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Demand response and renewables

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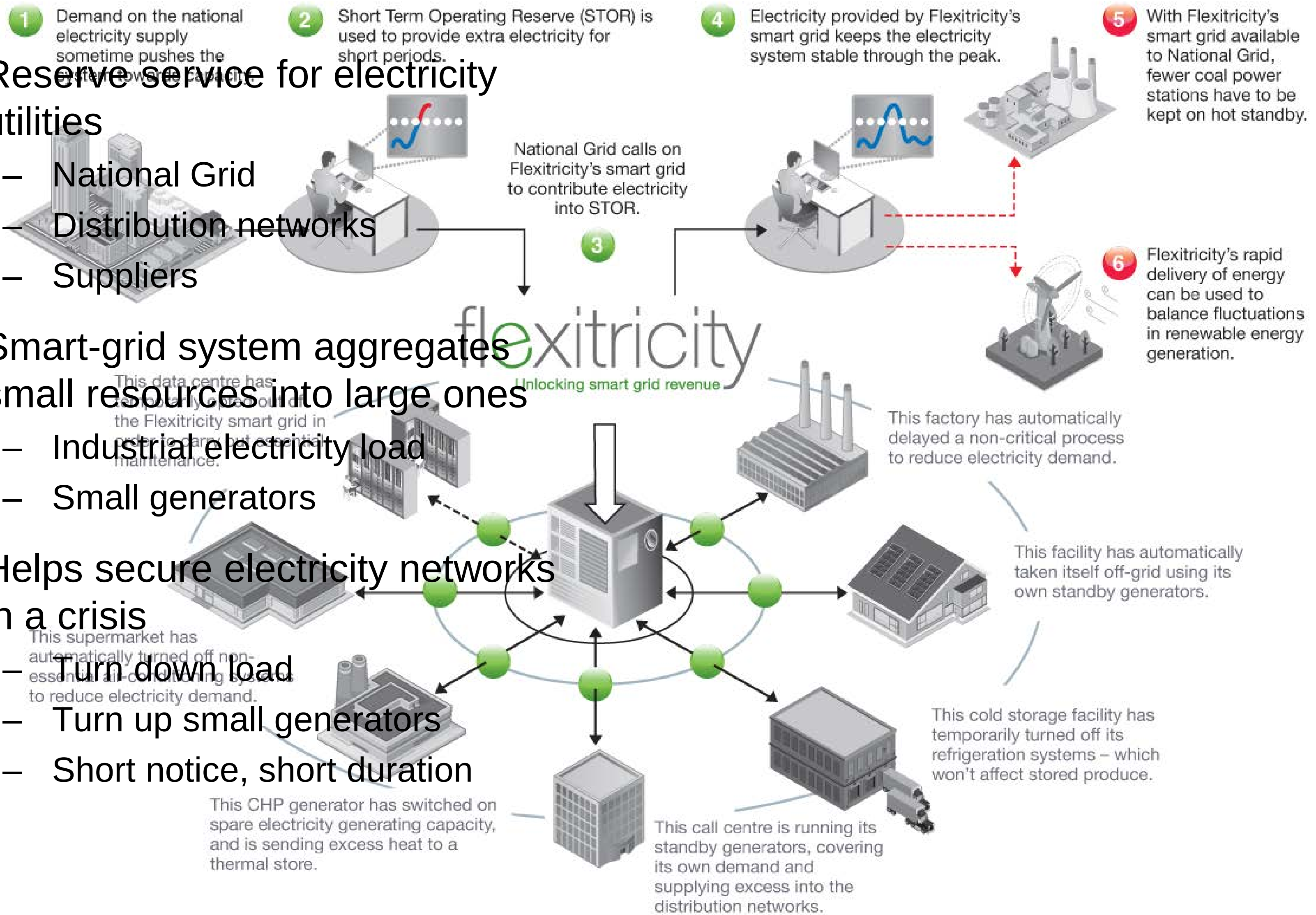
What does Flexitricity do?

- Reserve service for electricity utilities
  - National Grid
  - Distribution networks
  - Suppliers
- Smart-grid system aggregates small resources into large ones
  - Industrial electricity load
  - Small generators
- Helps secure electricity networks in a crisis
  - Turn down load
  - Turn up small generators
  - Short notice, short duration



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What is demand response?

- Actions by customers to change the amount of electricity they take off the grid at particular times in response to a signal
  - OFGEM

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Things that are not demand response

- We like
  - Energy efficiency
  - Information, inc. smart meters
  - Other smart network technologies
- We need to cope with
  - Heat pumps
  - Electric vehicles
  - Why not turn these into demand response?
- We don't like
  - Demand destruction (exporting emissions)
  - Demand packing (fake DR)

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The challenges of… any electricity grid

Conventional challenges

- Plant availability
  - Nuclear 84%
  - Coal 85%
  - CCGT 87%
- Largest element
  - Nuclear 1320MW
  - Interconnector 2000MW
- Demand forecast error

Renewable challenges

- Plant availability
  - Wind 10%
  - Hydro 75%
  - Biomass 85%
- Largest element
  - Some large biomass
  - Otherwise small elements
- Generation forecast error

Availability factors from National Grid winter outlook report 2012

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What are we trying to achieve with DR?

- Is it local, national or transnational?
- Is it about next winter, or the next 10 seconds?
- Adequate capacity, or adequate energy?
- Reducing peak demand, or responding to failures?
- Economic system management, or crisis survival?

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Demand response at local level

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Distribution network DR

- Geographical area
  - Single substation, possibly single busbar
- Trigger
  - High local demand
  - Transformer or feeder failures
- Response time
  - Pre-fault: 30 minutes
  - Post-fault: 3 minutes
- Duration
  - Generally a few hours
  - Could happen for several days in a row

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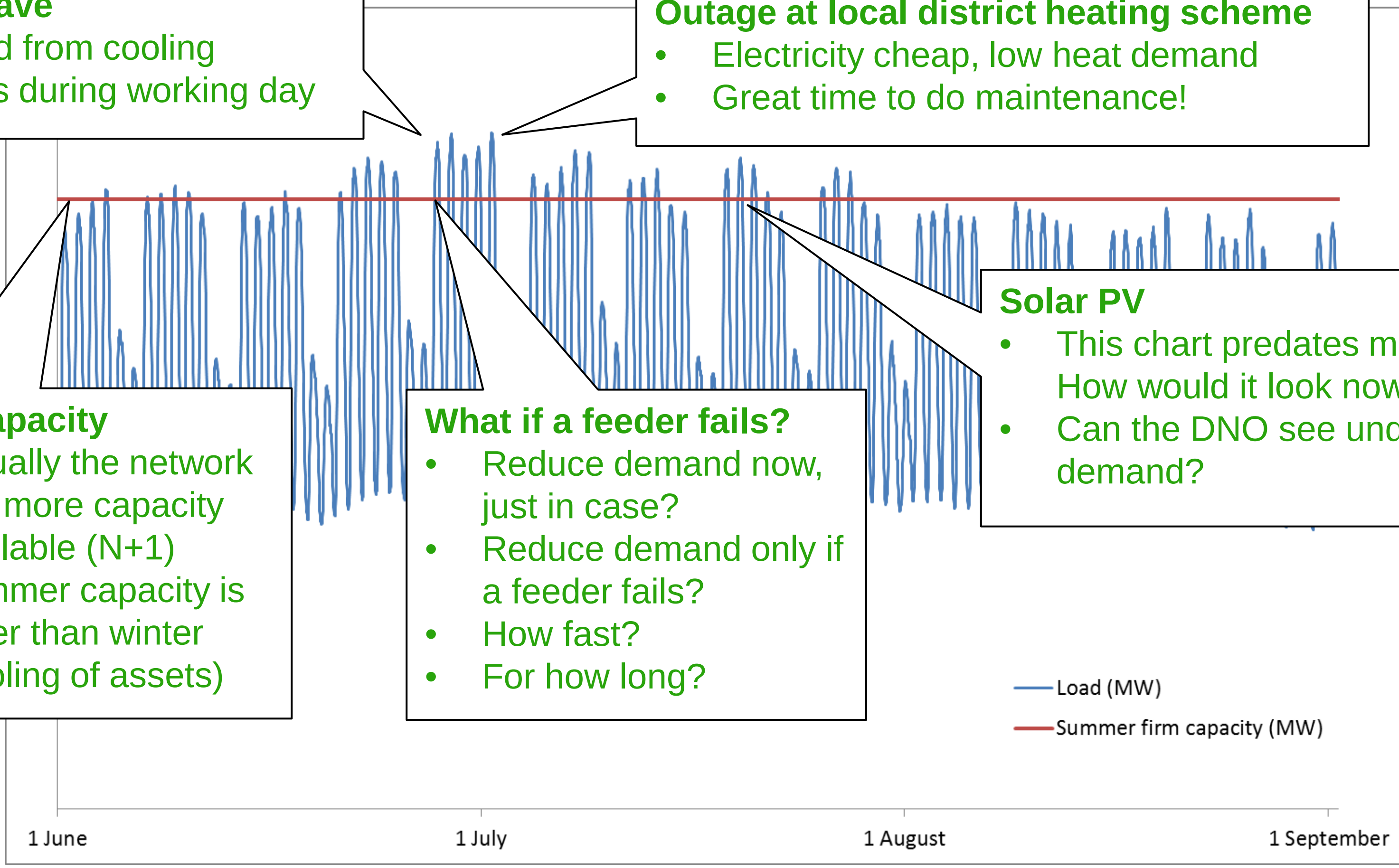
Demand response at substation level

Heat wave
Demand from cooling systems during working day

Outage at local district heating scheme
- Electricity cheap, low heat demand
- Great time to do maintenance!



Firm capacity
- Actually the network has more capacity available (N+1)
- Summer capacity is lower than winter (cooling of assets)

What if a feeder fails?
- Reduce demand now, just in case?
- Reduce demand only if a feeder fails?
- How fast?
- For how long?

Solar PV
- This chart predates mass PV. How would it look now?
- Can the DNO see underlying demand?

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First line DR: combined heat & power

- Planning ahead
  - Reduce stored heat
  - Make generation visible to DNO
  - Adjust maintenance schedule
  - Increase heat storage capacity
- Operations
  - Allow DNO to constrain ON
  - Store excess heat
  - Occasionally use heat dump

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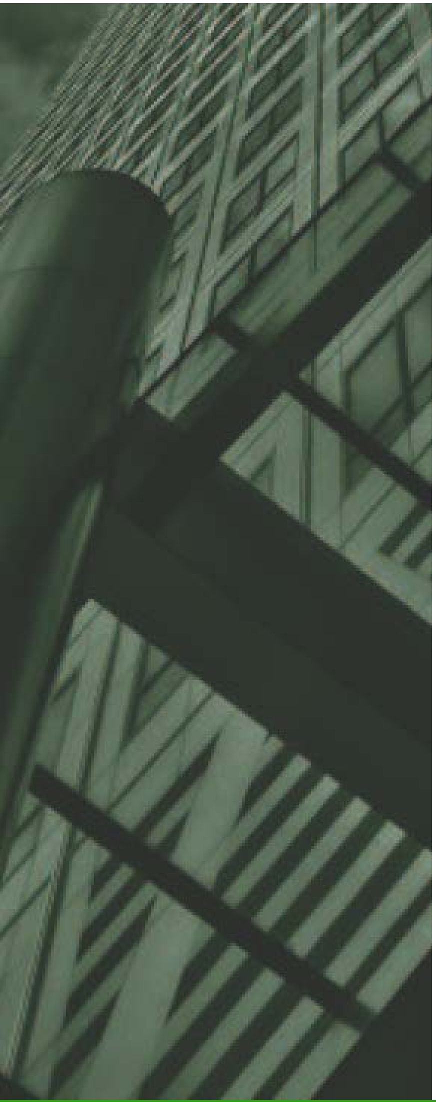
Second line DR: load management



- Space cooling
  - Ubiquitous flexible load
  - Low thermal inertia – short curtailment only
- Cold storage
  - Fewer locations
  - More inertia – long curtailment possible
  - Firm constraints
- Other loads
  - Water pumping
  - Manufacturing
  - Site-specific capability

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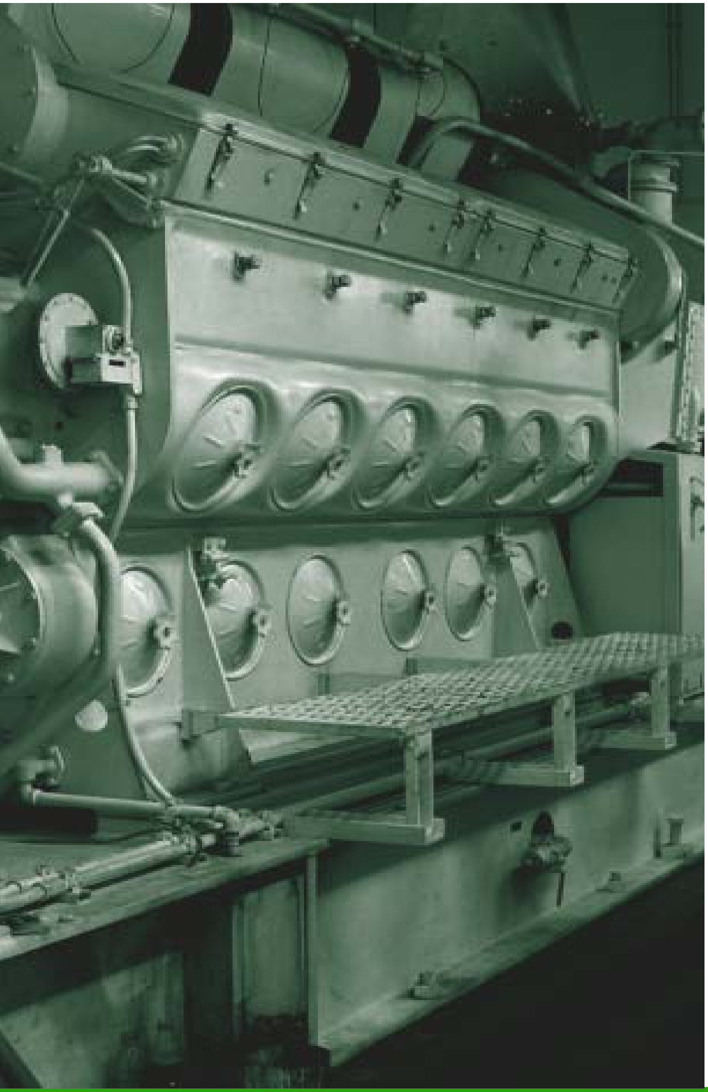
Third line DR: standby generation



- Standby generators are:
  - Everywhere
  - Desperately in need of testing
  - Expensive and polluting
- Role in demand response
  - There when you need it
  - Post-fault for DNO
  - Margin services for TSO
  - 50-100 hours/year
    - Roughly equivalent to good practice test and exercise regime

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Demand response at national level

1. Reserve

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National DR: reserve

- Geographical area
  - Regional / national
- Trigger
  - Rapid demand pickups, demand forecast errors
  - Major power station failures
  - High wind cutout
  - Wind forecast error (especially timing)
- Response time
  - A few minutes
- Duration
  - 15 minutes to 4 hours

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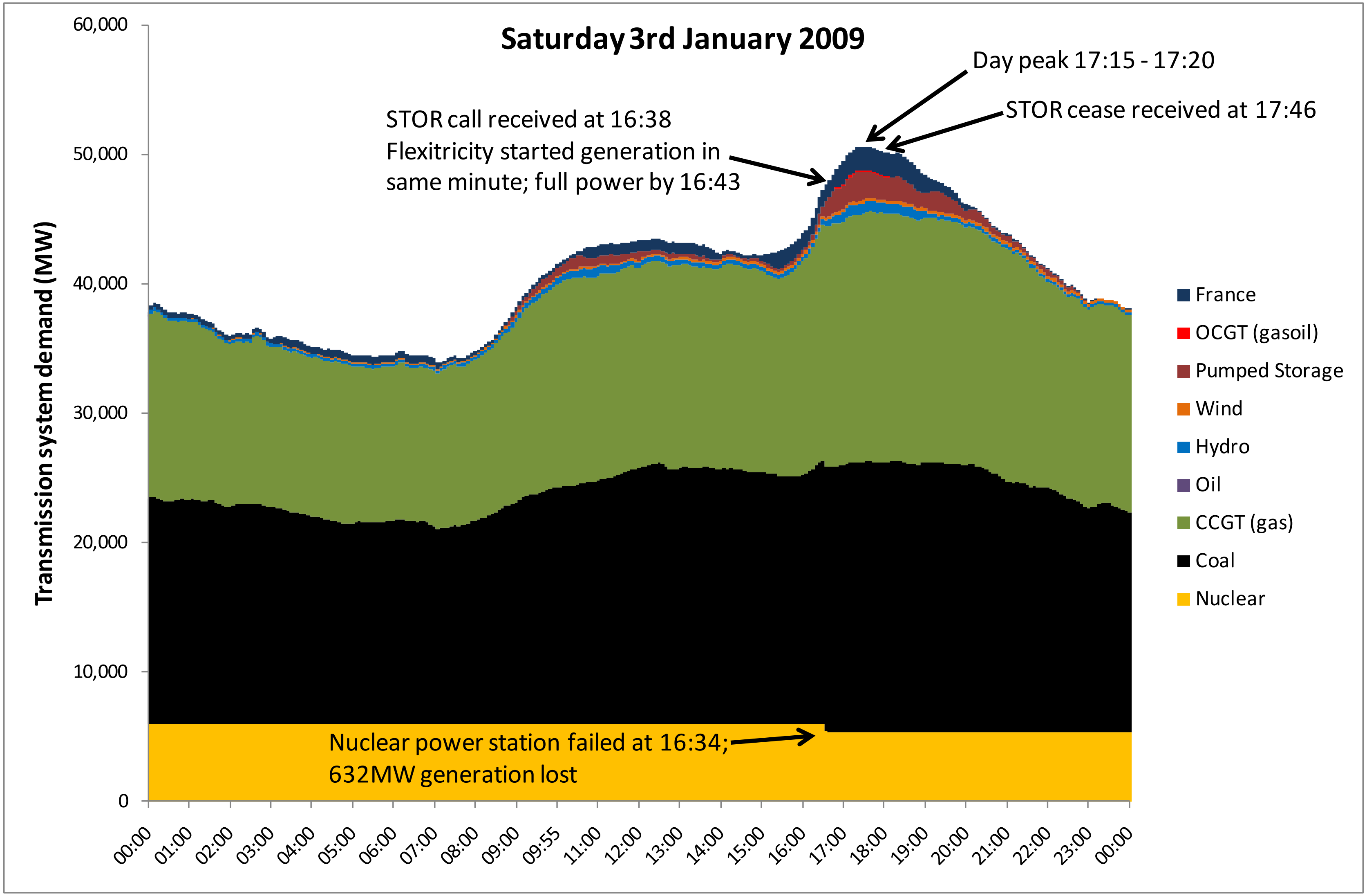

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Tilbury power station fire

- Rapid deload from 405MW at 07:53 when fire detected at Tilbury
- Flexitricity called by National Grid at 07:58
  - All but one Flexitricity site was dispatched
  - 38% of demand-side STOR calls went to Flexitricity

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Demand response at national level

2. Frequency response

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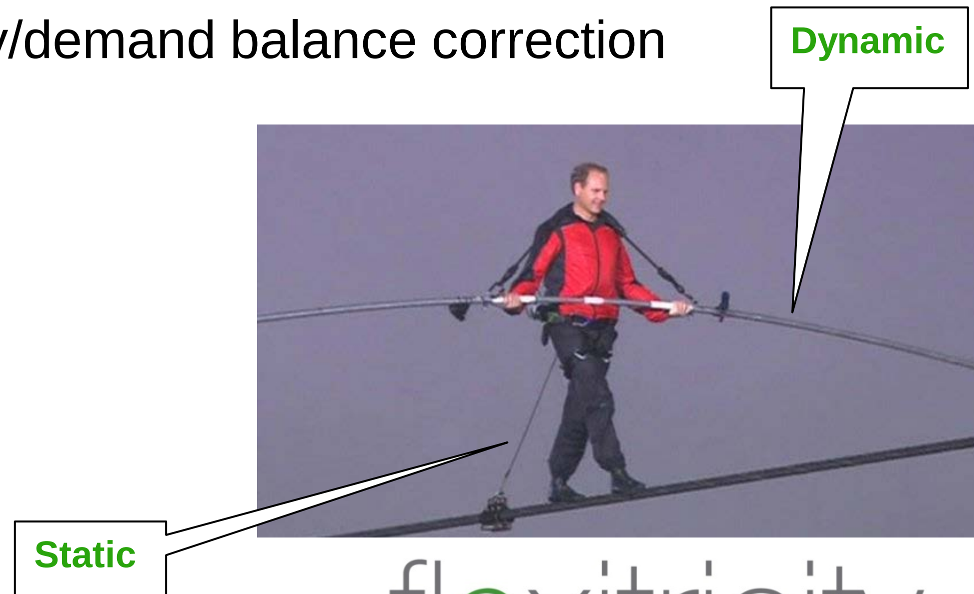
National DR: frequency response

- Geographical area
  - National / transnational (boundary: the AC network)
- Trigger
  - Static: major power station failures
  - Dynamic: continuous supply/demand balance correction
- Response time
  - Static: 1-2 seconds
  - Dynamic: continuous
- Duration
  - Static: 30 minutes
  - Dynamic: continuous



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Flexitricity Frontline™

Providing National Grid’s first line of protection against power cuts.

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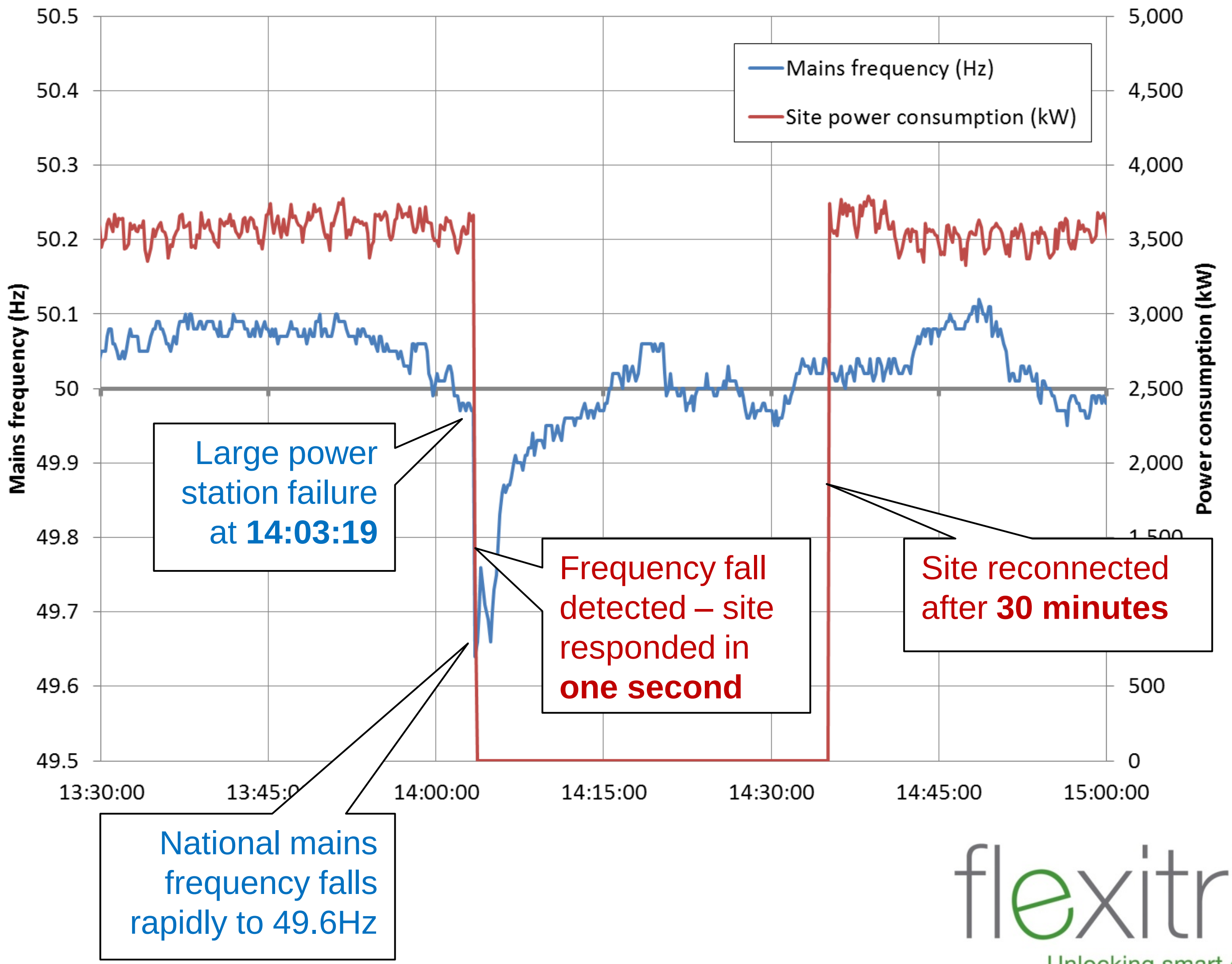
Frontline event



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Comparing local to national DR

Local

- Few options
- Peaks, network asset failures
- Capex saving
- Visibility of renewables

National

- Many options
- Peaks, forecast errors, power station failures
- Opex and capex saving
- Active management of renewables

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Demand response, renewable generation and grid efficiency

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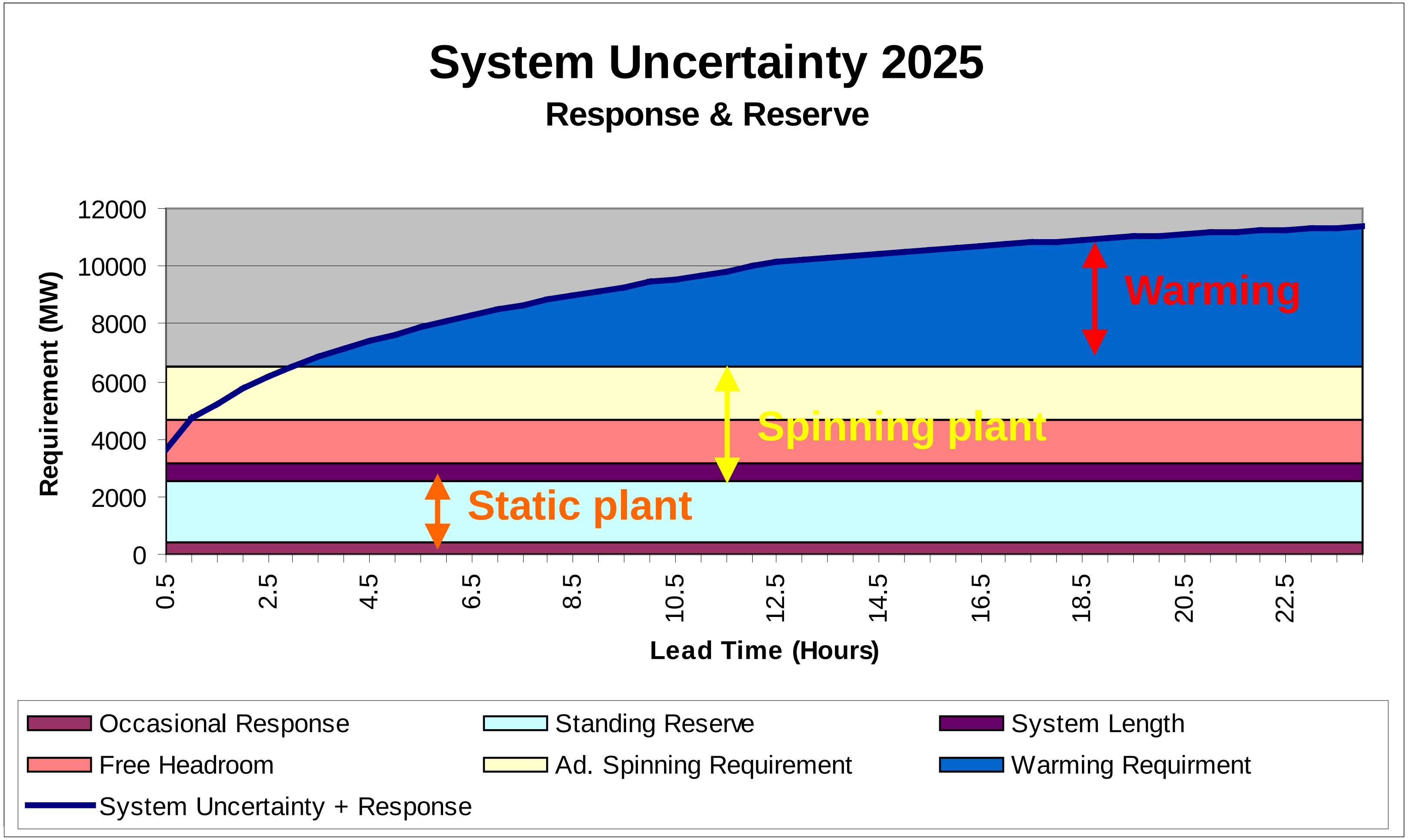
Planning (slightly) ahead



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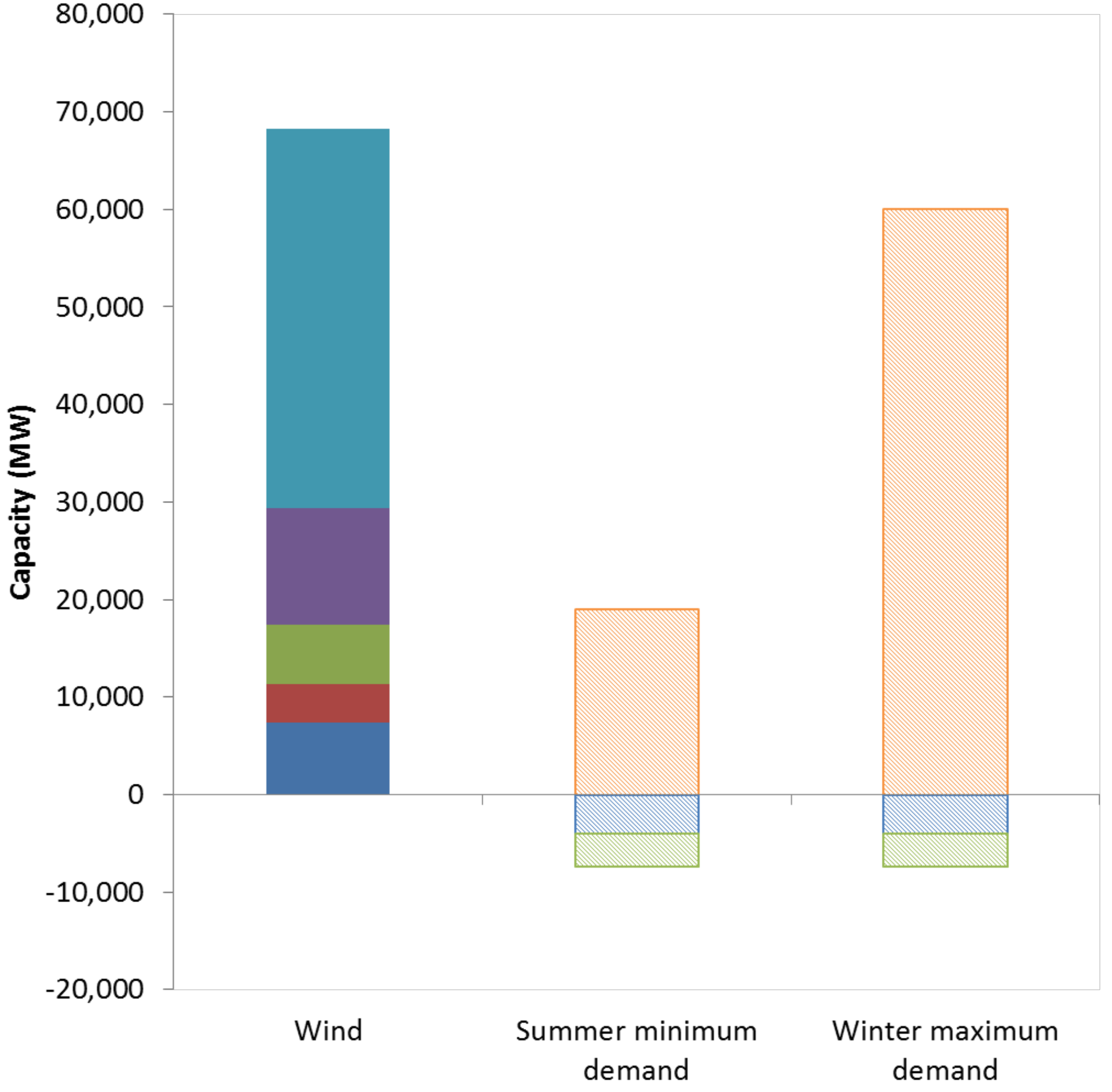
Demand response and renewables



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Demand response and renewables

- “You still need lots of gas power stations”
  - Wind is a great fuel-saver, but not a great capacity-saver
  - Demand response can provide some of the capacity
  - That saves capex
- “Networks can’t rely on distributed generation”
  - They can if
    - They can see it
    - They can control some of it
- “Thermal power stations are inefficient at part load”
  - Yes they are
  - Demand response tackles that

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Some numbers

- Startup time
  - Steam: ~6 hours at 10% fuel burn before synchronising
  - CCGT: ~2 hours
- Part-loading heat rate penalty

Type	25%	50%	75%
CCGT	78.8%	19.5%	10.2%
Coal, oil	27.6%	6.1%	1.0%

Global Energy Decisions, DG Comp 2006

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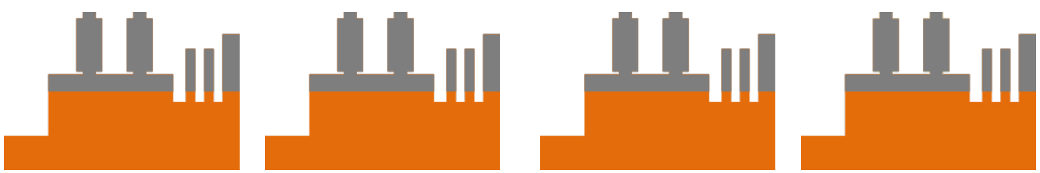
“Aunt Sally” calculation

We have four 500MW CCGTs to meet a 1500MW load

= 1500MW load

500MW 100% | **500MW 100%** | **500MW 100%** | **0MW 0%**

CO_2 emissions	540 tonnes/hour
System status	**NOT secure**
Margin	**None. System fails.**
Cost of margin (hour)	0 tonnes/MW/hour
Cost of margin (annual)	0 tonnes CO_2/MW



375MW 75% | **375MW 75%** | **375MW 75%** | **375MW 75%**

CO_2 emissions	595 tonnes/hour
System status	**SECURE**
Margin	**500MW**
Cost of margin (hour)	0.11 tonnes/MW/hour
Cost of margin (annual)	965 tonnes CO_2/MW

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Conclusions

- A renewable grid is not a revolution
  - We've been doing this stuff for years
  - Fossil and nuclear plant also need backup
- An efficient grid needs
  - Visibility
  - Flexibility
  - Controllability
- Demand response helps absorb renewables
  - Flexible customers can follow resource
  - Still scratching the surface

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