

# Application of GFM BESS in Australia

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# About AEMO

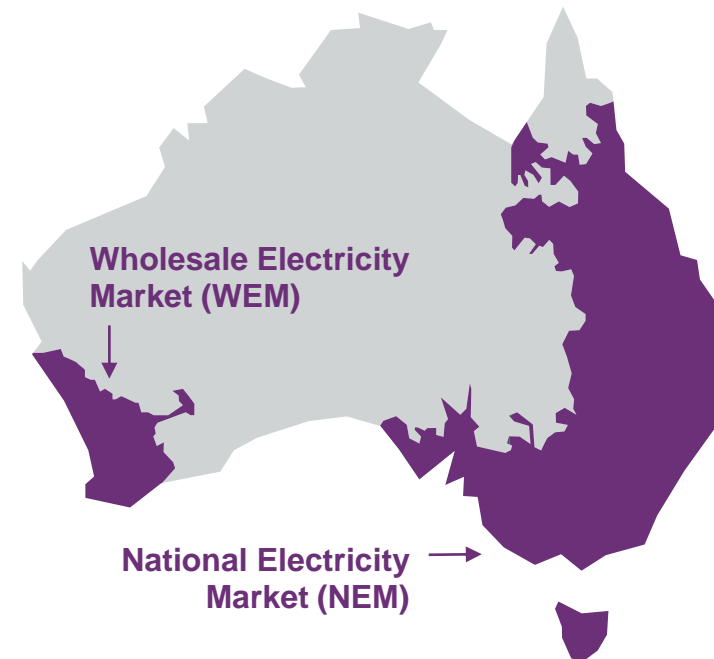
- AEMO is a member-based, not-for-profit organisation.
- We are the independent energy market and system operator and system planner for the National Electricity Market (NEM) and the WA Wholesale Electricity Market (WEM).
- We also operate retail and wholesale gas markets across south-eastern Australia and Victoria's gas pipeline grid.



AEMO Services is an independent subsidiary of AEMO, established in 2021 to enable the transparent provision of advisory and energy services to National Electricity Market jurisdictions.



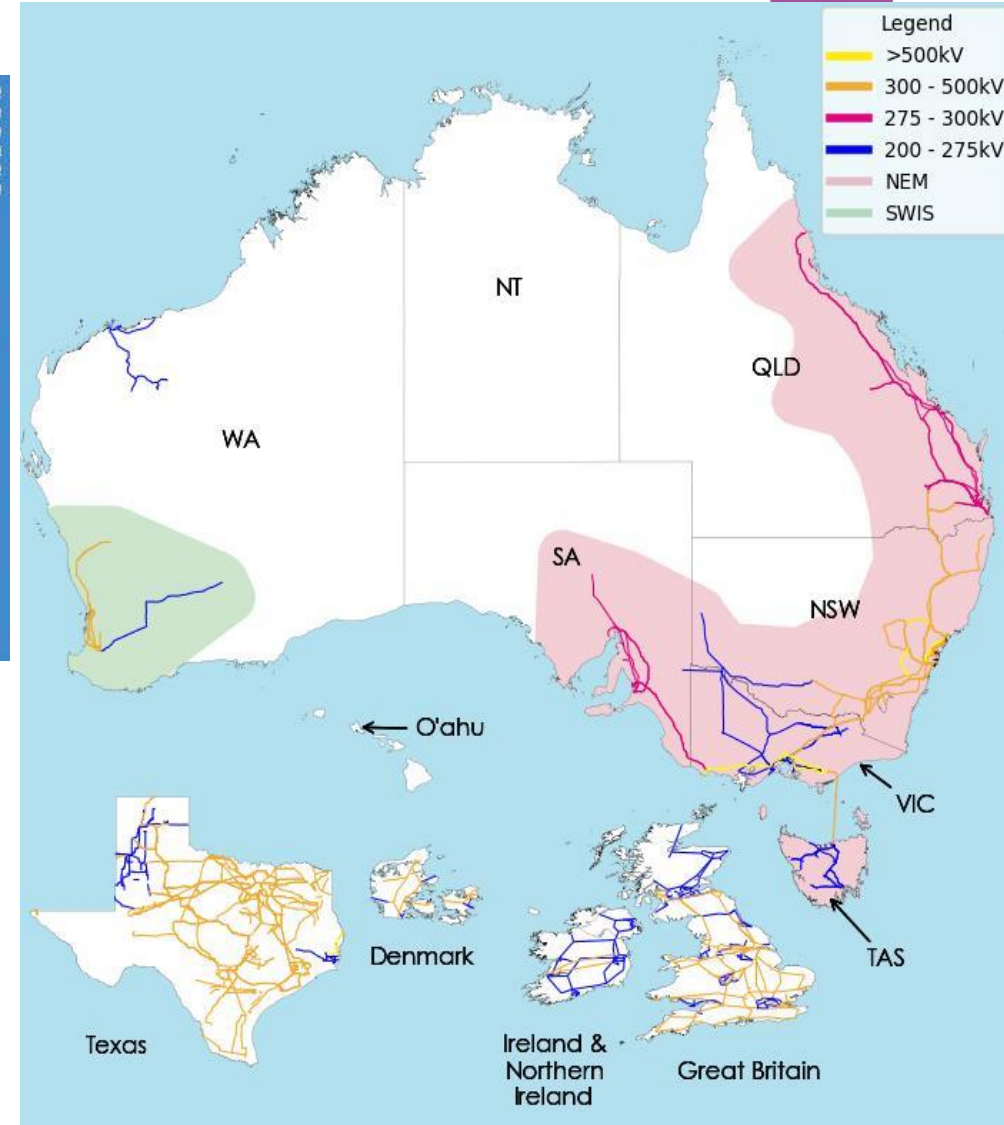
## Electricity



## Gas

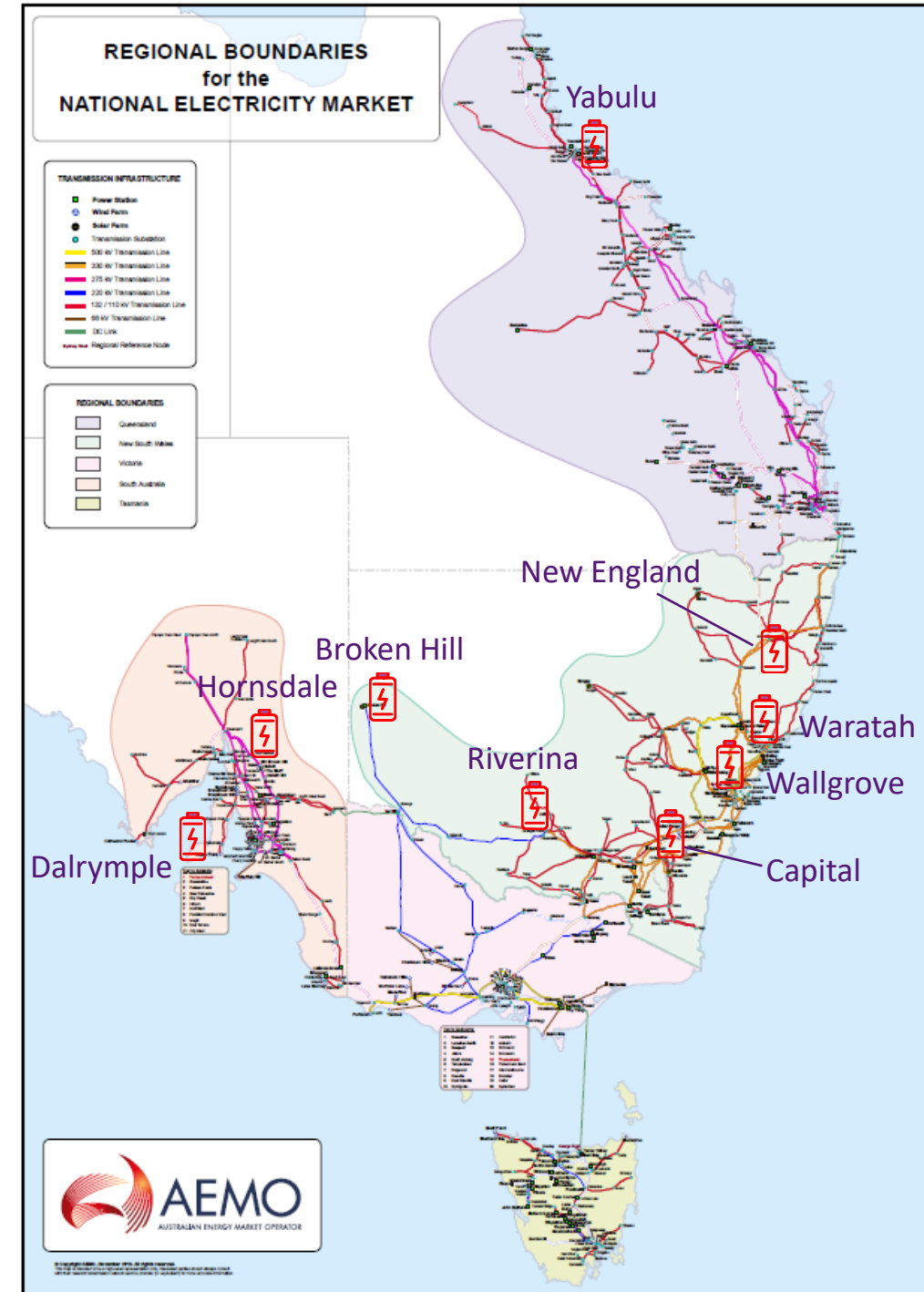


# How big is Australia?



# Grid-forming batteries

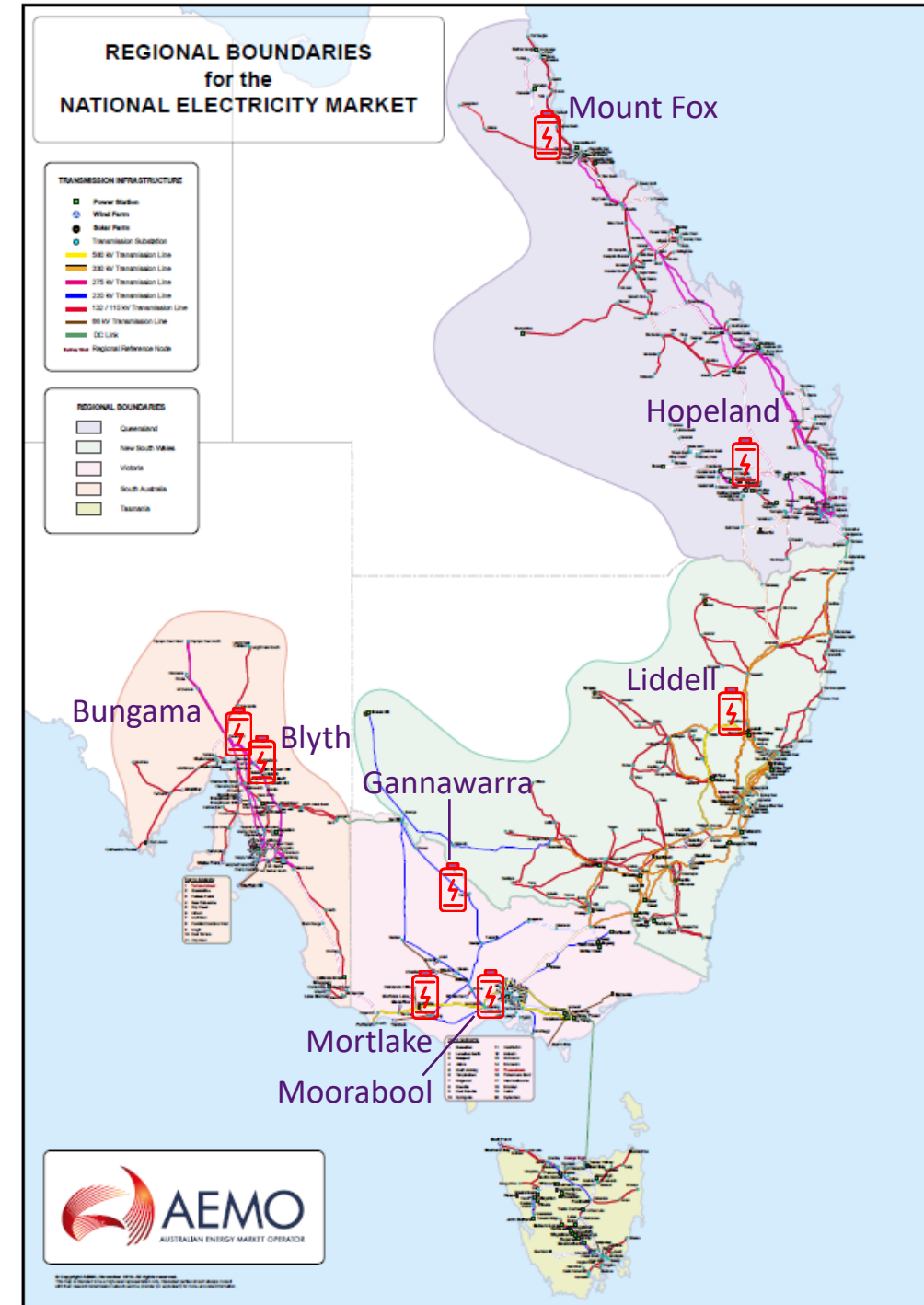
- In operation
  - Dalrymple BESS - 30 MW / 8 MWh (SA)
  - Hornsdale Power Reserve (aka Tesla Battery of South Australia) – 150 MW / 193.5 MWh (SA)
  - Wallgrove - 50 MW / 75 MWh (NSW)
- Likely in near future
  - Broken Hill – 50 MW / 100 MWh (NSW)
  - Riverina/Darlington Point – 150 MW / 300 MWh (NSW)
  - Captial – 100 MW (NSW)
  - New England – 50 MW / 50 MWh (NSW)
  - Yabulu BESS – 200MW / 400MWh (QLD)
  - Waratah Super Battery 850 MW / 1700 MWh (NSW)



# ARENA funded batteries

Developer	Capacity	Location	New/Retrofit
AGL	250 MW / 500 MWh	Liddell, New South Wales	New
FRV	250 MW / 550 MWh	Gannawarra, Victoria	New
Neoen	300 MW / 450 MWh	Moorabool, Victoria	Retrofit
Neoen	200 MW / 400 MWh	Hopeland, Queensland	New
Neoen	200 MW / 400 MWh	Blyth, South Australia	New
Origin	300 MW / 900 MWh	Mortlake, Victoria	New
Risen	200 MW / 400 MWh	Bungama, South Australia	New
TagEnergy	300 MW / 600 MWh	Mount Fox Queensland	New
Total	2.0 GW / 4.2 GWh	NEM, Australia	

Source: <https://arena.gov.au/news/arena-backs-eight-grid-scale-batteries-worth-2-7-billion/>



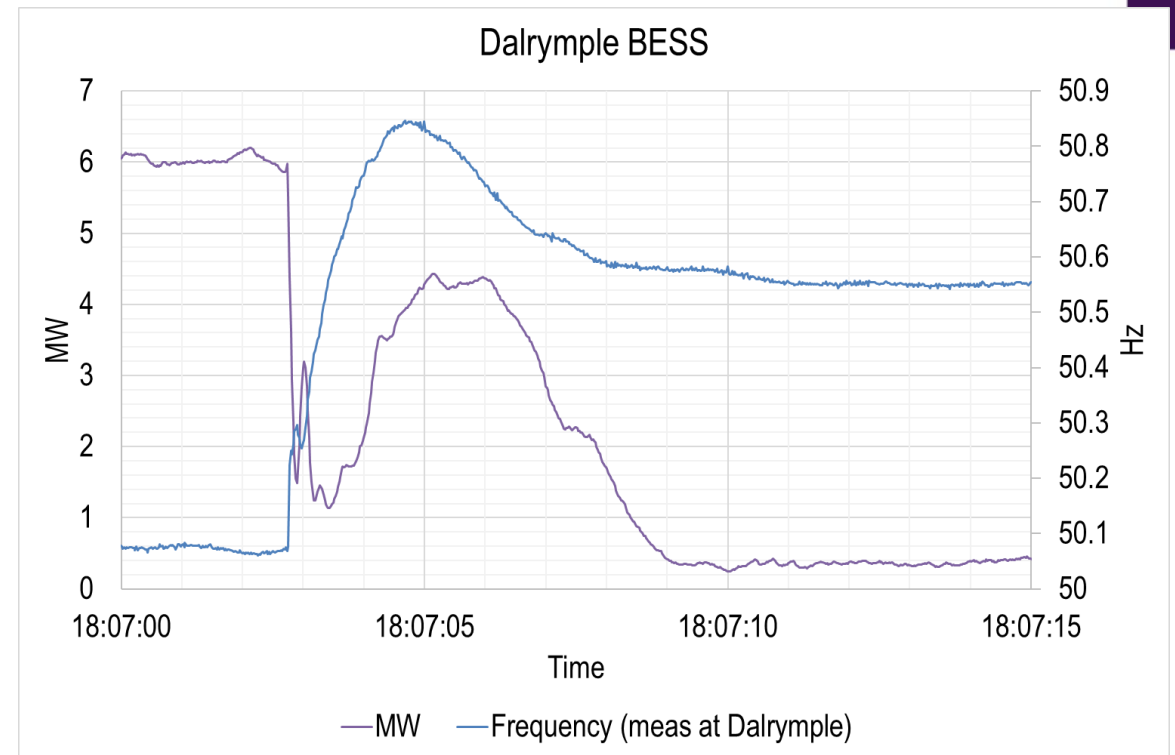
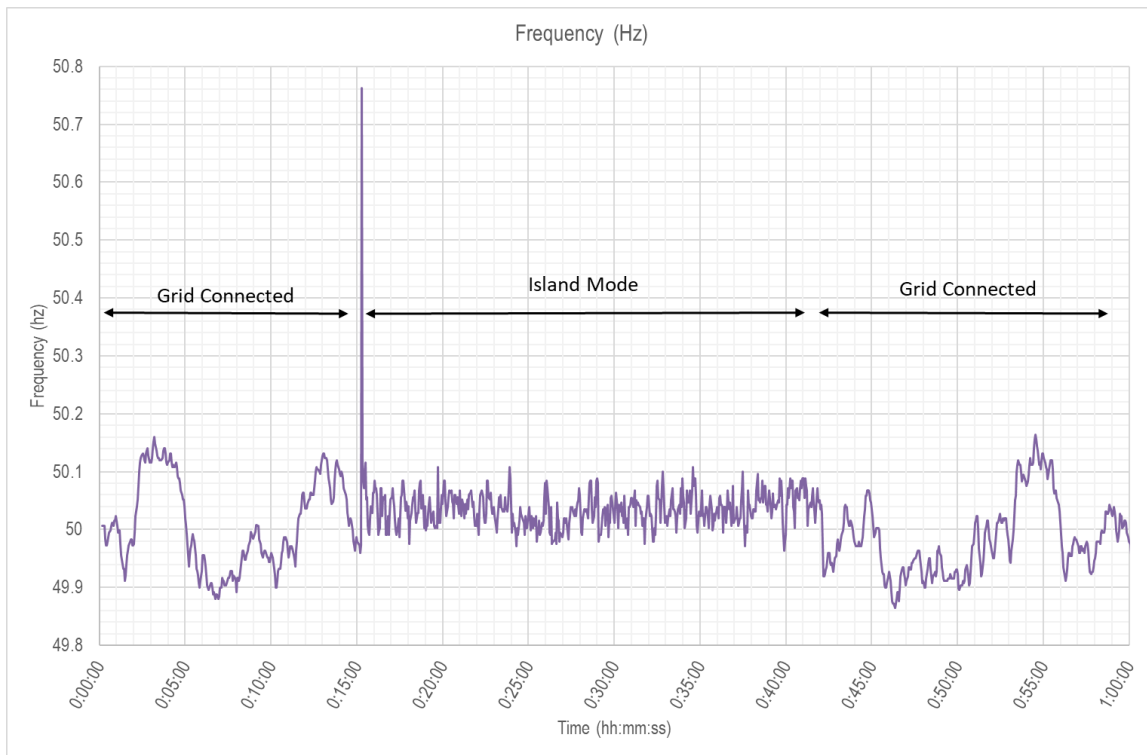
# Dalrymple BESS – features

- Dalrymple BESS: 30 MW / 8 MWh
- Operation at very low SCR
- Seamless transition from grid-connected to island mode during planned and unplanned events
- Synthetic inertia response
- Short term overload capacity (2 pu for 2 sec)
- Participation into System Integration Protection Scheme (SIPS)



# Dalrymple BESS – Performance

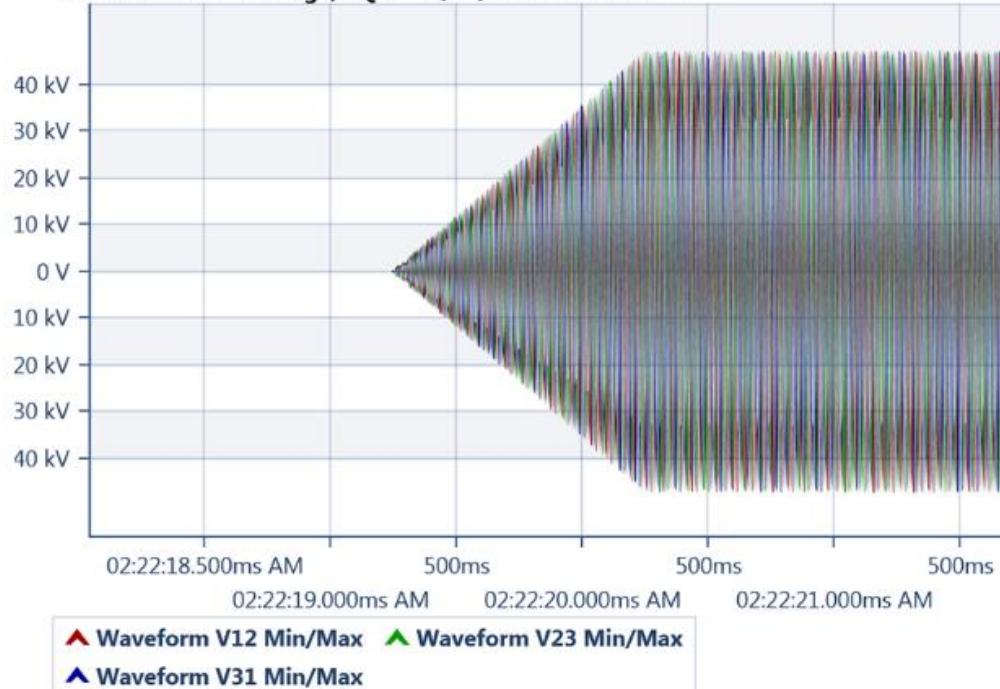
- Frequency control
- Inertial response



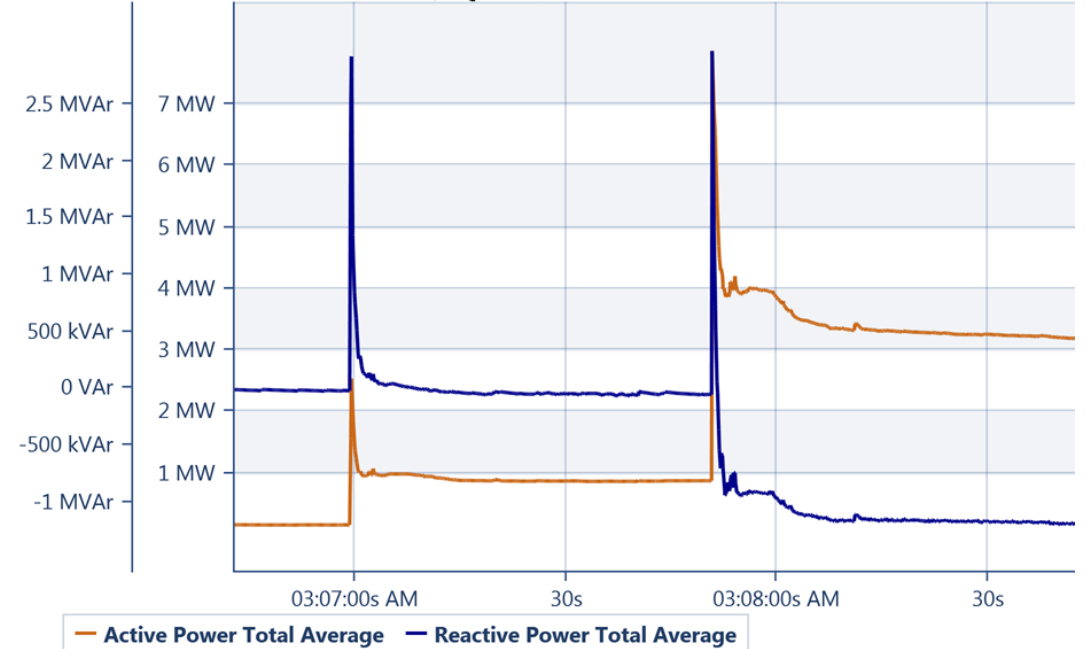
# Dalrymple BESS – Performance

- Black start – soft energization of 33 kV feeder
- Load pick up

Trend: Waveform Voltage, PQZIP 25/09/2018 05:01:10 PM

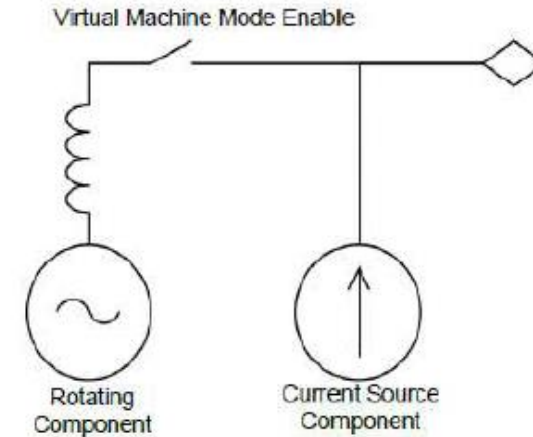


Trend: Active Power Reactive Power, PQZIP 25/09/2018 05:01:10 PM



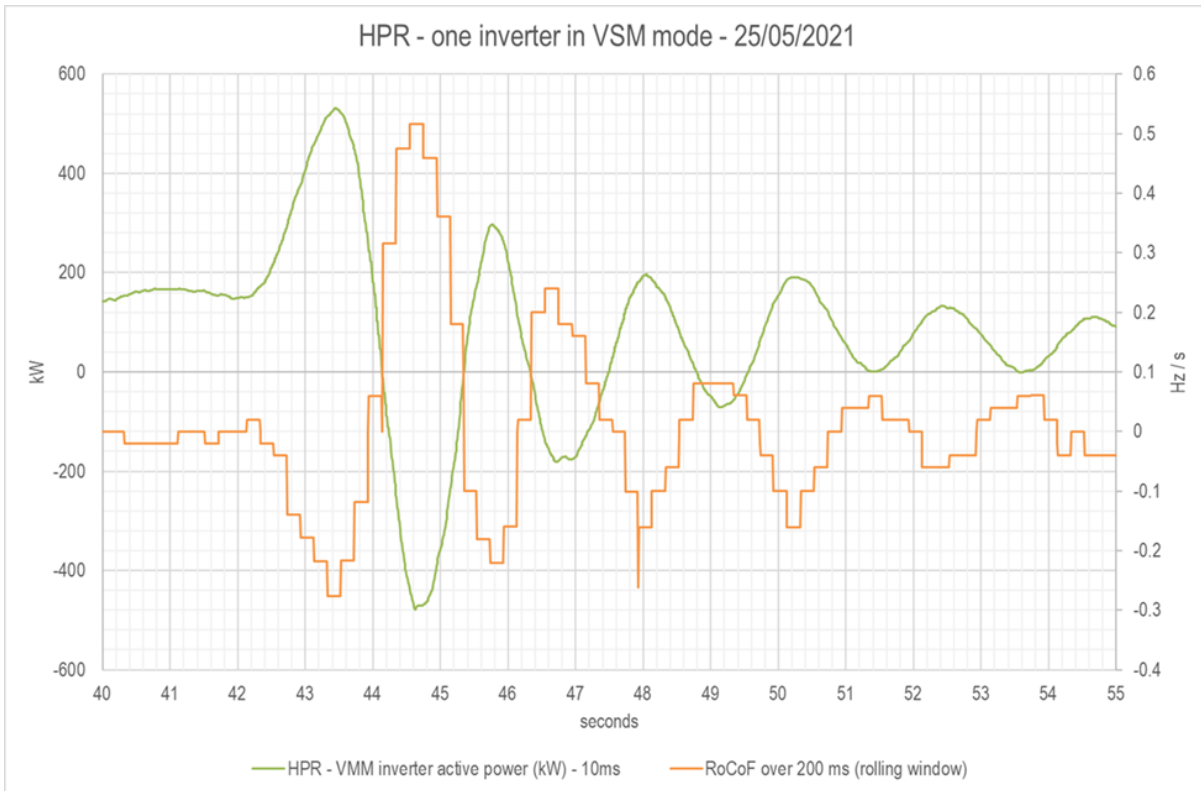
# Hornsdale Power Reserve

- HPR 150 MW / 193.5 MWh
- Virtual Machine Mode (VMM)
- Mimicking synchronous machine
- During steady state
  - Response dominated by current source component
- During disturbance
  - MW response proportion to the rate of change of frequency (RoCoF)
  - MVAr response in response to change in voltage
- Demonstrated capabilities
  - Inertial response

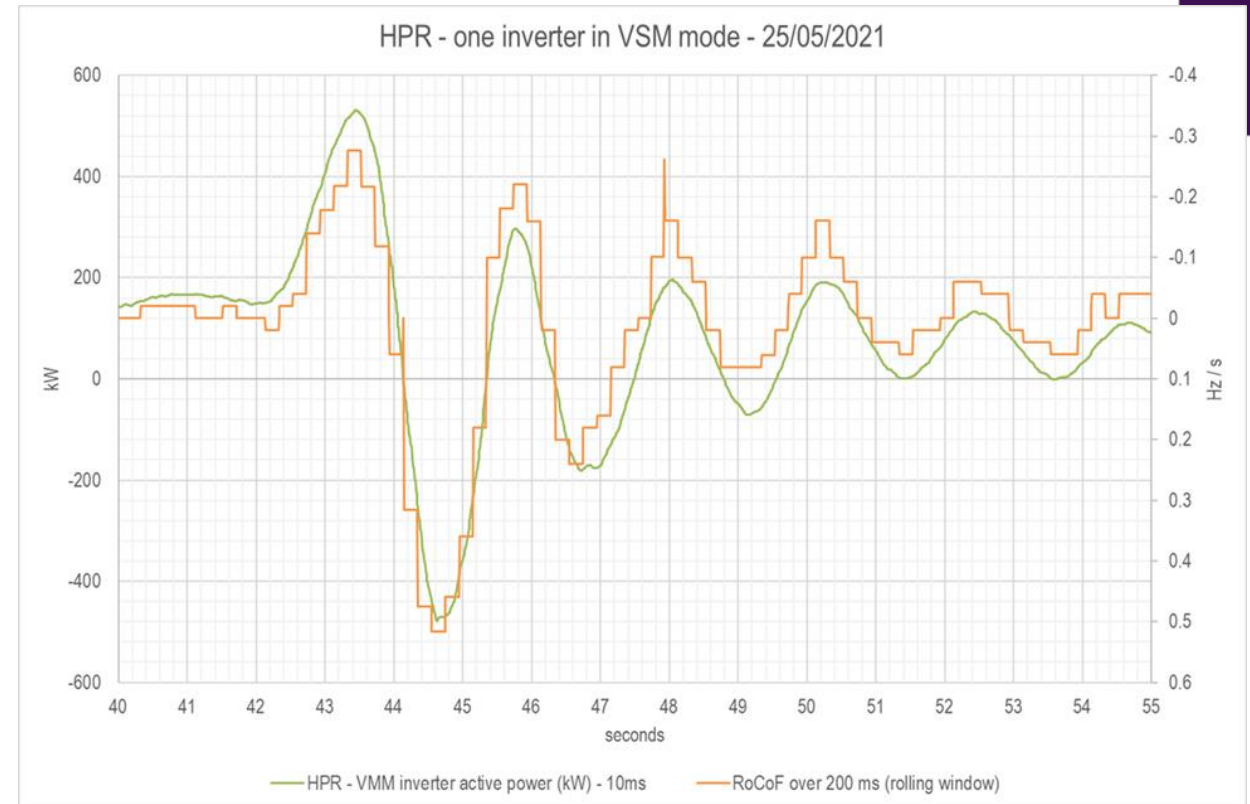


# HPR response to a disturbance

- Response is largely driven by the rate of change of frequency
- Maximum MW at max/min frequency vs max RoCoF



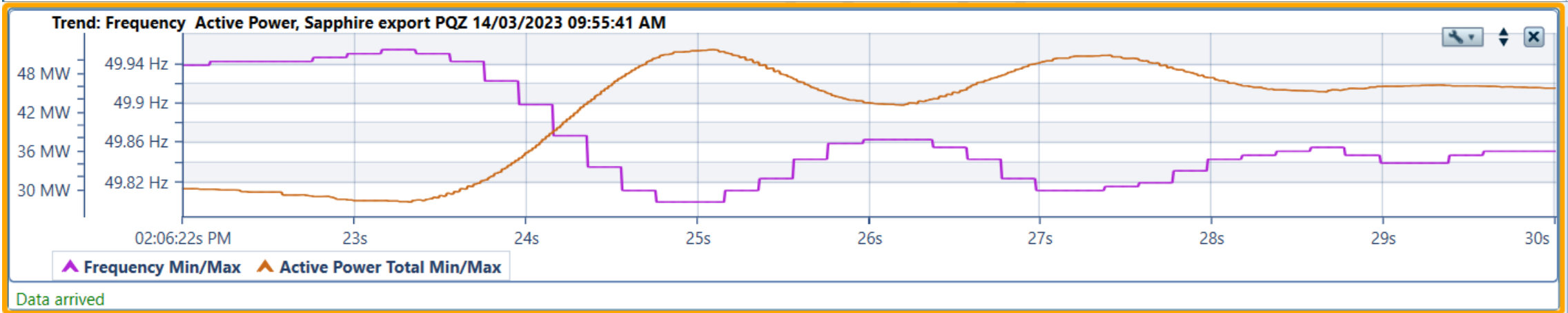
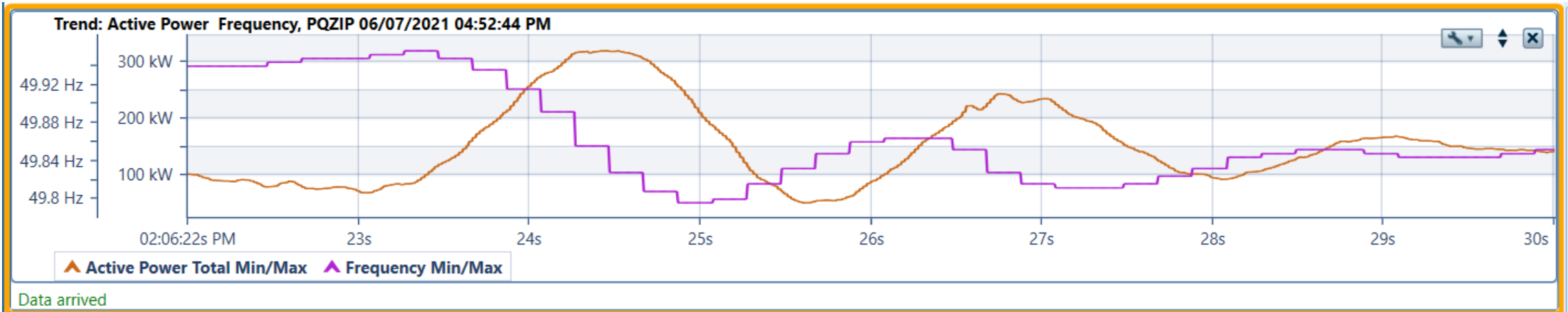
VSM inverter – kW vs ‘calculated’ RoCoF



VMM inverter – kW vs ‘calculated’ RoCoF  
(secondary Y axis reversed)

# HPR response to a disturbance

- GFM vs GFL response (inverter and site)



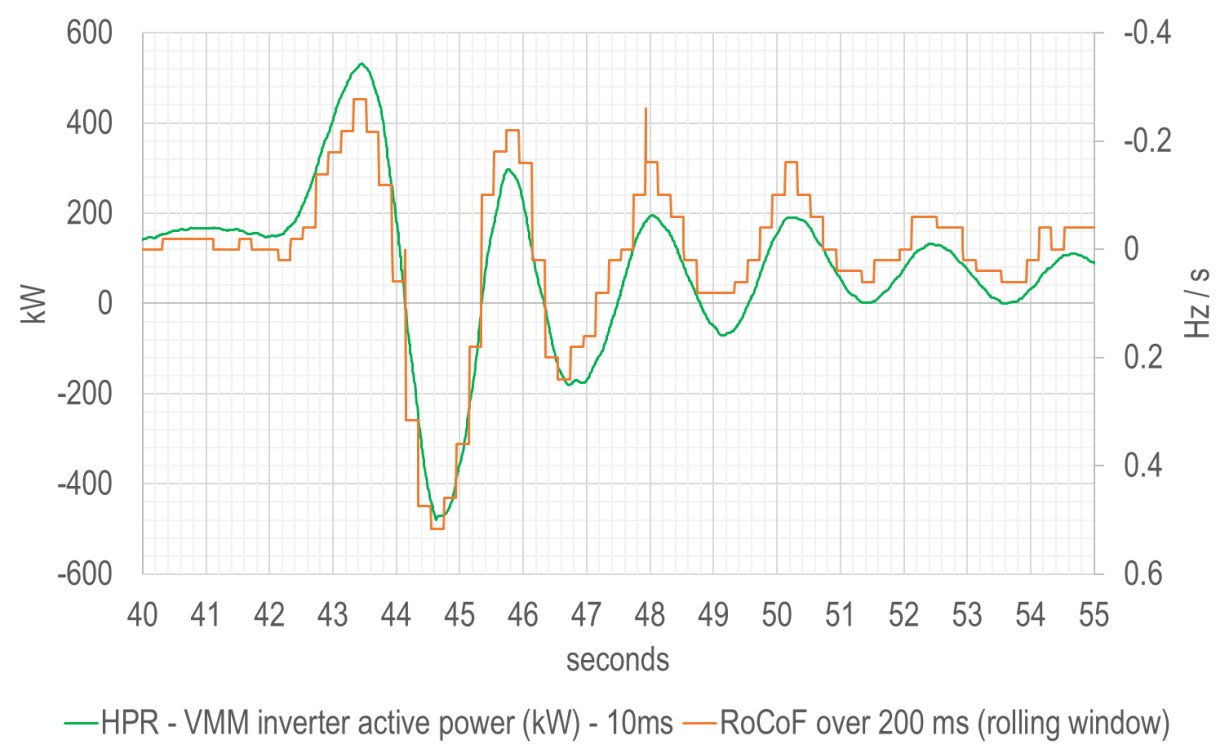
# Synchronous machine vs Virtual Machine Mode

- An example comparison

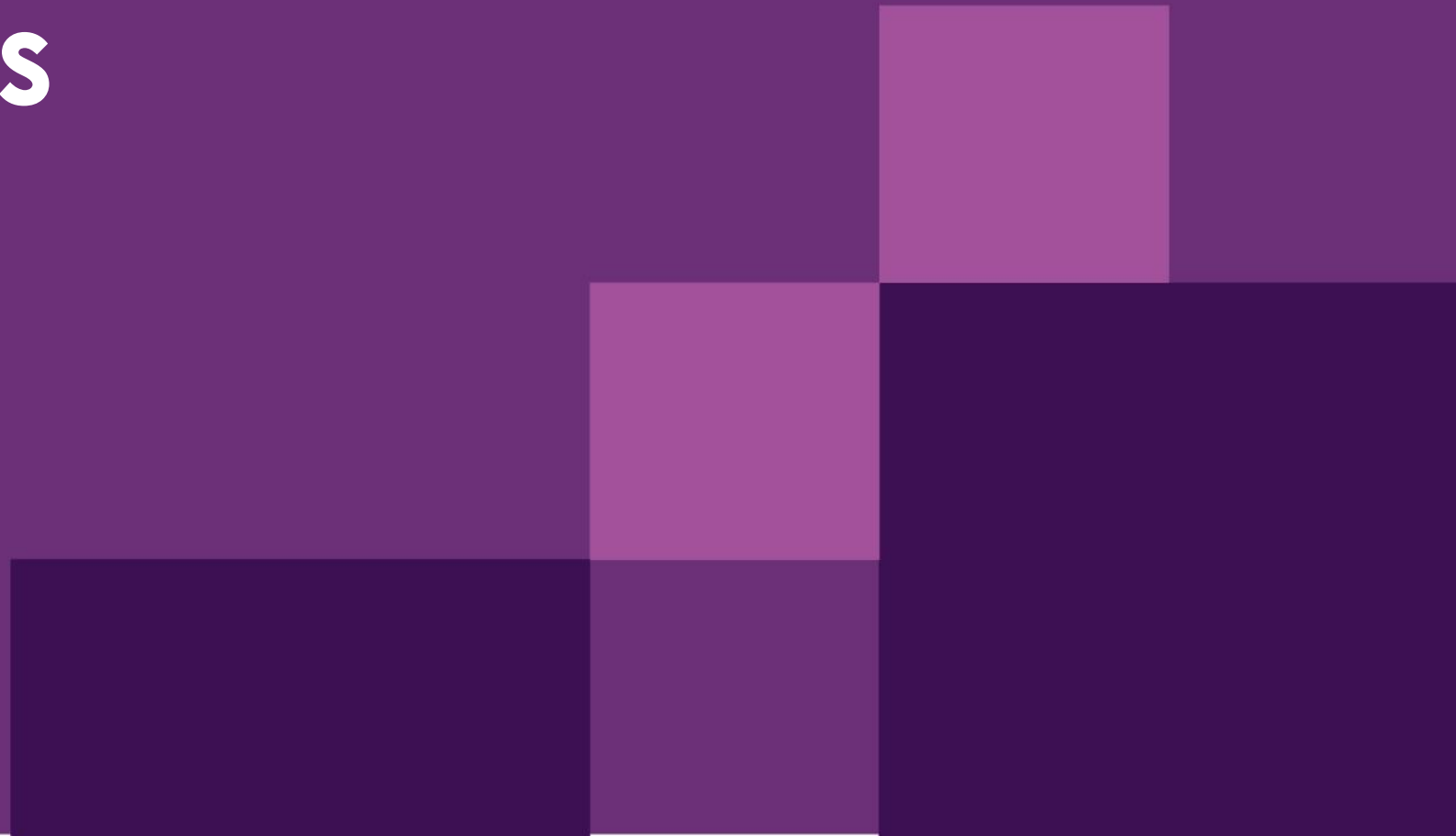
Synchronous Machine - 25 May 2021



HPR - one inverter in VSM mode - 25/05/2021

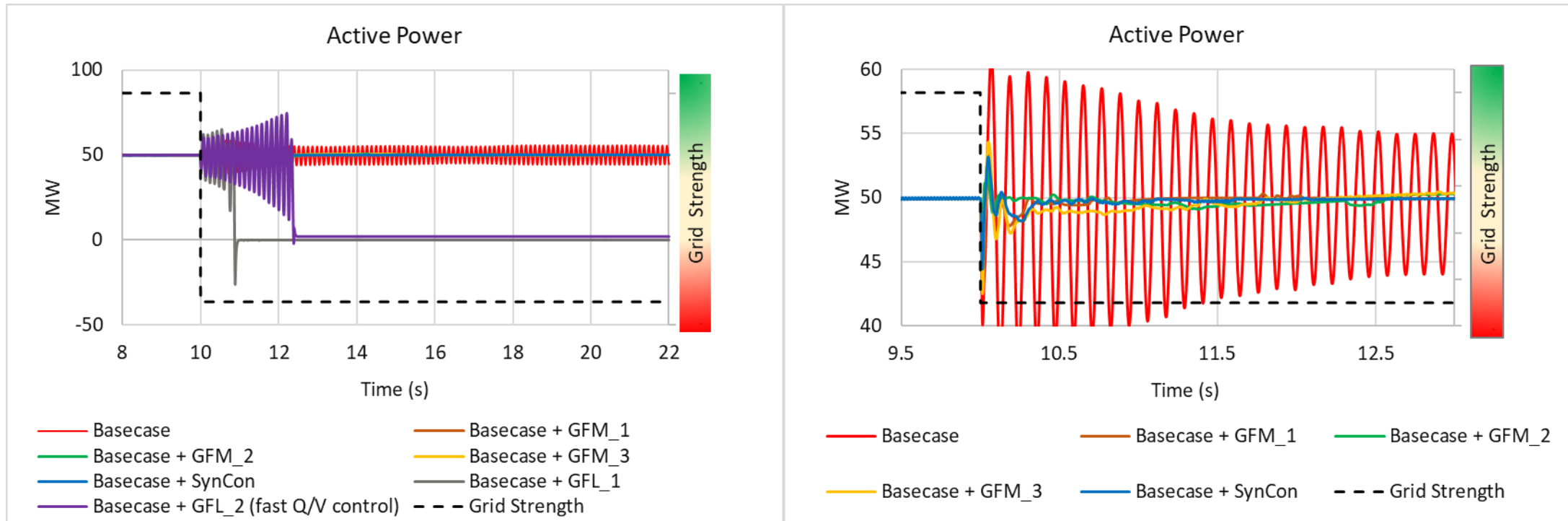


# Potential GFM applications



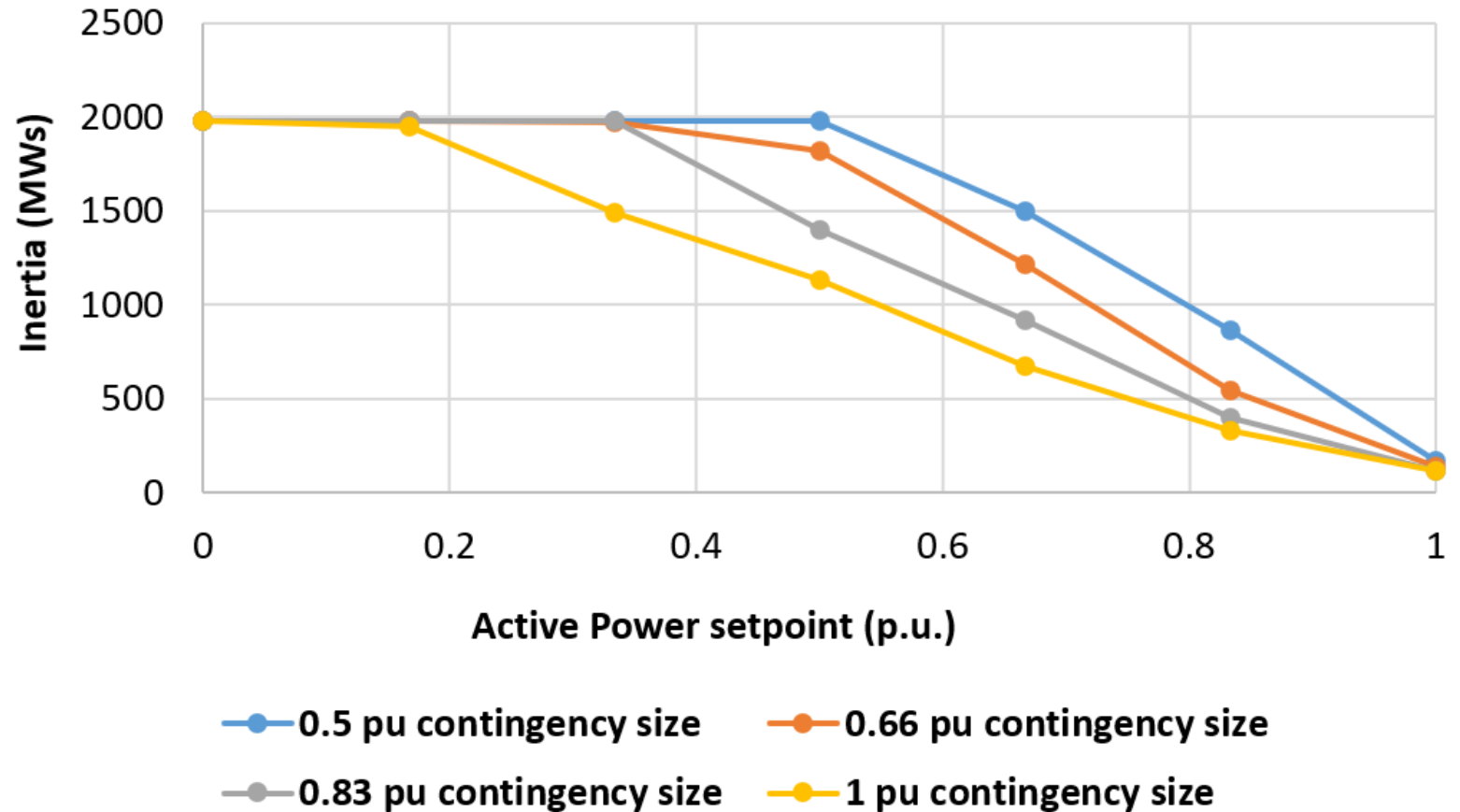
# System strength support

- Supporting stable operation of nearby GFL IBRs



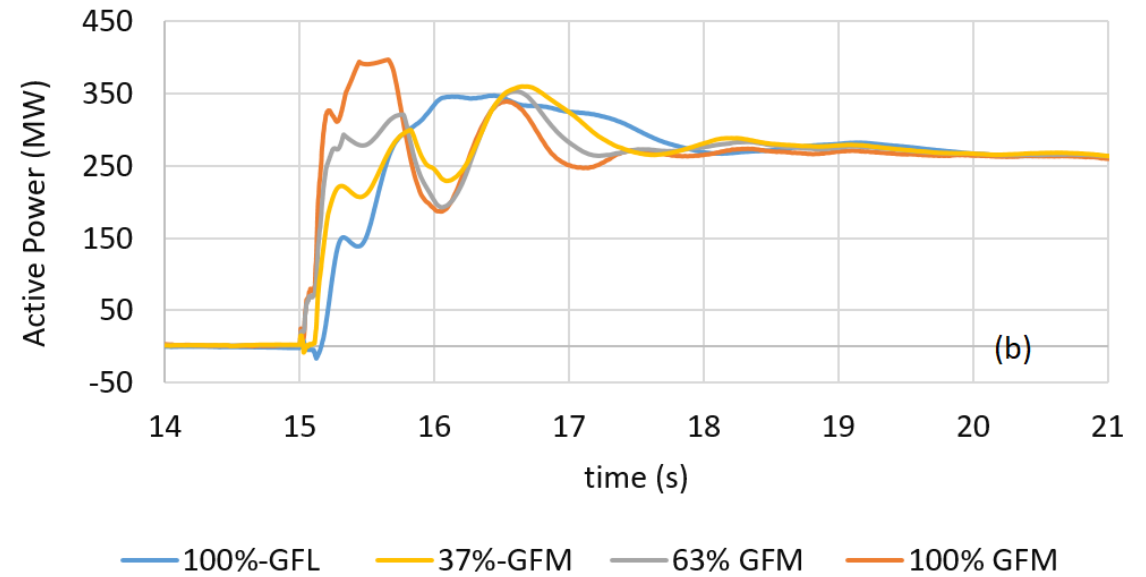
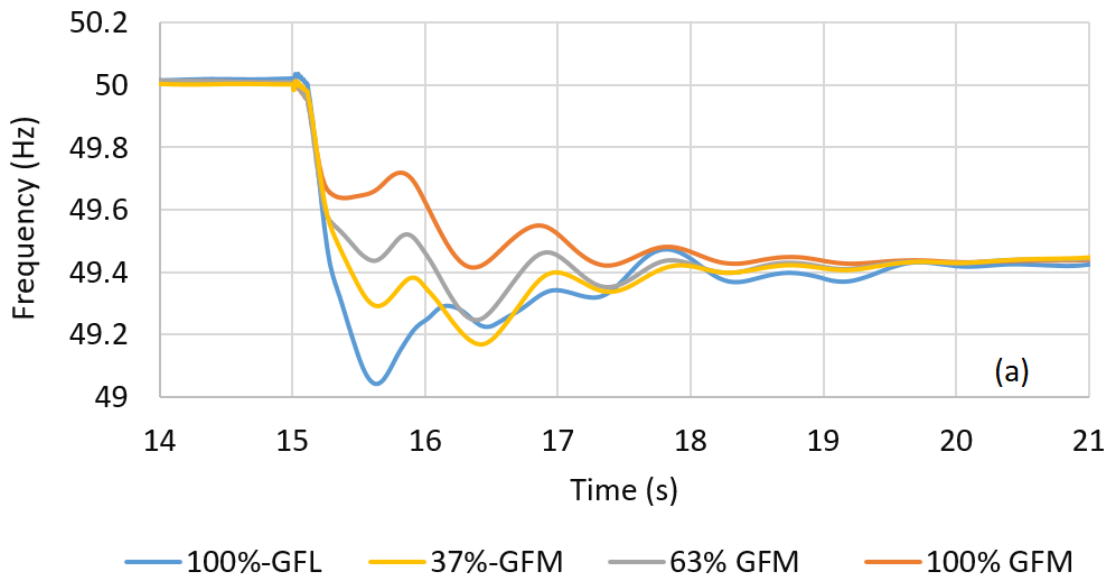
# Inertia contribution

- Operating point
- Headroom / foot-room
- Overload capacity
- Contingency
  - Generation vs load
  - Size



# Frequency control

- Contingency size of 280 MW. The total size of BESS was considered to be 400 MW





For more information visit

[aemo.com.au](http://aemo.com.au)