



# MEInetwork24 Seminar Series

17 July 2024

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#MEInetwork



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## Seminar #3: Wholesale Markets

Speaker:

**Paul Austin**

*Group Manager Reform Delivery  
Australian Energy Market Operator (AEMO)*

Moderator:

**A/Prof David Keith**

*A/Prof Strategy, Melbourne Business School (MBS)  
Associate Director - Innovation and Sustainability in  
MBS Centre for Sustainability and Business*

# MEInetwork24 Seminar Series



Seminar topic	Month
1. System overview: from generation to customer	2 May 2024
2. Transmission and distribution networks	4 Jun 2024
<b>3. Wholesale markets</b>	<b>17 Jul 2024</b>
4. Financial markets	7 Aug 2024
5. Retail markets	3 Sep 2024
6. Distributed energy resources	8 Oct 2024
7. Energy communities and microgrids	7 Nov 2024

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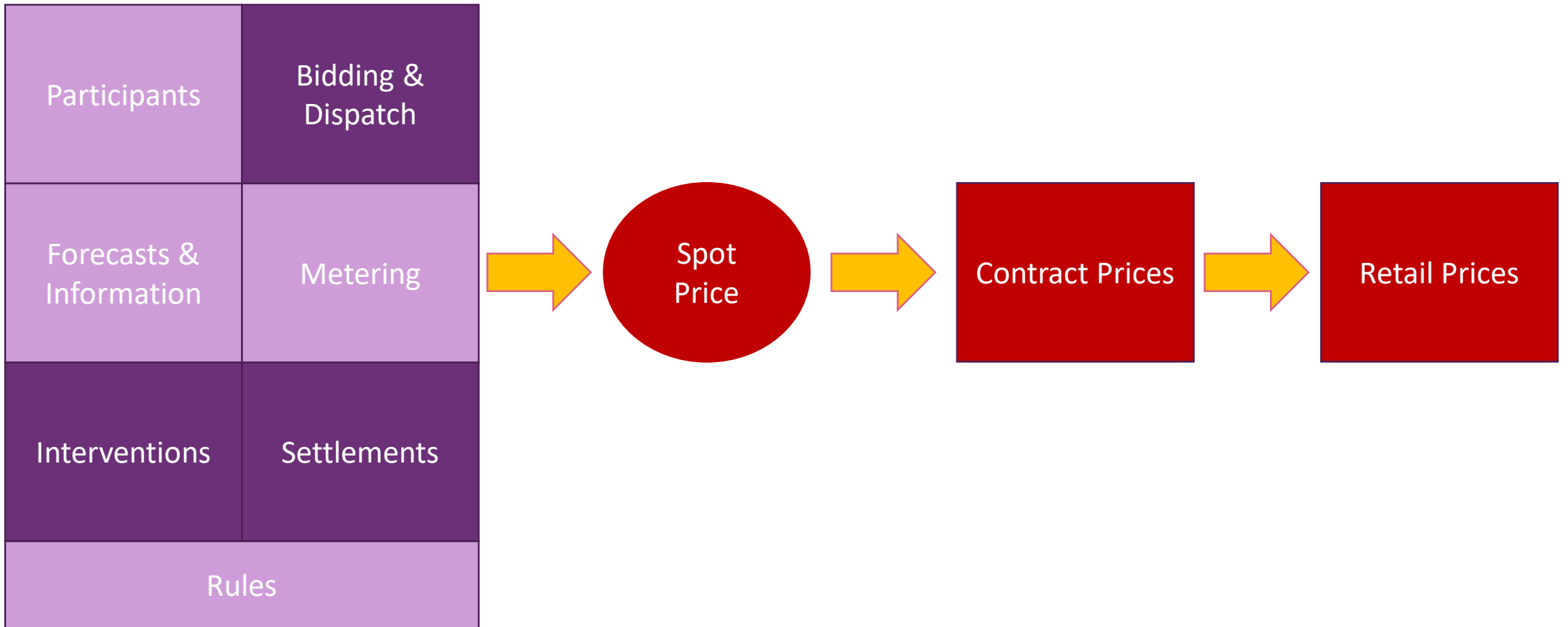
# Market Mechanics



# NEM Wholesale electricity market

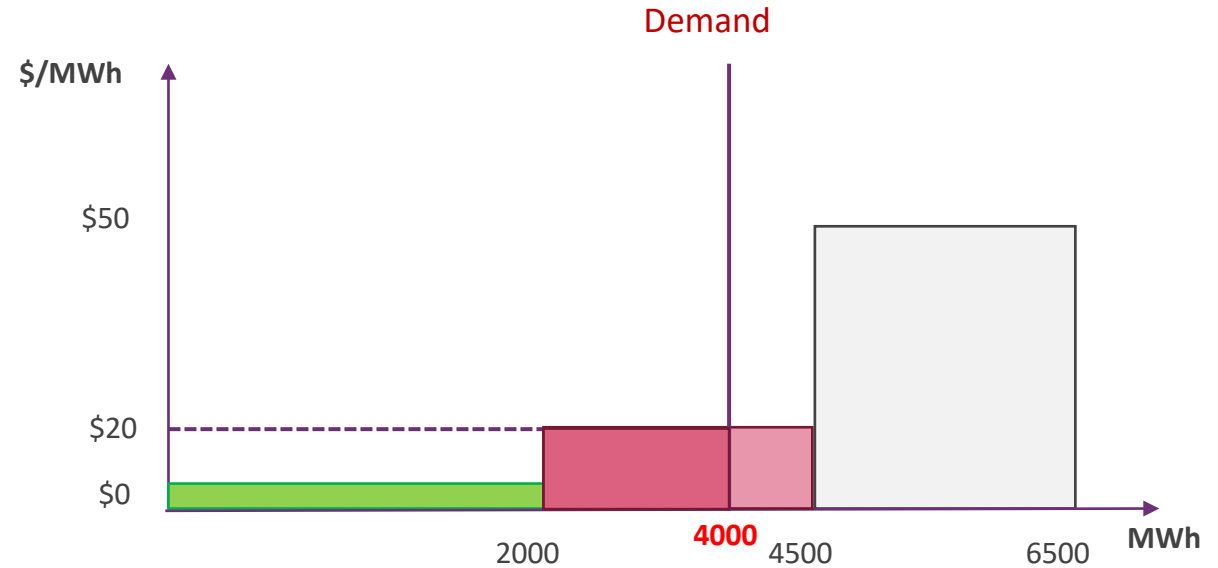
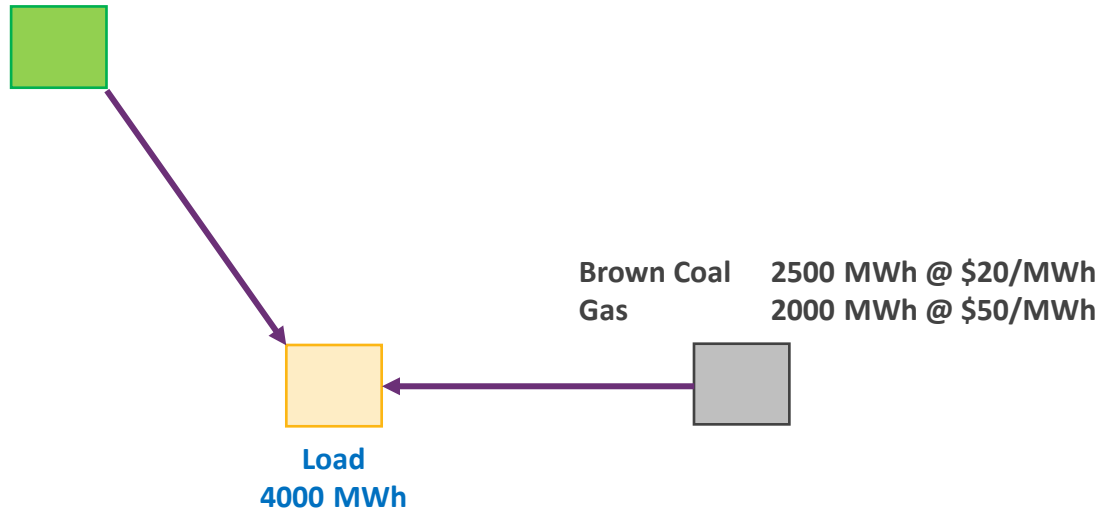


## Wholesale electricity market



# Bidding and Dispatch - Unconstrained

Renewables 2000 MWh @ \$0/MWh



## NEM Market Outcomes

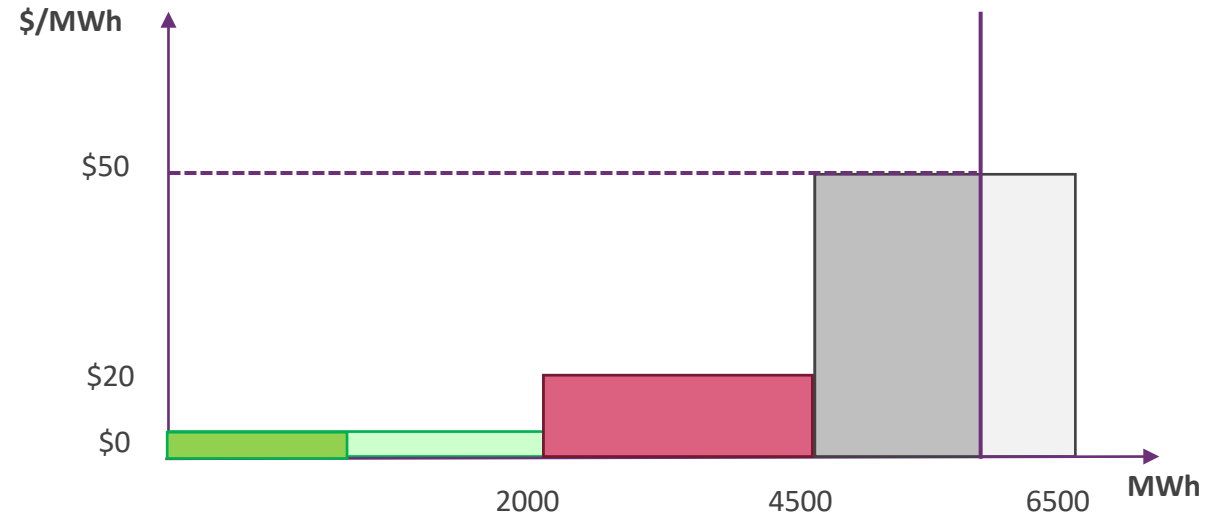
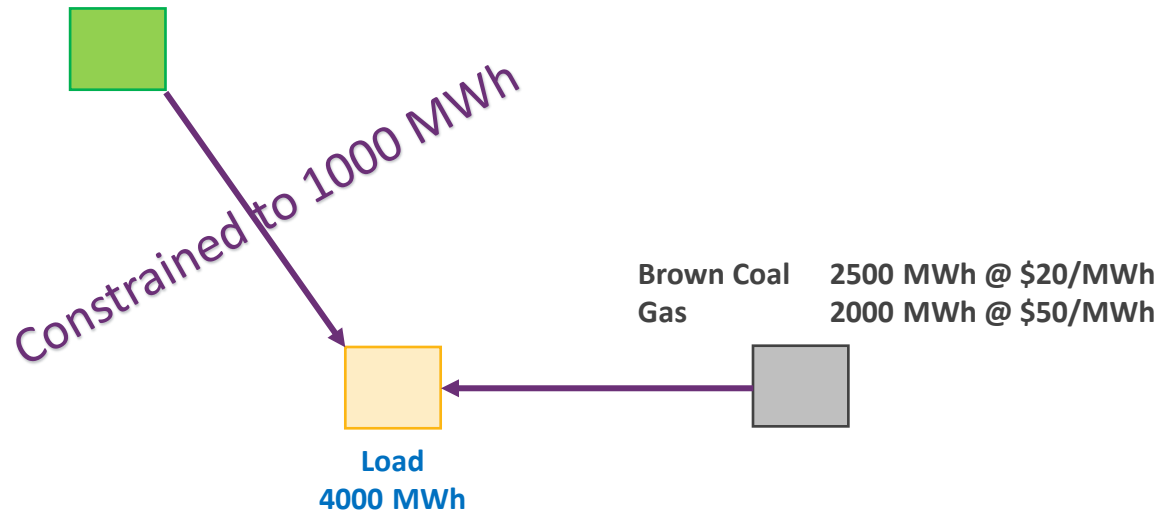
Price = \$20/MWh

## Dispatch Outcomes

Renewables	2000 MWh
Brown Coal	2000 MWh
Gas	0 MWh

# Bidding and Dispatch - Constrained

Renewables 2000 MWh @ \$0/MWh



## NEM Market Outcomes

Price = \$50/MWh ↑

## Dispatch Outcomes

Renewables 1000 MWh ↓

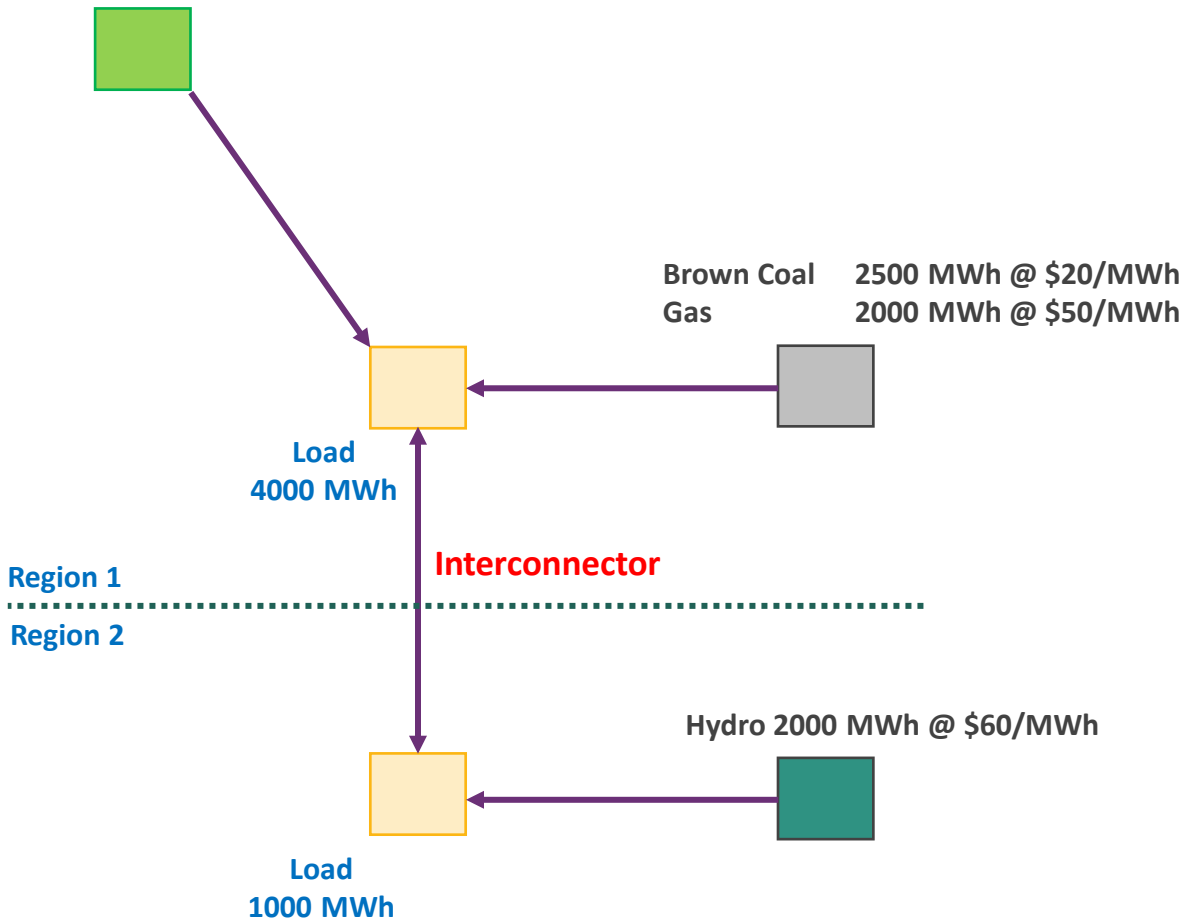
Brown Coal 2500 MWh ↑

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

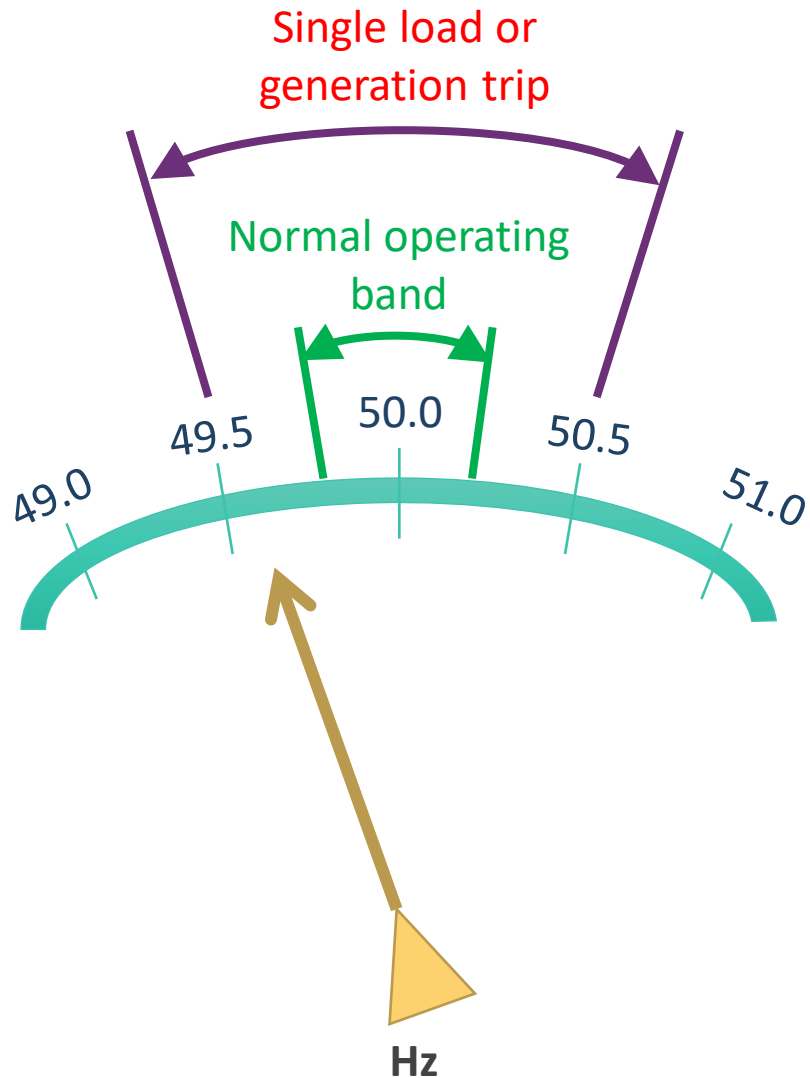
Region 2 Price = \$60/MWh

### 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 10 FCAS markets comprising.

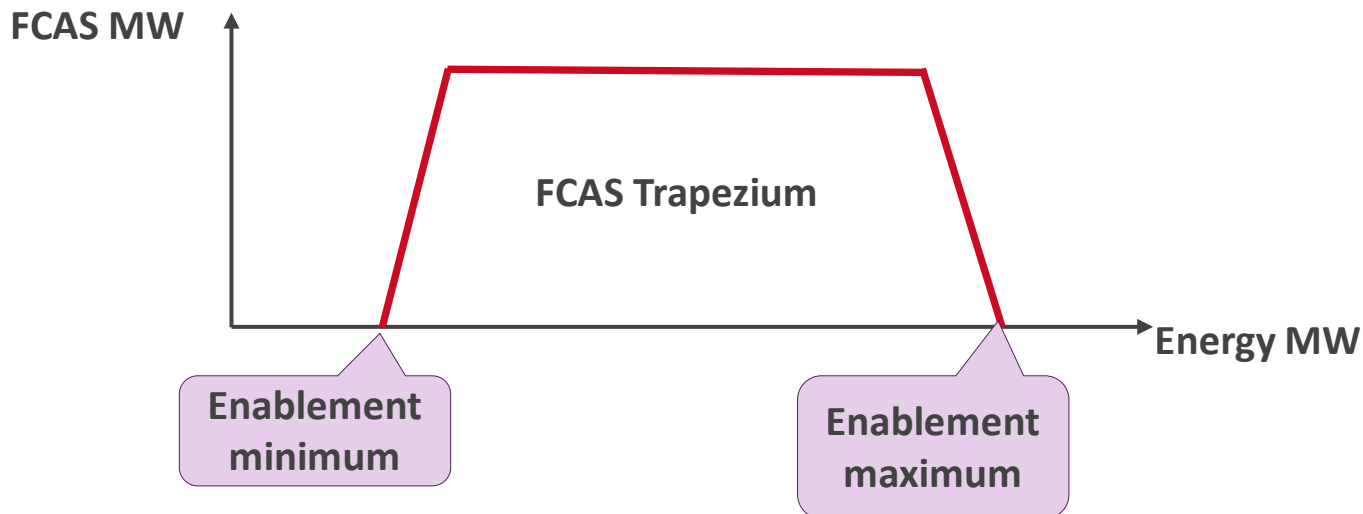
- **2 Regulation Markets (Raise & Lower)**
  - To manage fluctuations in supply and demand within the Normal Operating Frequency Band over a 5 minute dispatch interval.
- **8 Contingency Markets (Raise & Lower over 4 time periods)**
  - To restore the frequency to the NOFB following an unexpected event.
    - 1sec, 6sec, 60sec, 5min.
- 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	Service	Direction	1	2	3	4	5	6	7	8	9	10
Price (\$/MWh)	Energy	Gen	-1000	-100	0	6.80	28	48	618	1,118	7,198	17,500
Quantity (MW)	Energy	Gen	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.

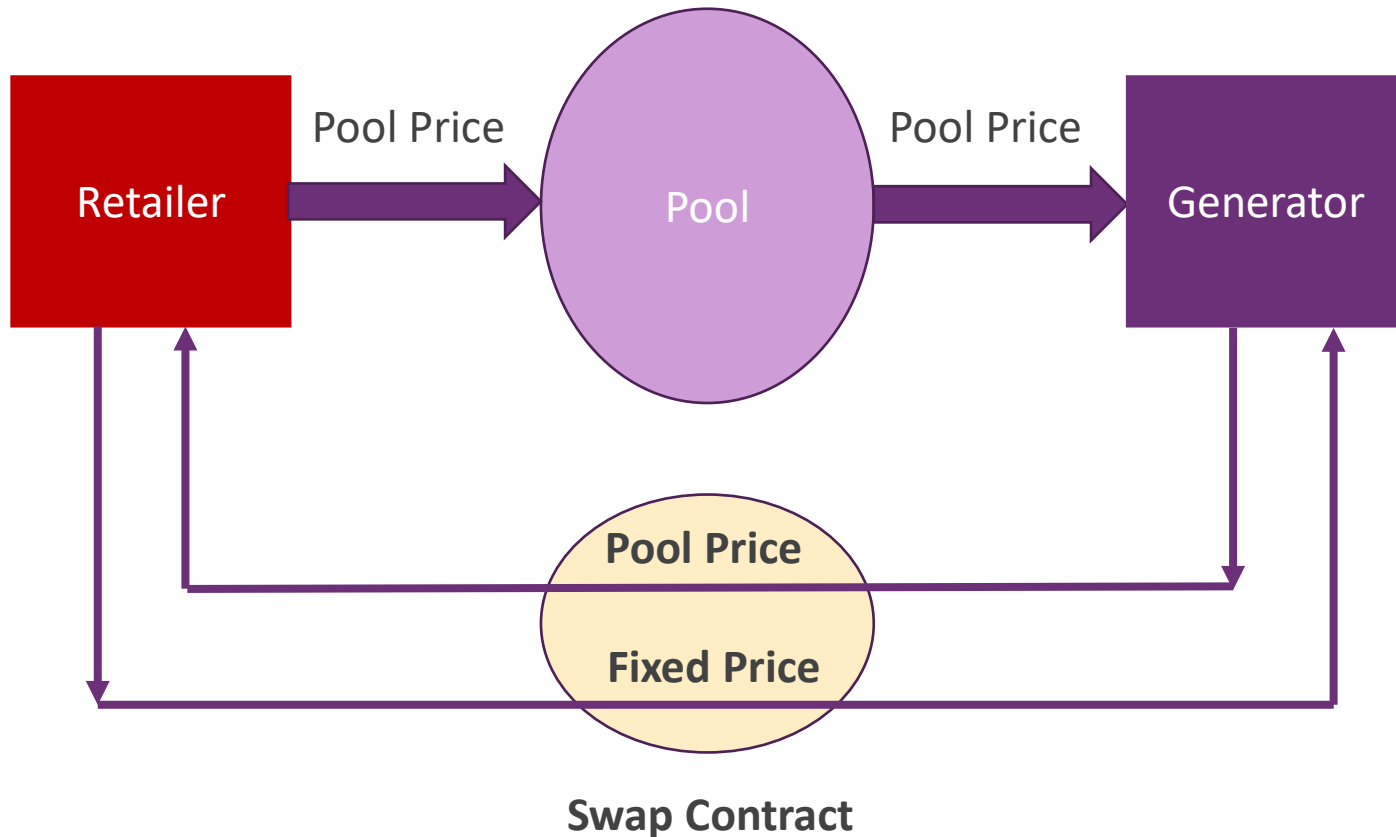


- Participants must lock in their 10 price bands by noon each day.
- They can reallocate volume between bands at any time but must give a rebid reason.
- NEMDE solves the market every 5 minutes and co-optimises between energy and FCAS.
- Most generators receive their dispatch instructions by AGC (Automatic Generator Control).
- Introduction of IESS means “Direction” now has to be specified and batteries that are scheduled bidirectional units can bid 20 bid bands, 10 Gen and 10 Load.

# AEMO can take actions outside the market to manage reliability and security

Type	Impose Constraints	Give Directions	Contract & Dispatch Reserves (RERT)	Procure System Services	Load Shedding
Why ?	Used for a variety of reasons e.g. transmission outages, security.	Maintain reliability and security.	Contract with providers of emergency reserves.	Procure system services e.g. system strength.	Instruct transmission company to shed load.
Note	Managed in NEMDE	Directed parties are compensated	Intervention pricing used to restore price signal	Only if can't be procured otherwise	Price set to Cap of \$17,500 /MWh

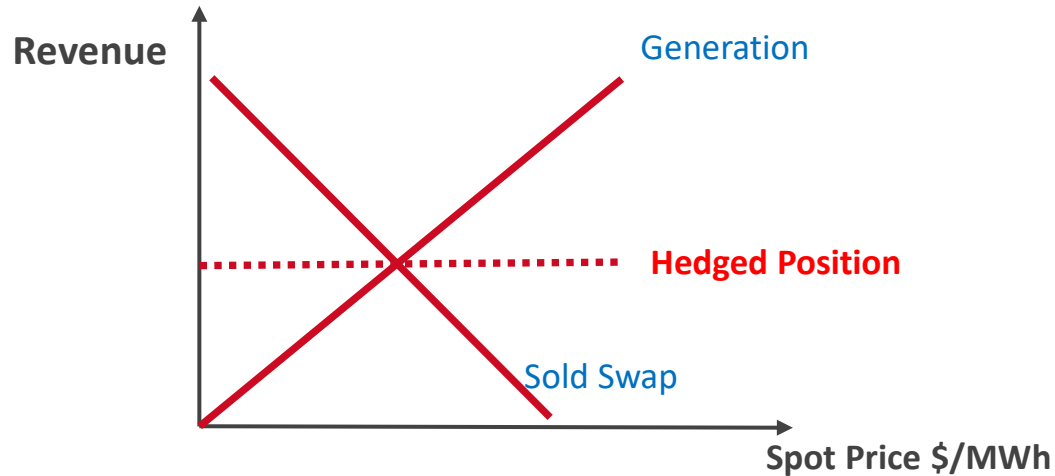
# Contract market complements spot market



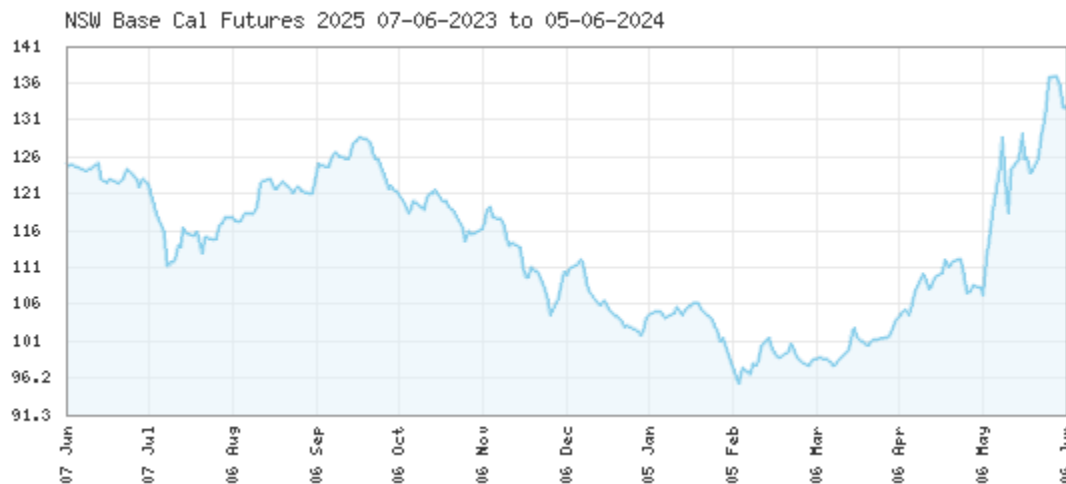
## Settlement of the Market

- Retailers must pay the Pool Price for all energy used by their customers.
- Generators receive Pool Price for all their output.
- Pool price exposure can be mitigated by entering into derivative contracts.
- A sustained period of high prices can trigger administered pricing which caps prices at \$600/MWh.
- Payments are based 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.

# Hedging and contract markets

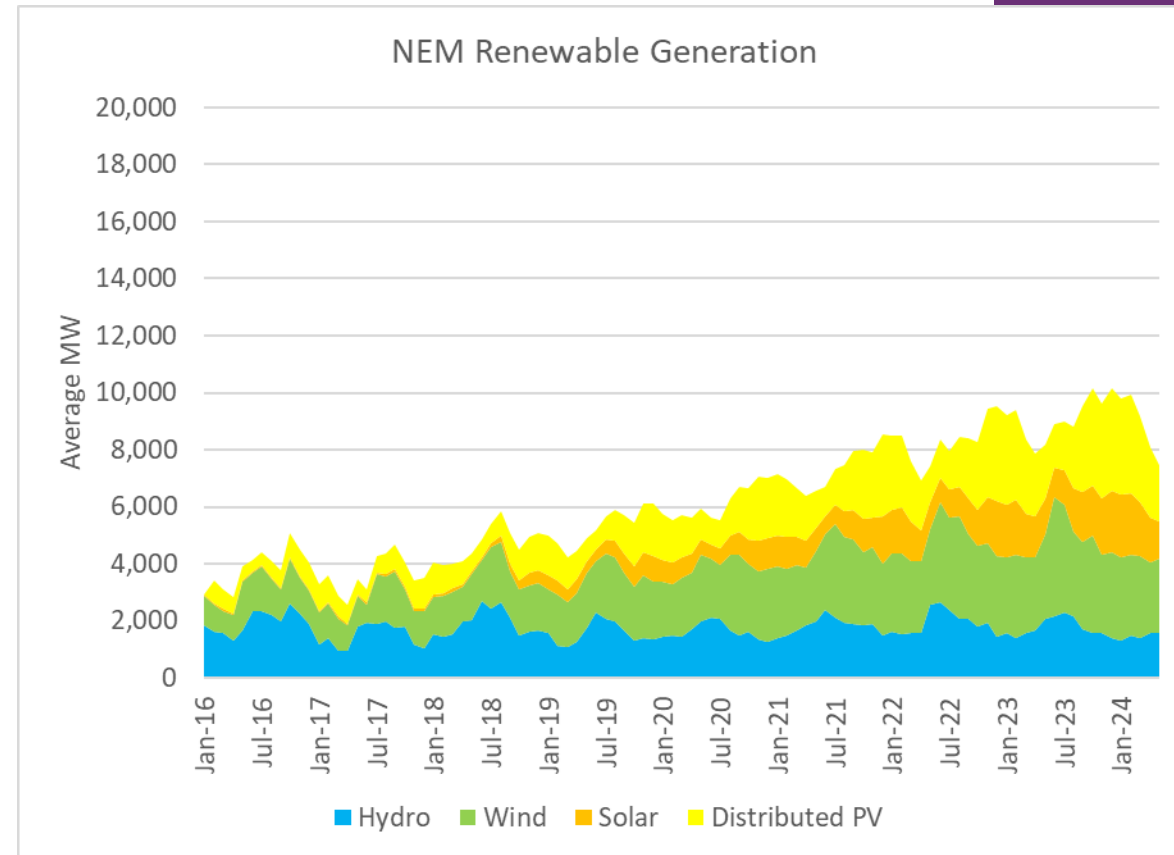
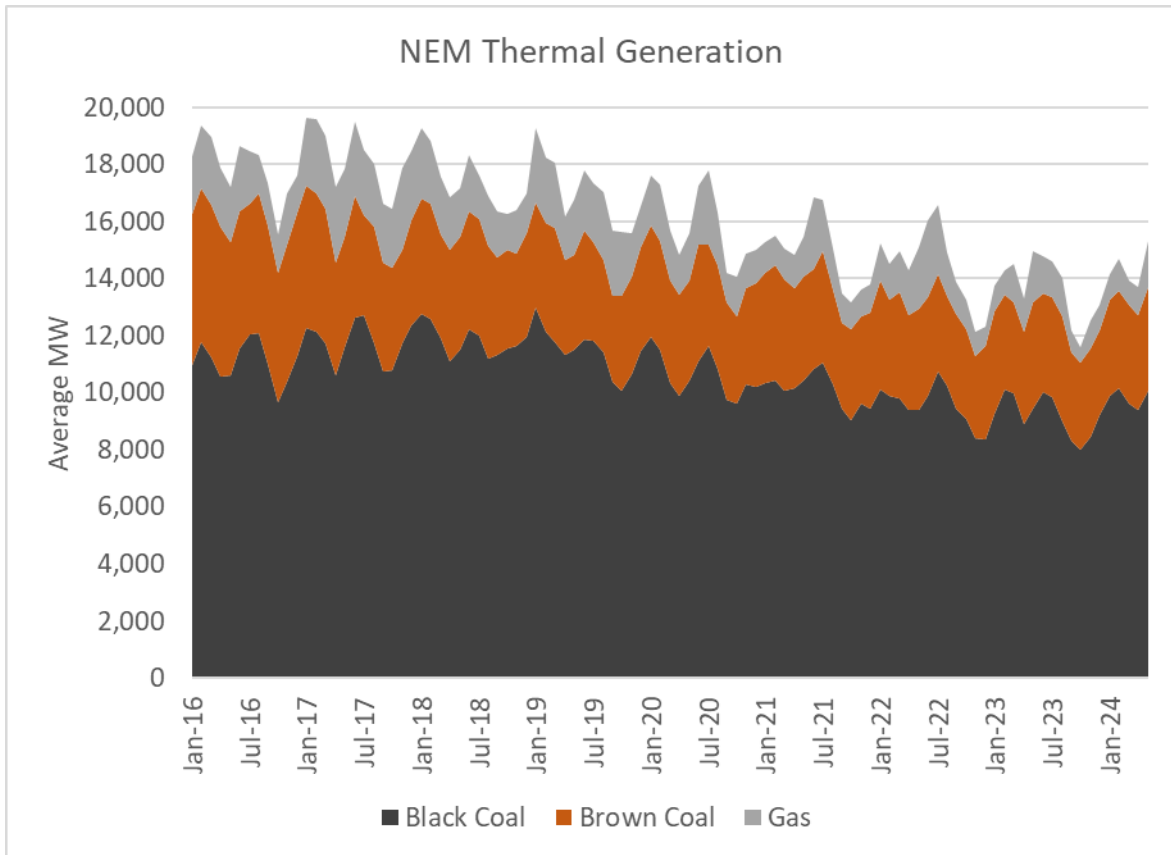


- Generators are naturally “long” (benefit from rising spot prices) whilst retailers are “short”.
- Derivative contracts are used to manage risk.
  - E.g. a generator can sell a swap contract to create a hedged position.
- Contracts can be traded bilaterally (OTC) or via the ASX futures exchange.
- Forward prices reflect expectations of future spot prices e.g. NSW Cal 25 contracts have risen sharply following recent volatility.
- Contract positions and risk management are key drivers of bidding strategies in the spot market.



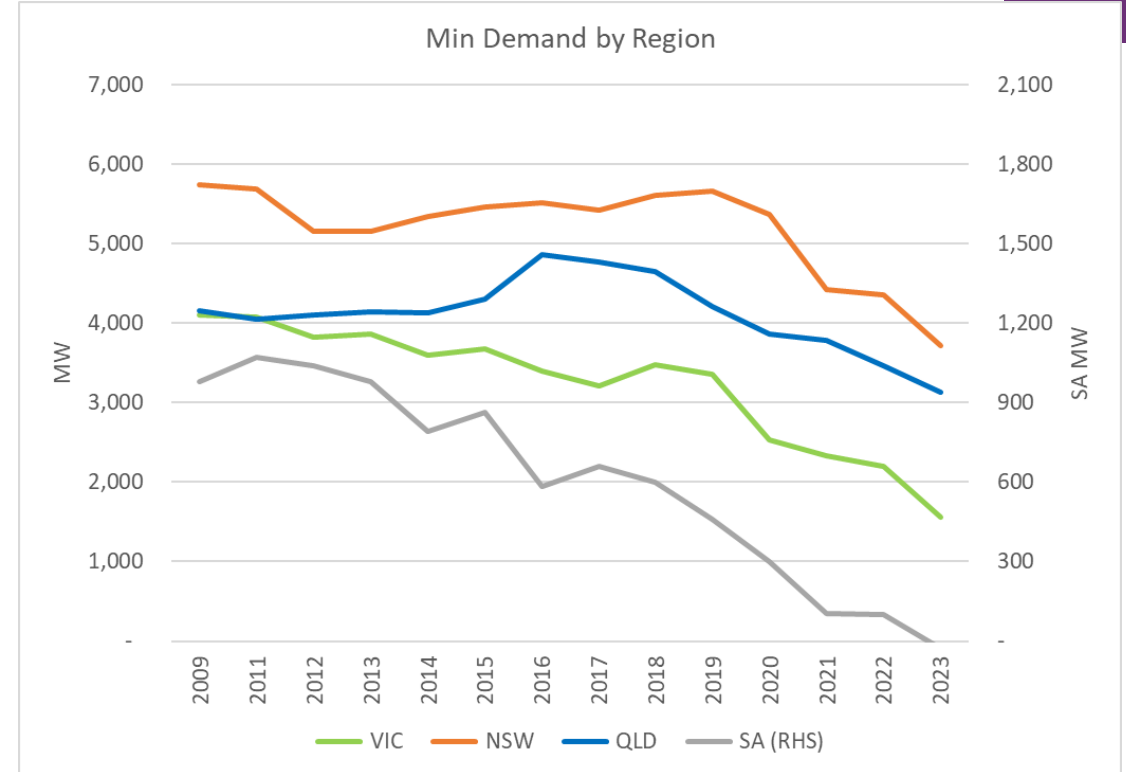
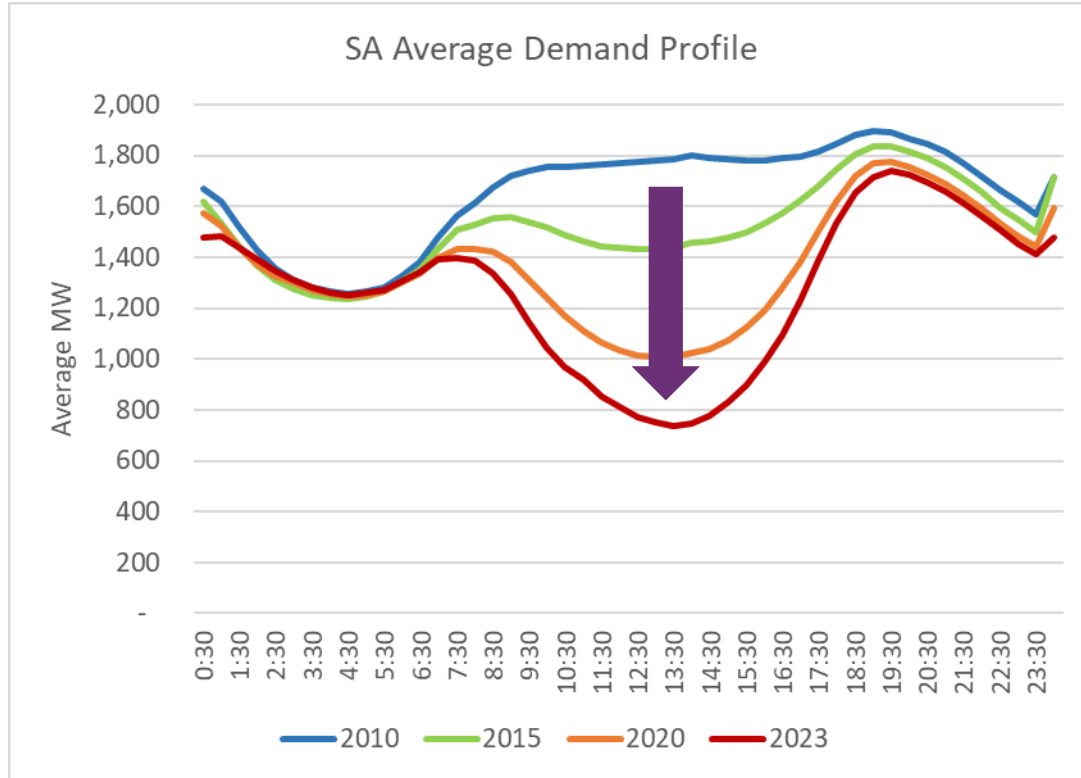
# Market Trends

# Renewables displacing thermal



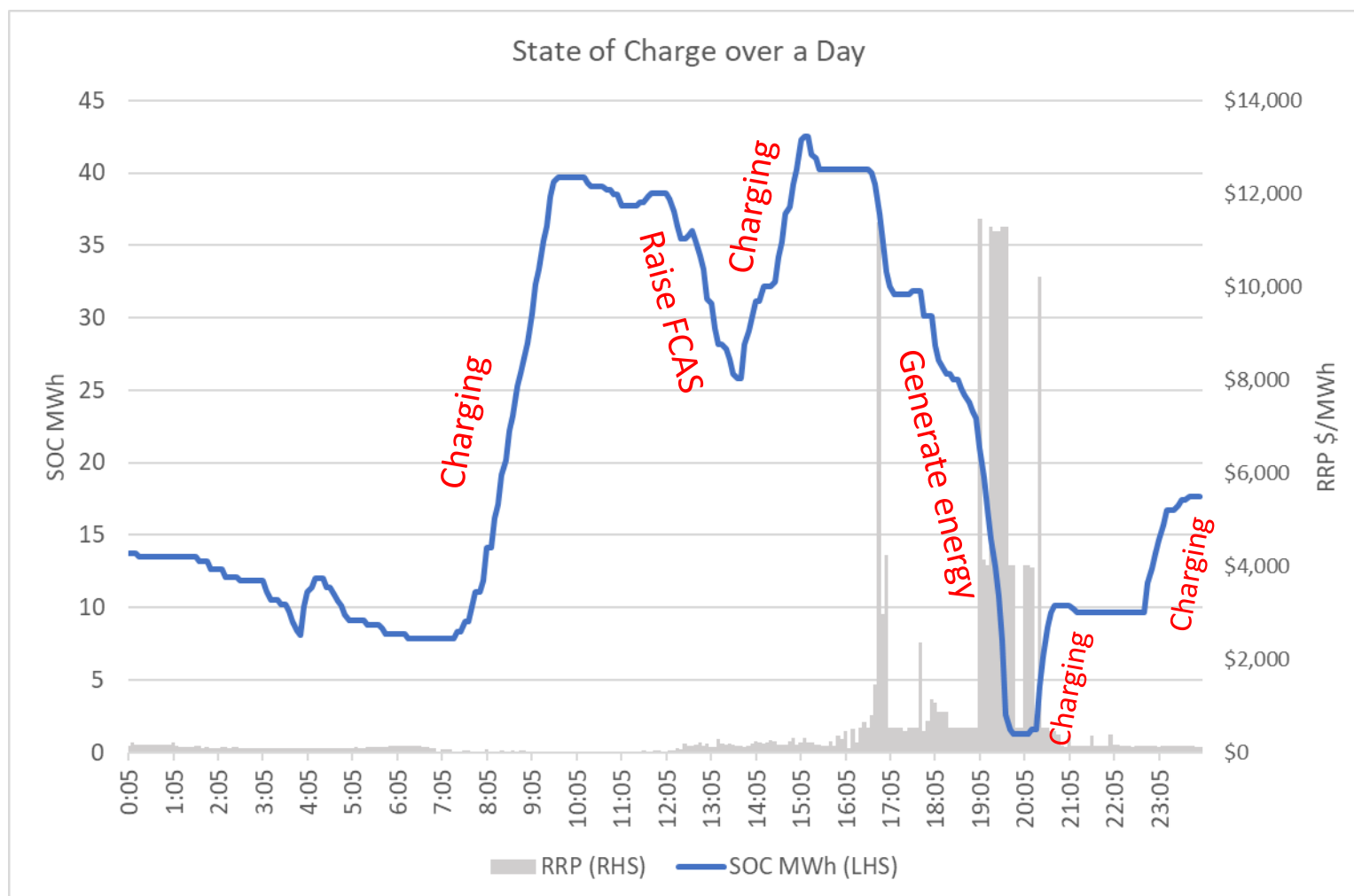
- The energy transition is proceeding at pace with coal generation declining from 75% in 2016 to 53% today.
- Renewables is growing strongly and has now reached 39% of generation output.

# Distributed PV driving down demand and price



- Distributed PV hollows out operational demand and creates a “duck curve” profile.
- This has resulted in the minimum demand shifting from overnight to midday.
- SA and Vic middle of the day prices are now negative on average.

# Role of batteries



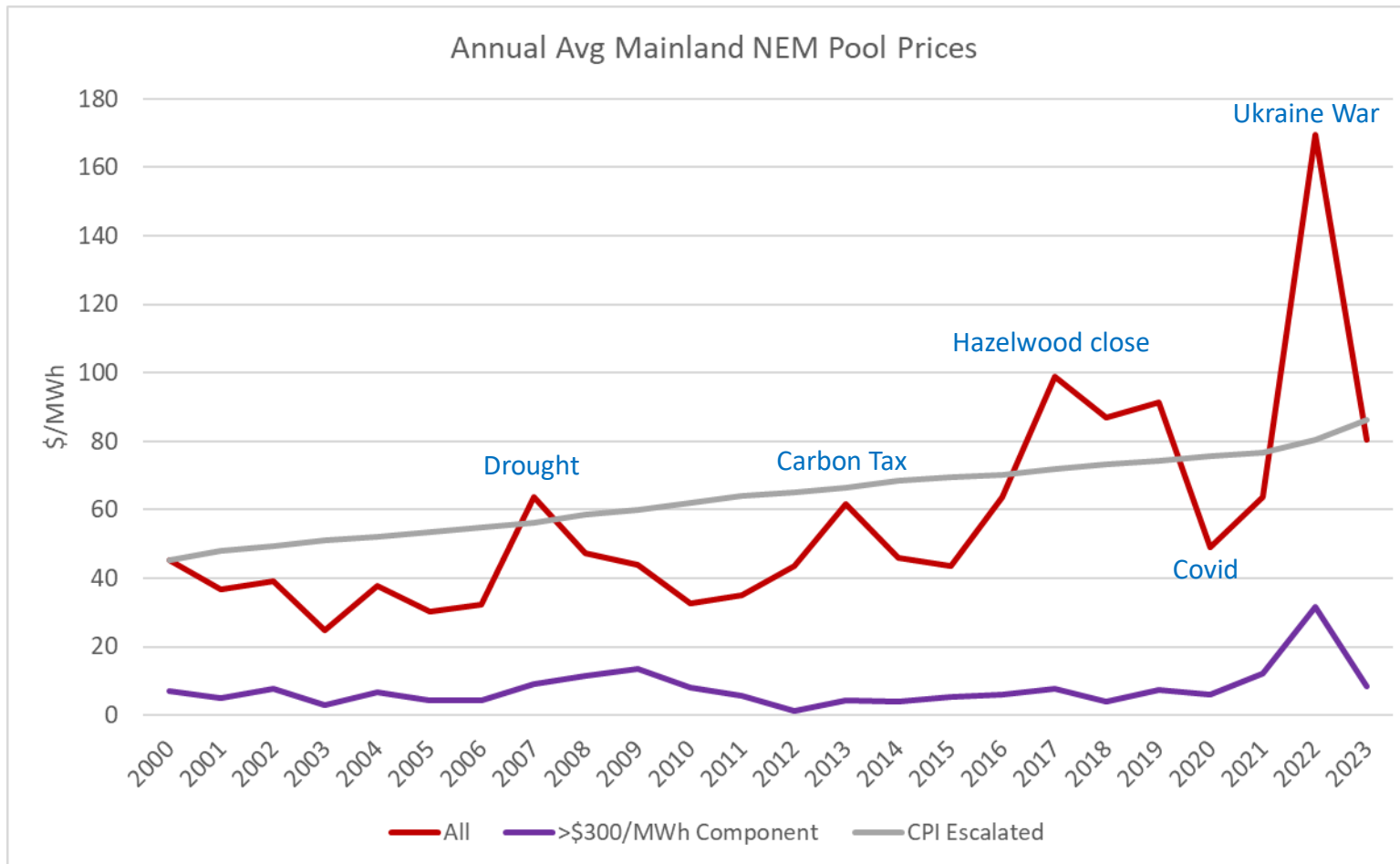
Batteries perform several roles in a power system:

- Stabilise frequency through FCAS provision by charging and discharging.
- Source of capacity to meet peak demands .
- Move energy from middle of day to evening peak.

Historically, FCAS provision has been just as important as energy provision.

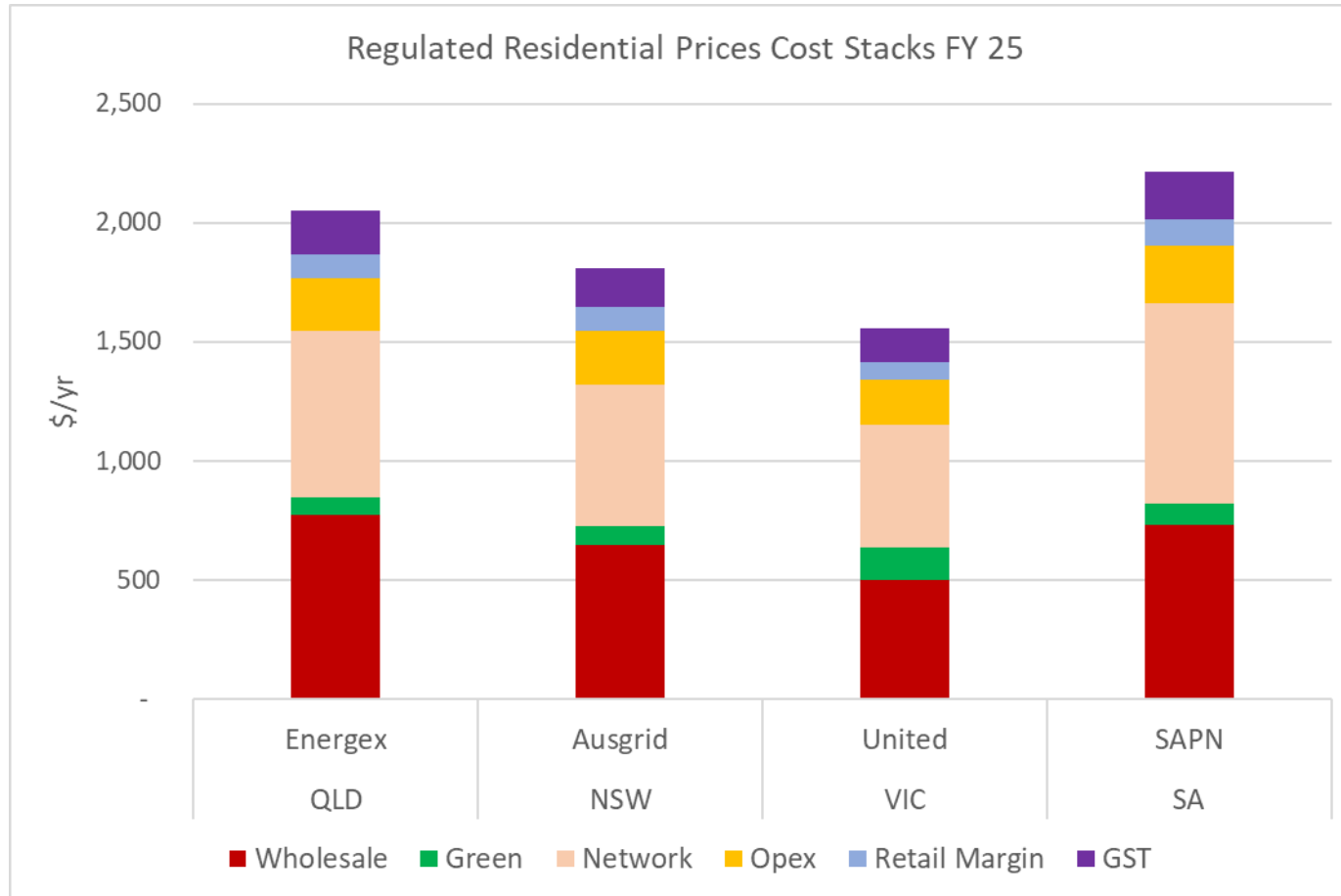
Batteries also participate in AEMO's System Integrity Protection Scheme (SIPS).

# NEM electricity prices



- NEM electricity prices are influenced by long term trends, fuel prices and specific shocks.
- Whilst price spikes attract much attention the contribution of >\$300/MWh prices remains small.
- 2022 was the most volatile year with an energy squeeze triggered by the Ukraine war creating consistently high prices.

# Wholesale & retail prices



## Large customers

- Pay a negotiated wholesale & green price to their retailer and network costs are typically passed through.

## Mass market customers

- Pay a bundled tariff that is related to the regulated tariff i.e. VDO or DMO.
- Wholesale prices comprise around 35-40% of the regulated tariff.
- This is set based on energy futures contracts traded on the ASX and a load shape premium.
- Wholesale price declines have flowed through to lower tariffs from 1 July.

# 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](https://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](https://AemoLearningAcademy.aemo.com.au)
- For more info contact: [EnergyEducation@aemo.com.au](mailto:EnergyEducation@aemo.com.au)

## NEM Overview

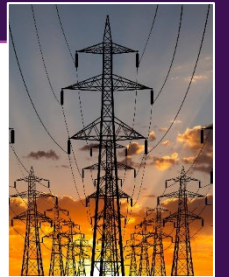
Details how the NEM operates as a physical power system and a wholesale market for electricity.



Held in-person in a single day, or online over two half-days – generally once or twice per month.

## 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.



Options for in-person or virtual attendance over two full-days or four half-days.

# energy.unimelb.edu.au

## Melbourne Energy Institute

Level 1, Melbourne Connect

700 Swanston Street, Carlton, VIC 3053



[mei-info@unimelb.edu.au](mailto:mei-info@unimelb.edu.au)



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