

PFR of Dispatched Generation on 25/08/2018

Excludes generation enabled for assisting FCAS

Summary of Regional Frequencies

- **QLD**
 - exporting to NSW
 - over frequency after AC separation from NSW (13:11:41.2)
- **SA**
 - initially under-frequency after QNI trip when connected to NSW-VIC
 - within 5 seconds (13:11:46.8), Heywood trips resulting in AC separation of SA and NSW-VIC
 - results in over-frequency
- **NSW-VIC**
 - under-frequency following successive trips of QNI and Heywood

Observing Generator PFR

- Data availability
 - FCAS Causer Pays data (4 second frequency)
 - NSW-VIC, SA, QLD regional frequency data (1 second frequency)
- Data limitations
 - communication delays and/or data processing in Causer Pays
 - leads to 'lagged' response in data
 - determine if appropriate to apply leading adjustment across dataset
 - sampling and/or data processing in Causer Pays
 - under-sampling might hide true generator response

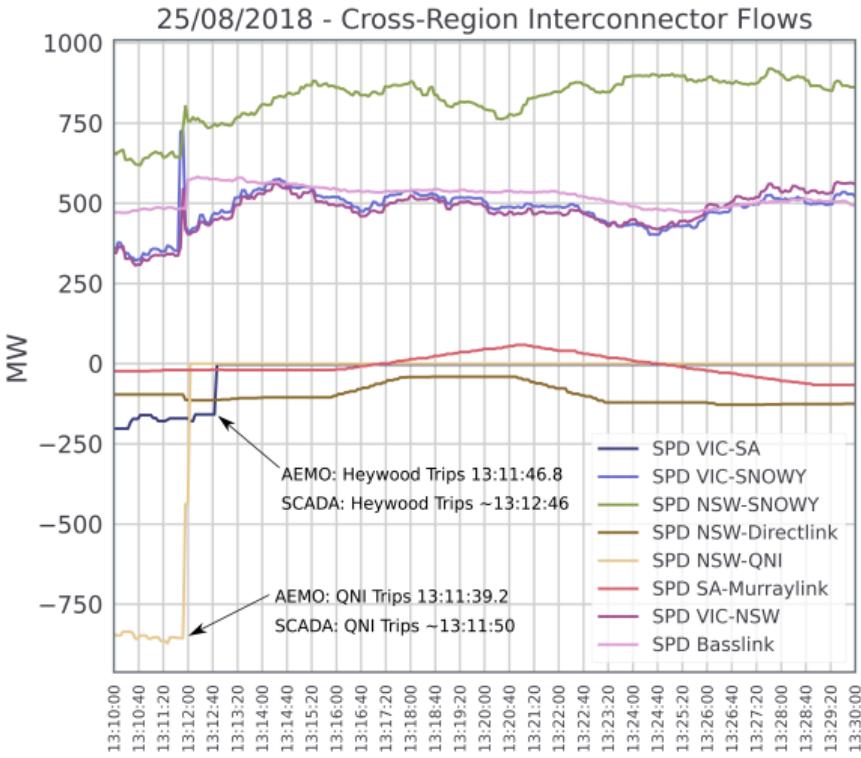
Observing Generator PFR

- Steps
 1. Determine if leading adjustment required for Causer Pays
 2. Identify generators scheduled for DI 13:10-13:15
 3. Isolate generators not providing assisting FCAS
 - Observed response will reflect PFR of generator when operation in frequency-responsive mode is not mandatory
 4. Use Causer Pays data to observe gen response over DI

Summary of Observations

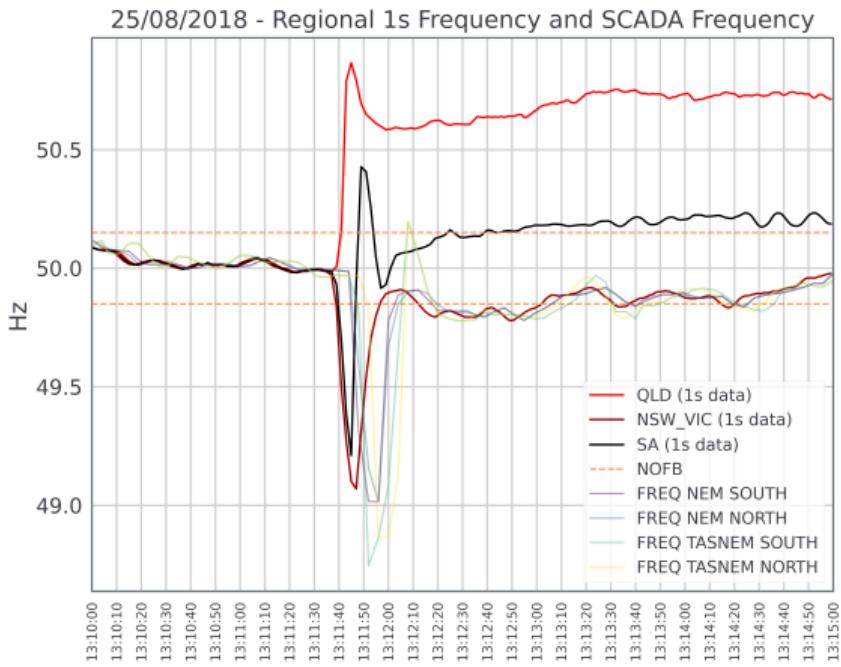
- Data lag
 - inconsistency in data lag for one interconnector
 - leading correction needed if interested in response magnitude rather than time?
 - **no lag correction/leading applied to Causer Pays dataset**
- Generator response
 - Predominantly no or withdrawn PFR for synchronous units
 - No response from inverter-based renewables except for GPS
 - Most interesting responses in SA and QLD where frequency deviation outside NOFB was sustained

Leading Adjustment - Interconnectors



- ~10 second lag in the QNI trip
- ~1 minute lag in Heywood trip in Causer Pays data
- Inconsistent lag

Leading Adjustment - Regional Frequencies



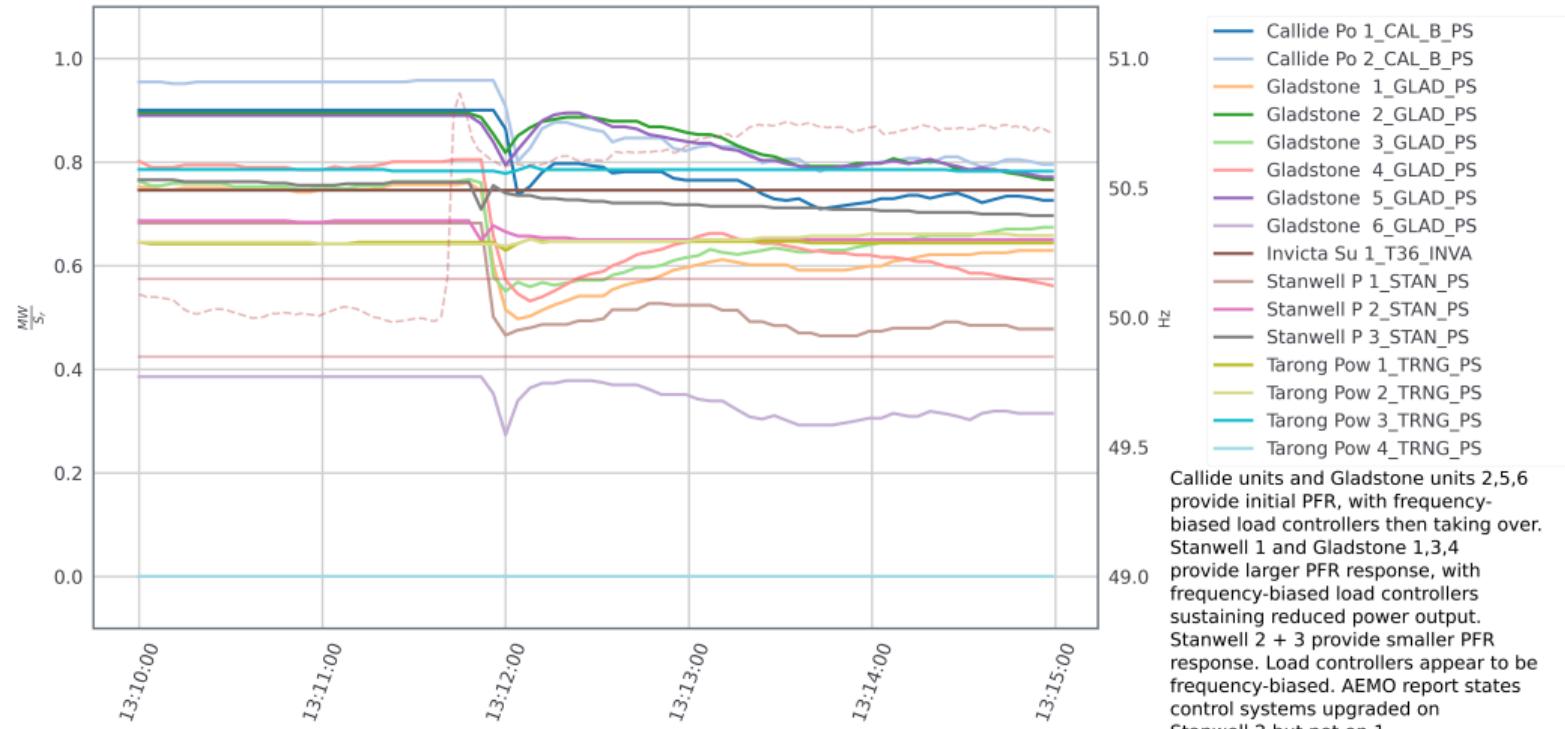
- Regional frequency data consistent with AEMO's report
- Causer Pays data for NEM North and South appears to match NSW-VIC
 - different nadir magnitude
 - lag of 8-10 seconds

Generator Response

- Operating modes as described in Undrill 2018
 - Droop mode or droop-dominated mode, where droop response is sustained. Load controller does not interfere,
 - Prescheduled output mode without frequency bias, where initial PFR withdrawn by load controller to scheduled load setpoint
 - Prescheduled output mode with frequency bias, where load controller moves unit to offset scheduled load setpoint after initial PFR. Offset dependent on system frequency
 - AGC mode
 - Non-responsive mode

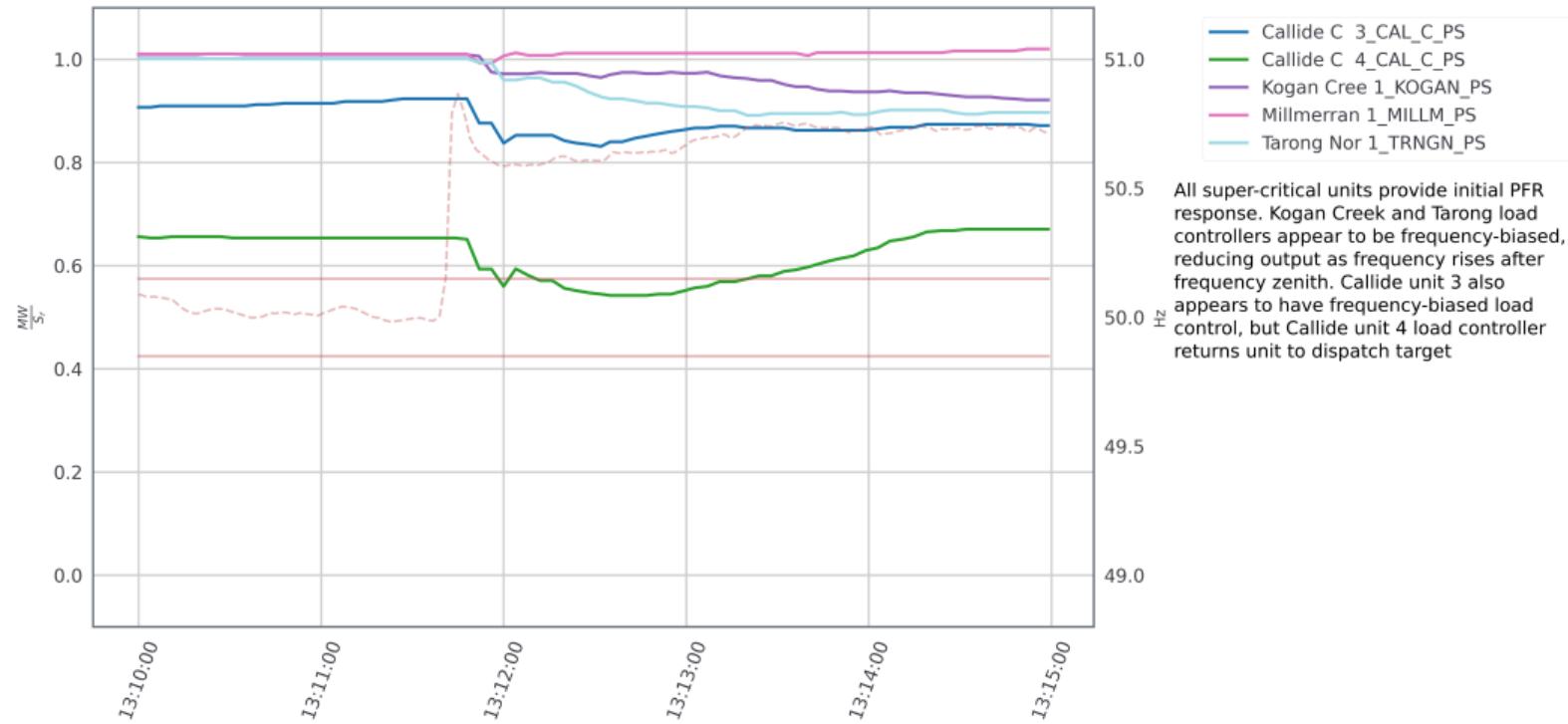
Generator Response - QLD Subcritical Coal

25/08/2018 - Steam Sub-Critical Generators power in QLD, excluding those enabled for FCAS Lower



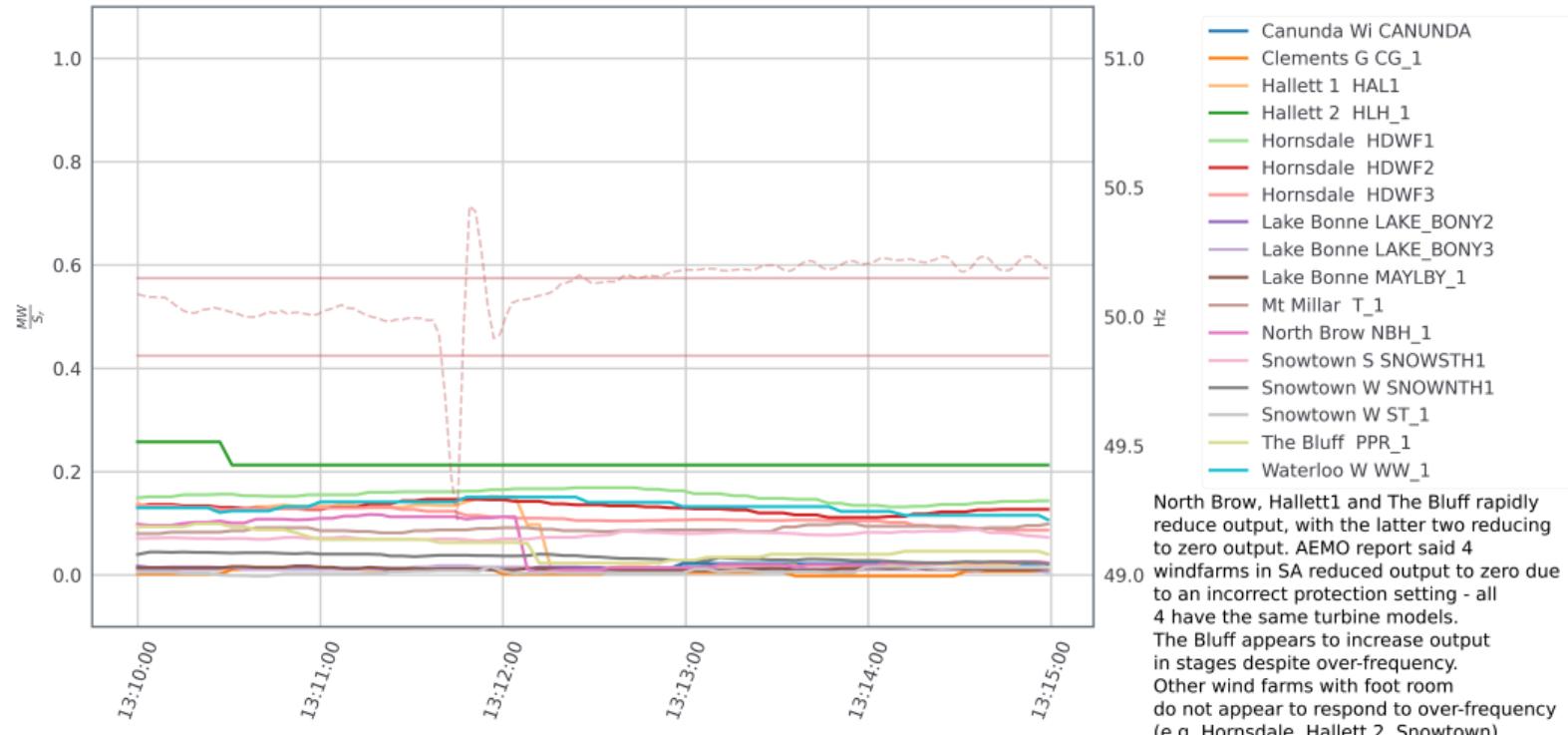
Generator Response - QLD Supercritical Coal

25/08/2018 - Steam Super Critical Generators power in QLD, excluding those enabled for FCAS Lower



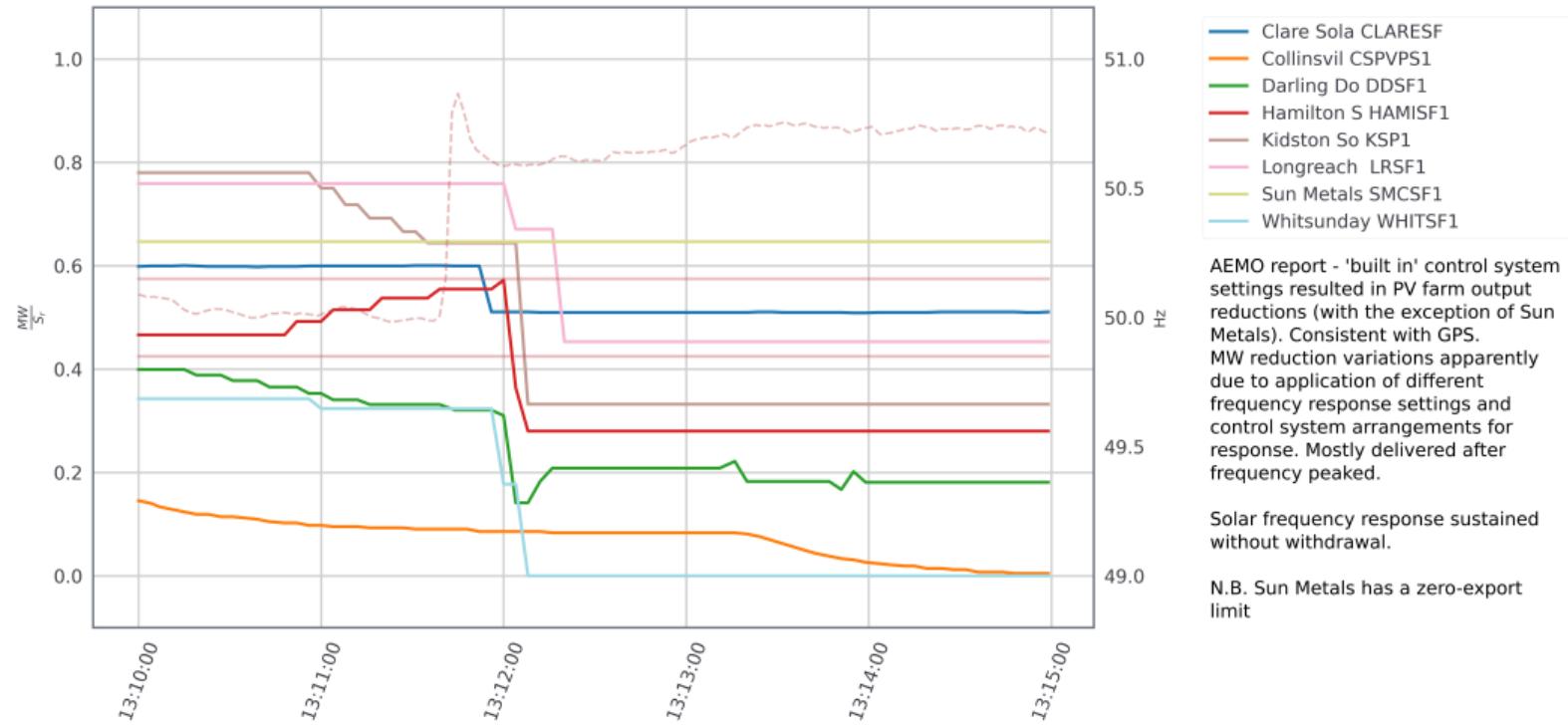
Generator Response - SA Wind

25/08/2018 - Wind Generators power in SA, excluding those enabled for FCAS Raise and Lower



Generator Response - QLD PV

25/08/2018 - PV Generators power in QLD, excluding those enabled for FCAS Lower



GTPS for Connection after 5/10/2018

- Schedule 5.2.5 of NER includes GTPS for connection
 - **S5.2.5.3** - Response to frequency disturbance
 - MAS AAS - Minimum ride-through times for various frequency bands
 - **S5.2.5.8** - Protection from disturbances
 - MAS - Facilities to automatically and rapidly reduce output by at least half if frequency exceeds level nominated by AEMO (not less than upper limit of OFTB - ± 1 Hz)
 - **S5.2.5.11** - Frequency control
 - MAS - not work against frequency control and *capability* of operating in frequency response mode
 - AAS - not work against frequency control and *capability* of operating in frequency response mode such that could provide all FCAS services
 - Frequency response mode must automatically provide proportional response