Some thoughts on capacity markets for electricity in Australia

Productivity Commission Seminar
Melbourne, 27 March 2018

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Outline

- Comment on the NEM and its outcomes so far
- Electricity market design theory (what is the problem?)
- Taxonomy of resource adequacy approaches (what are the possible solutions?)
- The rise of batteries and implications for electricity market design
- Comment on the National Energy Guarantee (NEG).

Comments on the NEM and its outcomes so far

Introductory comments on the NEM

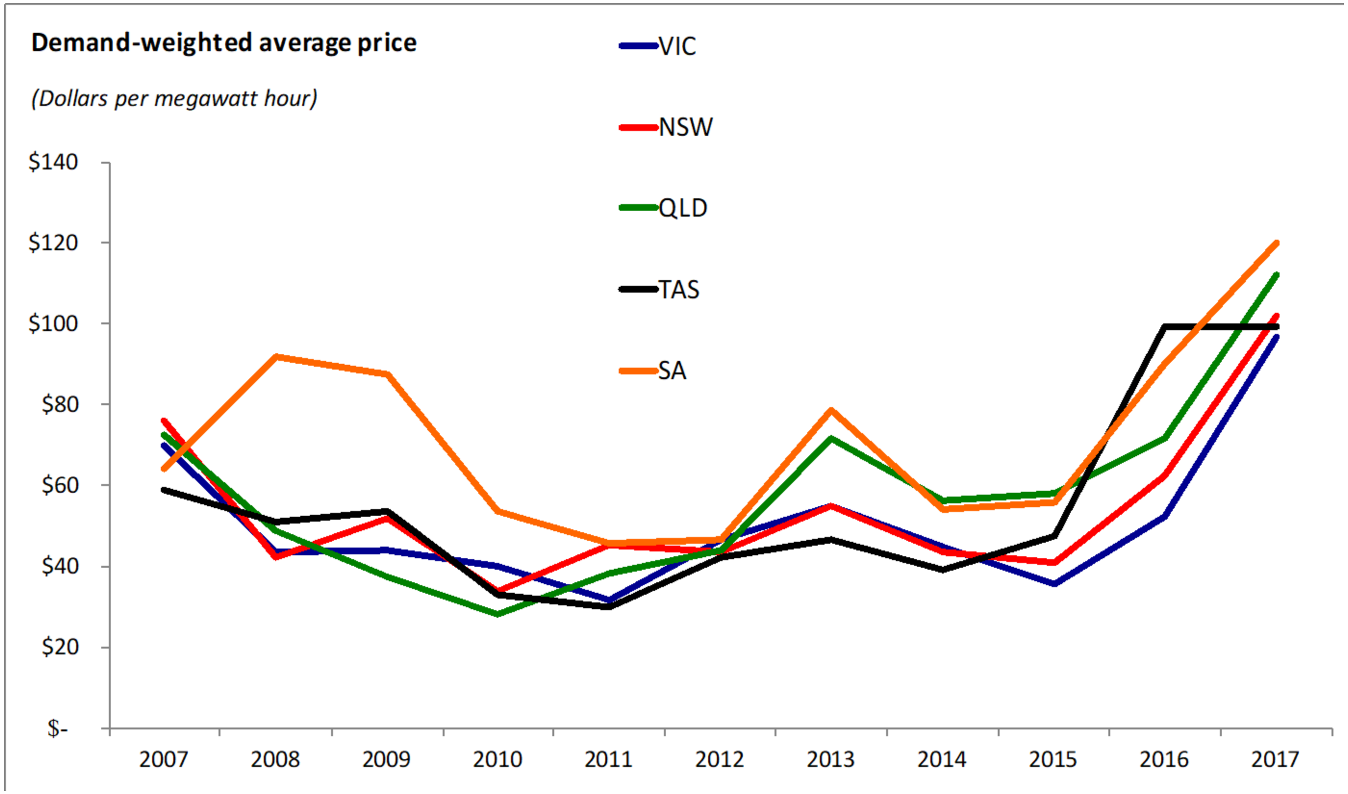
- Initial framework for industry re-restructuring introduced by Industry Commission in 1992. Creation of the NEM was the center-piece of the reform and a large part of the reason for it.
- NEM developed over seven years, and officially entered service in 1999.
- An unusual market in many ways:
  - A mandatory energy-only (“gross”) pool (reasonably common when it was introduced but now one of very few left – Ercot and NZEM other examples)
  - A regional market (not terribly unusual, but many others have adopted nodal prices)
  - Gate closure five minutes before real time and no day-ahead market (unusual)
  - Strategic capacity reserve (not unusual for energy-only market, but now rarely used)
- Developed when conditions were more benign than those today (substantial capacity surpluses, no emission reduction objective, no renewable energy objective, plentiful gas).

The NEM is ostensibly "energy-only" but there are many constraints and other sources of income, particularly for new entrants

- **Constraints**
  - Price floor and ceiling (higher than all other energy markets except New Zealand)
  - Cumulative price threshold
  - Moral/political suasion (e.g. Pelican Point SA in 2016, Queensland in 2017)
  - AEMO direction
  - Market suspension price

- **Additional sources of income**
  - RERT (Reliability and Emergency Reserve Trader) – apparently 1,100 MW contracted.
  - State government tenders (ACT, SA, VIC and probably also QLD and NSW soon)
  - ARENA, CFC
  - RET

Weighted average price outcomes have been ok(ish) but problematic lately (now 2–3x typical US and EU wholesale market prices)



AEMO data, author's analysis

With mine-mouth coal generation dominating production, inframarginal rent has been significant over the life of the NEM

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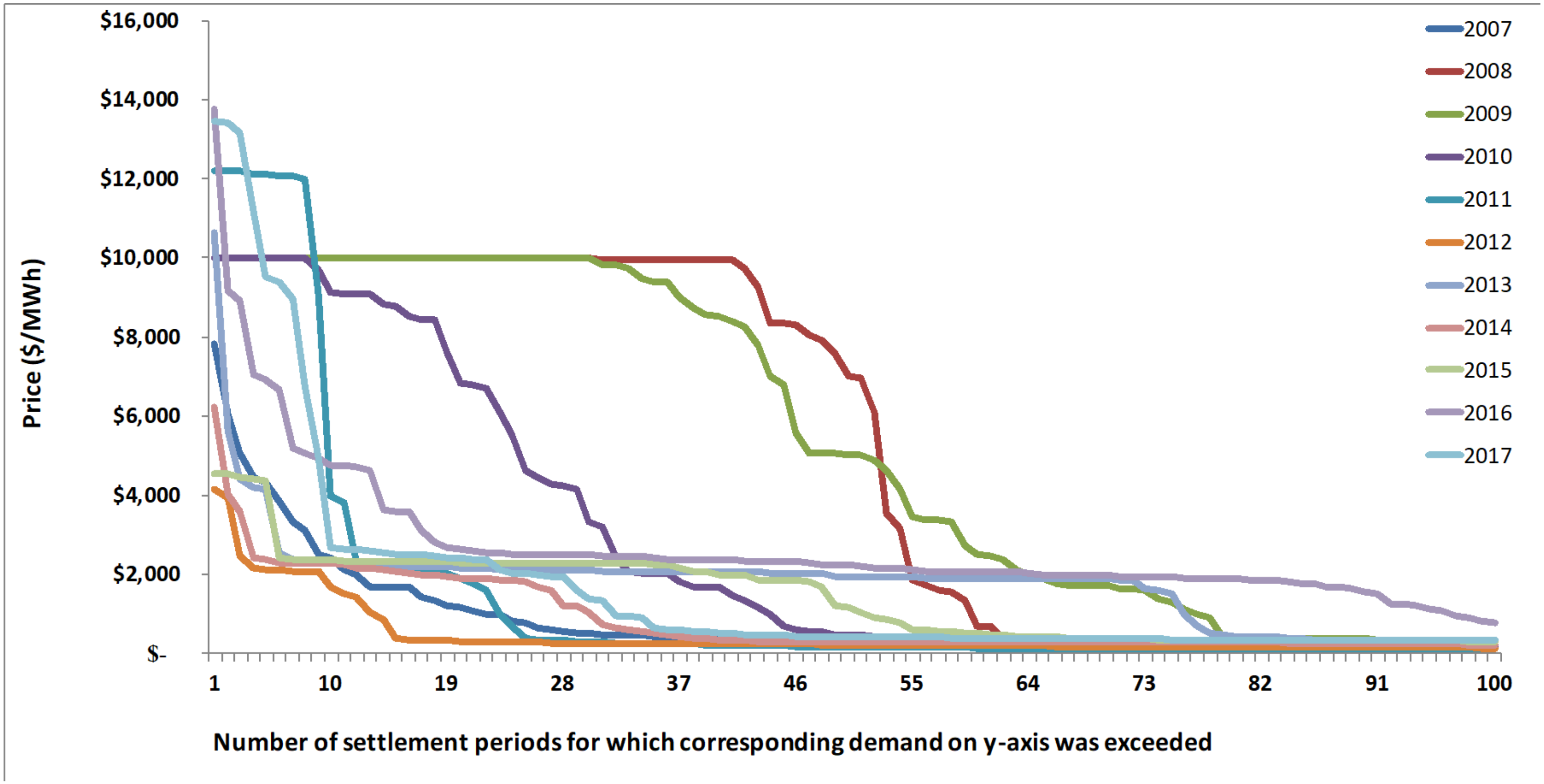
Scarcity rent has been significant in some markets



AEMO data, author's analysis

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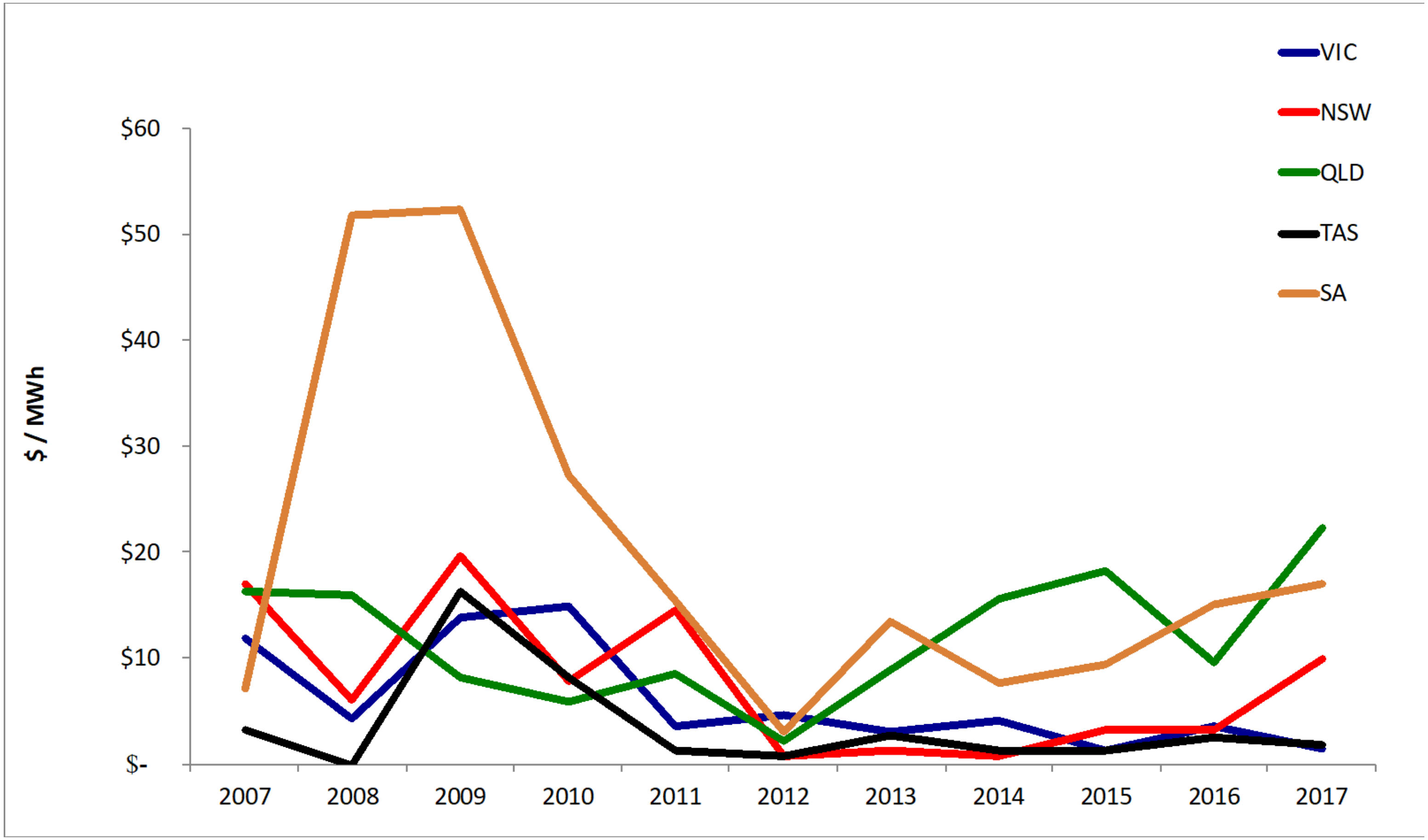
Impact of scarcity rent has been significant (though scarcity often seems contrived – exercise of market power has been an enduring issue)



AEMO data, author's analysis

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Electricity market design theory (what is the problem?)

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A theory of electricity markets

Price = (1 – LOLP).SRMC + LOLP.VoLL
= SRMC + LOLP.(VoLL – SRMC)
= payment for energy + payment for availability

Where SRMC = short run marginal costs
LOLP = loss of load probability, and
VoLL = Value of Lost load

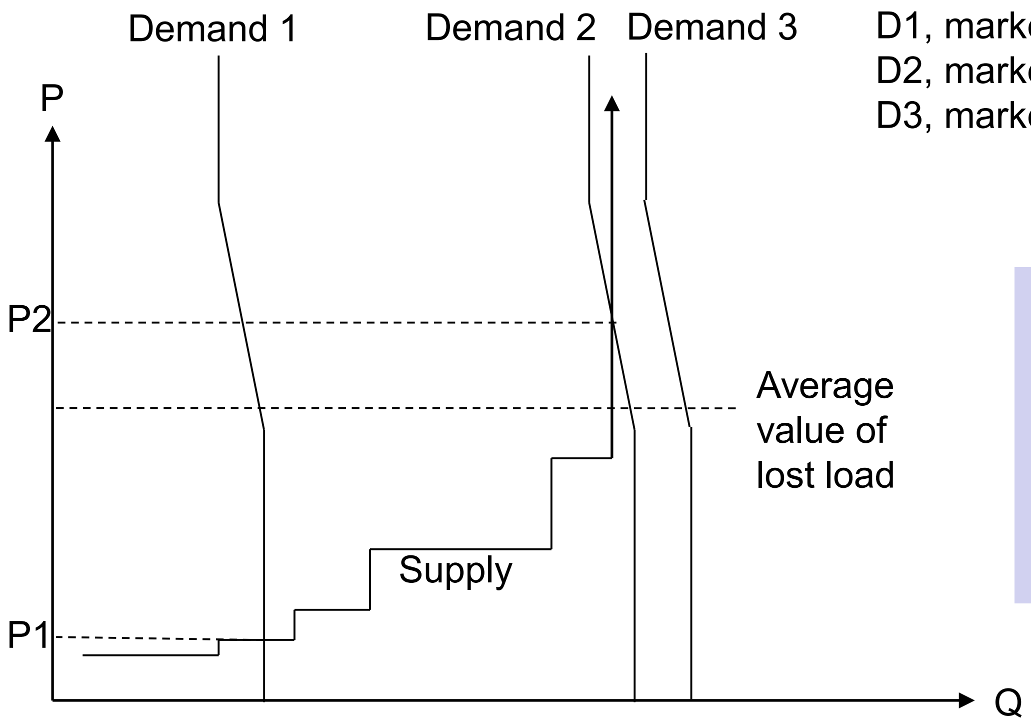
But energy markets bring various challenges, some common to other markets;

1. Incomplete markets (forward contracting is hard)
2. Missing markets (for example for rapid response, and elastic demand)
3. Externalities (security of supply).

The underlying problem is price elasticity of demand:

1. Very small amount of end-use demand sees the wholesale market price;
2. Most customers' demand is highly inelastic (although some is much more elastic than others')
3. Marginal and average price elasticity is highly uncertain.

Inelastic demand is the main challenge



D1, market clears at P1, no issues.
D2, market sets wrong price (P2) exceeding VoLL
D3, market does not clear and can't establish a price

"But P2 is not related to the average VoLL among inelastic customers. The fact that just one unusual customer who is watching the price and has an extremely high value for giving up his last MW of power should not be relevant to determining the value of reliability for the majority of customers."

And, how do you incentivise supply when all producers don't get paid if demand exceeds supply?

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Taxonomy of resource adequacy approaches (what are the possible solutions?)

A taxonomy of possible approaches to resource adequacy

Vertical integration and regulation

Examples

- Wherever wholesale markets don't exist

"Energy-only" market

- Unlimited spot price
- Capped spot price, strategic reserves
- Capped spot price, regulated capacity payment

Examples

Unlimited spot price:
- New Zealand (sort-of)

Capped spot price, strategic reserves:
- NEM (Australia)
- Sweden

Capped spot price, regulated capacity payment:
- Ireland
- Portugal
- Spain
- Italy
- Belgium
- Austria
- Original E&W pool
- Ercot (Texas) since 2015)

Capacity market

- Centralised market
- Capacity obligation

Examples

Centralised market:
- New York ISO
- Mid-West ISO
- Pennsylvania-New Jersey-Maryland ISO
- Great Britain
- Colombia
- Chile
- Alberta (under development)
- Germany (under development)
- WEM (Australia)
- Ontario (proposed)
- California

Capacity obligation:
- France

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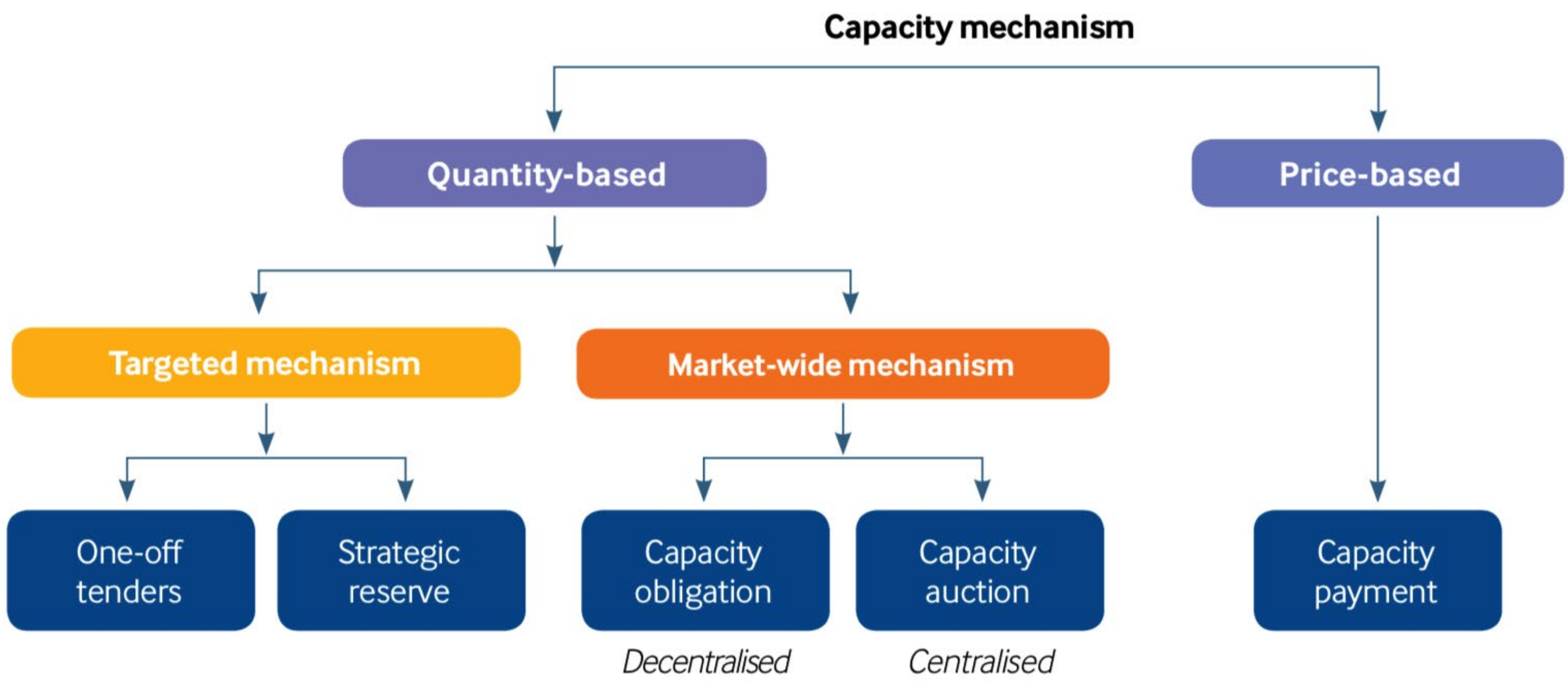
Another useful way of defining the taxonomy



Source: RTE, 2014

The rise of batteries and implications for electricity market design

Batteries radically improve power system flexibility

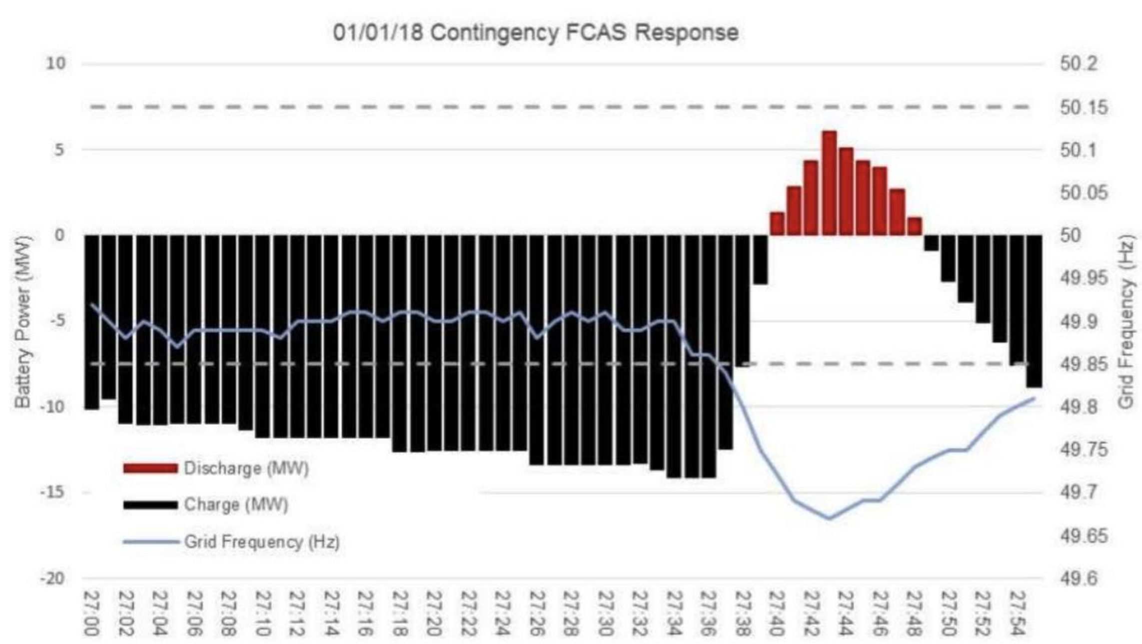


Figure 1: Hornsdale Power Reserve - response to contingency FCAS event

A 100 MW battery that is charging can deliver a 200 MW change in the balance between demand and supply, almost instantaneously.

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The rise of batteries in Australia

- SA Hornsdale Power Reserve (100 MW, 129 MWh) commissioned December 2017 (currently world's biggest battery but 100 MW/400 MWh battery now in development in Longbeach, California)
- SA Wattlepoint (30 MW, 8 MWh) under construction operational 2018
- VIC Bulgana (30 MW, 30 MWh) under construction operational 2018
- VIC Gannawarra (25 MW, 50 MWh) under construction operational 2018
- SA SIMEC-ZEN (120 MW, 140 MWh) currently being considered
- 20,000 distributed grid connected batteries installed in Australia in 2017 (up from 6,000 in 2016).
- Incoming government in SA promises $100m capital support for -40,000 household batteries in SA.

Implications of batteries: for electricity market design

- Batteries are far more flexible than fossil or hydro capacity
- Significant battery uptake is likely on both the supply and demand side of the market
- Concern about the exercise of market power associated with very high market price caps should diminish if there is a significant amount of super-flexible and price-responsive demand and supply
- Therefore a market with lots of batteries should be able to sustain a much higher market price limit than one without (without being worried about the exercise of market power)
- A higher market price limit reduces the prospect of “missing money” associated with capping prices in energy-only markets
- And so, technology change offers (a necessary, but not sufficient) condition for fulfilling the original energy-only intention, perhaps.

Comment on the National Energy Guarantee (NEG)

NEG has two limbs

- **Emission intensity obligation:** an obligation on retailers to reduce the emission intensity (CO_2-e per MWh) of the electricity that they supply below a to-be-defined threshold
- **Security obligation:** an obligation on retailers to procure capacity

Implementing the emission intensity obligation and not allowing a financial instrument related to emissions will require a change to a net market

- NEM is mandatory pool: generators required to sell into pool; i.e. forbidden from contracting directly with retailers or customers. Generators and retailers can negotiate price hedges (swaps) around the pool price, but no way to objectively allocate production to consumption: it's a pool!
- A physical supply obligation (emission intensity) on retailers in a market that does not allow physical supply contracts is impossible. NEM will either have to change from mandatory ("gross") pool to voluntary ("net") pool/balancing market, with most electricity to be transacted through physical contracts. Or, it will be necessary to create another financial instrument (lets call it a low carbon certificate) which retailers will have an obligation to acquire to meet emission intensity target.
- If policy makers have no appetite for low carbon certificate (yes this is the Finkel recommendation), then bi-lateral physical contracts will be required to resolve issues of adverse selection and moral hazard:
  - **Adverse selection:** generators that contract with retailers could substitute low emission generation with other generation of higher emission intensity unless the substitute generation is also measured and accounted for.
  - **Moral hazard**: retailers/large customers will seek to shift emission costs onto others unless the emission intensity of the generation that they contract is taken into their account (and, similarly, excluded in the calculation of the emission intensity factor that applies to other retailers/ customers).
- Not aware of this approach ever being used anywhere.

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Reliability guarantee is not clear

- First NEG document described obligation on retailers to contract for “slow start” and “fast start” “dispatchible” capacity.
- In latest NEG document, slow and fast is gone and instead describes obligation on retailers to buy capacity if the authorities expect supply to fall short of demand in some indeterminate future period.
- Latest iteration somewhat akin to French “capacity obligation” – generators/demand response create capacity credits and retailers have to buy them (akin to the RET for capacity instead of renewable energy).
- French approach took seven years from law to implementation:
  - Parliament passed law 2010
  - Decree established institutional arrangements 2012
  - Rules decided 2015
  - Scheme starts late 2017.