

Australia's is undergoing a fast passed energy transition

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- Agenda

- The NEM

- Overview

- Energy mix

- System Strength

- Energy Transition

- Today and plan to 2050

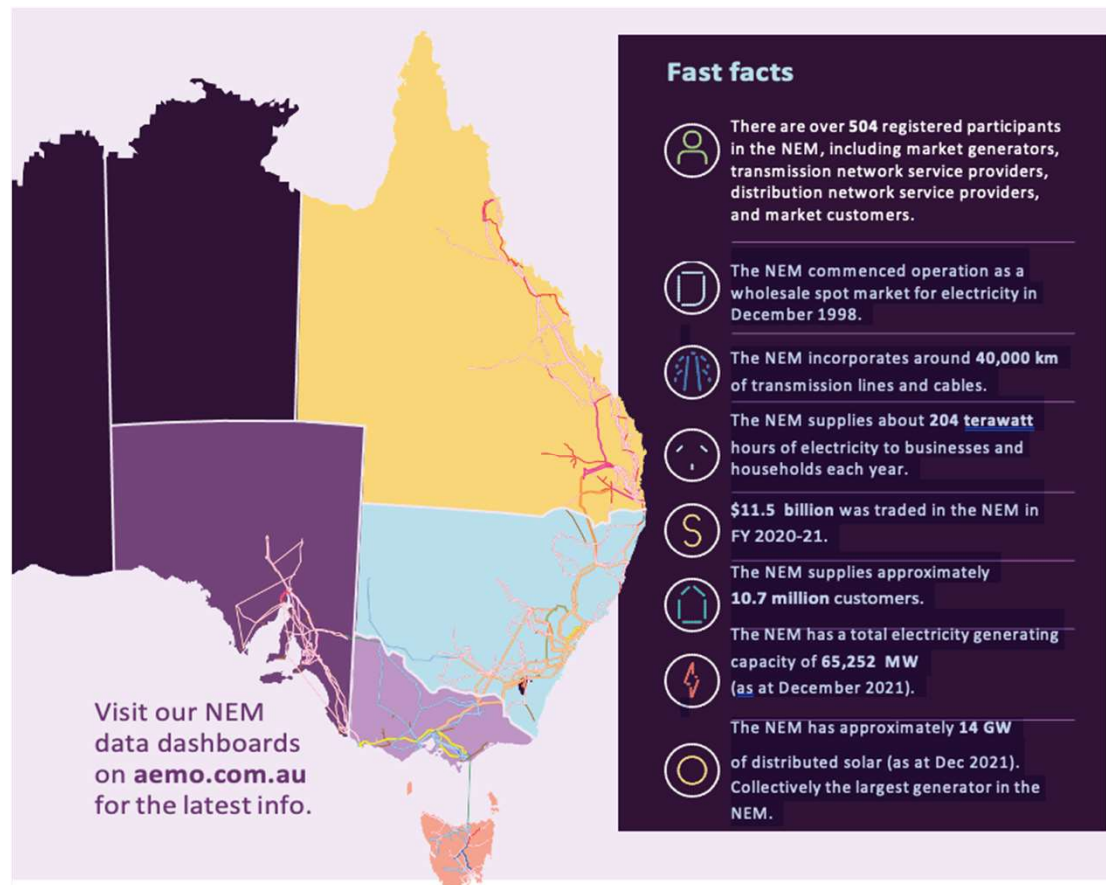
- Challenges

- Voltage Regulation

- Small signal oscillation – West Murray region

- Insufficient Smart Meter Penetration.

National Electricity Market (NEM)

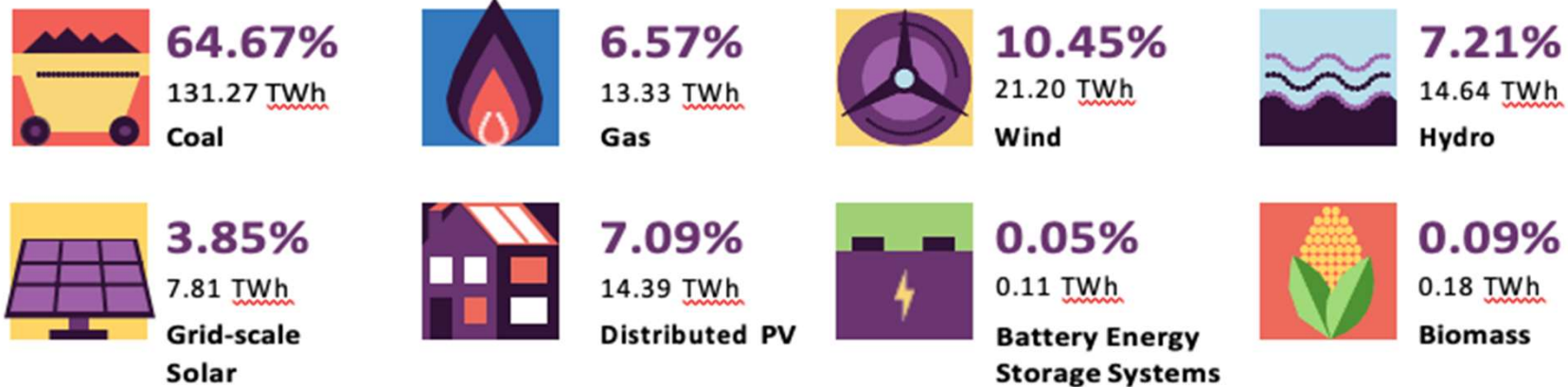


The National Electricity Market (NEM) operates on one of the world's longest interconnected power systems.

Australian Energy Market Operator (AEMO) is the independent system and market operator for the National Electricity Market (NEM)

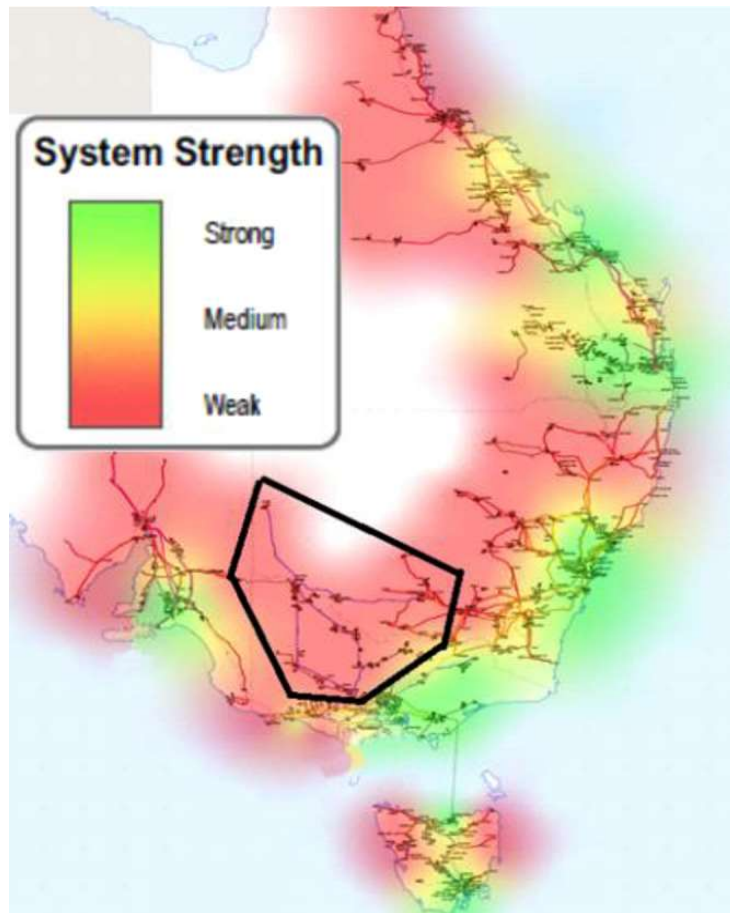
NEM Energy Mix

Annual generation by fuel type (2020/21)



- Renewables accounted for 33% of generation in 2021
- Inverter based renewables are voltage following ie Asynchronous
- Asynchronous generation is replacing Thermal synchronous generation resulting in loss of system inertia.
- The 1.6 M rooftop solar installations with 5.2 GW capacity causing minimum demand issues.

System Strength



- System strength is the ability of the power system to maintain and control the voltage waveform at any given location in the power system.
- The NEM has weak Grids in the areas best suited to large scale wind and solar generation.

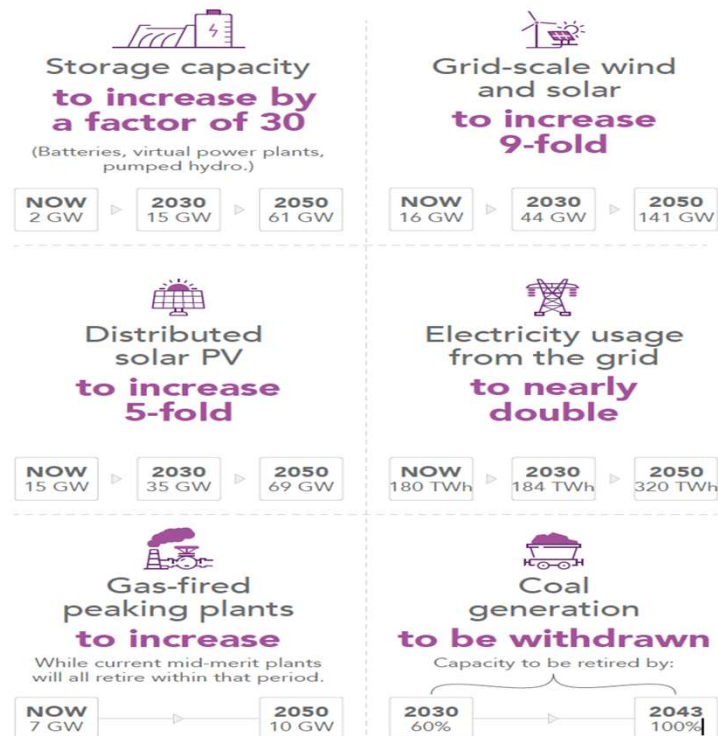
Low System Strength - Characteristics

- Wider area undamped voltage and power oscillations.
- Generator fault ride-through degradation.
- Mal-operation or failure of protection equipment to operate.
- Prolonged voltage recovery after a disturbance.
- Larger voltage step changes after switching capacitor or reactor banks.
- Instability of generator / dynamic plant voltage control systems.
- Increased harmonic distortion (a by-product of low system strength and higher system impedances).
- Deeper voltage dips and higher over-voltages (e.g. transients).

NEM the worlds unique renewables experiment

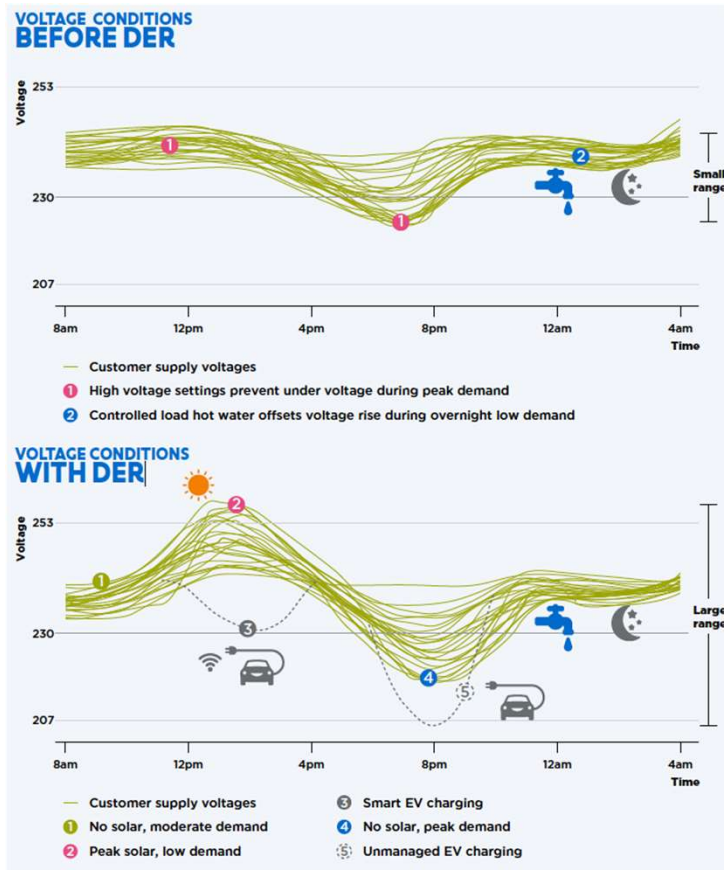
Expected energy transition to 2050

('Step Change' scenario)



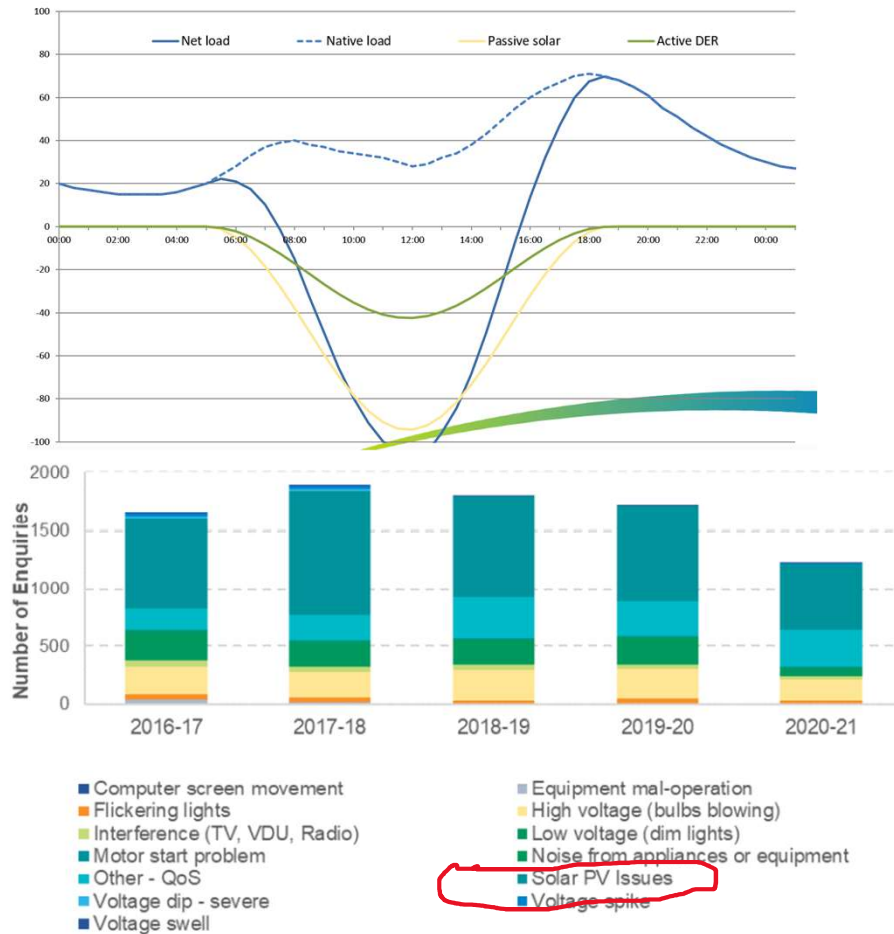
- Long skinny Grid
- Today behind the meter and utility scale renewable energy resources account for 33 % of national generation capacity.
- Over 3 Million rooftops have solar with average installed capacity of 8.5kw.
- Need to manage 100 per cent renewables penetration – at any moment in any day – by 2025.

Voltage regulation



- Voltage rises when DER supplies more energy than is required locally i.e., Negative demand.
- Remediation QLD – *Manually adjust Vogtle Taps. Now at the limits*
- Remediation VIC
- Solution SA – *DER curtailment.*

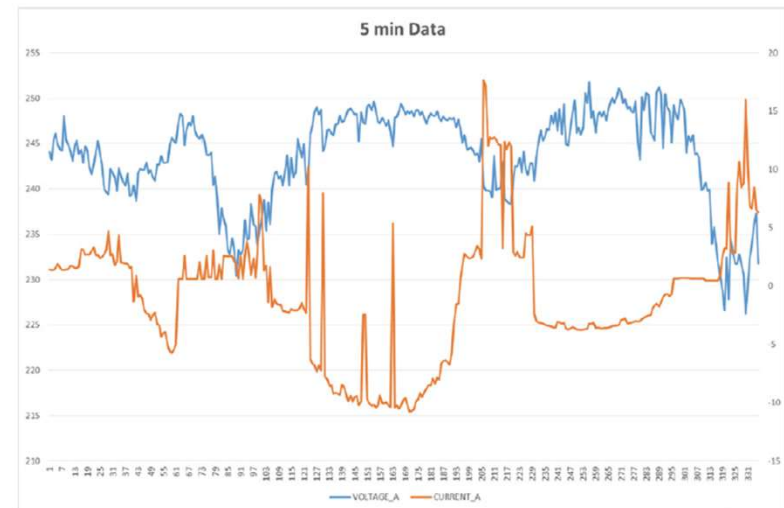
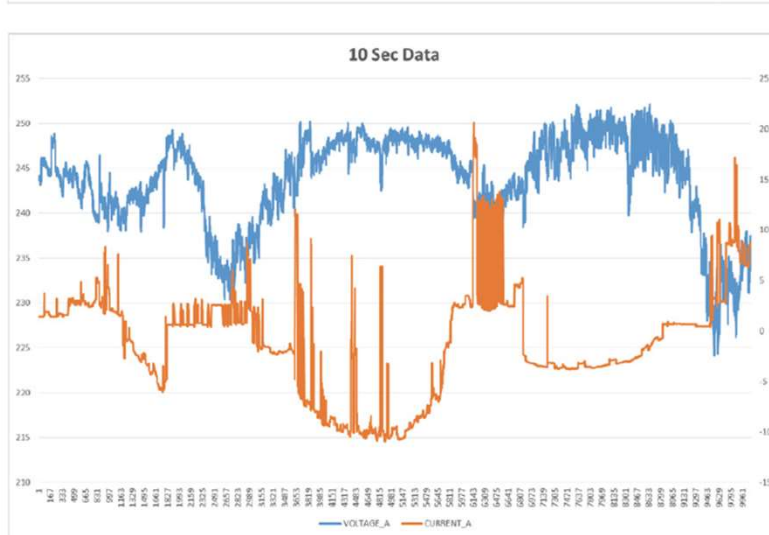
Queensland Networks



- In just over a decade solar PV capacity in Qld has increased 1000-fold, primarily on the distribution network
- Mitigation
 - V nominal changed from 240 +\ - 6% to 230 +10% -6%
 - The 230V standard & improved distribution voltage regulation accommodates more voltage rise/PV
 - Advanced autonomous inverter GSF mitigate impacts and maximise PV penetration
- Solar capacity continues to grow so more needs to be done to mitigate Voltage rise.

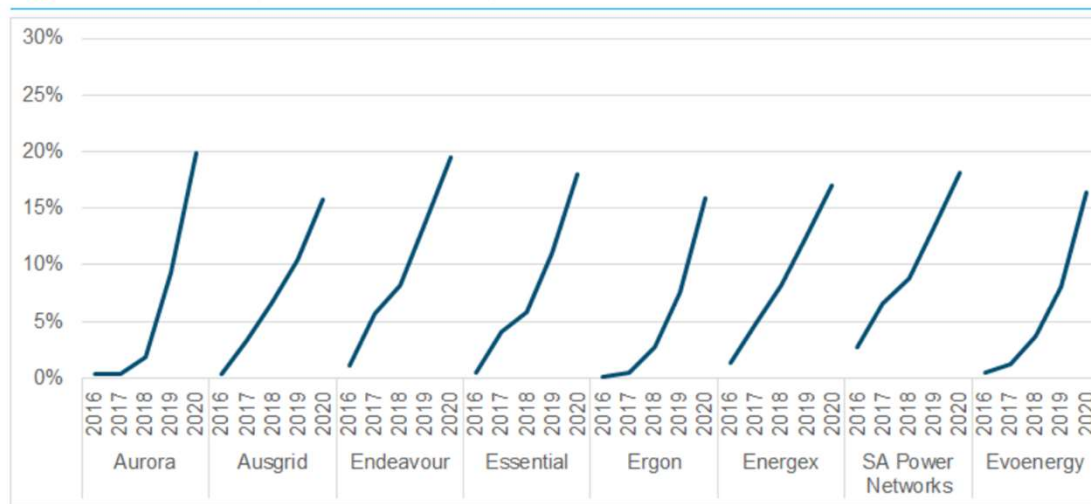
Smart Meters

- Over 2.8 Million Smart meters Inservice, > 99 % of the fleet
- 30 min interval energy moving to 5 min
- United Energy are using Smart Meter 5 min voltage data to provide dynamic voltage control - Fleet size approx. 600 k

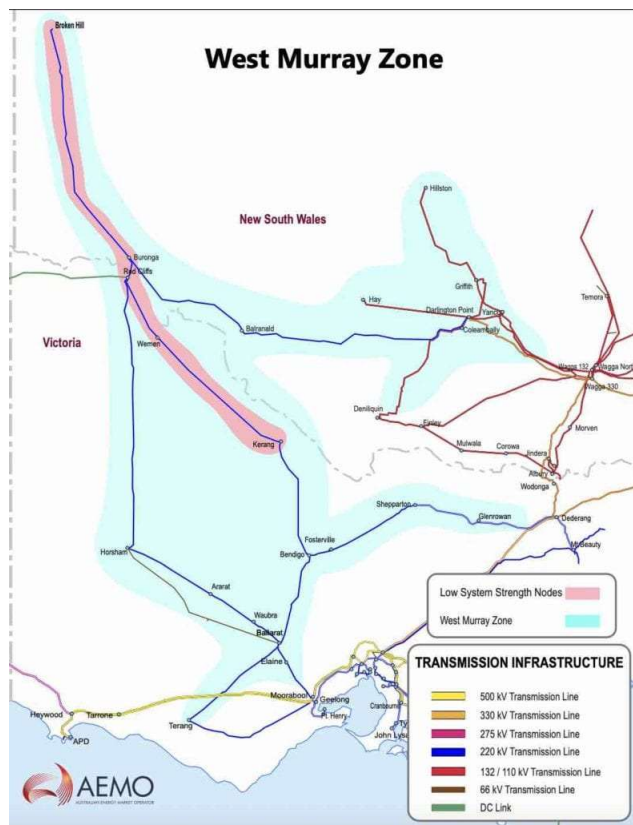


Smart Meter regulatory review

- Outside of Vic Smart meter penetration is < 25%
- AEMC undertaking a review to accelerate deployment.
- > 50% coverage is required to make use of PQ data for network monitoring and control.
- AEMC decision due 20 th of September

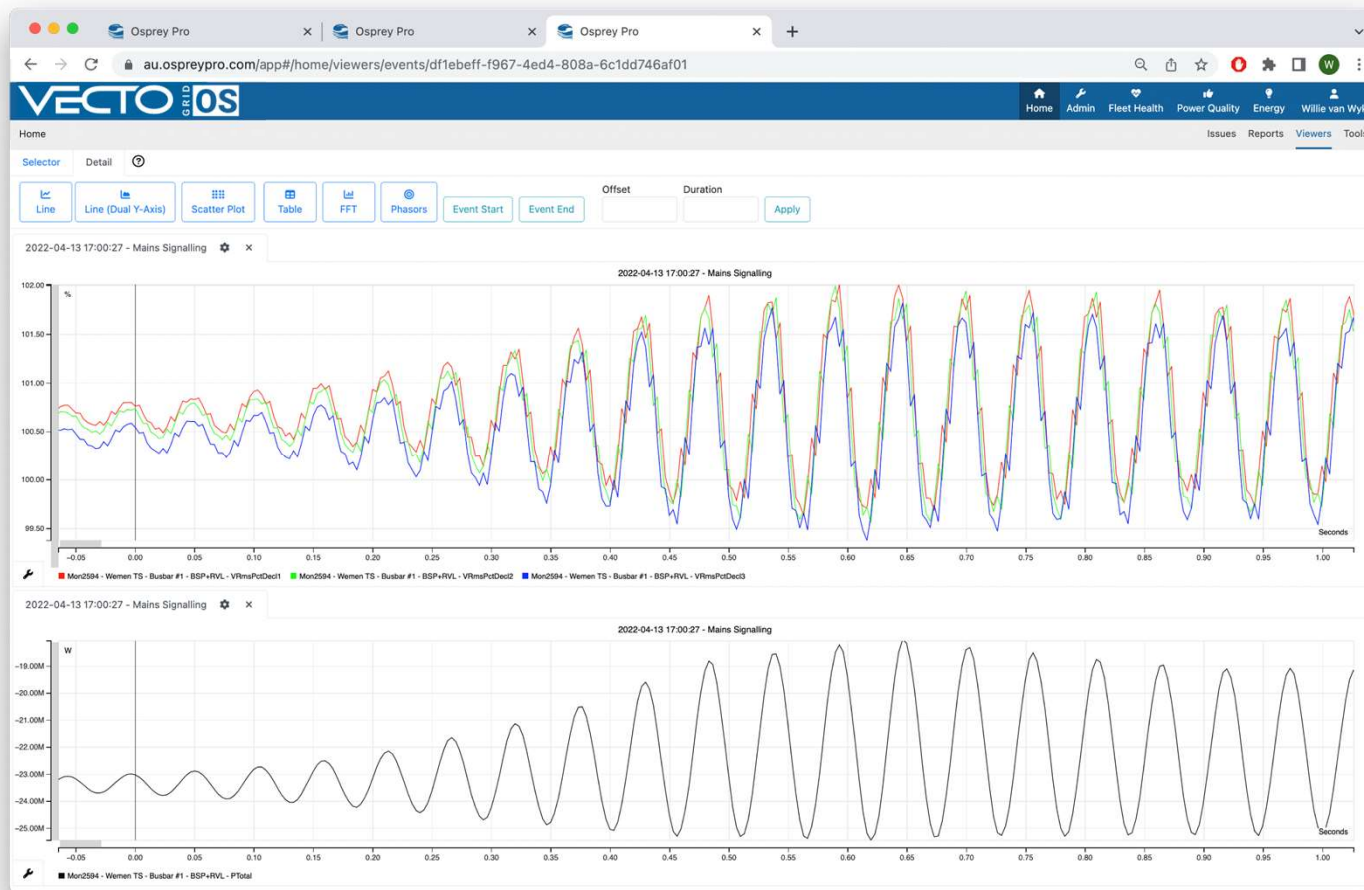


Sub-synchronous voltage oscillations



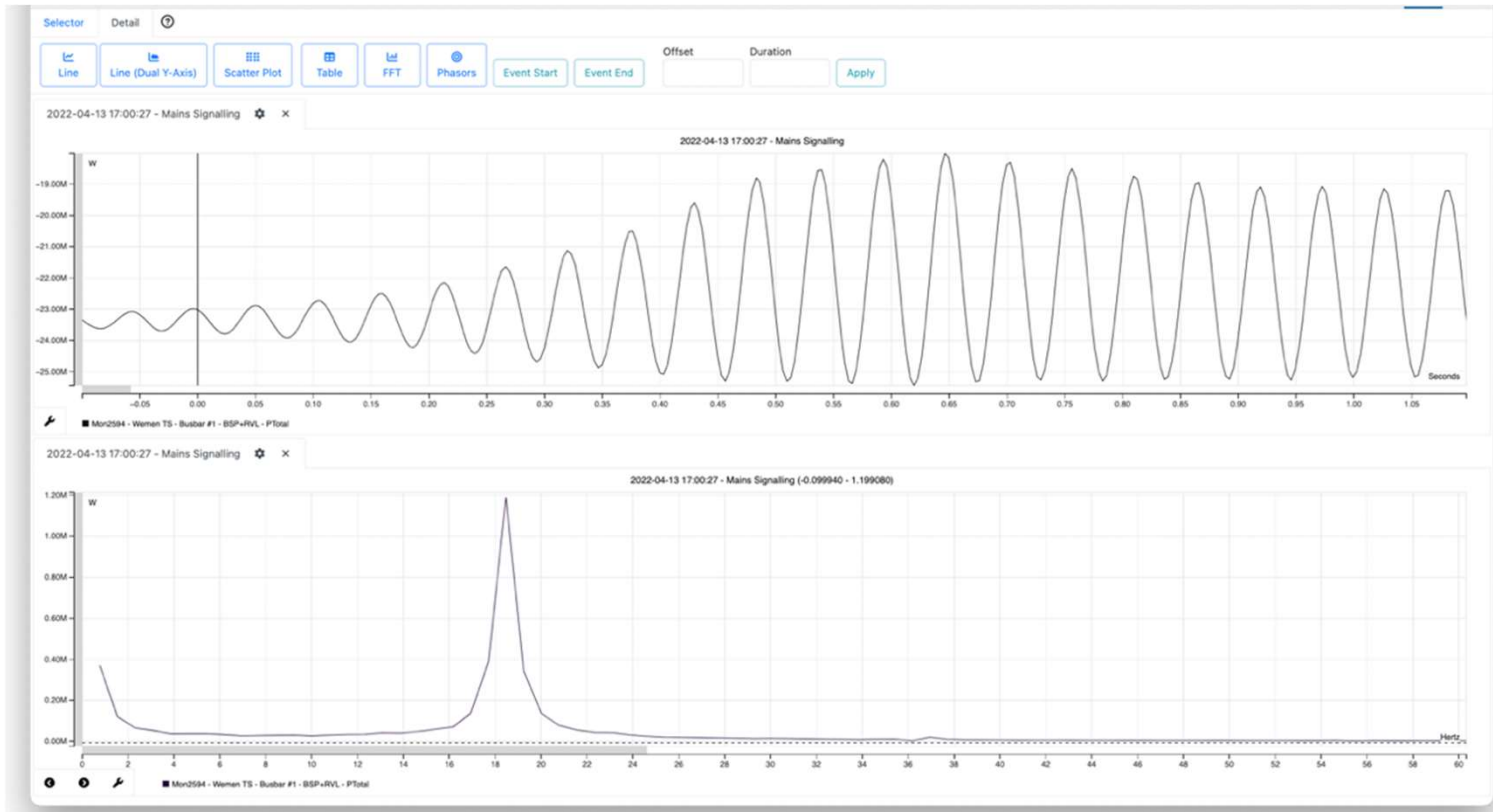
- AEMO has observed intermittent power system oscillations in the West Murray area.
- 19 Hz sub-synchronous voltage oscillations
- 4 analysers deployed to capture the events.

Small Signal oscillation



- Oscillations are spurious
- Voltage ($\pm 1\%$),
- Power oscillations in excess of 5MW on a 20MW
- CT Lab working with AEMO, AusNet and Powercor designed our system to permanently monitor the grid to identify oscillations

Small Signal oscillation



- FFT done on the EMT data

West Murray Investigation still underway

- The investigation is still underway
- Preliminary report due by end of September

- See AEMO
- <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/participate-in-the-market/network-connections/west-murray>

Class-A PQI Device
Class 0.2 Billing
PMU Device
Merging Unit
SCADA Transducer
Small Signal Analyser



500kHz Sampling Rate
Built-in Cellular Modem
Secure IP Based Comms
Linux Based Platform
Flexible Interfaces

GRID-MONITORING EDGE COMPUTER

Questions