



Melbourne
Energy
Institute



MELnetwork21 - Energy Systems Seminar Series

Seminar 3 Wholesale markets

Paul Austin

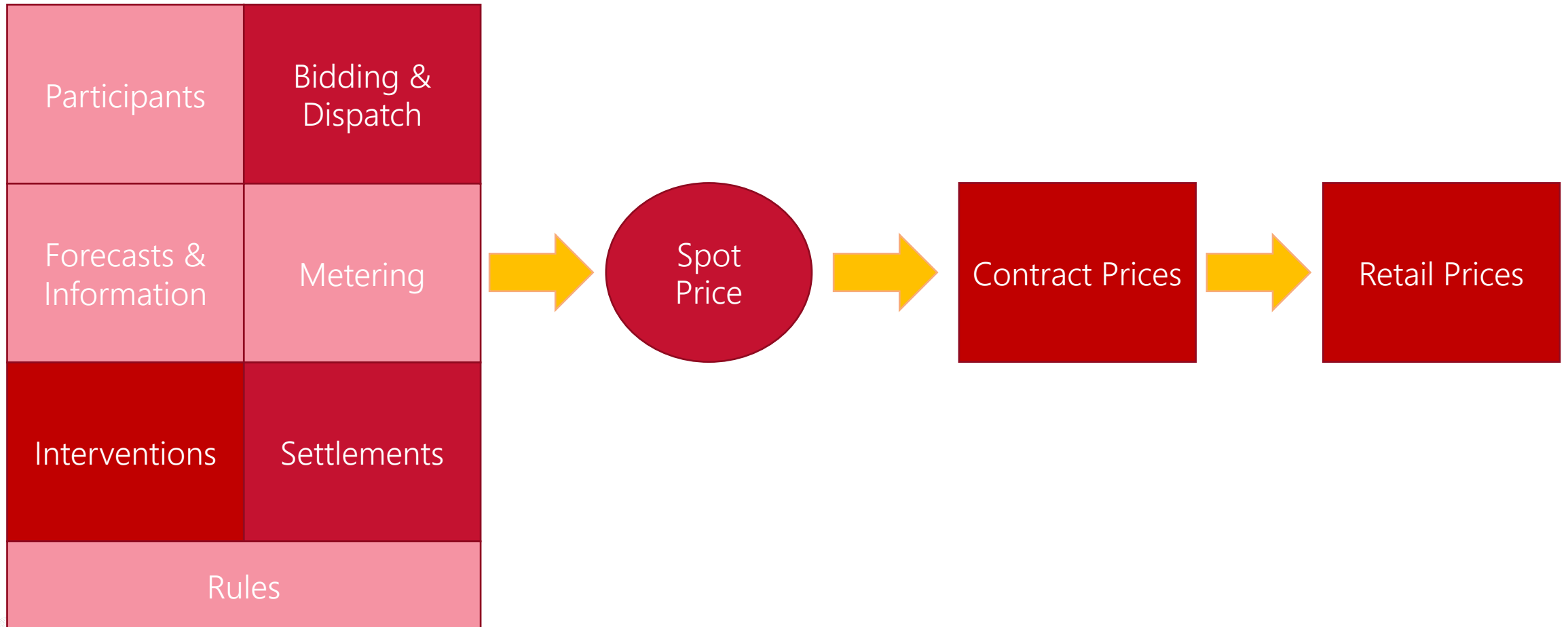
Group Manager Market Insights

Australian Energy Market Operator

Market Mechanics

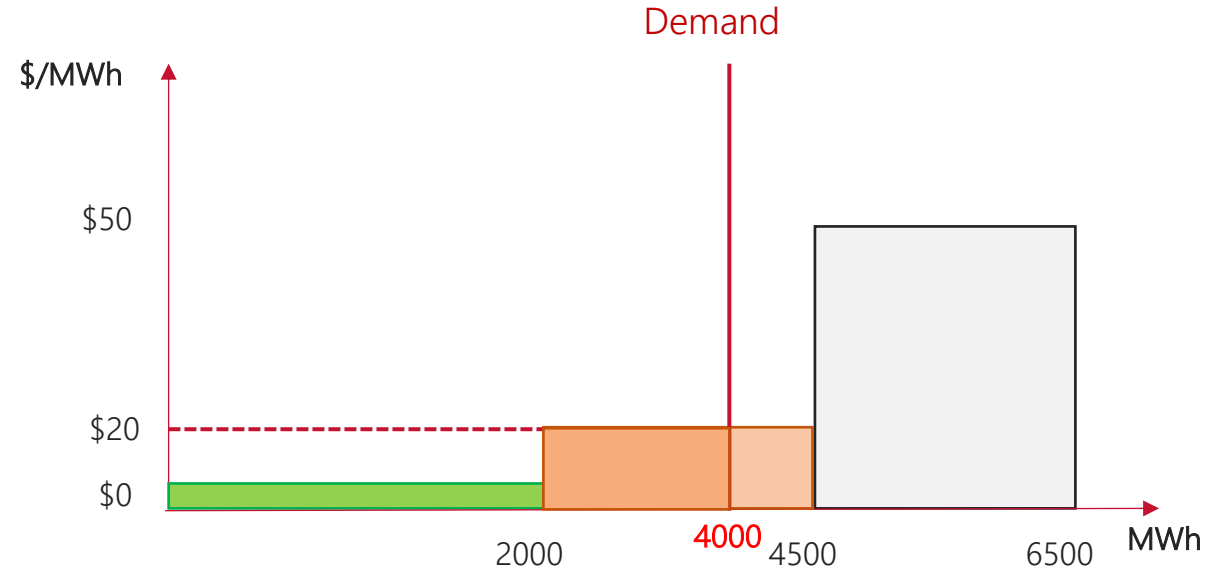
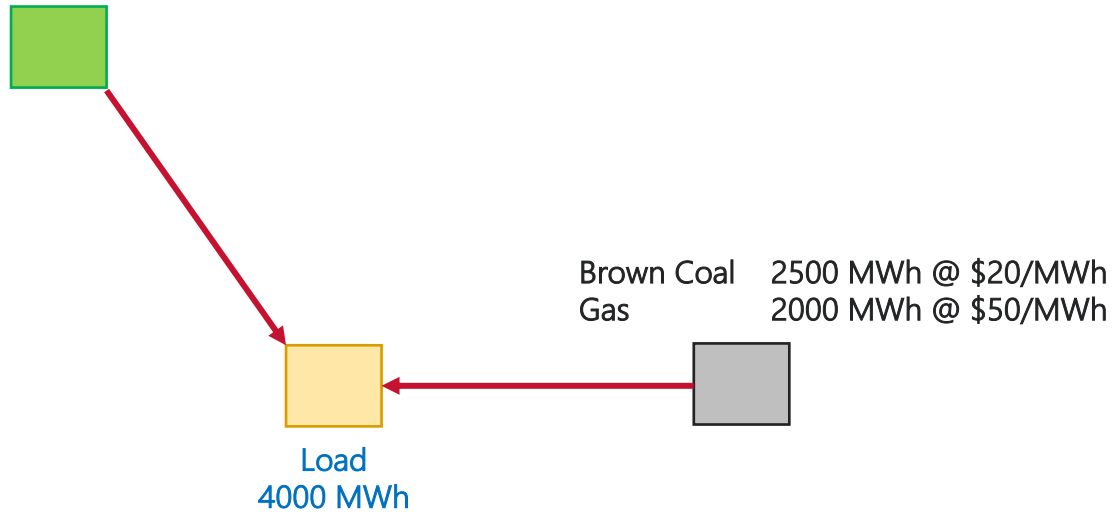
NEM Wholesale electricity market

Wholesale electricity market



Bidding and Dispatch - Unconstrained

Renewables 2000 MWh @ \$0/MWh



NEM Market Outcomes

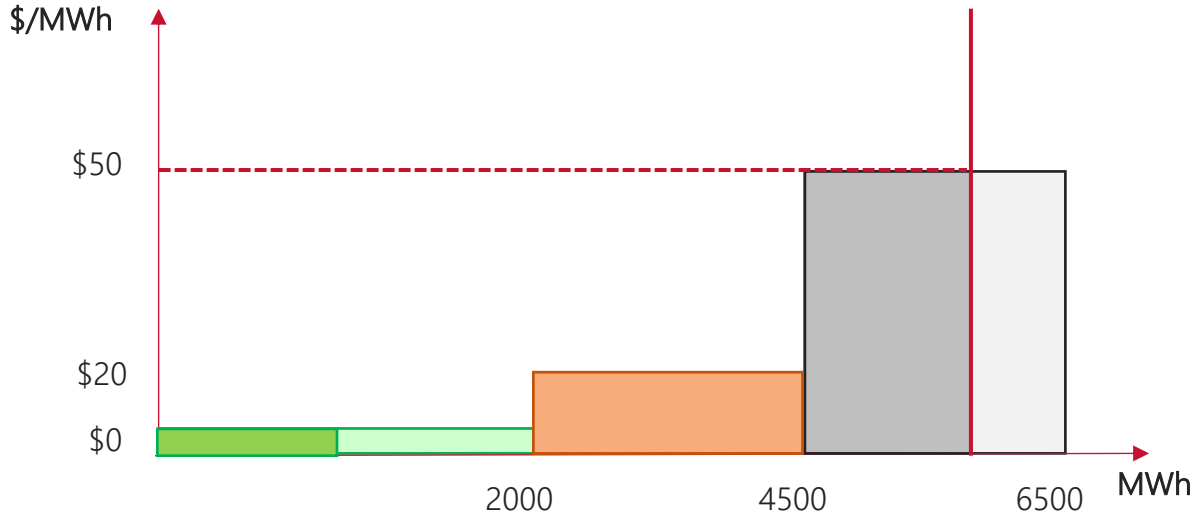
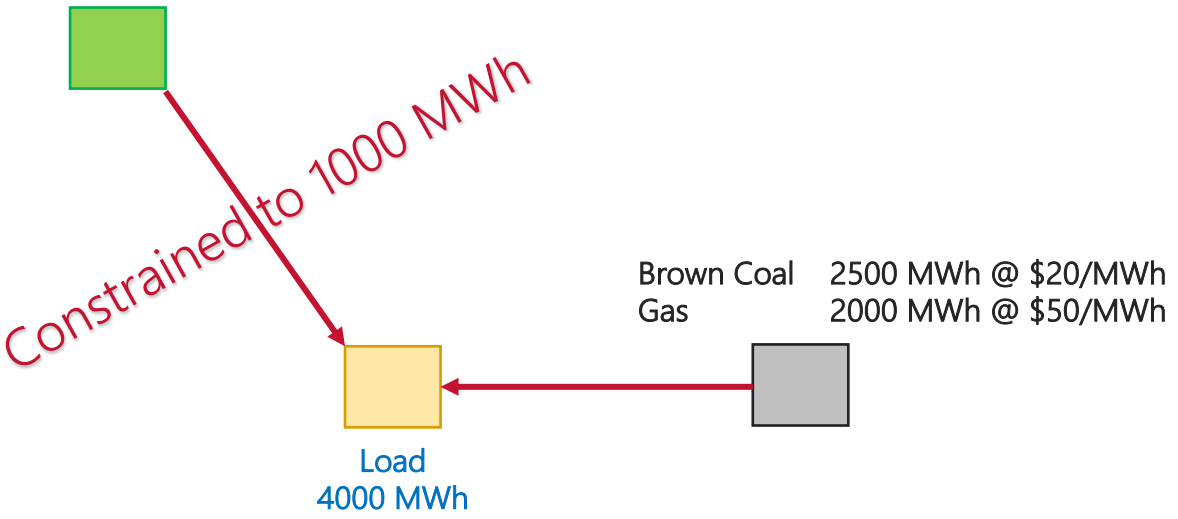
Price = \$20/MWh

Dispatch Outcomes

Renewables	2000 MWh
Brown Coal	2000 MWh
Gas	0 MWh

Bidding and Dispatch - Constrained

Renewables 2000 MWh @ \$0/MWh



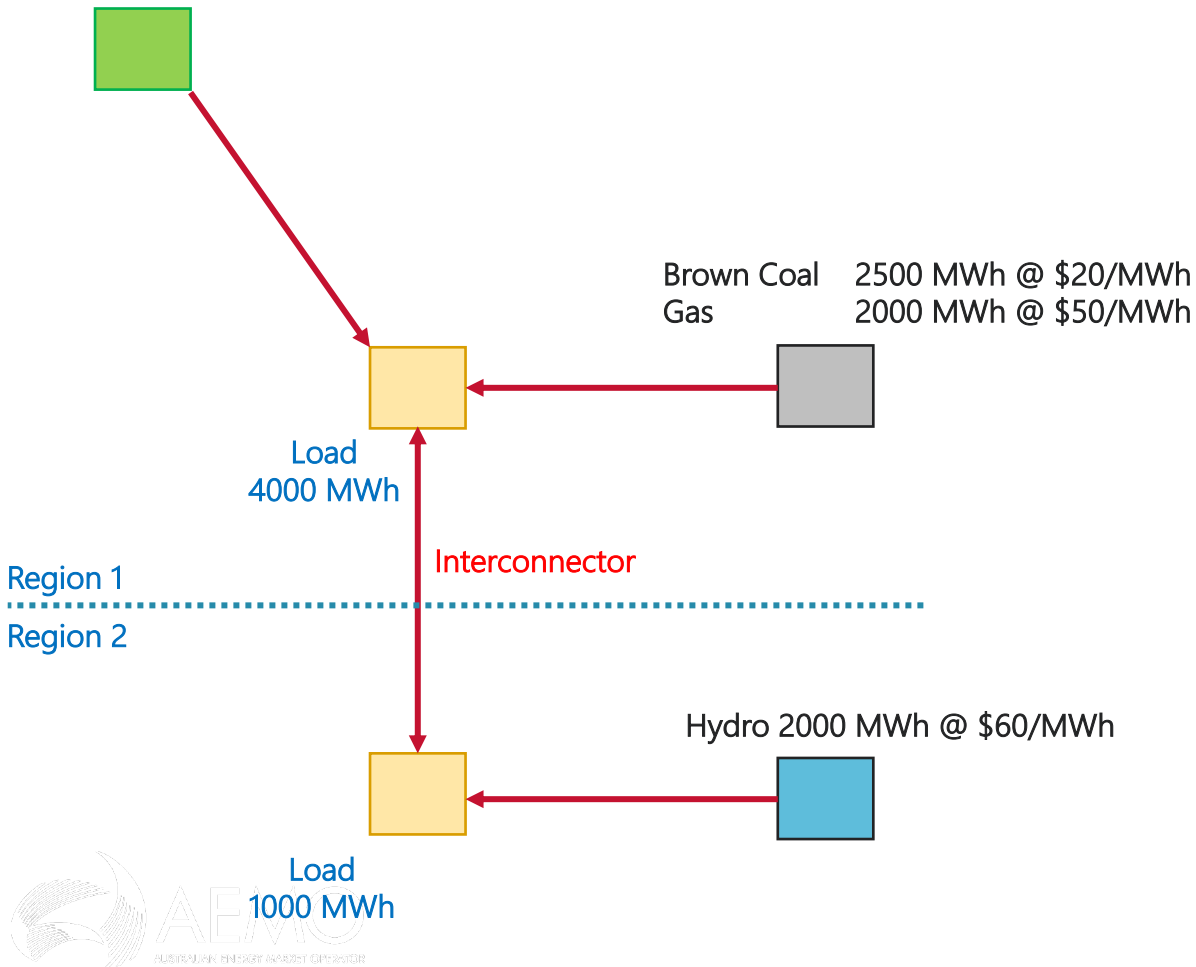
<u>NEM Market Outcomes</u>	
Price = \$50/MWh ↑	
<u>Dispatch Outcomes</u>	
Renewables	1000 MWh ↓
Brown Coal	2500 MWh ↑
Gas	500 MWh ↑

- Introducing constraints means that it is no longer a simple bid stack.
- Requires a linear program known as NEMDE (NEM Dispatch Engine) to solve.



Regions and Interconnectors

Renewables 2000 MWh @ \$0/MWh



No Interconnector Limit

Region 1 Price = \$50/MWh

Region 2 Price = \$50/MWh

Dispatch Outcomes

Renewables	2000 MWh
Brown Coal	2500 MWh
Gas	500 MWh
Hydro	0 MWh

400 MWh Interconnector Limit

Region 1 Price = \$20/MWh

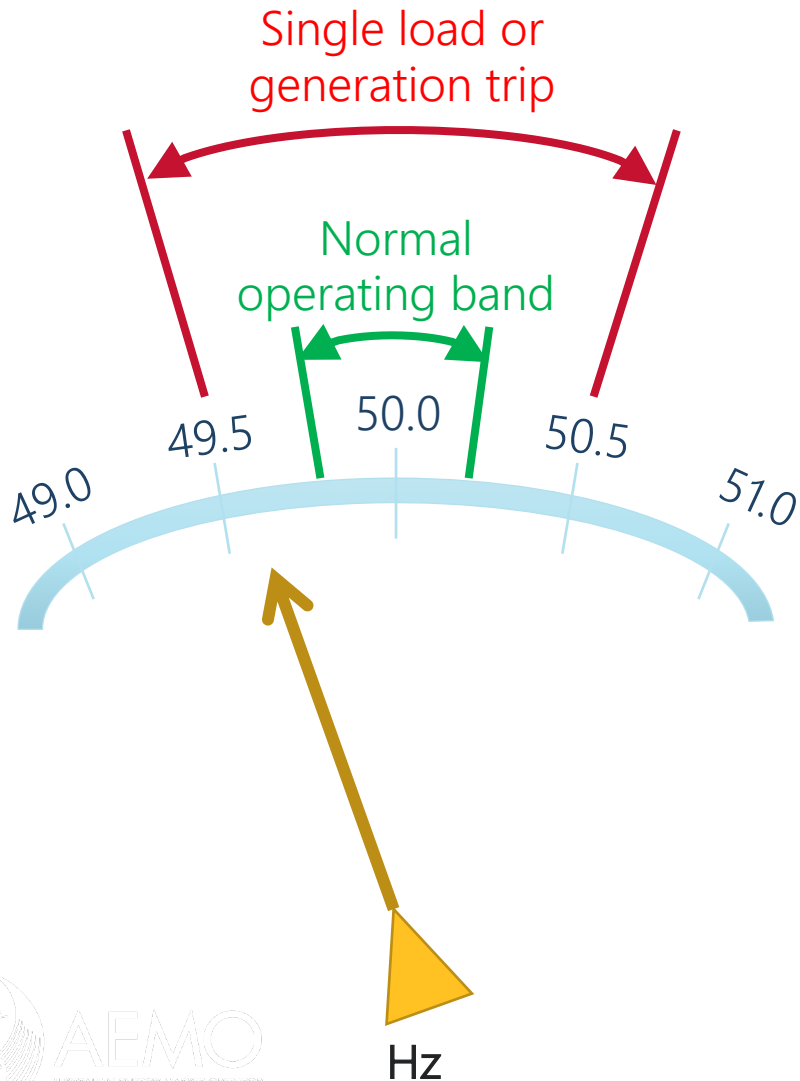
Region 2 Price = \$60/MWh

Dispatch Outcomes

Renewables	2000 MWh
Brown Coal	2400 MWh
Gas	0 MWh
Hydro	600 MWh



Frequency Control Ancillary Services (FCAS)



Managing a power system in real time is all about keeping & restoring frequency within defined tolerances.

The NEM operates 8 FCAS markets comprising.

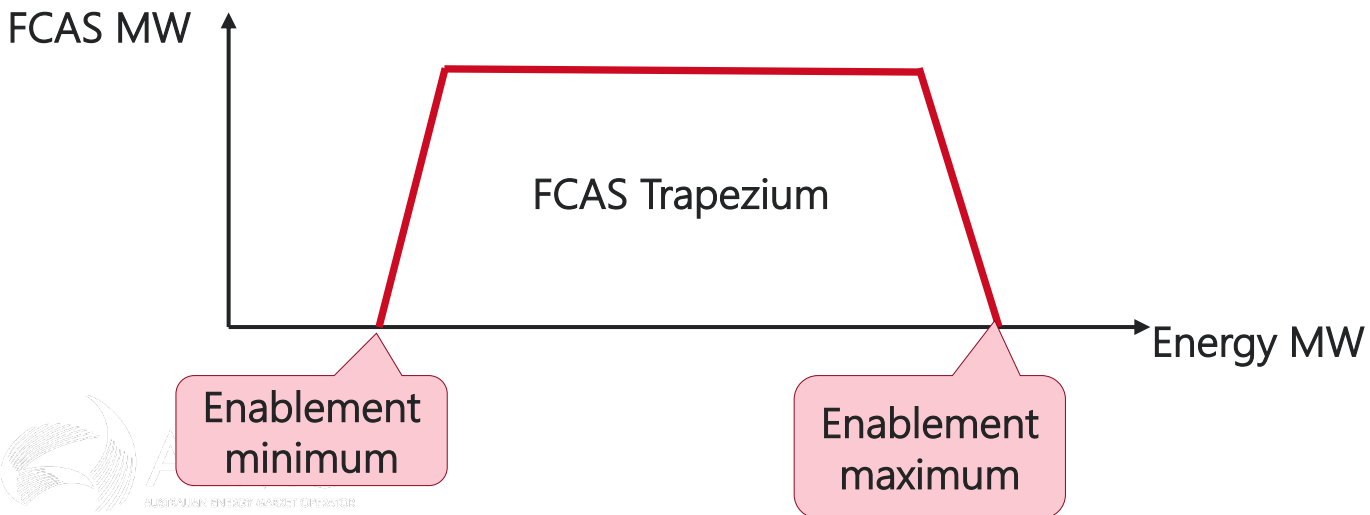
- **2 Regulation Markets (Raise & Lower)**
 - To manage fluctuations in supply and demand within the Normal Operating Frequency Band over a 5 minute dispatch interval.
- **6 Contingency Markets (Raise & Lower over 3 time periods)**
 - To restore the frequency to the NOFB following an unexpected event.
 - 6sec, 60sec, 5min.
- Raise and Lower are provided for each service.
- FCAS markets are for *enablement* only i.e. providers are paid whether or not they have to deliver the service.

Bidding in the NEM

Each generating unit can offer up to 10 price/qty bands for each energy and FCAS service.

Band	1	2	3	4	5	6	7	8	9	10
Price (\$/MWh)	-1000	-100	0	6.80	28	48	618	1,118	7,198	15,100
Quantity (MW)	50	80	40	20	40	40	40	60	60	70

The bid also contains physical characteristics of the unit such as ramp rates and available capacity to ensure that the dispatch solution is technically achievable e.g. the FCAS trapezium describes the mix of energy and FCAS services.



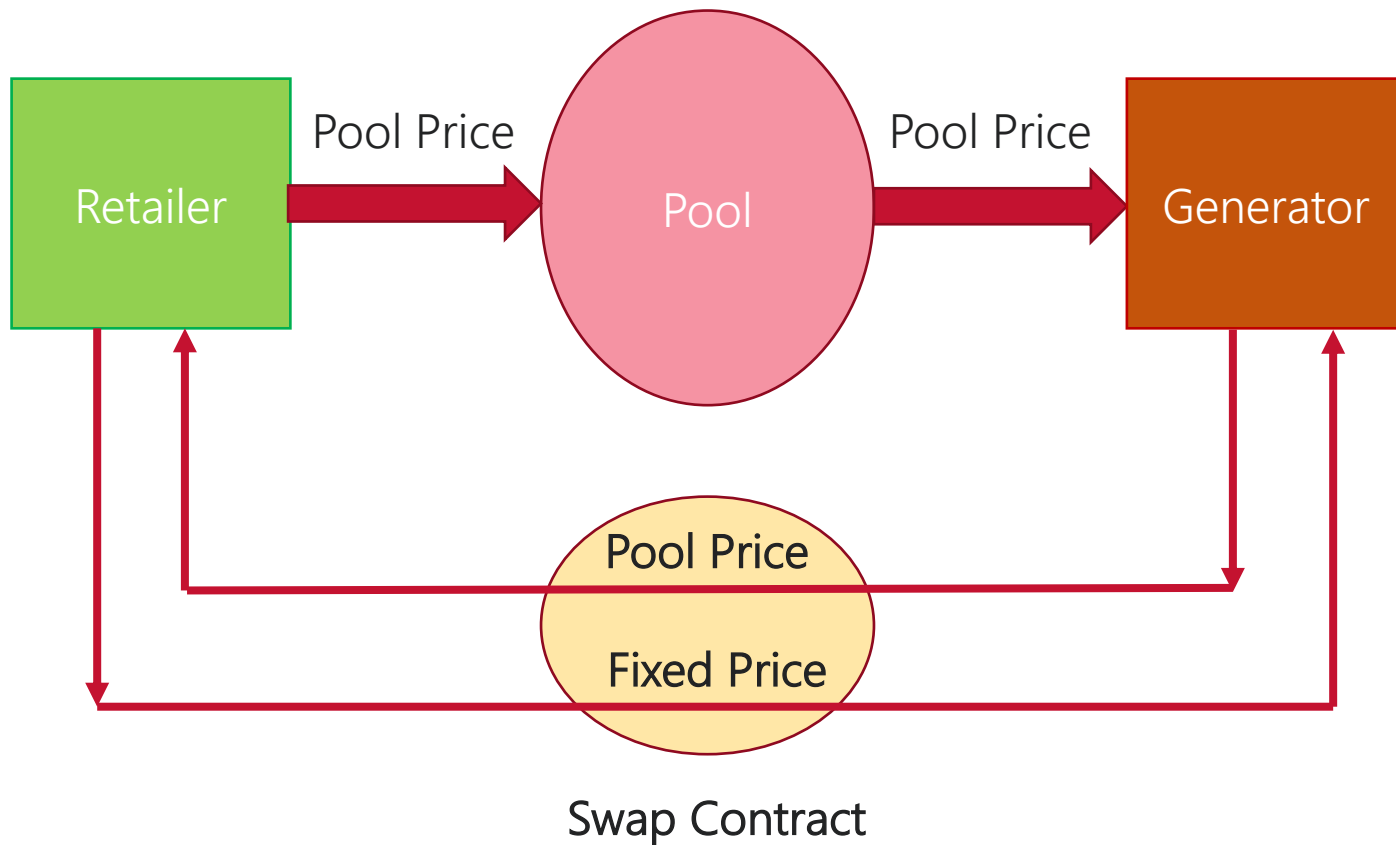
- Generators must lock in their 10 price bands by noon each day.
- They can reallocate volume between bands at any time but must give a rebid reason.
- NEMDE solves the market every 5 minutes and co-optimises between energy and FCAS.
- Most generators receive their dispatch instructions by AGC (Automatic Generator Control).

AEMO actions to manage reliability and security can impact market outcomes

Type	Constraints	Directions	Reliability & Emergency Reserve Trader (RERT)	Network Support & Control Ancillary Service (NSCAS)	Load Shedding
Why ?	Used for a variety of reasons e.g. transmission outages, security.	Out of merit order dispatch to maintain system strength.	Contract with providers of emergency reserves.	Contract for non-market services e.g. voltage support.	Instruct transmission company to shed load.
Note	Managed in NEMDE	Directed parties are compensated	Intervention pricing used to restore price signal.		Price set to Cap of \$15,100/MWh



Contract market complements spot market



Settlement of the Market

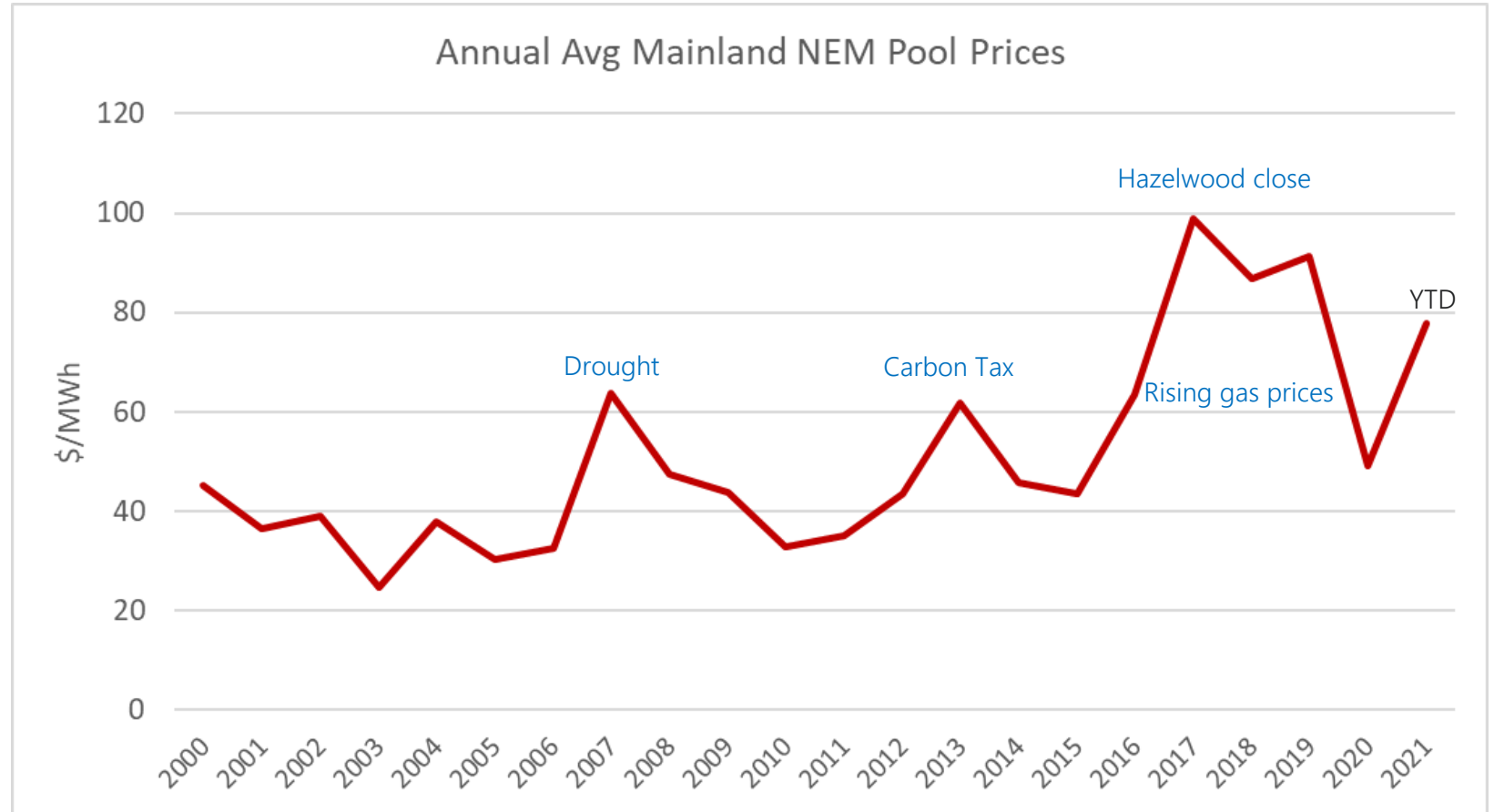
- Retailers must pay the Pool Price for all energy used by their customers.
- Prior to 5 Minute Settlement (5MS) pool prices are averaged over 30 minutes and applied to 30 minute metering.
- A sustained period of high prices can trigger administered pricing which caps prices at \$300/MWh.
- Payments rely on meter readings which are grossed up by distribution and transmission losses.
- Retailers must post prudentials with AEMO to cover their potential pool exposure. AEMO will request a margin call if this is insufficient.

Pool price exposure can be mitigated by entering into contracts.

Market Trends

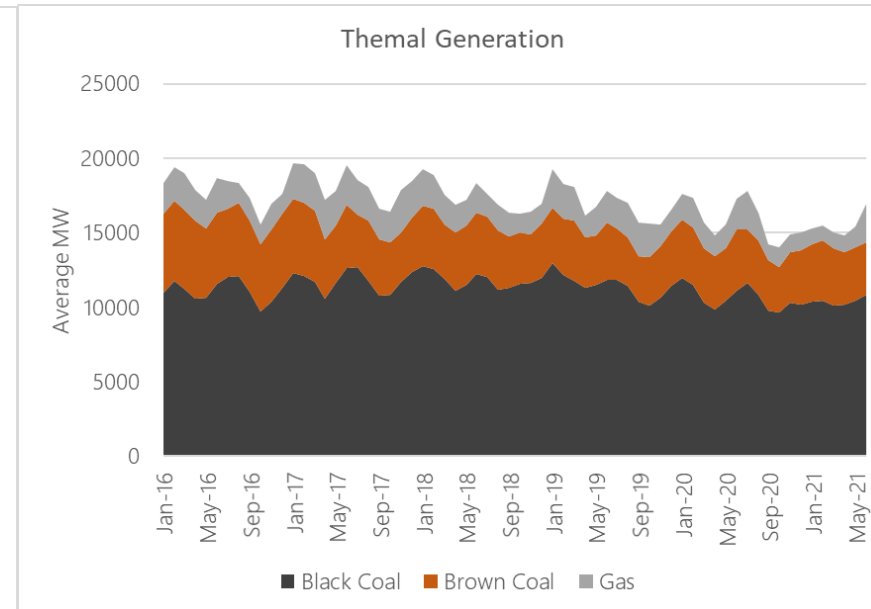
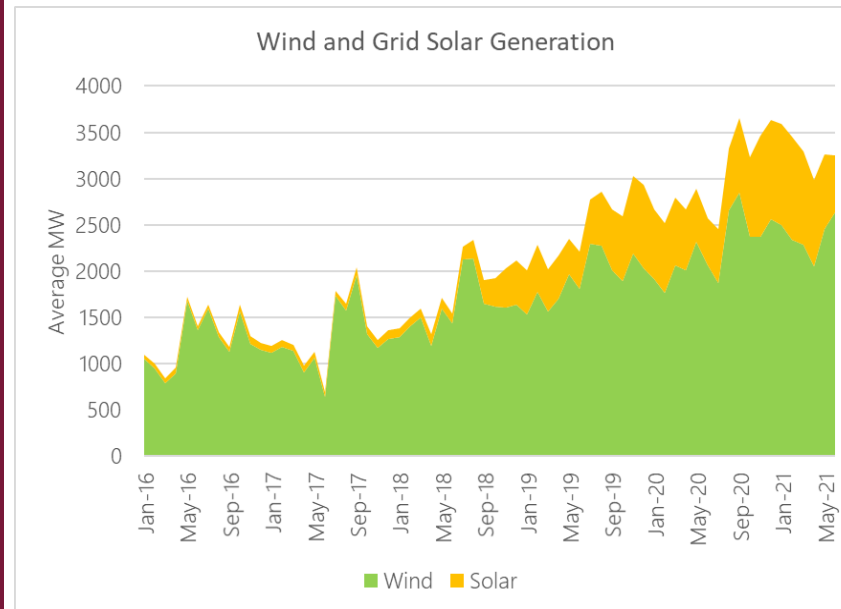
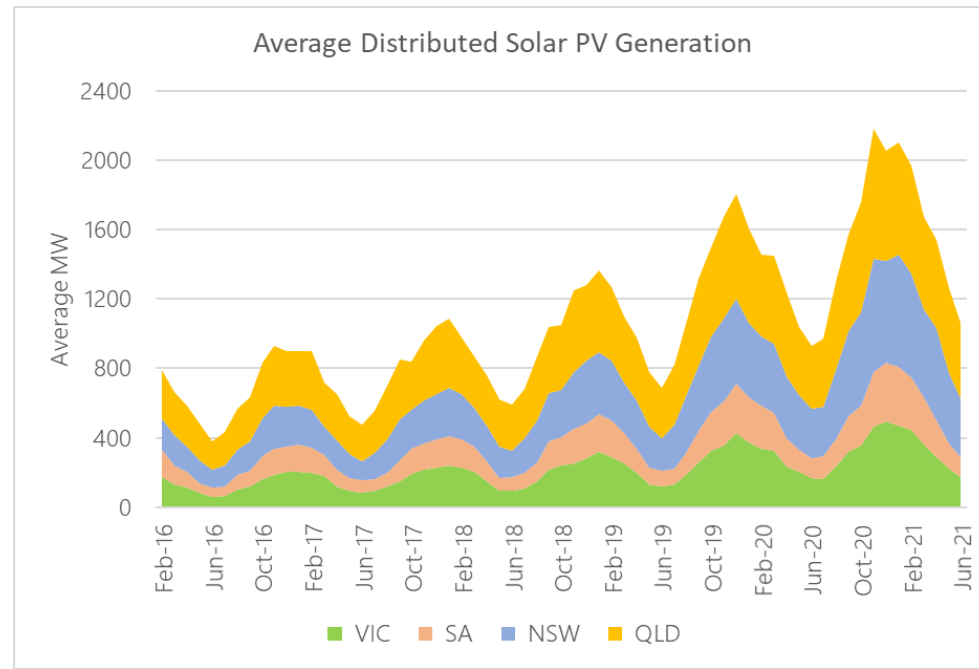
Electricity prices

Influenced by specific shocks and trends in fuel prices

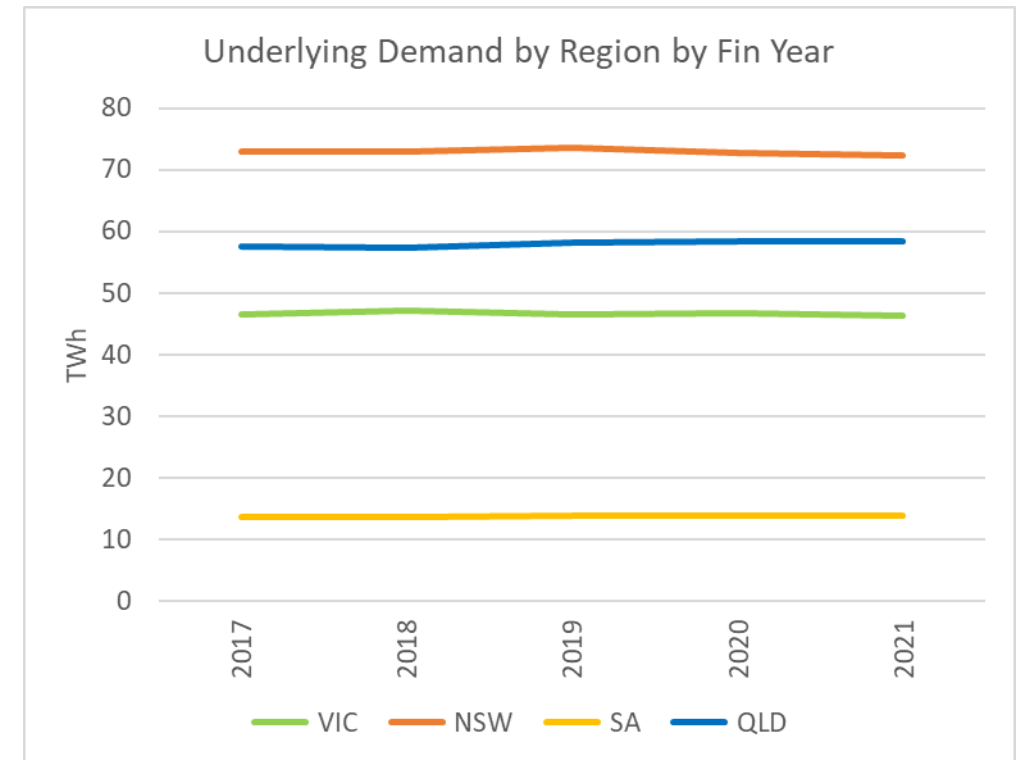
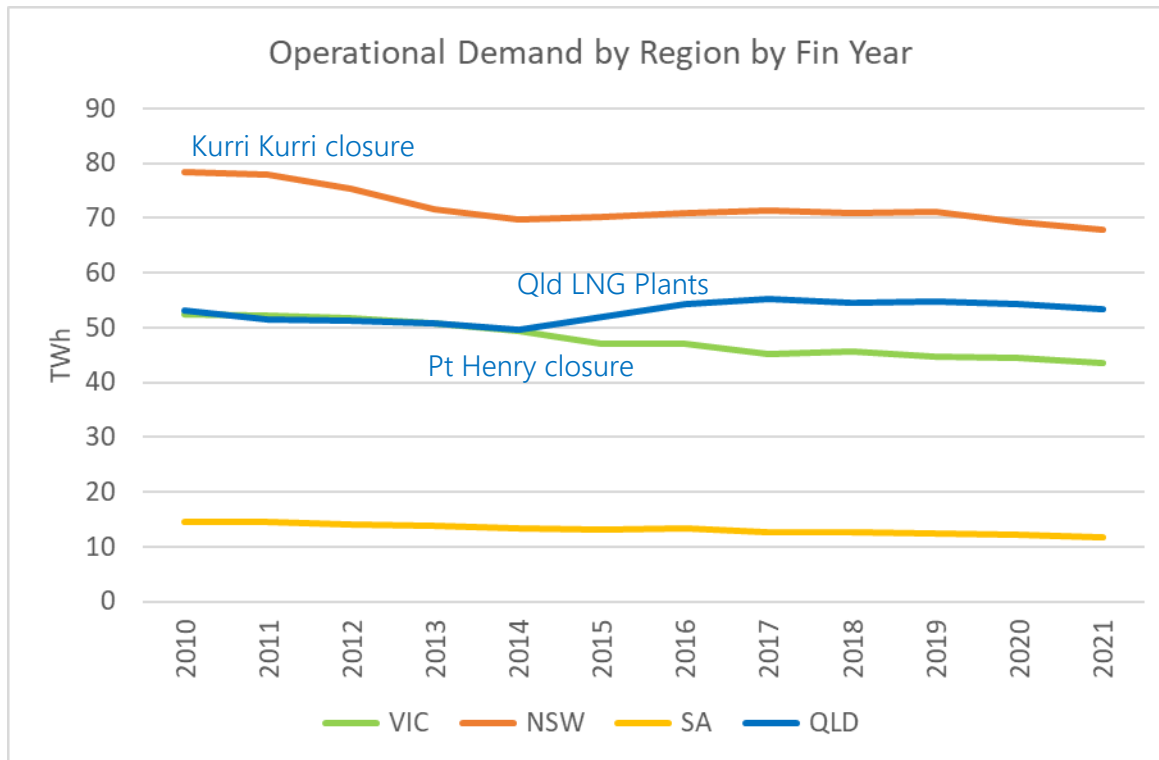


Renewables displacing thermal

Distributed solar is strongly seasonal, Q4 output is twice Q2 in south.

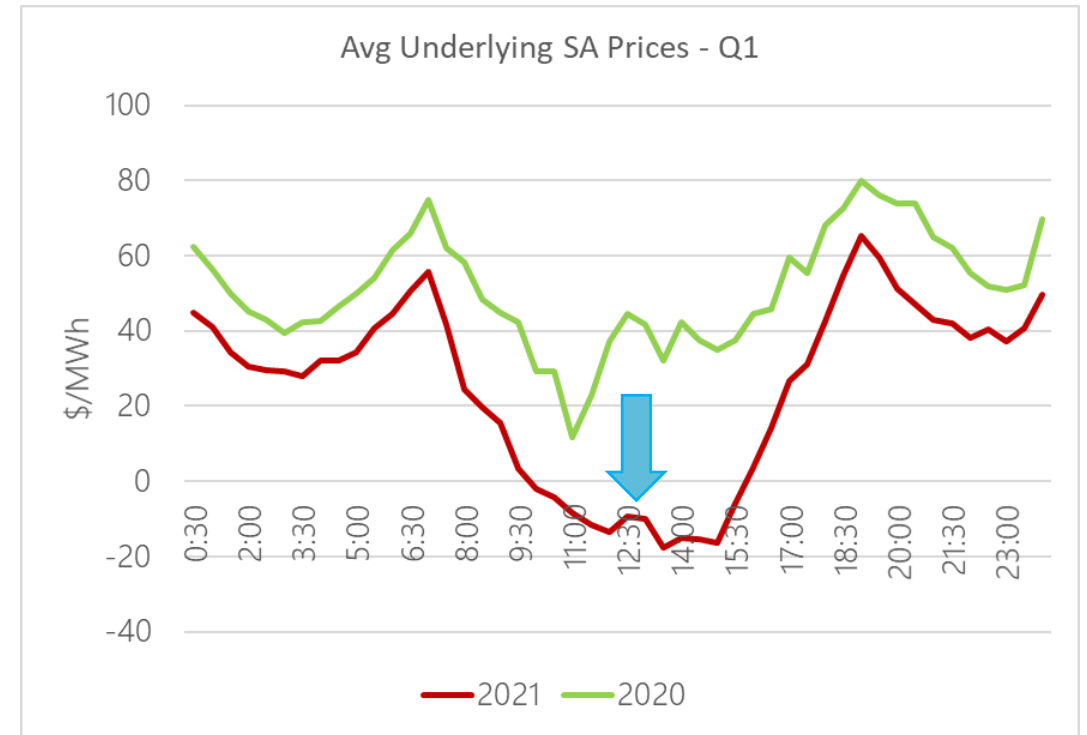
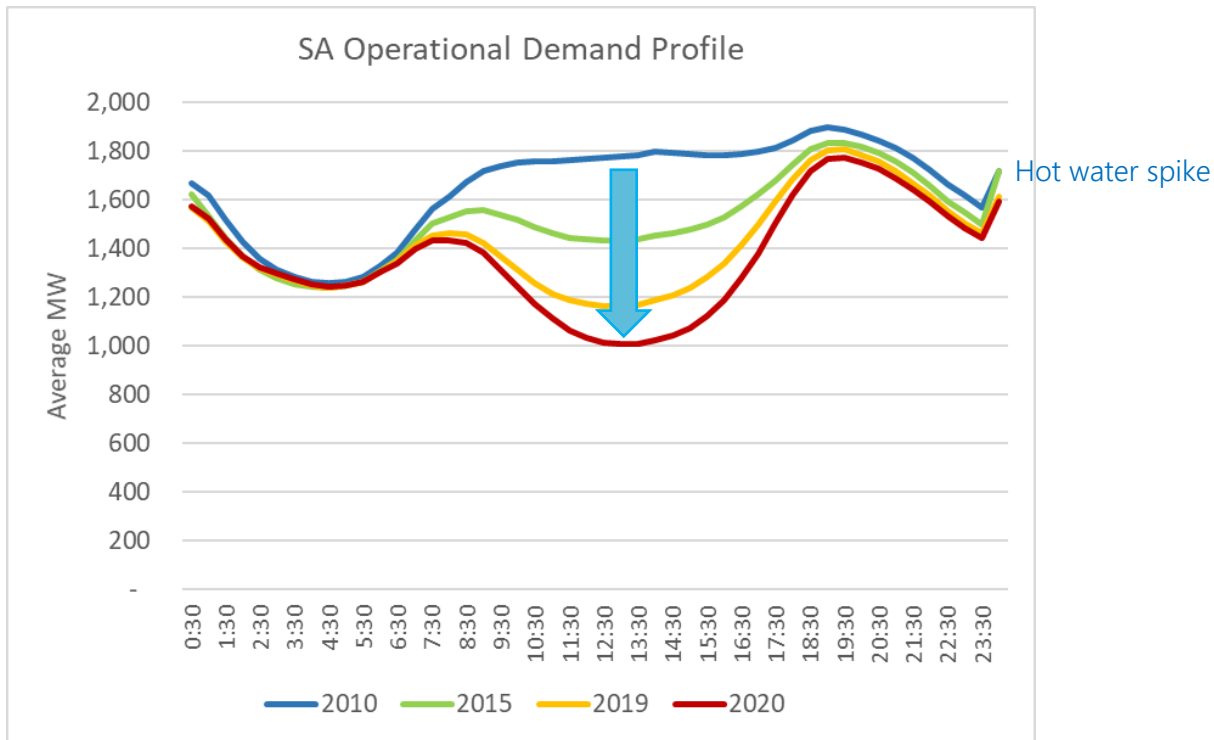


Grid demand is falling due to distributed PV



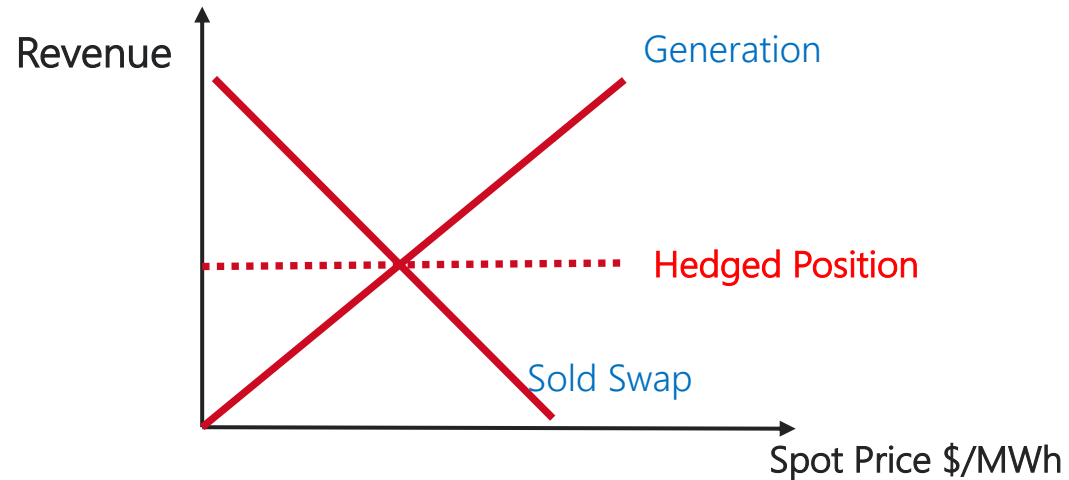
- Operational (grid) demand has declined due to growth in behind the meter distributed PV.
- Adding this back, underlying demand has been flat over the last few years. This reflects load growth due to increased households and economic activity being offset by energy efficiency.
- Operational demand is also highly influenced by changes in large industrial loads.

Distributed PV driving down demand and price



- Increasing distributed PV hollows out operational demand and creates a “duck curve” profile.
- This has resulted in the minimum demand shifting from overnight to midday.
- 10am to 2pm prices averaged *negative* \$12/MWh in Q1.
- This is putting pressure on feed in tariffs e.g. Flat Vic has fallen from 12c/kWh to 6.7c/kWh in 2 years.

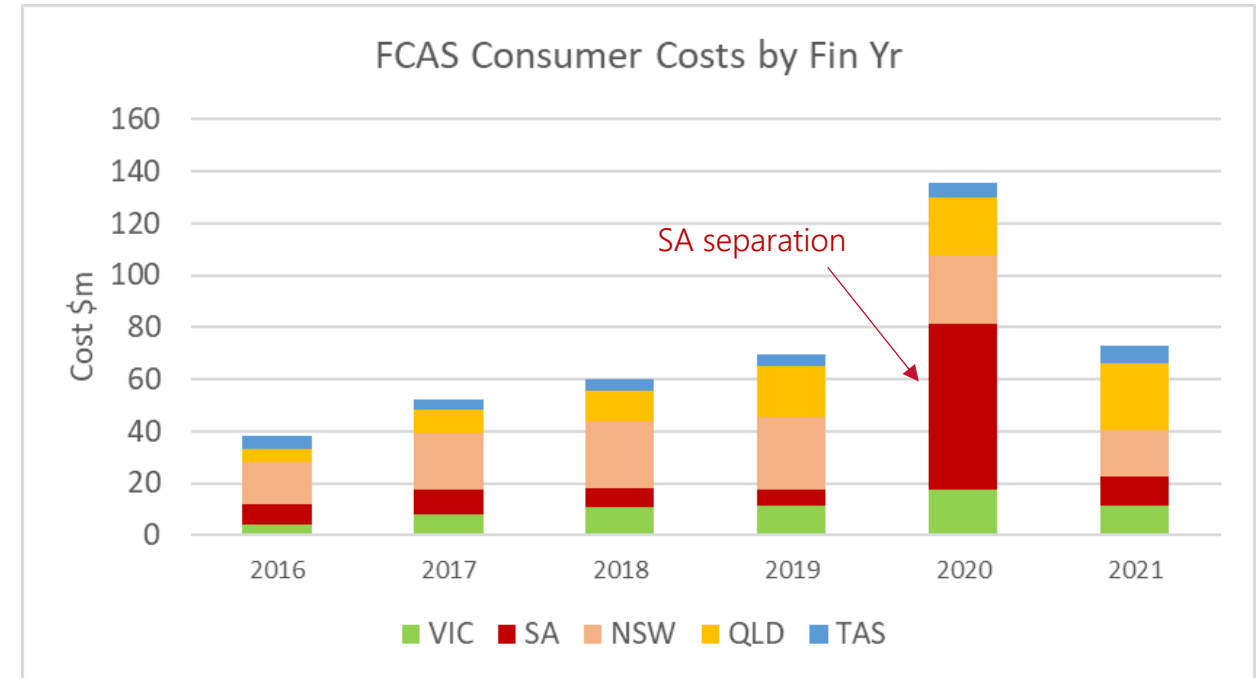
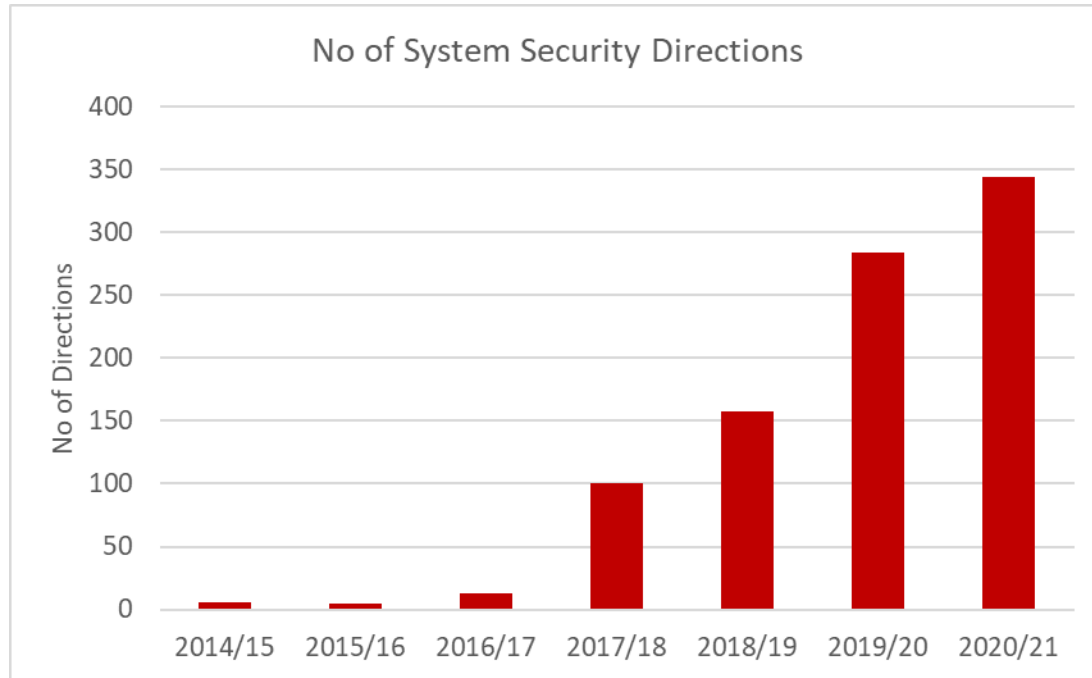
Hedging and contract markets



- Generators are naturally “long” (benefit from rising spot prices) whilst retailers are “short”.
- Derivative contracts are used to manage risk.
 - E.g. a generator can sell a swap contract to create a hedged position.
- Contracts can be traded bilaterally (OTC) or via the ASX futures exchange.
- Forward prices reflect expectations of future spot prices
 - e.g. Callide incident in May saw a jump in Cal 22 prices as traders factored in the reduced supply outlook.
- Contract positions and risk management are key drivers of bidding strategies in the spot market.
 - E.g. a hedged generator is indifferent to pool price and will bid at $-\$1000/\text{MWh}$ to ensure it gets dispatched.



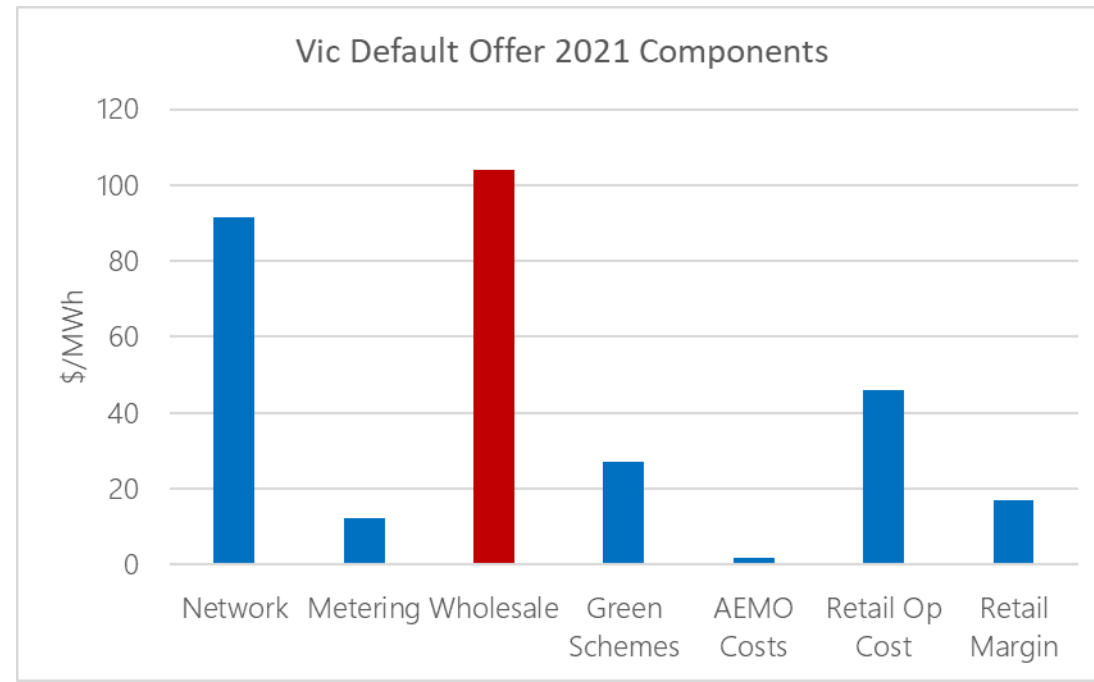
System security costs are increasing



- Increasing penetration of renewables leads to displacement of traditional synchronous generators that bring essential system services e.g. inertia and system strength.
- AEMO has increasingly need to intervene in SA to protect system security. Electranet are currently commissioning synchronous condensers which should reduce these directions.
- FCAS costs are also increasing as AEMO has increased Regulation and Contingency requirements. Grid scale batteries such as Hornsdale make most of their income from FCAS provision.

Impact on electricity bills

Wholesale price changes are a key driver of electricity bills



- Large customers negotiate the wholesale price with their retailer and other costs are typically passed through.
- Mass market customers pay a bundled tariff that is related to the regulated tariff e.g. VDO or AER's Default Market Offer (DMO).
- The annual regulated tariff resets take account of changes in wholesale prices e.g. NSW wholesale price component for FY22 fell from \$111/MWh to \$88/MWh which led to a 5% reduction in the default tariff.

AEMO industry education courses

AEMO offers expert-led industry education courses on Australia's electricity and gas markets, market mechanisms, and operational processes

- Details of all courses available on AEMO website:
aemo.com.au/learn/industry-courses
or google *AEMO courses*
- Covers electricity and gas markets, and a wide range of experience levels
Free eLearning courses for the NEM and for Gas
- Enrolments via the AEMO Learning Academy:
aemolearningacademy.aemo.com.au
- For more info contact:
energyeducation@aemo.com.au



NEM Overview

Details how the NEM operates as a physical power system and a wholesale market for electricity.

- Held online over 2 x half days – next scheduled for:
- 24 & 26 August
 - 21 & 23 September



Network and Frequency Control Ancillary Service (FCAS) Constraints in the NEM

Explores the network characteristics that determine constraints, how constraints are derived and formulated, and their effects on dispatch outcomes.

- Held online over 4 x half days – next scheduled for:
- 7-10 September