

Low Carbon London Demand Response Trials – An early perspective I&C Lessons Learnt/General Progress Update

16th May 2012

Liam O'Sullivan, Programme Director, Low Carbon London



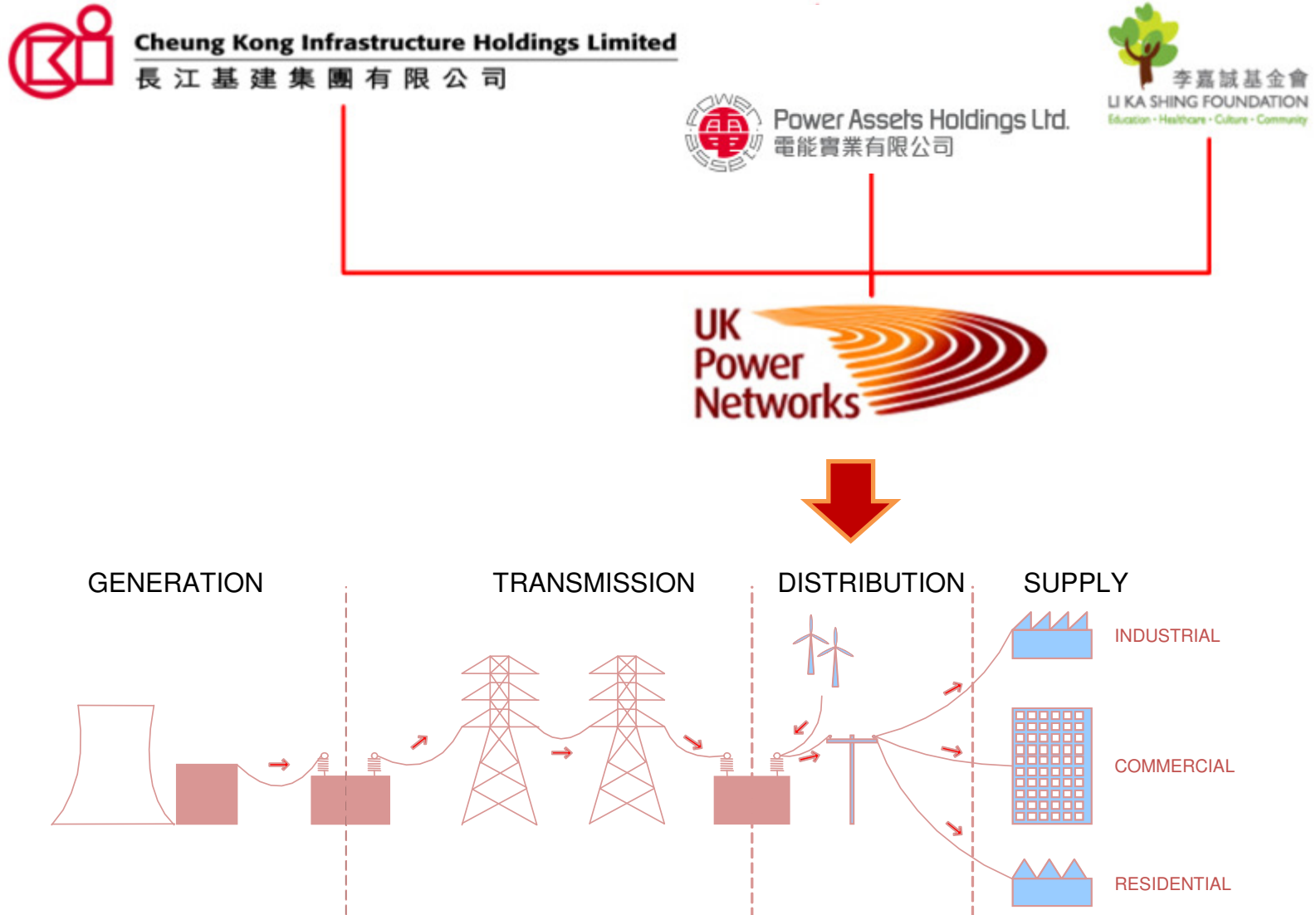
**UK
Power
Networks**



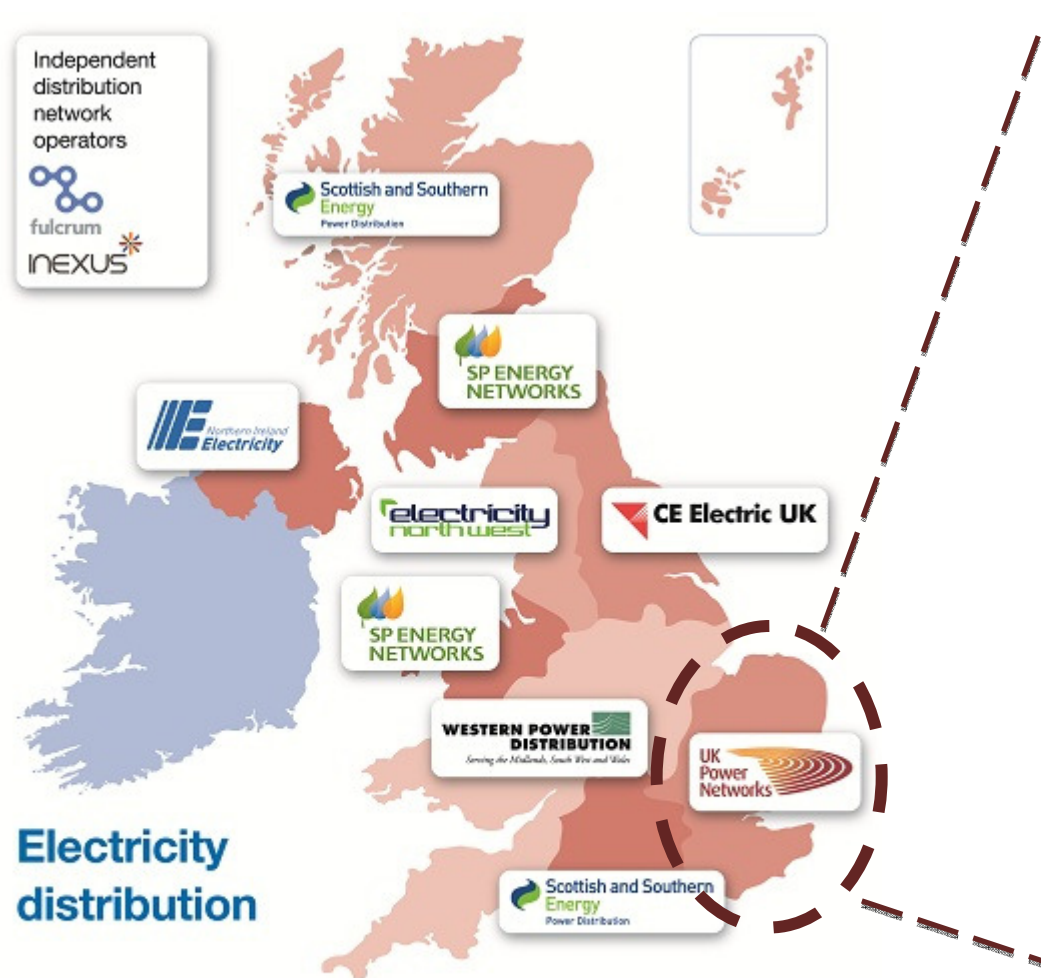
Agenda

- Introduction, refresher and progress to date
- Demand Response Trials
- Carbon Impact
- Typical I&C Customer Profile in London & Customer Recruitment
- Break
- Conflicts and Synergies with other Demand Response programmes
- Baseline Methodology
- Next steps – what the trials will look like
- Closing remarks and emerging issues (including Q&A)

UK Power Networks



UK Power Networks



	Total	% of Industry
End Customers Millions	8.0	28%
Service Area km ²	29,165	12%
Underground Network km	134,767	29%
Overhead Network km	47,391	15%
Energy Distributed TWh	89.4	28%
Peak Demand MW	16,229	N/A
New Connections	130,768	35%

Low Carbon London - A learning journey

Learning how to create a smart low carbon city

A pioneering demonstration project, trialling new technologies, commercial innovation and design, operation and network management strategies...

- Smart Meters
- Wind Twinning
- Demand Side Management/I&C, Smart Appliances, Demand Flexibility
- Distributed Generation
- Electric Vehicles
- Heat Pumps
- New Tools, Operational and Investment Practices
- Learning Lab
- Conclusions/Video



Progress: some key highlights

- **A comprehensive project plan, solution design, trial hypothesis, test cases and a fully mobilised delivery team – deliver the learning AND the programme outcomes & objectives.**
- **A common demand response contract** between three external aggregators and UK Power Networks to enable sign up of customers to reduce load at peak times on selected substations.
- c. 13MW's signed up and further c.10MW as prospects.....



Demand Side Management (DSM)

Challenge:

Our low carbon electricity future is dependent on matching electricity demand to available, intermittent supply

Our response:

Monitor how energy efficiency schemes and time-of-use tariffs affect residential & SME (Small and Medium Enterprises) customer electricity demand

Assess the impact of these initiatives on the electricity network

Work with commercial aggregators to establish new demand response (DR) contracts with industrial & commercial customers

Can demand response postpone/defer network reinforcement?
(When/How/Who/What/Where)



To what extent different demand side management initiatives can influence customers' electricity consumption

Low Carbon London Demand Response Trials – An early perspective Summary

16th May 2012

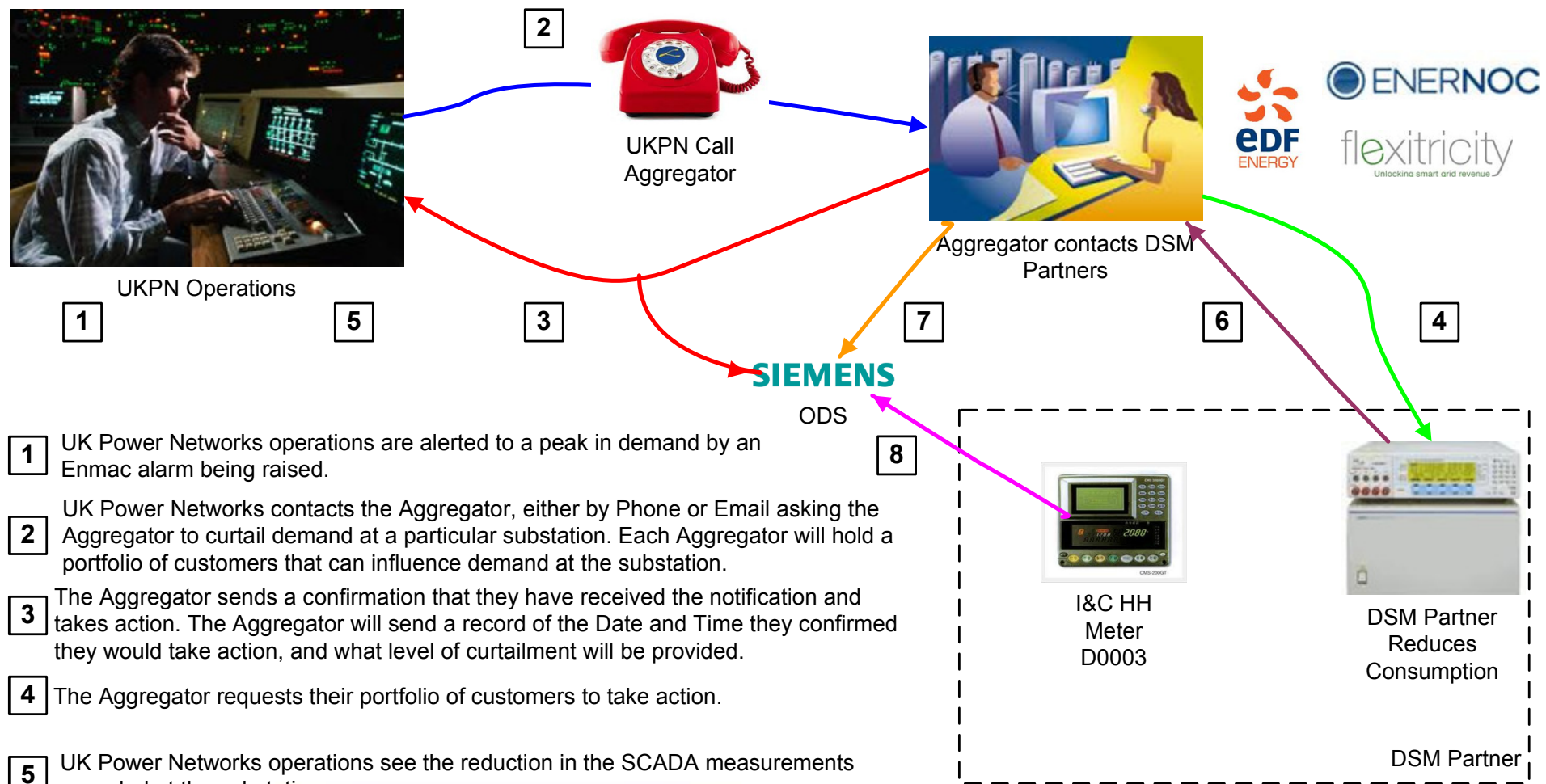
Liam O'Sullivan, Programme Director, Low Carbon London



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Networks



Method of triggering demand response:



- 1** UK Power Networks operations are alerted to a peak in demand by an Enmac alarm being raised.
- 2** UK Power Networks contacts the Aggregator, either by Phone or Email asking the Aggregator to curtail demand at a particular substation. Each Aggregator will hold a portfolio of customers that can influence demand at the substation.
- 3** The Aggregator sends a confirmation that they have received the notification and takes action. The Aggregator will send a record of the Date and Time they confirmed they would take action, and what level of curtailment will be provided.
- 4** The Aggregator requests their portfolio of customers to take action.
- 5** UK Power Networks operations see the reduction in the SCADA measurements recorded at the substation.

- 6** The Aggregator collects measurement data on a time interval basis on the progress of the curtailment across all customers in the portfolio.
- 7** The Aggregator will send a file containing the measurement data at the customer level to the Operational Data Store.
- 8** UK Power Networks obtains HH I&C metering data.

SUMMARY - is it smart?

- The current established ways of managing networks will quickly become unsustainable.
- We have built a strong foundation for innovation – as good if not better than other DNO's.
- Any expertise developed through this process must be transferred and embedded into the rest of the business, partners and professionals, government, policy makers.
- Commercial innovation, strategic partnerships and customer engagement is crucial.
- Must have embedded this philosophy into our business by RIIO-ED1.
- Enable us to shape our business and enable us to become a top performing company under the new regulatory framework (RIIO-ED1).

This is the beginning of a new era in the management of electricity networks and asset management, future is here future is now!!

SIEMENS



Institute for Sustainability

nationalgrid



Any questions?



**Imperial College
London**



MAYOR OF LONDON



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Low Carbon London Demand Response Trial

An early perspective from our winter trial

Andrew Alabraba

16th May 2012



UK
Power
Networks



Demand Side Management (DSM)

- DSM has been traditionally seen as a means of reducing peak electricity demand so that utilities can delay building further capacity
- When DSM is applied to the consumption of energy in general not just electricity but fuels of all types
- This gives the rise to the concept of ‘smart grids’

“an electricity power system which can significantly integrate the actions of all users connected to it – generators consumers, and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies”

Smart Grid

Characteristics of a Smart Grid

Smart technologies to economically enhance the service quality, reliability, security and safety of the electricity supply

Smart communications system to provide greater end-to-end visibility of network conditions

Connections of low/zero carbon distributed generation (DG)

Smart power flow, storage, voltage and fault level management

Smart management of flexible/responsive demand to improve load factor, minimise losses and create additional capacity headroom

Strategies to minimise the network loading impact of electrification of heat and transport

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Demand Response

- Residential and Small Medium Enterprises (SME) consume approximately 50% of the electricity produced in the UK
- Increase in DG will mean that power flows will no longer be unidirectional and predictable
- UK Power Networks understands that the estimated load growth due to electrification of heat and transport we will need to be able to shift or reduce demand locally at the point of need

DNO to DSO process

- A Distribution Network Operator (DNO) will continue to respond to load growth in maximum or peak demand – it has no ability, desire or flexibility to influence demand or generation
- A Distribution System Operator (DSO) will take advantage of the network benefits of smart grid technology and have access to a portfolio of:
 - Responsive demand
 - Storage
 - Controllable generation assets
- Inflexible to flexible , reactive to proactive

Responsive Demand

- Flexible Demand such as electric vehicles, heat, cooling, white goods and storage
- Dispatchable Resources such as network storage, demand response and DG contracts
- Responsive demand can be obtained by managing residential and SME consumer demand via Time of Use (ToU) tariffs, by leveraging Industrial and Commercial (I&C) demand response and dispatchable generation

LCL Demand Response - Trial Objectives

- Provide network support
- Defer network reinforcement
- Determine the type of I&C customer responsive demand we have in London
- Understand the effects on the distribution network of demand recovery
- Instil confidence in our business that demand response of I&C customers is a reliable tool to be used in the Control Room
- Determine the conflicts between DNOs and National Grid

LCL Demand Response - Our Contract

- Contract between UK Power Networks and the Aggregator
- Flexitricity, EDF Energy and EnerNOC
- Up to 25 MW of demand response
- Availability payment / MWh
- Utilisation payment / MWh
- Provide a response within 30 minutes

Winter Trial

- Testing of processes
- 2 events in the month of March
 - 1st event successful and a 2 MW demand response given for 2 hours between 13:00 and 15:00
 - 2nd event 2 MW demand response given 30 minutes late due to fuel pump failure between 14:00 and 16:00
- Aggregated demand vs. large single point loads



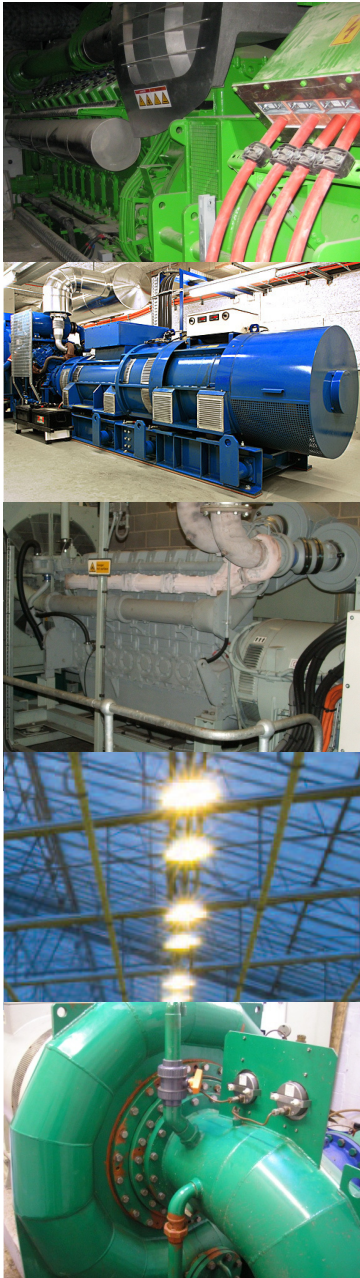
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Carbon and the smart grid

Alastair Martin

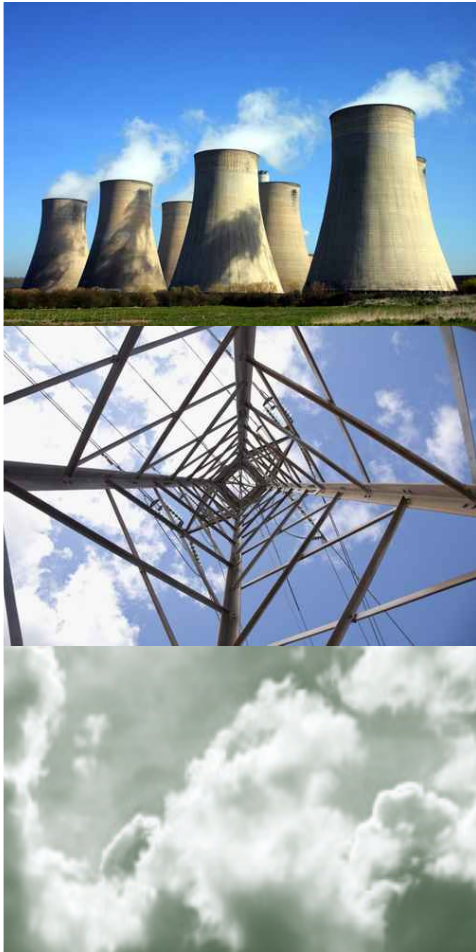
Can smart grids reduce carbon?

- The question
 - Smart grids help manage networks, but at what cost?
- Typical smart grid resources
 - Standby generation (mainly diesel)
 - Other dispatchable generation (mainly CHP)
 - Load management (deferring consumption)



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Where does the smart grid act?



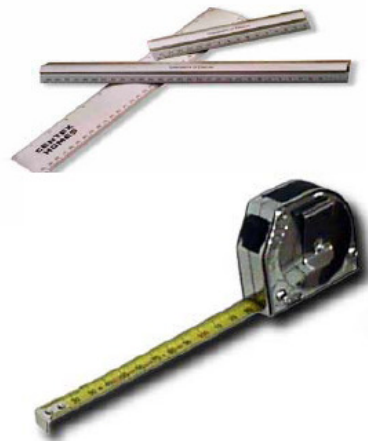
- National energy balance
 - Uncertainty and margin
 - Peak reduction
- Transmission networks
 - Constraints
- Distribution networks
 - Peak reduction
 - Faults and constraints

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Forecasting: National Grid's view...

Forecasting Tools

Demand



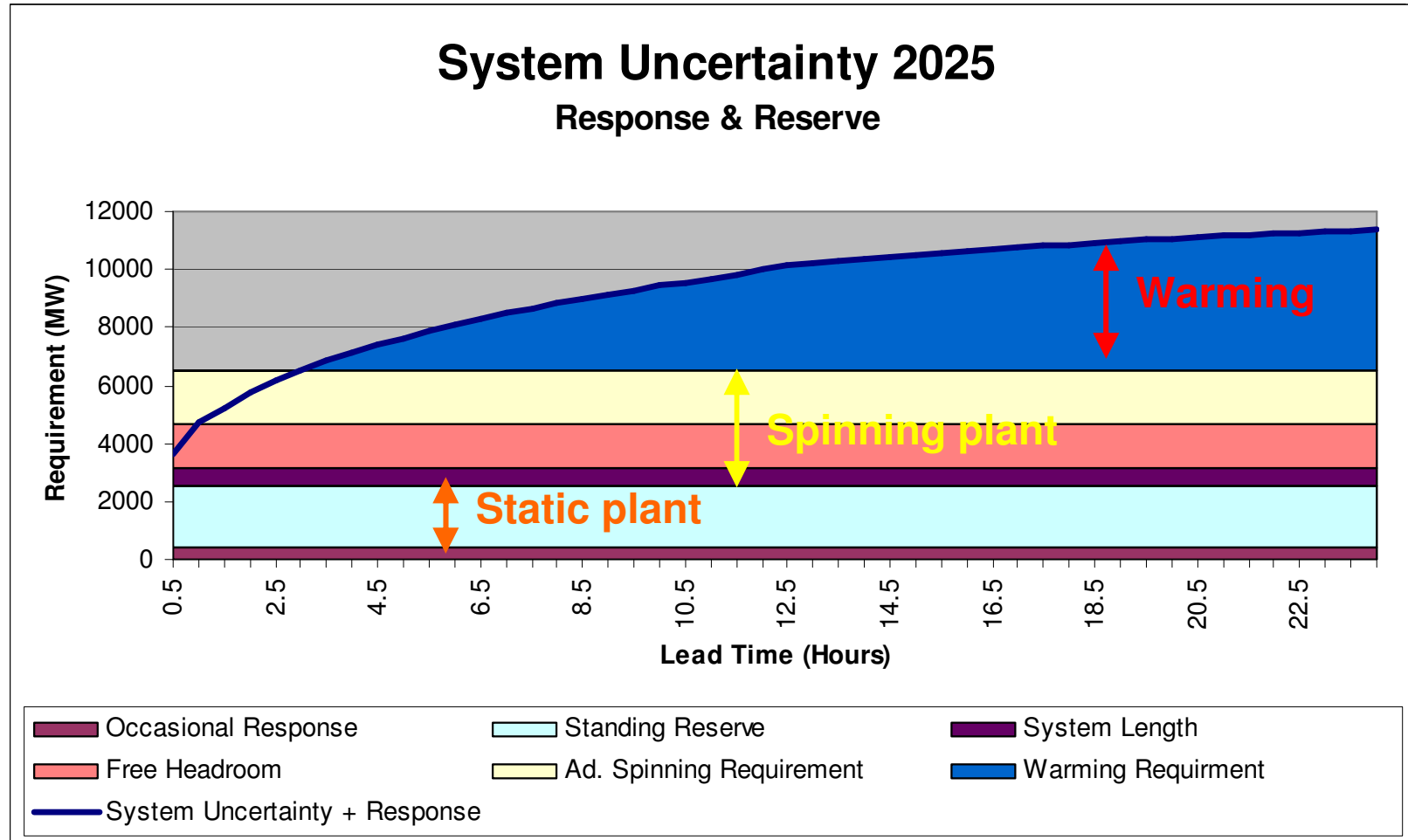
Supply



Source: National Grid

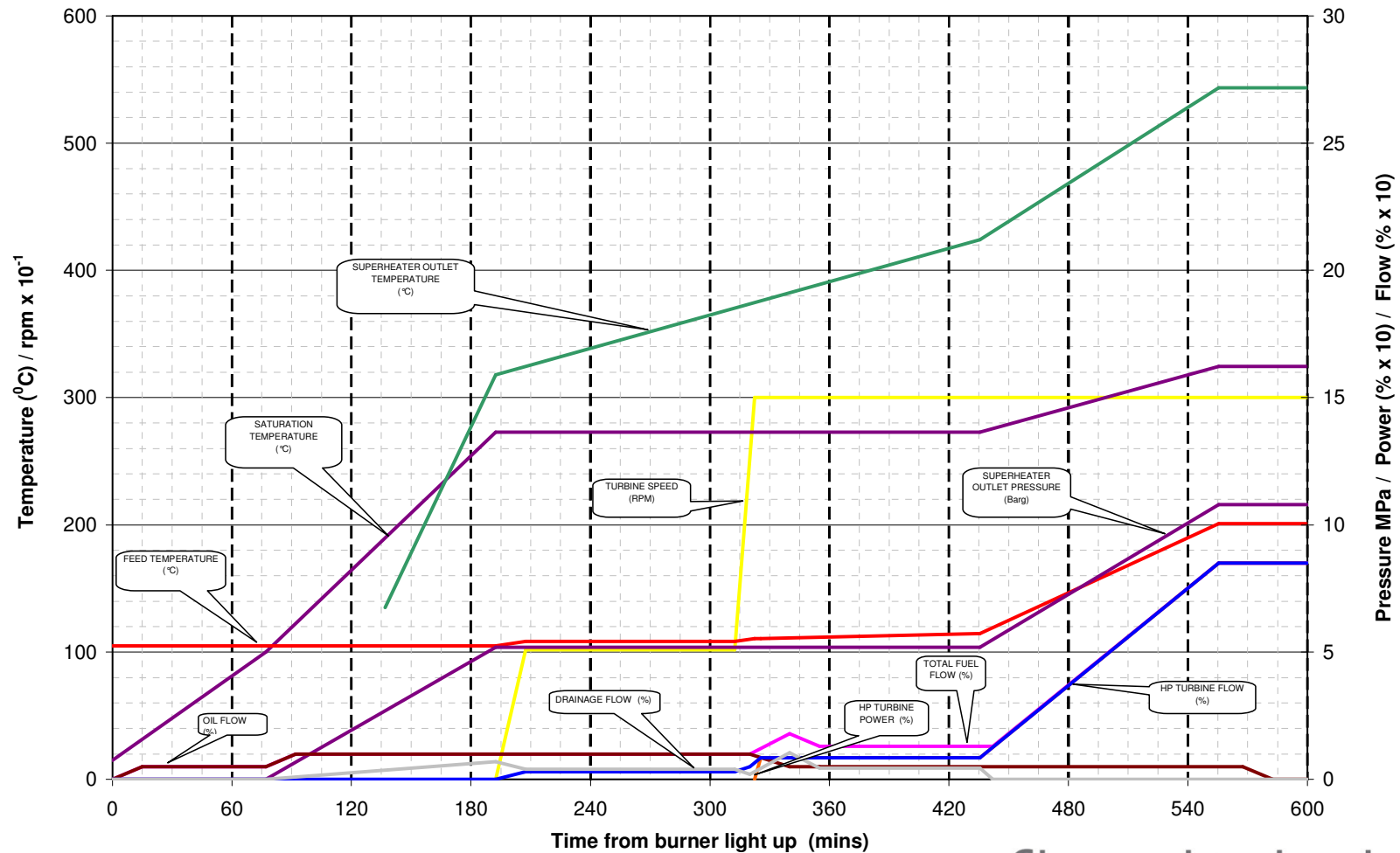
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Planning (slightly) ahead



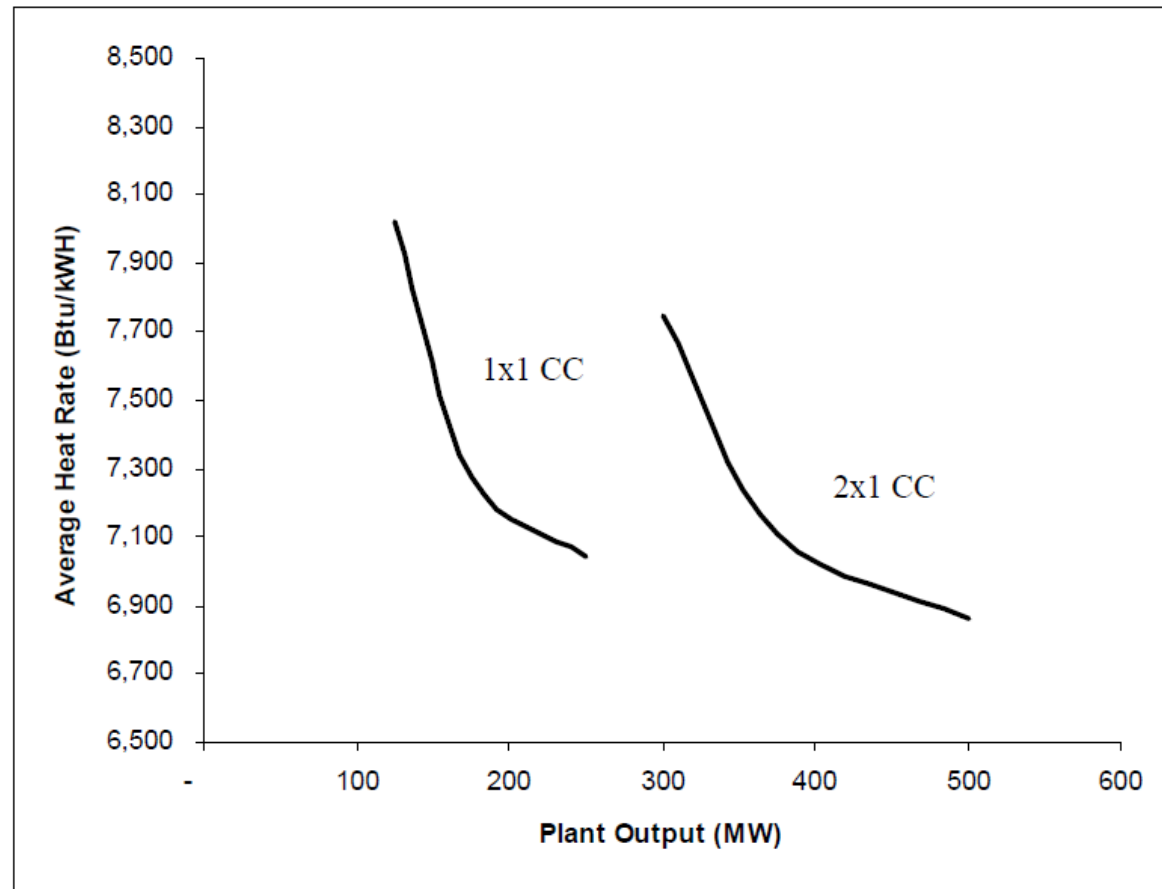
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Warming a coal station



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Part loading a CCGT station



Kram & Stallard, 2001

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Some numbers

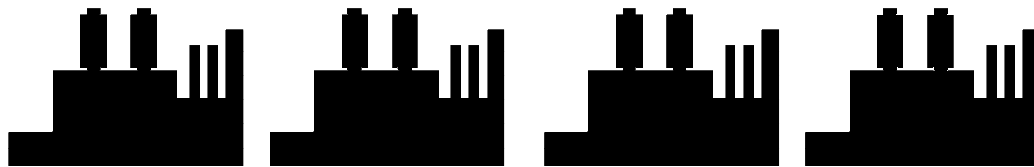
- Startup time
 - Steam: ~6 hours at 10% fuel burn before synchronising
 - CCGT: ~2 hours
- Part-loading heat rate penalty

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

“Aunt Sally” calculation

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



= 1500MW load



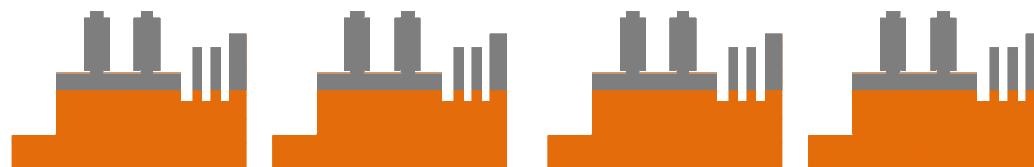
500MW
100%

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%

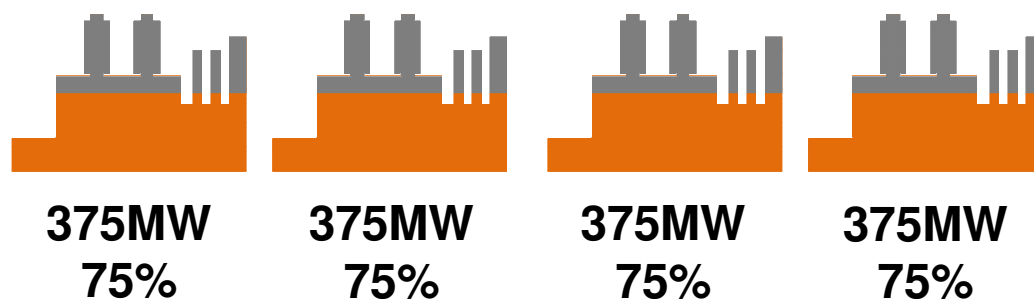
375MW
75%

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

The carbon cost of margin

- The provision of margin is paramount to system security
- How much margin is created and then remains un-used?
- How much margin will be required in a low-carbon future energy mix?
 - Present: ~3,500MW
 - National Grid “gone green”: ~8,000MW in 2020

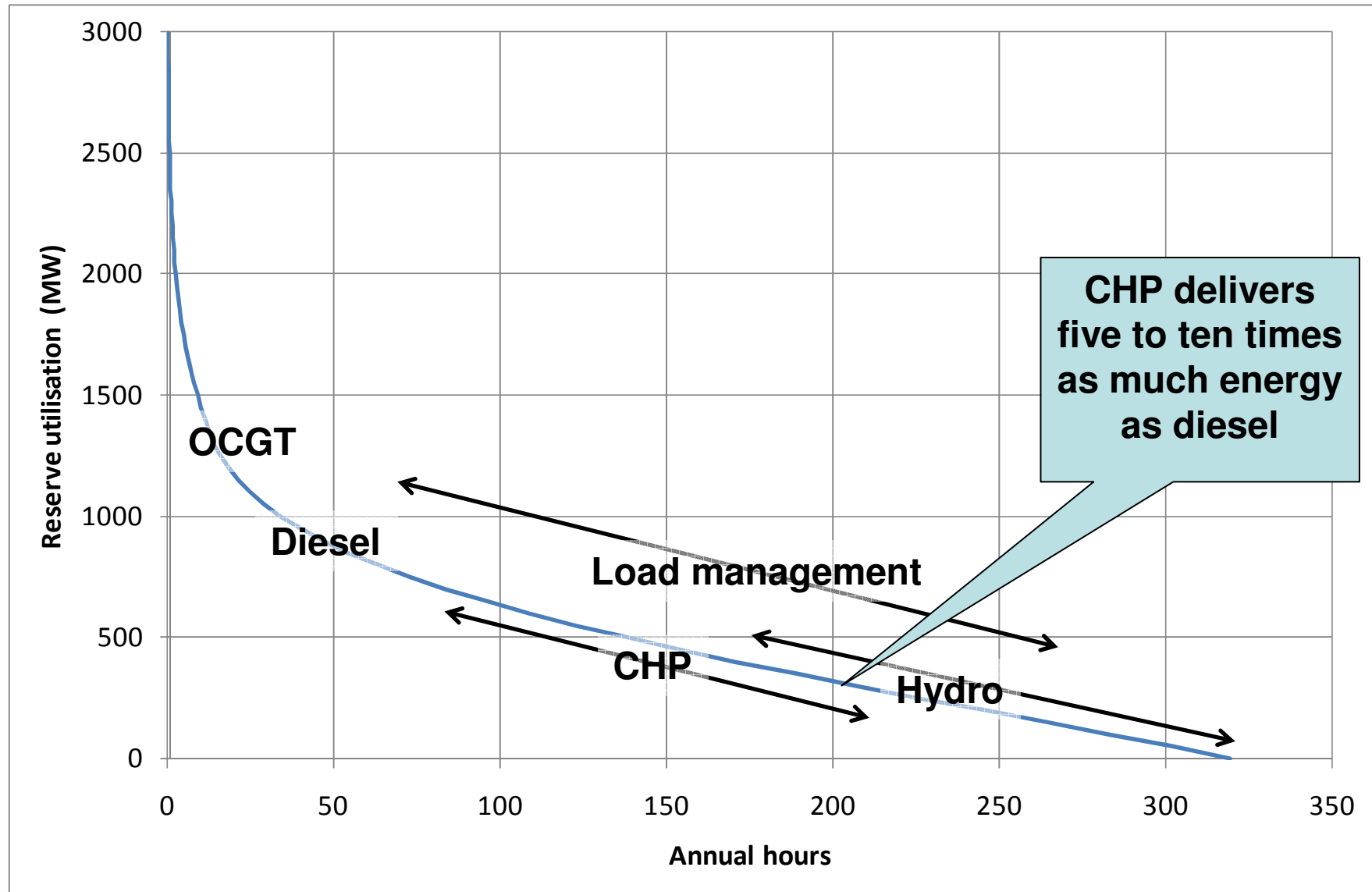


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Aunt Sally for generation

- Part-loaded CCGT margin cost: 965 tonnes CO₂/MW pa
- Diesel margin cost per MW:
 - When not running: 0 tonnes CO₂/MW pa
 - Run 50 hours @ 750 gCO₂/kWh
 - Running emissions: 38 tonnes CO₂/MW pa
- CHP margin cost per MW:
 - Running 250 extra hours @ 570 gCO₂/MW pa
 - Running emissions: 142 tonnes CO₂/MW pa
 - Heat stores eliminate margin emissions!

Margin utilisation and “sweet spots”



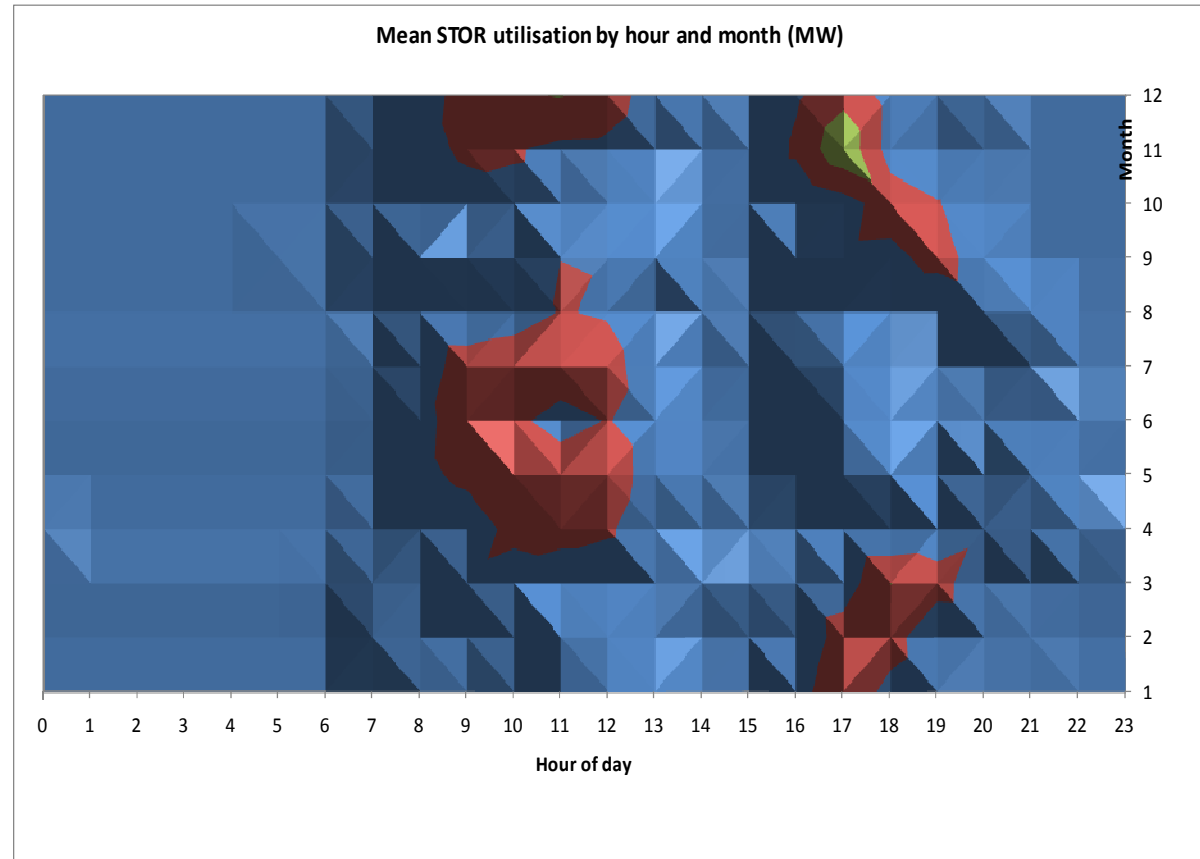
Carbon in distribution networks

- Distribution is different
 - DNOs do not balance supply and demand
 - DNOs manage network capacity
- Flexible capacity is a national resource
 - Smart grid \neq off grid
 - Shared demand-side resources?
 - Double procurement is inefficient
- Stressed networks are usually demand-heavy

Distribution losses

- Mean distribution losses ~8%
- Losses during high reserve utilisation ~15%
- Distributed reserve disproportionately affects I²R losses
- Effect is greater in highly-loaded networks

(Barrett/SENCO 2000, using OFGEM Line Loss Adjustment Factors)



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Will the smart grid always be rational?



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welcome





Typical Customer Profile & Customer Recruitment

Low Carbon London Learning Event 16th May 2012

Henrietta Stock

Portfolio Strategy Manager



Typical I&C Customer Profile in London

- Office buildings, data centres, retail space
- Leased buildings
- Shared ownership of buildings/floors
- Use of facilities management companies
- Many loads are considered business critical e.g. air conditioning for data centres
 - Not prepared to reduce demand
 - Have back-up generation
- Customers prefer not to be remotely managed
- A small number of loads >1MW on each target sub-station
- Many large single point generators – back up generation and CHP.



Challenges

- Customers are cautious
 - LCL is not as well known as STOR
 - Most customers have not heard of the programme
 - Customers are not putting all of their potential in to the programme initially
 - Need more marketing of the programme
- Conflict with other programmes
 - STOR terms preclude the option to undertake STOR and LCL simultaneously
 - Availability windows overlap Mon-Fri
 - Potential conflict/confusion over fit with ANM trials
- Customers are taking a long time to achieve internal sign-off for new terms relating to LCL.

Successes

- The higher revenue on offer compared to STOR is attractive
 - Easier to sign up an LCL customer than a STOR customer because risk/reward is better, except
 - Uncertainty about what UKPN will do after 2013 seriously impacts the business case
- Some customers appreciate the flexibility of a learning programme



thank you



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Smart grid conflicts and synergies

Alastair Martin

Conflicts and synergies

- Conflict *n* /'känˌflikt/
 - a serious disagreement or argument, typically a **protracted** one
 - a prolonged armed struggle
 - an **incompatibility** between two or more opinions, principles, or interests
- Synergy *n* /'sinərjē/
 - the interaction or **cooperation** of two or more organisations, substances, or other agents to produce a **combined effect greater than the sum of their separate effects**

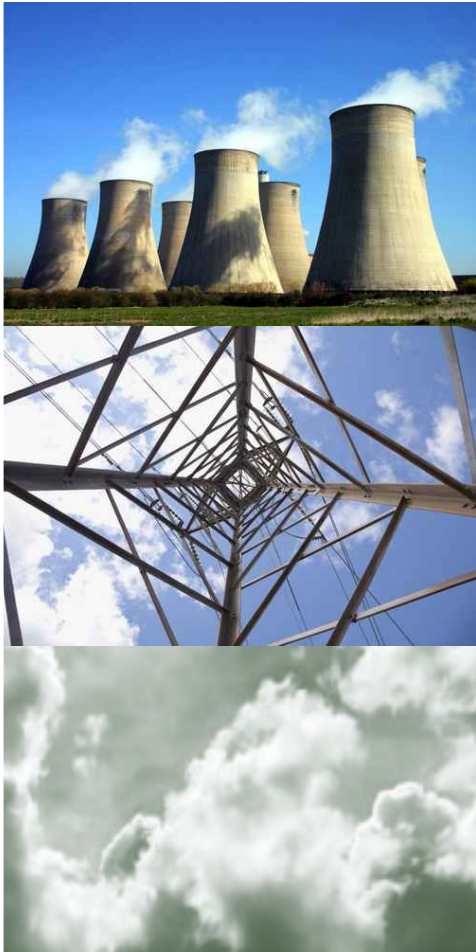
Where is the conflict?

- Same things from same resources
 - Winter peaks (synergy)
- Same things from different resources,
 - Inefficient procurement (missed synergy)
- Different things from different resources
 - As above
- Different things from same resources
 - Short-term operating reserve
 - Pre-fault demand reduction
 - Can we turn conflict into synergy?



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What does National Grid want?



- Margin (including STOR)
 - Fixed megawatt change in net demand
 - Set service periods (STOR: 11hrs/day)
 - Agreed notice periods (1s – 12hrs)
 - Controlled by National Grid
- Peak (triads) and constraint management
- Certainty
 - Trading arrangements penalise inaccurate forecasts
- Internal synergies

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What do DNOs want?

- Pre-fault demand reduction
 - Staying within firm capacity
 - Reducing demand *to* not *by* a target level
 - Only relevant during peaks
- Post-fault demand reduction
 - Keeping customers connected when assets fail
 - Quicker response



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Margin versus peak management



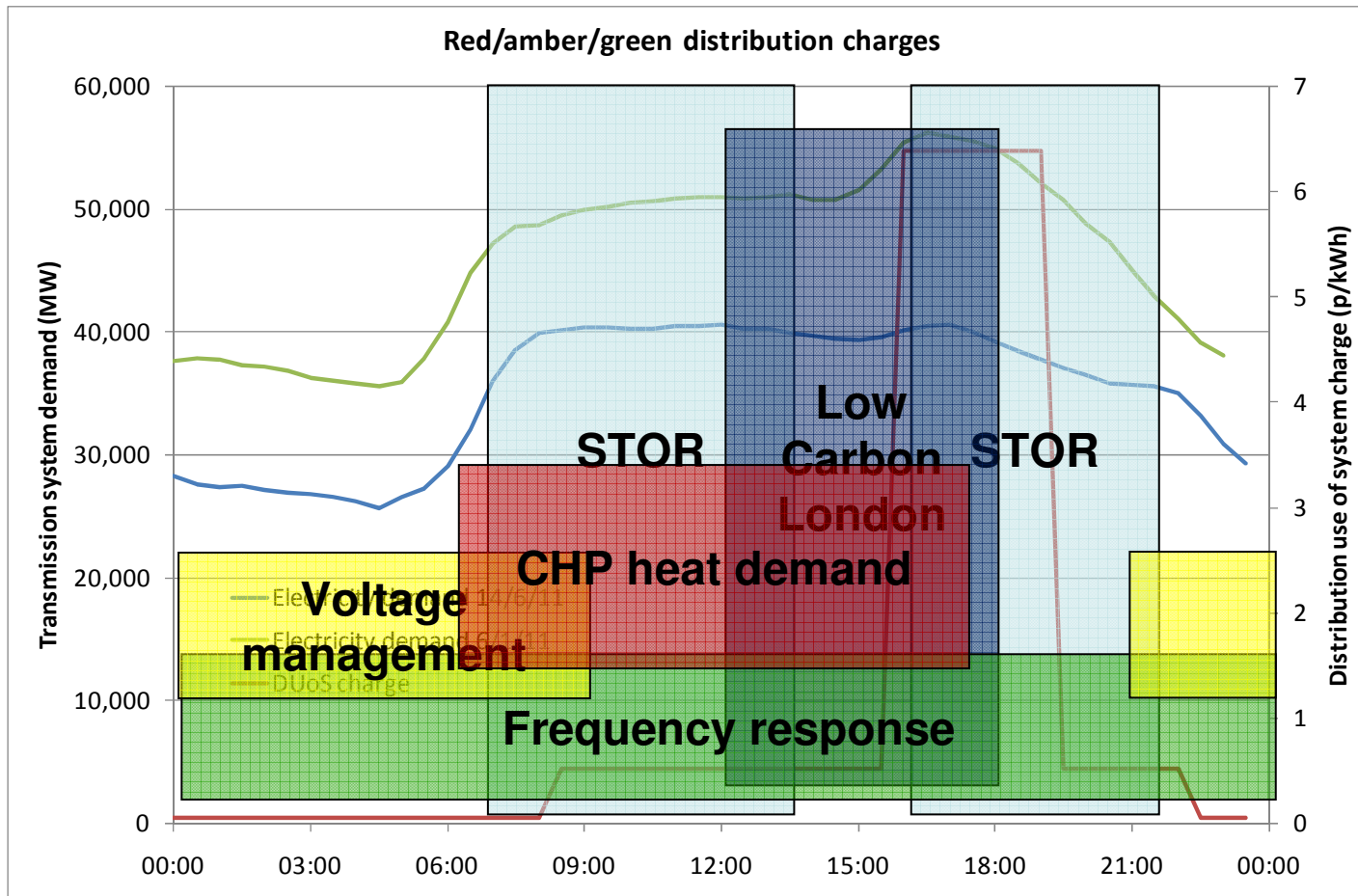
- Margin example
 - Tilbury fire 27/2/12
 - 405MW deload from 07:53
 - Flexitricity called 07:58
 - Driven by energy balance



- Peak reduction example: triads
 - Around 20 peaks/winter
 - Driven by network capacity

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Time-of-day conflicts



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Demand packing

- Scheduling demand into periods in which demand response is likely to be required
- Improves forecastability
- Makes everything else worse
 - More emissions
 - More network stress
 - Defeats energy efficiency
 - Increases base electricity cost
- Baseline metering is much better



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From conflicts to synergies

- Recognising different needs
 - DNO: security
 - National Grid: operational planning
- Knowing what's going on
 - Post-event statistics
 - Rules of engagement
 - Operational information flows
- Control of access
 - Common dispatch platforms
 - “All services” reserve market?



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The Demand Response Baseline

Aaron Jenkins

16 May 2012

The Demand Response Baseline

If Demand Response can be distilled to two essential criteria, they are:

- **How Demand Response resources perform**
- **How to measure Demand Response performance**

Baseline - Defined

A baseline is an estimate of the electricity that would have been consumed by a customer in the absence of a demand response despatch.

Baseline - Performance Calculation

The difference between:

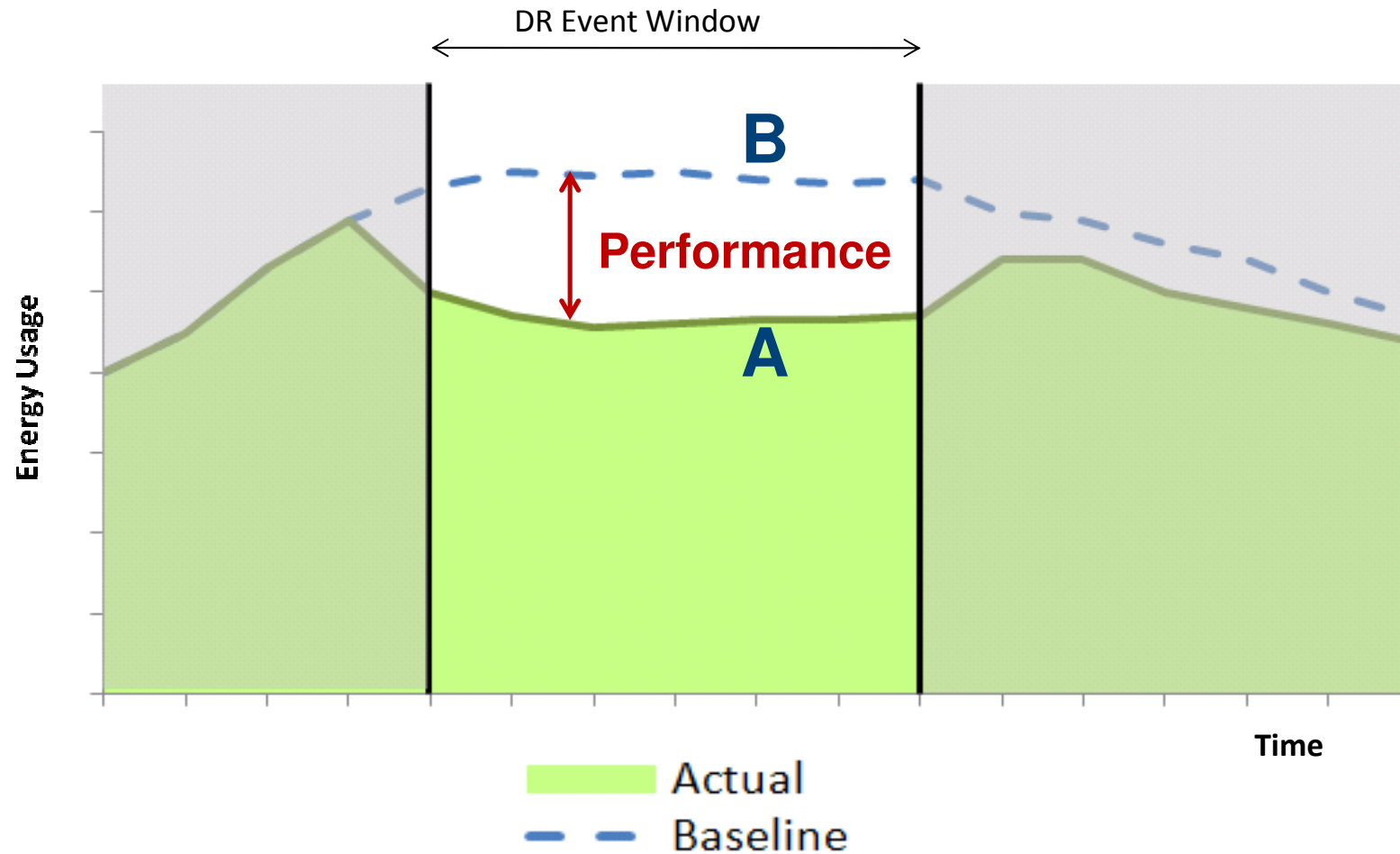
(B) The customers B.aseline and,

(A) The customers A.ctual energy consumption,

Determines the total contribution to a demand
response despatch.

$$\mathbf{B - A = Performance}$$

Baseline – In Action

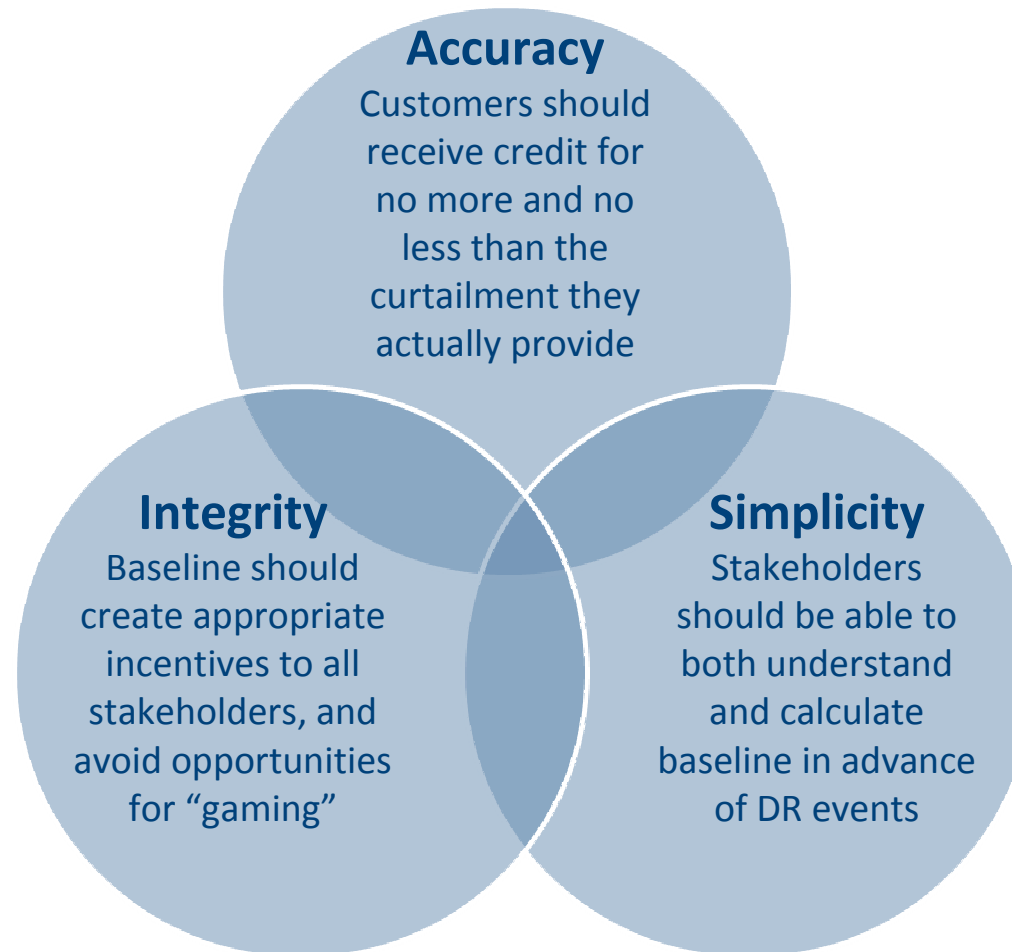


Baseline – Design Criteria

Design factors for baseline development must reach a satisfactory compromise of:

- **Accuracy**
- **Simplicity**
- **Integrity**

Baseline – Design Criteria



Baseline Design – Low Carbon London

Specific characteristics of the Low Carbon London programme affecting baseline selection:

- **Weather driven need (summer-peaking)**
- **Demographic makeup (low industrial users)**
- **Days and hours of programme operation**

Baseline Selection – “High 5 of 10”

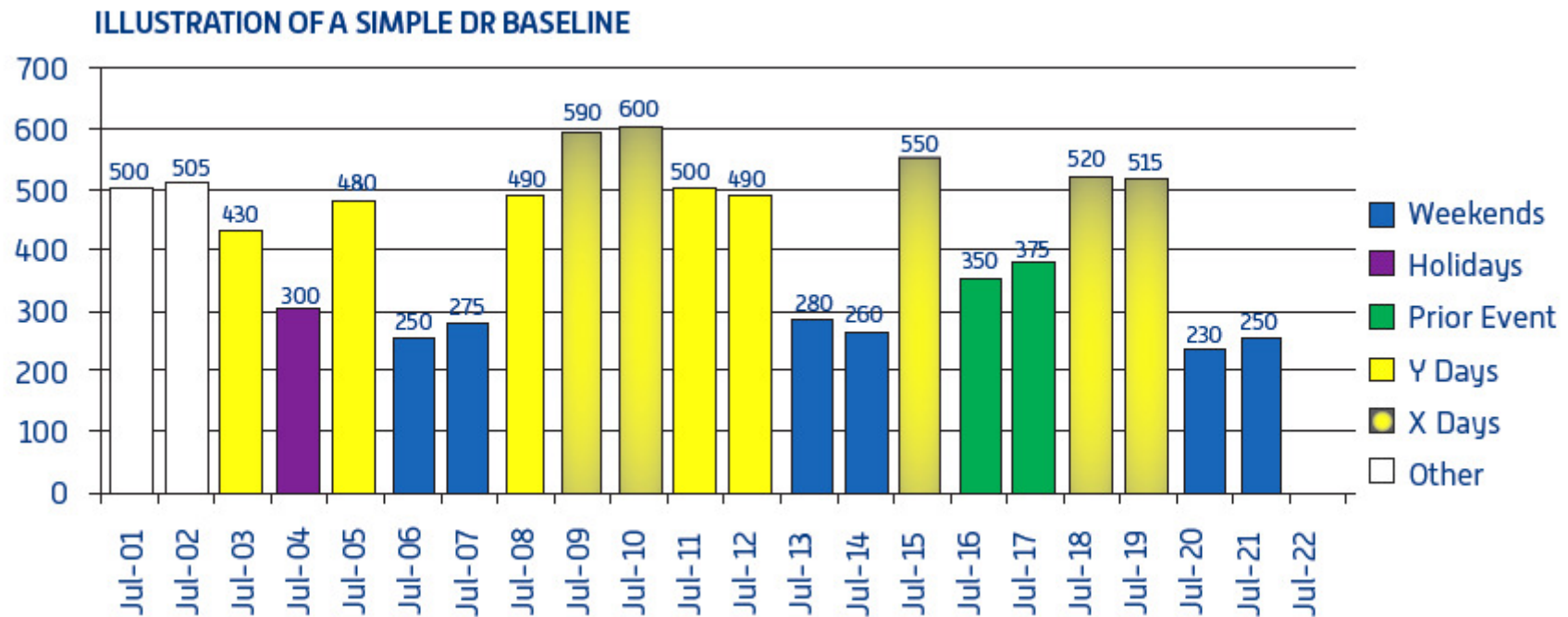
- A “High 5 of 10” profile baseline considers the 10 most recent days preceding an event and uses data from the 5 days with the highest load to calculate the baseline.
- Holidays, weekends, and previous event days are excluded since they are not accurate representations of a customer’s normal energy usage.

Baseline Selection – “High 5 of 10”

Mon	Tue	Wed	Thur	Fri	Sat	Sun
July 1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

Holiday	Current Event Day
Weekend	Y Day
Past Event Day	X Day

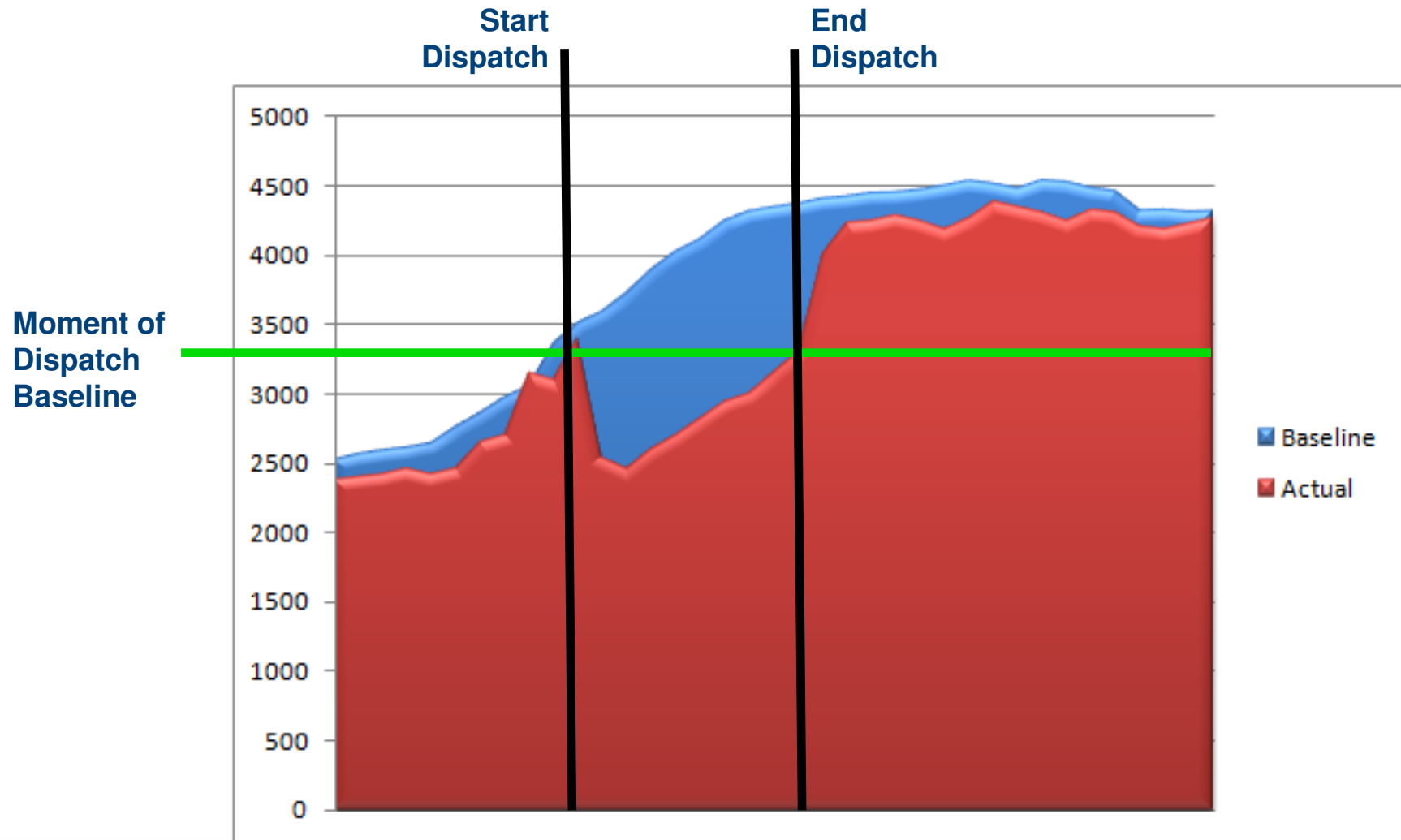
Baseline Selection – “High 5 of 10”



Baseline - Comparison

Moment of Dispatch Baseline	High 5 of 10 Baseline
Baseline cannot be predicted in advance	Baseline can be calculated as much as 24 hours in advance
Single value flat-line baseline	Variable baseline, follows general load profile
Higher likelihood of unmeasured performance	Lower likelihood of unmeasured performance
Decreases overall value to the customer	Increases overall value to the customer (greater participation)

Baseline - Comparison

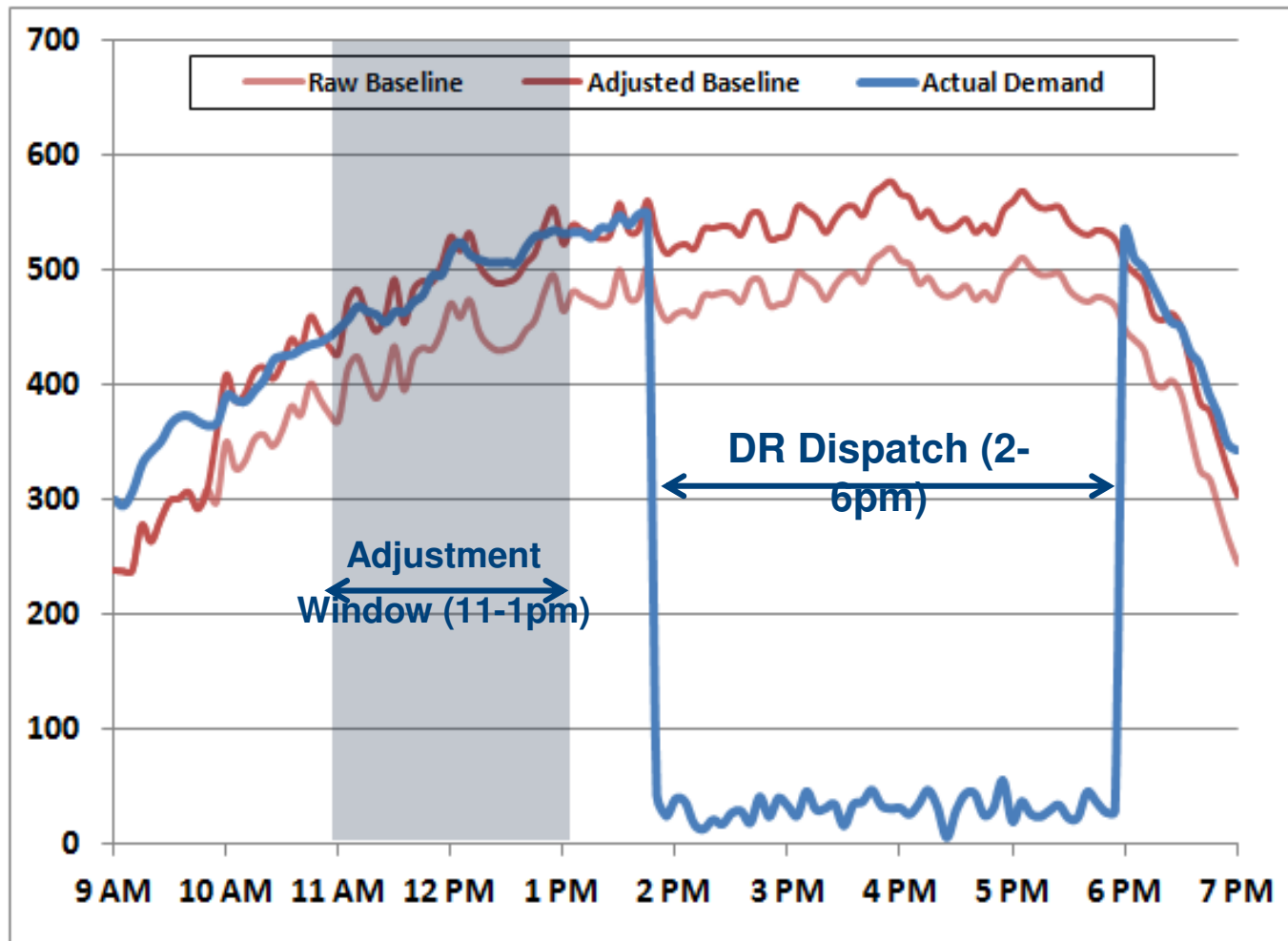


Baseline High 5 of 10 - Adjustments

Baseline adjustments are necessary to more accurately reflect load conditions on the day of dispatch.

- While the baseline predicts the shape of a facility's energy usage, the baseline adjustment predicts the magnitude of a facility's energy usage on a given day.
- Additive Adjustment – Allow for upward adjustment of the baseline when actual load exceeds the baseline on the day of dispatch.
- Capping – Upper limit, or cap, on upward adjustment of the baseline.

Baseline Adjustment - Example





Questions?



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EC2V 7JX

Low Carbon London Demand Response Trial

Next Steps

Paul Pretlove
16th May 2012



Next Steps

- Summer Trial – June '12 to August '12
- 13.7 MW signed up and ready to participate with additional MWs currently in negotiations
- Multiple events to test network constraint scenarios, both real and simulated
- Embedding demand response trials within the business and more importantly the control room