Australia's National Electricity Market

Prof. Paul Simshauser AM

November 2022

Agenda

01 Headlines from Australia

02 The NEM's RE Supercycle

03 System Operations

04 Market Prices

05 System Planning

Headlines from Australia

Impacts of the War in Ukraine

- LNG and coal export prices have impacted domestic markets
- High coal fleet outage rates, severe weather (impacted solar PV and coal production)
- Wholesale electricity prices increased sharply, from ~$70/MWh to ~$200+/MWh (£40-111)
- Residential tariffs semi-regulated, hedges delay price shocks
- Australia's decade-long climate policy discontinuity appears to have ended
- RE seen to solve current problems => RE Investment Supercycle continuing
- Competition *within the NEM* is sound. Competition *for the NEM* is 'fracturing'
- State Governments pursuing zonal policies & driving investment

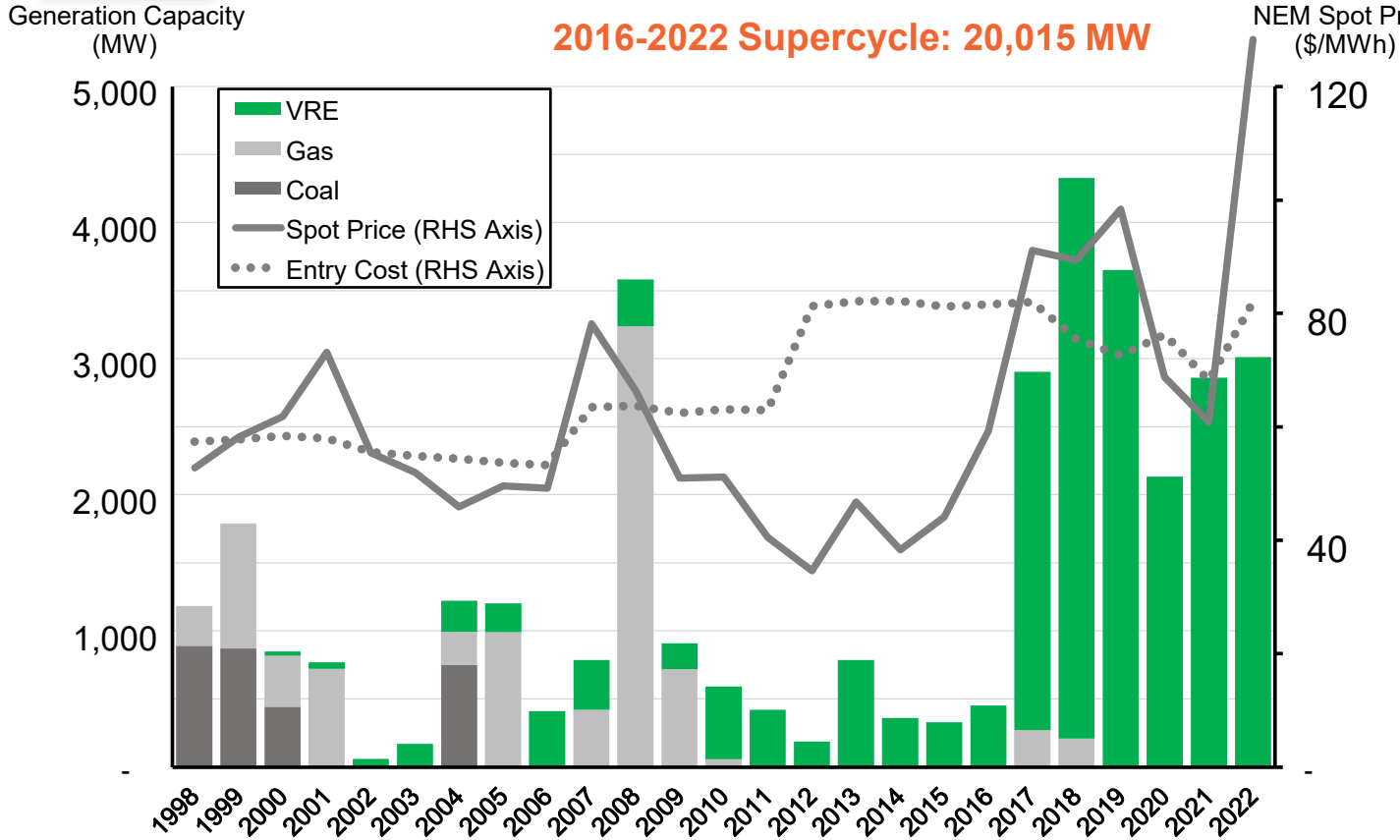
Australia's National Electricity Market

Max Demand 10 GW
Energy Demand 60 TWh
Generation 15 GW
+ 5 GW rooftop solar

FAST FACTS

- NEM = Eastern States: QLD, NSW, VIC, SA, TAS.
  - Popn. 22.3 million, 9.4 million households
- Energy Only Gross Pool, VoLL = AUD $15,500/MWh / £9,000
- Maximum (Grid) Demand = 35 GW,
- Final Energy Demand = 205 TWh (incl. rooftop ~8.5%)
- Aggregate Supply 60 GW existing + 10 GW committed
  - Wind & Solar 22 GW
  - Batteries – 1.2 GW
  - + Rooftop Solar PV ~16 GW

NEM RE Supercycle (investment commitments)



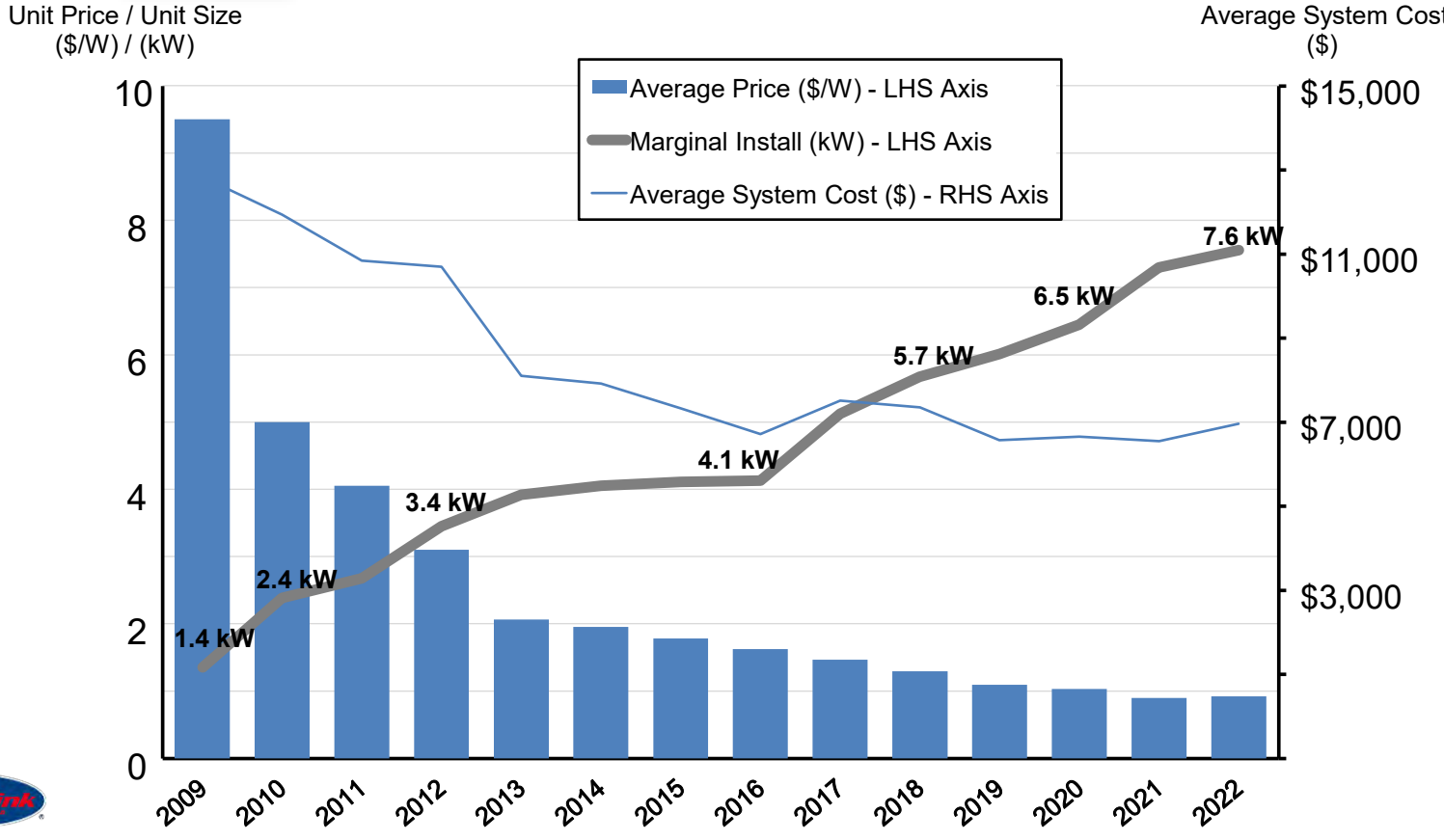
AGGREGATE
- $33.1 bn
- 20,015 MW
- 161 Projects

SOLAR PV
- $15.7 bn
- 10,553 MW
- 107 Projects

WIND
- $17.0 bn
- 8,909 MW
- 50 Projects

Source: EPRG Working Paper No.2014. Updated Oct 2022.

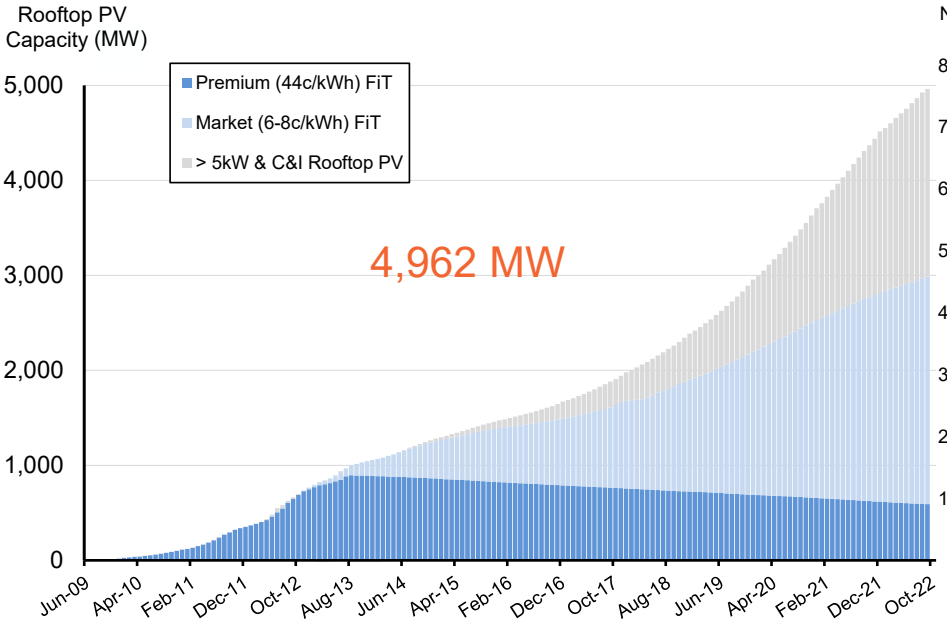
Rooftop solar PV: cheaper and larger

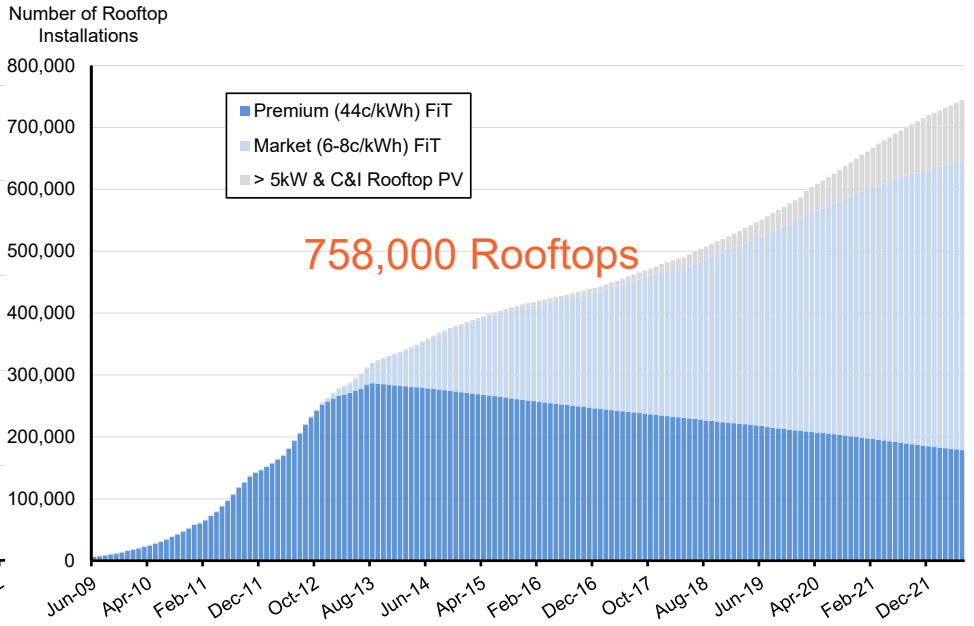


Source: EPRG Working Paper No.2125. Updated Oct 2022.

Kitchen table investments: QLD rooftop PV

Queensland household take-up rate = 43.3%. Highest in the world.





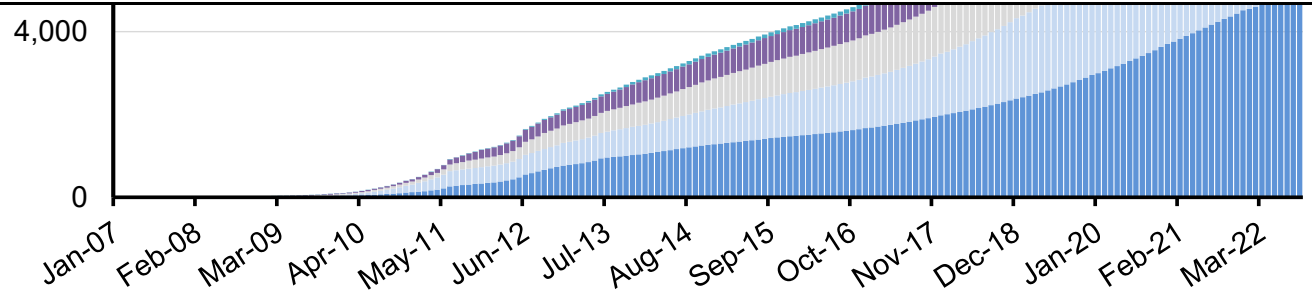
C&I = Commercial & Industrial

Source: EPRG Working Paper No.2125. Updated Oct 2022.

Rooftop PV by NEM Region

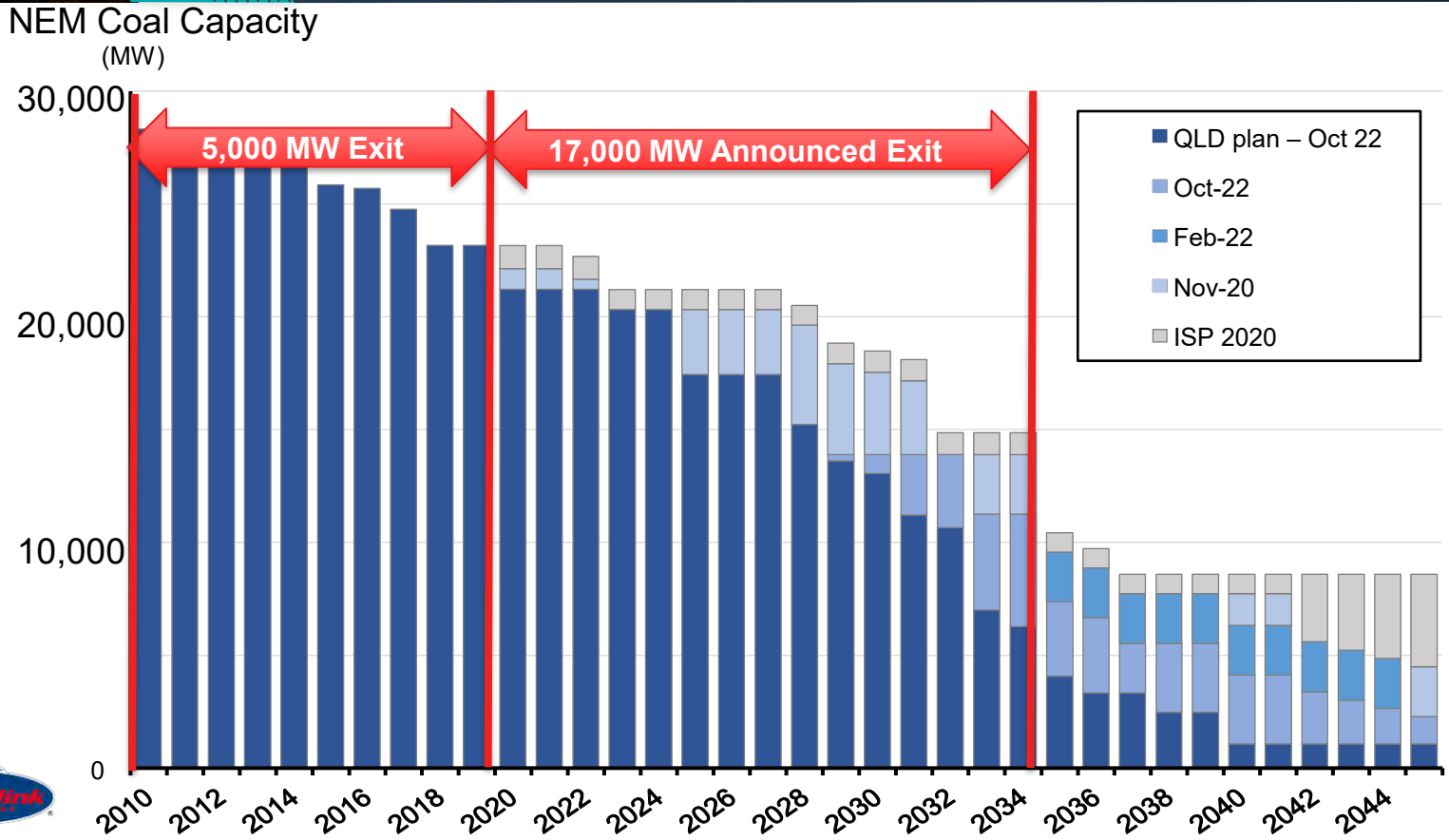
Rooftop PV Capacity (MW)

State	Population (millions)	Solar PV Takeup Rate	Energy Demand (GWh)	Rooftop PV (MW)	Rooftop PV (GWh)	Rooftop PV Market Share
Queensland	5.2	43.3%	60,000	5,000	5,800	9.7%
South Australia	1.8	42.4%	14,000	2,000	2,400	17.1%
New South Wales	8.2	28.8%	72,000	5,000	5,400	7.5%
Victoria	6.7	24.1%	47,000	3,500	3,700	7.9%
Tasmania	0.5	18.3%	11,000	240	250	2.3%
NEM Total	22.3	31.6%	204,000	15,740	17,550	8.6%
Western Australia	2.7	37.5%	21,000	2,200	3,200	15.2%
Australia Total	25.0	32.2%	225,000	17,940	20,750	9.2%



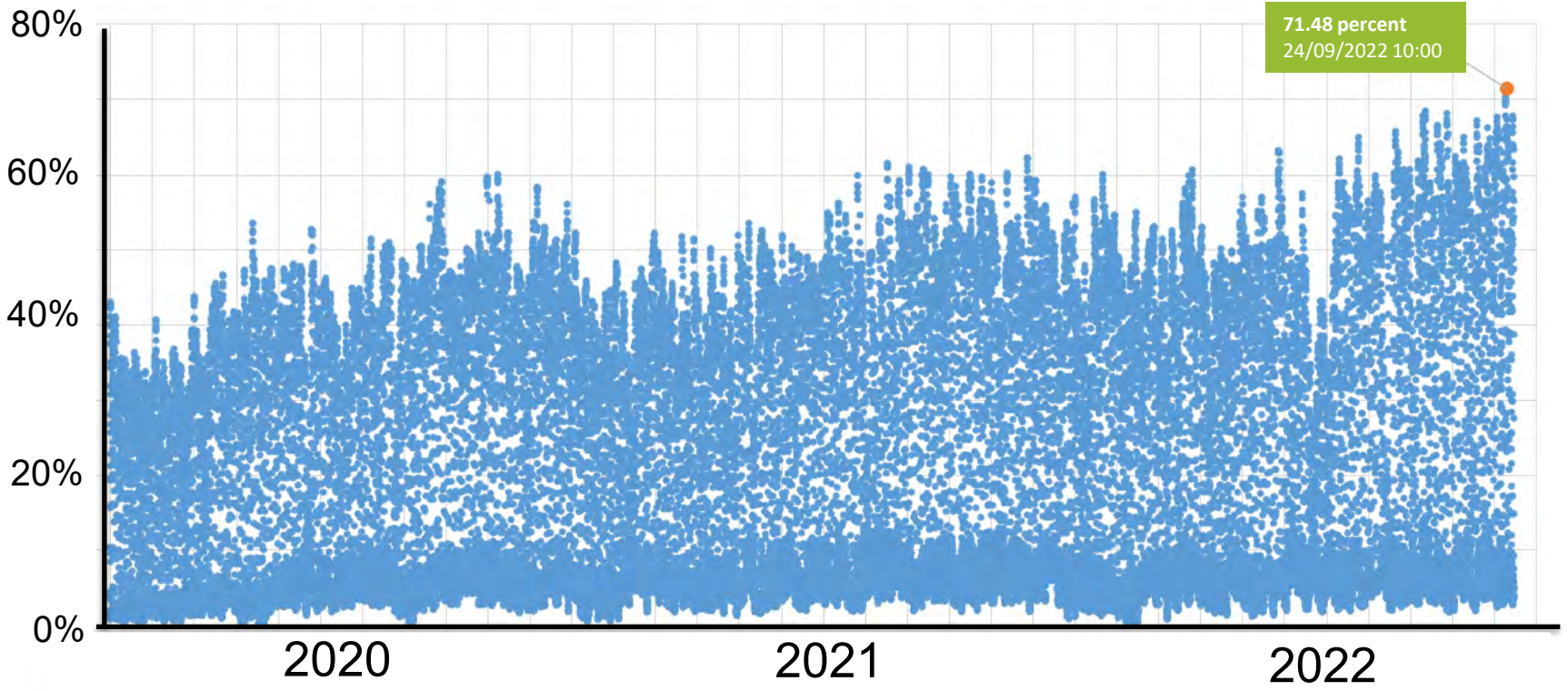
Source: EPRG Working Paper No.2125. Updated Oct 2022.

Coal exit announcements - accelerating since CoP26

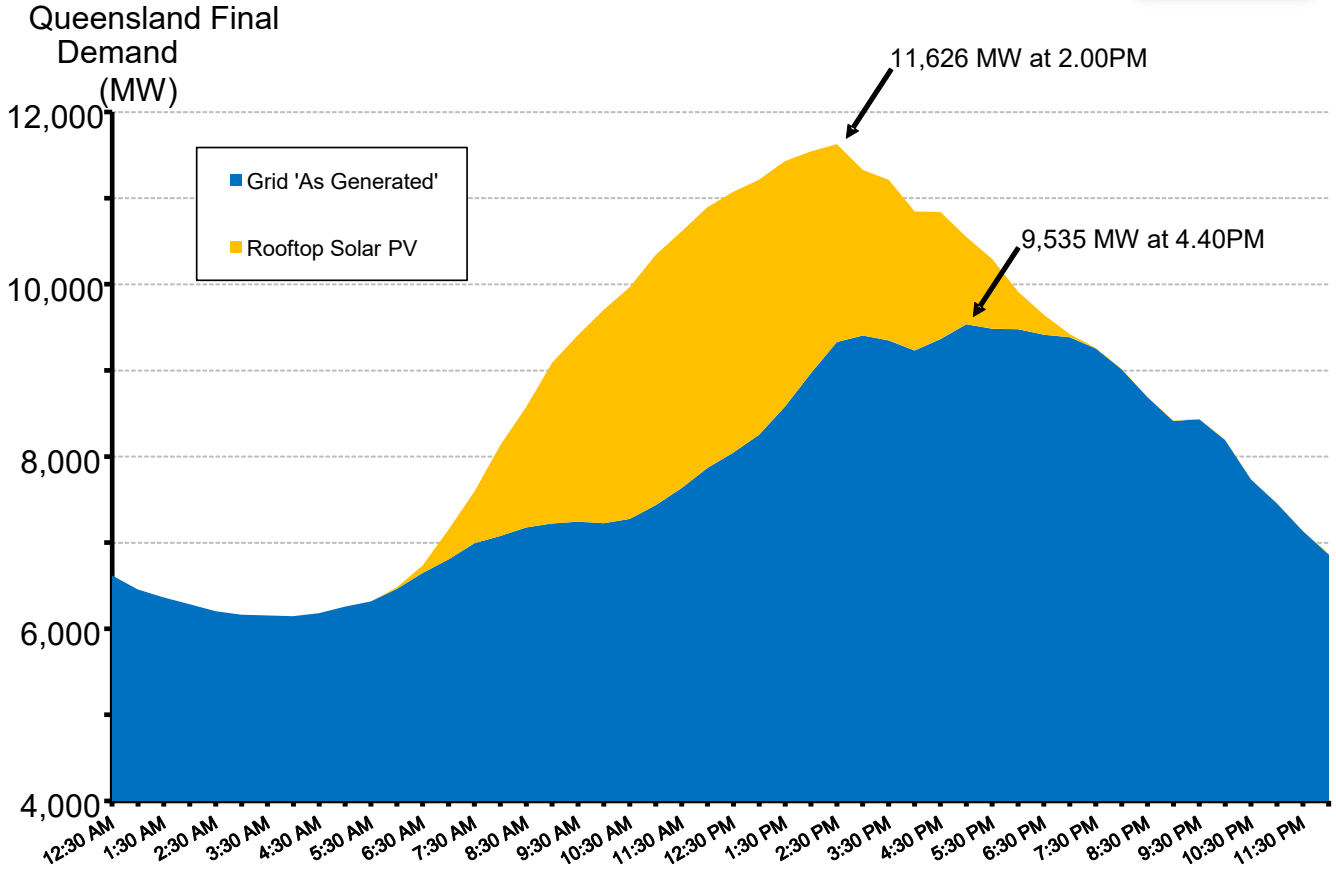


Sources: EPRG Working Paper No.2014. ISP. Updated Oct 2022.

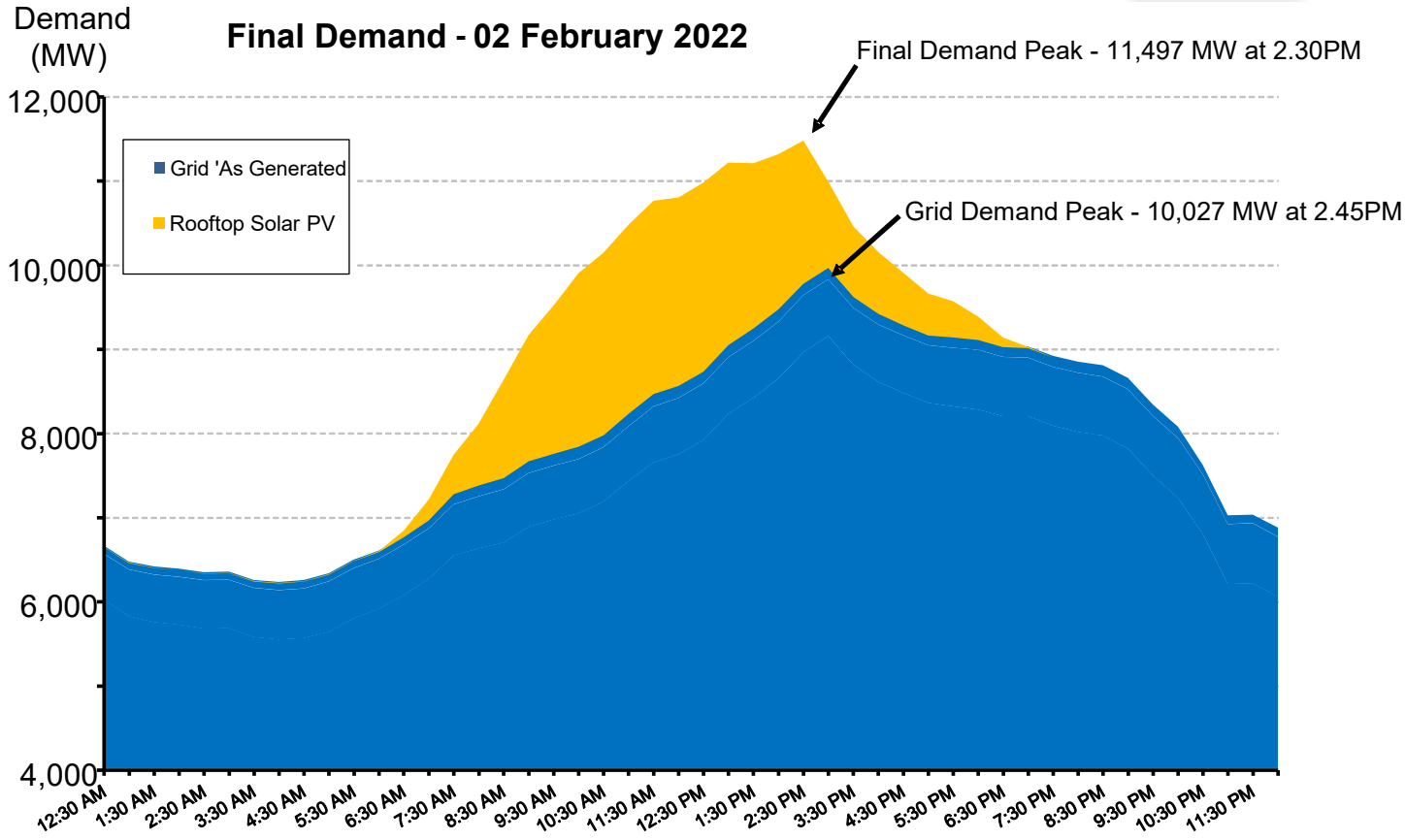
RE Market Share in Qld (30min data, 2020-2022)



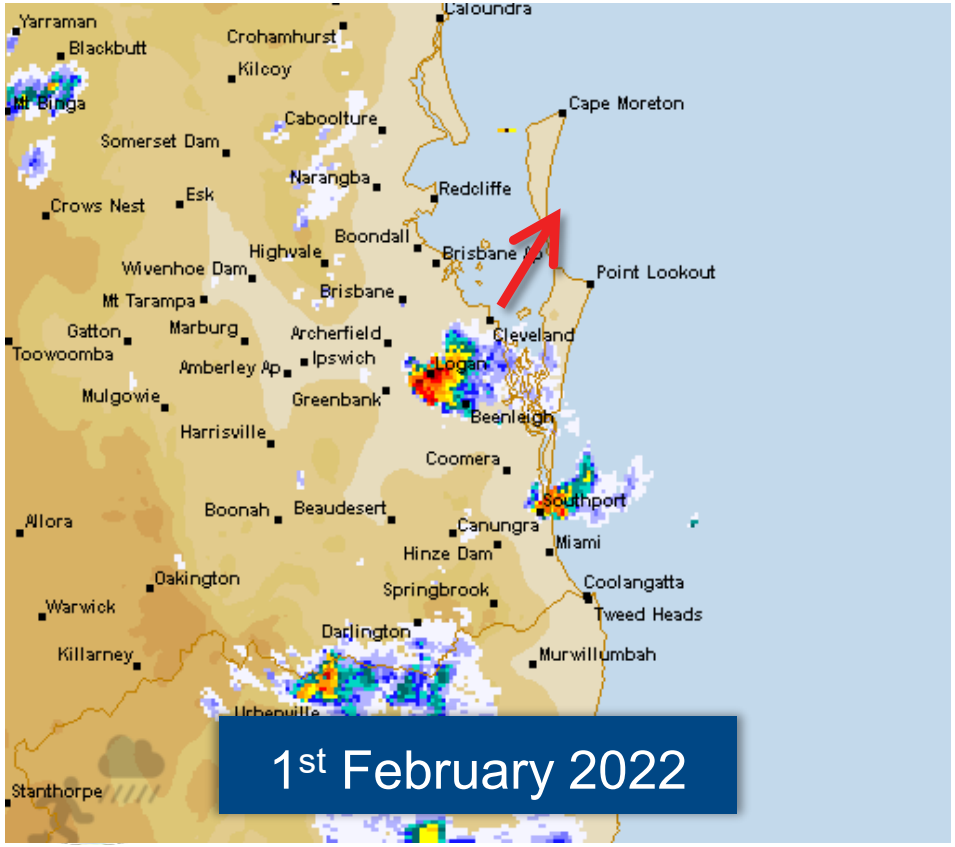
Rooftop PV: Final vs Grid Max Demand (01-Feb-22)



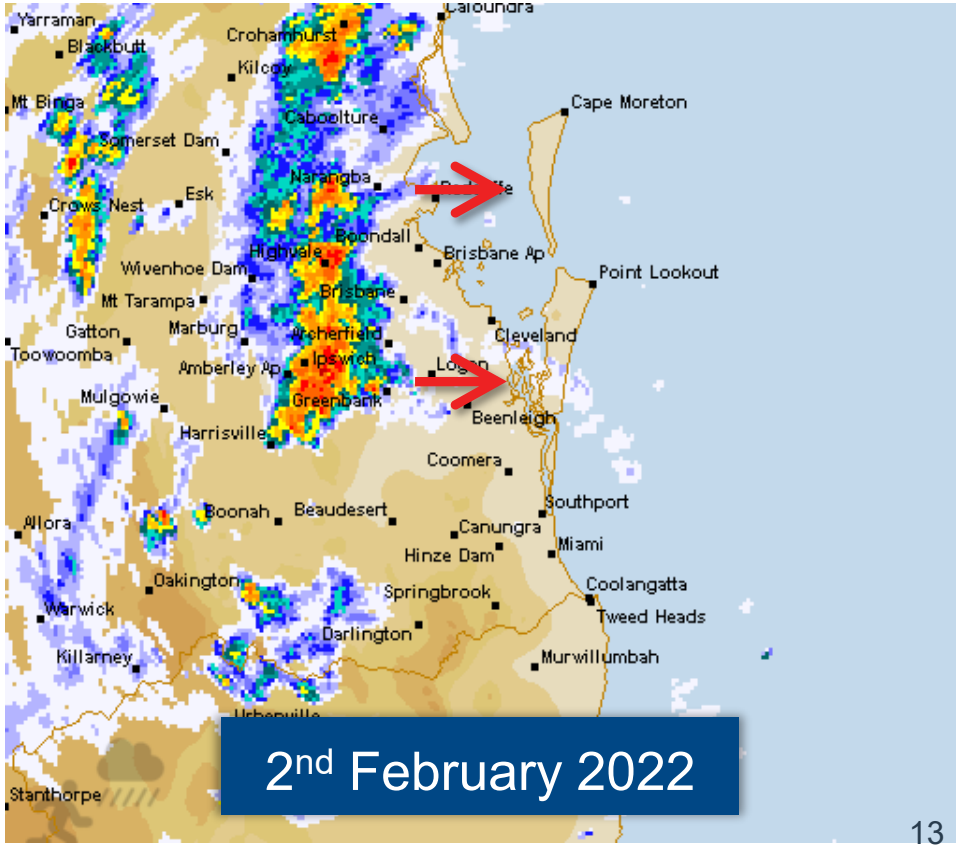
Rooftop PV: Final vs Grid Max Demand (02-Feb-22)



Very different storms on each day



1st February 2022



2nd February 2022

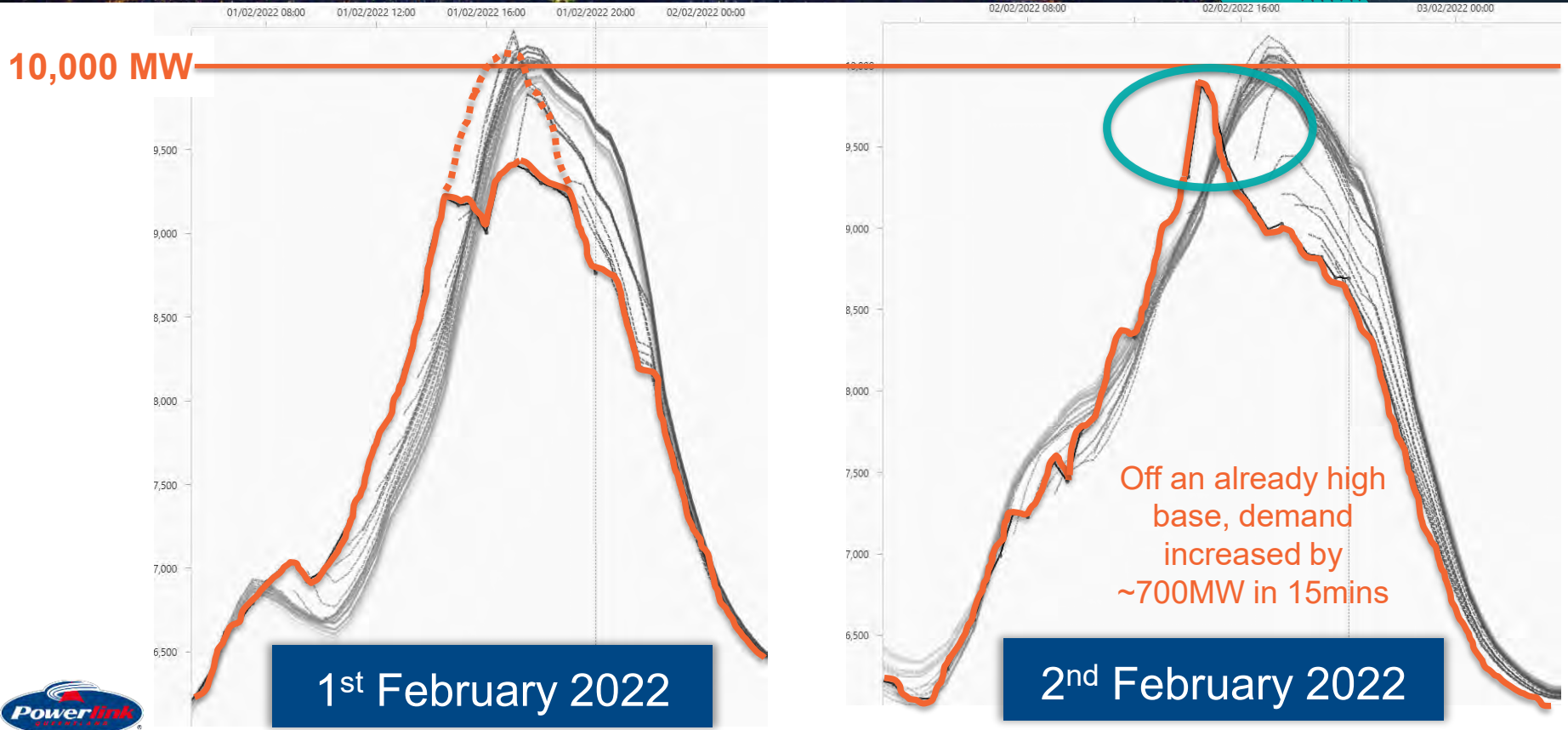
The “Queensland Rooftop Solar Effect”

Sun setting towards the west

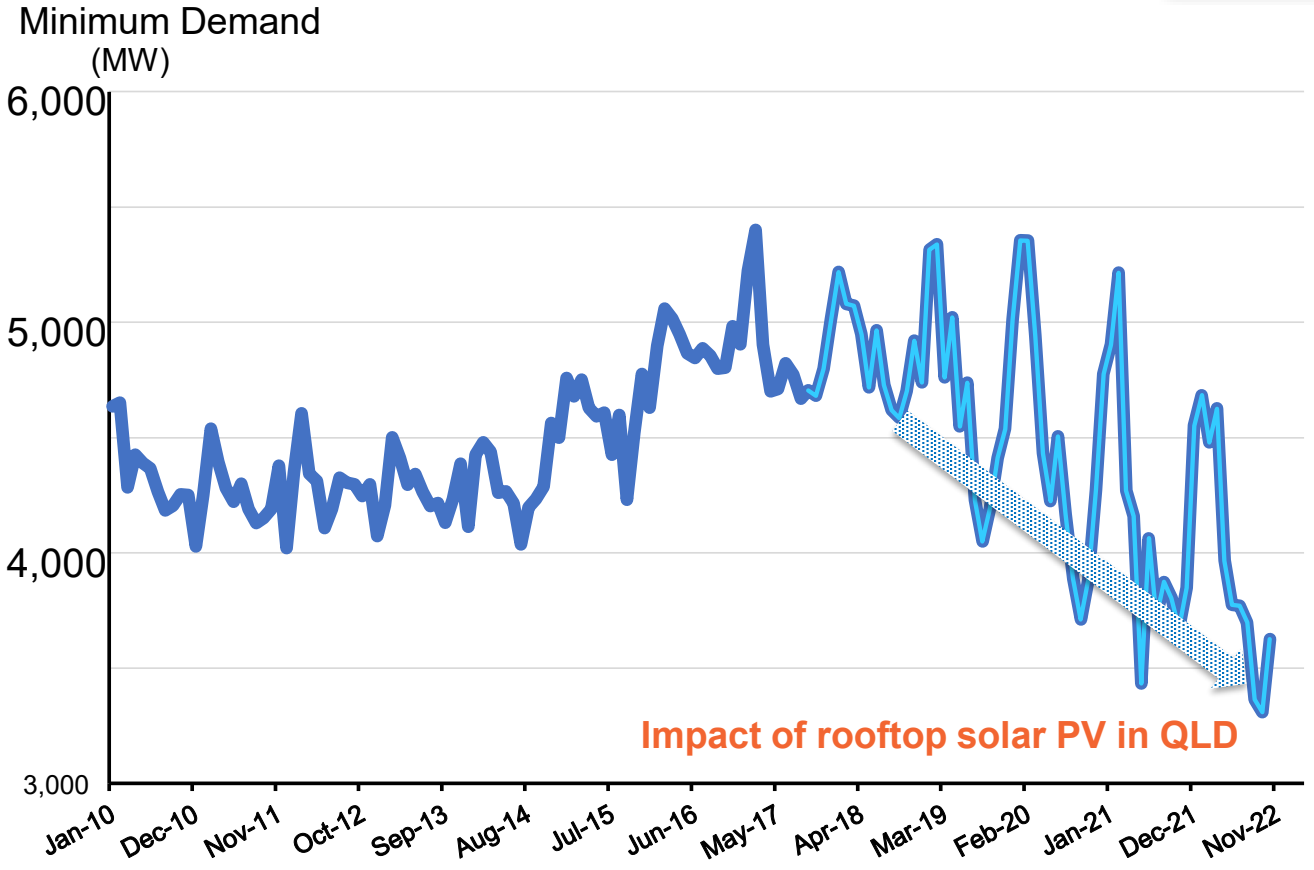
Storm approaching load centre from the west

Shadow reaches the load centre first, with a delay before the rain and cooler air arrives

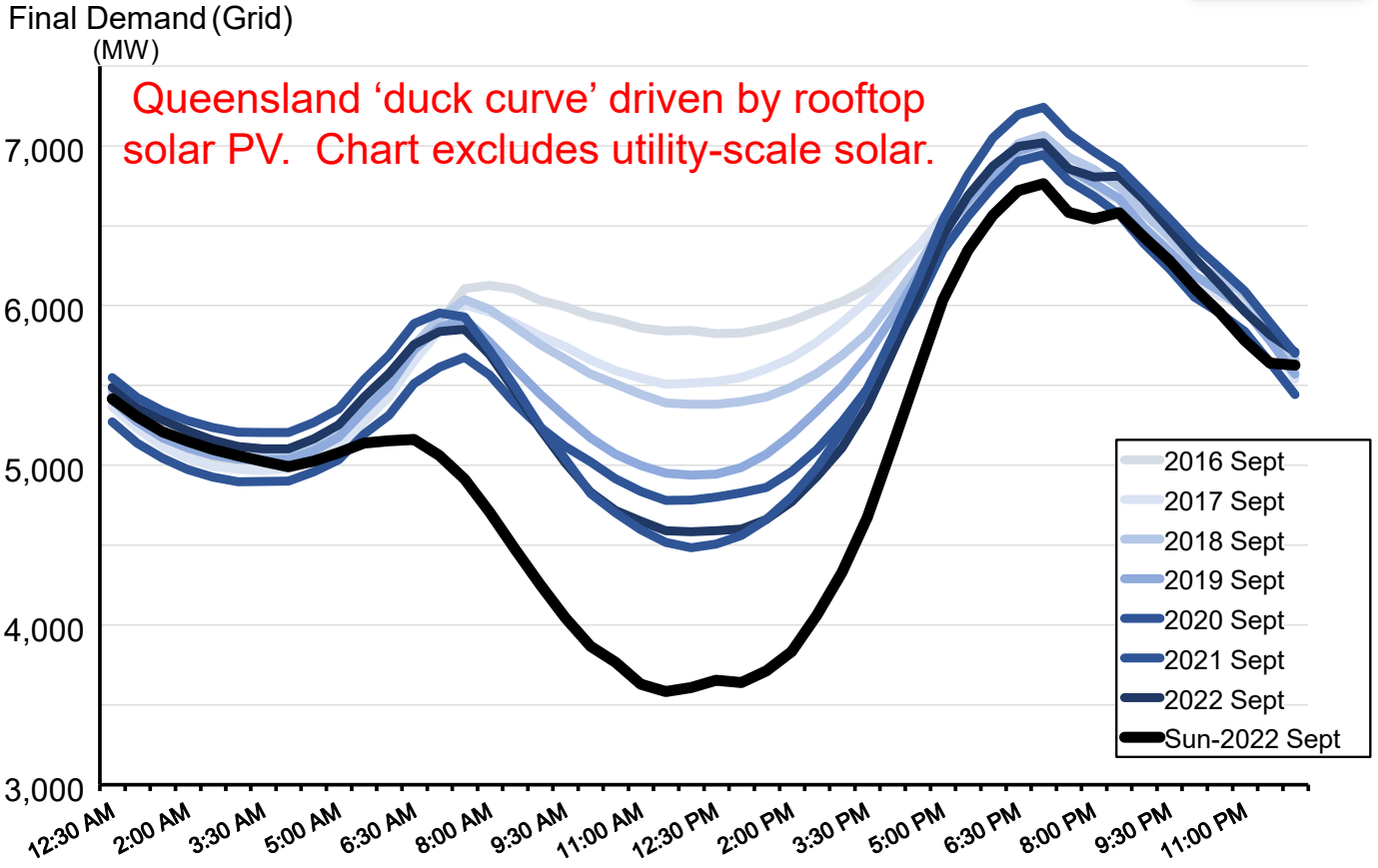
Intra-day forecasts vs actual



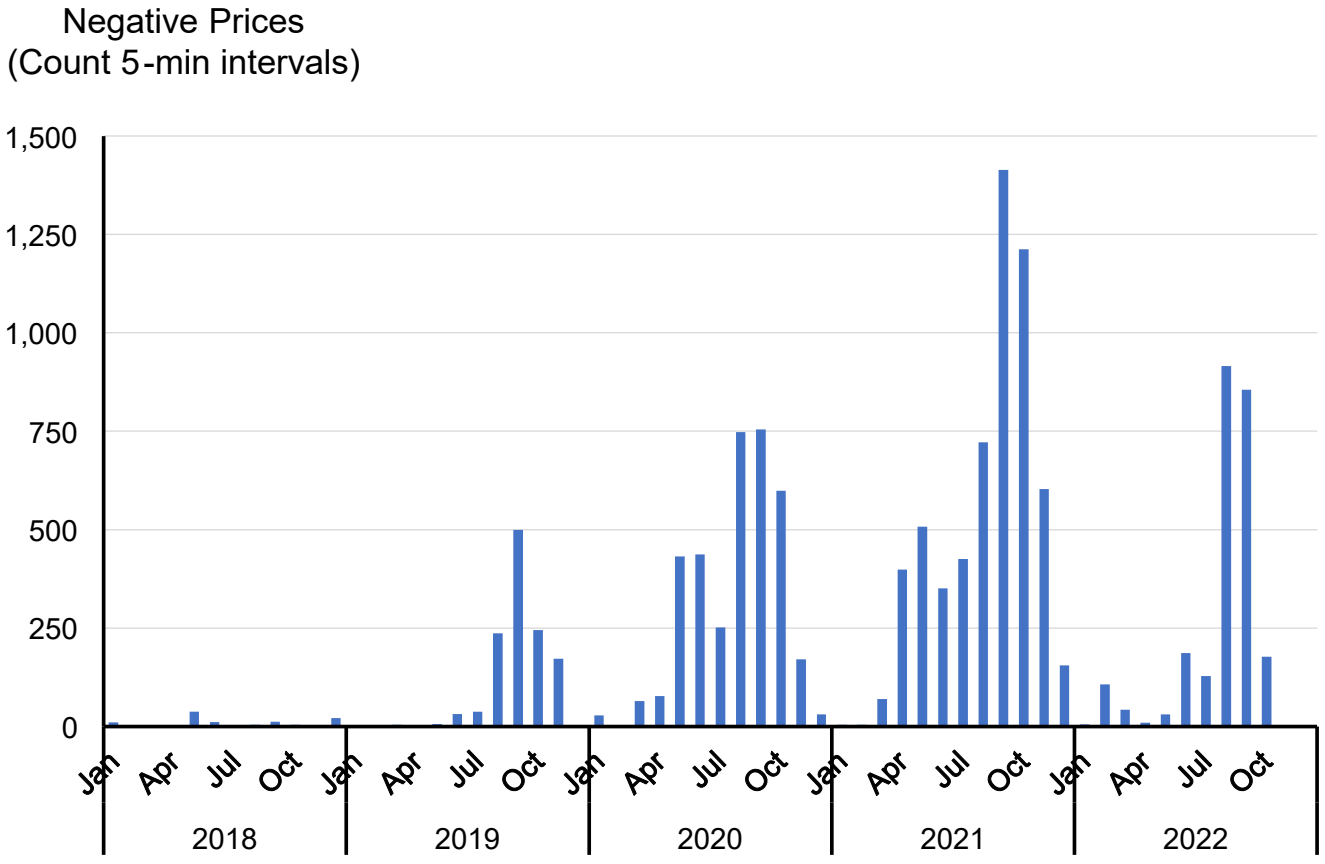
Minimum system demand & Rooftop PV (non-scheduled)



QLD September Average Final (Grid) Demand



Frequency of negative prices

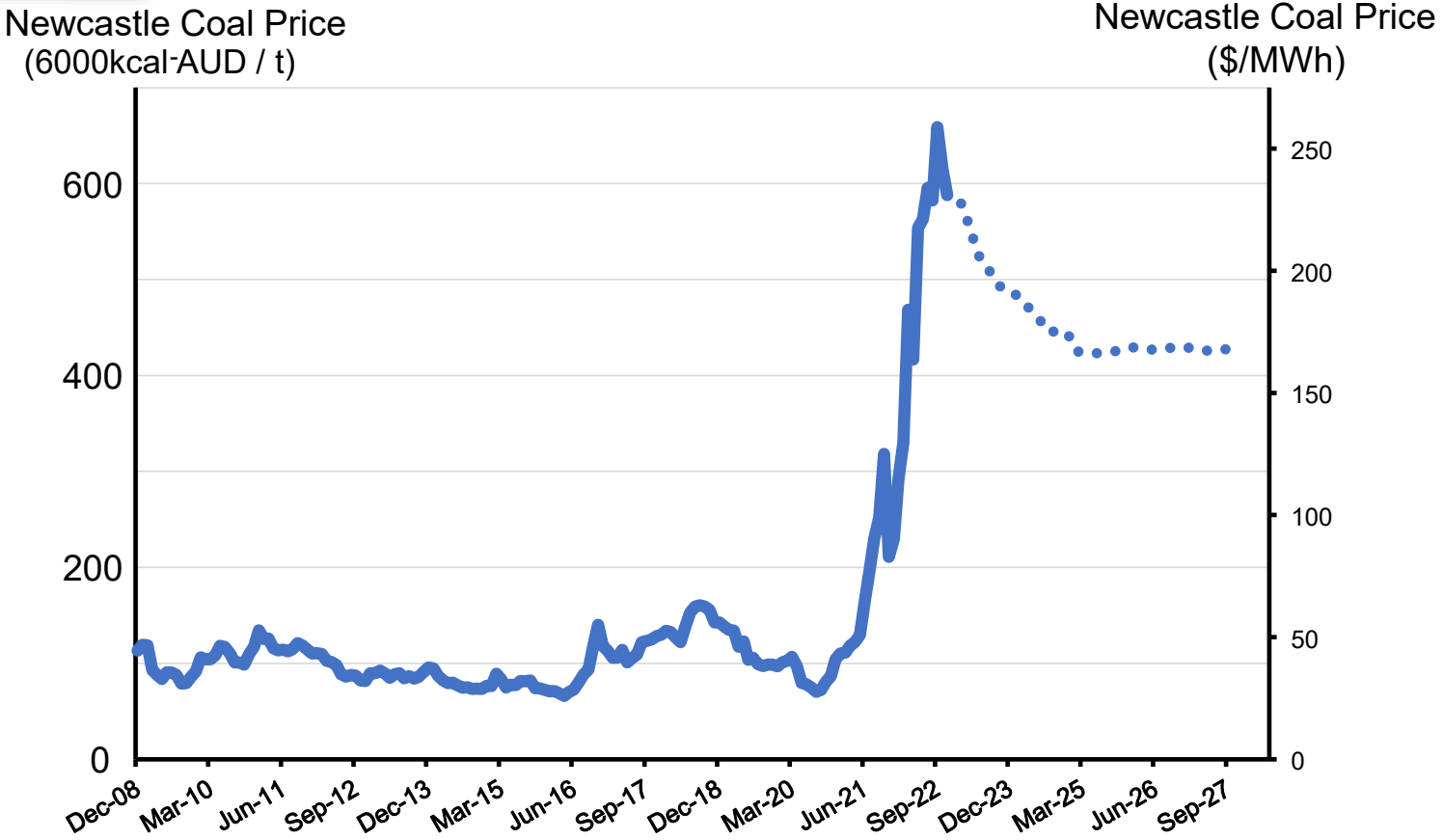


System operations

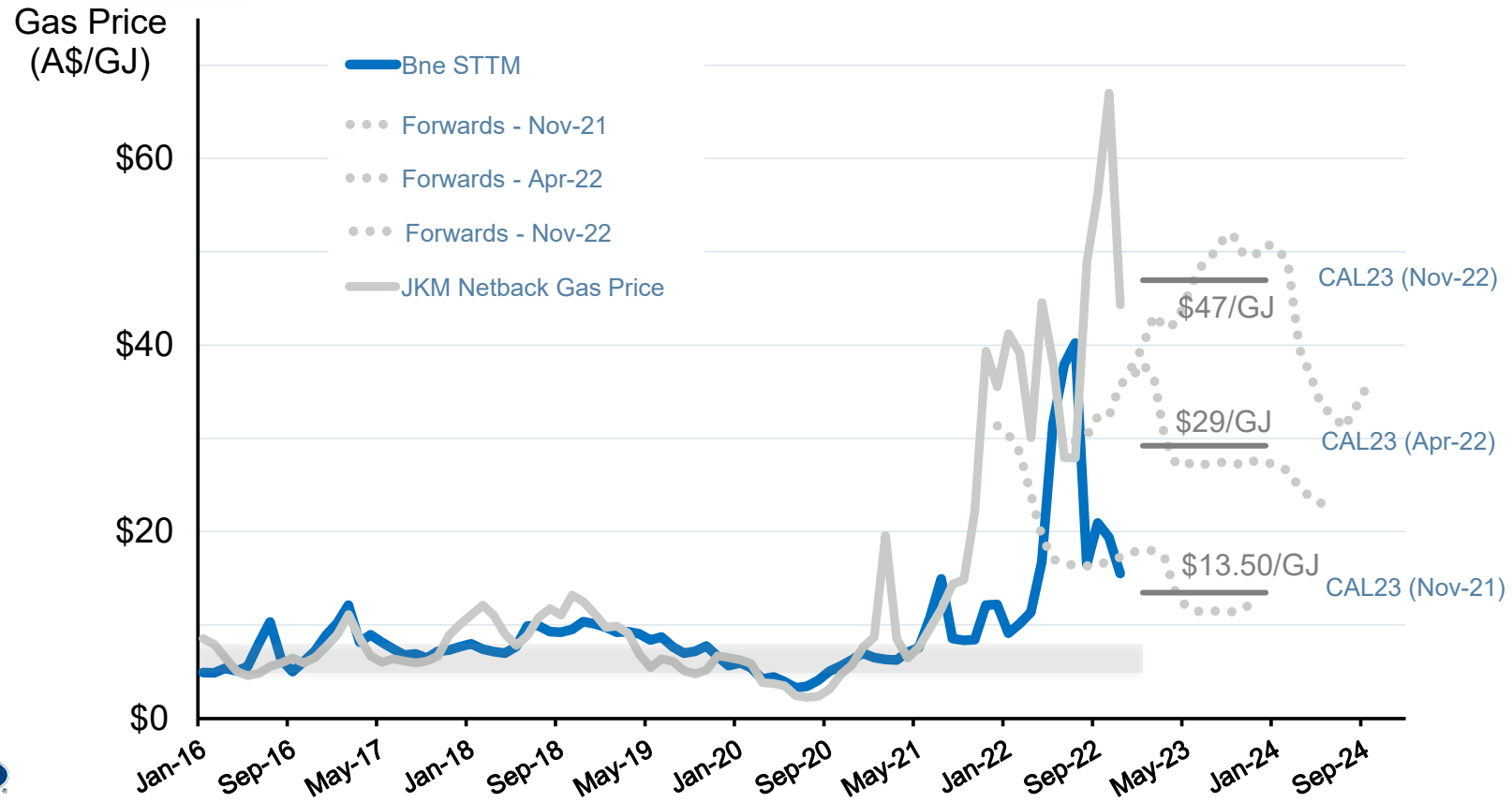
- Modes of power system failure are multiplying
- The changing plant stock means **adjustments** to market are required
  - Anticipative System Strength
  - Expanding Frequency Control Ancillary Services
  - Maximising output from ‘Renewable Energy Zones’ (via WAMPAC* & FCAS)
  - Transitional ‘reliability mechanism’ (vis-à-vis coal exit)

*Wide Area Monitoring, Protection & Control

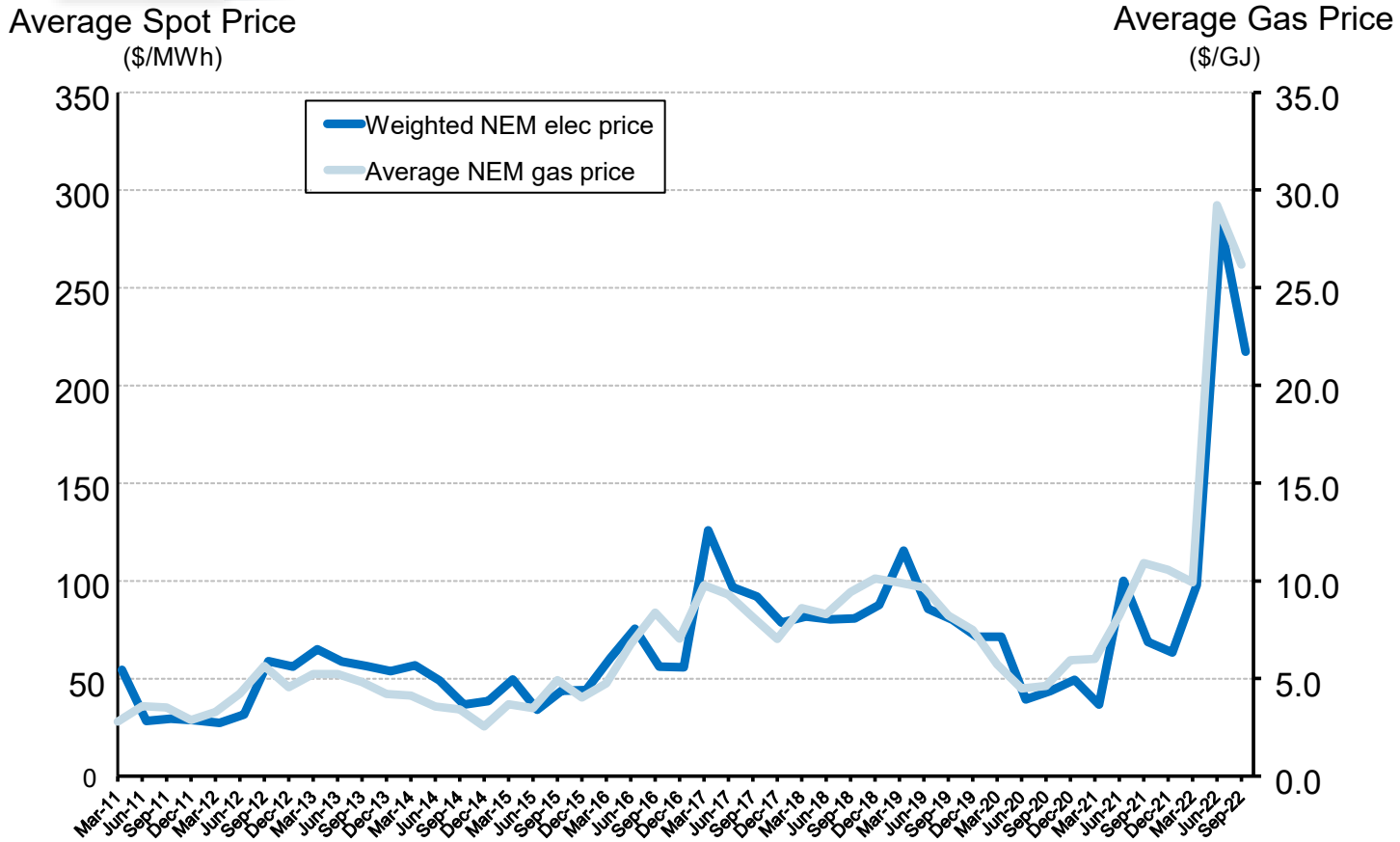
Thermal coal prices – record highs



JKM Netback vs Spot Gas - high but structural break

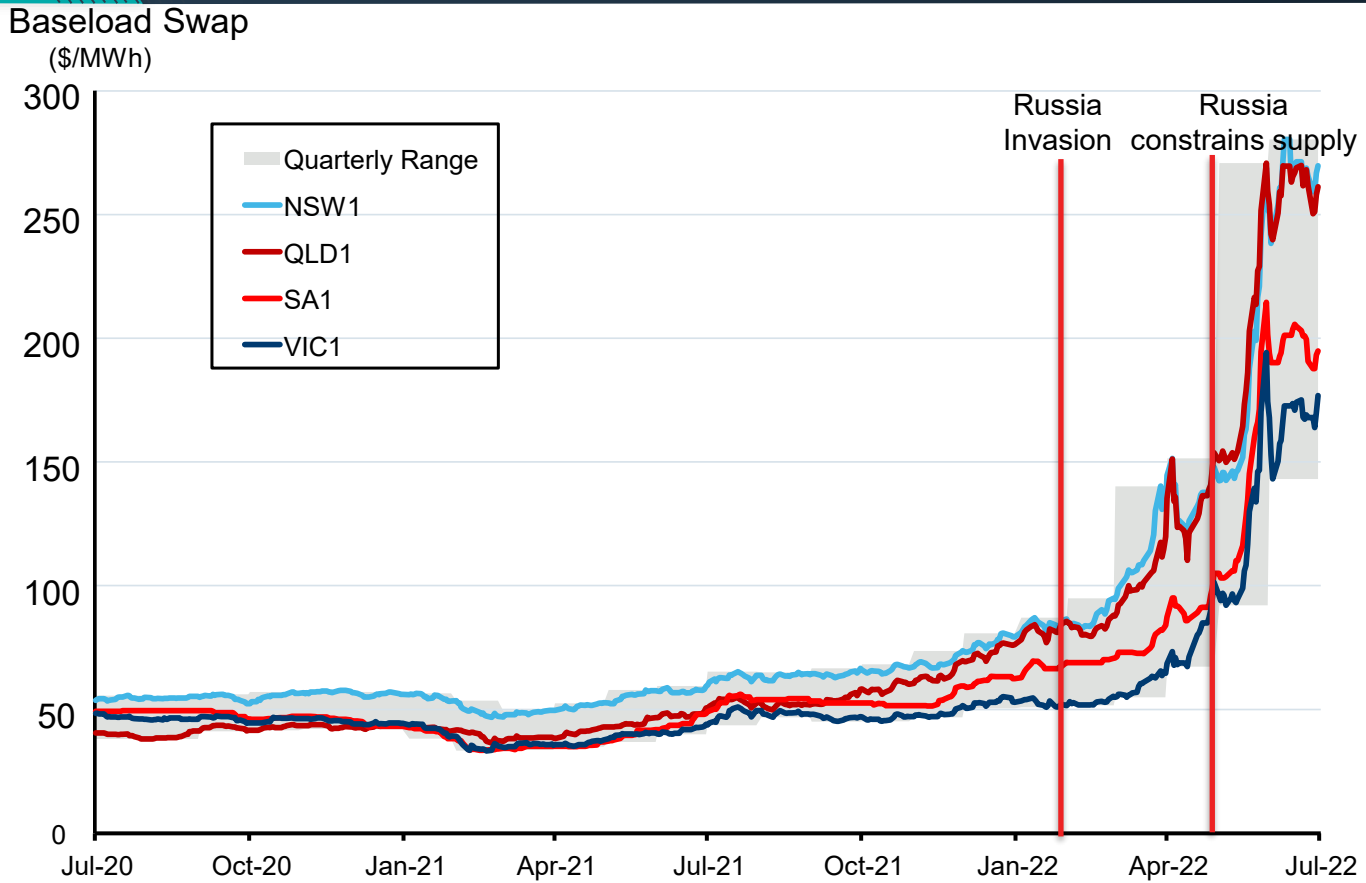


Why gas matters in the NEM

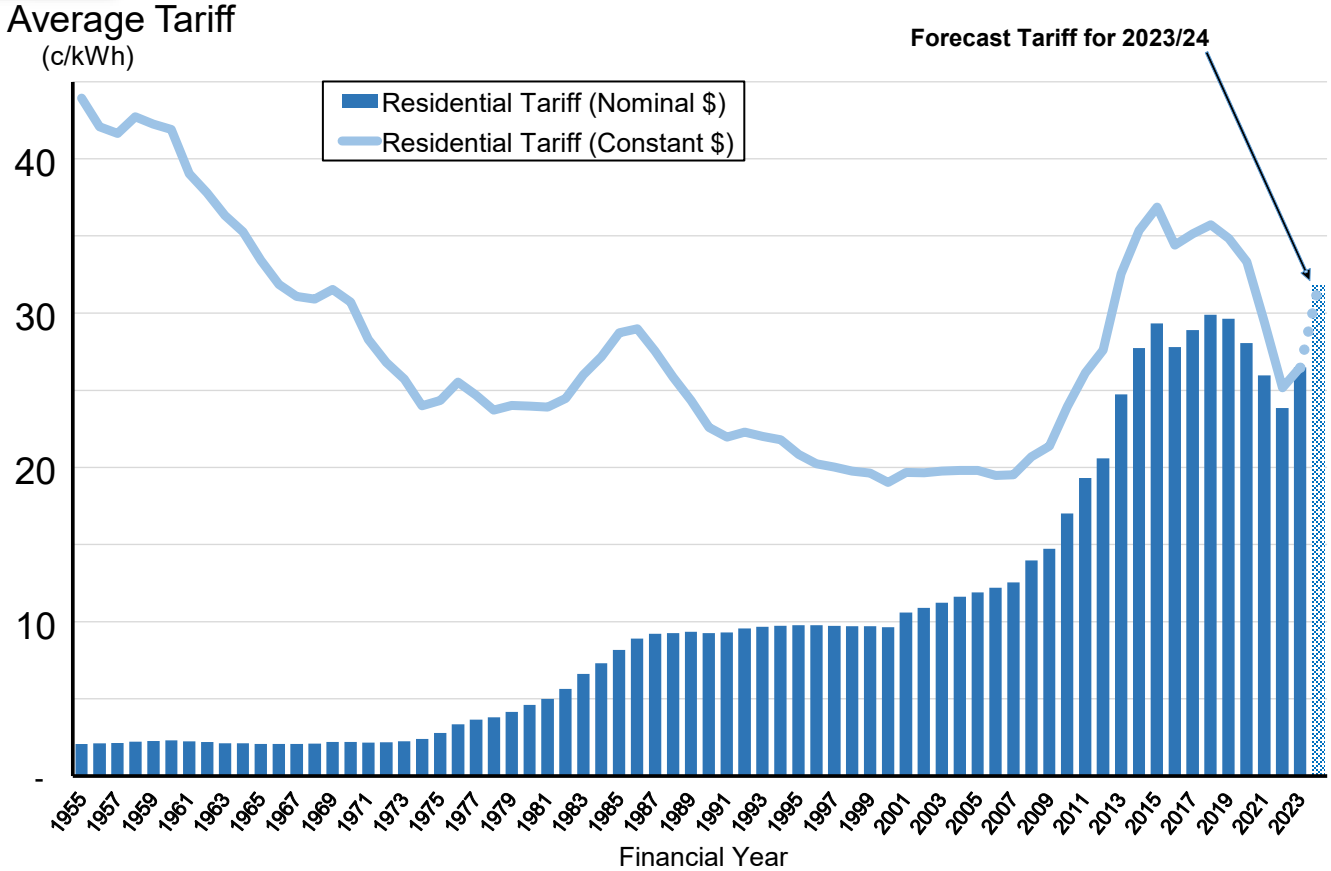


Source: EPRG Working Paper No.2014. Updated Oct 2022.

Run of Trade – FY23 Swaps

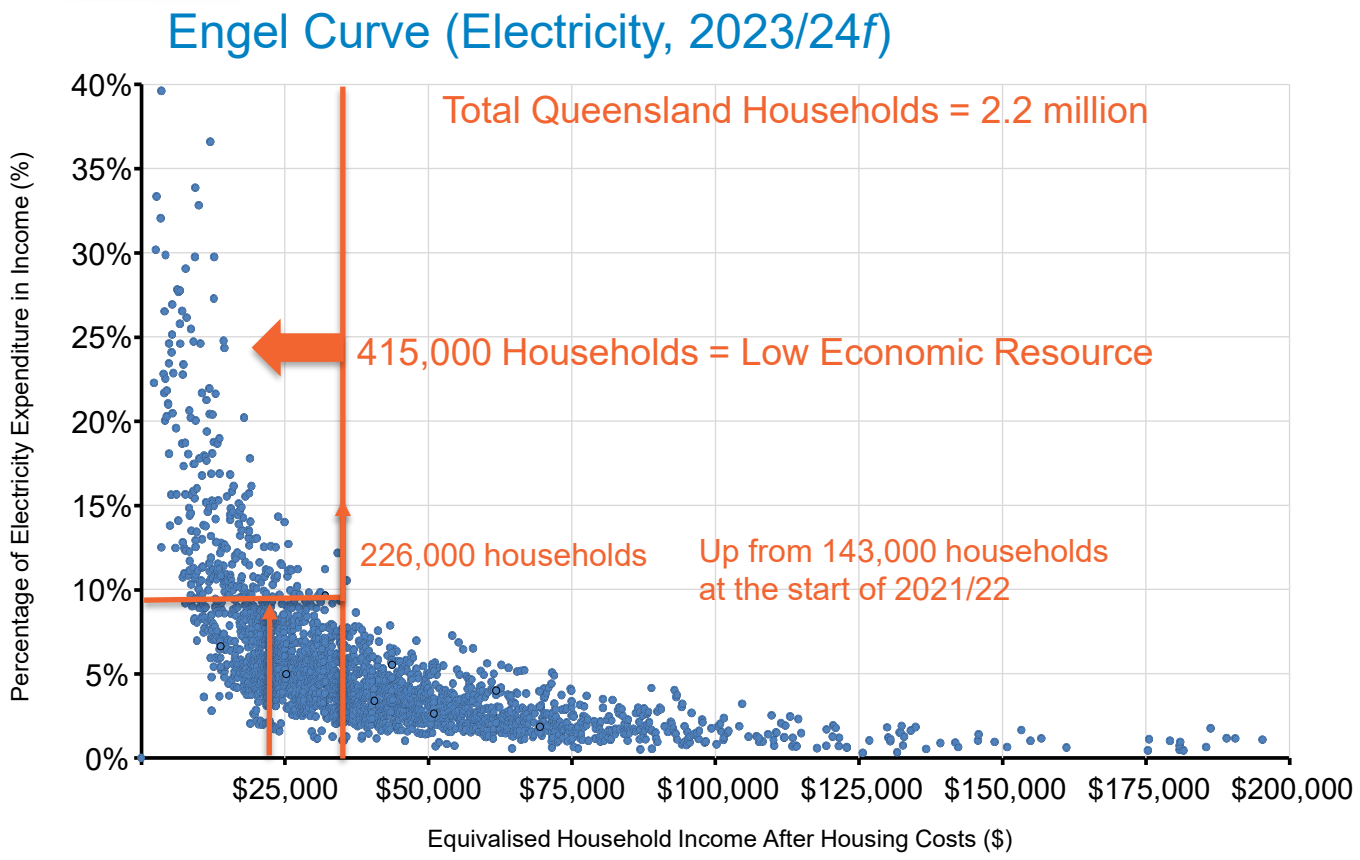


Queensland residential tariff (1955-2023)



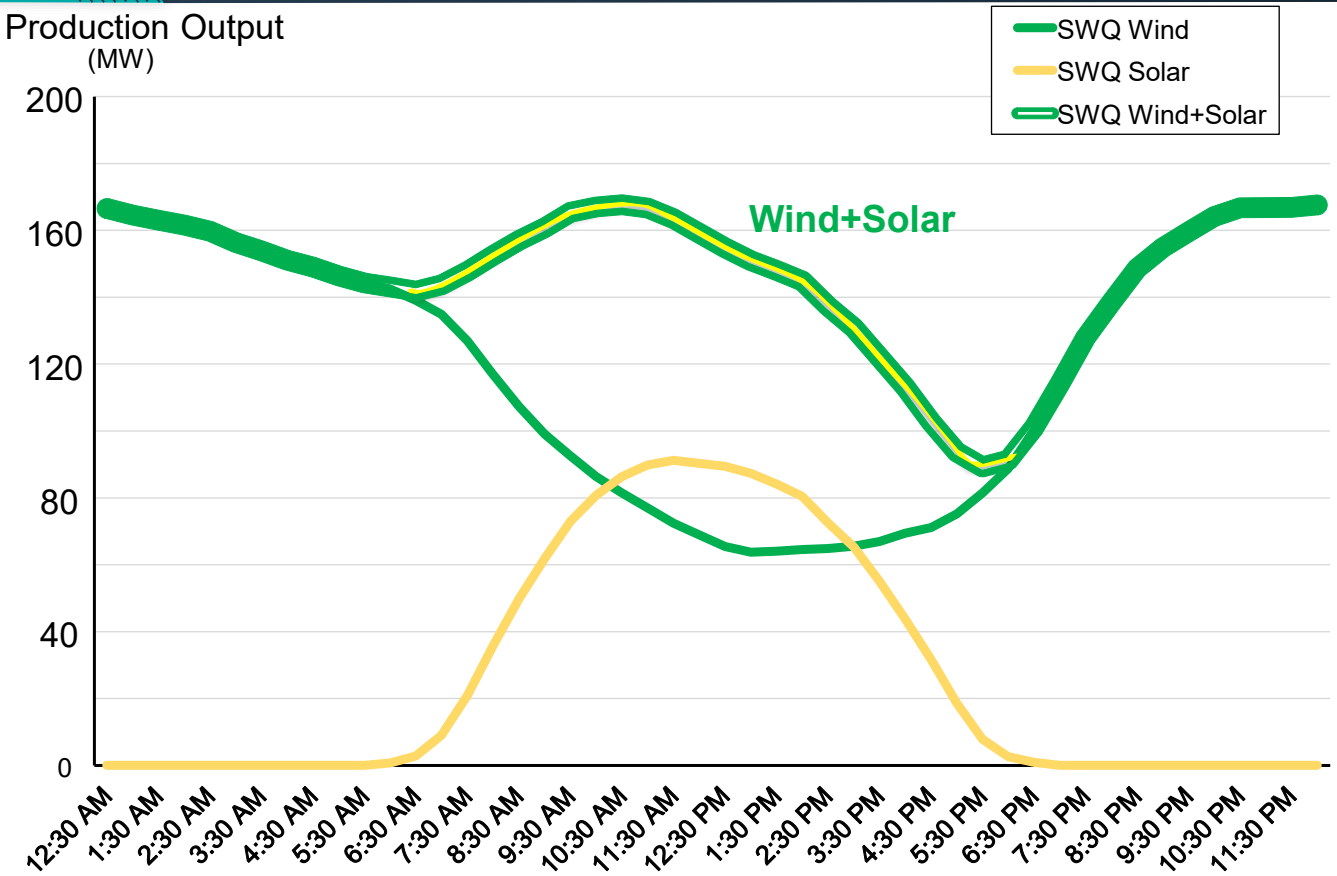
Source: EPRG Working Paper No.2216.

Engel Curve – Queensland households



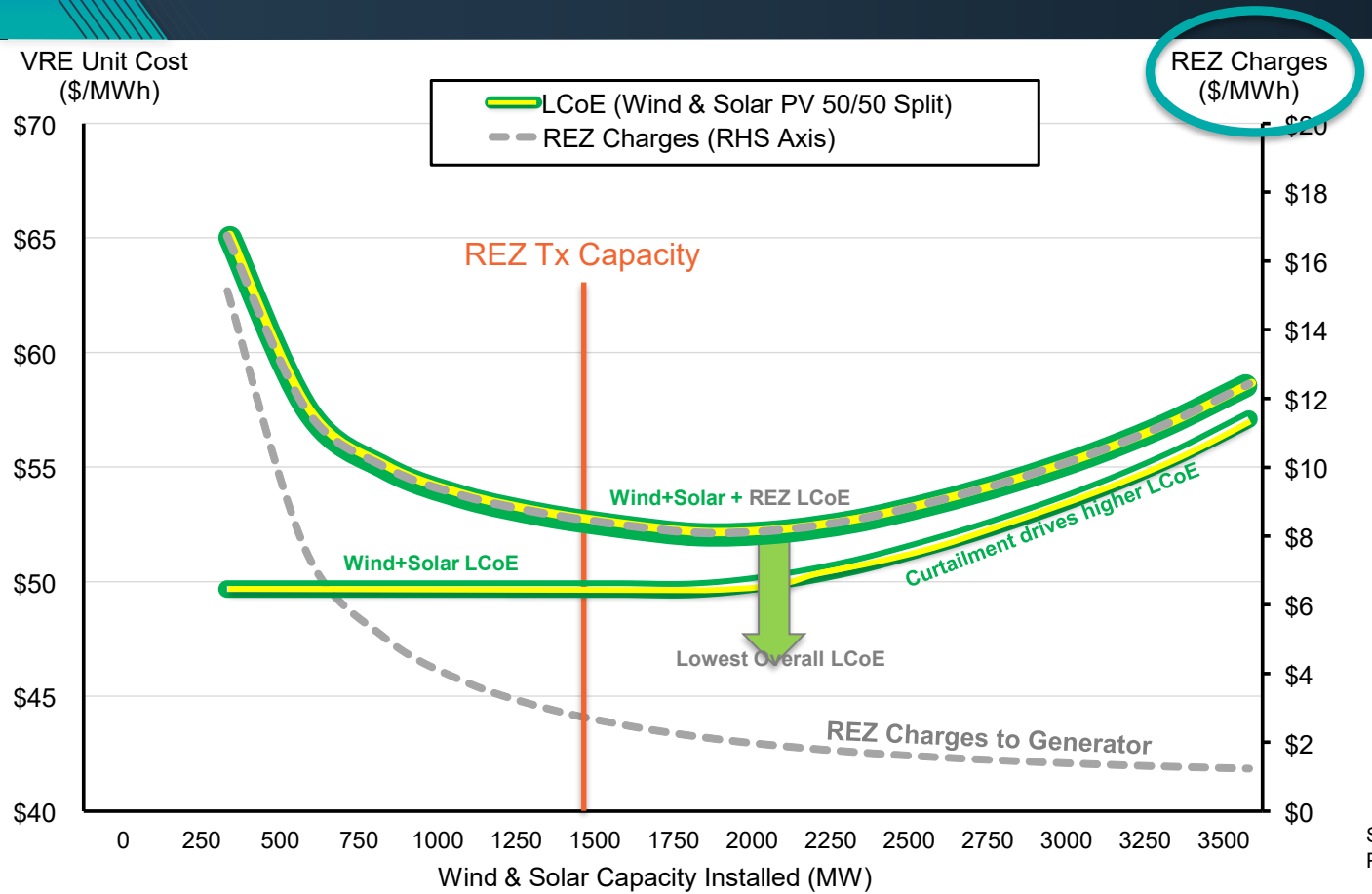
Source: EPRG Working Paper No.2108.

Supply Response – VRE



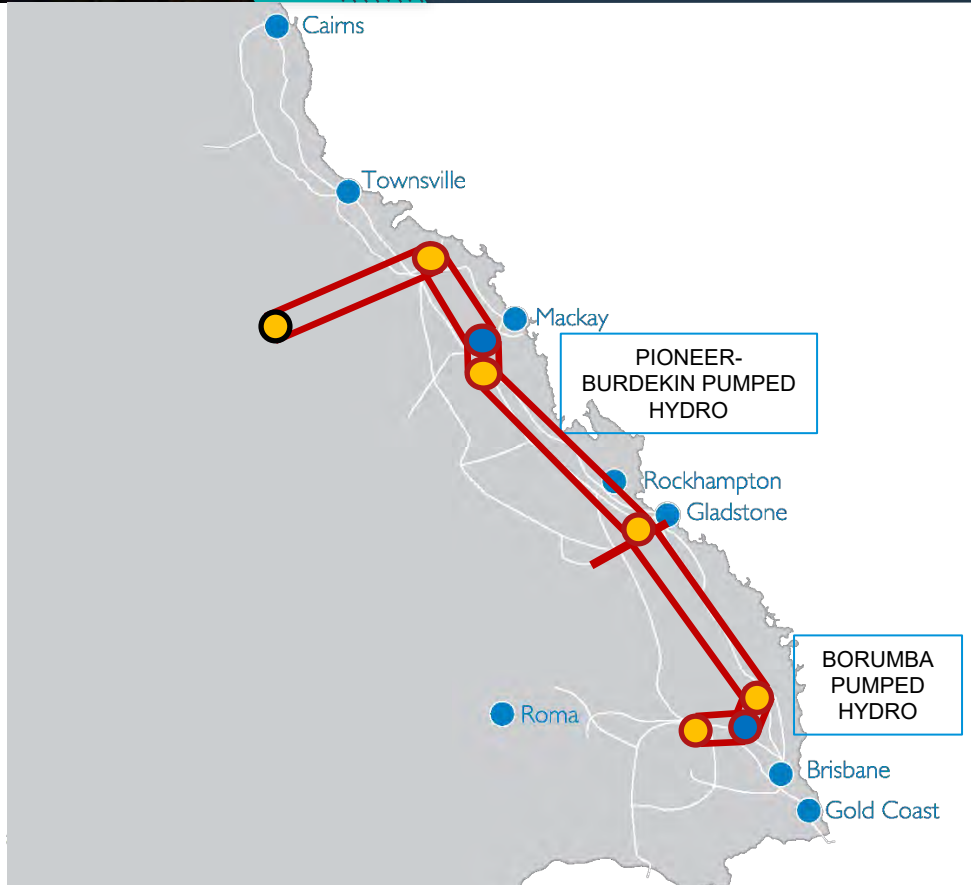
Source: EPRG Working Paper No.2121.

Optimising Renewable Energy Zones



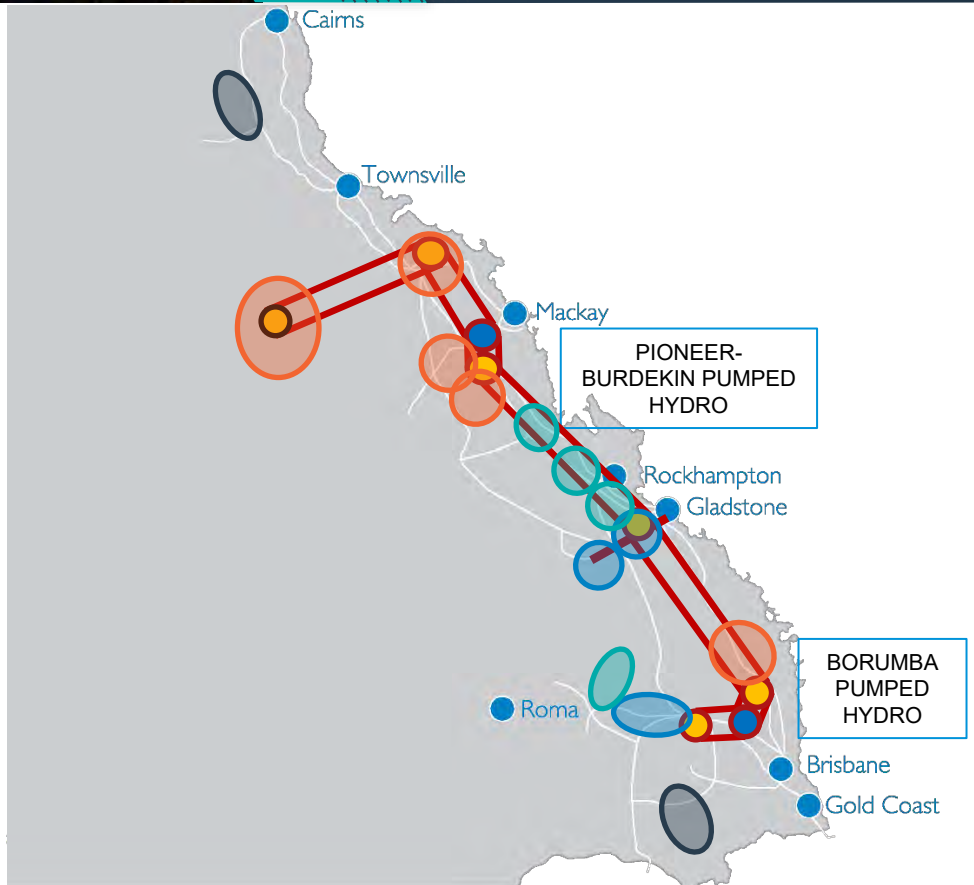
Source: EPRG Working Paper No.2121.

Development of Queensland's SuperGrid



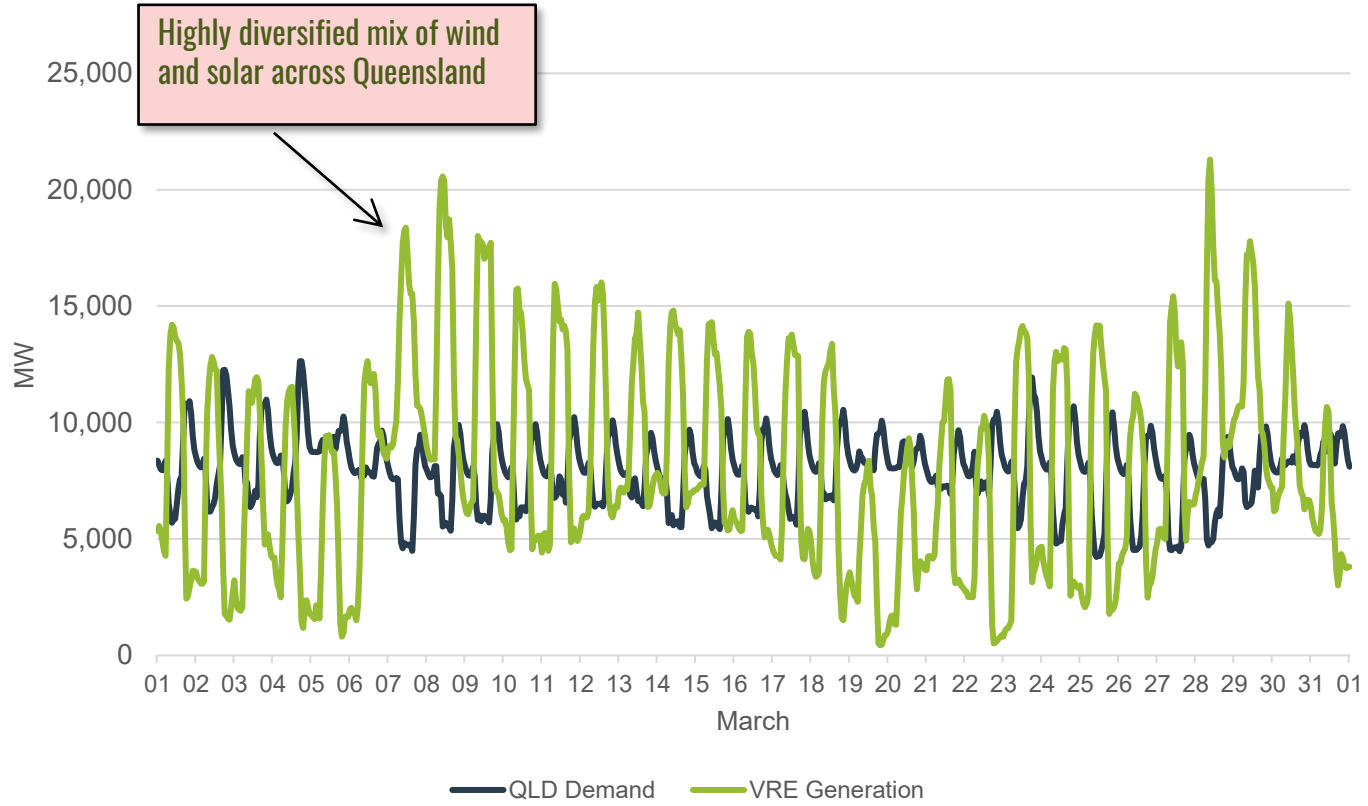
- Stage 1: 2GW Borumba Pumped Hydro connection
- Stage 2: Central Queensland Connection - electrification
- Stage 3: 5GW Pioneer-Burdekin Pumped Hydro
- Stage 4: Hughenden Clean Energy Hub
  - 10,000's MW of solar & wind resources

Queensland Renewable Energy Zones



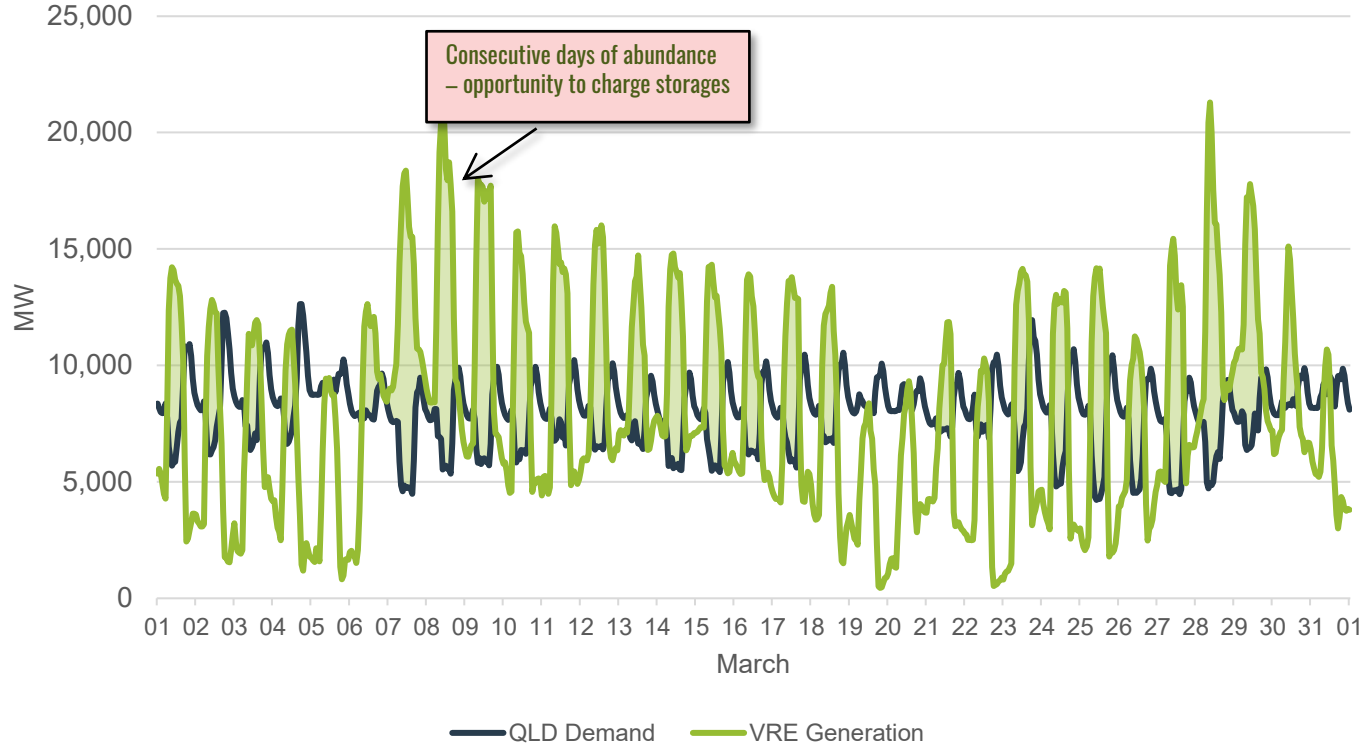
Queensland system operations:

Effect of variability in supply (simulation of March 2035)



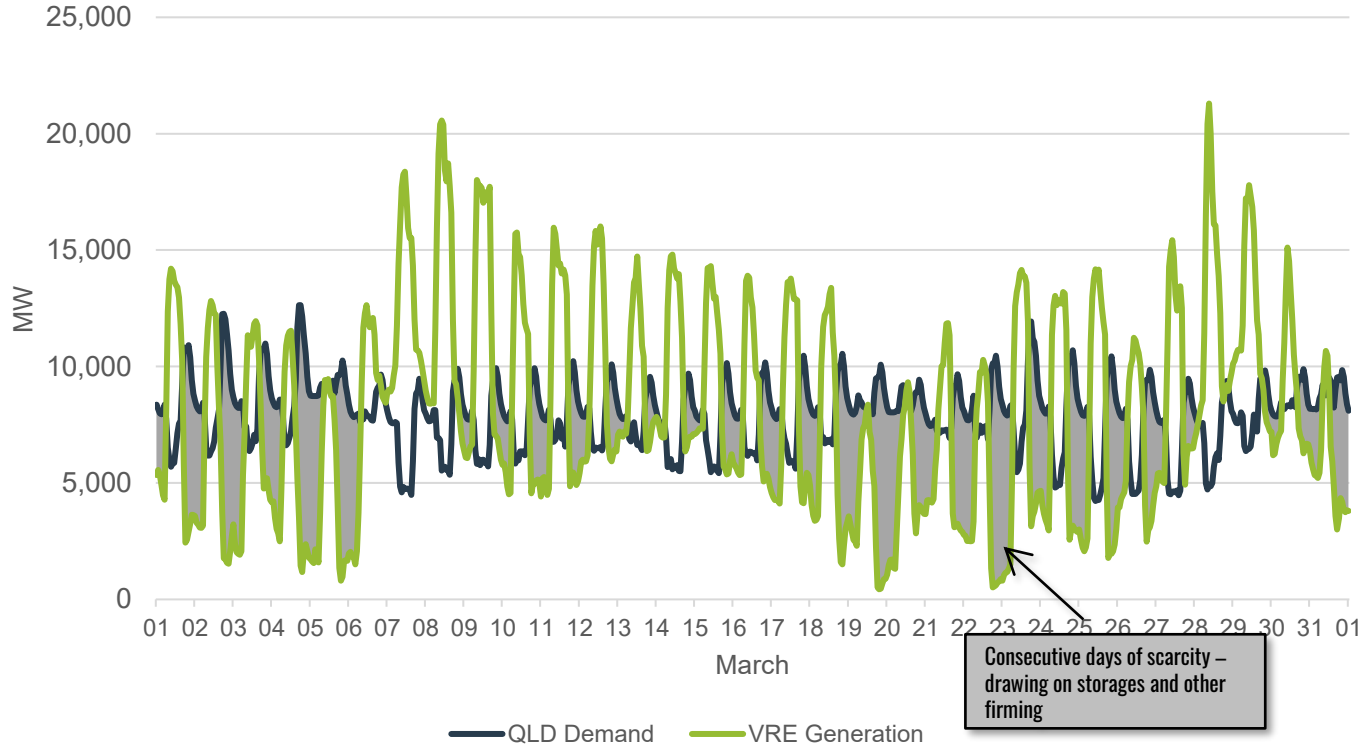
Queensland system operation:

Effect of variability in supply (simulation of March 2035)



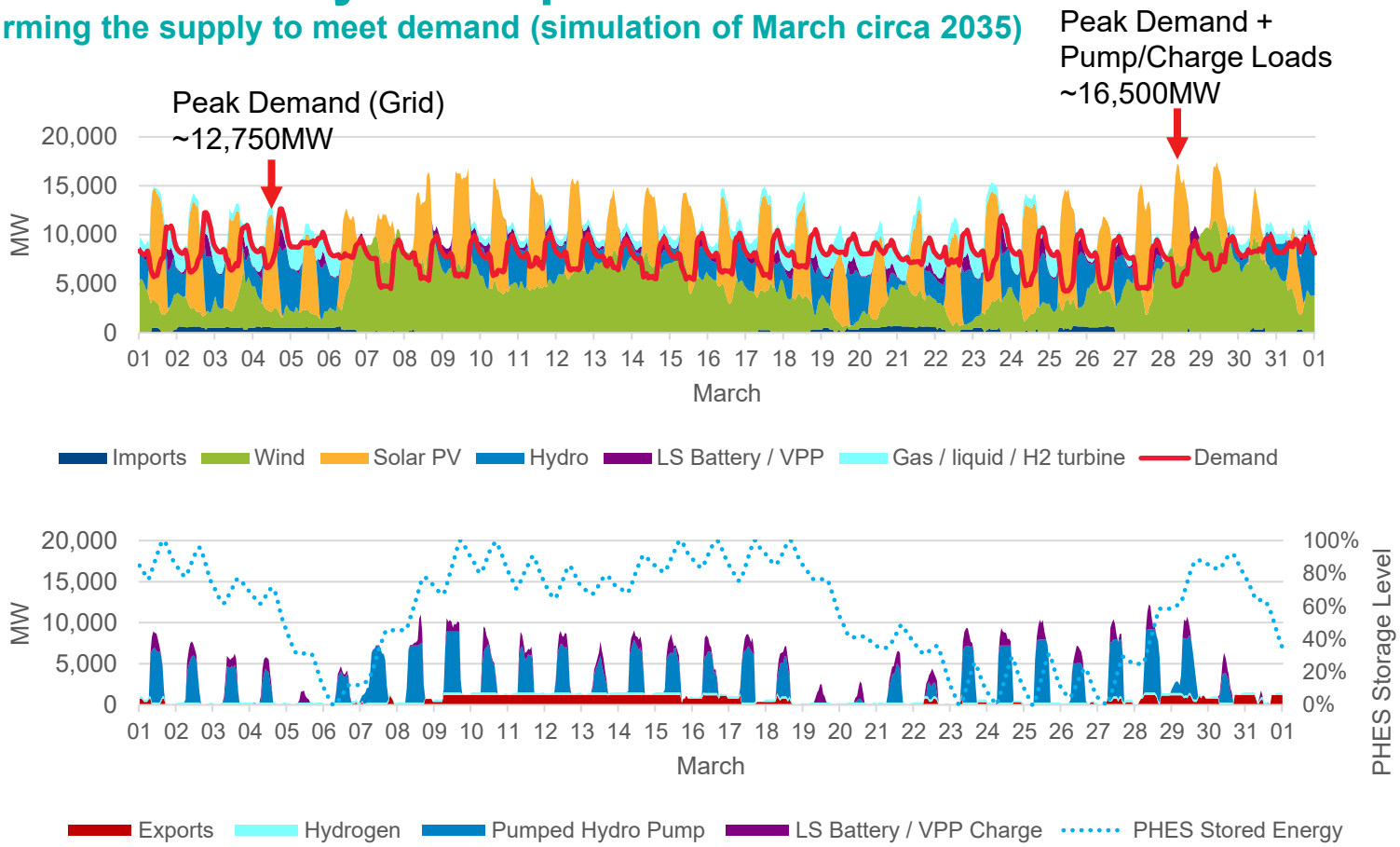
Queensland system operation:

Effect of variability in supply (simulation of March 2035)



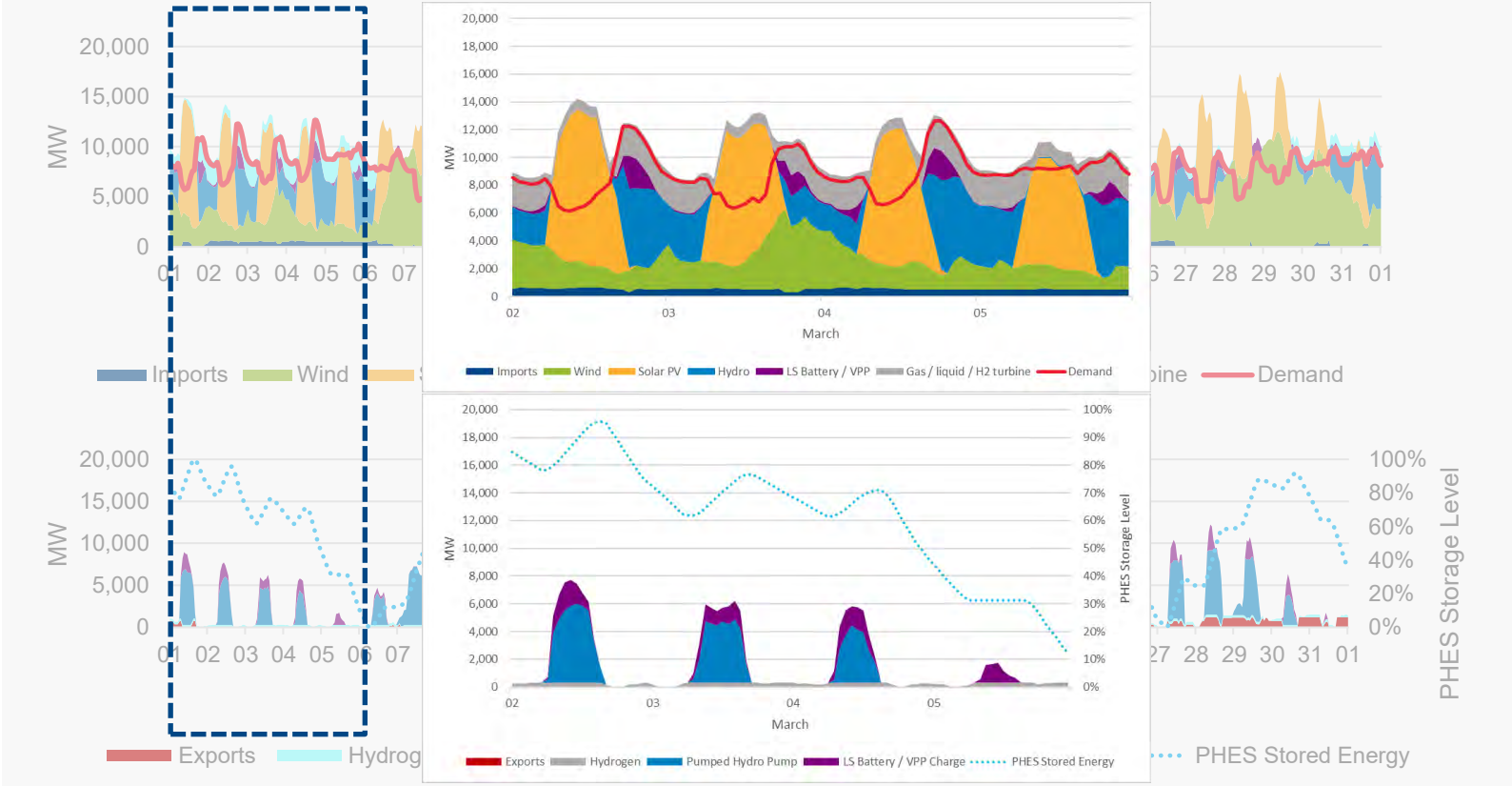
Queensland system operation:

Firming the supply to meet demand (simulation of March circa 2035)



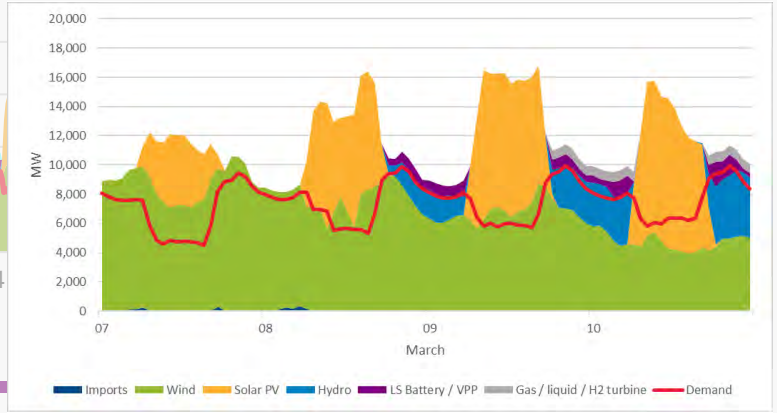
Queensland system operation:

Firming the supply to meet demand (simulation of March circa 2035)



Queensland system operation:

Firming the supply to meet demand (simulation of March circa 2035)



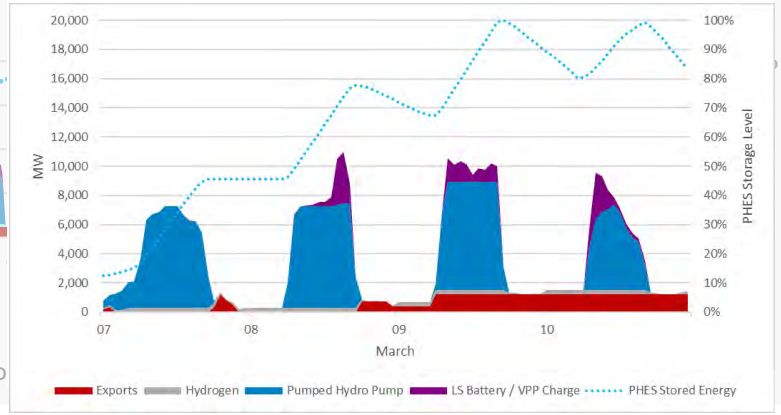


Chart Pack References (EPRG Working Papers)

- Simshauser & Gilmore (2020) “Is the NEM broken? Policy discontinuity and the 2017-2020 investment supercycle”, **EPRG Working Paper No.2014**.
- Simshauser (2021) “Vulnerable households and fuel poverty: policy targeting efficiency in Australia’s National Electricity Market”, **EPRG Working Paper No.2108**.
- Simshauser, Billimoria & Rogers (2021) “Optimising VRE Plant Capacity in Renewable Energy Zones”, **EPRG Working Paper No. 2121.**
- Simshauser (2021) “Rooftop solar PV and the peak load problem in the NEM’s Queensland Region”, **EPRG Working Paper No. 2125.**
- Simshauser (2022) “Fuel poverty in Queensland: horizontal and vertical impacts of the 2022 energy crisis”, **EPRG Working Paper No.2216.**
- Simshauser, Nelson & Gilmore, (2022), “The sunshine state: implications from mass rooftop solar PV take-up rates in Queensland”, **EPRG Working Paper No.2219.**