity (MW)	Energy Density (MWh)
Frequency Control (FCAS)	■ ■ ■	■
Network Loading Control (NLCAS)	■ ■	■ ■ ■
Output shaping (of VRE)	■	■ ■
Reserve Energy Capacity (Reliability)	■	■ ■ ■
Energy Arbitrage	■	■ ■ ■
Synthetic Inertia (Resilience)	■ ■ ■	■ ■
Grid Forming (future)	■	■
Voltage support (NSCAS)	■ ■ ■	■ ■ ■
Black start support (SRAS)	■ ■ ■	■ ■ ■

Frequency control services: Regulation FCAS response



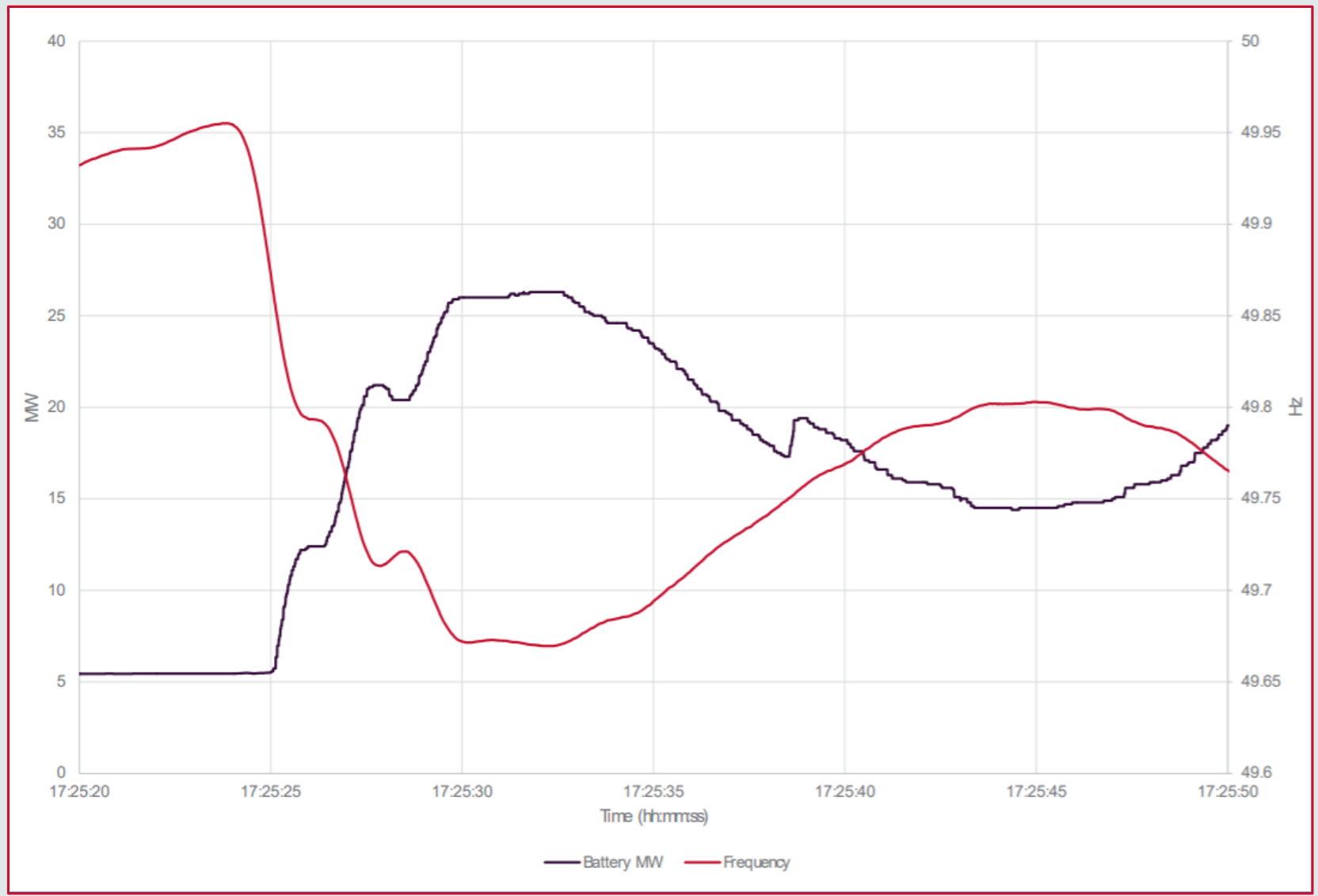
Steam turbine



Energy storage

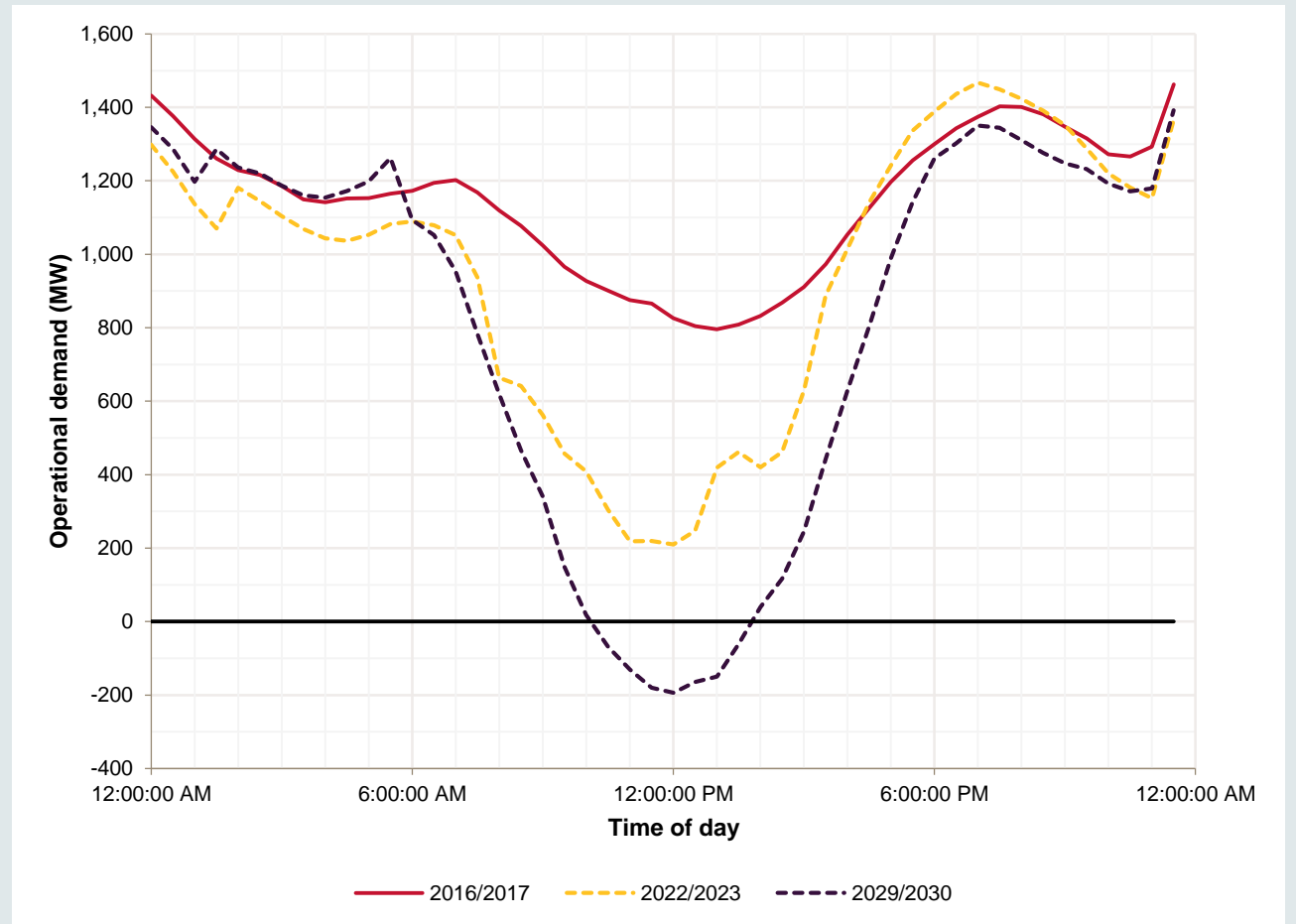
Frequency control services

Energy storage
Contingency FCAS
response



Potential Energy Services

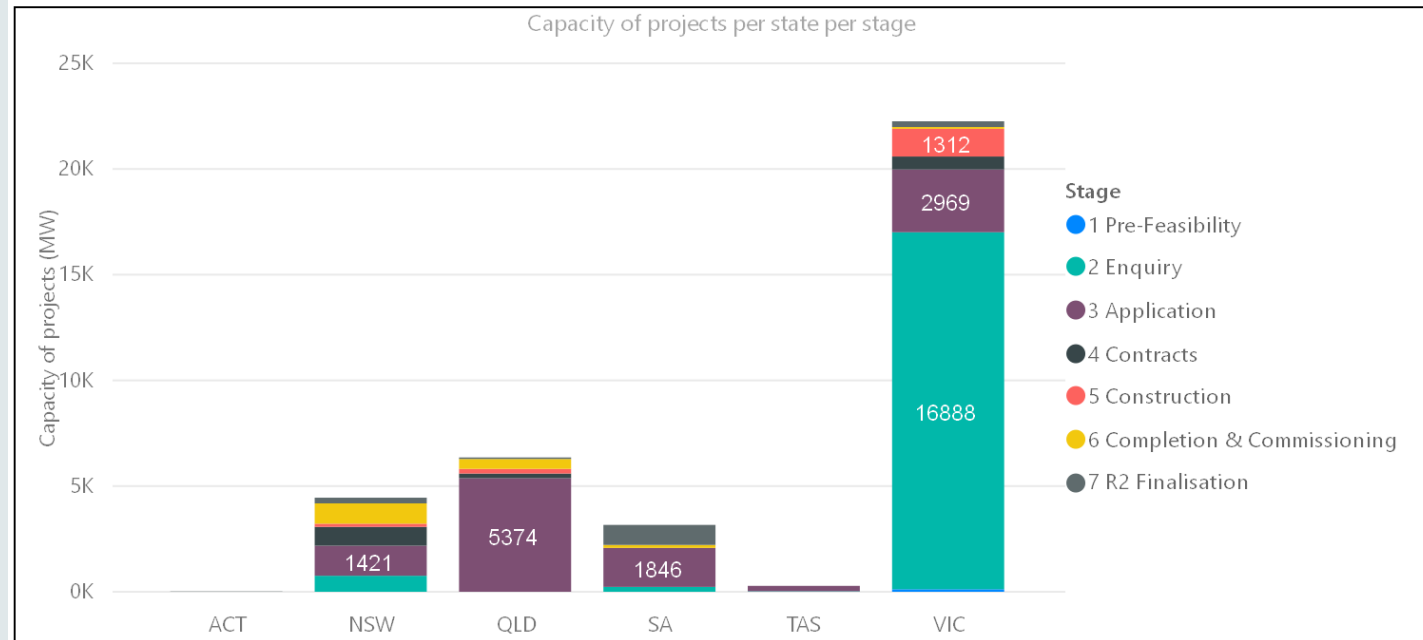
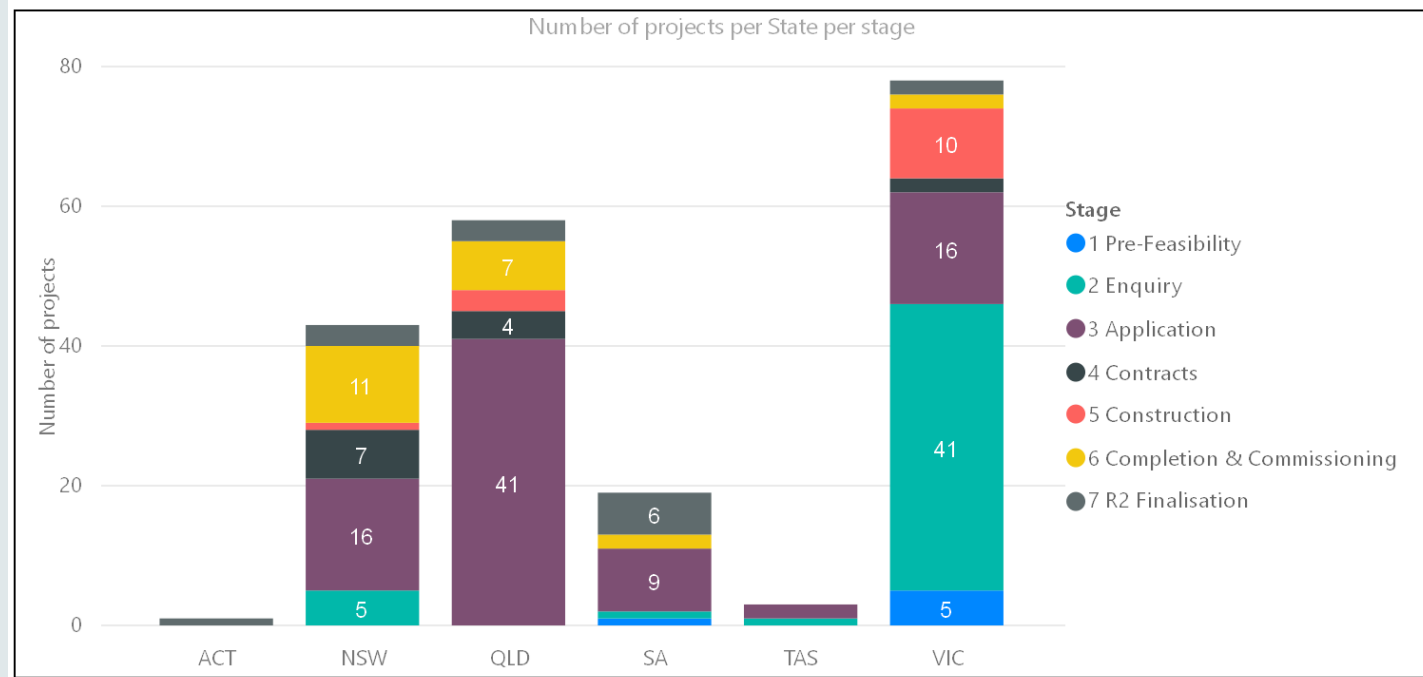
- RES output shaping and smoothing
 - Reduce curtailment and connection infrastructure costs
 - Avoid negative price spikes coincident with oversupply of RES
- Reserve capacity
 - Provide short-term and fast start power during peak demand periods
- Energy Arbitrage
 - Flatten daily load curve
 - Avoid high cost generation requirements



Future opportunities

- Synthetic inertia
 1. Retirement of thermal generation will withdraw traditional inertia
 2. Fast response synthetic inertia will be required to support the grid and arrest high RoCoF
 3. BESS can potentially provide this fast response service
- Grid forming
 1. Present inverter technology is grid following (current sources)
 2. Decreasing system strength can expose CSI to instability
 3. Grid forming inverters can regulate voltage and frequency
- SRAS support
 1. Additional voltage support for the transmission network
 2. Provide stabilising load to restart services

Potential growth in BESS opportunities



Conclusions

- Unbundling of energy and ancillary services will allow energy density and power capacity to be sized purpose specific
- Utility scale storage needed to support future RES development and coal fired generation retirement
- Co-location will determine upper limit of installed capacity, most likely <20% of co-sited RES power
- Transmission congestion and curtailment, need for firming capacity, and load shaping is expected to influence size of storage
- Energy storage up to 4-6 hours at full output an observed trend for energy services and less than 1 hour for frequency control services