Research Highlights on Energy Storage

Reflections on energy storage research at Reading

Dr Ben Potter

Associate Professor of Energy Systems

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Energy & Environmental Engineering,
School of the Built Environment,
University of Reading

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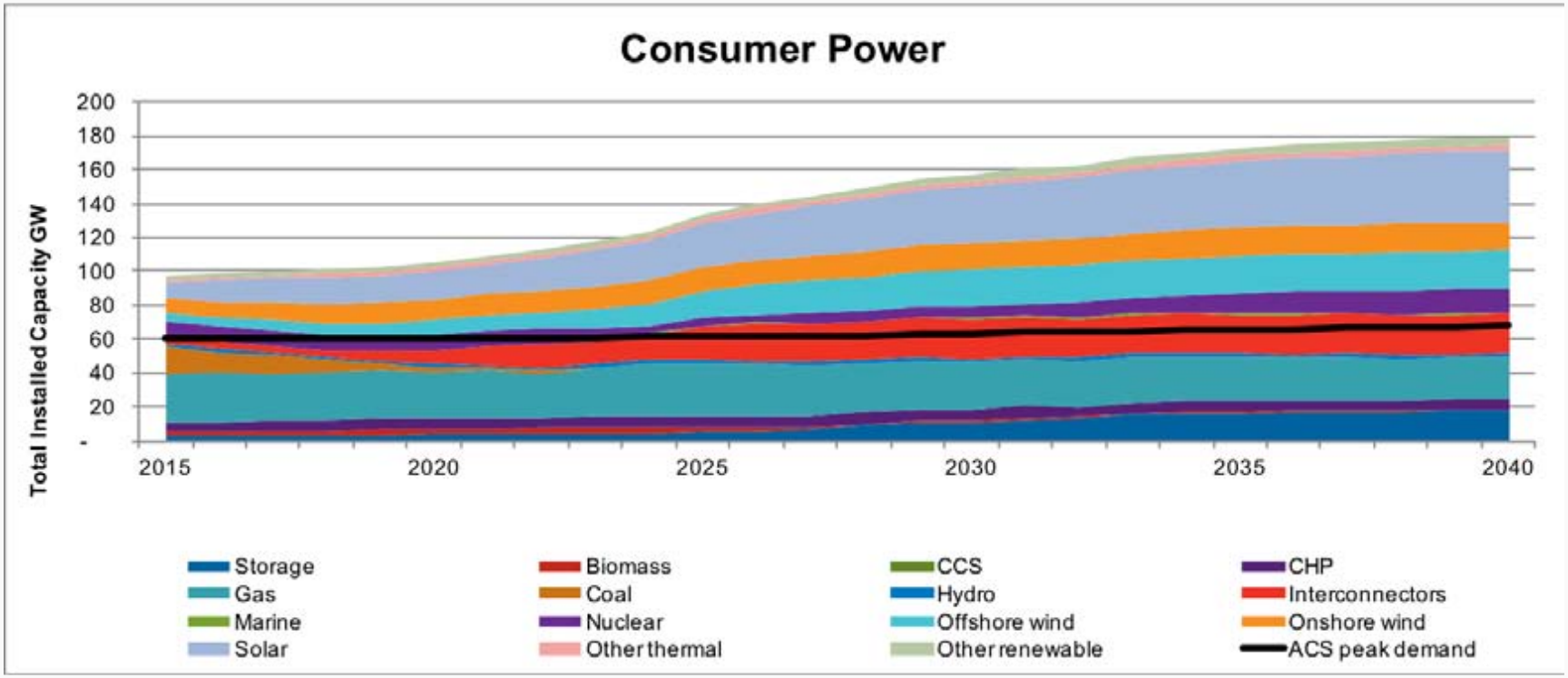
The rise of energy storage

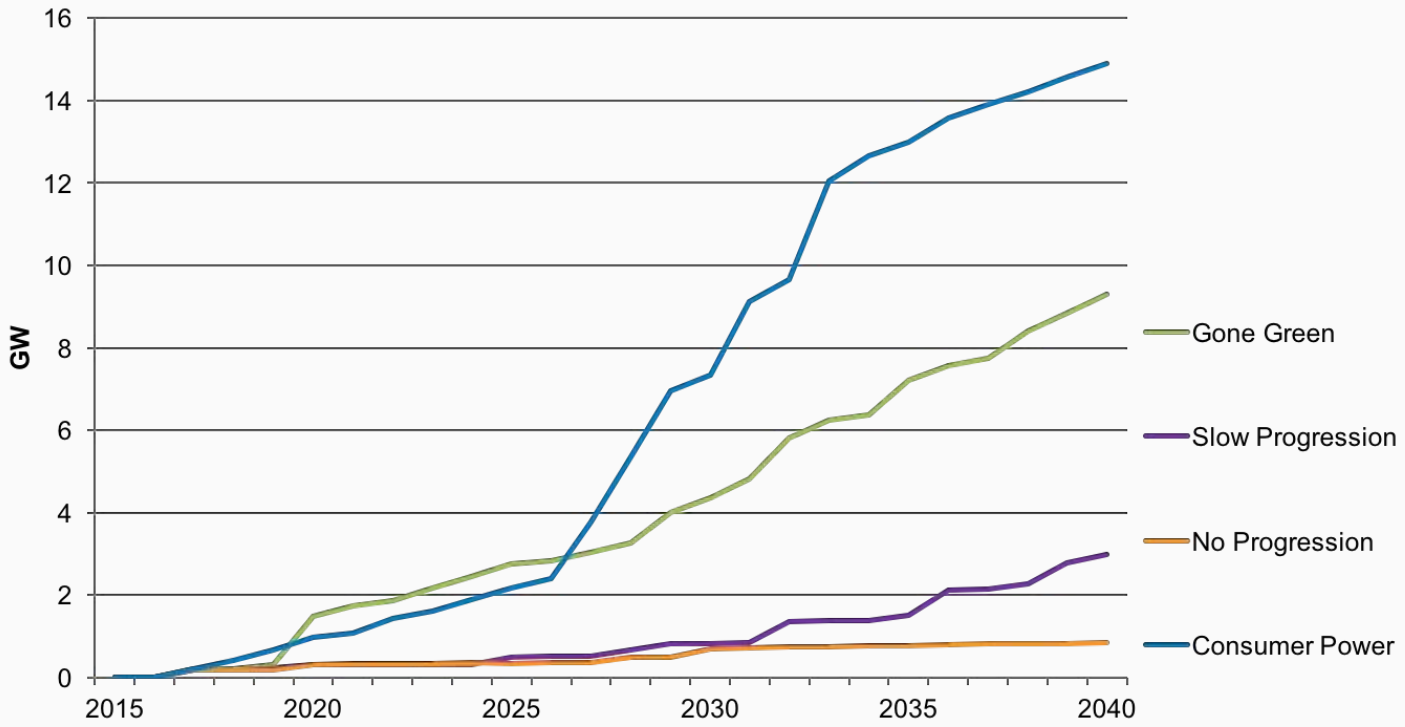
National Grid's Future Energy Scenario - Consumer led



Source: [2]

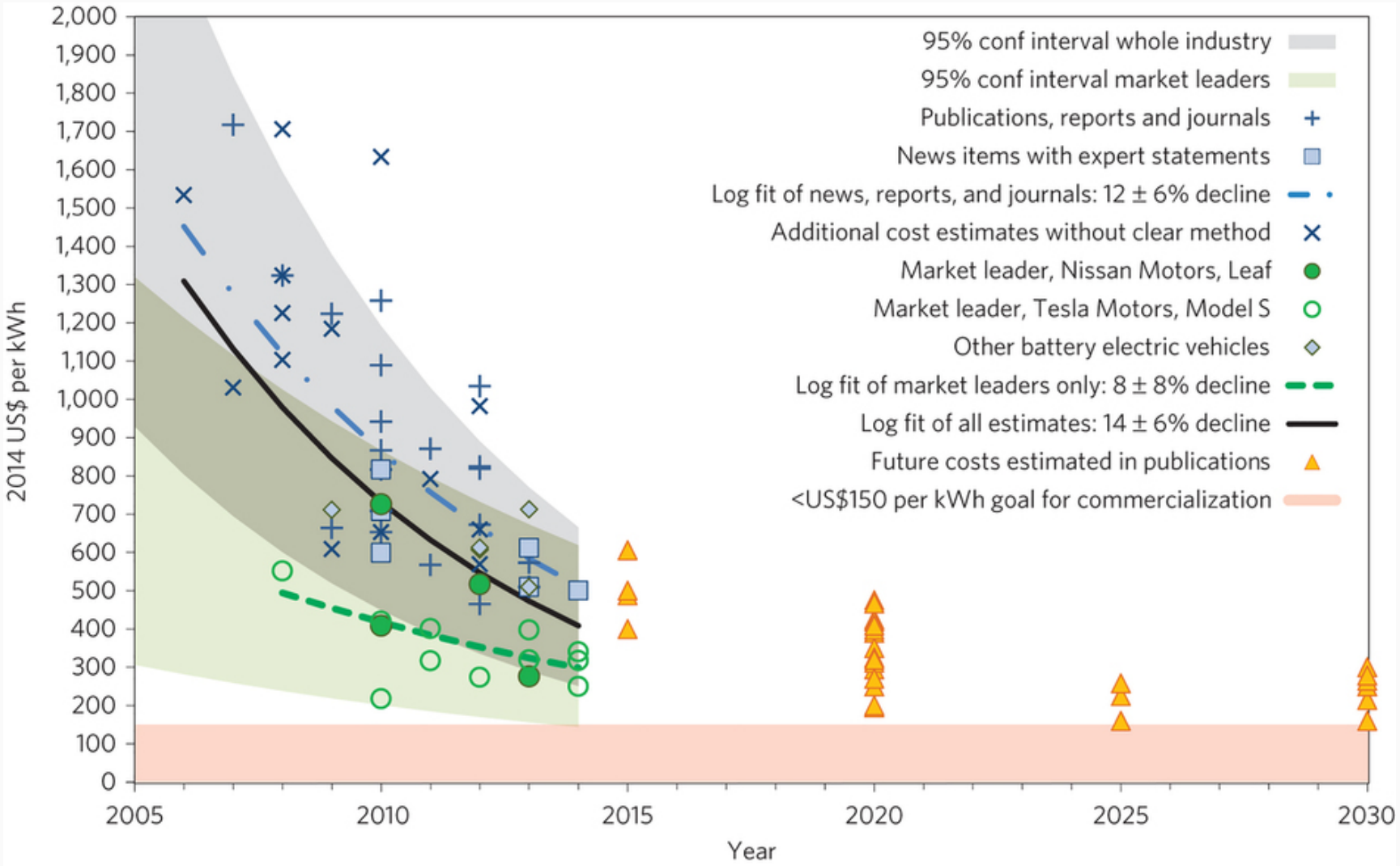
- Consumer-power: market driven with little government intervention.
- Smaller-scale storage and EVs may well follow this scenario.
- The uptake of storage may also be underestimated.

Storage in all four scenarios



- FES does not currently include electric vehicle as grid storage
- National Grid's 'Gone Green' scenario predicts 9.7M EVs by 2040, and some models predict more than twice this uptake.
- 10% of those EVs charging at the same time using 7 kW home chargers would result in a power demand of 6.7 GW.

The price of Lithium-Ion batteries



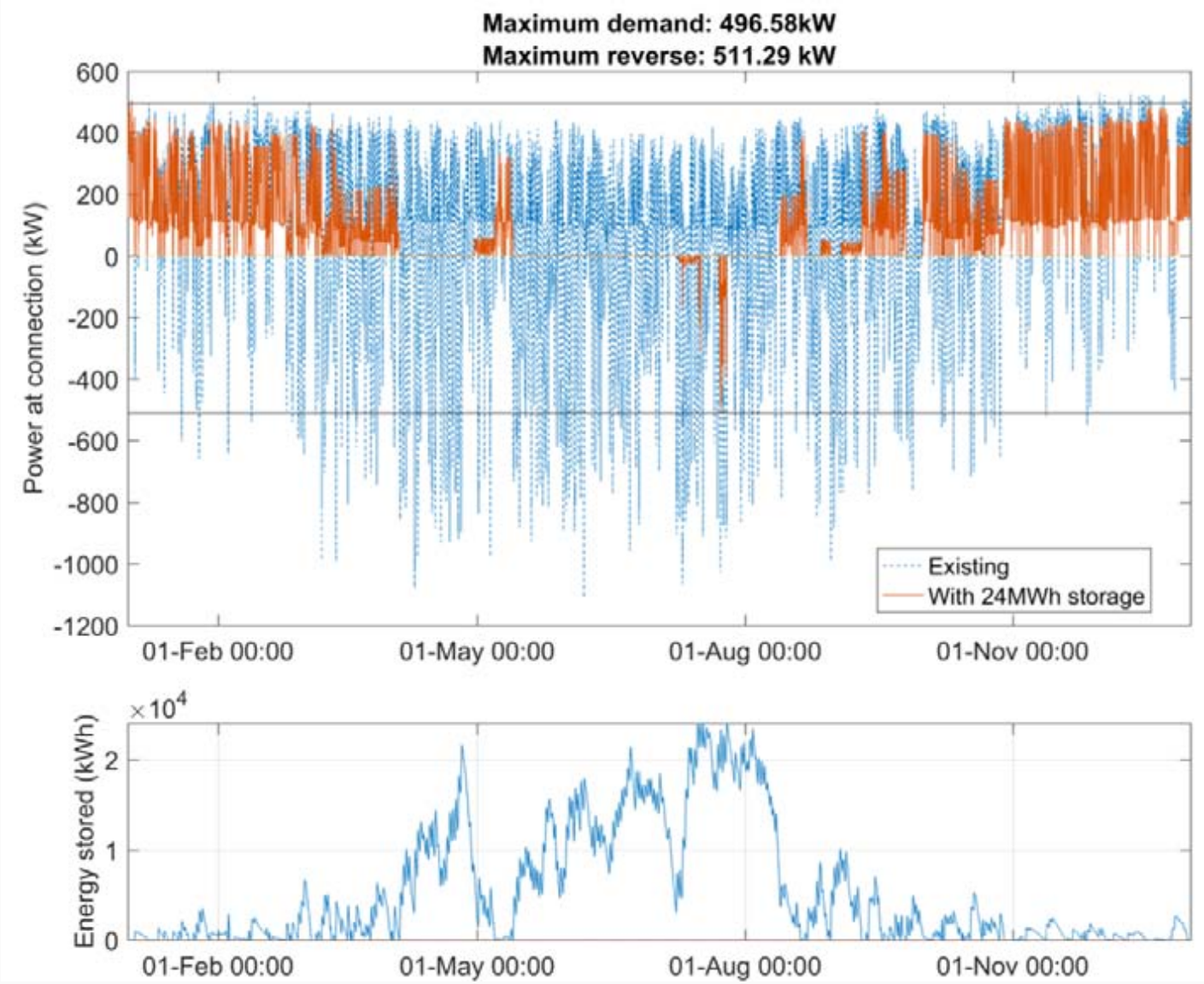
Source: [4]

The price of Lithium-Ion batteries

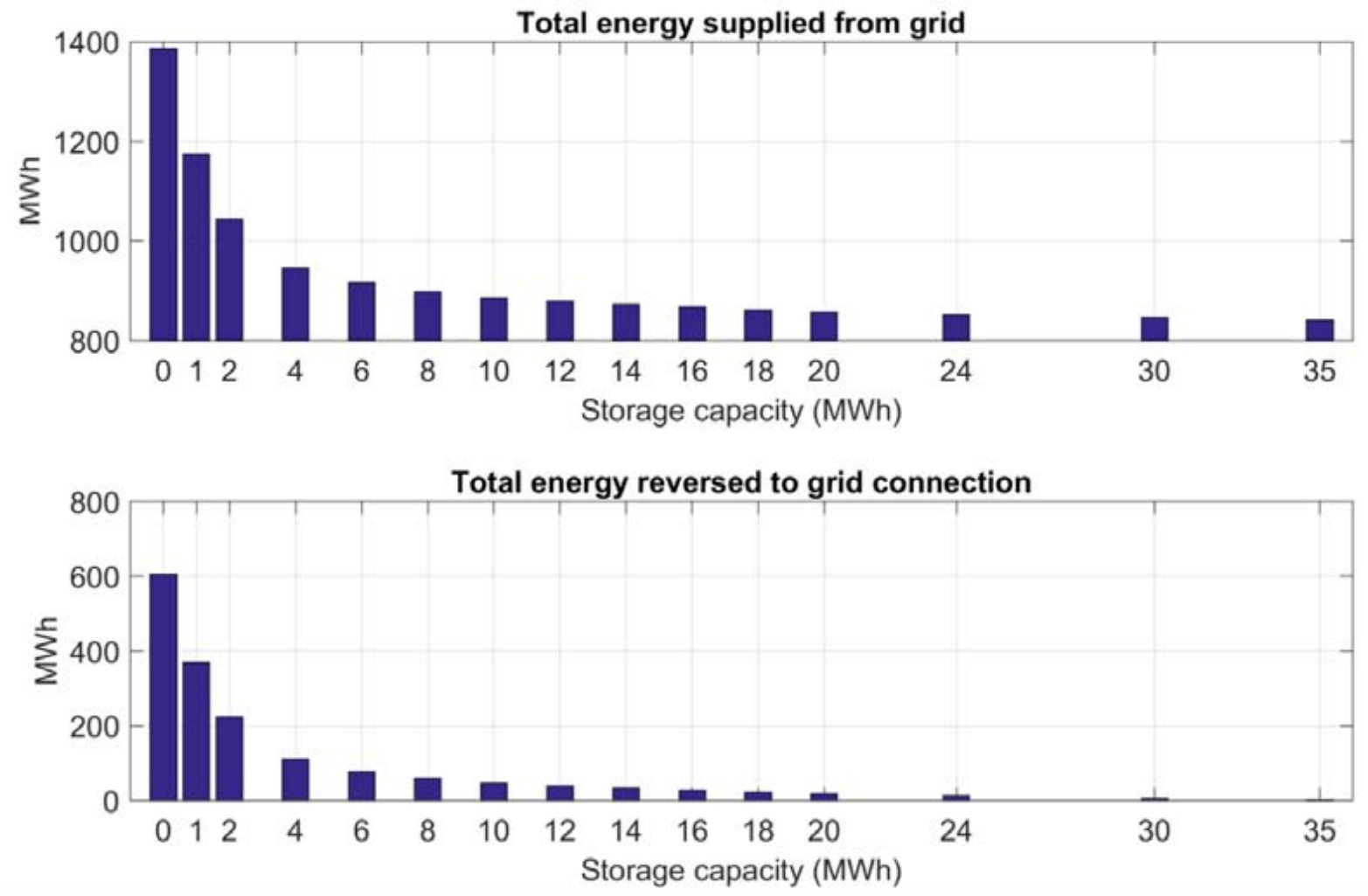
- Since 2014, the cost of completed EV battery packs have crashed from \$400/kWh to \$200/kWh [1].
- GM has said that it's paying LG \$145/kWh for the cells in the 2017 Bolt battery pack [1].

Reducing network connection costs with storage

Storage and solar to minimise grid power flow



Selecting the right size storage system

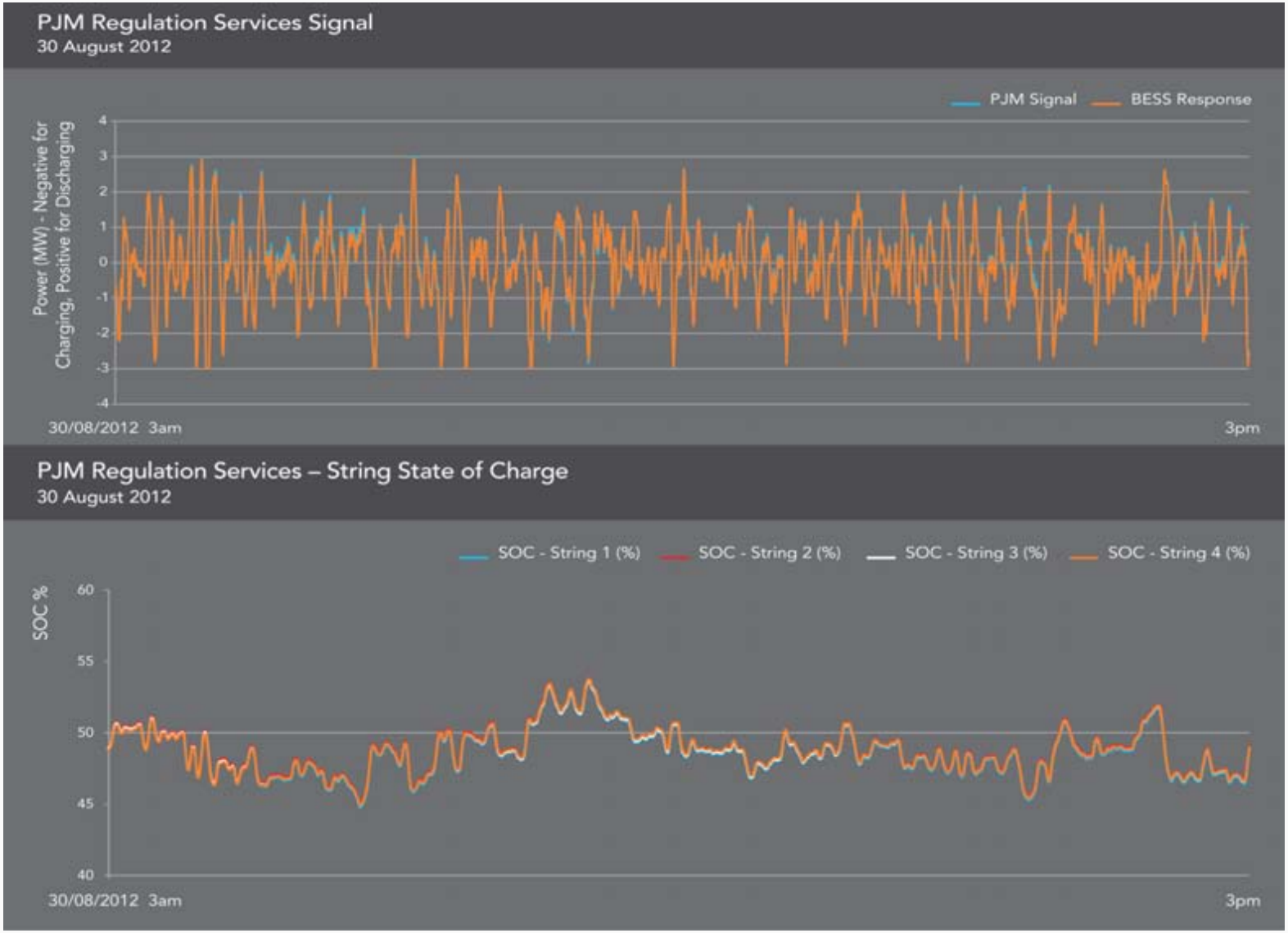


Reflections

- Mainly a problem of energy rather than power.
- Daily, monthly and seasonal time-scales at work.
- Business-case modelling is critical to determine the size of the storage device.
- In this example, it would also be important to asses whether selling excess solar energy is better than reducing network connection costs.
- Storage should be considered as capable of multiple uses and the business case based on all these uses.

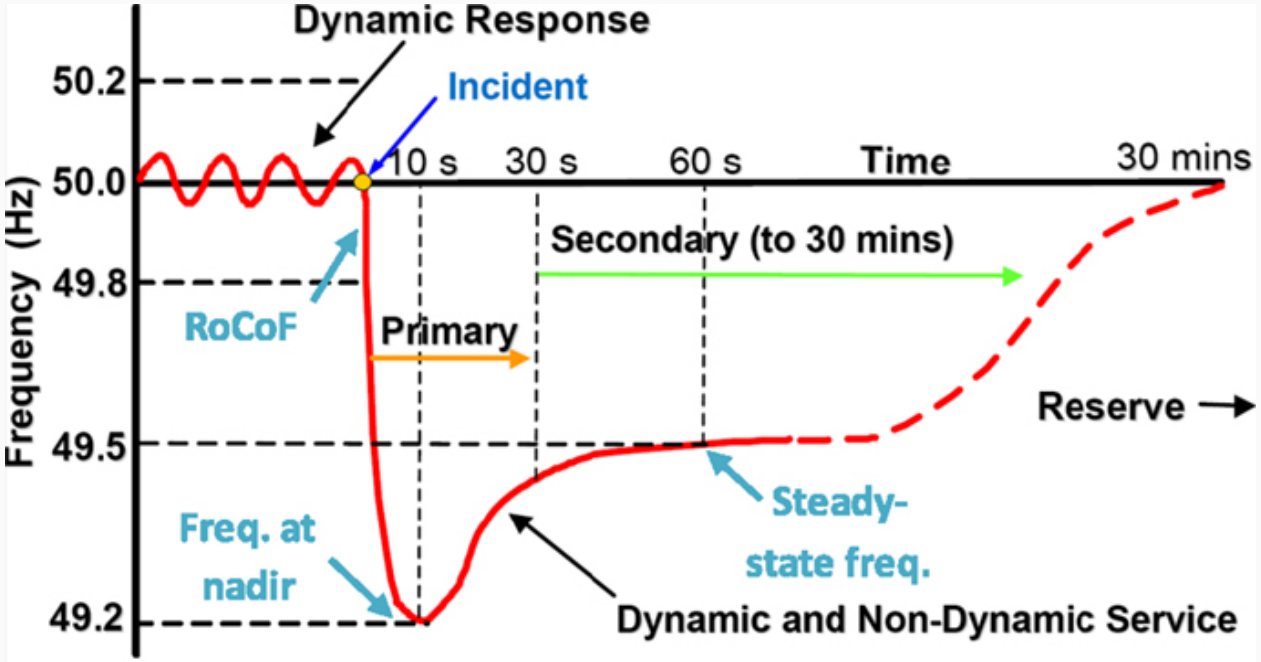
Using storage for frequency response

Power is more important than energy for frequency response



3MW Advanced lead acid battery providing frequency regulation [6].

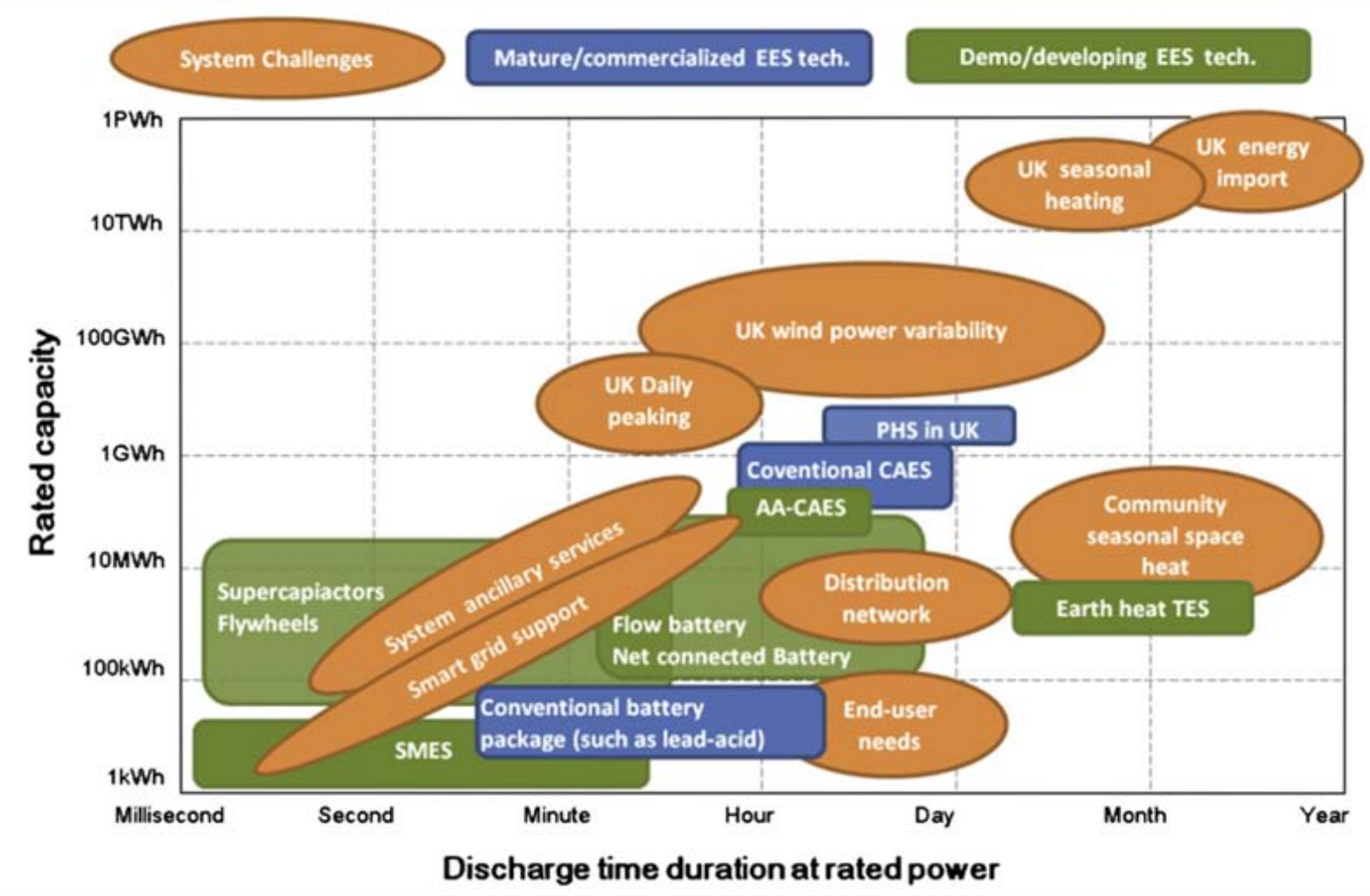
Frequency response in more detail



Source: [5]

- The revenue for the different types of response are different.
- Not all storage technologies will be suitable for the different types of response.

Response times and capacities of energy storage



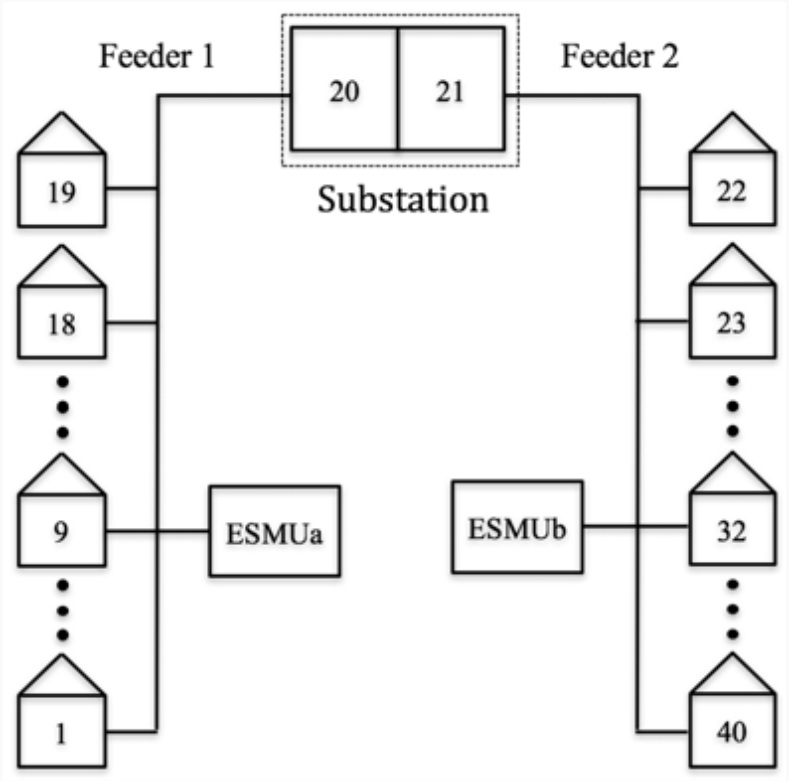
Source: [3]

Reflections

- A given energy storage solution be attractive for a variety of reasons e.g. availability, cost, pre-existing.
- However, this solution may not have a sufficient response time for specific revenue-generating ancillary services such as frequency response.
- Hybrid storage solutions can combine technologies such as adding capacitors to a lead-acid system.
- Aggregators may be able to construct a portfolio of controlled storage to respond across a wide-range of time-scales.
- Communications and control remain an important consideration in the response time of energy storage.

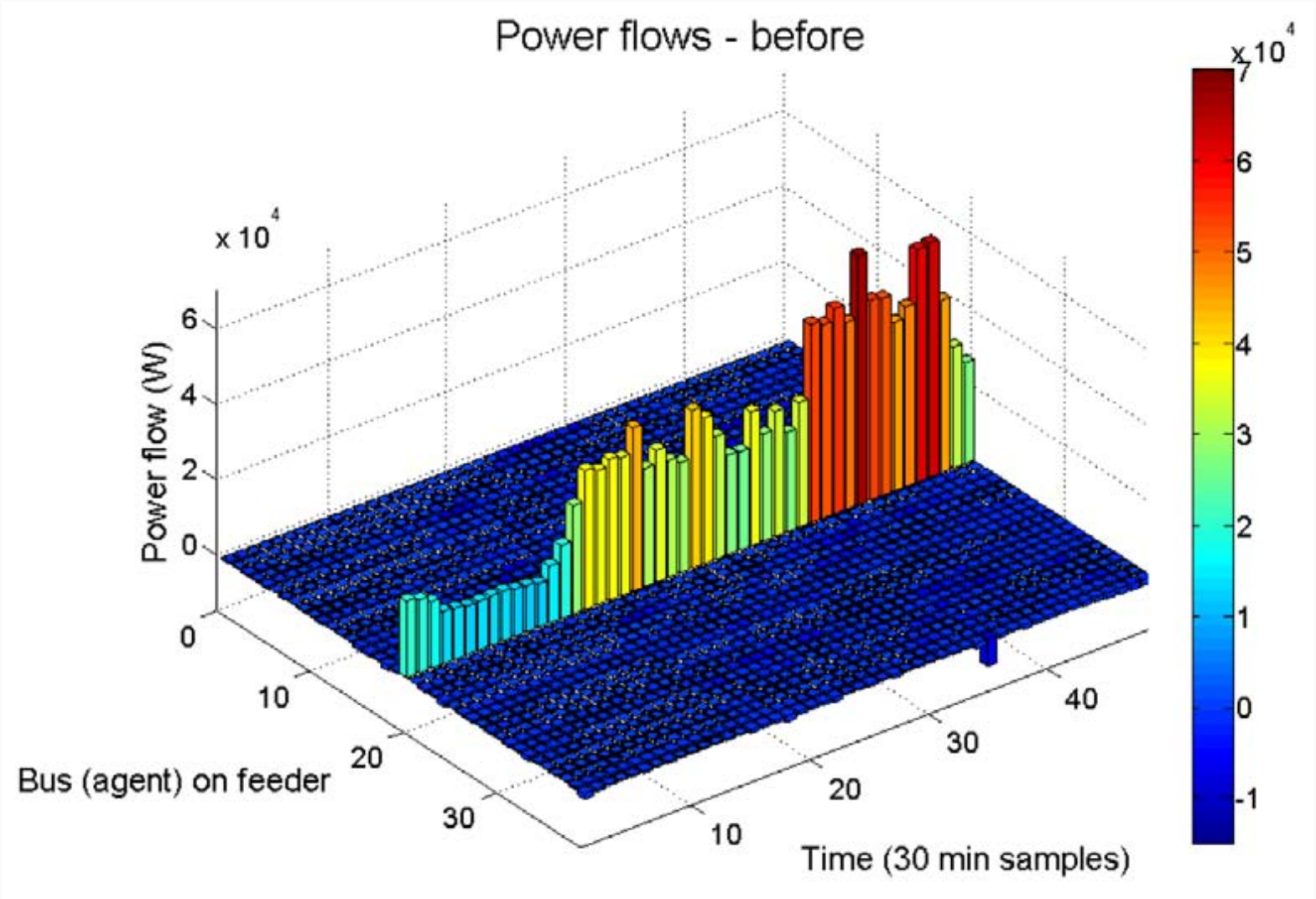
Agent-based control of storage

Agent-based control of a neighbourhood

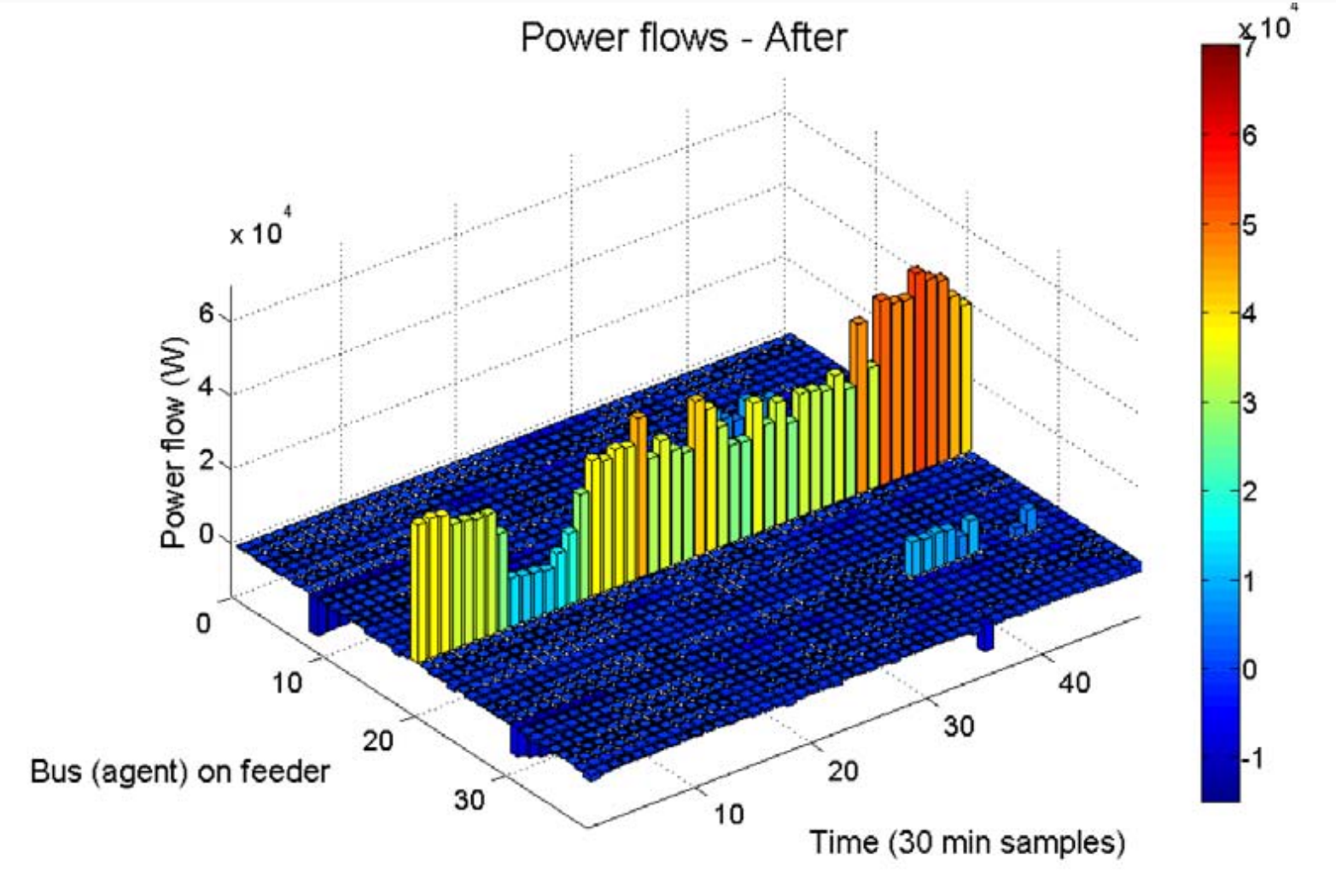


- Agent-based systems can be used to control storage for peak reduction.
- Can also be used to power loads during a failure of grid supply, but must prioritise.

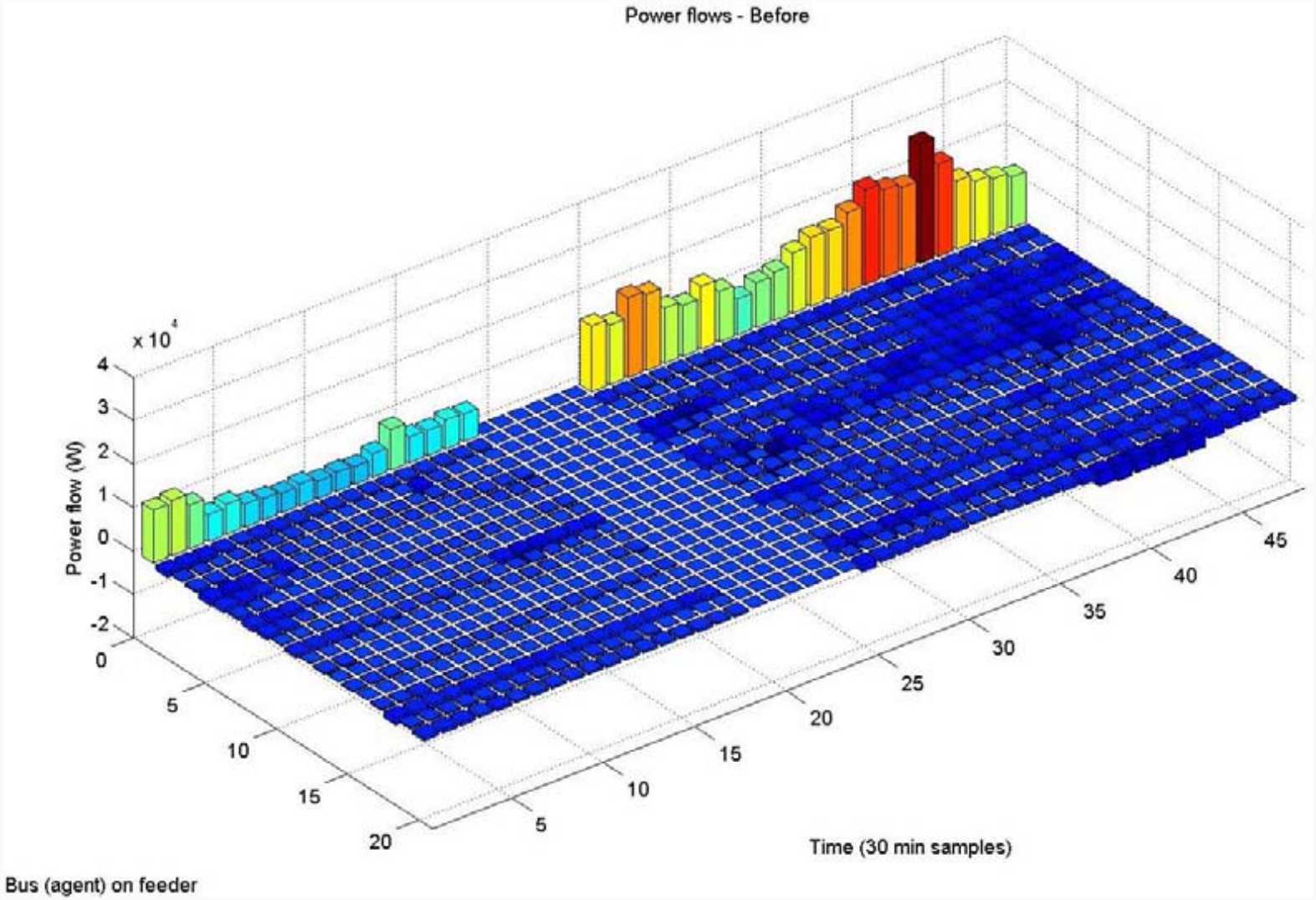
Feeder demand without storage



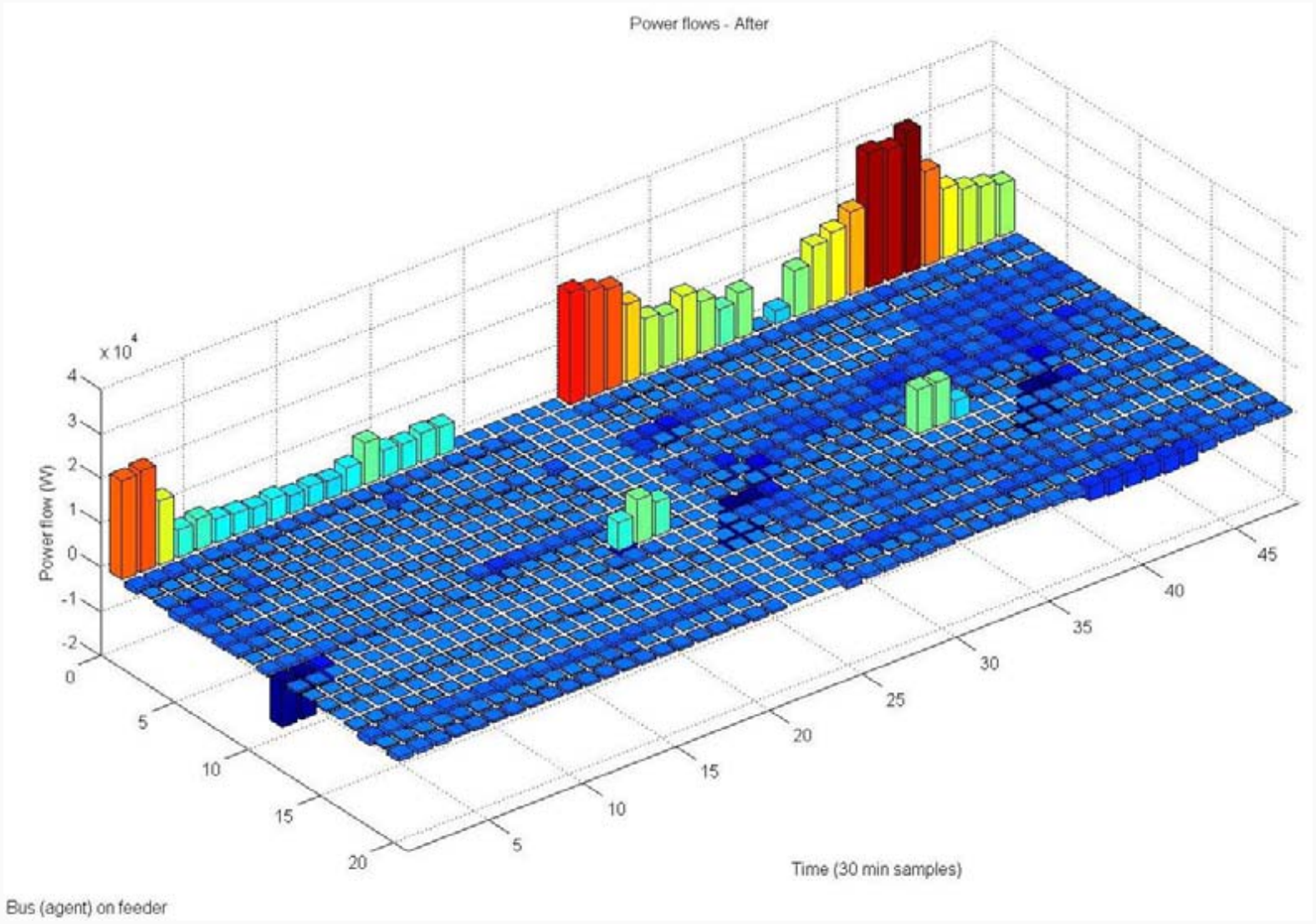
Peak reducing with storage



Feeder demand with power cut



Agent-based load prioritisation

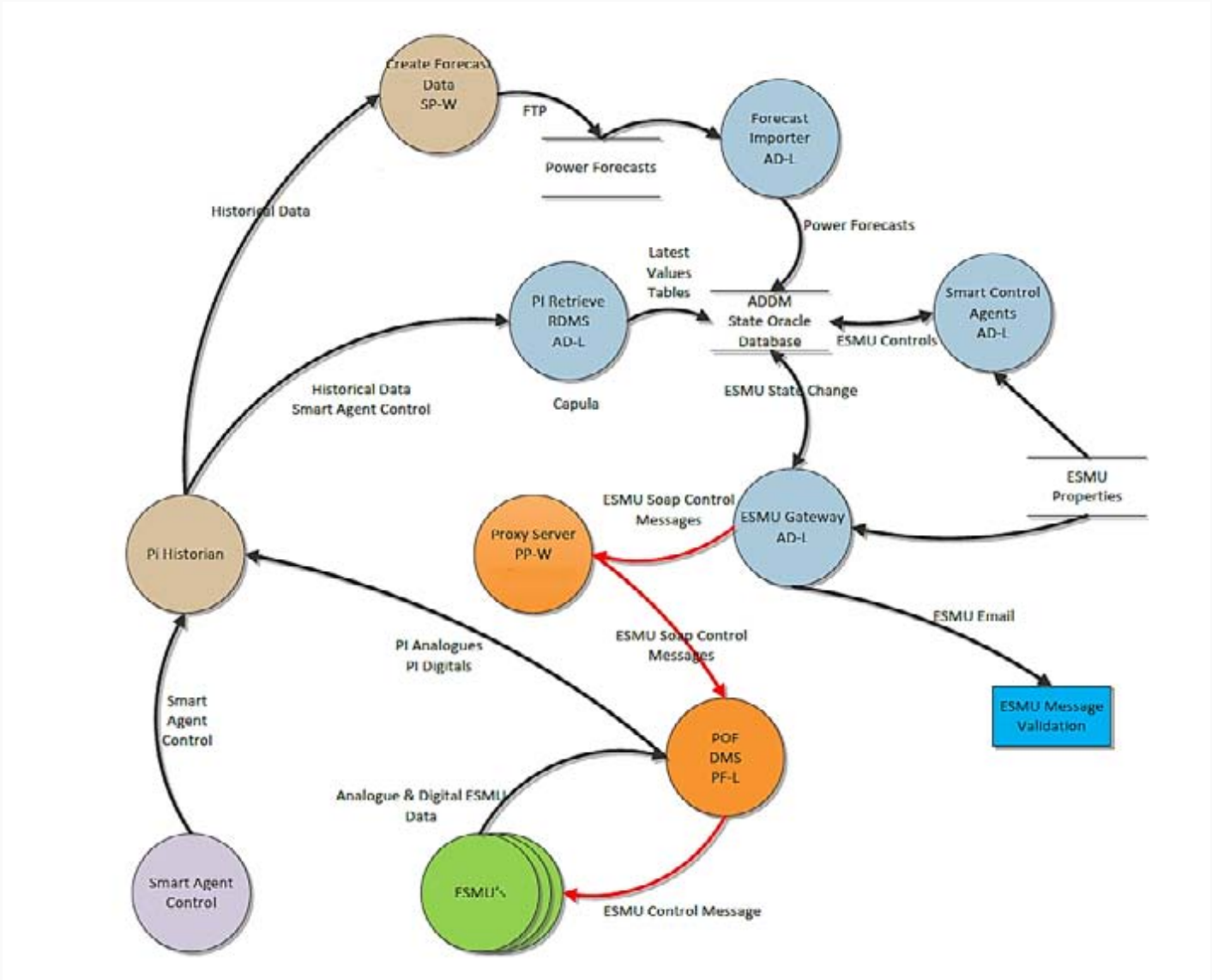


Reflections

- Agents work together to find a low cost balanced solution or a low carbon solution.
- Agents can operate without constant communication with a central 'brain'.
- There will probably always be winners and losers in any single agent-based negotiation, especially with explicit load prioritisation.
- It's important to ensure that it's not always the same losers.
- Some smart control schemes struggle to avoid penalising those can't participate or be flexible with their demand. Those are often the people who are struggling to pay their bills.

Communications & Security

IT Structure for smart control (NTVV Project)

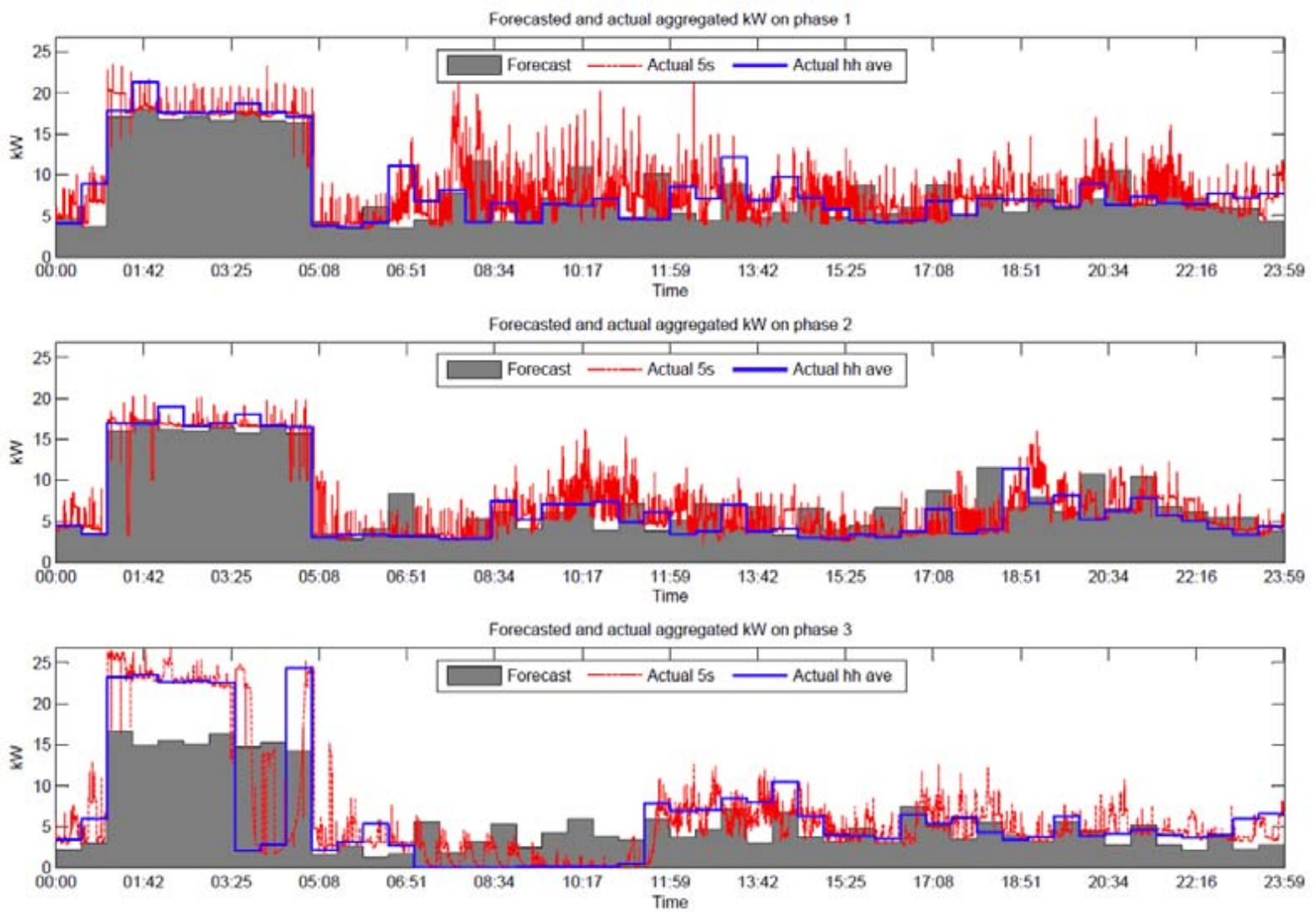


Reflections

- Centralised vs. decentralised intelligence and control can have a big impact on the number of messages.
- Rather like our transmission network, there will be key pinch points in the network in the path to central systems or near the most useful assets.
- The structure used for a small or even medium-scale trials may well not be appropriate for large-scale roll-out.
- It only takes one security breach for all confidence (and revenue-generating contracts) to be lost.
- We are likely only underestimating security issues. Professional support for security is often only brought in after a breach or once production systems are already in place.

Using forecasts to control storage

Challenges with forecasting



Reflections

- Forecasting is hard but you probably need them to make money.
- It's important to consider what the forecast will be used for.
- Forecasts must be fit for purpose for control systems and visa versa.
- Forecast errors may result in sub-optimal behaviour that leads to the same people being disadvantaged.
- When forecasting human behaviour, it's sometimes better to just ask them.

The End. Thank you.

Make a note of any questions for the panel Q&A session.

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