The Potential Value of Energy Storage as a Provider of Multiple Balancing Services

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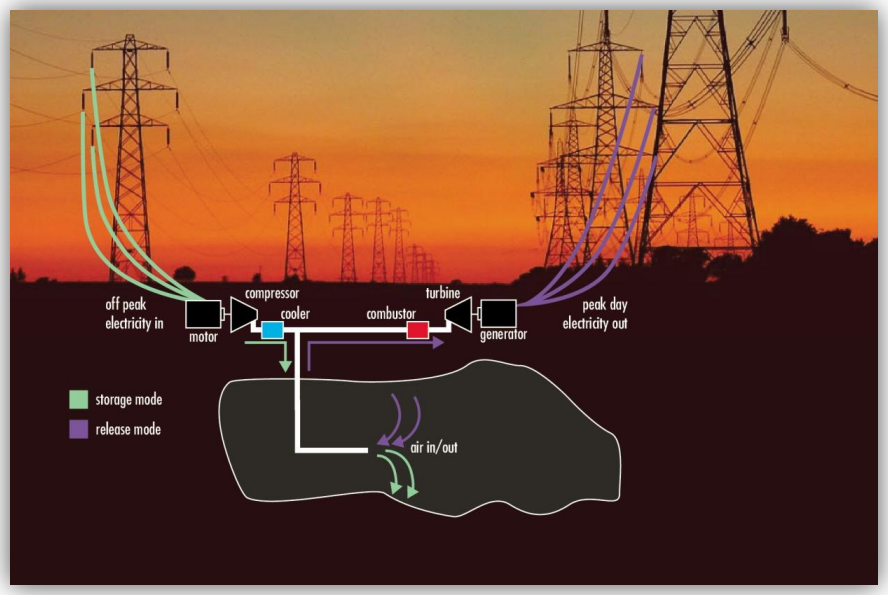
The University of Warwick in partnership with National Grid


off peak
electricity in
motor
compressor
cooler
combustor
turbine
generator
peak day
electricity out
storage mode
release mode
air in/out

Questions to Address

- What services could energy storage provide to the system operator?
- Could provision of multiple services be possible? If so, which?
- What would be the expected revenue from providing such services/combinations of services?
- What issues need to be considered, for instance reliability?

Frequency Response

- National Grid is obliged to maintain system frequency at close to 50Hz
- Employs generators to increase or decrease power output to control system frequency
- Cost to National Grid is approximately £170m per year

Reactive Power Services

- Important for voltage management
- Generators paid to absorb/generate reactive power to control local voltage levels
- Cost to National Grid is approximately £68m per year (expected to increase)

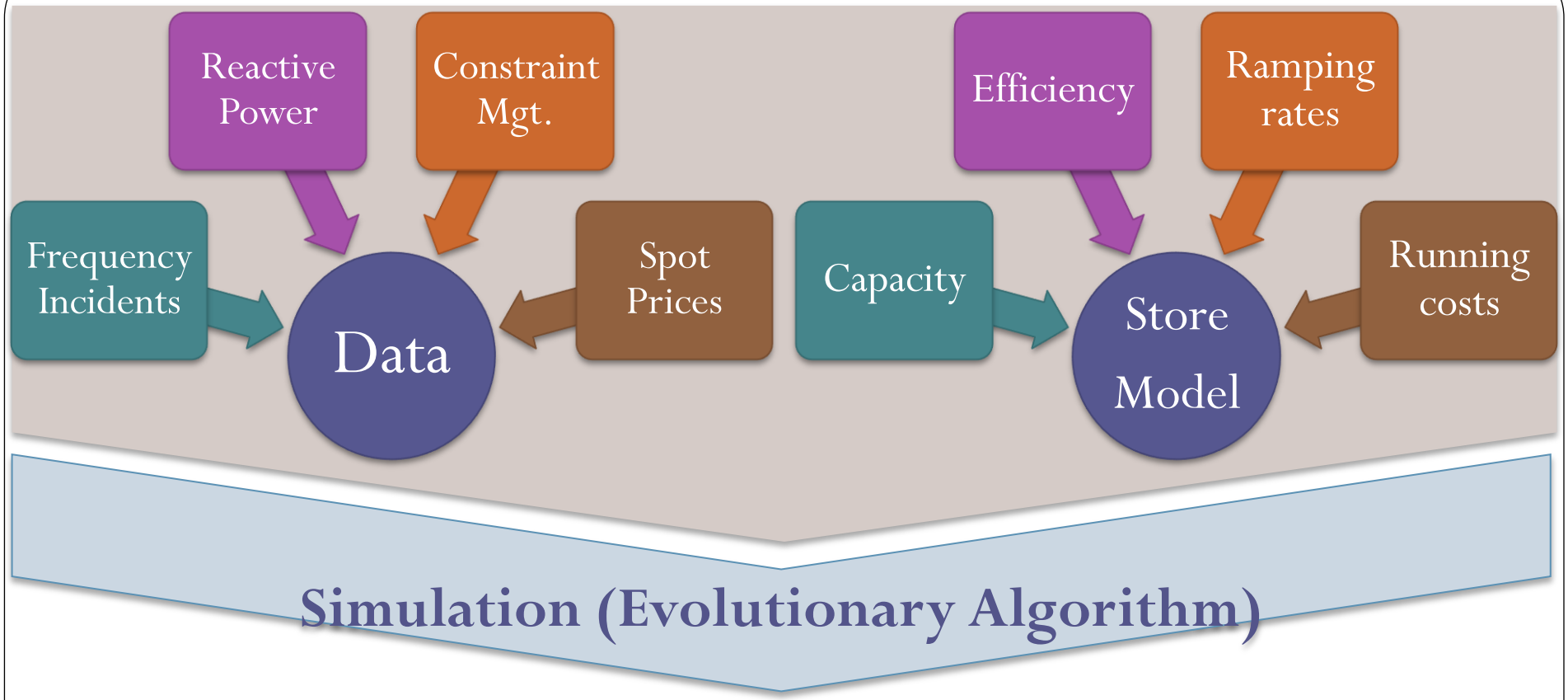
Network Development and Constraint Management

- Creation of new power generation or areas of demand can increase congestion on power lines
- National Grid invests to reinforce the network to prevent congestion issues
- An optimally-located energy store could delay or even eliminate some of these investment costs

System Challenges

Cause	Effect	Impacted Services
Embedded Generation (Renewable Power)	Lower System Inertia	Frequency Response
	Less predictable power supply	
	Supply further from consumption	Reactive Power Services
Interconnectors to continental Europe	Lines less loaded (particularly at night)	
Electrification of Transport	Greater electricity demand	Infrastructure Reinforcement

Project Outline



Simulation (Evolutionary Algorithm)

- **Optimal Operation Strategy (when to charge and discharge)**
- **Expected Revenue/Savings to National Grid**
- **Optimal Combination of Services Contracts**

Summary

- The potential value of future energy storage technologies is hard to estimate
  - Multiple services could be provided, but the feasibility and profitability of combining service provision is still unclear
- A study based on real data about the current provision of balancing services should help with estimating the potential role energy storage could play in a future energy market
- If energy storage could be shown to offer a financially viable alternative to current methods, this could have an impact on policy making and investment in energy storage technology research

Thank You

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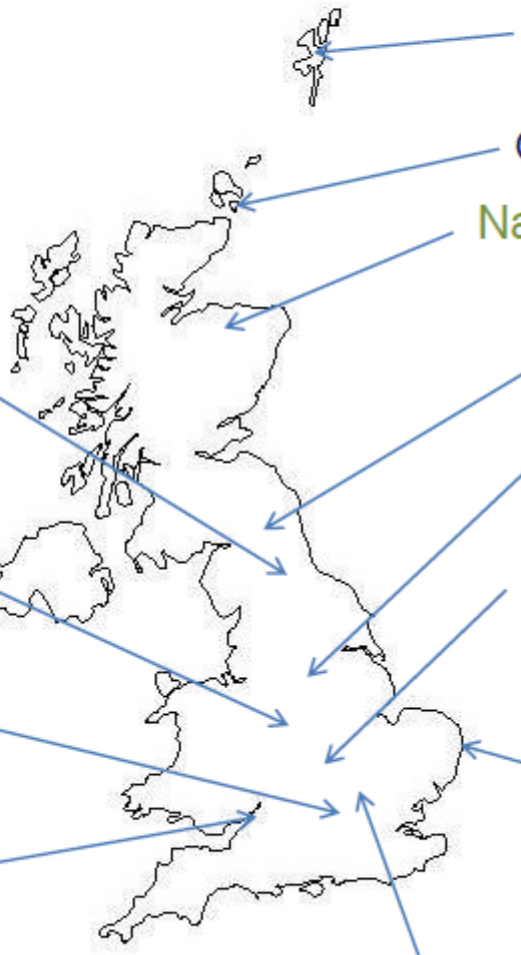
centre for complexity science

nationalgrid

Installations as at 1 November 2013

ENERGY STORAGE esof OPERATORS FORUM

Key
Commissioned
Under construction
Planned
Decommissioned



Shetland 1 MW 6 MWh
Shetland 1 MW 3 MWh
Orkney 2 MW 500 kWh
Nairn 100 kW / 150 kWh
Wooler 100 kW 200 kWh
50 kW 100 kWh
Maltby 50 kW 100 kWh
Milton Keynes 150 kW 450 kWh
Hemsby 200 kW 200 kWh
Leighton Buzzard 6 MW 10 MWh
Darlington 2.5 MW 5 MWh
100 kW 200 kWh
50 kW 100 kWh
Willenhall 2 MW 375 kWh
Chalvey 25 kW 25 kWh
Bristol 90 kW up to 321 kWh
6 kW 14.4 kWh