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Energy storage and its value to electricity consumers

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Energy storage and its value: Presentation Overview

- Initial research on the value of storage
 - Initial research & motivation
 - Key Findings
- “Myth of Storage”
 - Bulk Storage versus the grid
 - What value can storage provide?
 - In what conditions might this make sense?
- Challenges and remaining questions?
 - Who should own storage?
 - What are the other values?

Initial Study

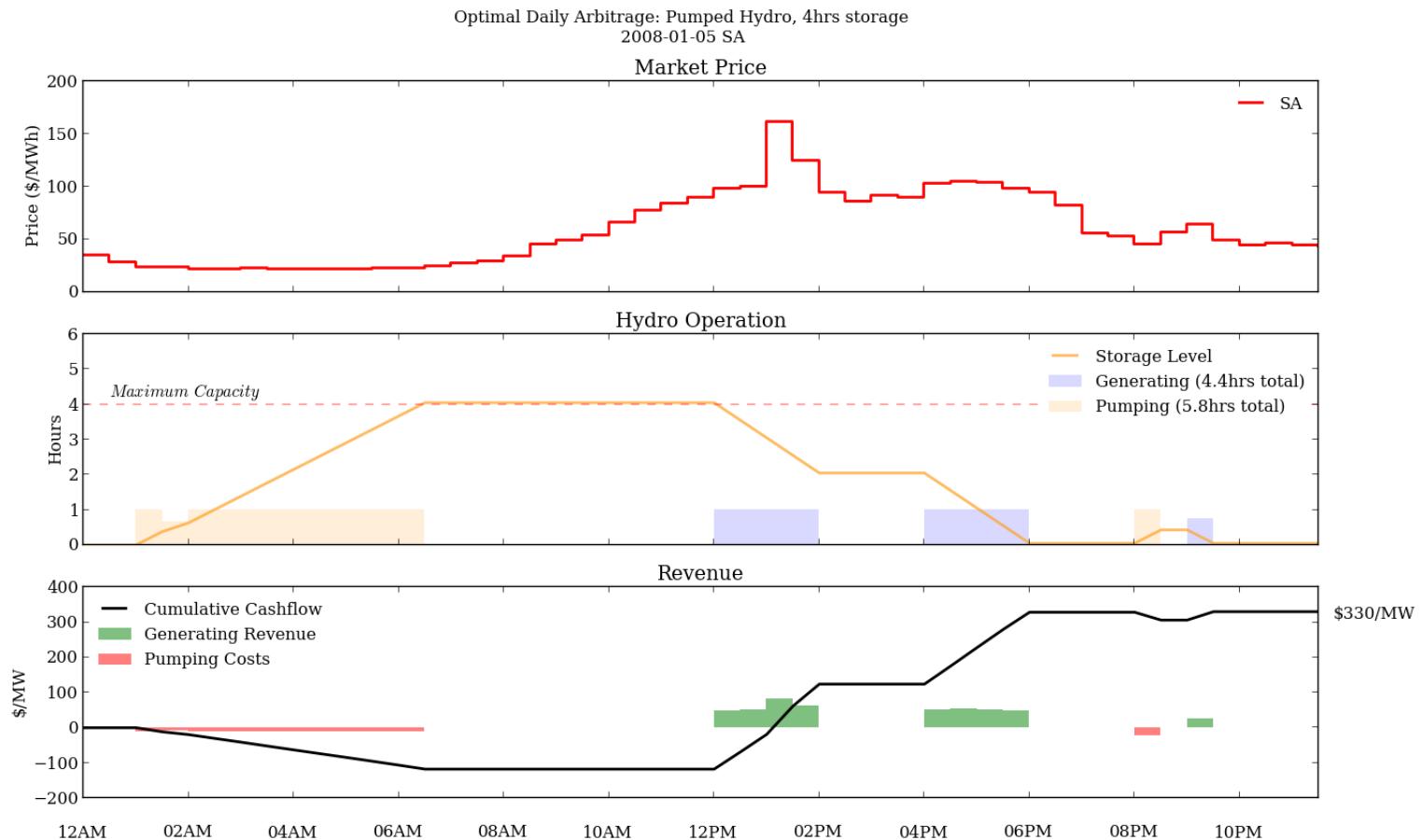
- Opportunities for Pumped Hydro Energy Storage in Australia
 - Melbourne Energy Institute and ARUP
 - Reviewing technology, costs and potential in Australia
 - Benefits in a future grid
- Small Device Energy Arbitrage
 - Best understood and studied applications of energy storage
 - Device is assumed to small enough that its charges and discharges do not affect the price of electricity
 - “Price taker” analysis, assumes perfect optimization (buy high, sell low)
 - Often employs “perfect foresight” of electricity prices.
 - This analysis is informed by analysis of arbitrage value in PJM (Sioshansi et al, 2009)

Sioshansi, Ramteen, Paul Denholm, Thomas Jenkin, and Jurgen Weiss. "Estimating the Value of Electricity Storage in PJM: Arbitrage and Some Welfare Effects." Energy Economics 31, no. 2 (March 2009): 269–277. doi:10.1016/j.eneco.2008.10.005.

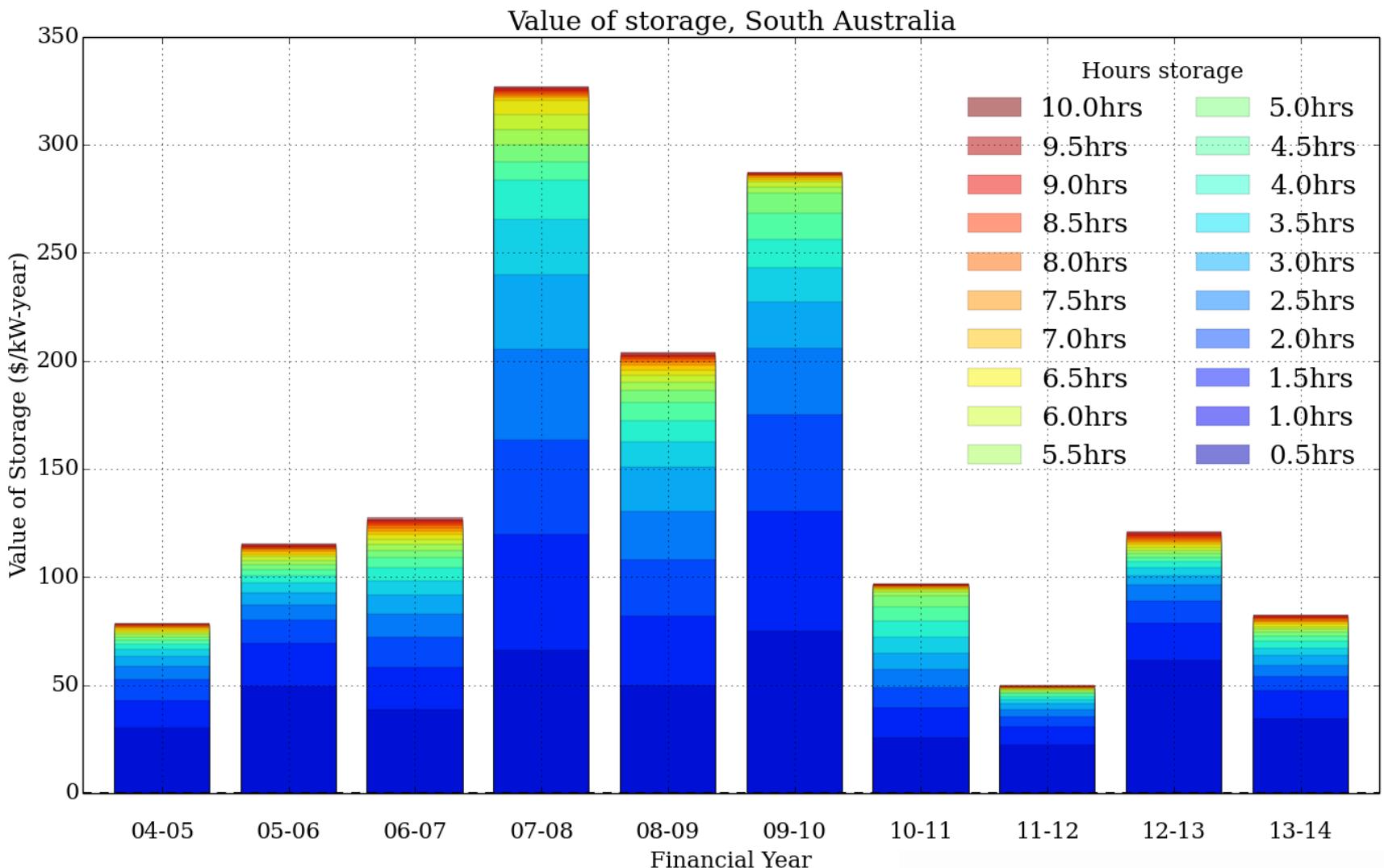


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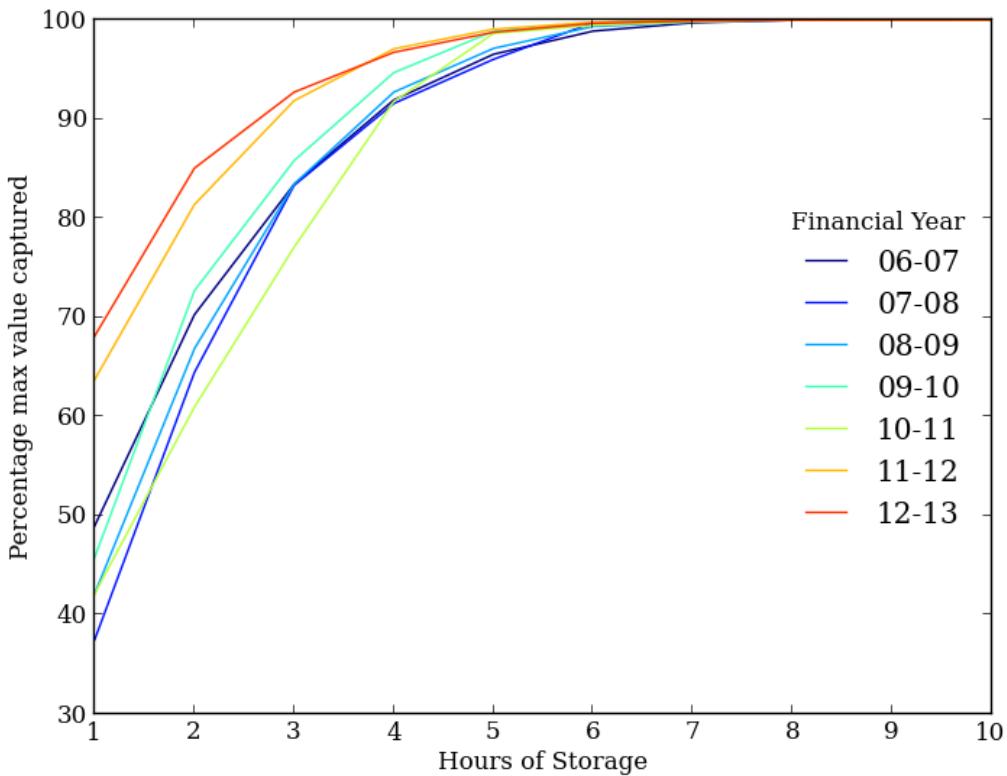
Initial Study



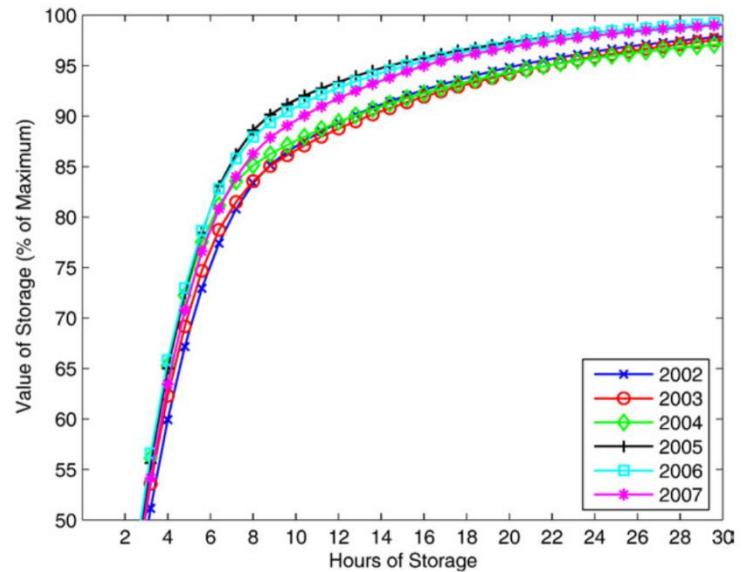
Arbitrage Analysis: Key Findings



Arbitrage Analysis: Key Findings



Percentage arbitrage value captured, as a percentage of annual maximum theoretical value



[source: Sioshansi]

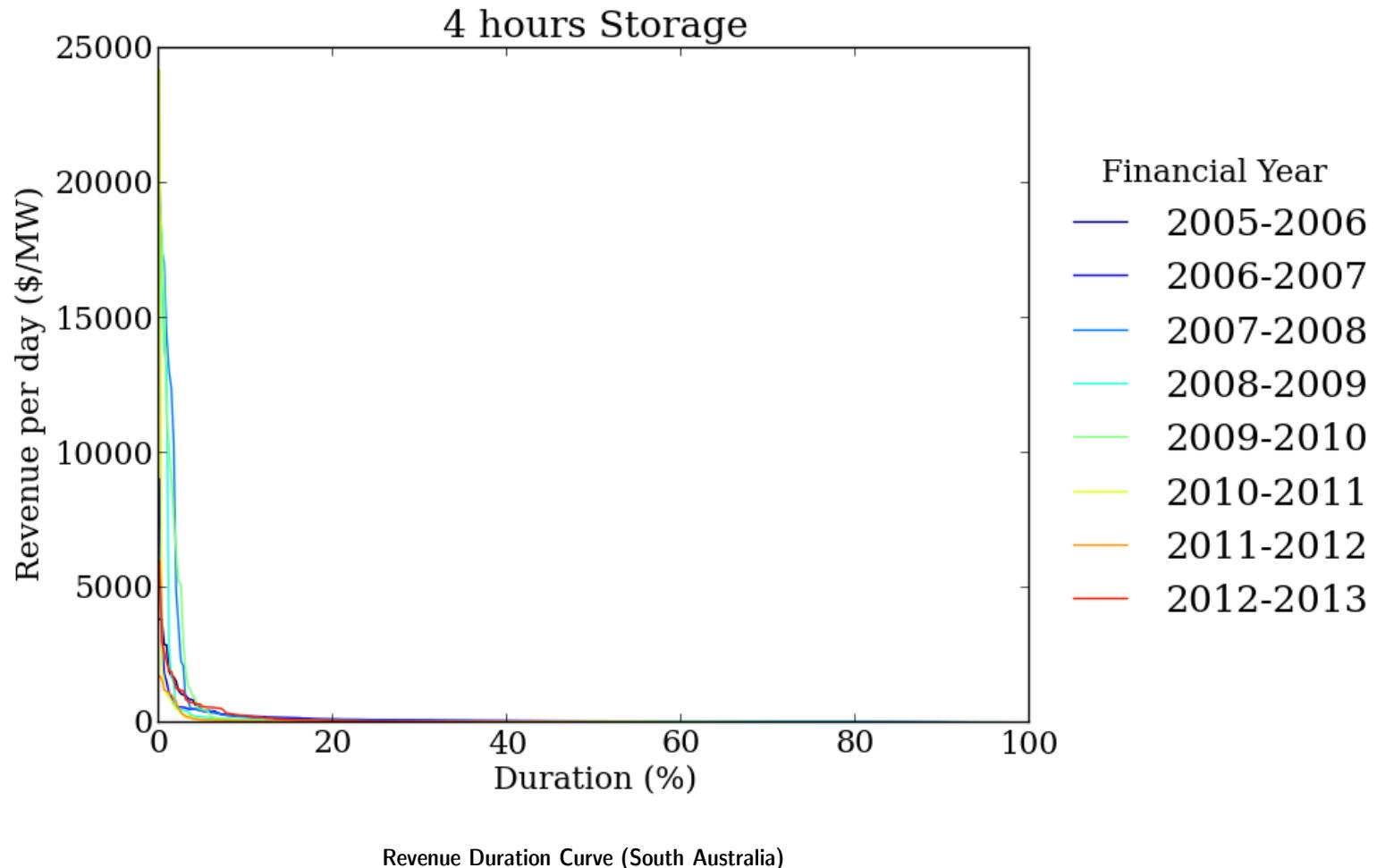


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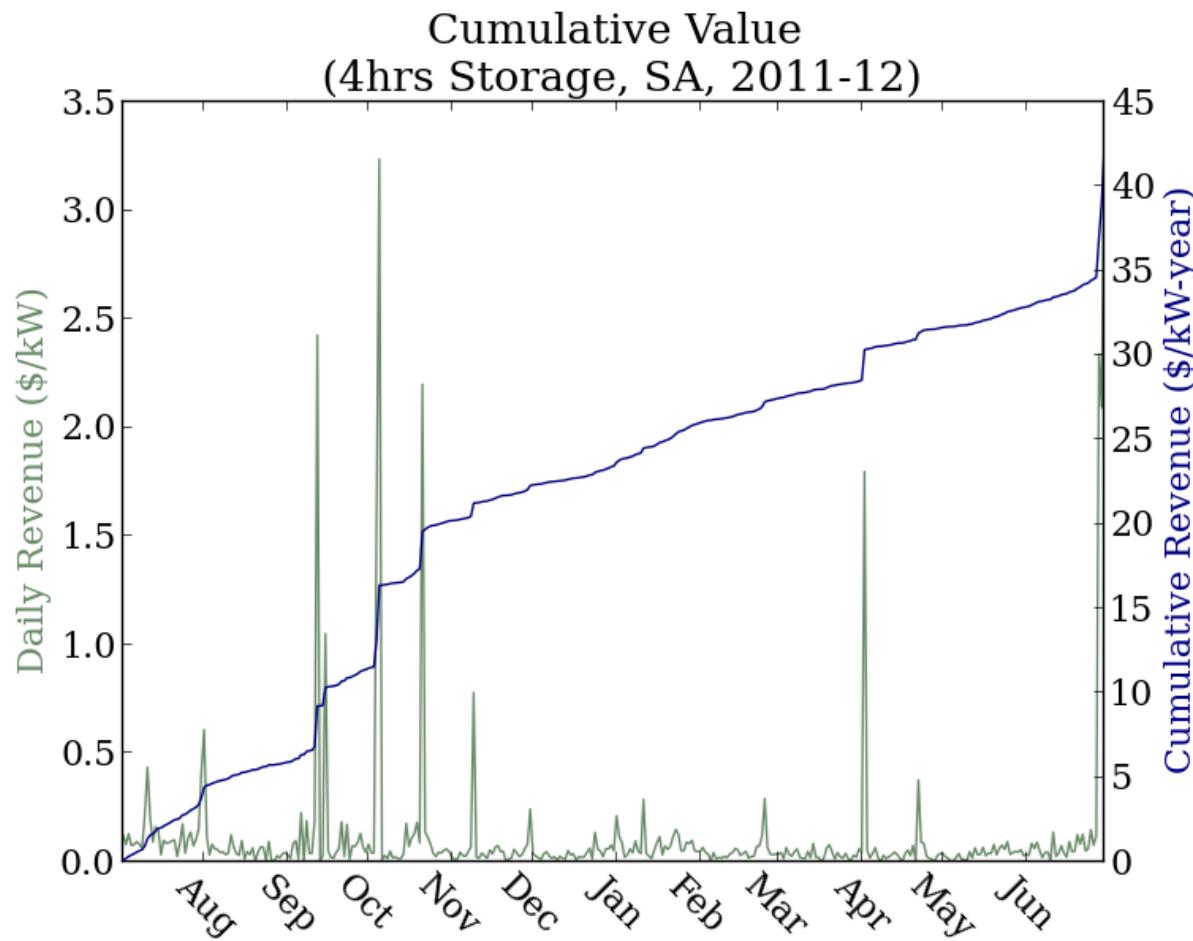


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Arbitrage Analysis: Key Findings



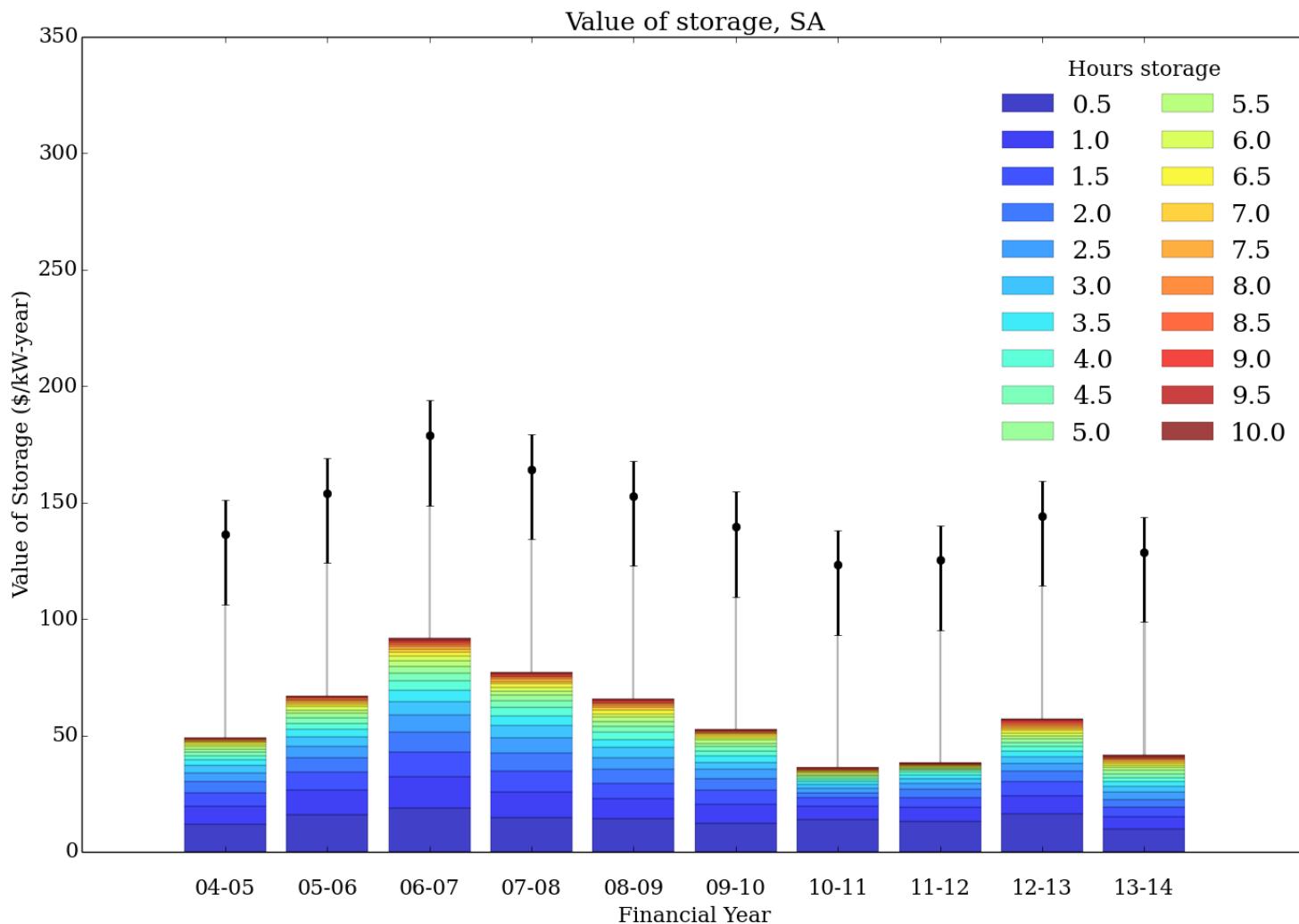
Arbitrage Analysis: Key Findings



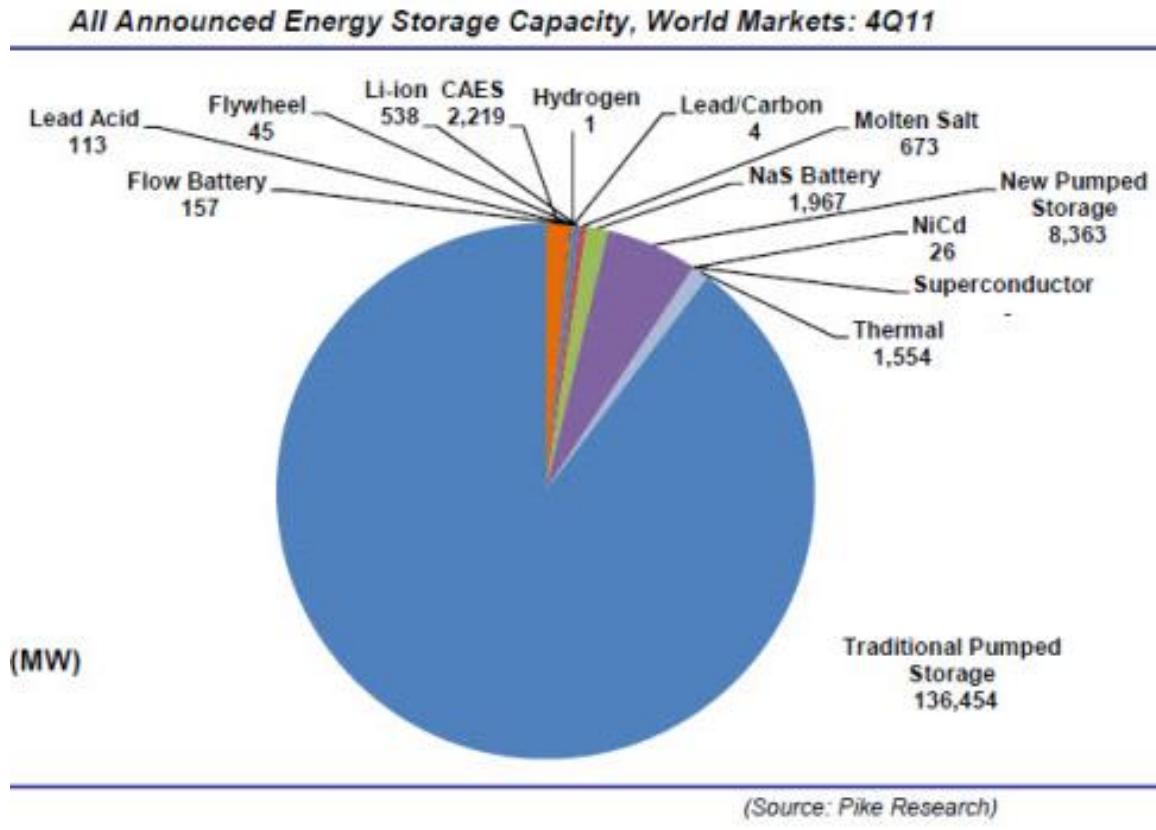
“Myth of Storage”

- The grid as a ‘virtual battery’
 - Energy security and reliability is currently delivered by the grid
 - Current grid is designed to take handle fluctuation (including extreme fluctuations, e.g. large generator tripping off).
 - Renewable generation is variable but not unpredictable
 - The grid is already effectively a ‘virtual battery’
 - Storage alone is an expensive way to achieve reliability
- What is the value of storage?
 - Storage essentially provides capacity value
 - Similar services to OCGT and other peaking capacity
 - OCGT is the primary competition with storage in the market
 - Further analyses was required in this context
 - Rather than focus on arbitrage value, and load shifting

Contracted Capacity Value



Case Study: PHES vs OCGT



Globally

- 136 GW of PHES operating

Europe

- 11 GW under construction or in planning.

China:

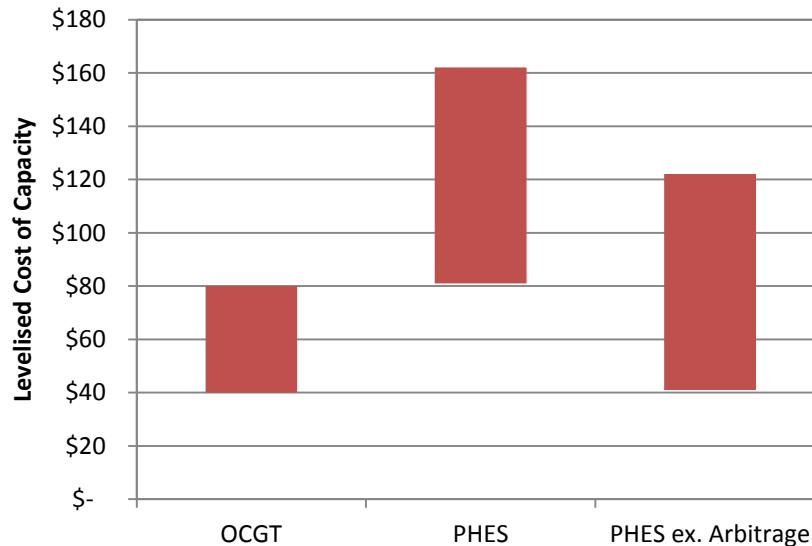
- 10 GW under construction.

USA:

- New legislation to spur new development

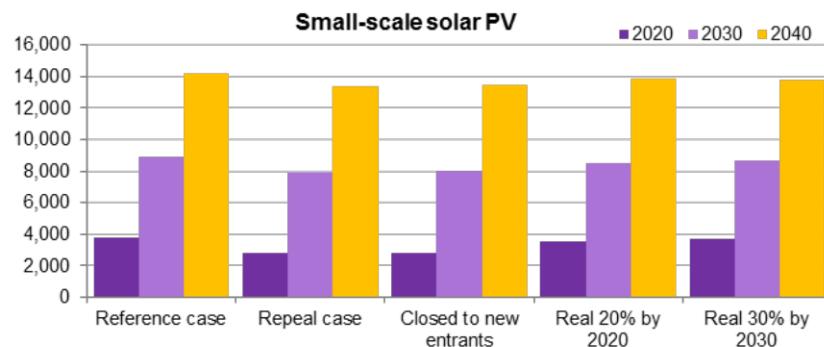
Case Study: PHES vs OCGT

- Pumped Hydro Energy Storage
 - Cost in the range of \$800-\$1600/MW [EPRI]
 - Additional Revenue from intra day arbitrage
- OCGT
 - Potentially easier to install closer to network constraints and loads
 - Only revenue from capacity (due to cost of gas)



Is it needed?

- Not right now
- However, not difficult to image circumstance where this might change
 - Withdrawal of capacity
 - More Solar PV and Wind (?)
 - Gas price effects (?)
 - The long-term, with deep decarbonisation



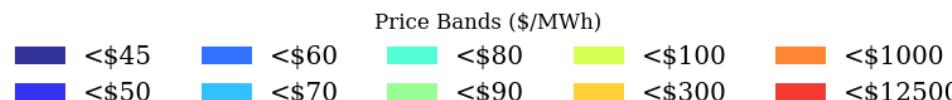
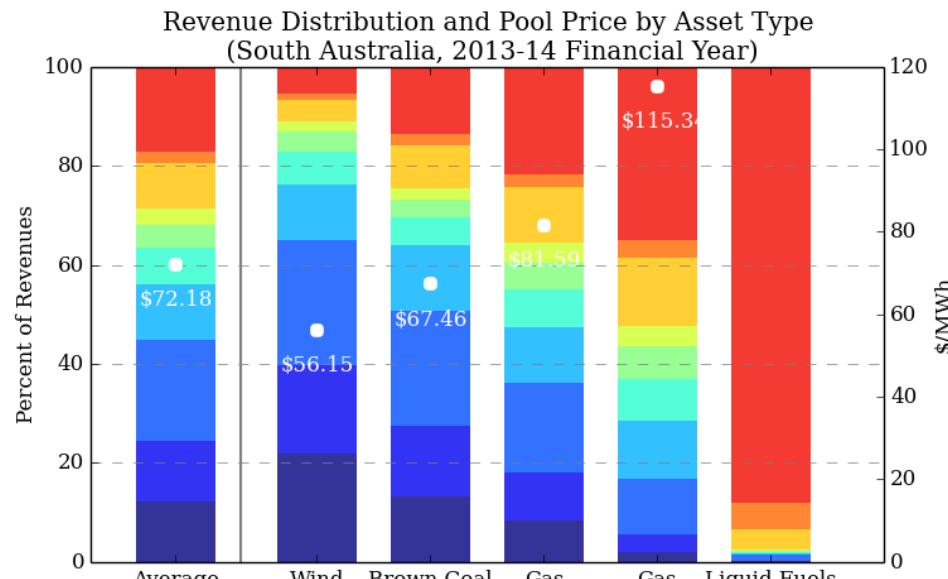
[source: ACIL Allen]

Further Questions

- This analysis only considers energy arbitrage and capacity value in the wholesale market
 - Maybe additional value resulting from co-optimisation between ancillary services and energy markets
 - Network could be significant
- Large scale storage can potentially provide other social welfare improvements
 - Increased utilisation of electricity infrastructure
 - Value is extremely site specific and hard to quantify
 - Not necessarily captured by a private-sector actor relying on arbitrage and capacity value
 - What is the best ownership structure? Regulated entities may have better incentives (as they may value these social benefits)

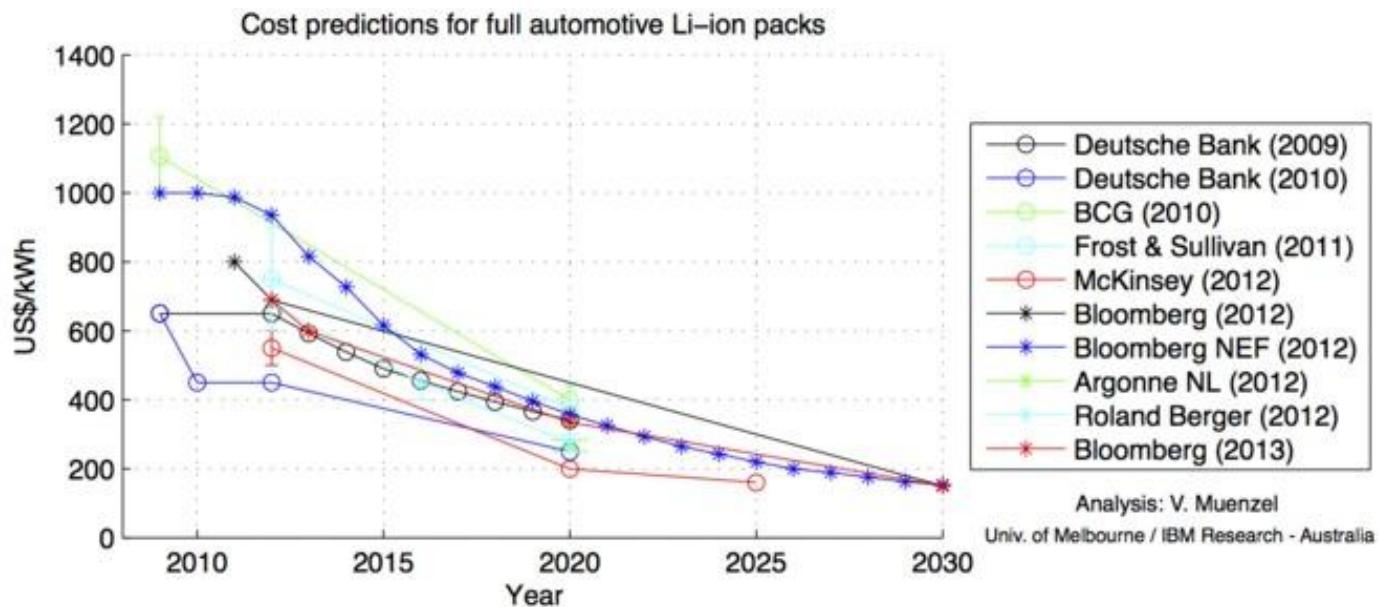
Further Questions

- Generators vs Consumers vs Merchant Storage ?
 - Merchant storage operators maximise welfare
 - Generators tend to under use, consumers overuse



Other Research

- Small-scale rooftop PV & Storage
 - “PV Generation and Demand Mismatch: Evaluating the Potential of Residential Storage”





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