Can batteries solve South Australia's power problems ?

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Outline

- Batteries – recent headlines to set the scene
- Diagnosis - What is SA's power "problem" ?
- Possible solutions
- Economics of distributed (behind the meter) battery
- Economics of large scale (in front of the meter) battery

Recent press headlines – international

- Over 50,000 solar storage systems are now installed in Germany: German solar association expects their number will double to 100,000 in 2018.
- Tesla patent application outlines design to scale battery systems to 1000 MW per hour
- Macquarie Capital has closed first non-recourse project financing of 50 MW battery based energy storage.
- Telsa “Giga factory” will be world’s largest building
- SDG&E, AES bring world's largest lithium ion battery storage online in California: 30 MW, 120 MWh. SDG&E says the AES batteries will enhance regional energy reliability while maximizing renewable energy use in the region. The 400,000 batteries are similar to those found in electric vehicles and are housed in 24 containers.
- There are more than 10 GW of projects in the U.S.'s energy storage pipeline, according to GTM Research.

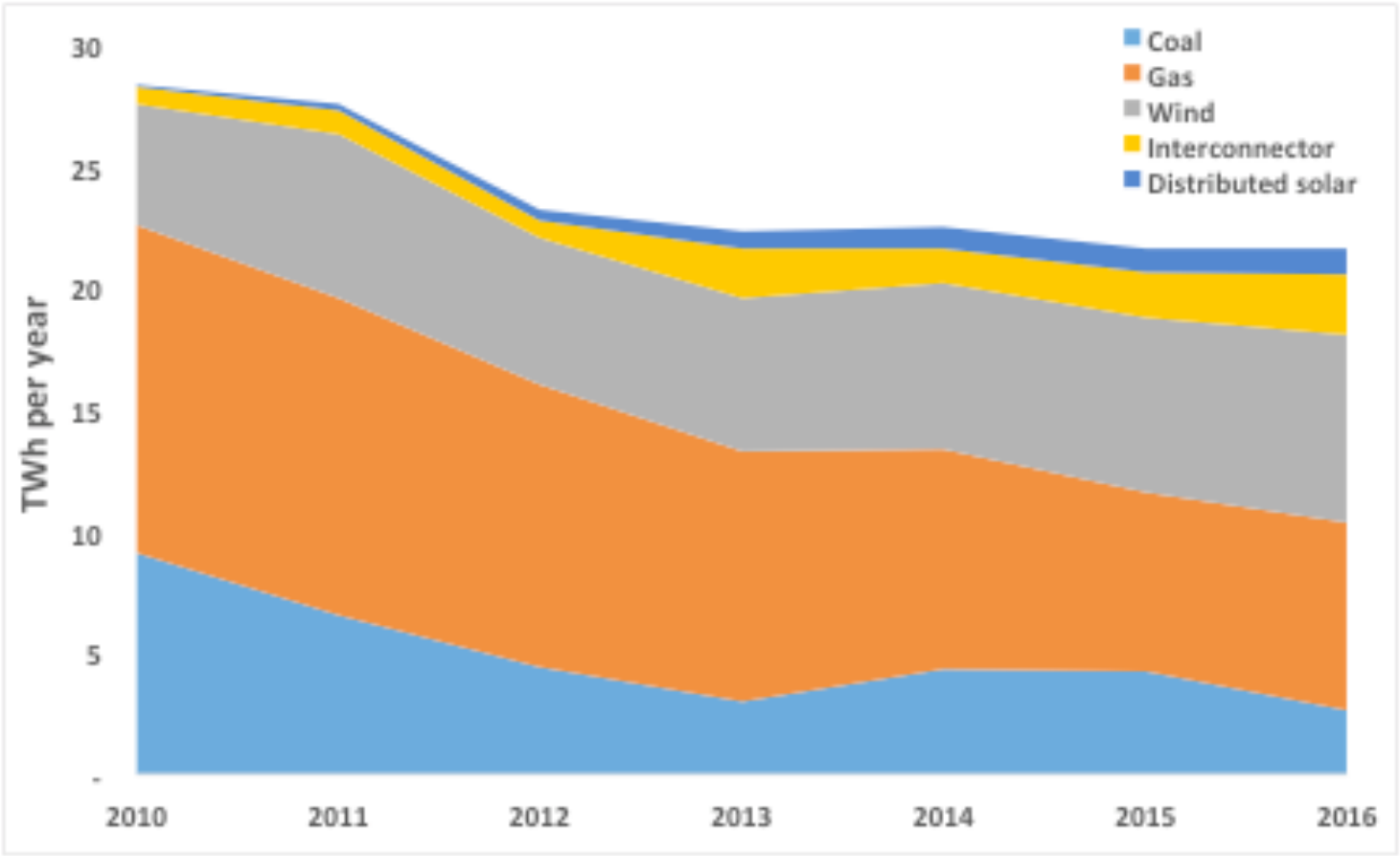
Recent press headlines - National

- Battery storage could solve SA "power crisis" in 100 days, says Tesla
- Gas shortfall presents huge opportunities for "cheaper" battery storage
- CEFC plans to repeat solar success in battery storage: Broadbent says backing large-scale energy storage a key focus for CEFC in 2017 in a high renewable grid.
- US battery maker sees "tremendous opportunity" with Australian utilities: SimpliPhi Power CEO in talks on battery storage with Australia's "progressive" utilities and transmission companies.
- Lyon Group plans to build the world's biggest solar+storage project in South Australia
- A 14 MWh battery previously only used for backup power was reconfigured to sell into PJM markets.
- AGL has brought online what it says is the world's largest residential virtual power plant: AGL has so far installed batteries in over 60 homes in suburban Adelaide, South Australia, in a project that is expected to have 1,000 grid-connected batteries with a total peak capacity of 5 MW and 7 MWh when completed in about 18 months.

SA's power "problems" and challenges

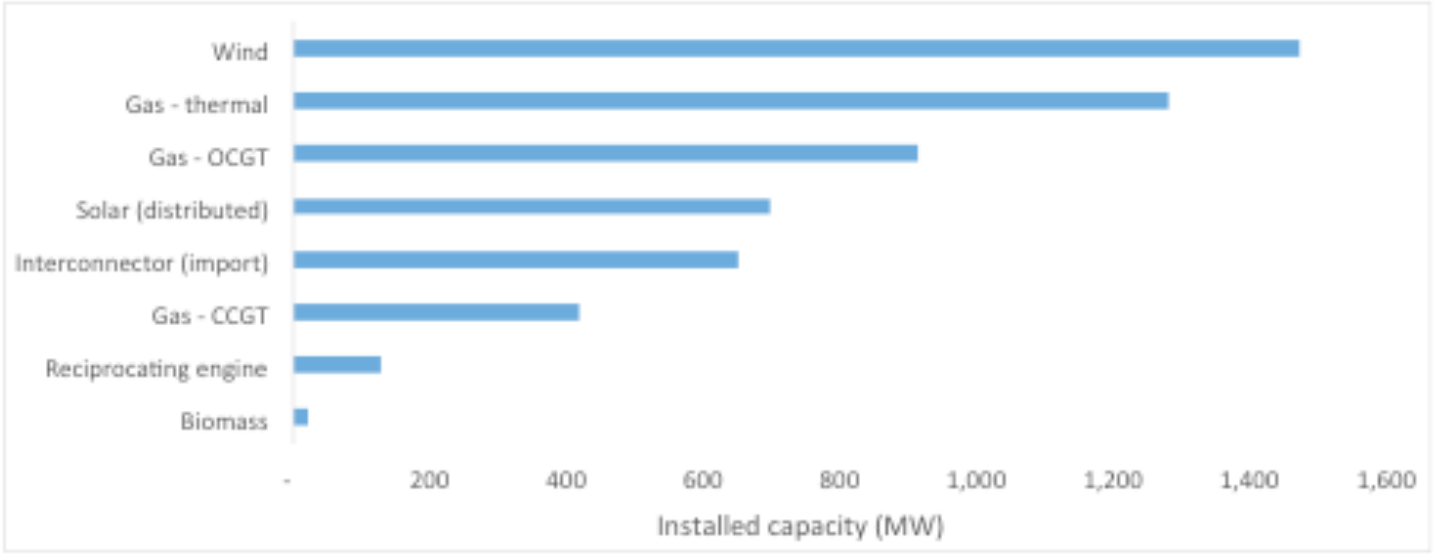
- V. high retail and wholesale market concentration
- Predominant marginal fuel source (gas) has become scarce and consequently expensive
- Transmission and distribution network become very expensive (and evidently not resilient to increasingly extreme weather)
- Rapid decline in dispatchable fossil capacity replaced by intermittent renewable capacity
- Increasingly reliant on imports but electrically quite remote from the main interconnected production and demand hub in VIC and NSW.
- And consequently ....
  - Very high retail prices (I estimate to be comparable to Denmark – the highest in the world)
  - Legitimate concerns about the security of supply

Figure 1. Electricity production in South Australia, by source



Source: Data from Australian Energy Market Operator, authors' analysis

Figure 2. Generation capacity in South Australia, by source



Source: Data from Australian Energy Market Operator and Renewable Energy Regulator, authors' analysis

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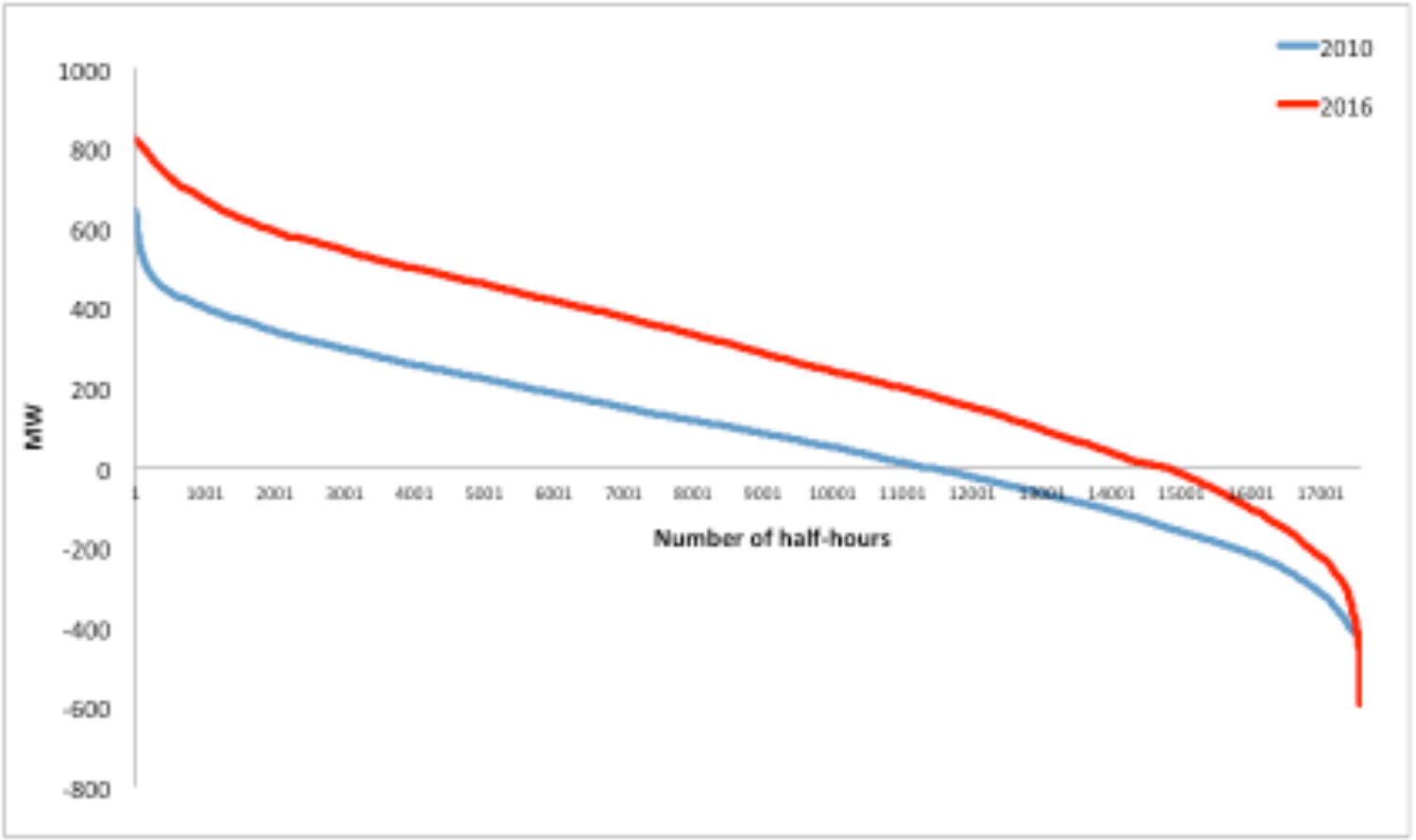
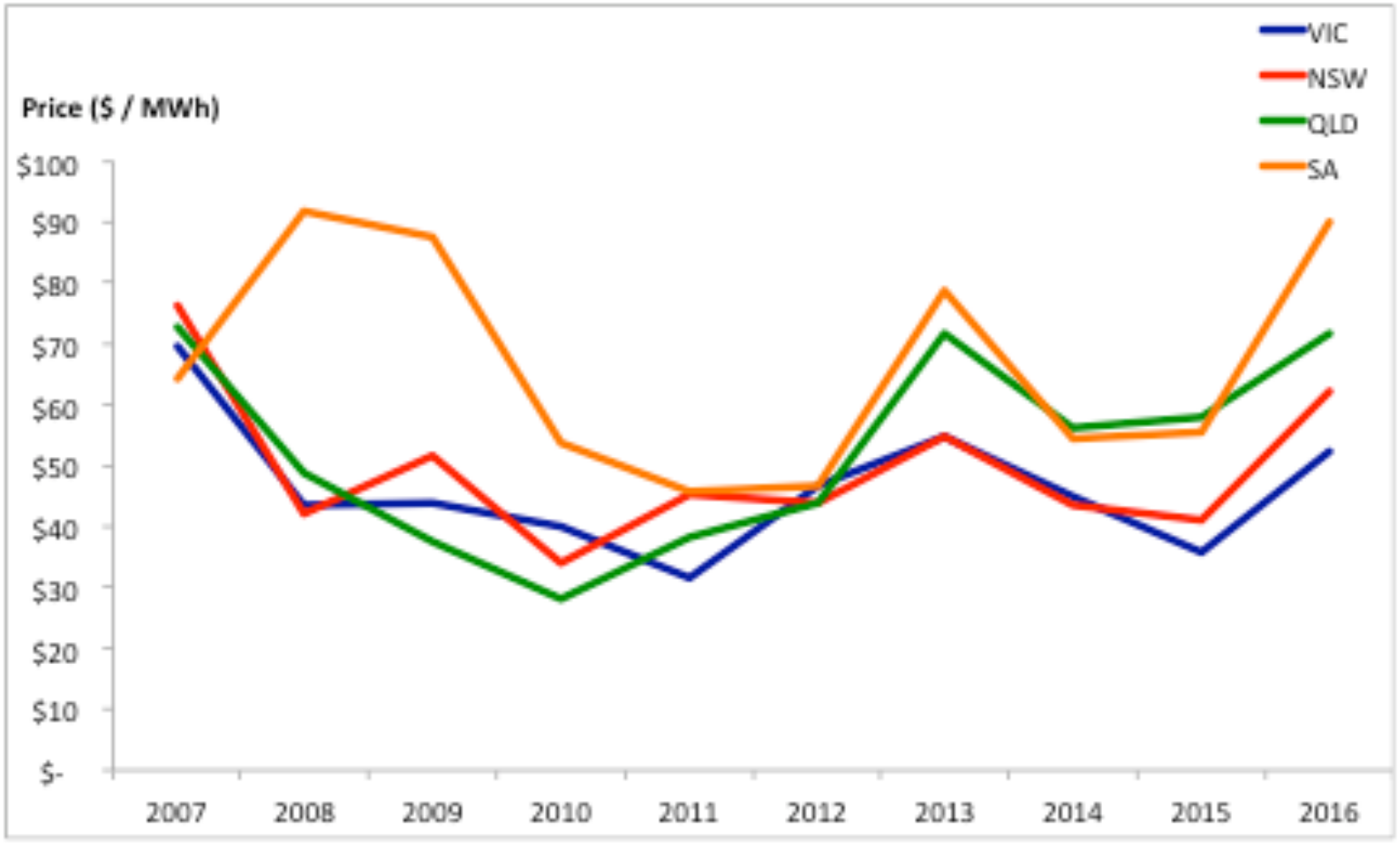
Figure 3. Interconnector load duration curve



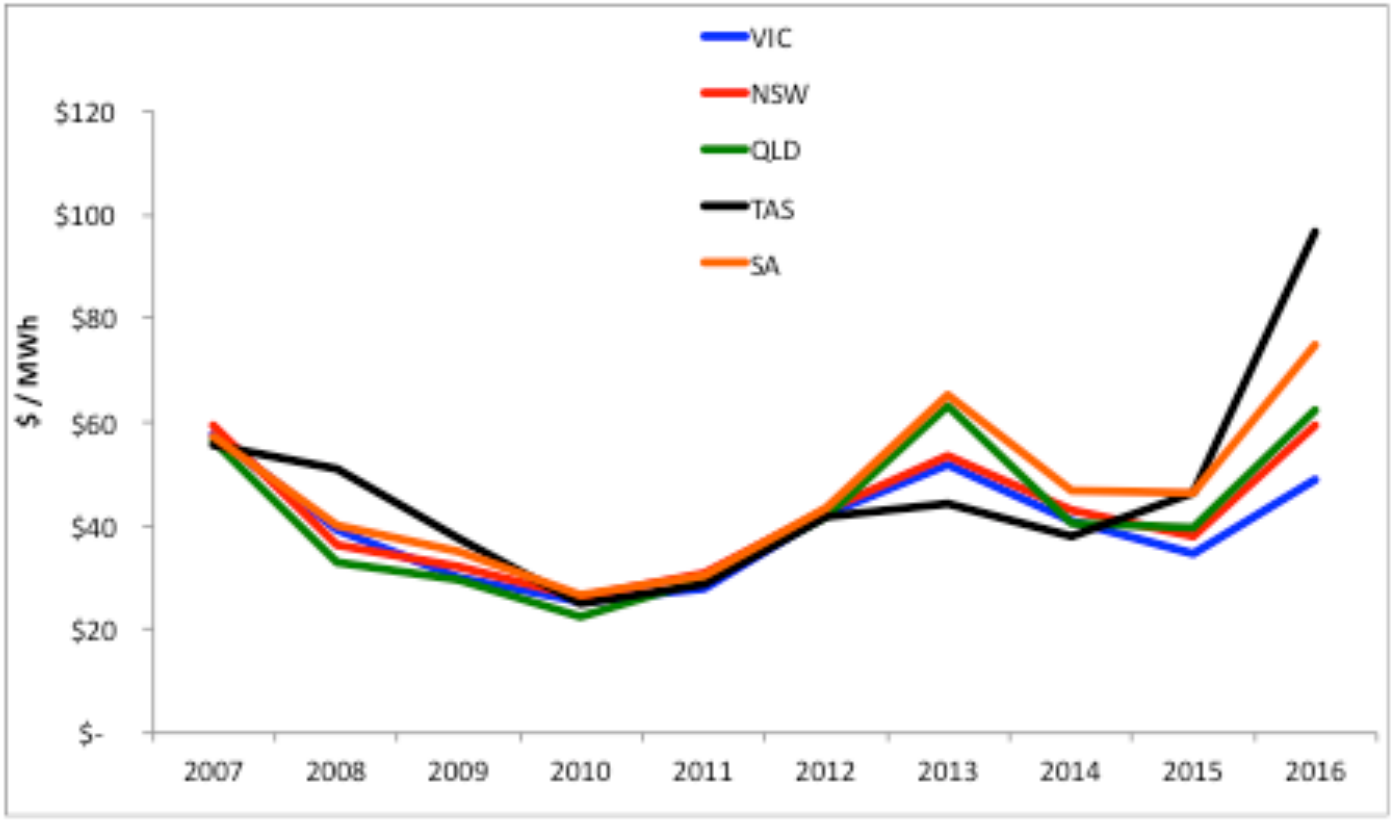
Source: Data from Australian Energy Market Operator, authors' analysis

Figure 4. Demand-weighted average spot prices in the National Electricity Market



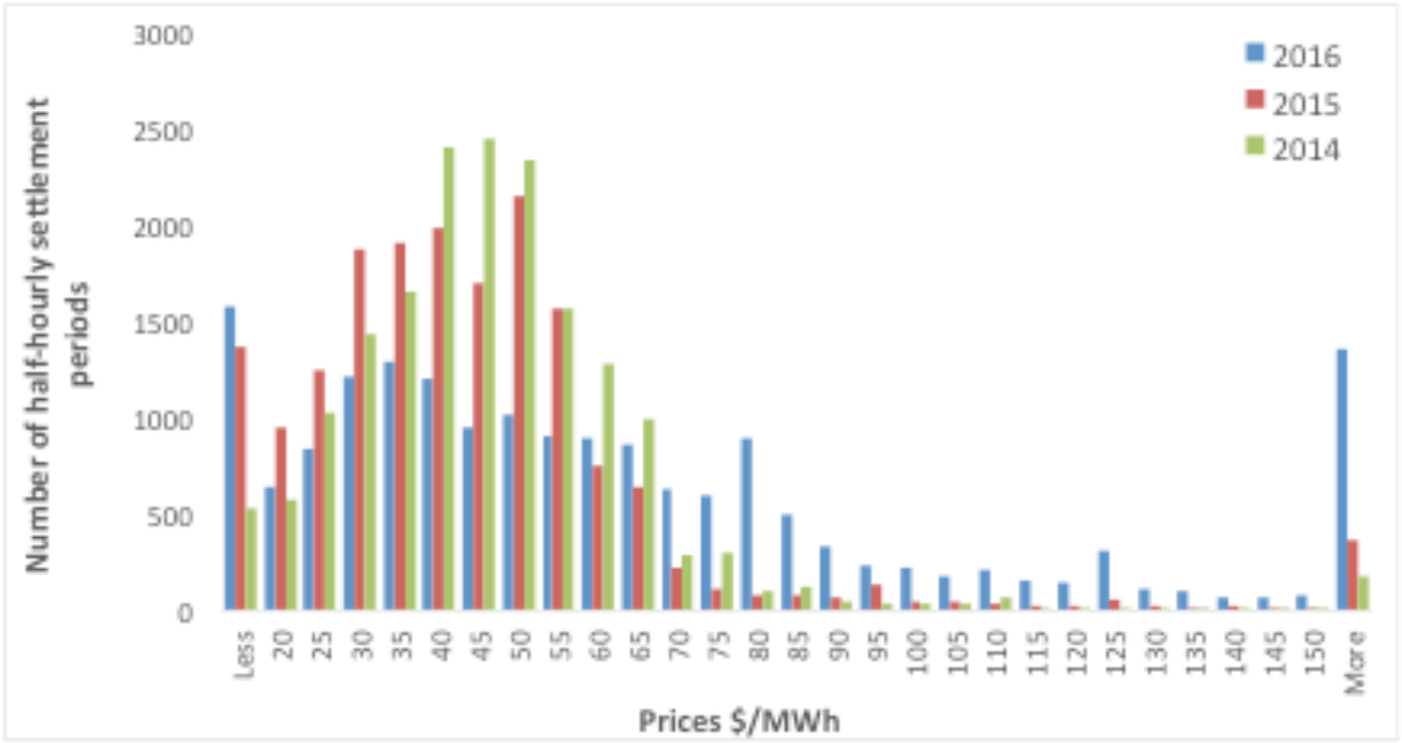
Source: Data from Australian Energy Market Operator, authors' analysis

Figure 5. Demand-weighted average spot prices excluding the highest priced 72 settlement periods



Source: Data from Australian Energy Market Operator, authors' analysis

Figure 6. Histogram of half-hourly settlement periods in the wholesale market in South Australia



Source: Data from Australian Energy Market Operator, authors' analysis

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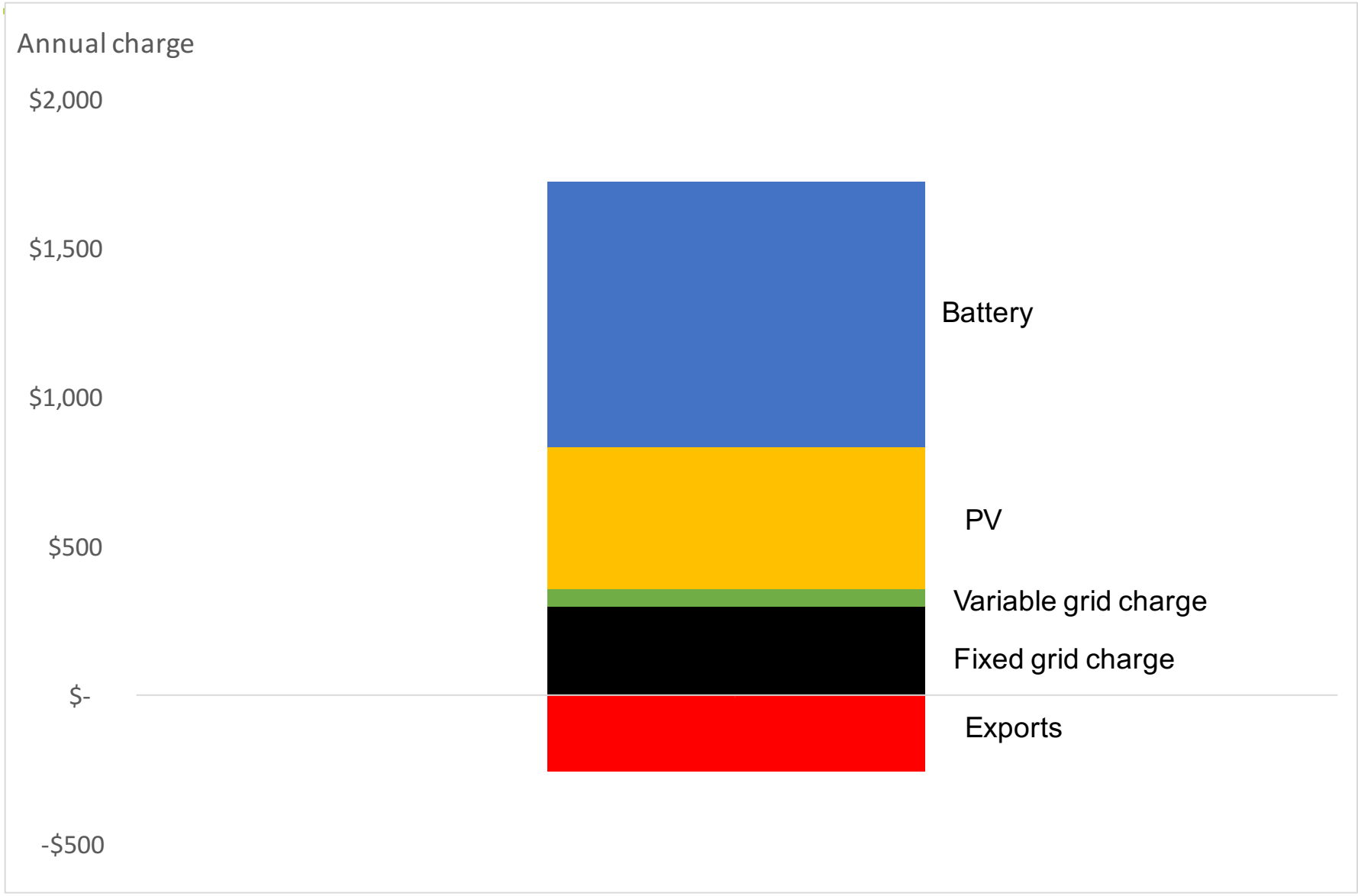
Solutions ?

- **Run a tighter ship:**
  - Improve governance, accountability and market oversight;
  - Strengthen wholesale and retail competition (or if not possible, make other changes to ensure industry puts customers first);
  - Make demand more price elastic in the short term.
- **Throw (someone else's) money at it:**
  - Pumped hydro
  - More interconnection
  - Gas peaking capacity
  - Batteries

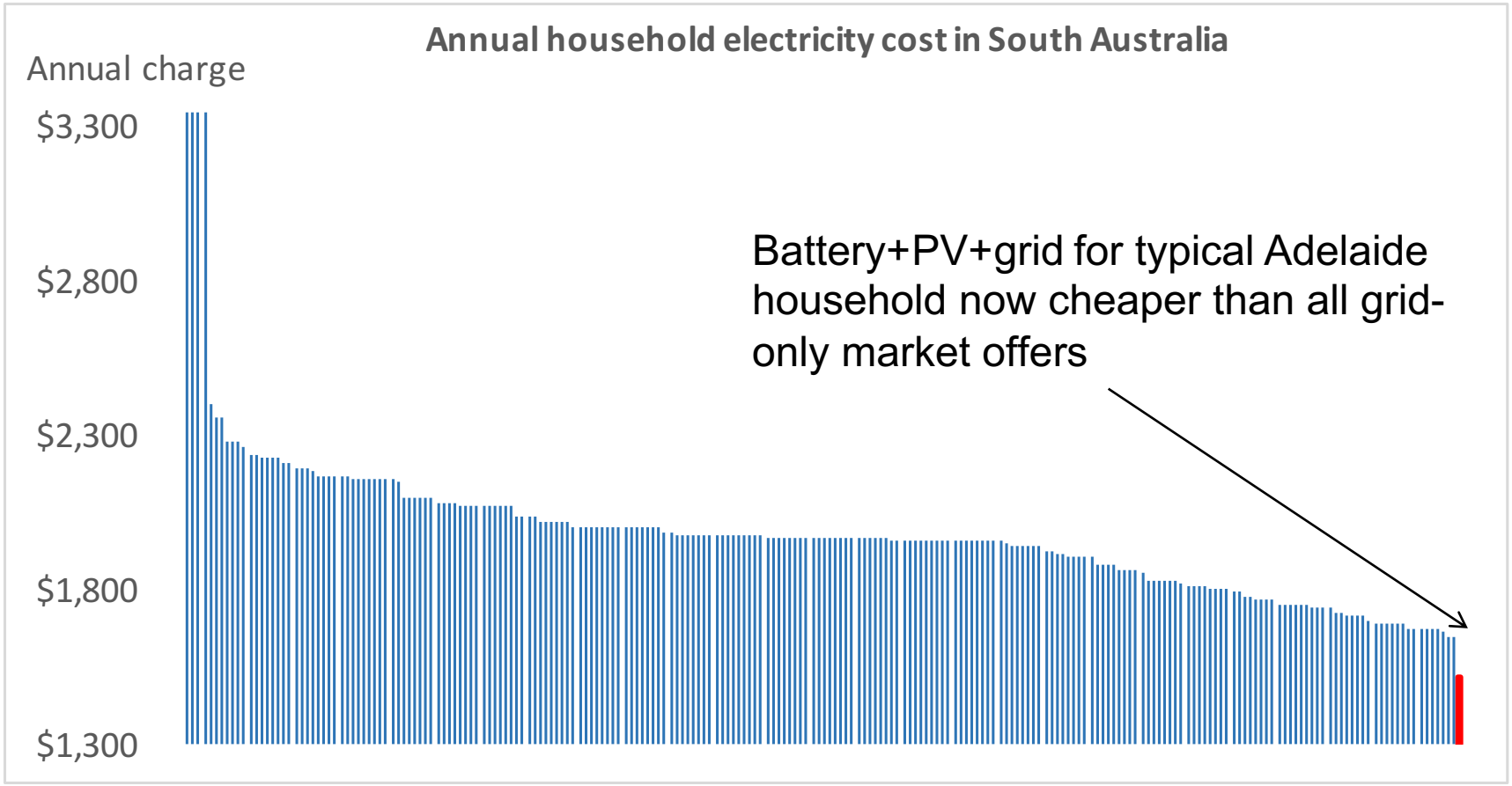
Behind the meter battery economics straight-forward but calculation can be complex

- Capital outlay to achieve operating cost reduction
- Operating cost reduction achieved through arbitrage:
  - Peak v off-peak grid (some value)
  - Distributed generation (solar) v grid (big value)
- Perhaps some value from network payments to sell back to grid to relieve network congestion (always lots of talk about this … but talk is cheap).

Battery+PV+grid annual bill for 4,800 kWh per year household in Adeliade



Battery+PV+grid v grid-only in Adelaide



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Turning to large scale (in front of the meter) batteries …

- Large scale batteries provide temporal arbitrage but also flexibility (rapid increases in consumption or production that is valuable in keeping power systems stable.

- Large scale batteries also provide services valuable to transmission and distribution:

  - Reduce/eliminate congestion
  - Improve reliability
  - Resolve local voltage issues

Battery substitutes and complements

- Substitutes:
  - transmission line/transformer,
  - peaking generator
  - pumped hydro
  - Price-responsive demand (short term)

- Complements:
  - battery + generator (particularly renewable one),
  - battery + transmission line/transformer
  - Battery + price responsive demand

- Substitutability and complementarity between battery, pumped hydro, gas, price responsive demand can be resolved by market participants.

- But substitutability and complementarity between battery raises important public policy questions: should regulated transmission providers be restricted from owning or operating batteries?

But though battery and transmission can be close substitute, the actual picture is complex

Battery	Transmission
Temporal arbitrage	Locational arbitrage
Scalable	Lumpy
Small economy of scale	v. large economies of scale
Easily relocatable	fixed
Short lead time	v. long lead time
Minor planning/environmental issues	Huge planning/environmental issues
Limited supply	In principle no supply limitation

Even leaving aside difficulty in comparing costs, technical differences mean comparison is complex

Should regulated network providers be excluded from battery market

- Separation of transmission from generation/demand deemed essential for operation of competitive wholesale and retail markets. Though possible loss of economies of co-ordination, policy to adopt market suggests offsetting gains from competition will be greater.

- Q: So why should we think differently about batteries?
- A: possibly because they are even better substitute/complement for transmission than generation/load. So loss of economies of co-ordination may be even larger.

- Q: Will a transmission company prevented from owning or operating batteries seek to crowd out batteries ?
- A: Yes
- Q: Can regulation stop this?
- A: track-record of regulation in Australia not convincing.

- Q: Do we need to consider separation of transmission planning and transmission asset ownership to protect against the pursuit of vested interests?
- A: Yes!

So, to the question: can batteries fix SA's power problems ?

1. Know one knows. The technology is developing and costs declining rapidly. There are global developers with deep pockets itching to give it a go and establish a lead in a nascent technology. Australia's governments and agencies are keen to encourage them

2. Market developments will lead policy makers: change is too fast for government to keep up.

3. Substitutability and complementarity gives rise to important public interest questions on the role of transmission in this new industry. As a starting point we need to think about separating network planning from the ownership of regulated network assets.

4. Market economists greatly needed here - as with so many other aspects of energy policy in Australia