WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Welcome & Introduction

IET London: Savoy Place

20th June 2018

Roger Hey

Future Networks Manager

Housekeeping

What the day will include?

Our Balancing Act conference will provide the opportunity to:

- Discuss future challenges for the LV network and network flexibility.
- Provide information on WPD's distribution system needs in areas which we expect to become constrained for demand in the near future.
- Participate in an interactive session to discuss the challenges and opportunities involved in creating flexible services and markets, and what could be the best solutions for customers.
- Explore the latest learnings from our DSR and flexibility projects.
- Overview of DSO transition and projects enabling the transition.

Agenda

09.30 – Registration & Refreshments - *Held in the Maxwell Library*
10.00 – Welcome & Introductions
10.10 – Project Entire
10.40 – WPD/NG Regional Development Programme
11.00 – Facilitating Neutral Markets: Signposting Distribution System Needs
11.30 – Refreshments - *Held in the Maxwell Library*
11.50 – Flexibility Panel Session
12.40 – Lunch - *Held in the Maxwell Library*
13.30 – FREEDOM Project
14.00 – Carbon Tracing
14.20 – Afternoon Refreshments - *Held in the Maxwell Library*
14.50 – DSO Transition Projects
15.30 – Close

Innovation Objectives

The objectives of WPD's innovation programme are to:

- Develop new *smart* techniques that will accommodate increased load, storage and generation (Distributed Energy Resources – DER) at lower costs/quicker connections than conventional reinforcement.
- Facilitate regional and local energy markets; including local flexibility services.
- Improve business performance against one or more of our core goals of safety, customer service, reliability, the environment or cost effectiveness.
- Ensure solutions are compatible with the existing network.
- Deliver solutions so that they become business as usual.
- Provide long term, whole system outcomes and value for money for consumers.
- Assist the UK to reduce carbon emissions and combat climate change.

NEW

WESTERN POWER DISTRIBUTION REVISE

WESTERN POWER DISTRIBUTION EFFS

WESTERN POWER DISTRIBUTION NETWORK EQUILIBRIUM

WESTERN POWER DISTRIBUTION OPEN LV

WESTERN POWER DISTRIBUTION SMART ENERGY ISLES

WESTERN POWER DISTRIBUTION PLUGS AND SOCKETS

Future Networks Programme

Assets

- Management of distribution assets
- Exploitation of asset & network information
- Developing Smart Grid Technology

Customers

- Distributed Generation
- Connecting Electric Vehicles
- Adopting Battery Storage
- Facilitating Flexibility

Operations

- Maintaining Reliability
- Strategic Forecasting
- Transitioning to DSO
- Operational Efficiency

Network and Customer Data

Network Improvements and System Operability

- Improved Statistical Ratings for OHL
- DEDUCE
- Primary Networks Power Quality Analysis
- Stochastic Load Flow
- Visual Data Processing
- Network Islanding
- Common Information Model
- Harmonic Mitigation
- Virtual STATCOM

Transition to a Low Carbon Future

- Heat & Fleet
- Virtual Telemetry
- Feeder Fault Level
- Solar Storage
- LV Connect & Manage
- FREEDOM
- Electric Nation
- Industrial & Commercial Storage
- Hydrogen Heat & Fleet

New technologies and commercial evolution

- MVDC
- 5G Design
- OHL Director
- Entire
- LV Fault Location
- On-street EV Charging
- Smart Energy Isles
- Visibility Plugs & Socket
- DEDUCE

Customer and Stakeholder Focus

- Power Electronic FLM
- Power Electronic FCL
- Self System Design
- New Build Standards
- LCT Response
- Carbon Portal

Safety, Health and Environment

- Simulated Training
- SF6 Alternatives
- Robot Trades
- LV Sensitive Earth Fault Protection
- Wildlife Protection
- Losses Investigation
- Advanced Vegetation Management

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Project Entire

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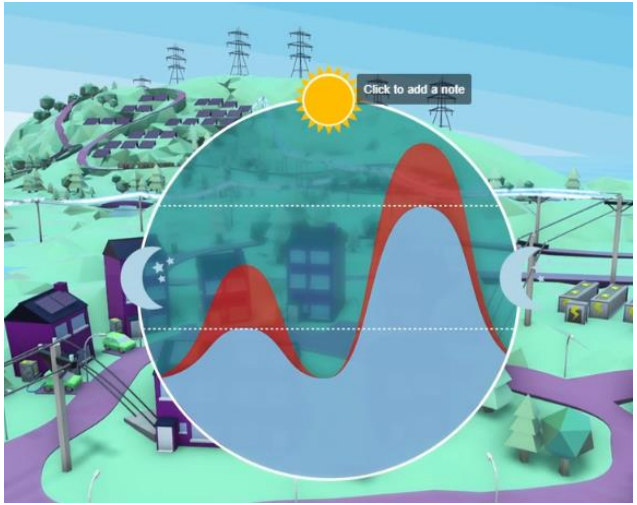
Matt Watson

Innovation & Low Carbon Networks Engineer

What is Demand Side Response

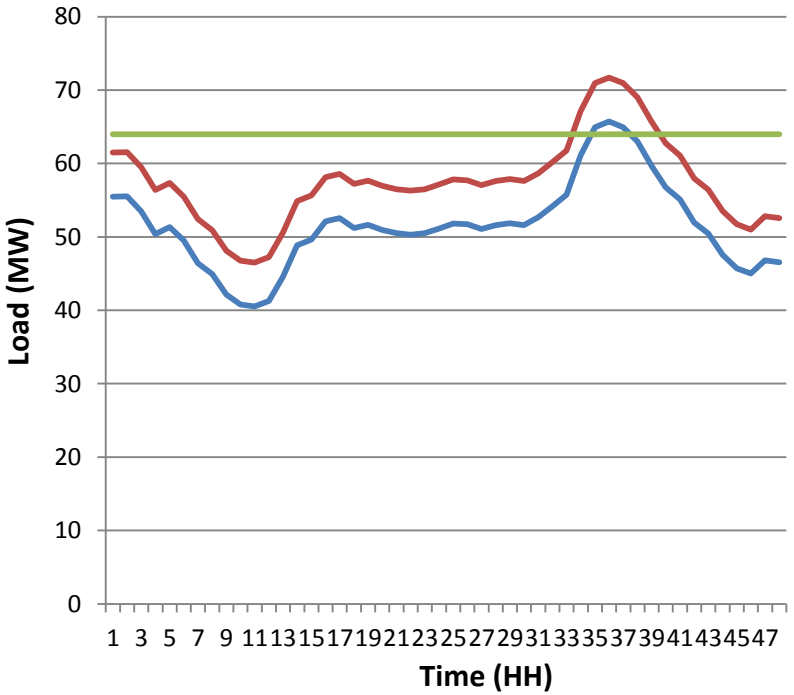
- *'Demand Side Response is intelligent energy usage. It enables businesses and consumers to save on total energy costs and reduce their carbon footprints by increasing, decreasing or shifting their electricity consumption'* - Power Responsive

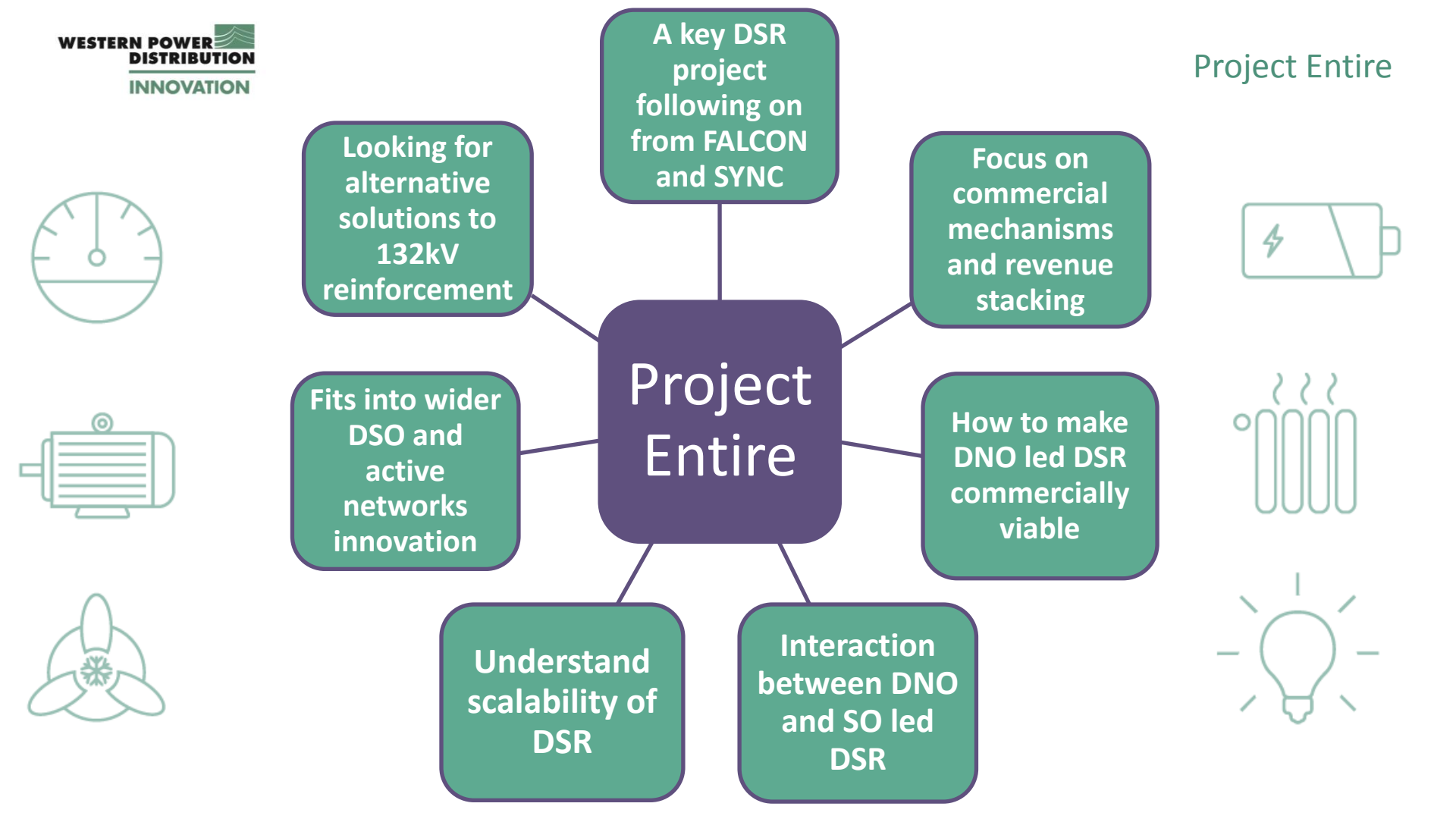
- Utilises customer flexibility to help the network
- Demand Side includes DER (all non-BM)
- Flexibility following a signal
- "can" means both technically but also commercially



Why would a DNO want to use DSR?

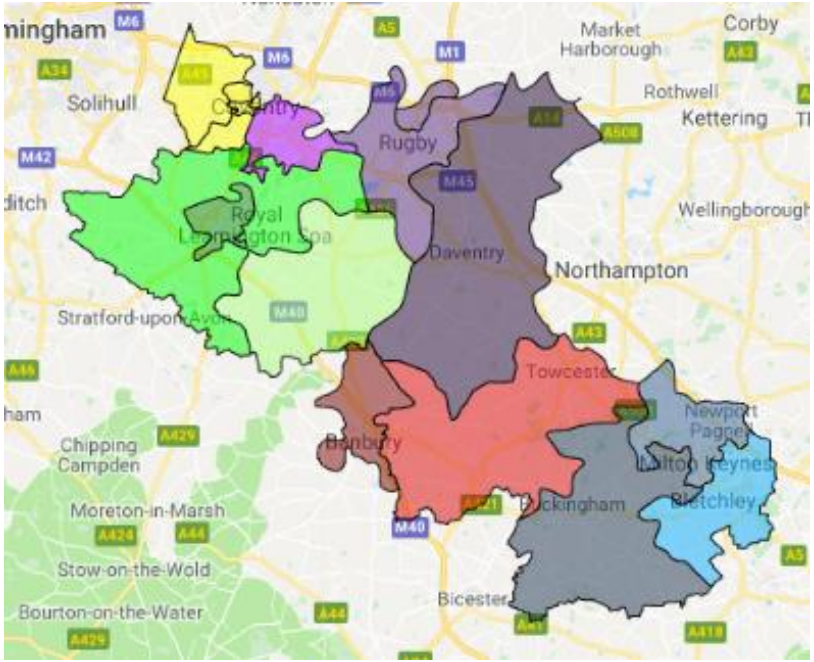
- Avoid or defer reinforcement
- For both winter peak and summer minimum
- Will always compare against traditional reinforcement which has variable costs
- DNO services are:
  - Locational
  - Focussed on higher voltages
  - Limited capacity (pay as you go)
  - Always compared with reinforcement
  - Potentially time bound




Project Entire
A key DSR project following on from FALCON and SYNC
Looking for alternative solutions to 132kV reinforcement
Focus on commercial mechanisms and revenue stacking
Fits into wider DSO and active networks innovation
How to make DNO led DSR commercially viable
Understand scalability of DSR
Interaction between DNO and SO led DSR

Project Entire

- Looked to recruit customers in 14 zones in the East Midlands
- Along the M1-M40 corridor
- Offered under Flexible Power Brand



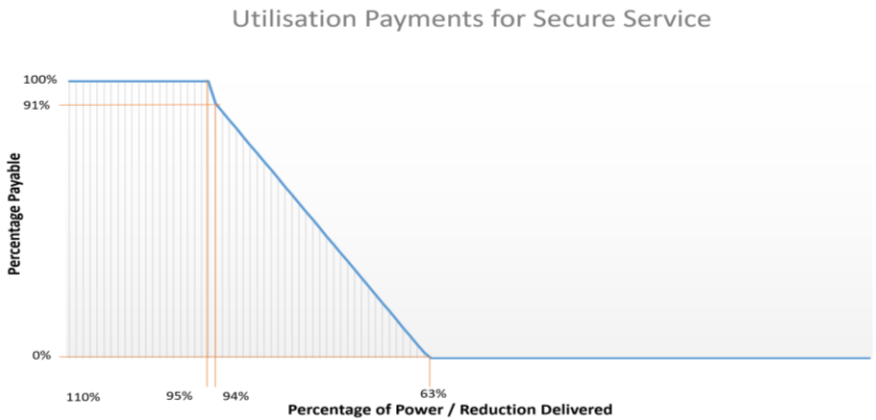
Three Services

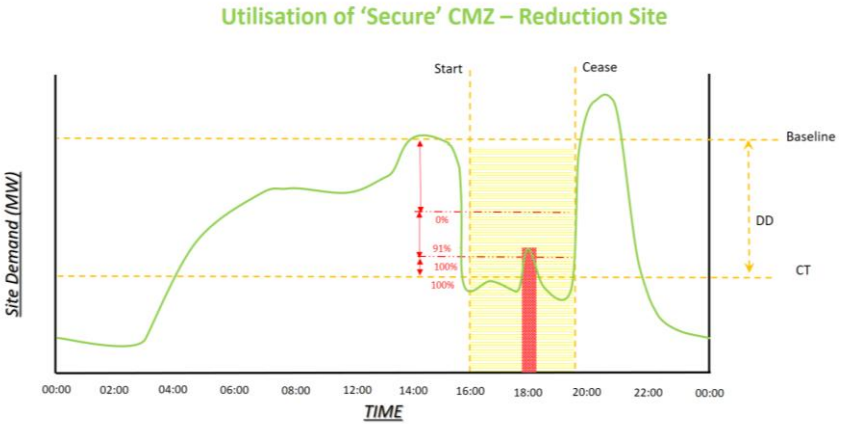
	Secure	Dynamic	Restore
Advance Payment	Arming	Availability	None
Utilisation	Medium	High	Premium
Customer declaration	Week Ahead	Week Ahead	Week Ahead
FP Accept / Reject	Week Ahead	Week Ahead	Automatic Accept
Dispatch Notice	Week Ahead	15 minutes	15 Minutes
Seasonal Requirement	All	Summer	All
Site Type	Half Hourly Metered	Half Hourly Metered	Half Hourly Metered
Generation	✓	✓	✓
Load Reduction	✓	✓	✓

- Secure and Dynamic are main services, Restore is additional
- Based on weekly process to enhance interactions with other services

Payment Mechanism

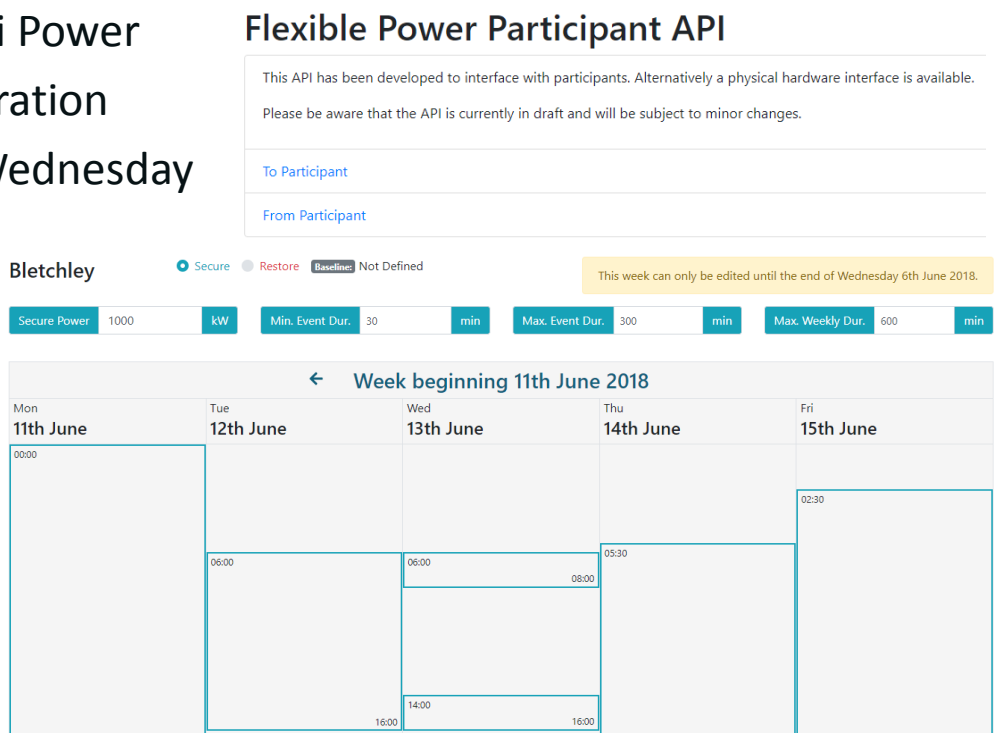
- Arming/Availability fee
- Utilisation fee
- Full delivery incentivised through claw backs (3% per 1% under-delivered)





Systems

- Cloud based system delivered by Kiwi Power
- Customer portal for availability declaration
- Customers enter availability by Wednesday (midnight)
- WPD accept by midday Thursday
- API for monitoring and dispatch
- Self test environment available
- Signals sent 15 mins before event
- Minute by minute metering



Recruitment

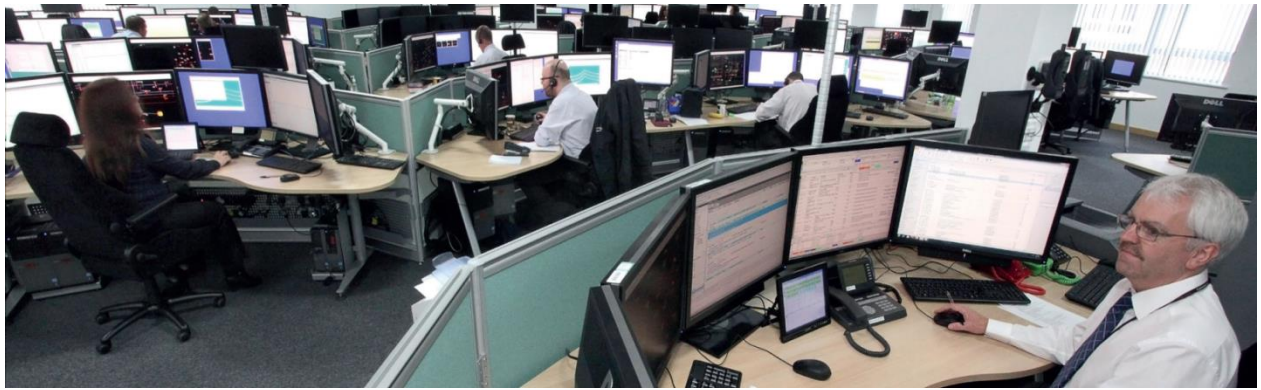
- Initially ran EoI to asses viability of zones
- Simple process aimed at understanding what was available in zones
- Over 121MW of capacity responded across 69 sites

	Total	Compliant	Potential	Non-Compliant
Sites	69	34	23	12
MW	121.47	41.46	17.95	62.06

- 12 zones taken forward to full procurement
- Full procurement still underway. Participants in various stages of on boarding

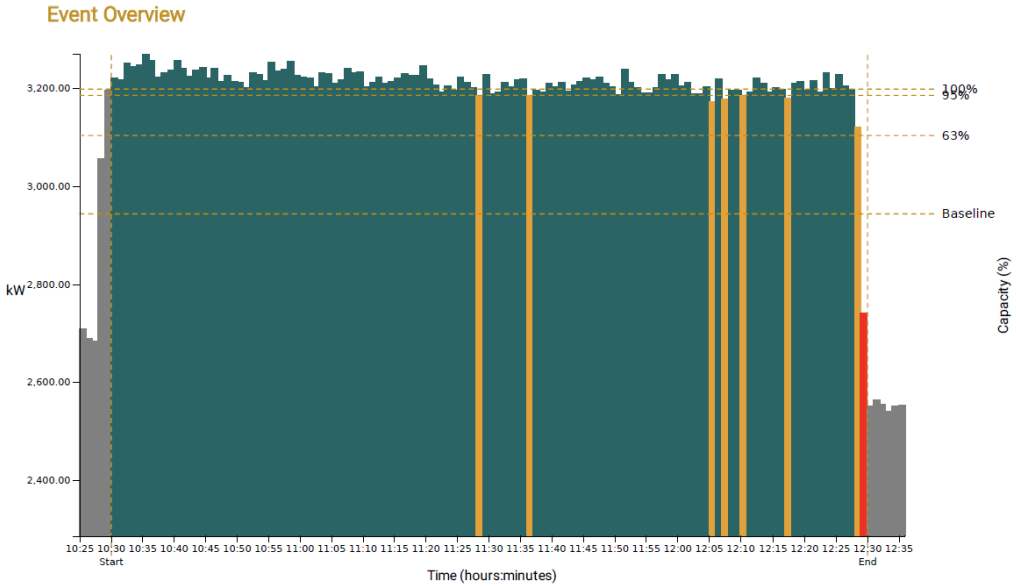
Operations

- Systems live since April
- First calls made with successful delivery
- Multiple sites and zones live
- Many more sites in pipeline
- Further testing planned over the rest of the year



Settlement

- Each event has a performance report and earning statement created.
- Performance report: aimed at showing delivery
- Earning statement: highlights impacts on income
- Monthly invoicing



Key Learning to Date

- Role of DNO in revenue stacking
- Significant interest in services, however sign ups have taken longer than expected
- Generally positive feedback on service structures, however some issues with the freedom given
- API set up has been taken positively and is a simple way of interfacing
- Calls have been successful to date
- Internal processes and systems are simple to use

Next steps

- Continue Operations till March 2019
- Continue to on-board participants
- Understand participant reliability
- Survey market understanding of the services
- Collect participant feedback on processes
- Log relevant learning
- Close project in April 2019
- Feed into wider DSR roll out plans
- Feed into ENA Open Networks project

Flexible Power
By Western Power Distribution

ena
energynetworks association

Any Questions?

THANKS FOR LISTENING

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

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WPD/NG Regional Development Programme

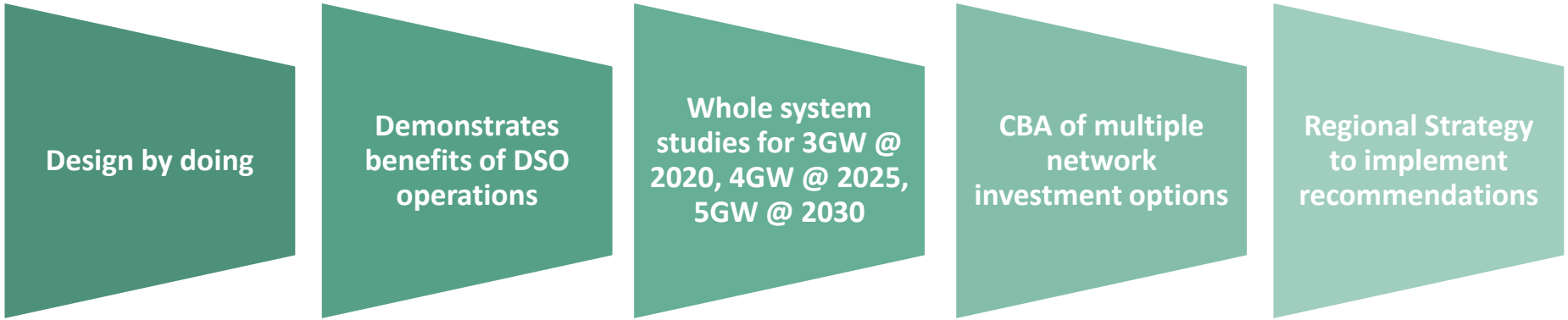
South West Licence Area

IET London: Savoy Place
20th June 2018

Nigel Turvey
Network Strategy & Innovation Manager

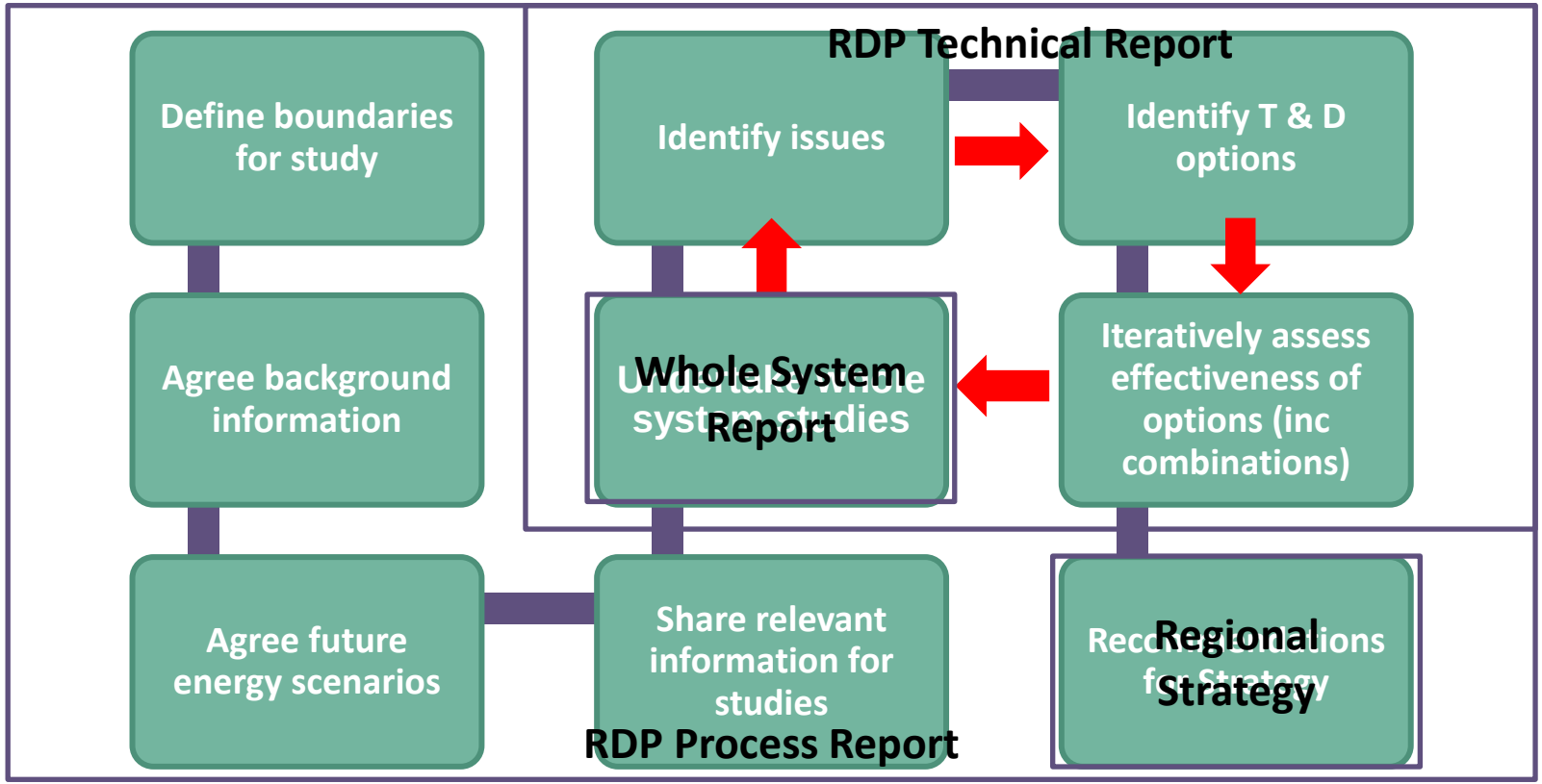
WPD/NG Regional Development Programme

RDPs were set up to provide detailed analysis of areas of the network which have large amounts of Distributed Energy Resource (DER) and known transmission / distribution network issues in accommodating that DER.

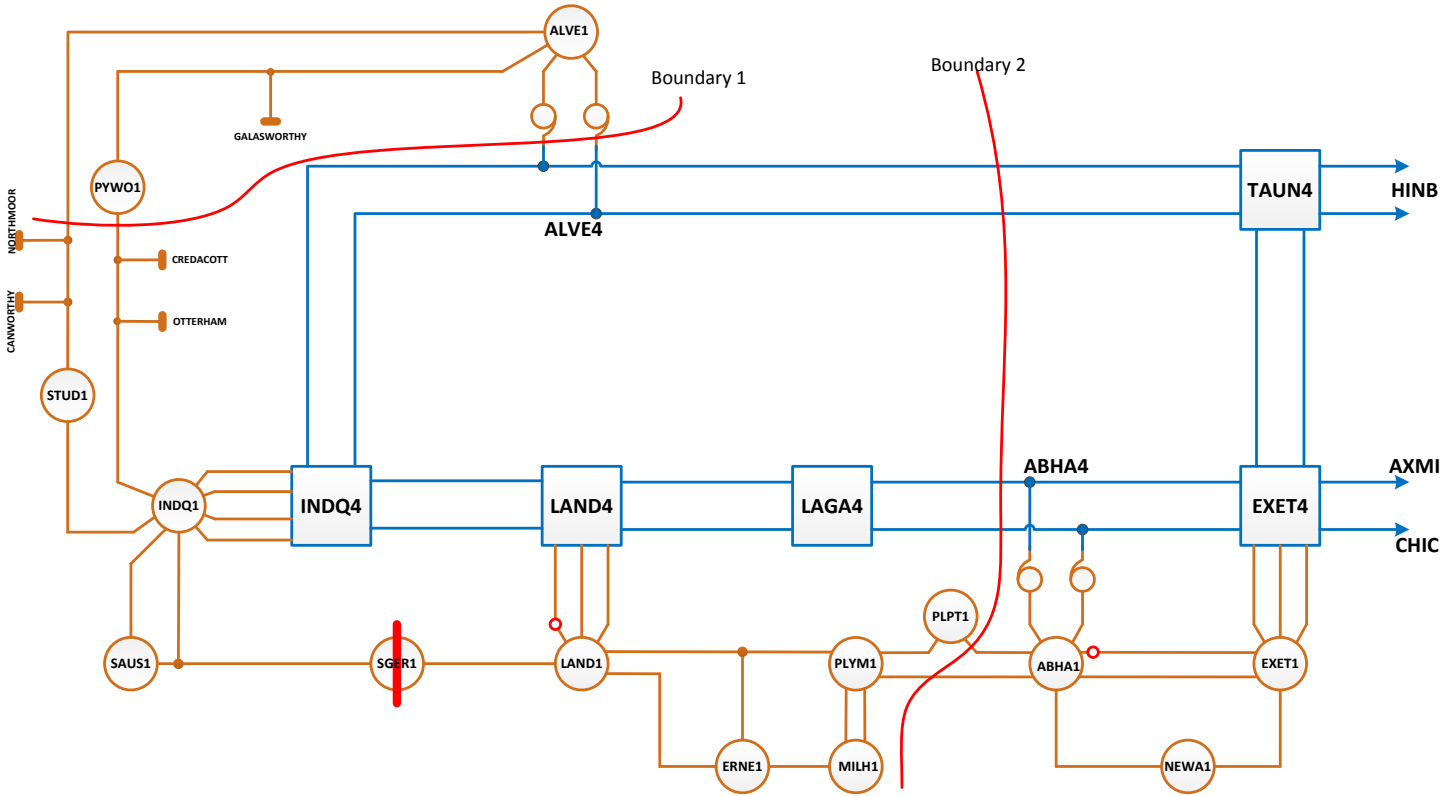


The South West peninsular was chosen due to the abundance of potential renewable resources and the recognised limitations in network export capacity across both transmission and distribution networks

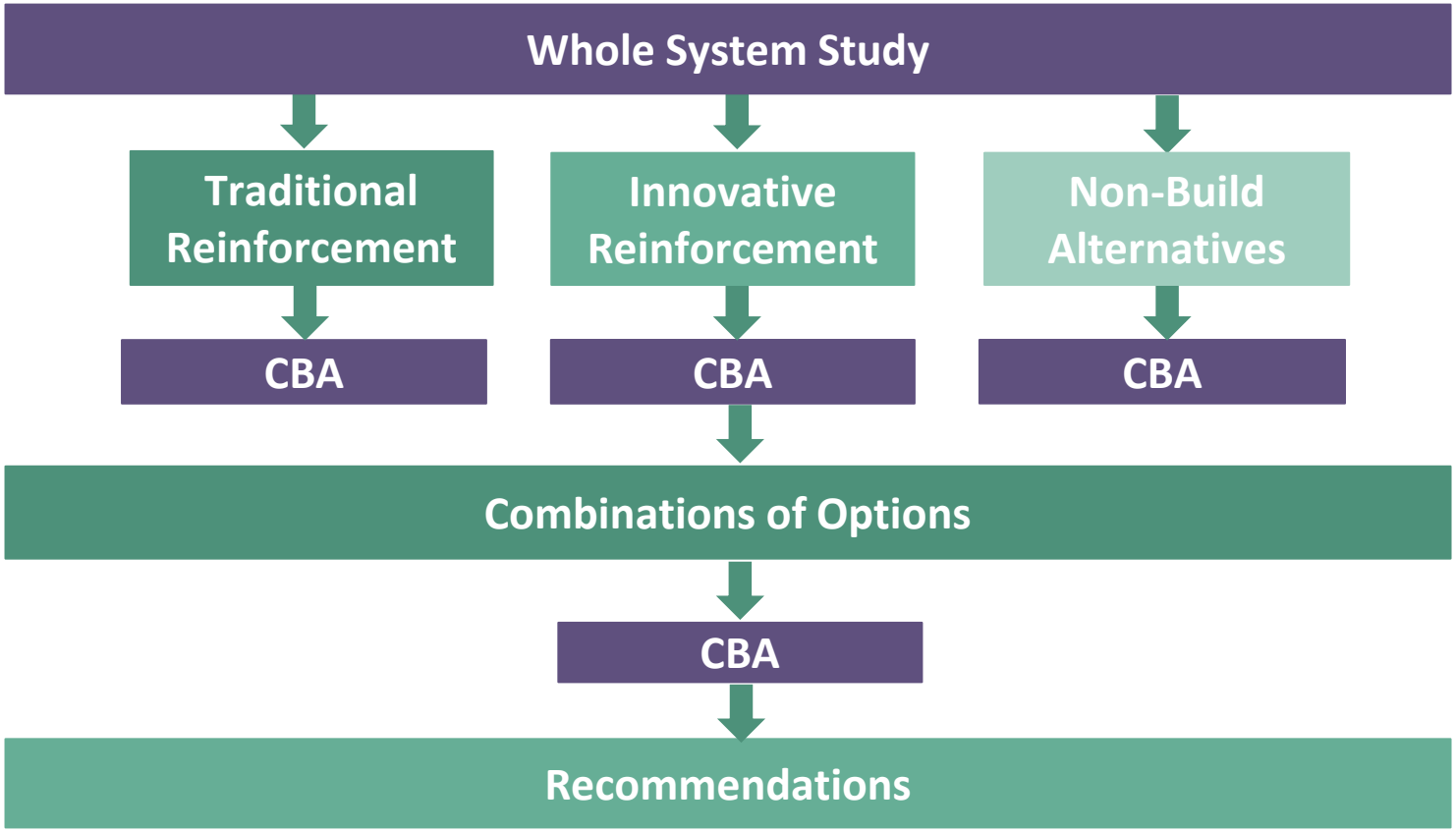
RDP Process


RDP Technical Report
Define boundaries for study
Identify issues
Identify T & D options
Agree background information
Undertake whole system studies
Whole System Report
Iteratively assess effectiveness of options (inc combinations)
Agree future energy scenarios
Share relevant information for studies
RDP Process Report
Recommendations for Strategy
Regional Strategy

Define Boundaries for Study



Options Assessment



Recommendations for Strategy

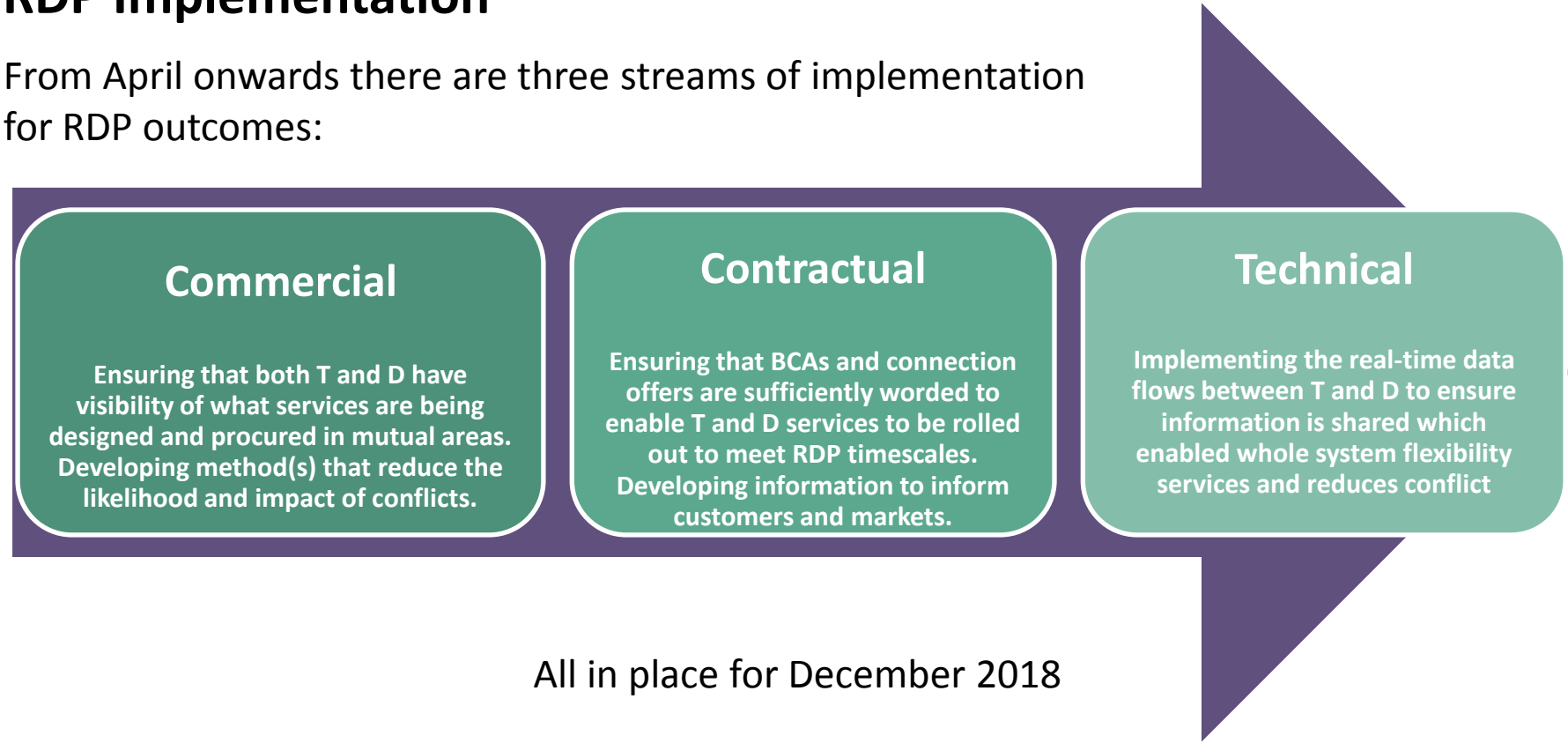
- Network (T & D) can accommodate all scenarios to 2020 and most of the non-aggressive uptake scenarios to 2025.
- 2025 and beyond will require significant modification to both networks. Traditional reinforcement would be in excess of £30m to 2030.
- Issues predominately driven by solar peak PV – will leave traditional build solutions largely underutilised for much of year.
- Voltage stability limits DER uptake, more so if 132kV is unparalleled.
- Operational curtailment for transmission security issues (n-3, non-compensated) and thermal/voltage issues (n-1,n-2,compensated) are most economic for peaking constraints.
- Visibility and control of DER to be enacted by DNOs, who can then provide to TSOs.
- Quicker, more efficient connections for customers via deep Connect & Manage process.
- T&D service co-ordination will be important, but has minimal impact currently. RDP implementation will further develop this.

Learning Outcomes for WPD/NG

- Significant interactions between T & D, particularly where D networks are meshed and DER uptake is large.
- T and D use significantly different assumptions on demand and generation behaviour compared to installed capacities, resulting in different network outcomes.
- Better exchange of data between T & D for planning/modelling purposes would allow some whole system solutions to be explored or quantified without significant collaborative modelling.
- D has a wealth of information on load contribution which would be useful to inform T-planning.
- T has lots of information on services which could be useful for DSOs.
- FES are useful tools for coordinating future planning strategies, particularly if the planning methodologies are aligned.
- FES methodology is not hugely accurate at a regional level and D-FES is more accurate at a granular level.
- More active network operation, with contractual/commercial mitigation methods can enable economic network investment versus deterministic.
- Operability issues will become more prevalent and limiting, so information on how DER contributes to operability will be useful.

RDP Implementation

From April onwards there are three streams of implementation for RDP outcomes:



All in place for December 2018

THANKS FOR LISTENING

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

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Facilitating Neutral Markets

Ben Godfrey
Network Strategy Team Manager

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Overview

- **Signposting**
  - Why do we need more data visibility?
  - What is signposting?
  - What information will be published?
- **Forecasting**
  - Why is it important?
  - What information will be published?
- **Procurement**
  - What will we procure
  - How will we procure it?
- **Q&A**

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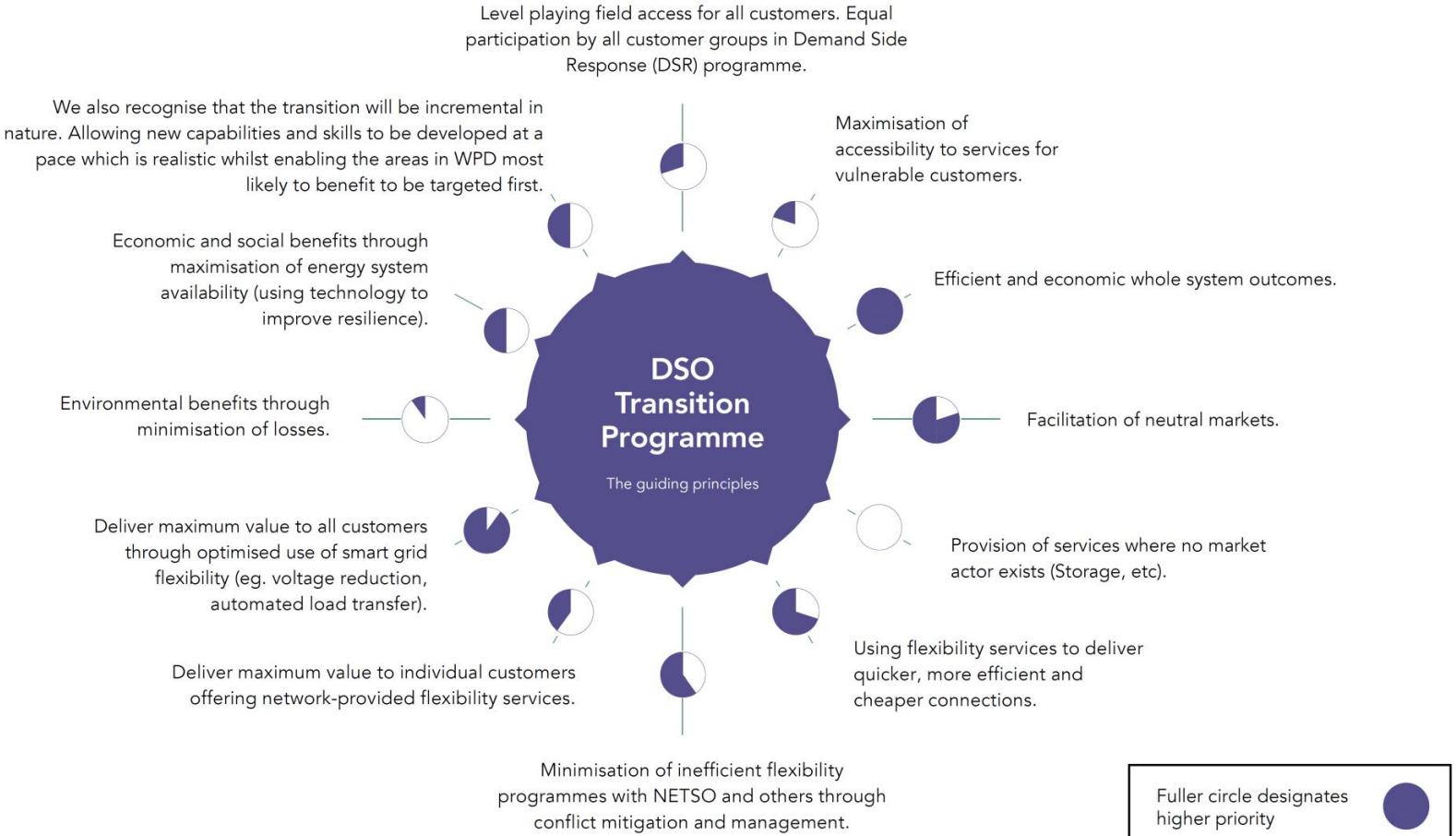
Facilitating Neutral Markets



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DSO Transition

Flexibility was a key theme from our stakeholder engagement and feedback.

Transparency and simplification of future markets will enable customers to participate.

> AS DISTRIBUTION NETWORKS BECOME MORE VISIBLE, COMMUNICATION TO ALL CUSTOMER GROUPS WILL BE KEY.

> FLEXIBILITY MARKETS NEED TO BE SIMPLE TO UNDERSTAND AND PARTICIPATE IN.

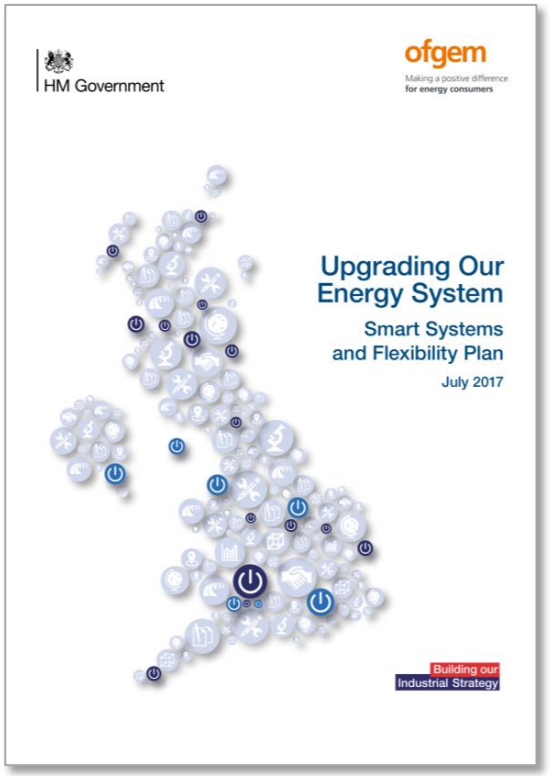
> WPD SHOULD PROVIDE MORE DETAIL TO CUSTOMERS ON WHERE THEY CAN PARTICIPATE, HOW THEY CAN PARTICIPATE AND WHAT BENEFITS PARTICIPATION MAY BRING.

> CROSS SECTOR WORKING IS VITAL. GOVERNMENT, LOCAL LEADERS, REGULATORS AND THE ENERGY MARKETS MUST WORK TOGETHER.

> SMART INTERVENTIONS SHOULD BE APPLIED ACROSS THE WHOLE NETWORK AND AT ALL VOLTAGES.

> A DSO WILL NOT NEED TO INVEST IN STORAGE AS THE MARKET WILL PROVIDE THIS WHEN REQUIRED.

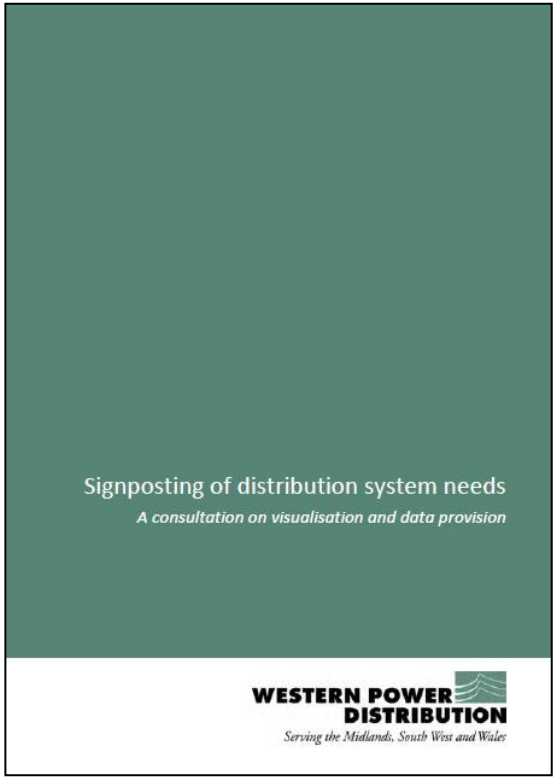
Whole System Benefits



ofgem

"If we take advantage of the opportunities, we can create new businesses and jobs, empower consumers and help people save up to £40bn off their energy bills in the coming decades"

Transparency of Information

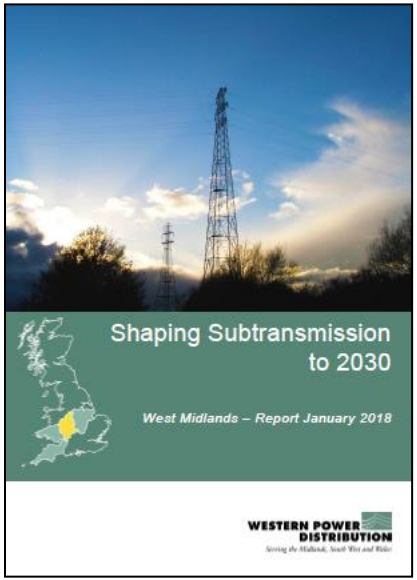


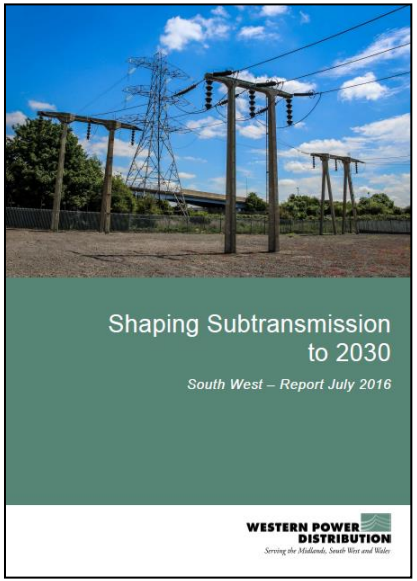
In April of this year we issued a consultation on how our stakeholders would value more information on system needs and how we should be presenting that information:

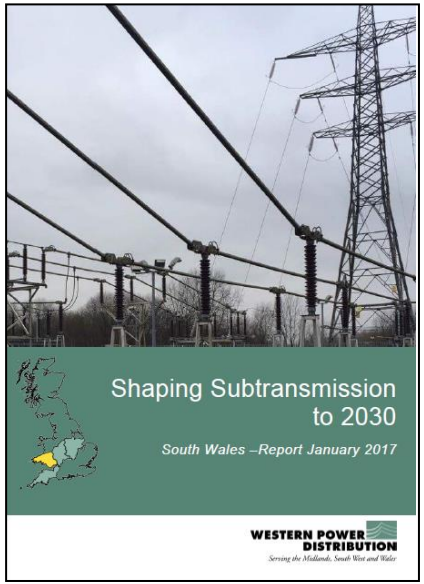
- ✓ Long term visibility of constraints
- ✓ Information based on scenario modelling
- ✓ Raw data should be downloadable
- ✓ Services need to be stackable

Signposting

Using WPD's Shaping Subtransmission Reports to identify future potential network constraints.







Why Publish Signposting Information?

- To facilitate neutral markets for flexibility service.
- Provide enough information so that flexibility services and markets can naturally develop.
- Investigate the potential for flexibility services to provide an alternative to conventional reinforcement.
- Development an understanding about the level and type of flexibility services may be available to WPD.

What is Signposting?

Signposting IS:

- A description of the system need to alleviate a potential network constraint.
- A description of the required behaviour of flexibility services in a network area (in a ESA).

Signposting IS NOT:

- An invitation to tender for the provision of flexibility services to WPD.
- A here and now requirement, or an exact description of system needs.
- The only or best solution to network constraints.

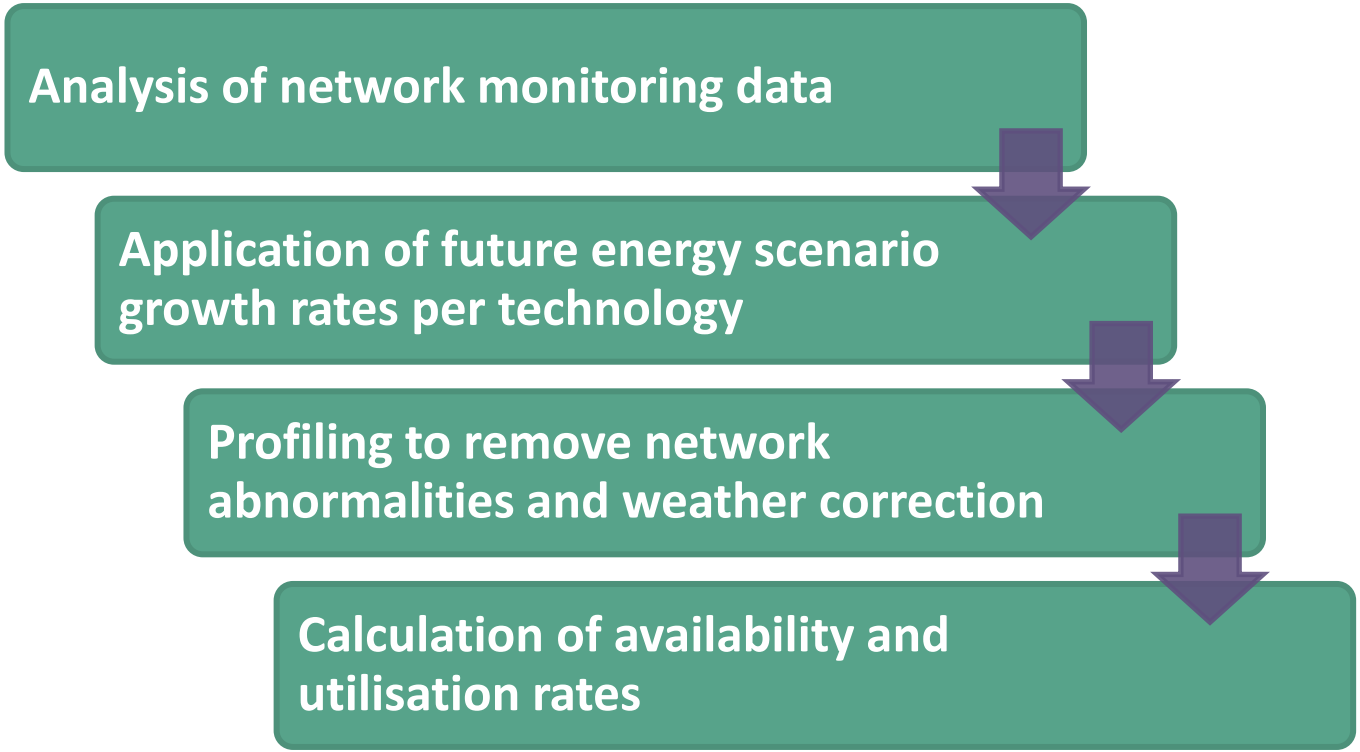
Information Publish Under Signposting

Provide the following for zones with future system needs across all four licence areas:

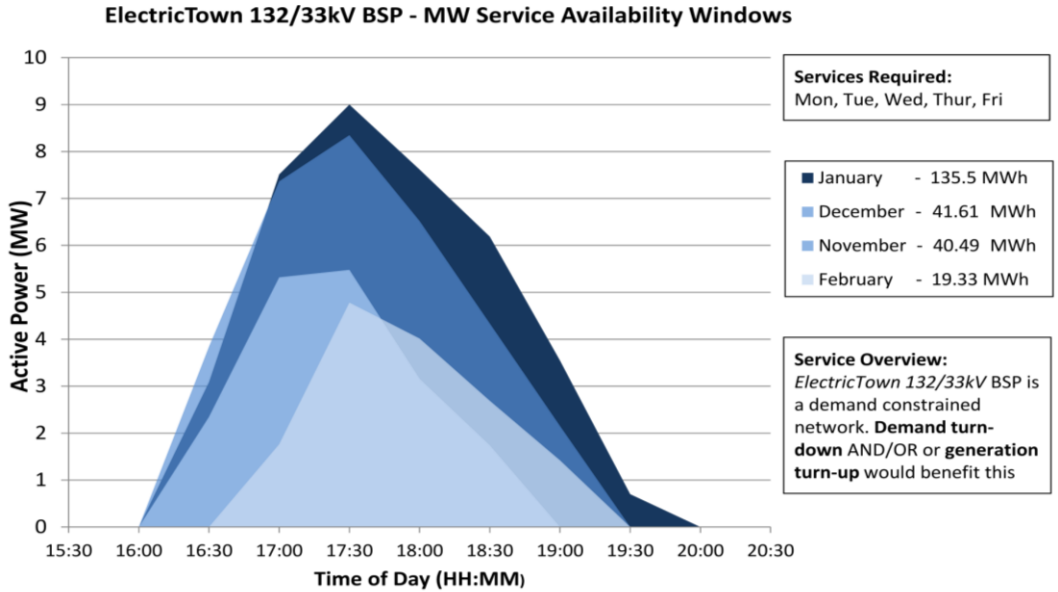
What **months** would flexibility be required.
What **days** in the week would flexibility be required.
What **time** of day would flexibility be required.
What would be the required **peak power** (MW) (per month).
How much **energy** would be required (MWh) (per month).

We are **NOT** indicating:
When we think the system need will develop for each BSP.
What the product mix will be.
What the tendering process will be.
When the tenders will be needed.

How is the information created?

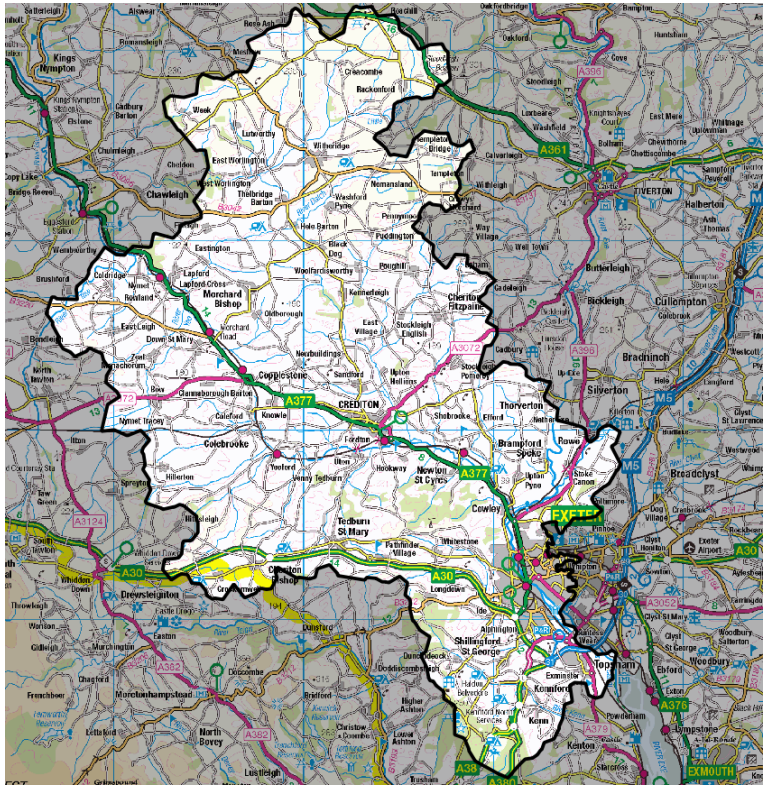


What information is presented?



Signposting information will be provided for a 5 year window and cover the four future energy scenarios used within WPD Strategic Investment Options reports.

What information is presented?

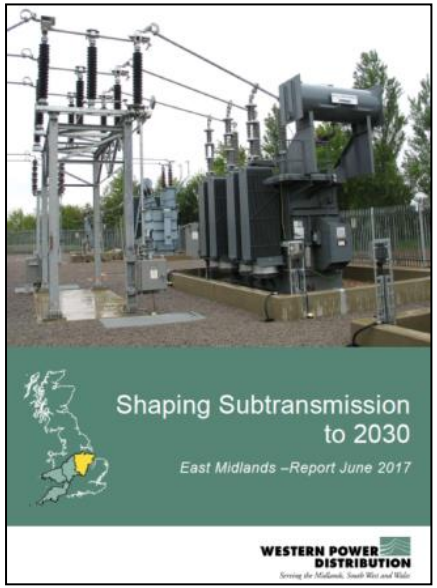


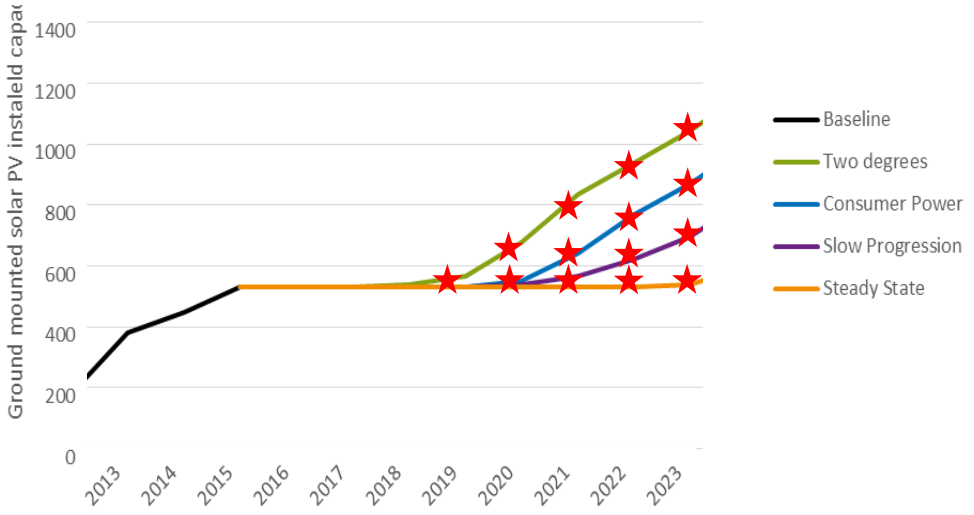
For each area on our network with forecasted constraints, we will provide signposting information ahead of those networks becoming constrained.

Example Image showing a geographic area where future flexibility service may be required.

What Information is Presented?

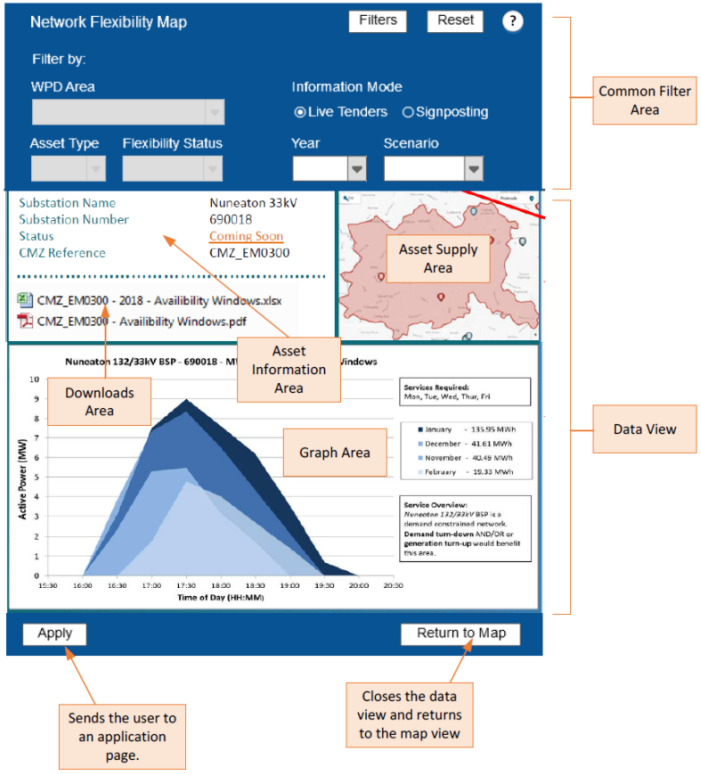
Signposting information will be provided for a 5 year window and cover the four future energy scenarios used within WPD Strategic Investment Options reports.





20 scenarios across 5 years

Where is this information published?



Using a similar functionality to our network capacity map, our network flexibility map is publically available on our website:

www.westernpower.co.uk/signposting

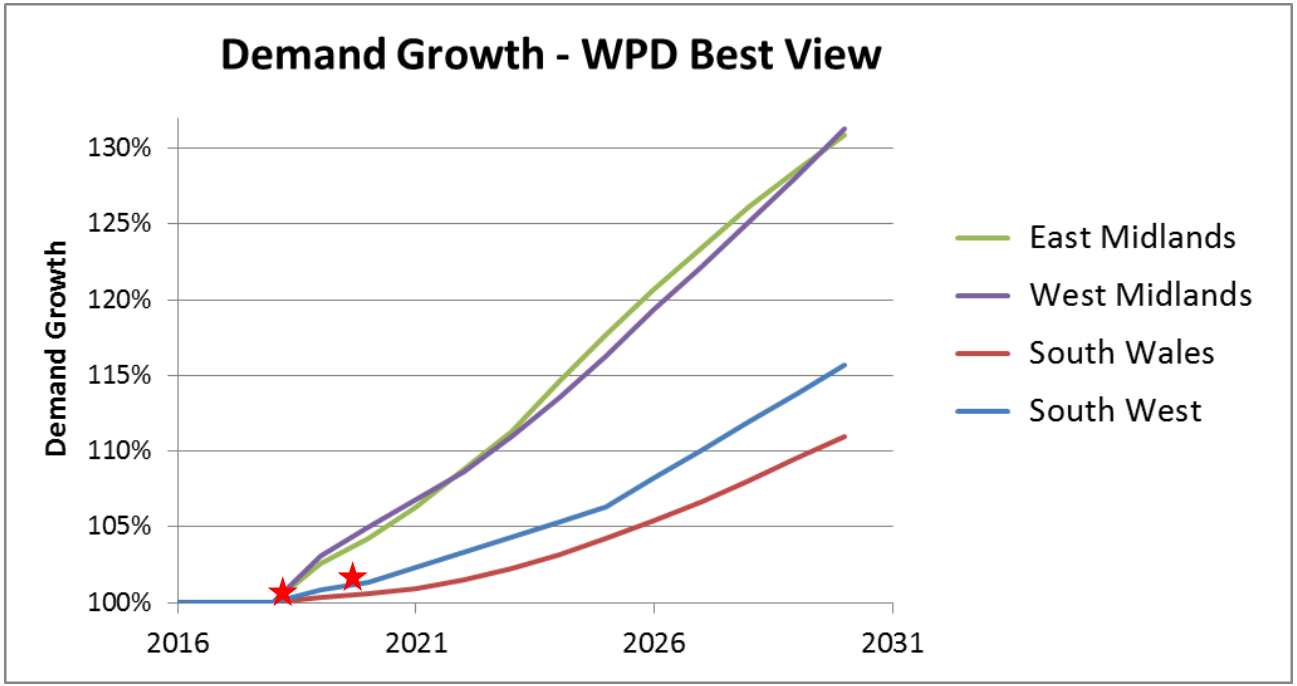
This displays information on:

- Geographic supply area
- MW peak and length for availability
- Estimated MWh utilisation
- Months applicable
- Days applicable
- Raw data downloads

What is forecasting?

- Determination of when constraints are expected to materialise.
- Forecasting information presents WPD's best view of the flexibility requirements needed on our network.
- Future seasonal flexibility requirements for live procurements will be published in a similar style to signposting.
- Quantification of system needs.
- Prioritised by the areas with the greatest system need.

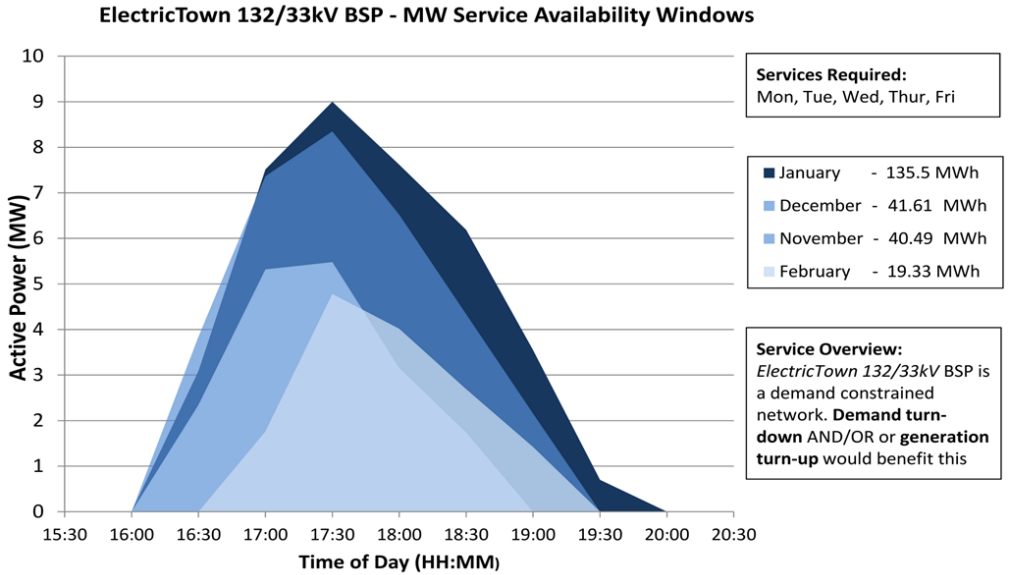
Forecasting



WPD's Best view on future network constraints and required flexibility services

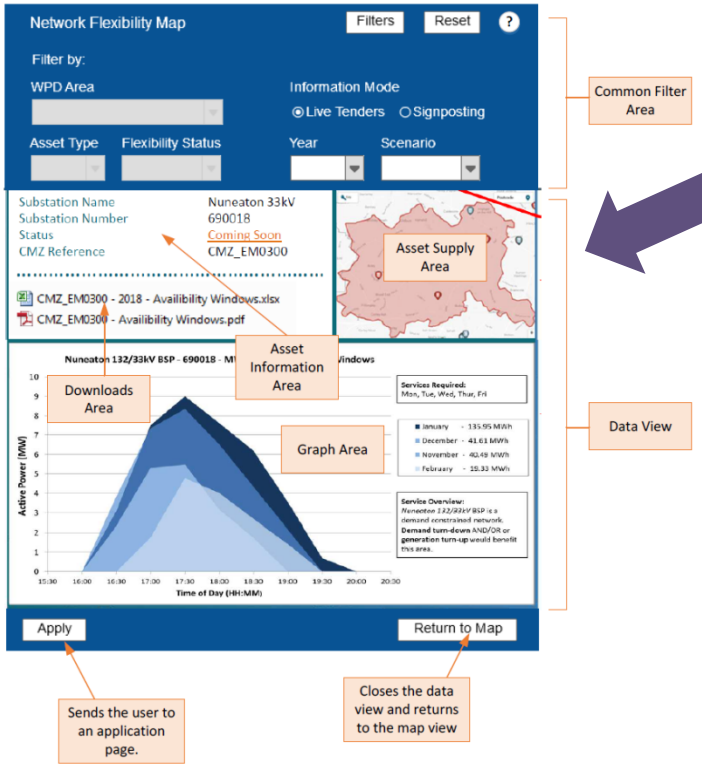
Single scenario for each year for a two year window

What information is presented?



- Procurement documents will be published alongside the network flexibility map information
- Geographic supply area
- MW peak and length for availability
- Estimated MWh utilisation
- Months applicable
- Days applicable
- Raw data downloads

Zones under live Procurement



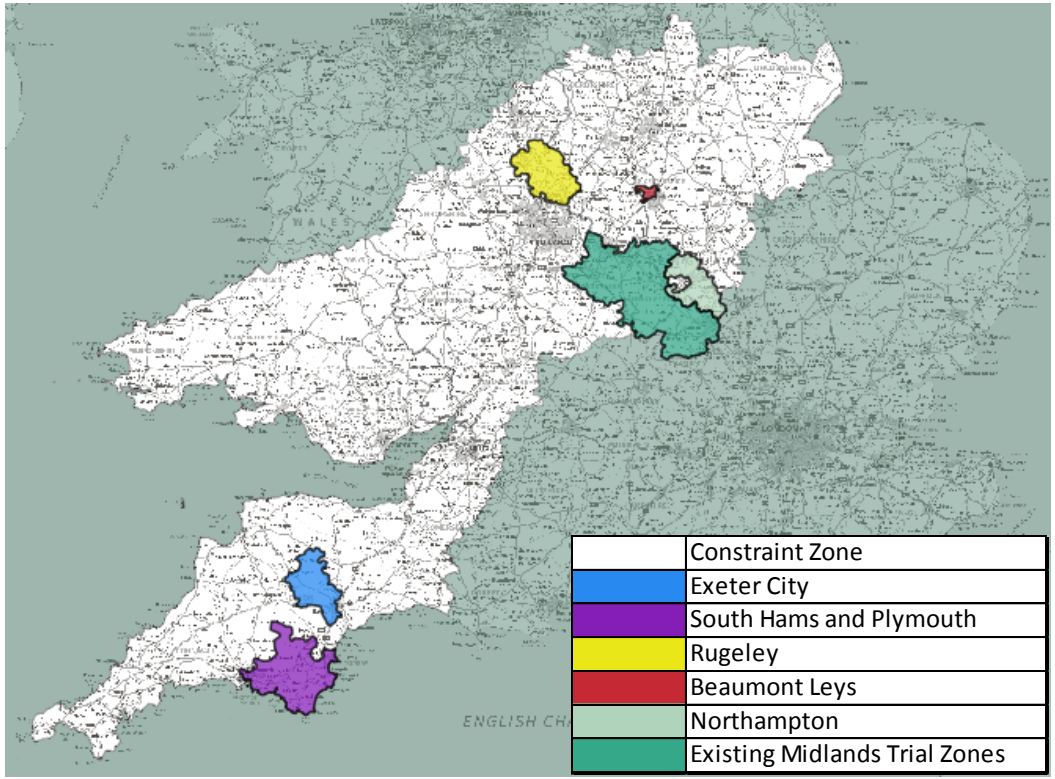
Zones under live procurement will also be displayed in our network flexibility map environment.

Using a similar functionality to our network capacity map, our network flexibility map is publically available on our website:

www.westernpower.co.uk/signposting

Procurement

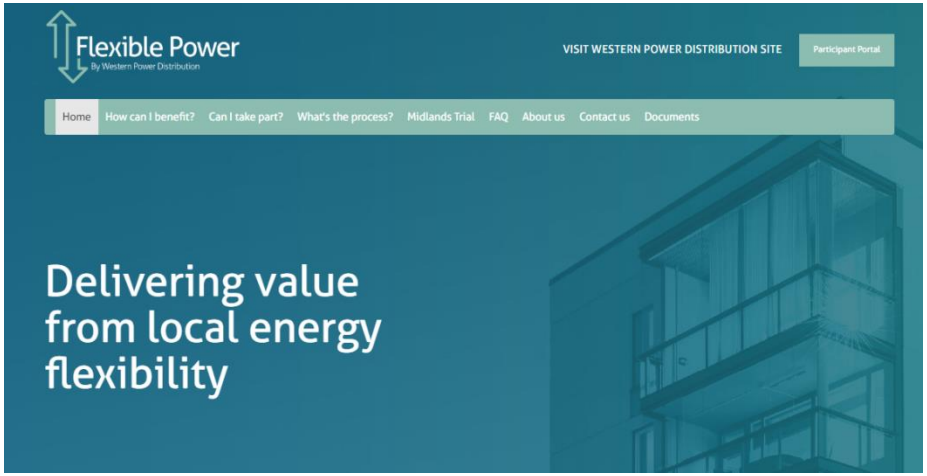
- 5 new constraints in 18 zones
- To operate over the winter of 2018 and the summer of 2019
- Services based on Entre trial
- Requirements based on forecasting
- Roll out of BAU non-network alternatives to reinforcement



How we procure

- Through Flexible Power
- Full information on website: www.flexiblepower.co.uk
- Also in Expression of Interest document
- Start with an Expression of Interest to determine zone viability
- Responses need to be submitted by **17.00** on the **11/07/2018**

Flexible Power
By Western Power Distribution



Timeline

Expression of Interest

Mid May to early July

Procure

Mild July to mid September

Build and Test

Mid September to late October

Operate

November 2018 to October 2019

Key date:

- **17.00 on the 11/07/2018, Expression of Interest closes**

System Needs and Products

Learning from Business As Usual

- The value of additional information through Signposting
- The adaption of services for new network requirements
- Procurement of Restore only services
- Potential for weekend running (questions in EoI)
- Development of more realistic procurement timescales

What is the potential for a mature Flexibility Market?

1.4GW of connections facilitated through flexibility ahead of conventional reinforcement

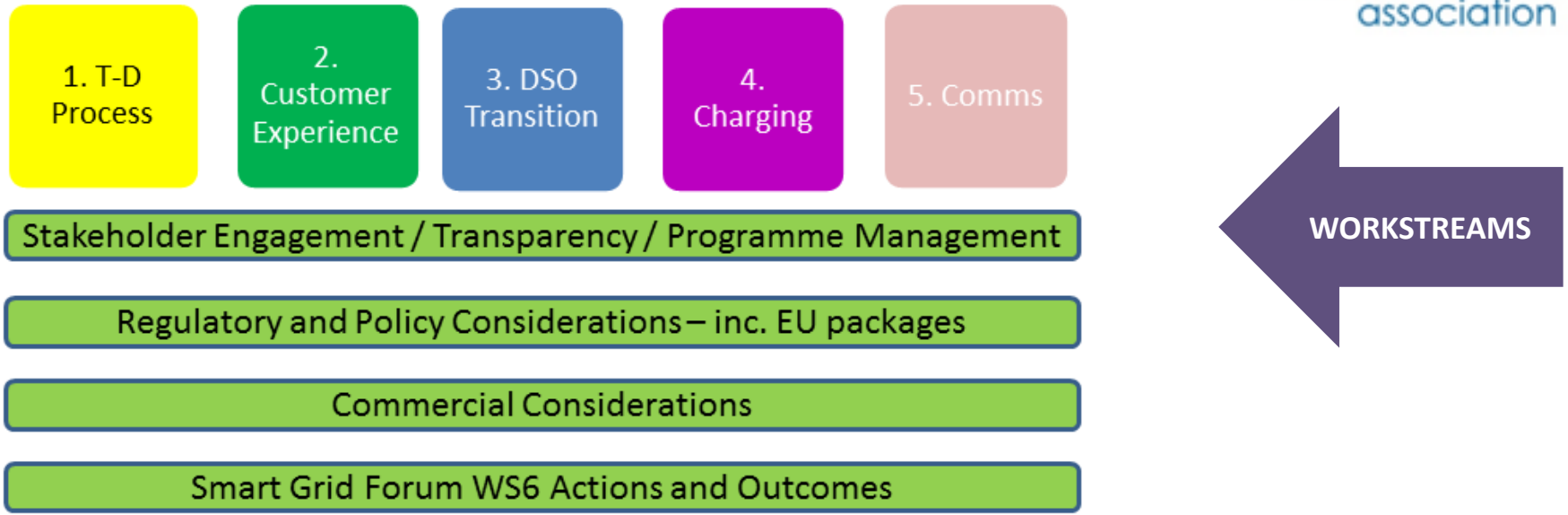
Up to £150m of network reinforcement deferred year on year

25,000 MWh of energy required to balance demand locally

Market potential of around £6-8m per annum within WPD licence areas

Collaboration with Industry

- We will be feeding into the Open Networks WS1 P6 programme – Regional Service Requirements – to develop a consistent approach to how system operators signal local requirements.



WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Further Collaboration

If you have any questions in relation to WPD's Network Strategy work, please contact WPD on the details below:

Email: wpdnetworkstrategy@westernpower.co.uk

By post:
Network Strategy Team
Western Power Distribution
Feeder Road
Bristol
BS2 0TB

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Break

Refreshments in the Maxwell Library (1st Floor)

Resume at 11:50am

WESTERN POWER DISTRIBUTION

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Flexibility Panel Session

Chair: Brendan Coyne, The Energyst

Panellists:

Yoav Zingher - Kiwi Power

Rhiannon Marsh - National Grid

Eddie Proffitt - MEUC

Nigel Turvey - WPD

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Lunch

Served in the Maxwell Library (1st Floor)

Resume at 13:30pm

Smart Hybrid Heating in a Whole Energy System

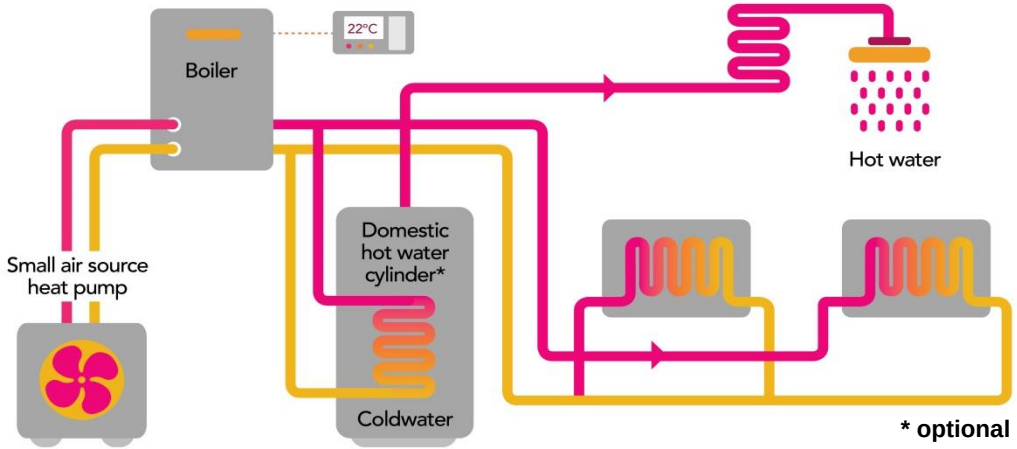
Faithful Chanda – WPD
Oliver Lancaster – Wales & West Utilities
Tom Veli – PassivSystems

Introduction

£5.2m collaborative project between WPD, Wales & West Utilities, PassivSystems, Imperial College, Delta-ee and City University to evaluate Hybrid Heating Systems

Installed into 75 homes in 2017 in the Bridgend ‘Living Heat Lab’

Low cost retrofit to existing wet system with unique smart controller



Project Objectives

- Use the ability of the hybrid heating system to allow **smart switching between gas and electric load** to provide fuel arbitrage and highly flexible demand response services.

- Demonstrate the **consumer cost, carbon and energy system security benefits** of large-scale deployment of hybrid heating systems.

- Gain insights into the means of **balancing the interests of the consumer, supplier, and network operators** when seeking to derive value from the demand flexibility.

Installations

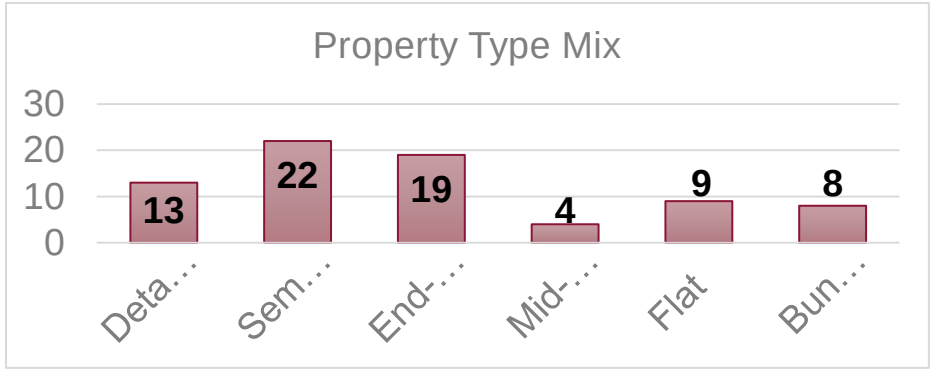
75 installations are now completed:

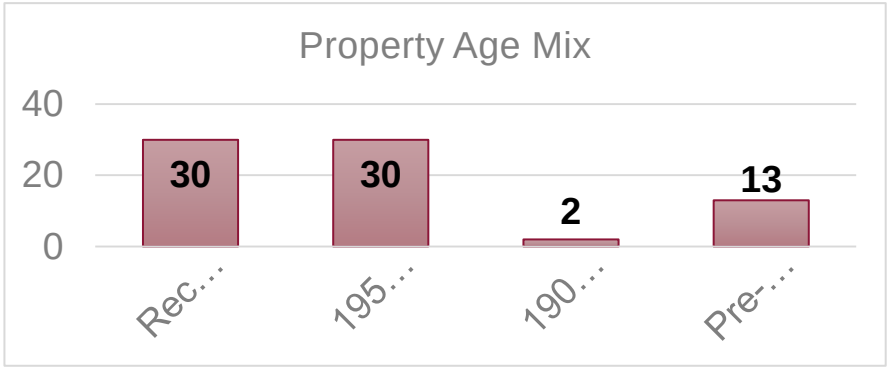
- 16 x Daikin Combined Unit (WDS Clean Energy installer)
- 16 x Samsung & Worcester Bosch Boiler (Spire Renewables installer)
- 43 x MasterTherm & Vaillant Boiler (Thermal Earth installer)

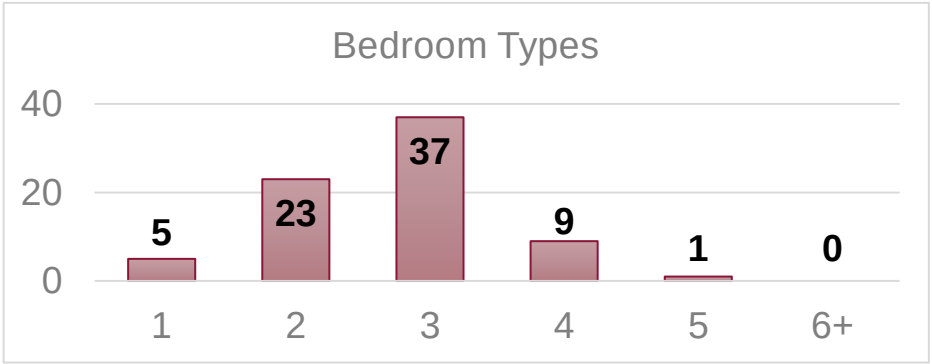
Example: Samsung HP – 5kw

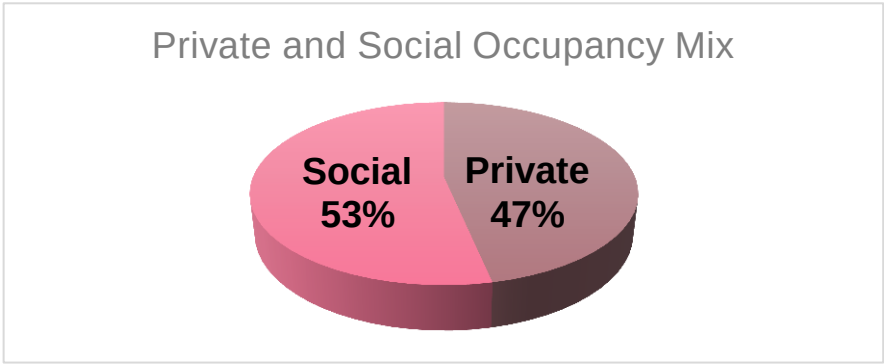
Freedom Project

Property Information





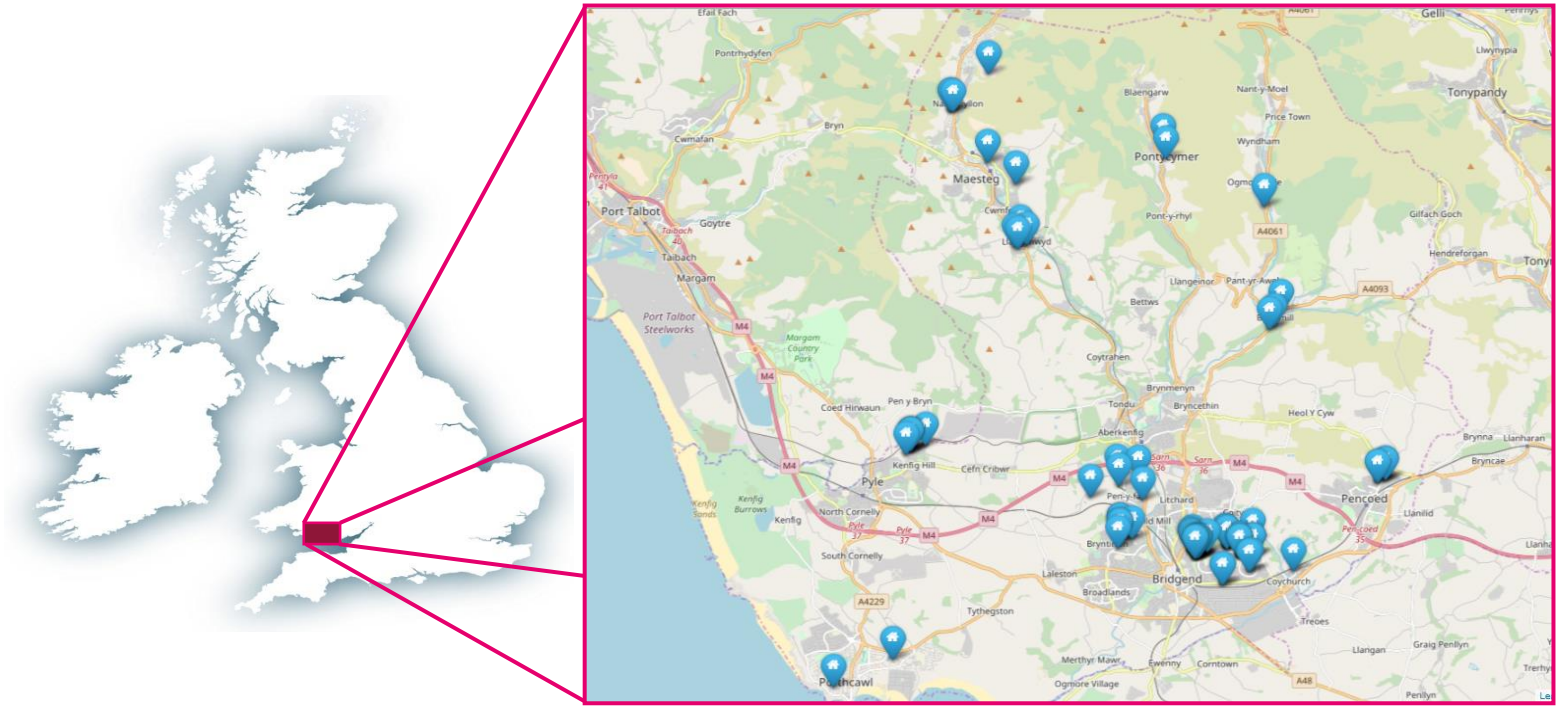




3x off-gas-grid properties, 3x systems boilers, 1x retrofit to an existing boiler

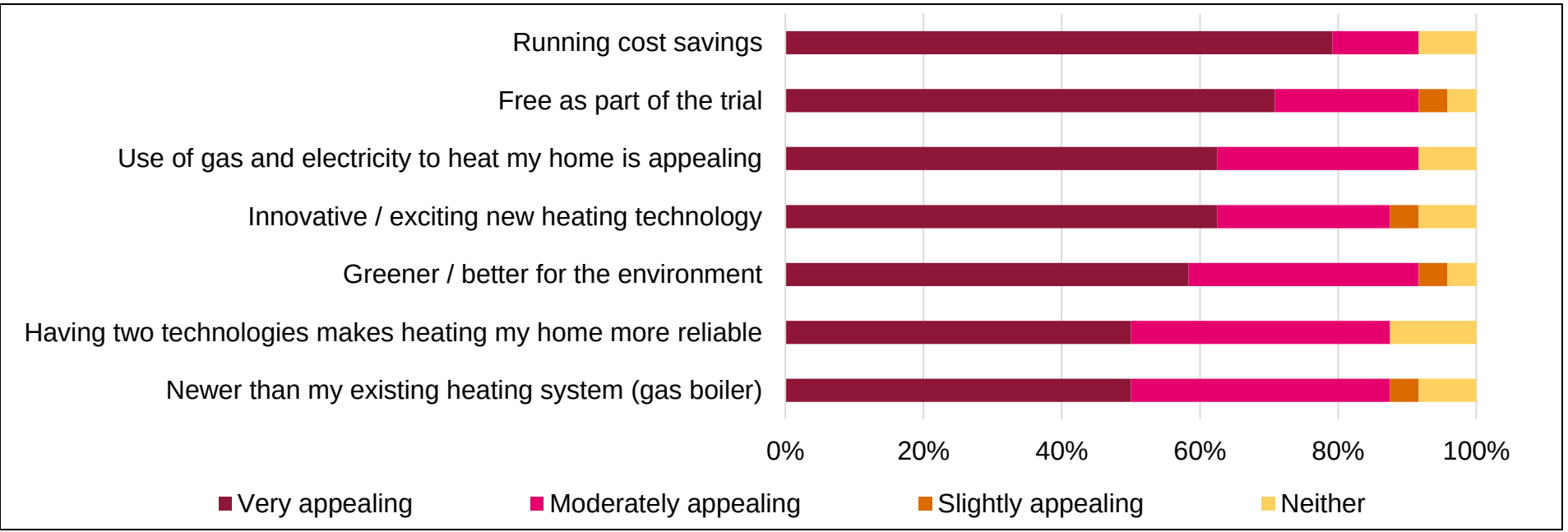
Locations – South Wales, Bridgend

Freedom Project



Main Phase Consumer Feedback

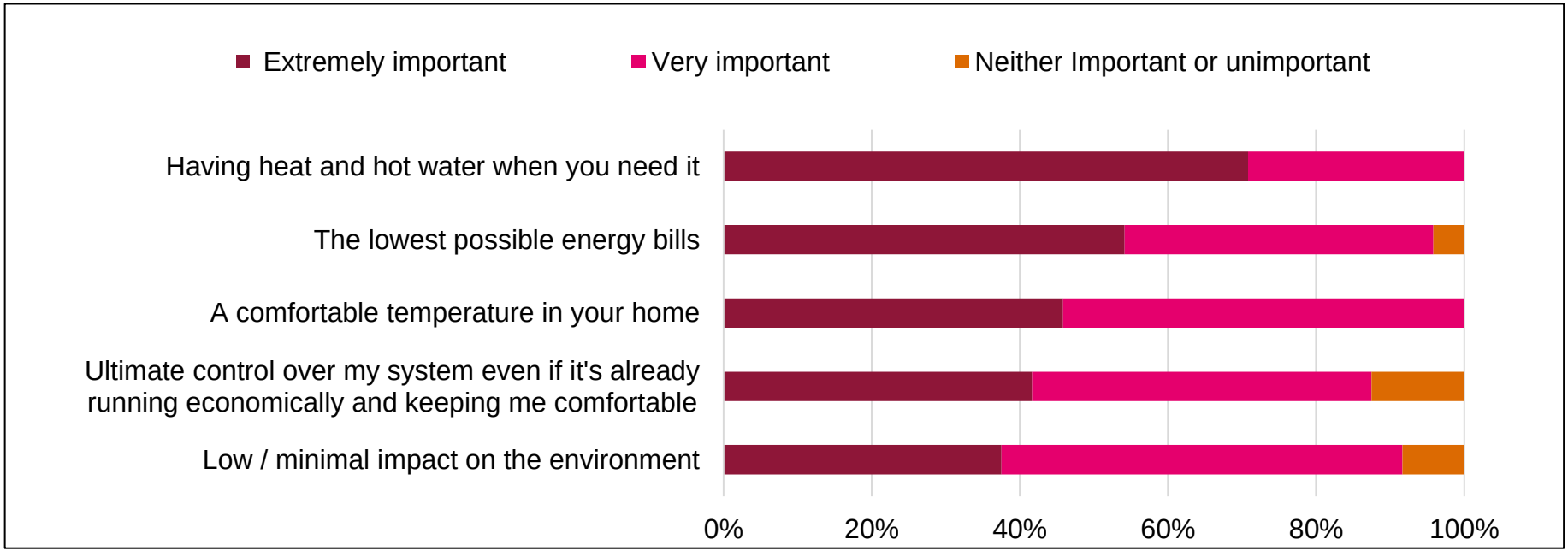
What are the reasons for considering a hybrid?



Running costs and capital costs are the biggest customer driver

Main Phase Consumer Feedback

What is important for the consumer from their heating system?



Customers prioritise reliability, low bills and comfort

The Future with Heat Pumps

Future Energy Potential

- Heat pumps are a small but growing part of the UK energy market
- In significant numbers could place a significant additional demand on the electricity network
- Challenges:
  - Network Operability – e.g. steep demand increases if heat pumps switch on simultaneously
  - Network Planning – e.g. peak demand increase
  - Especially at peak times
- Important for the decarbonisation of heat energy generation in the UK

Challenges of Climate Change

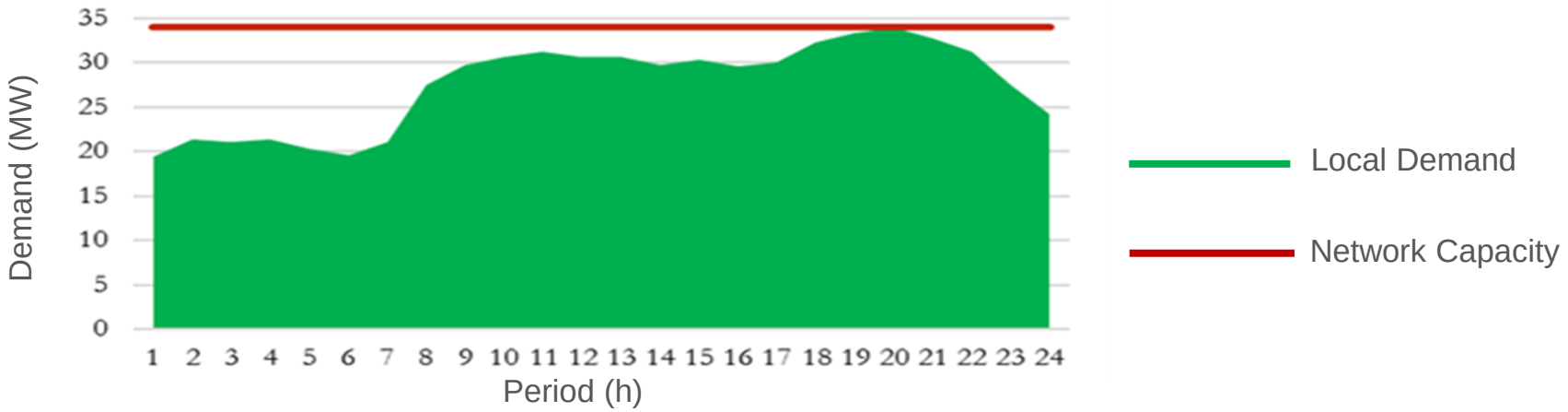
Influence on Climate Change

- Gas boilers are the predominant technology for the provision of domestic space heating and hot water in the UK
- Market penetration ~ 80%
- Heat pumps may have higher running costs compared to gas boilers unless a seasonal performance factor (SPF) or higher is achieved, with insulation or upgrades to heat delivery system
- Challenges:
  - Need to meet carbon reduction targets, by reducing dependency on fossil gas heating
  - Hybrids offer the flexible solution to make best use of renewable gas and electricity.

Local Electricity Demand

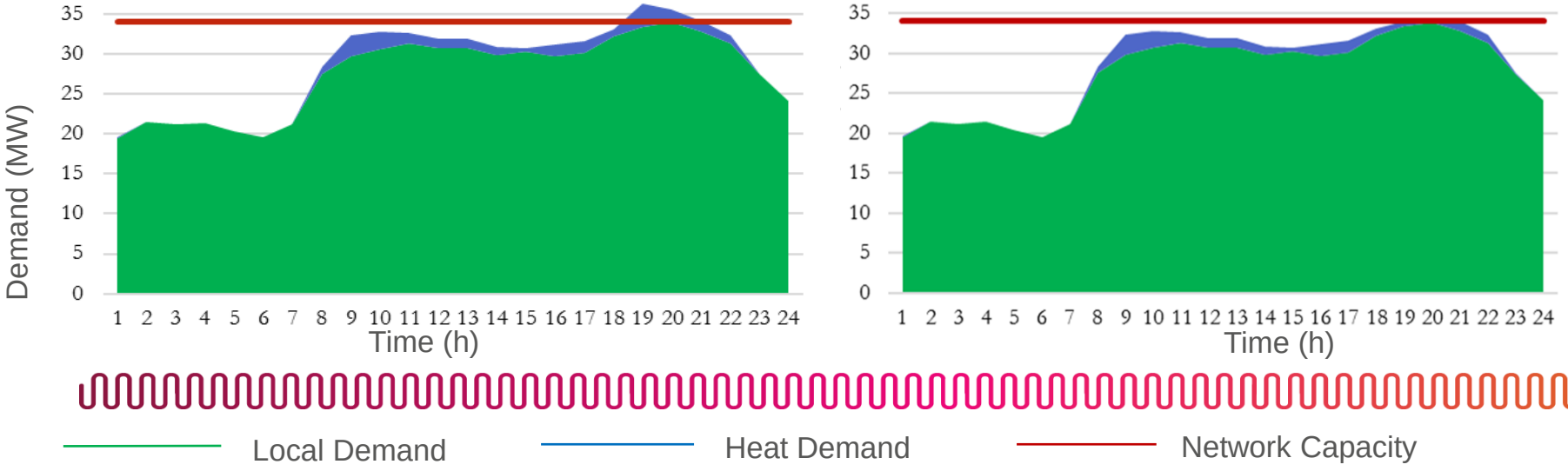
Between 18:00 and 22:00hr:

- Primary substation demand is at peak
- Nearly overloading the primary substation
- Adding electrification of residential heat demand will overload the distribution network



Supporting the Distribution Network

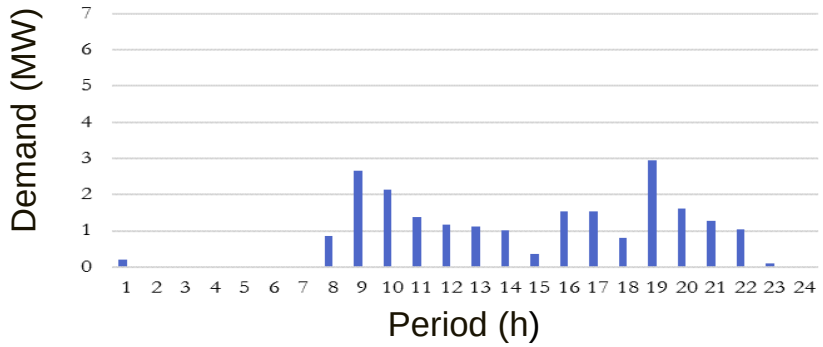
- At peak demand, hybrid heating systems can switch energy supply from electricity to gas:
  - Supported by developments in controls and automation
- Reduce additional demand at the distribution networks to defer network reinforcements
  - Potentially flexible loads

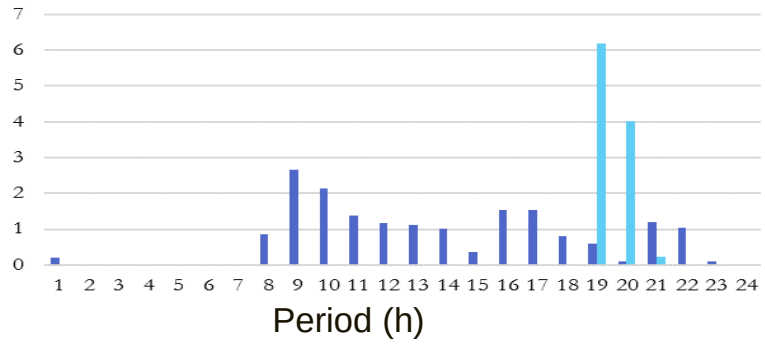


Defer Reinforcement

Hybrid heating systems can offer dual fuel flexibility

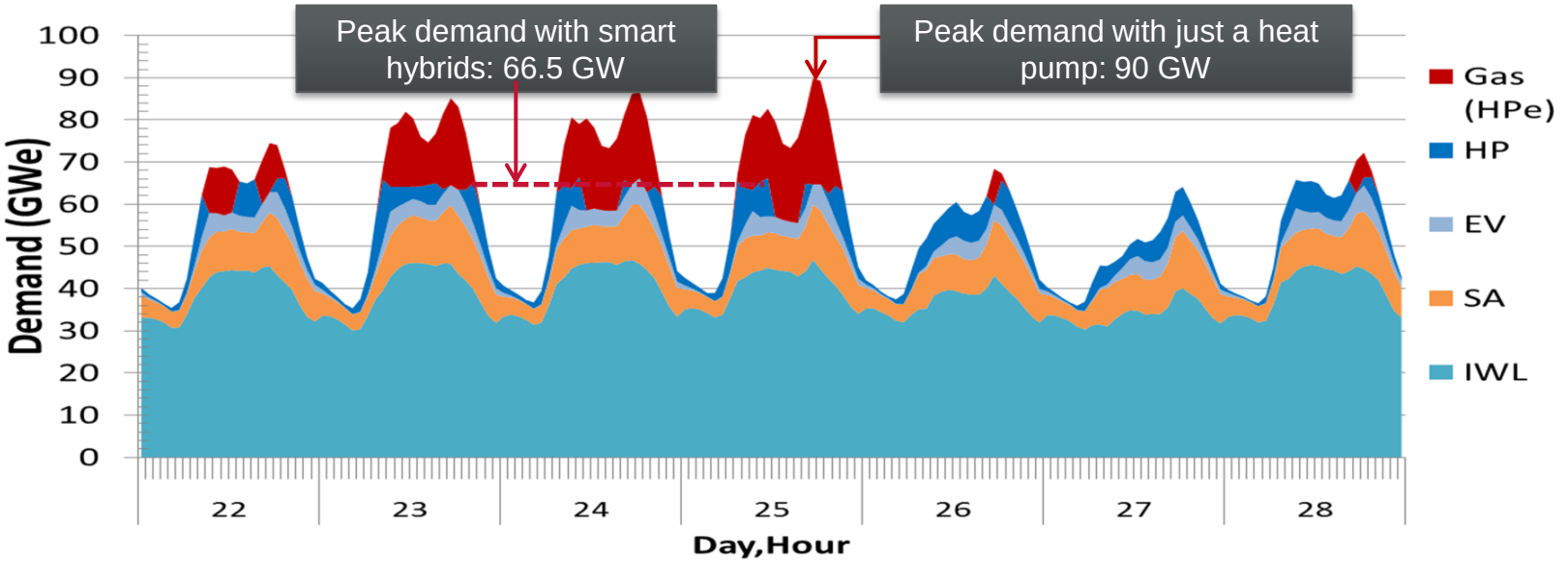
- Can be exploited to support network operation – change daily load profile
- Defer reinforcements, without compromising end-user's comfort levels
- Switch energy supply to gas during peak electricity demand on the DN
- Reduce the additional demand at the distribution network due to heat requirements





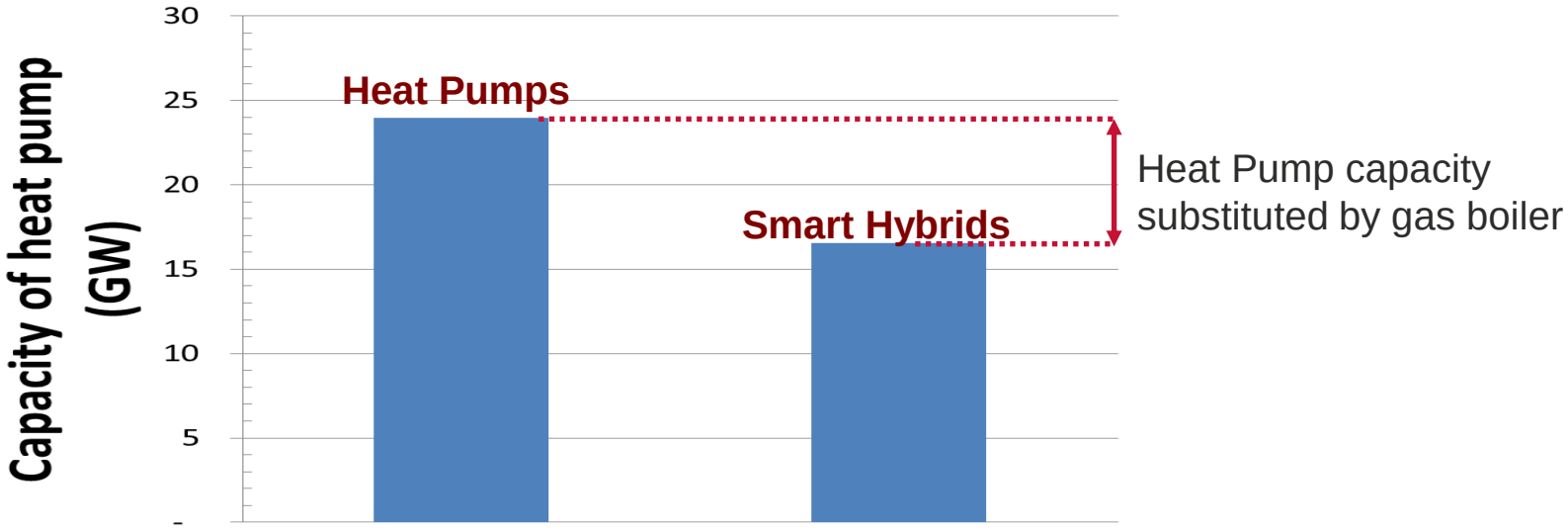
Electricity Supply Gas supply

Impact of Hybrid Heating Systems on electricity peak demand



Smart controlled hybrid heating systems will not increase electricity peak demand

Impact of use of gas on the electricity capacity of heat pumps



Use of the gas boiler reduces the electricity capacity of the heat pump

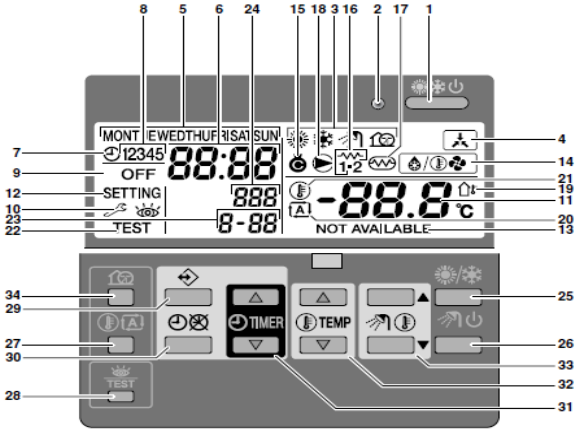
PassivSystems technology

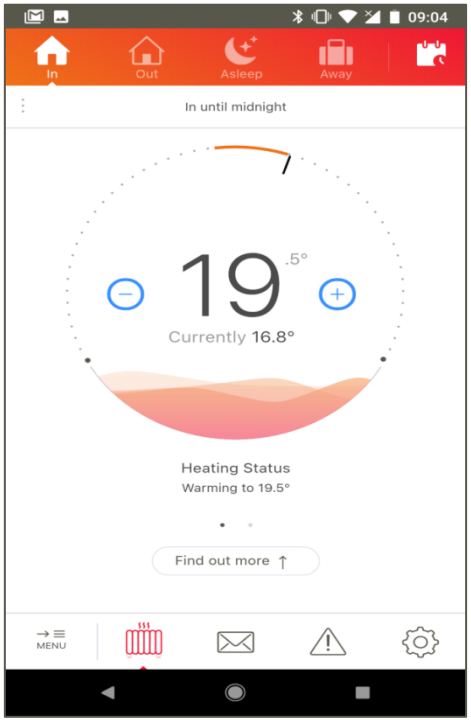
- User simply chooses when they want to be warm
  - Remote control with friendly smartphone app
  - Feedback on system operation: increases trust

- PassivSystems smart control software
  - Learns the thermal properties of the home
  - Predicts energy input required to meet householder's comfort
  - Calculates the optimal control strategy to minimise cost (or carbon…)

- Cloud services to coordinate consumption between homes
  - Aggregate energy forecasts from each home
  - Calculate demand flexibility to shift load (e.g. away from peaks)
  - Push instructions to execute demand side response

Conventional heat pump user experience

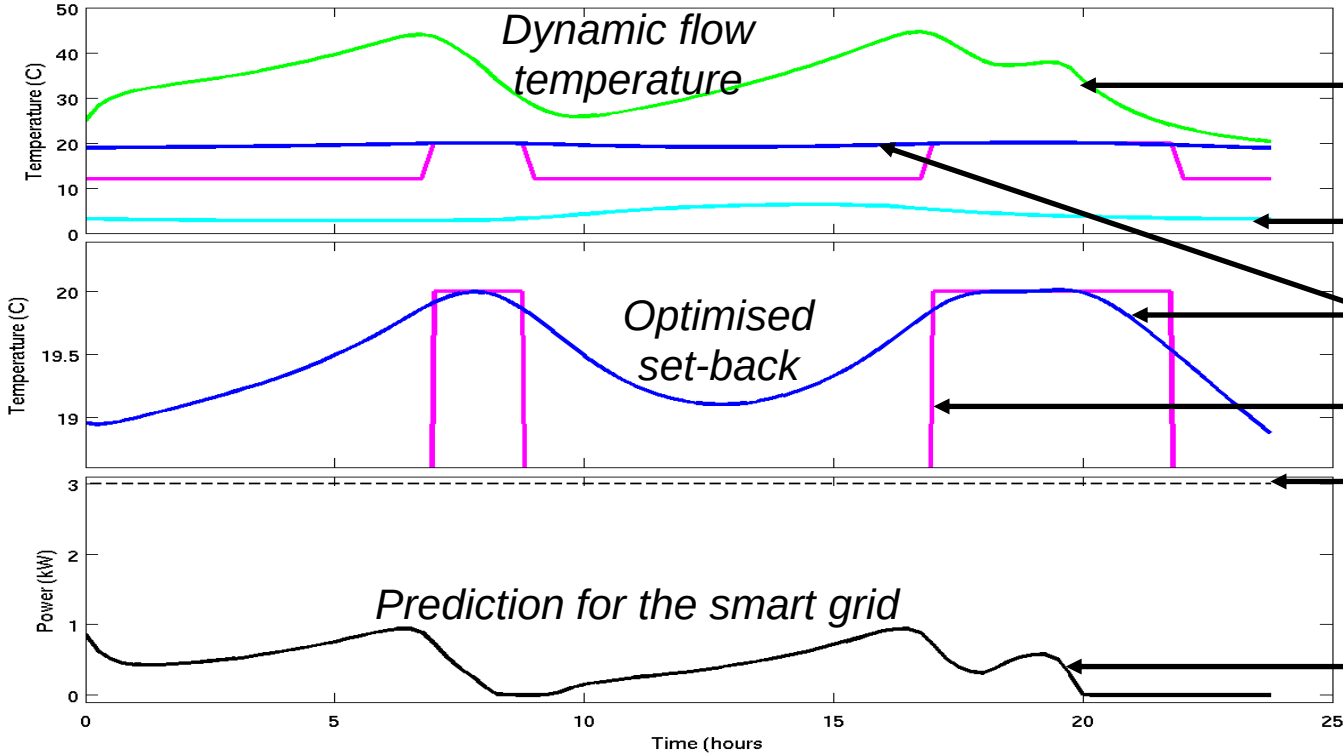




Should a householder turn their heat pump off overnight?

…leave it to us.

Predictive demand control



Target water flow temperature (output)

Weather forecast (input)

Target room temperature (output)

User set point (input)

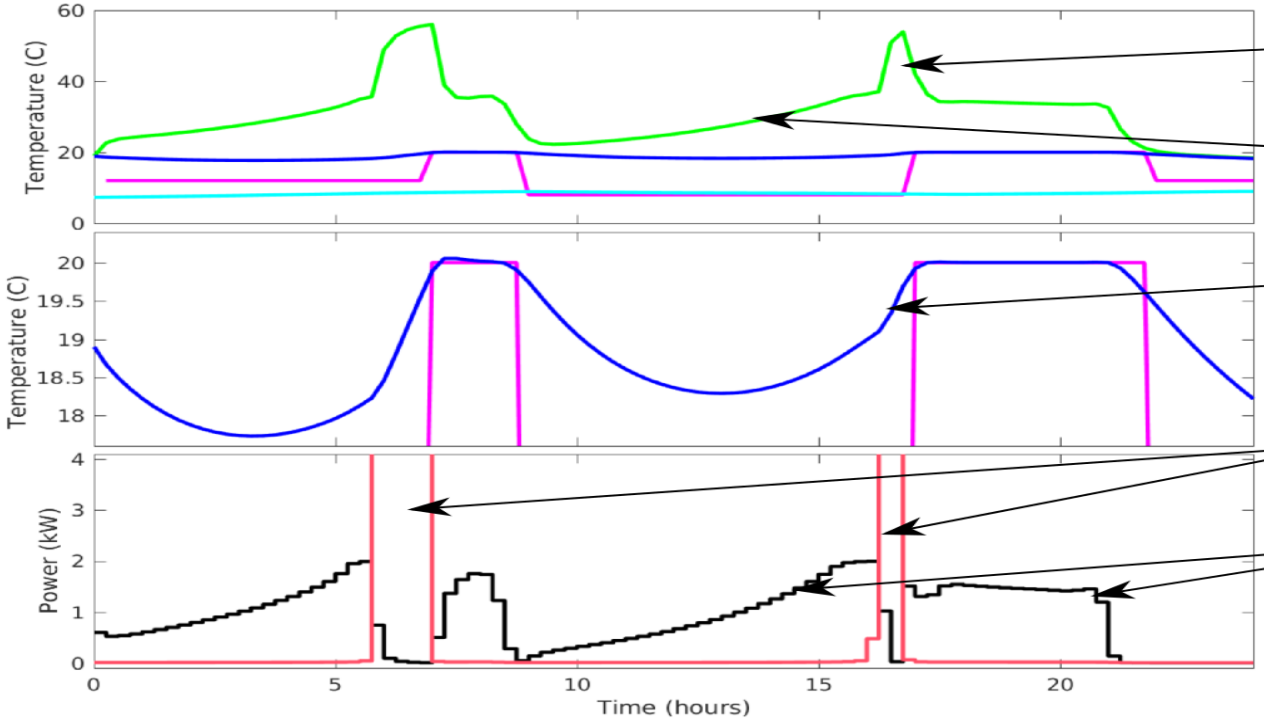
Maximum power limit (input)

Expected power consumption (output)

Controlling hybrid heating systems

- Conventional approach: programme to switch to gas boiler if colder than (for example) 5°C outside
  - Not easy to choose the transition temperature correctly
  - Fuel switch strategy based on current conditions only
- Passiv optimised approach: **predict** the most cost-effective transition strategy
  - Results in a heat pump “base load” and uses the boiler to provide “bursts” of heat
  - Set gas/electricity price ratio and that’s it
  - Automatically handles heat pump capacity limit (enabling smaller, cheaper heat pumps)

Optimised hybrid control



Bursts of high temperature from boiler to warm house up quickly

Heat pump operates at low flow temperature only, maximising COP

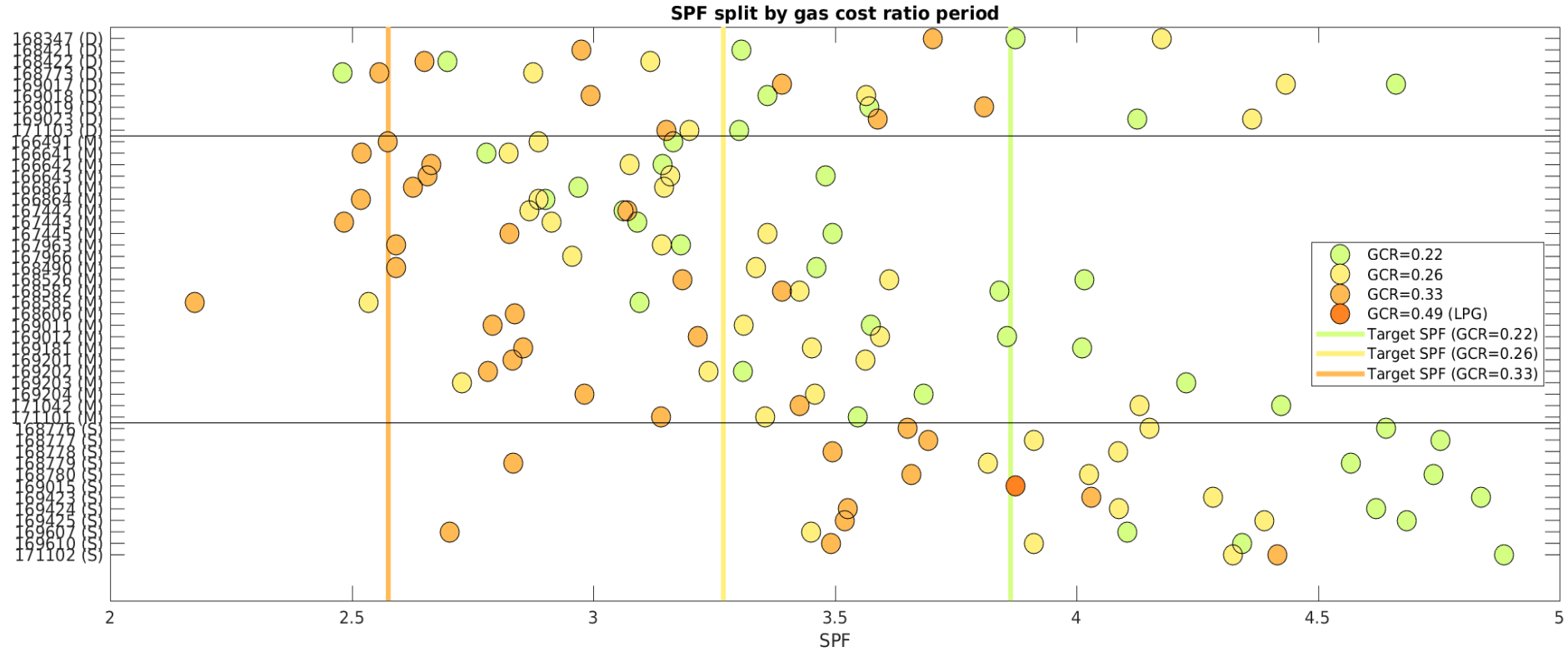
Sharp warming using the boiler enables lower average temperature, reducing fabric heat losses

Short bursts of boiler usage (in red, 15kW, cut off)

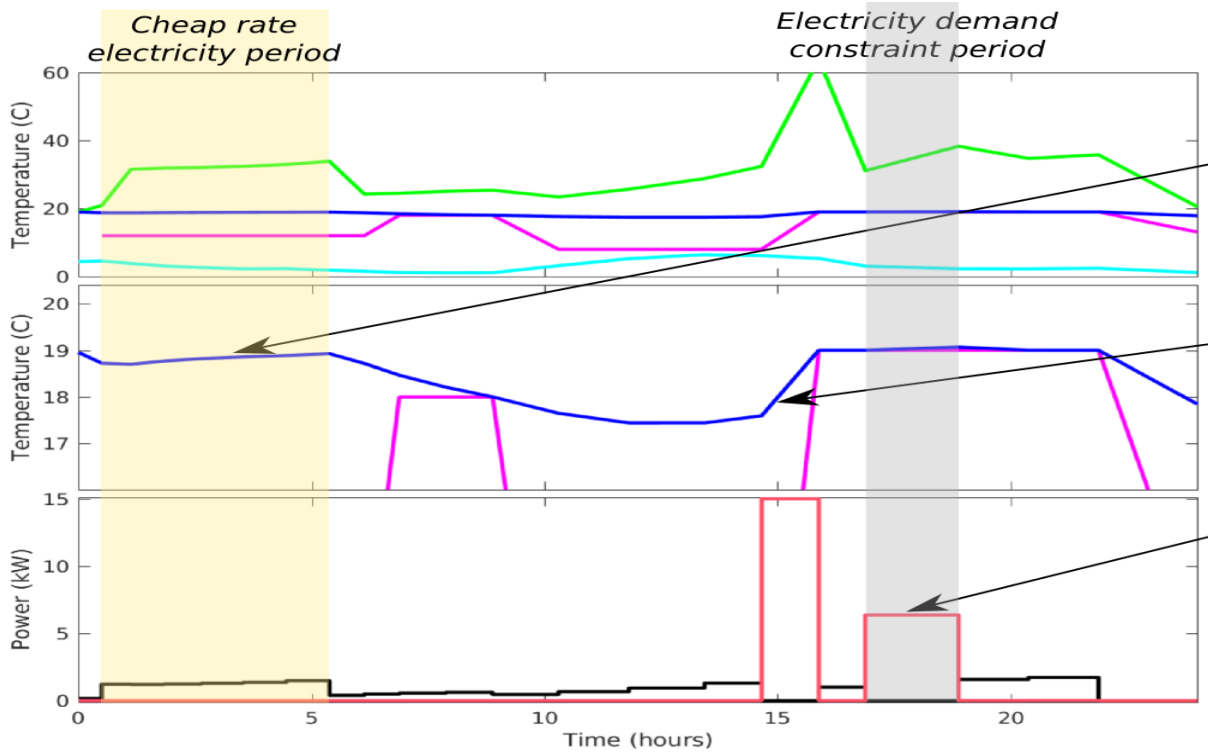
Heat pump provides "base load" and maintains flat temperatures

Gas:Electricity price ratio of **1:3.** Gas usage: **red**, Electricity usage: **black**.

Seasonal performance factor achieved



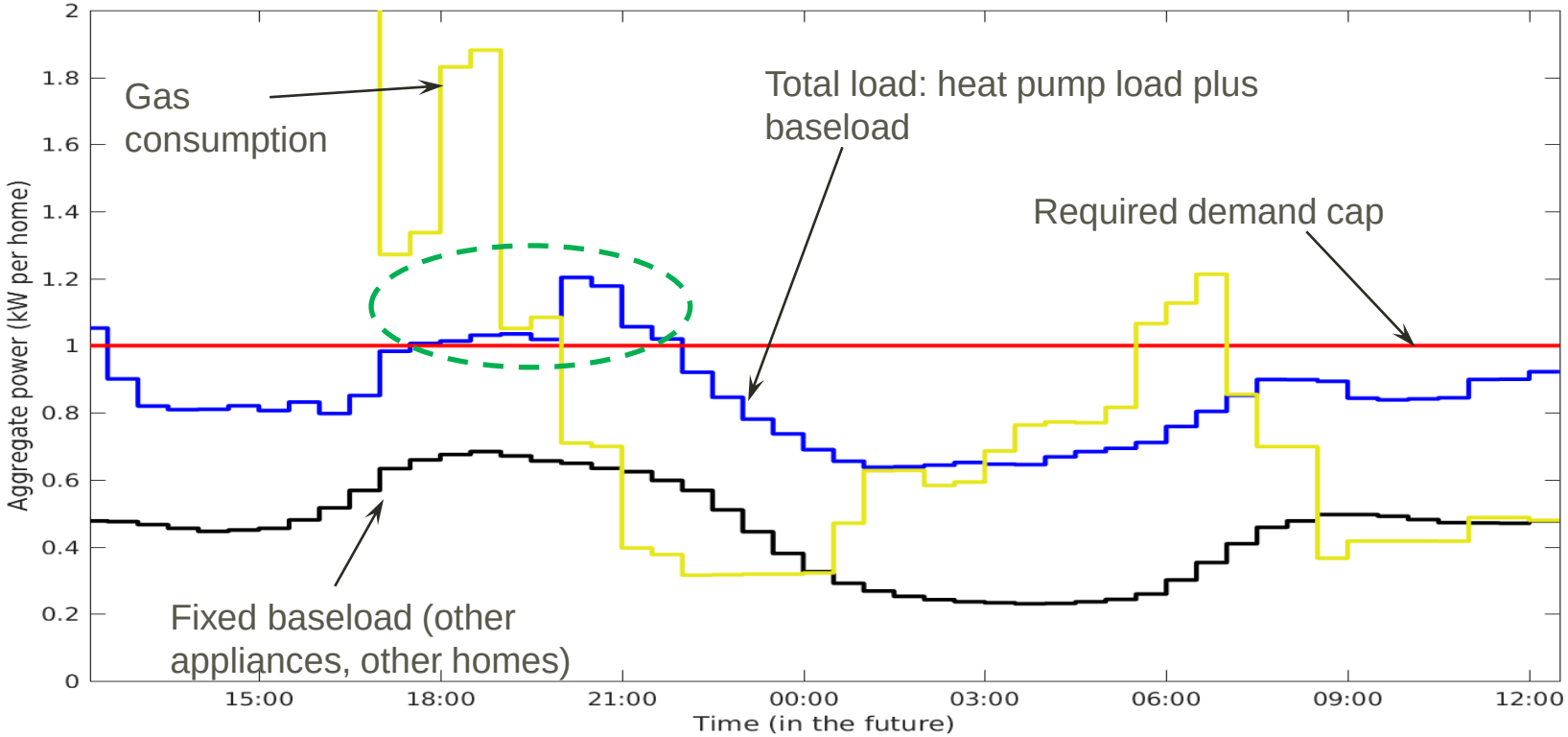
Advance planning for cheap rates and demand constraints



Gas usage: **red**, Electricity usage: **black**.

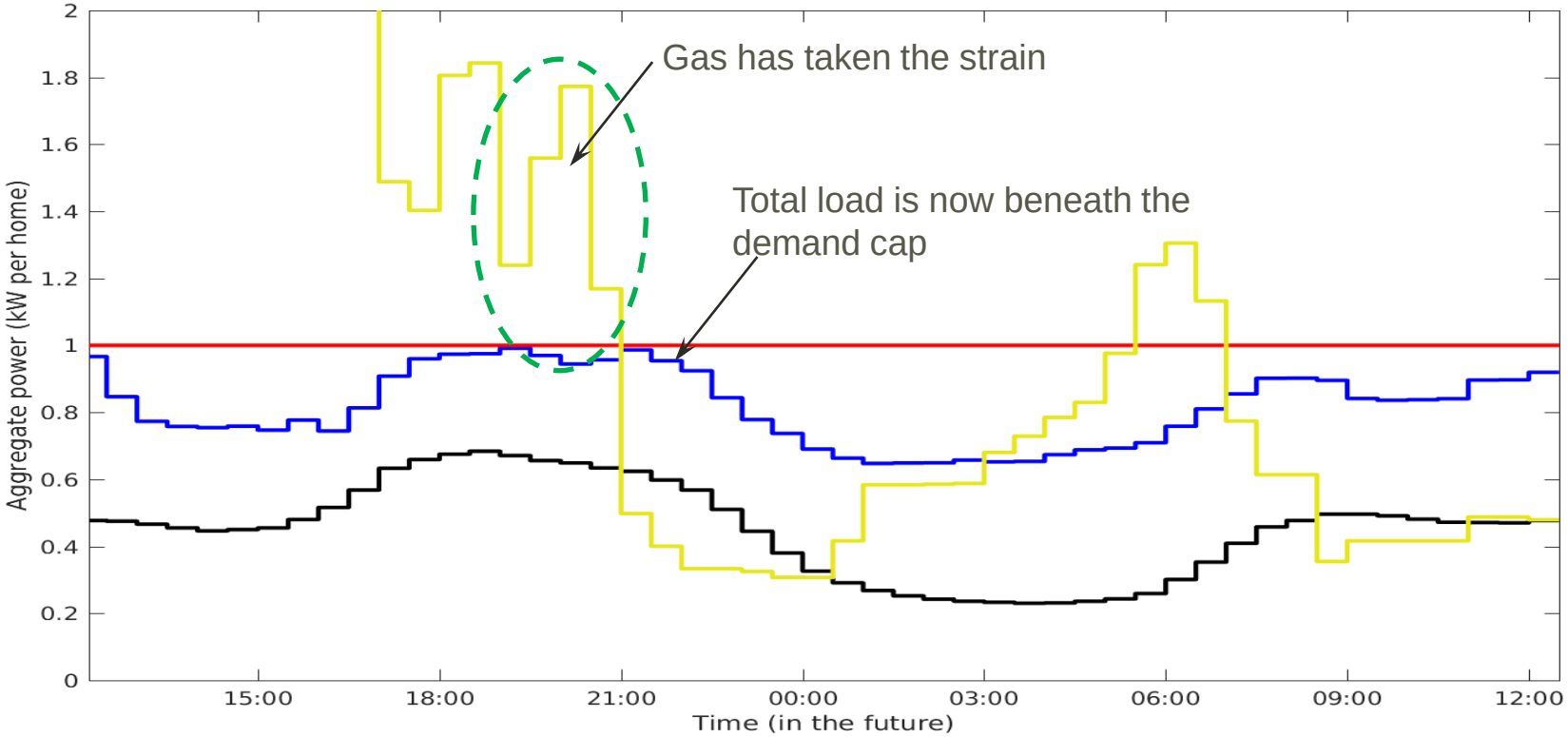
Aggregate load capping

Aggregate power consumption with simulated baseload added



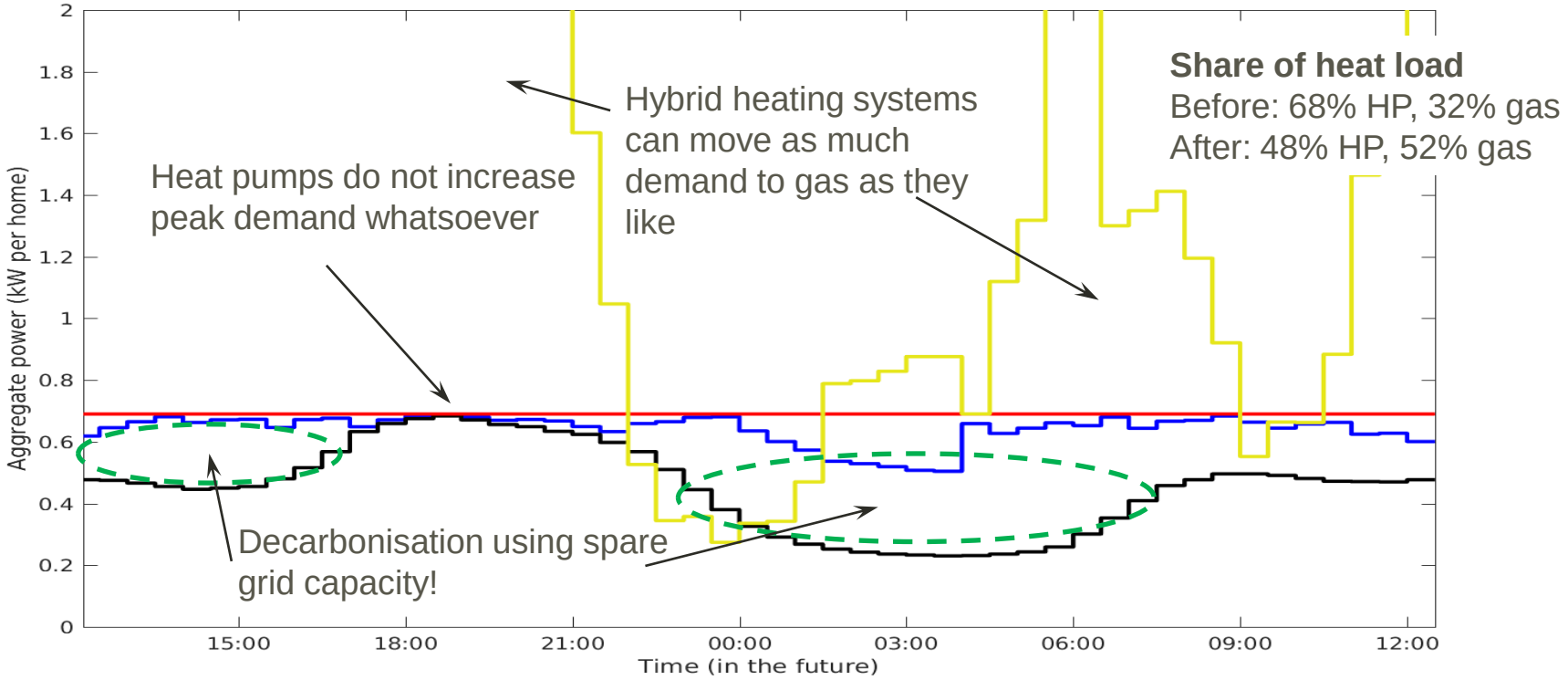
Aggregate load capping

After demand management to keep load below 1kW per home



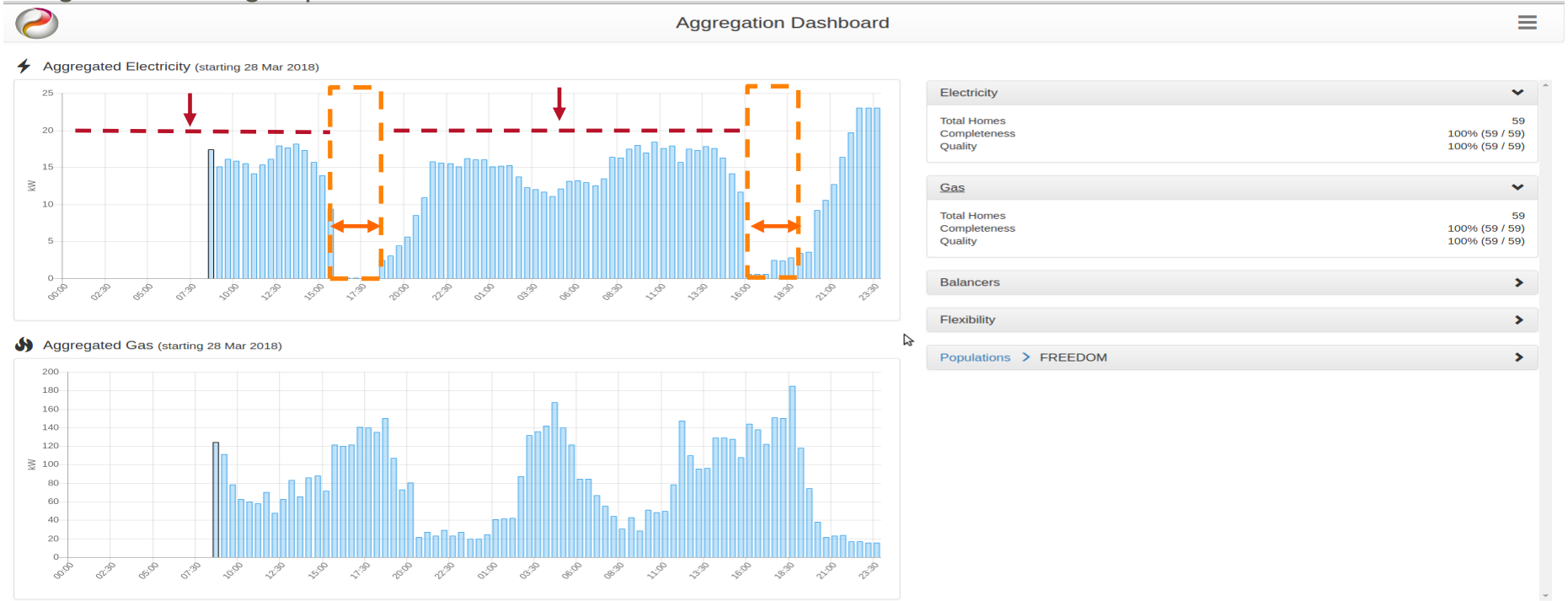
Aggregate load capping

Load can be kept below *baseload* demand peak if necessary



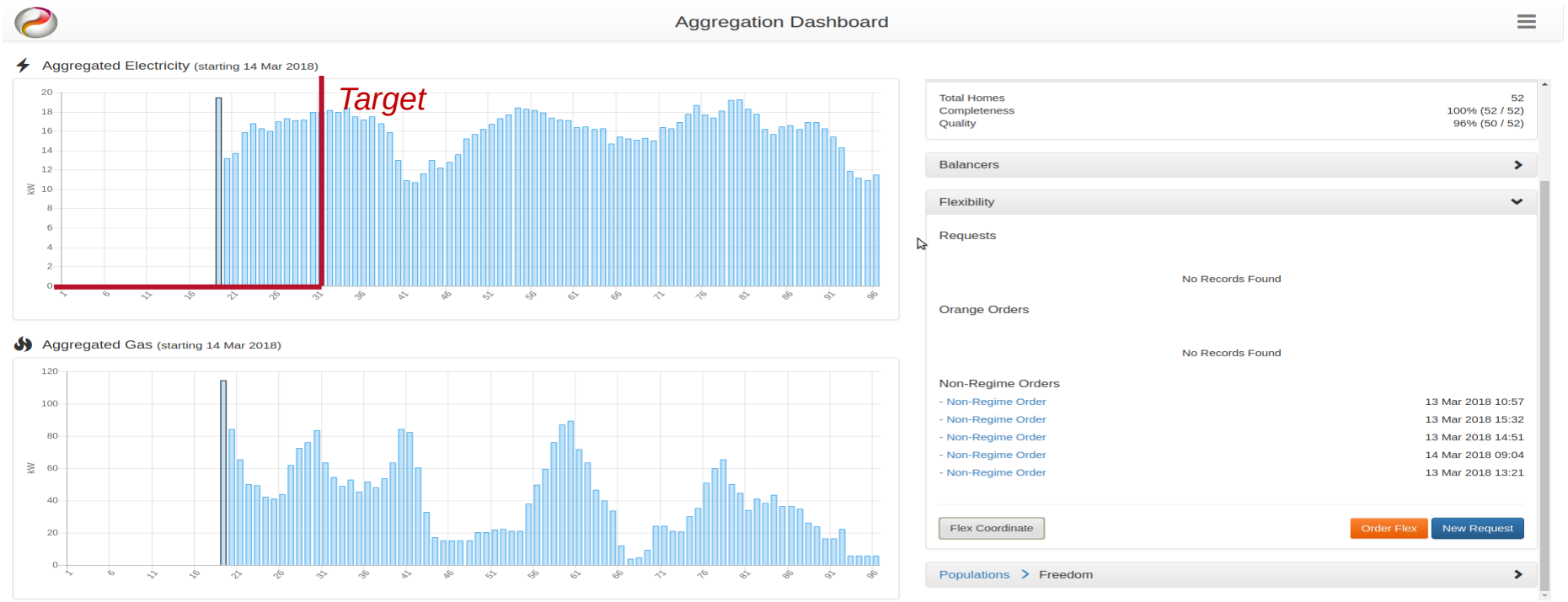
Example Aggregation

This example shows homes with hybrid heating systems being individually optimised to constrain whole home capacity below Elexon standard profile peak and using SWALEC red rate distribution charging price signal to avoid grid peaks.



Live demand management dashboard

14th March, 09:28:34



Live demand management dashboard

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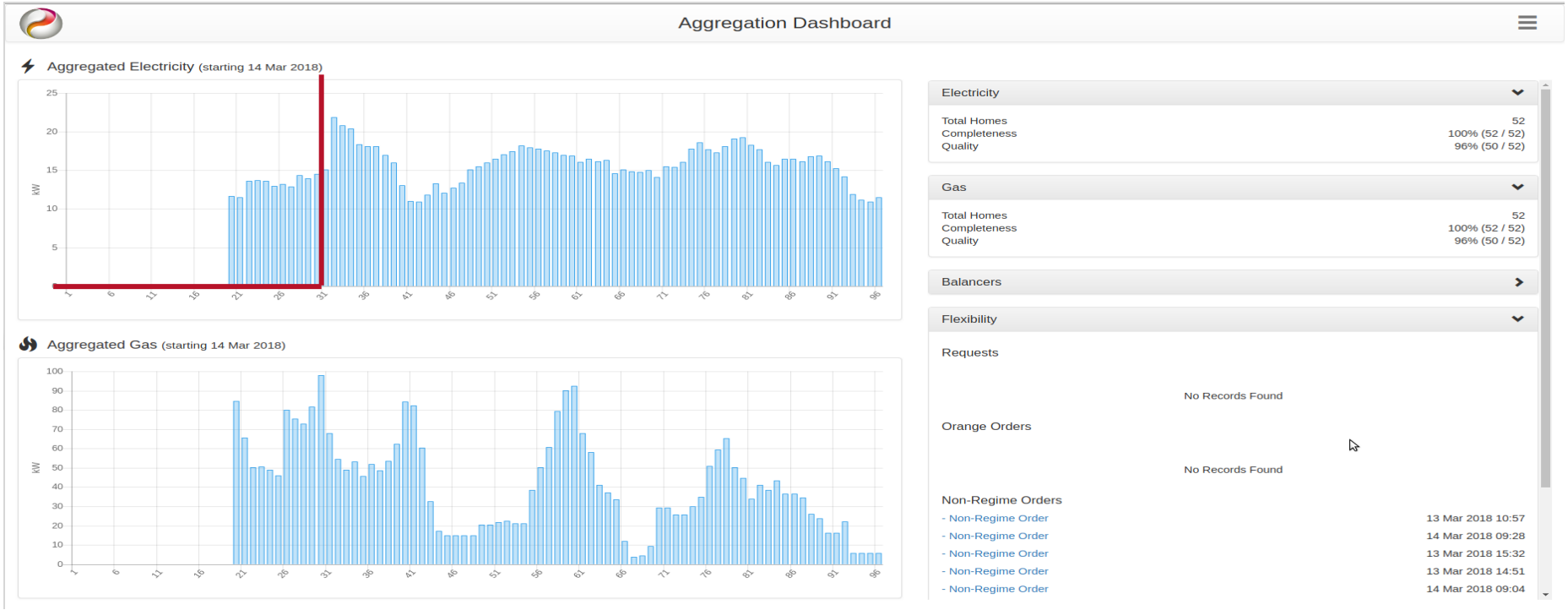

Live demand management dashboard

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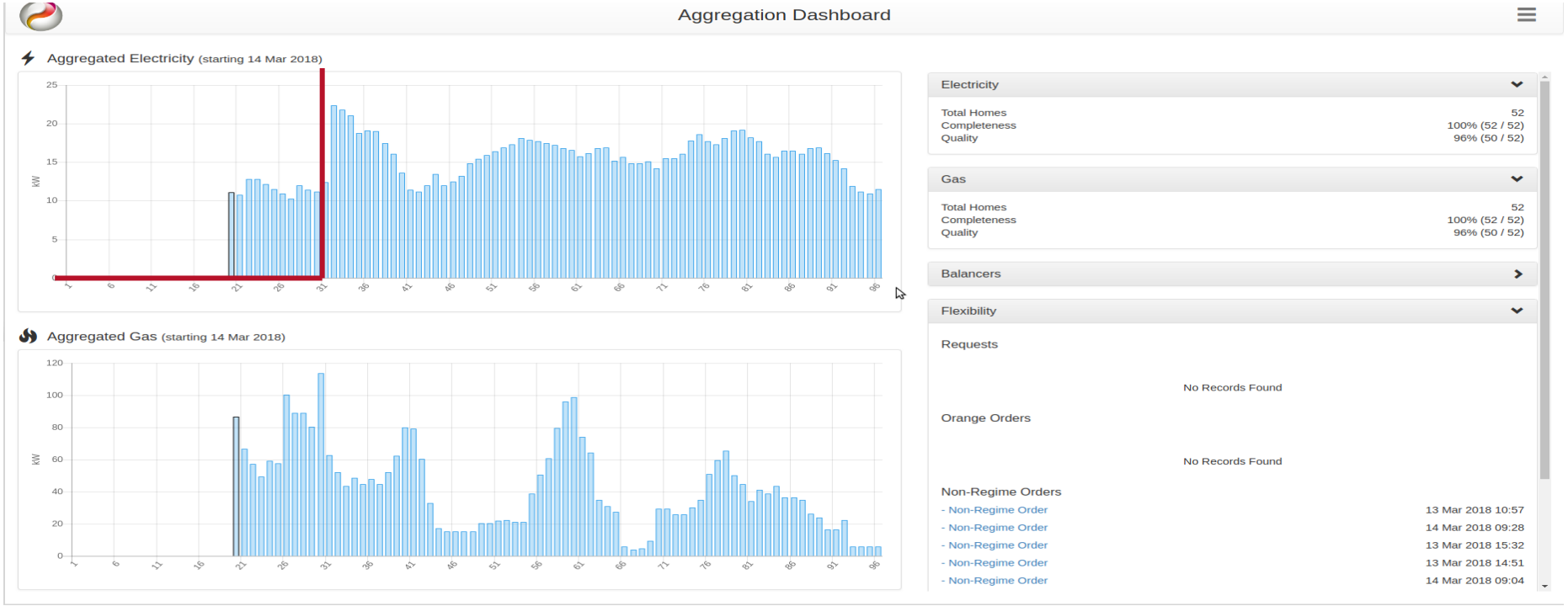

Live demand management dashboard

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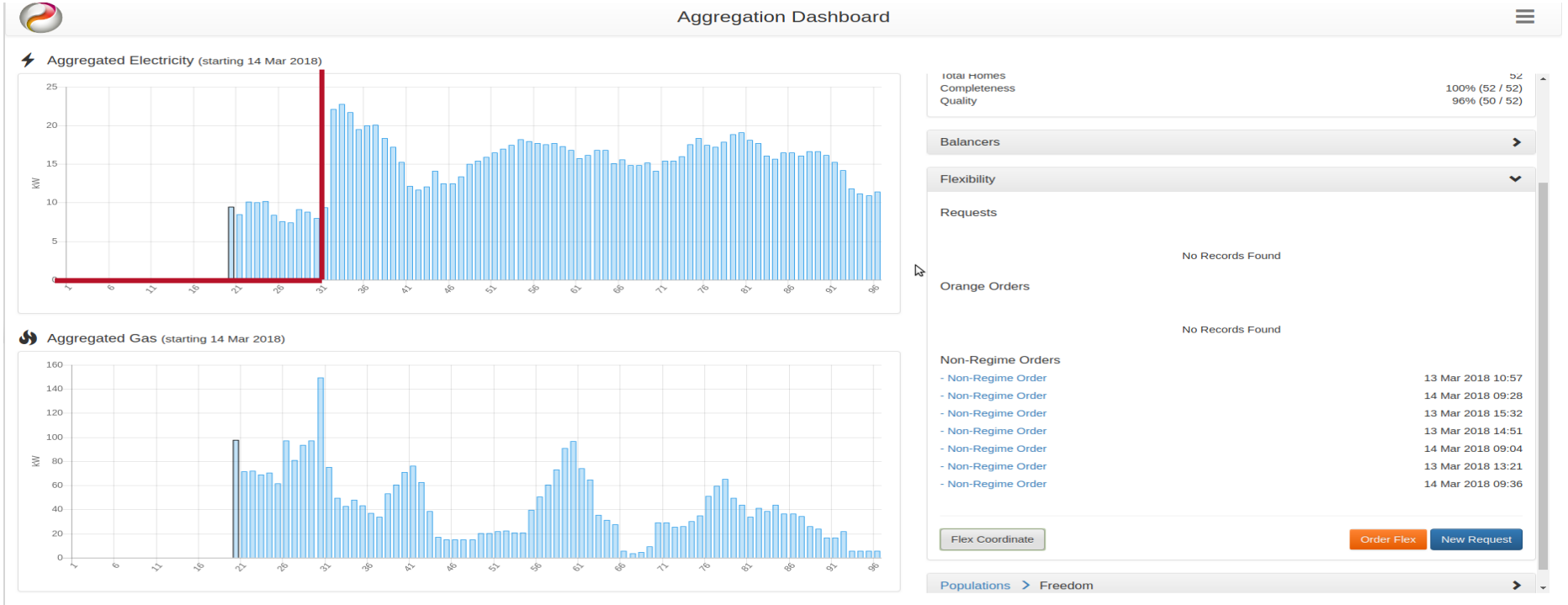

Live demand management dashboard

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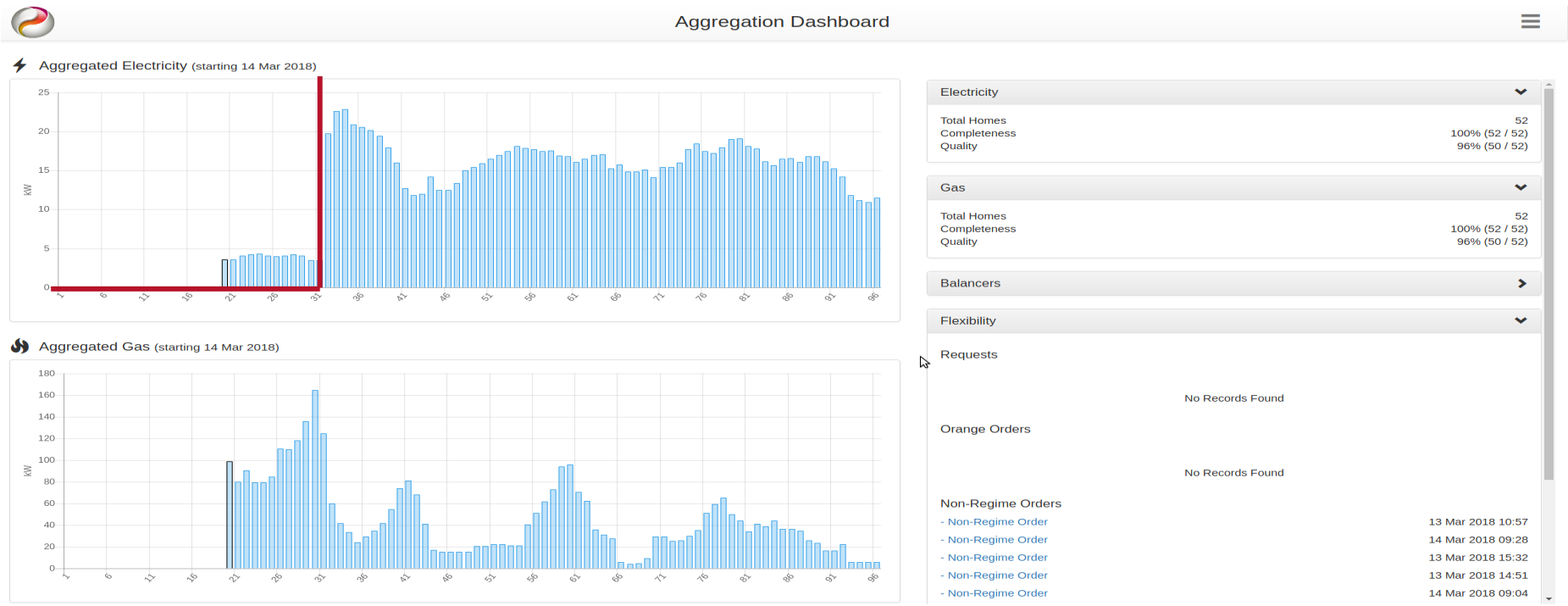

Live demand management dashboard

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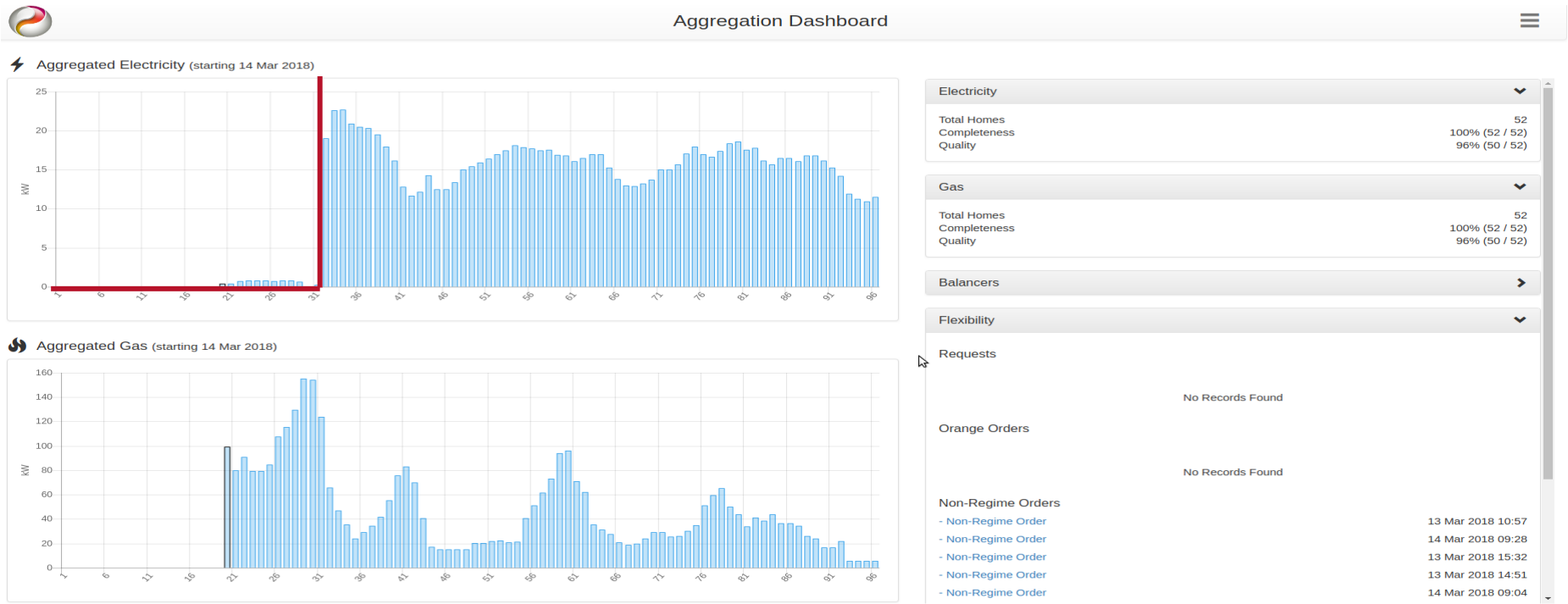
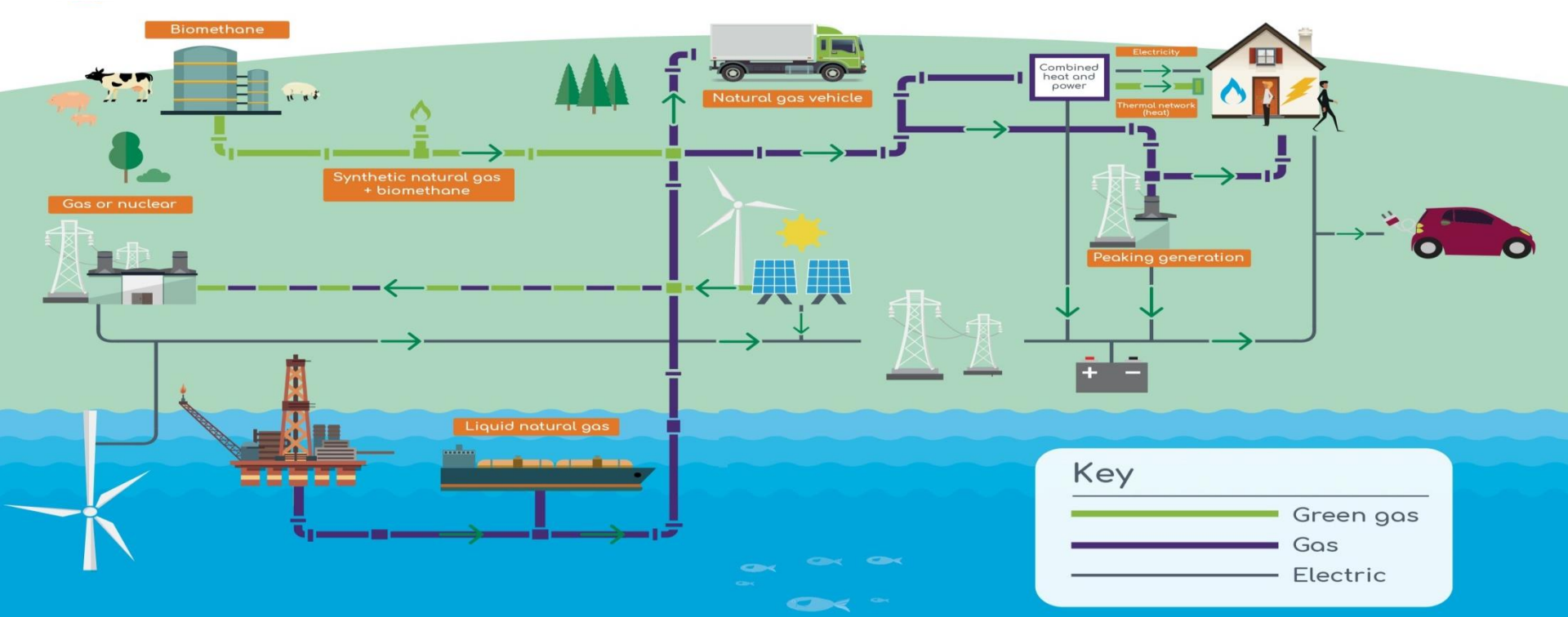


Whole Energy System Approach

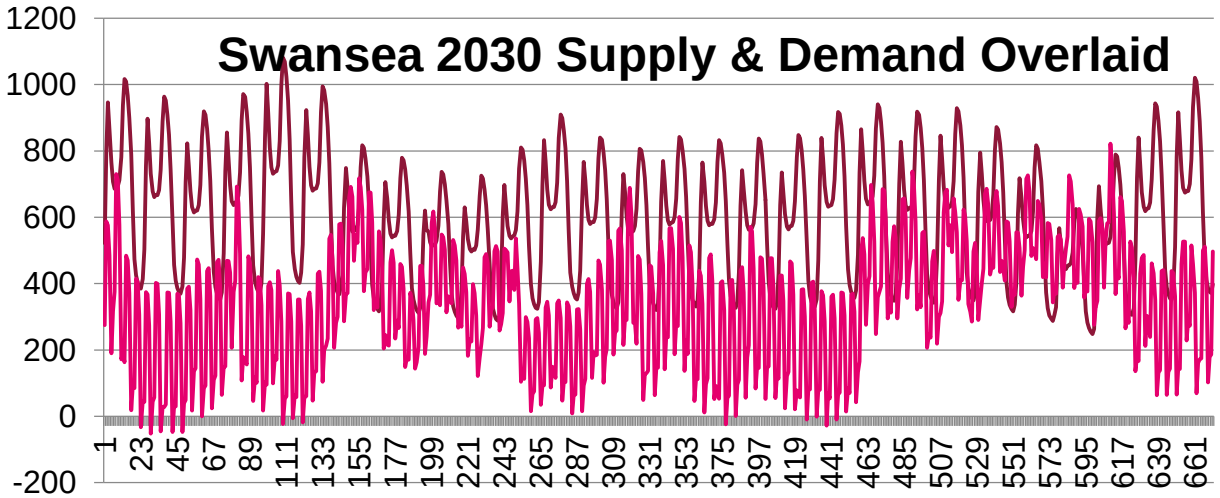
Freedom Project

Freedom brings efficient integration into the home



Whole Systems Simulation

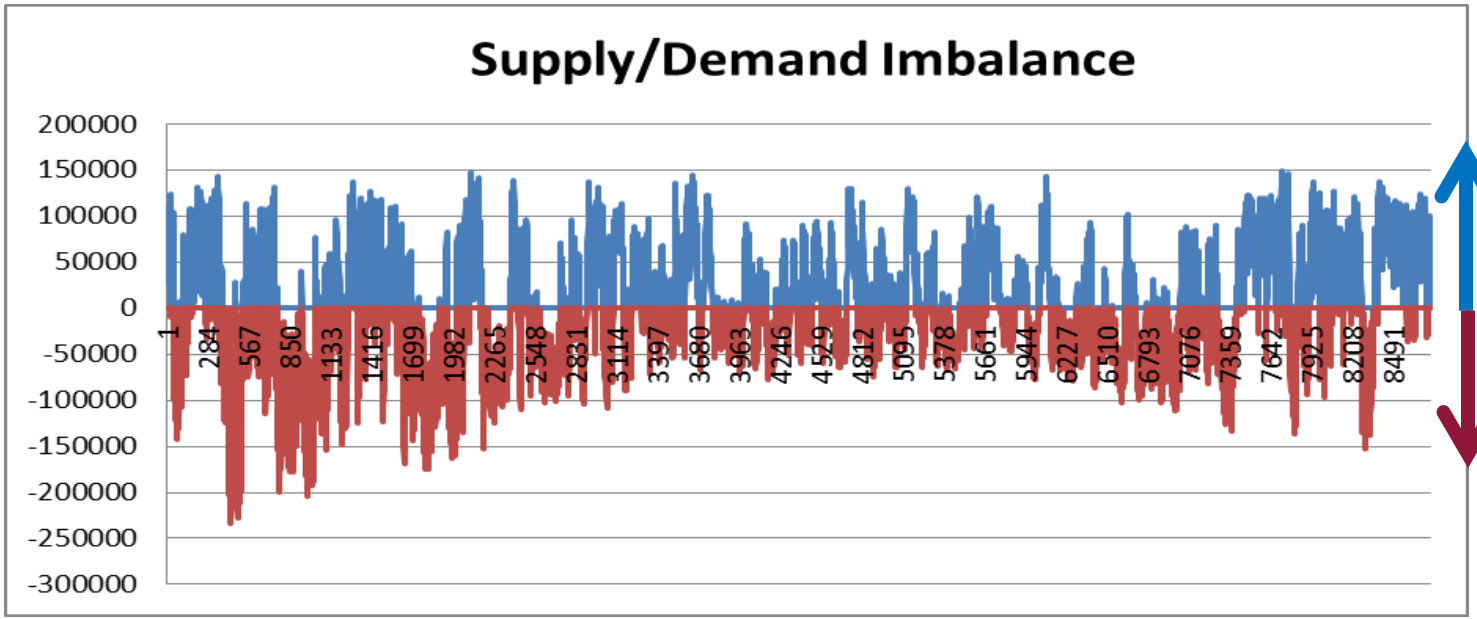
	Swansea (MW)
Peak Demand	1080
Wind	500*
Solar	500*
Marine (Tidal)	340
Total Generation	1340



*National equivalent of 200 GW of Solar/Wind – circa 5 times CCC 2030 high deployment.
(From UK Committee on Climate Change – Power Sector Scenarios, 5th Carbon Budget, Hypothetical 2030 Scenario 2015)

Smart Switching

Freedom Project



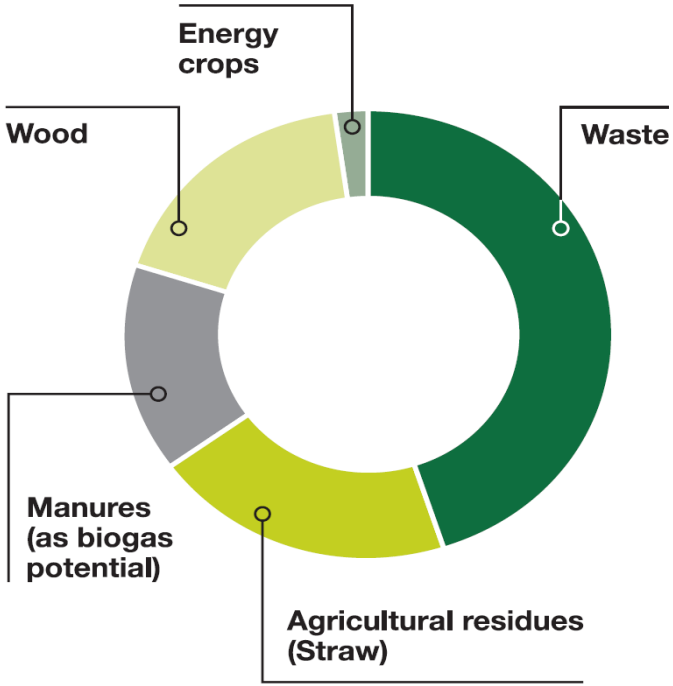
Use Electricity: cheap & low carbon

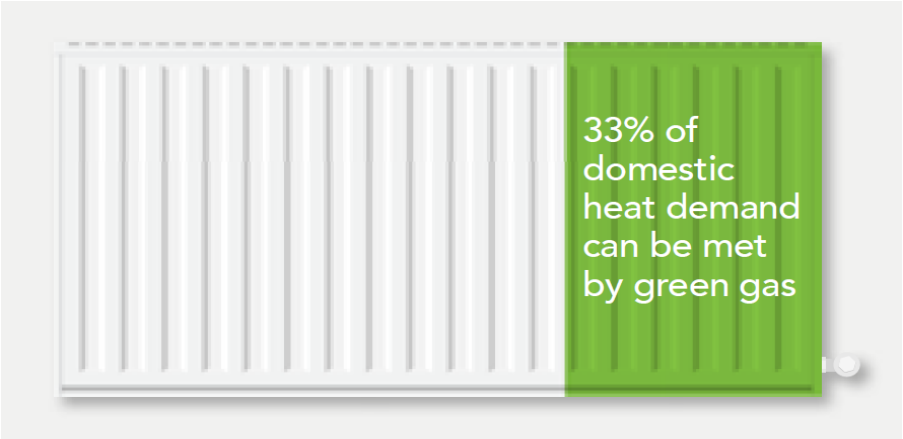
Could deliver **70%** reduction in gas throughput

Use Gas: cheap, flexibly available & greening

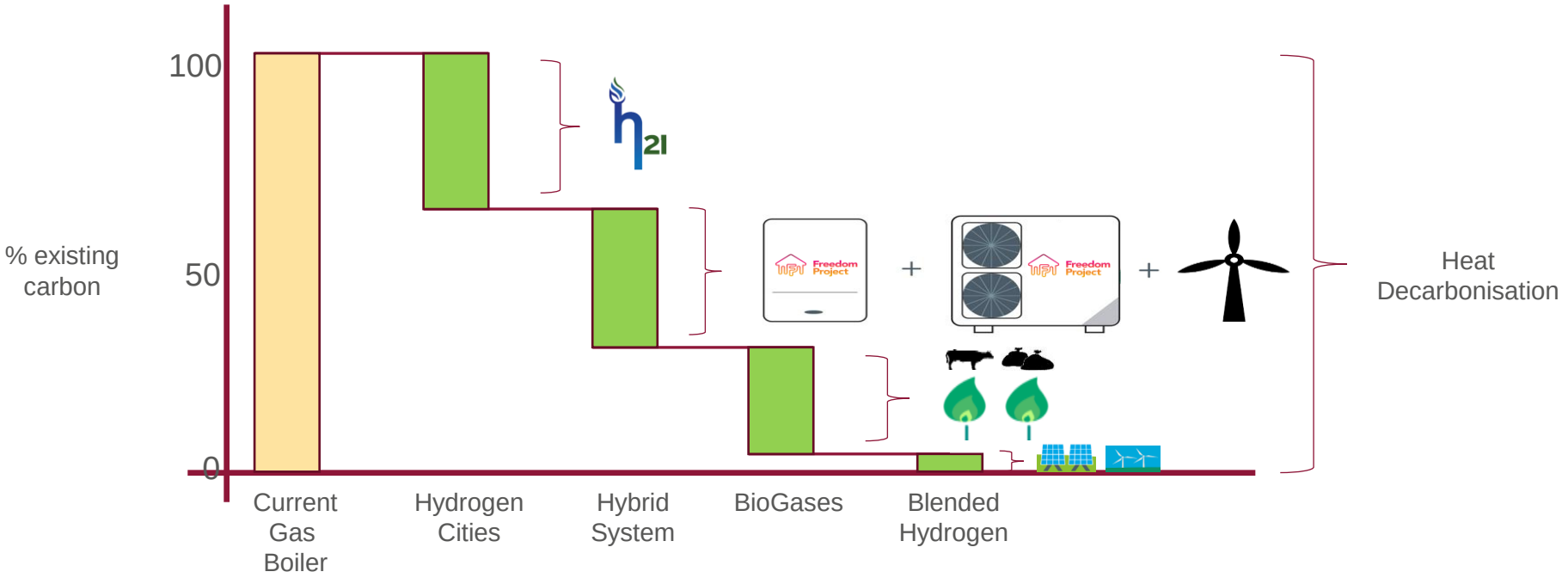
Green Gas

Freedom Project





Decarbonising Domestic Heat



Some Latest Project Findings

- Smart switching decision 17,520 times a year driven by:
  - Fuel price ratio
  - Marginal carbon intensity
  - Electricity network capacity constraints
  - Cold demand
- Hybrids using natural gas offer lower cost and lower carbon heat compared to using a heat pump alone.
- Imperial has identified £1.3-1.7b gross savings/year, predominantly through avoided DNO reinforcement & avoided building of generating capacity

Key Messages

Offers a trilemma solution

- Affordability:
  - Provides easy to use **lowest cost heat** – smart controls with demand aggregation unlock the full value of hybrid heating from fuel arbitrage, DSR and frequency response
  - Opens potential for **zero capital cost** to consumer through a heat service proposition
  - Simulated to create value – **not reliant on further domestic incentives**

Key Messages

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- Sustainability:
  - Complete load flexibility which **favours low carbon electricity**, topped up by gas
  - Compounds the **benefits from a greening gas network**

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- Sustainability:
  - Complete load flexibility which **favours low carbon electricity**, topped up by gas
  - Compounds the **benefits from a greening gas network**

- Security
  - **Uncompromised heat** delivered, which **avoids DNO peaks & reinforcement**
  - **Storage & flexibility in gas network** fills renewable generation intermittency troughs


Freedom Project
EXTERNAL TEMPERATURE
RENEWABLE ELECTRICITY AVAILABILITY
ELECTRICITY NETWORK CONSTRAINT
HIGH
LOW
ON
OFF
BIOMETHANE PLANT
WALES&WEST UTILITIES
passivSYSTEMS
WESTERN POWER DISTRIBUTION

WESTERN POWER DISTRIBUTION

INNOVATION

NEXT GENERATION NETWORKS

Carbon Tracer

IET London: Savoy Place

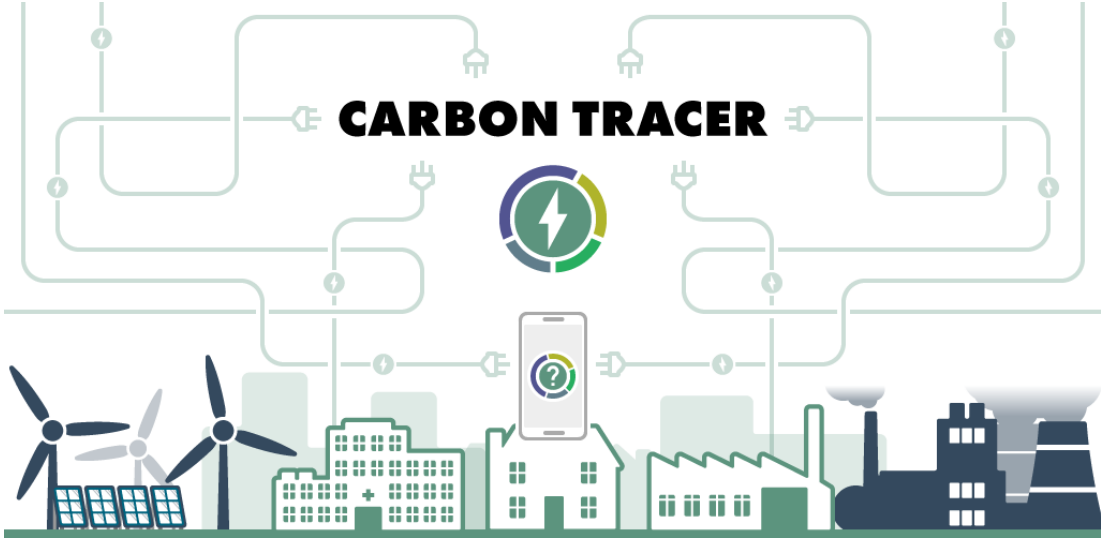
20th June 2018

Paul Charleton - Project Manager, WPD

Manu Ravishankar & Oliver Richards - Carbon Trust

Presentation Structure

- Part 1 - Carbon Tracer Implementation (WPD)
- Part 2 - User Engagement and Feedback (Carbon Trust)
- Q&A (All)



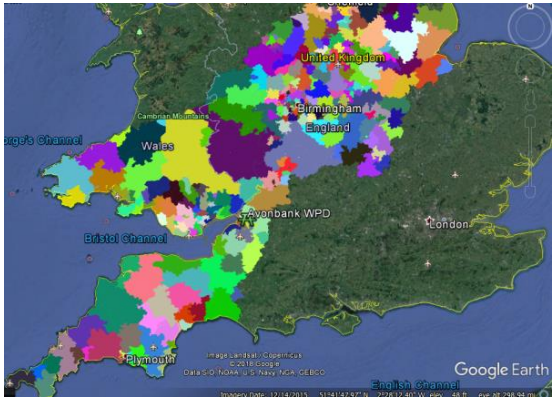
Part 1 – Carbon Tracer Implementation

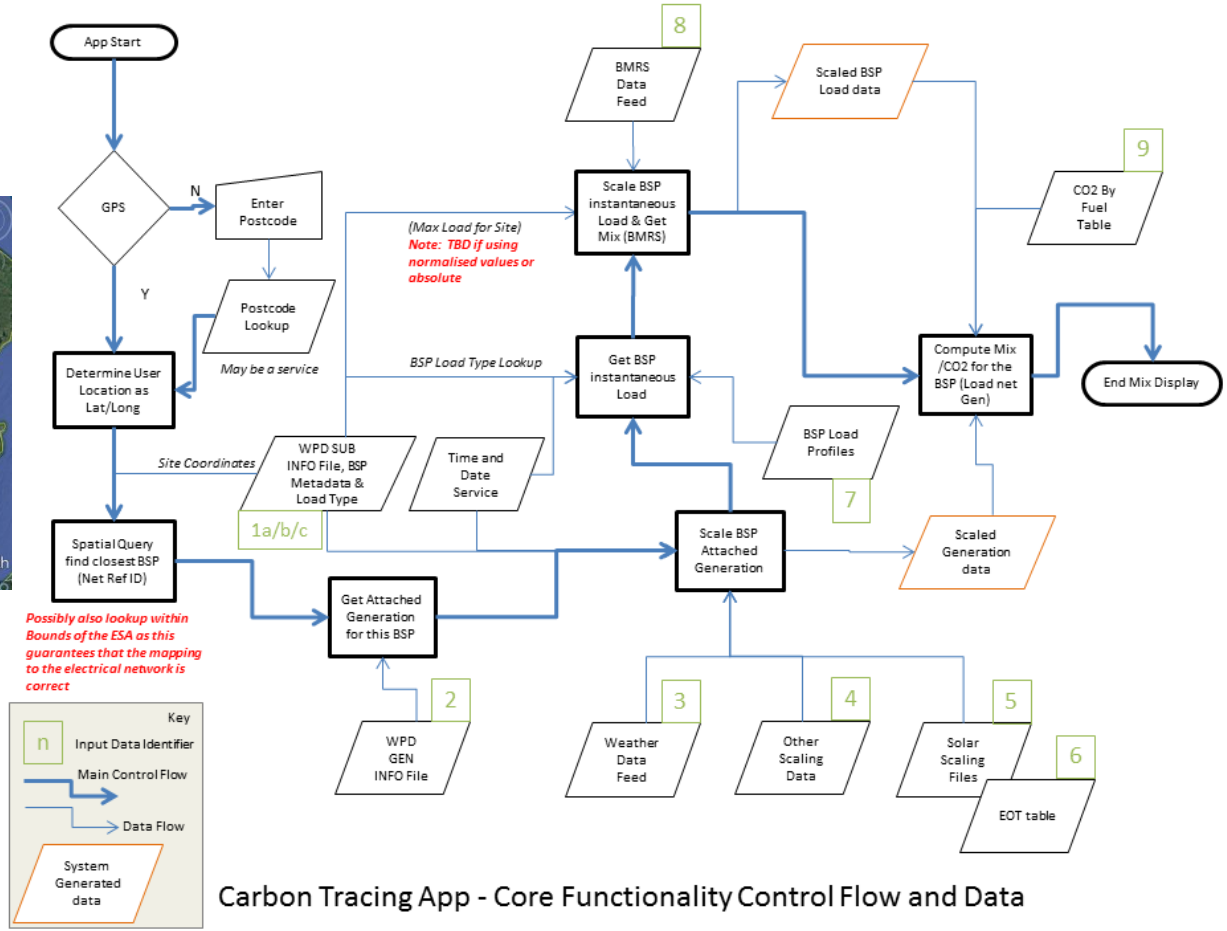
- **Brief:** To provide a mobile app & shadow website
- **Objective:** To improve customer awareness of their electricity supply: DNO role, Electricity mix and Carbon intensity, Determine user response to Carbon Intensity
- WPD + Carbon Trust + Enigma Interactive + Smart Grid Consultancy
- Essentially an IT project with engineering, consultancy and specialist developer support
- **Main elements:** Supporting Data, GUI designs, Algorithms, Test & Operations
  - Source the necessary supporting data both internally and externally and find best approach to handling
  - Animate the data to reflect prevailing conditions, demand, date/time, weather, grid infeed variability
  - Research the layout and features of the app/website and iterate with trials
  - Implementation, test, rollout and operations

Main Design Assumptions

- App and shadow website
- Simple, easy to understand and extensible for future additions
- Hosted externally to WPD for security reasons
- Operate at the BSP level ~270 of these in WPD – manageable size
- Instantaneous demand at each BSP from template load profiles by BSP “type” (derived from strategic studies programme in normalised form) and max demand values
- Generation attached capacity information is *SCALED* to current conditions
- Gap between demand and local generation filled by grid infeed (BMRS)
- Now, Today, Forecast and History data views
- Supporting functions: location change/recall, FAQs, Landing information, Contact and onward links, rewards (honesty based status enhancement)

Data elements

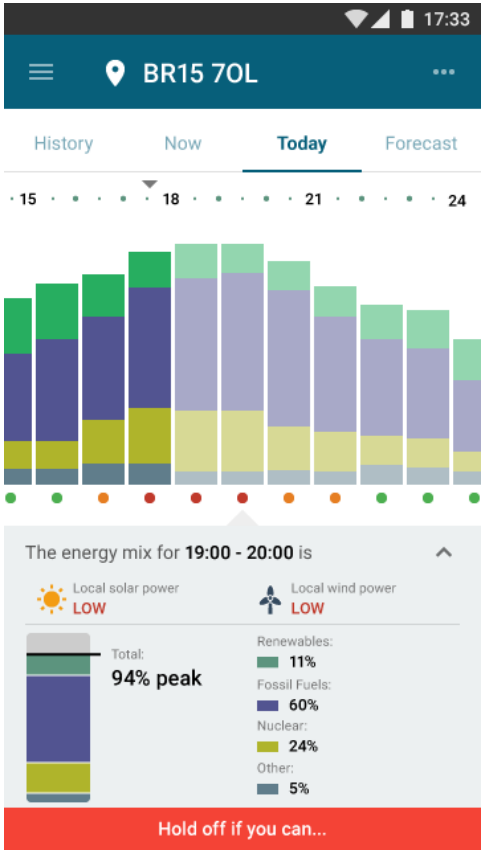




Carbon Tracing App - Core Functionality Control Flow and Data

Data

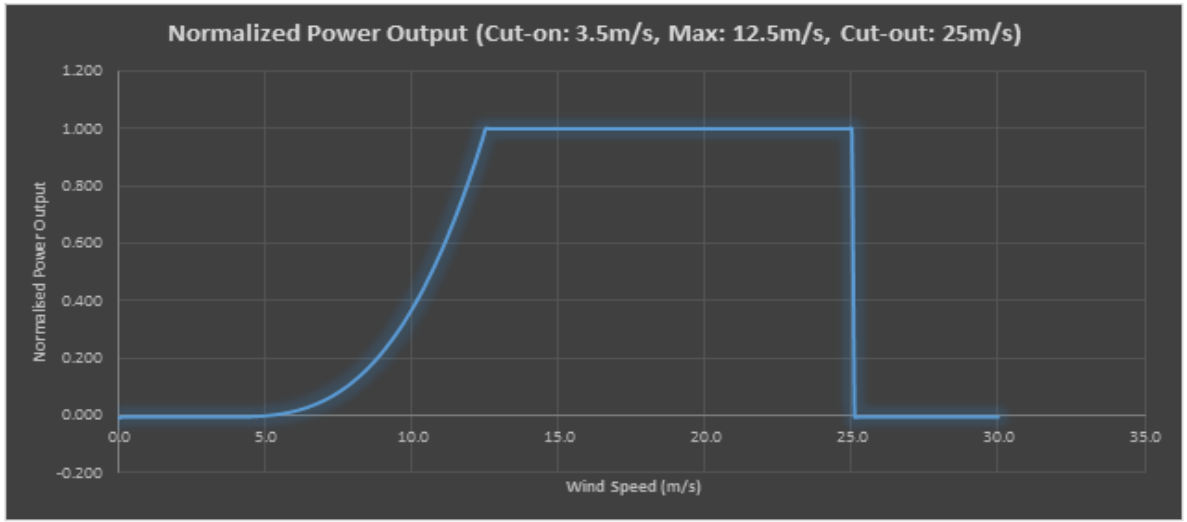
- Supply area polygon definitions (localise user to network)
- BSP Data
  - Type > normalised load profile (Urban, Rural, Mixed, Midday Peaking)
  - Coordinates (pin placement & data lookups)
  - Maximum load (convert normalised load to actual instantaneous value)
- Local Generation (by BSP) from EAM system reports, renewed regularly
- Scaling Data by generation type (generic)
- Special treatment wind and solar generation
- Weather feed (Darkskies API service, instantaneous and forecast)
- BMRS National Grid instantaneous and forecast Details
- Almanac data for treatment of time, fuel mix table for carbon intensity



Algorithms (1)

- Wind and Solar dominate
- Generation scaled by static factor derived from strategic studies
- Wind generation single dynamic scaling based on assumed average turbine size and weather feed

$$P = \frac{1}{2} C_P \rho A U^3$$

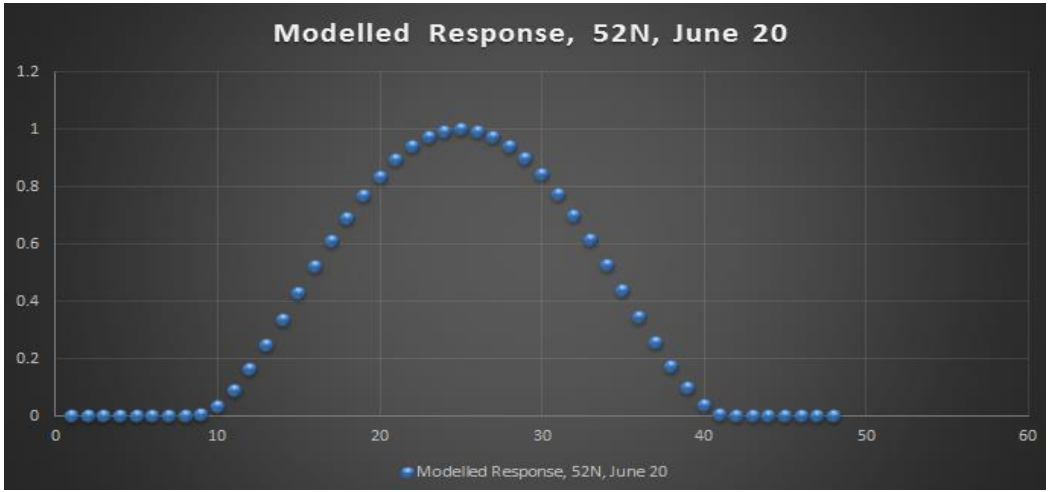


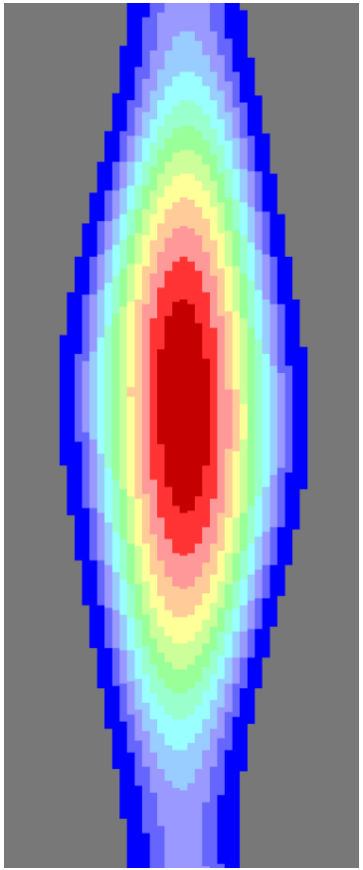
Algorithms (2)

- Solar Scaling in 2 phases using base response curve by latitude:

- Weather Scaling - Cloud cover/precipitation attenuation

- Time & Date Scaling





Test, Rollout & Operations

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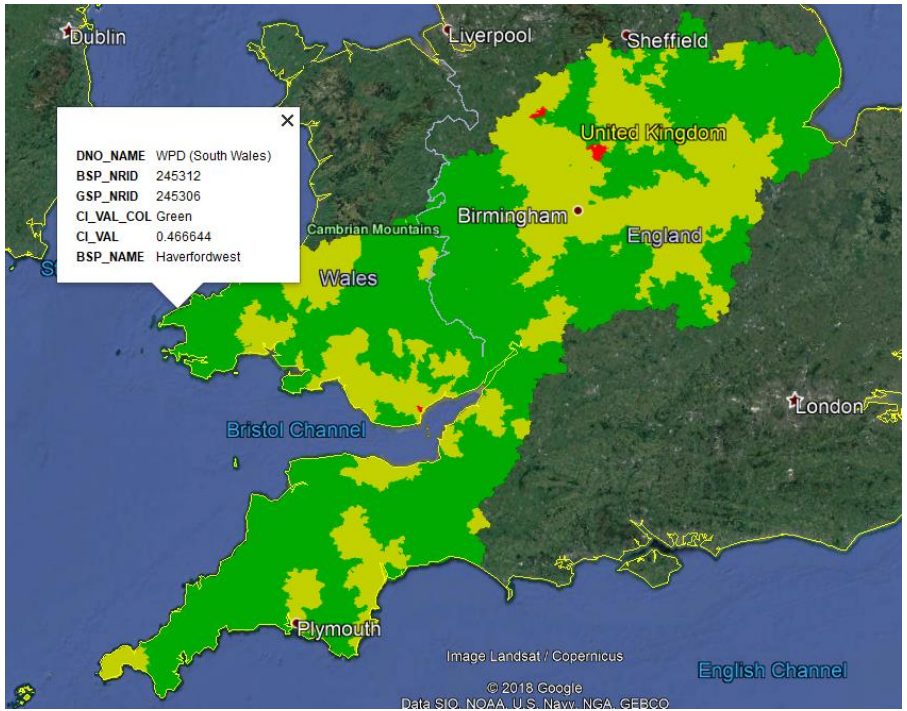
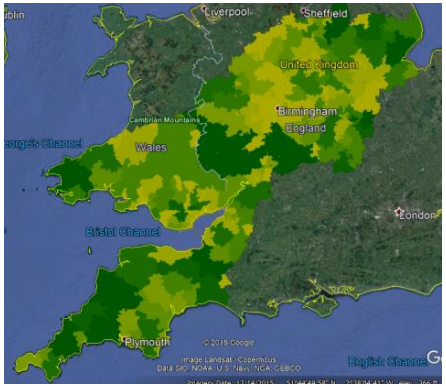
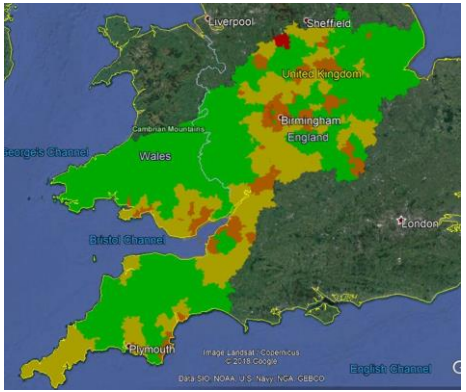
Additional Emerging Follow-ons



Dynamic Map of Carbon Intensity by BSP (May 19, 1pm)



Onshore Wind Installed Capacities



BSPs by Classification, Urban, Rural, Mixed, Midday

Part 2 - User Engagement and Feedback - Agenda

1. Introduction to Carbon Trust
2. Overview of integrated method
3. Impact of app on awareness
4. Impact of app on potential actions
5. Summary of results

We work with governments, multilateral organisations, businesses and the public sector, helping them contribute to and benefit from a more sustainable future

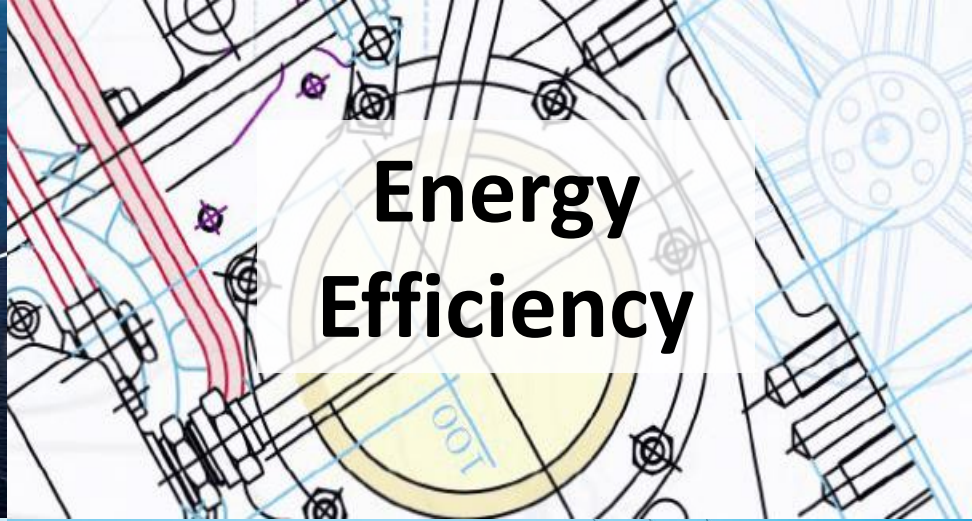
Who we are

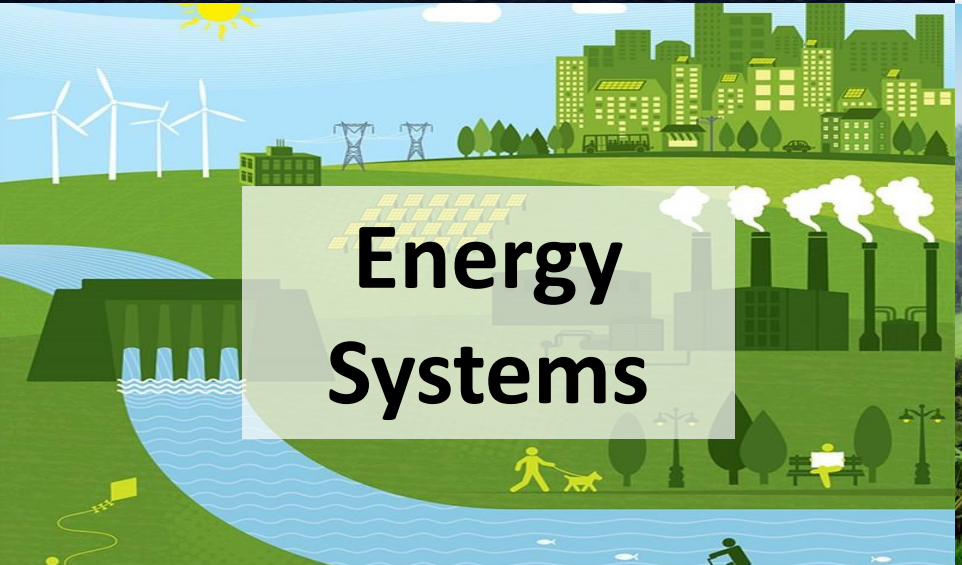
- Mission driven, not for profit low-carbon experts – rigorous, evidence-based, impartial
- Over 15 years' experience at the cutting edge of the low-carbon agenda
- 180 experts spanning 30 nationalities

What we do

- We **advise clients**, cutting through uncertainty to provide insights that support better decisions
- We **run programmes** that overcome financial, technical and behavioural barriers
- We **recognise performance** through assurance and certification of positive outcomes


CARBON TRUST
Renewable Energy

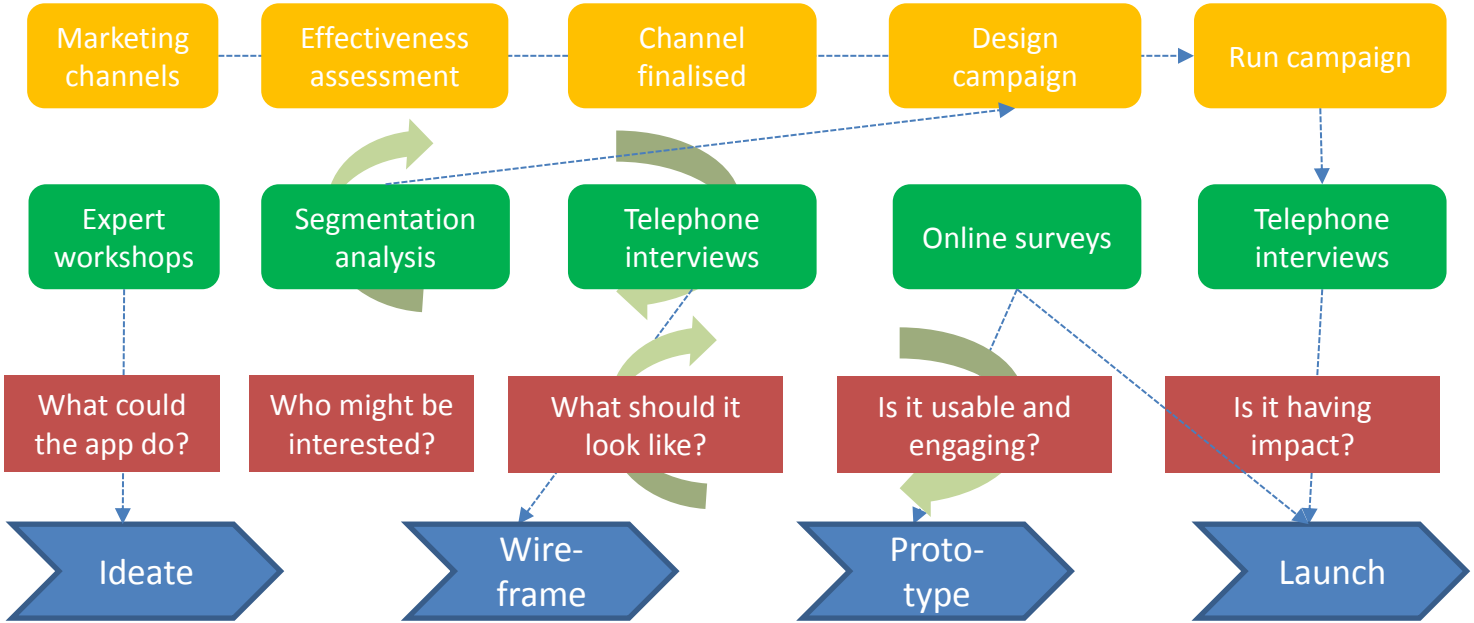

Energy Efficiency


Energy Systems


Energy Access

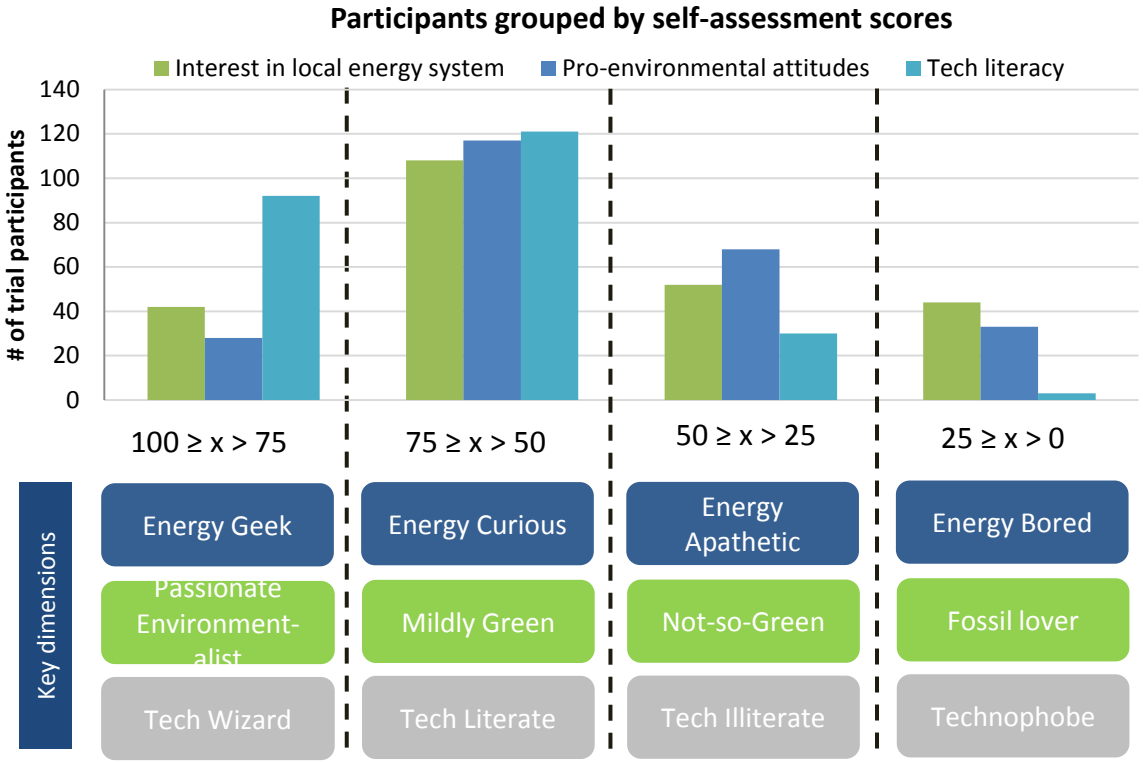
Our integrated app development method helped to create a successful app and project

We took a iterative and agile approach to raising interest and user testing of features as part of overall development.



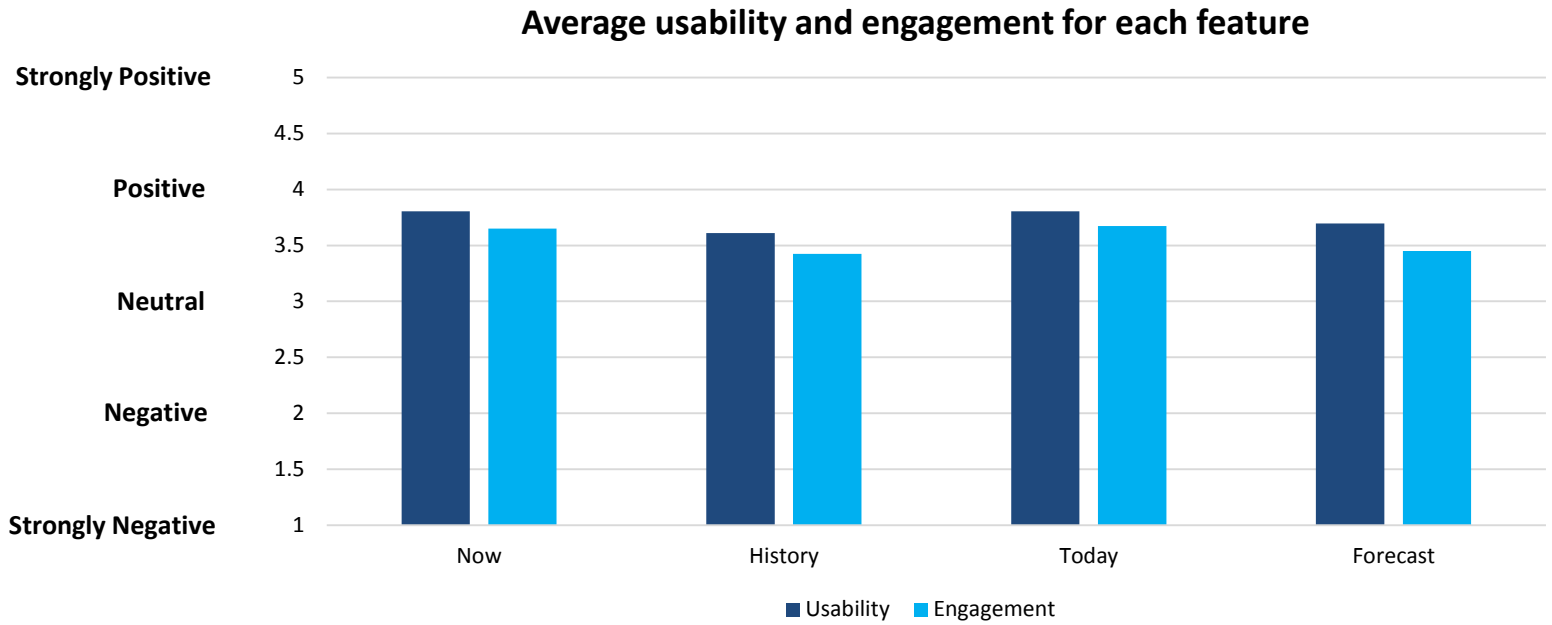
Over 250 user engagements were conducted to segment and gather feedback on the app

Three key dimensions: Awareness of energy, passion about environment and engagement with technology



We used a user perceptibility scale to test usability and engagement to improve features

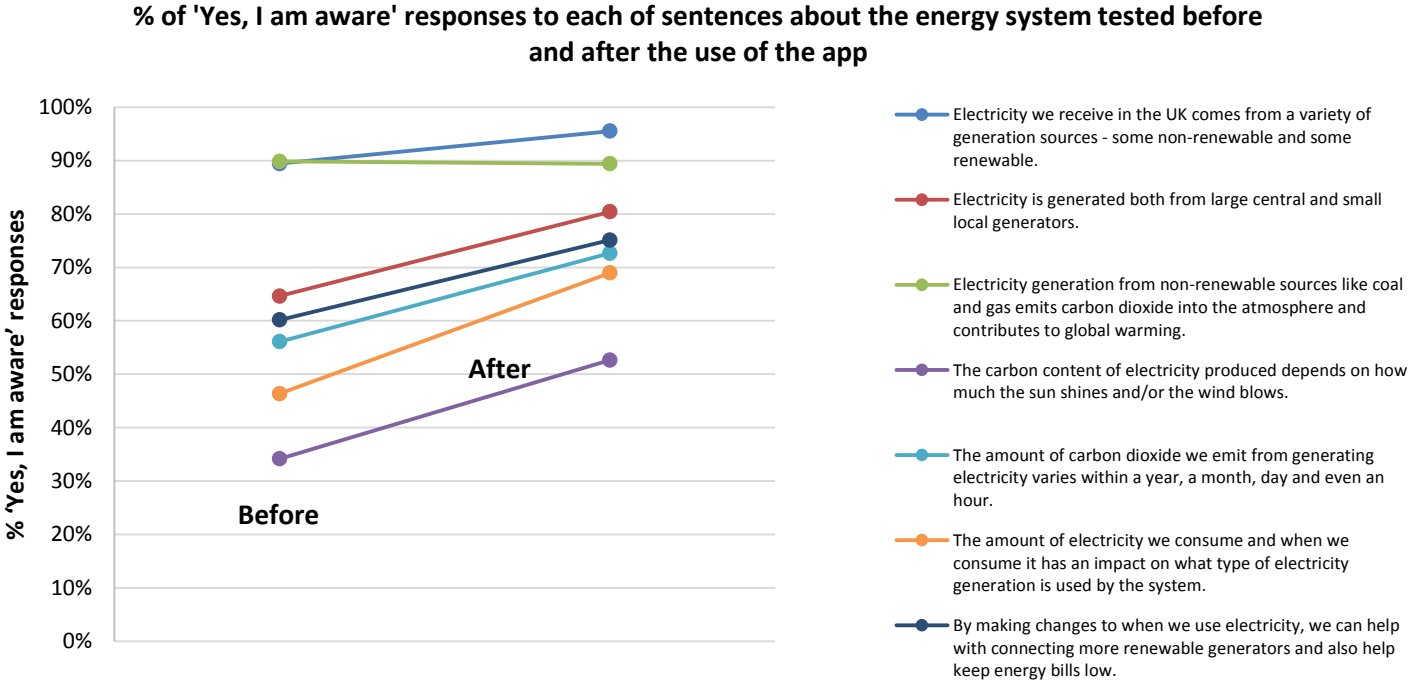
‘Now’ and ‘Today’ screens proved most engaging and usable for the test users



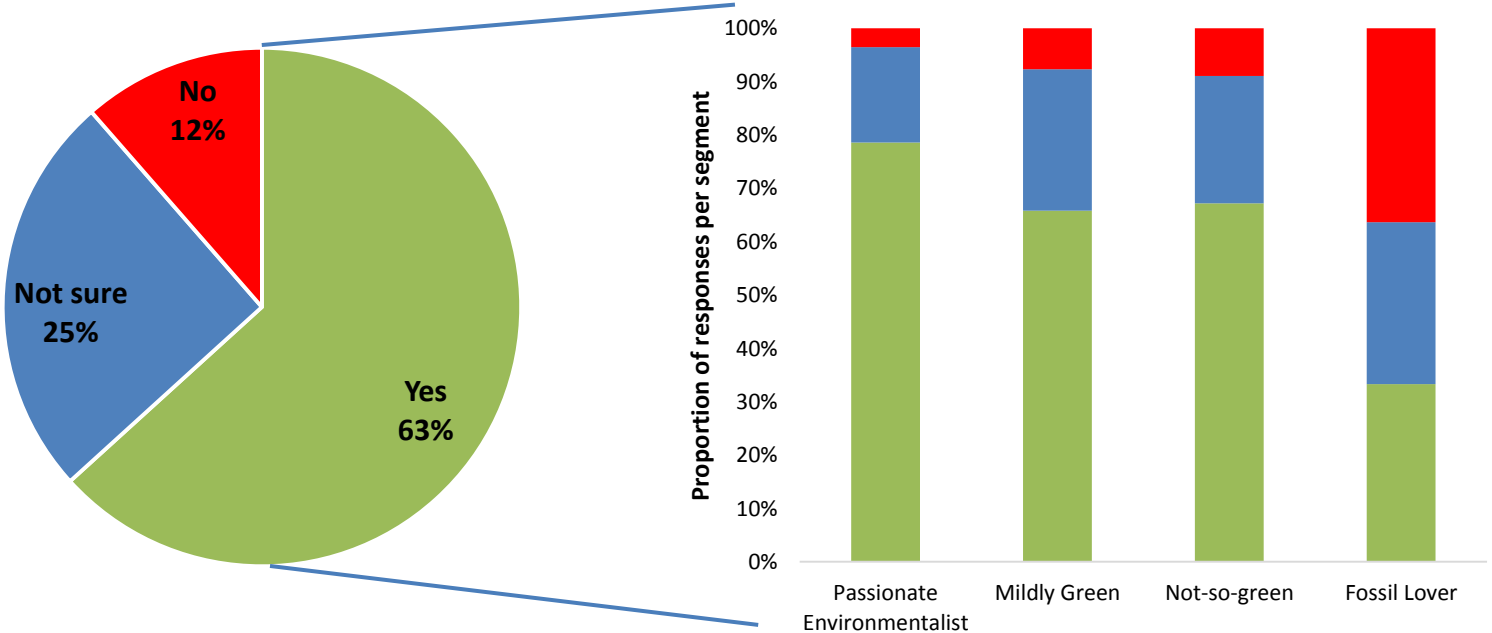
UPScale averages scores for engagement and usability between 1 (Strongly Negative) and 5 (Strongly Positive)

We demonstrated apps such as these have an important role in raising consumer awareness of local energy systems

Real opportunity to build on this app for greater engagement in the energy transition



Carbon intensity is an important metric when engaging the “greener” population to drive change in demand



Would you consider using this app to change when you use electricity in order to use low carbon electricity more?

n = 255

Summary of key findings

Segmentation and targeted marketing campaigns delivered cost effective user engagement for testing and downloads (~1800 with high retention)

The app within the trial boundaries has been very successful in raising the awareness around local energy systems and this has significant benefits

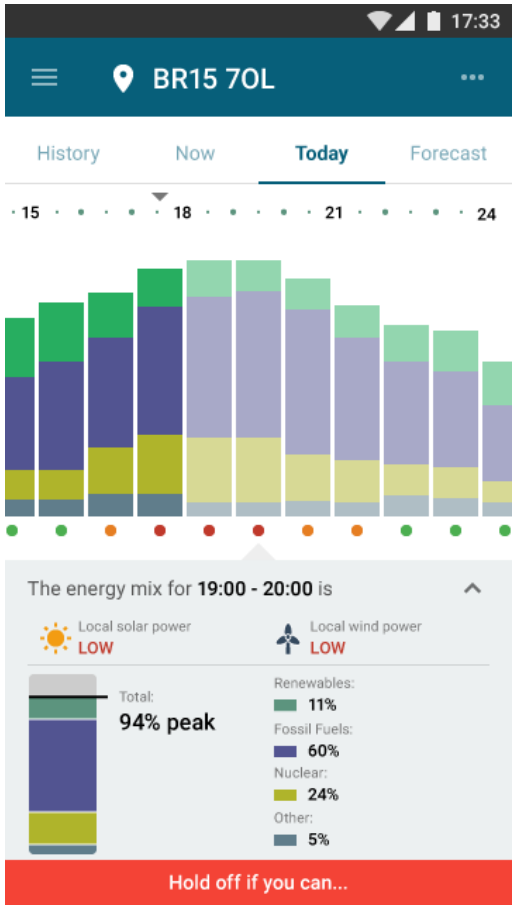
The app is engaging to a segment of the population where this could be potentially used to drive behavioural change

There is additional work required to drive positive action using such an app:

1. Layering prices and other signals onto carbon intensity
2. Shortening and Improving forecast
3. Making it application specific such as for electric vehicle charging
4. Linking up with automation and control

Next Steps

- Continue app operations
- Accept user feedback and implement selected updates
  - Routine updates (security, ops, data updates)
  - Strategic updates (improvements, additions)
  - Reactive updates (take user comments into account
- Continue to understand app use
- Carbon Portal development for data dissemination



Any Questions?

THANKS FOR LISTENING

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Break

Refreshments in the Maxwell Library (1st Floor)

Resume at 14:50pm

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INNOVATION

NEXT GENERATION NETWORKS

DSO Transition Projects

IET London: Savoy Place

20th June 2018

Jenny Woodruff

Innovation & Low Carbon Networks Engineer

Agenda

- DSO Transition, the story so far
- Where are the key gaps for DNOs
- Next steps for Open Networks
- Innovation projects for the DSO transition
- Overview of TRANSITION, EFFS and FUSION
- Questions

DSO Transition, the story so far

- Demand side response/ flexibility services has been used for a long time outside the UK
- UK Innovation projects have investigated technologies, incentives, customer aspects.
- Extra impetus in 2017 with the growing awareness of the value of flexible networks.
- DNOs developing and consulting on their DSO strategies.

Smart Systems & Flexibility Plan

Ofgem & BEIS suggested potential for £40bn actions to;

- Remove barriers to smart technology including storage
- Enable smart homes and businesses
- Make markets work for flexibility

ENA - Open Networks

Objectives include;

- Improved T-D processes for shared services and operation
- Develop a more detailed view of the required transition from DNO to DSO.

Open Networks – Phase 1 – DSO Functions

Function	Description
System Co-ordination	Co-ordinate energy and power transfers with other networks Whole system planning, operation and optimisation across different timescales.
Network Operation	Safe, within limits, secure against credible events, co-ordinate with GBSO, etc.
Investment Planning	Identify requirements, secure most efficient provision including non-network options
Connections & Connection Rights	Fair, cost-effective access , range of connection options to meet customer requirements efficiently
System Defence & Restoration	Local and regional services to enhance whole system security, low probability-high risk events, means to recover from widespread disruption.
Service/Market Facilitation	Develop fair, transparent local service markets to support whole system optimisation. Capacity products, Interfaces with GBSO and DER, control system infrastructure
Service Provision	Access or provide on behalf of others for whole system efficiency
Charging	Set DUoS, Determine Point of Connection , Connection charges etc.

Open Networks – Phase 1 – Competencies

1. Forecasting
2. Regulatory Codes & Frameworks
3. Commercial Relationships & Whole System Pricing
4. Whole System Coordination
5. Power System Analysis
6. Contractual Arrangements & Service Compliance
7. Dispatch
8. Outage Planning
9. Data Management
10. Settlement
11. Customer Account Management
12. Change Management

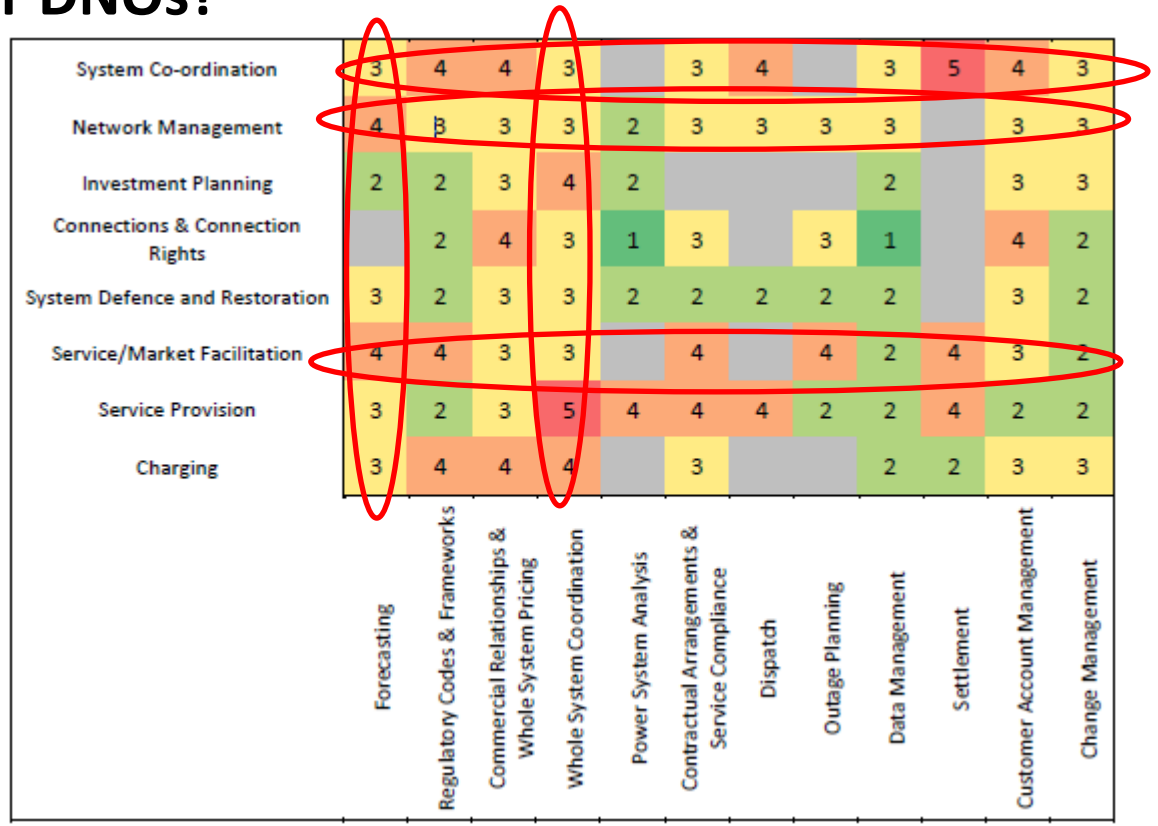
Where are the key gaps for DNOs?

Functions

- System co-ordination
- Network management
- Service/ Market Facilitation

Competencies

- Forecasting
- Whole System Coordination

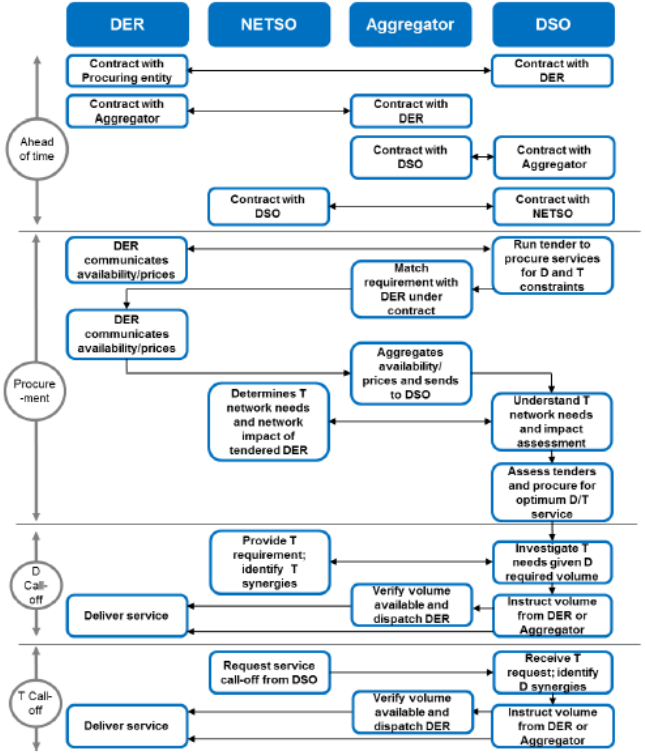


Open Networks – Phase 1 – Market Models

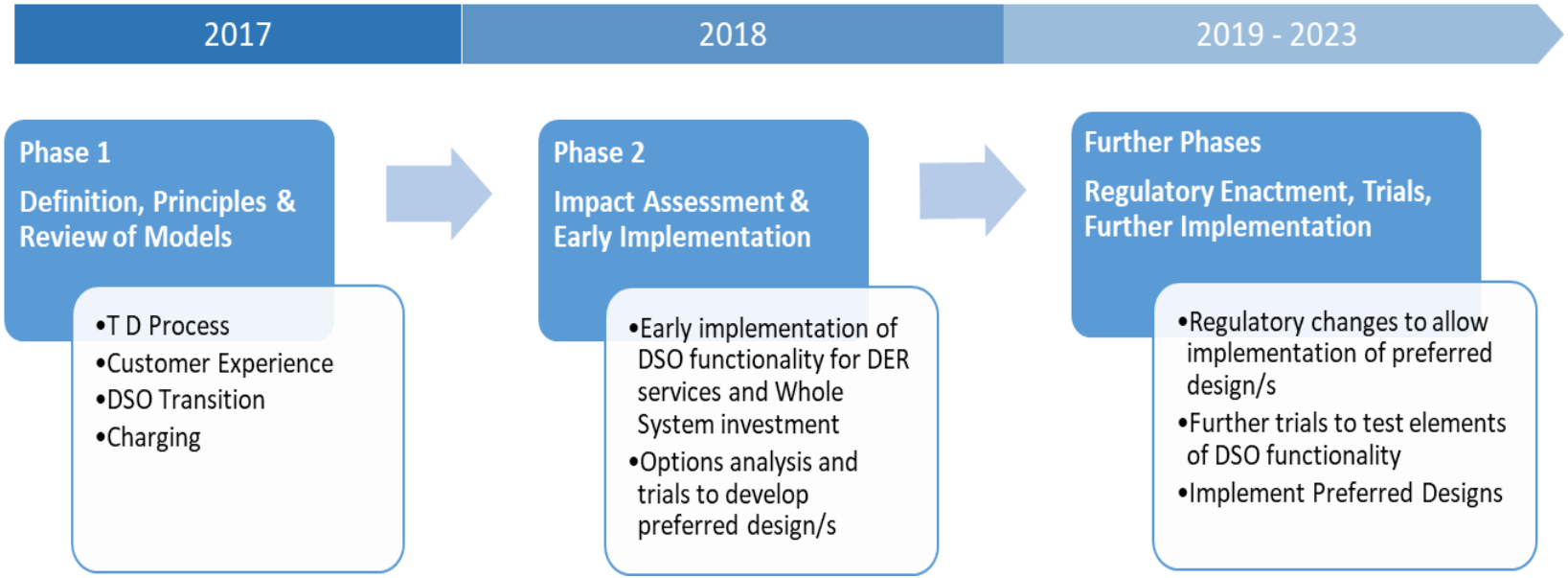
Originally six different Market Models were defined. An additional market model was proposed by Ofgem.

These differ in the responsibility for procuring and dispatching flexibility services . Procurement and dispatch can be by one party on behalf of another, a joint exercise or carried out independently in parallel.

The Smart Grid Architecture Model is being used to further define the market models .



Next steps for Open Networks

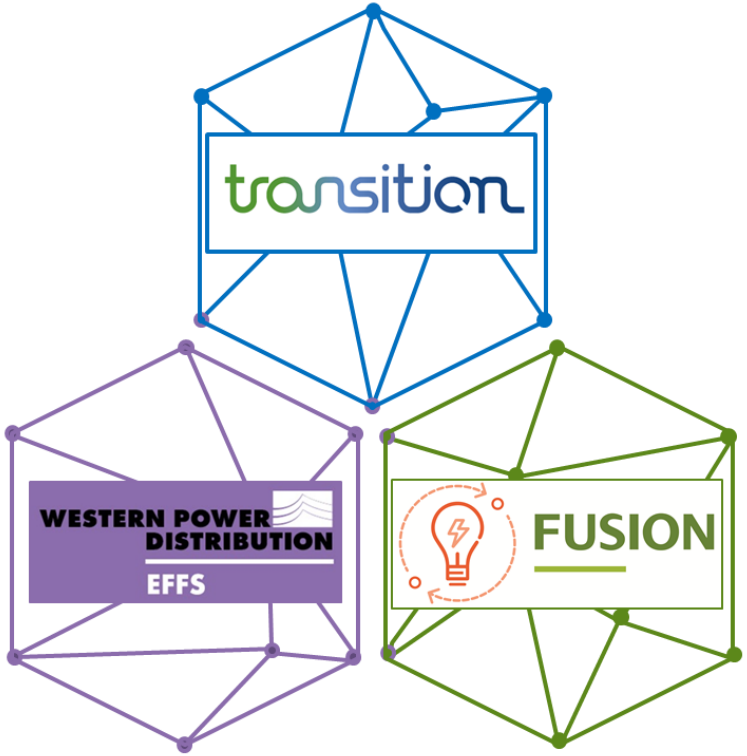


2018 - Phase 2, is about developing the impact analysis of the options further

Trials to test the DSO functionality are recognised as an essential element after Phase 2

T.E.F. Innovation projects

- Build on Open Network outputs
- Contribute to the DSO Functions and Competencies where there are significant gaps
- All include development of software for the new DSO functions
- Practical trials to validate Open Networks outputs e.g. market models, data exchanges

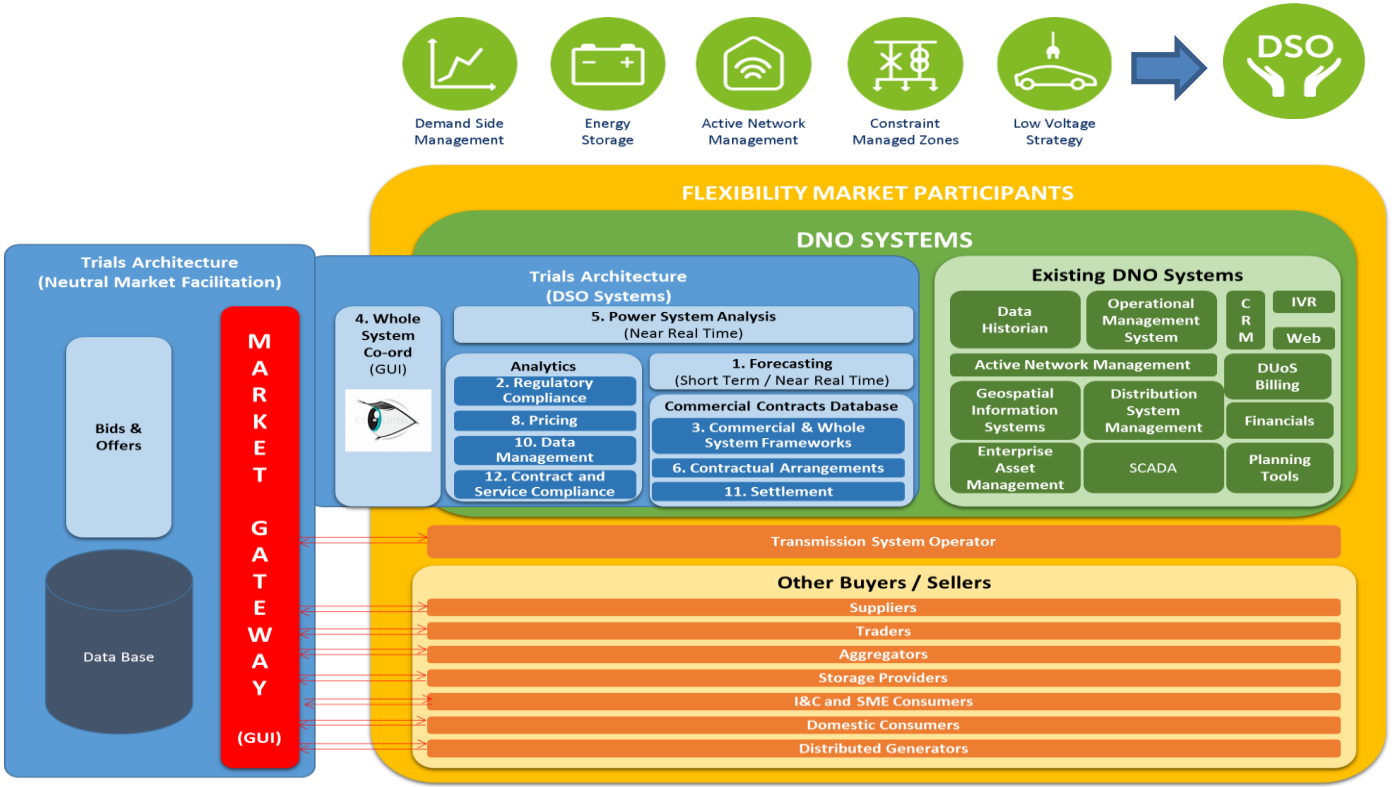


Innovation projects for the DSO Transition - 2017 NIC

	TRANSITION	EFFS	FUSION
Approx. Duration	5 years	3 years	5 years
ON Market models	Not trying to prove any specific market model.	Likely to be Model 5 – closest to ENTIRE and Cornwall Local Energy Market	USEF (hybrid of Models 5 & 6)
Trials	Up to two trial locations across GB, each with three trial phases within two year duration.	Limited physical trials as is more software focused. Will link in with Project ENTIRE and Cornwall Local Energy Market.	One trial location, with three trial phases within two year duration.

TRANSITION – Neutral Market Facilitator

Link to DSO video

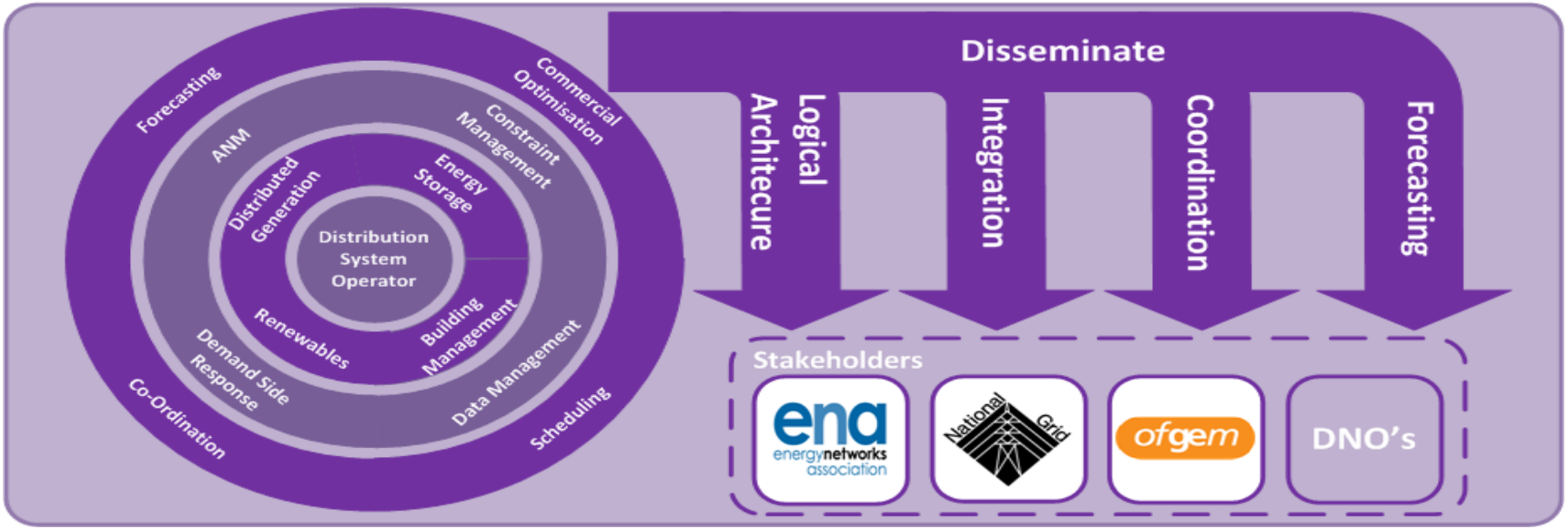


- Informed Stakeholders
- Evidential base
- Step towards BAU
- A robust, neutral solution

ATKINS origamienergy CGI | electricity north west Scottish & Southern Electricity Networks

Electricity Flexibility and Forecasting Systems (EFFS) - The Concept

- Building and testing software to support the DSO role
- Based on an agreed set of DSO functions
- Delivering a blueprint that can be used by other DNOs for cheaper, speedier transition
- Leveraging existing projects for customer recruitment

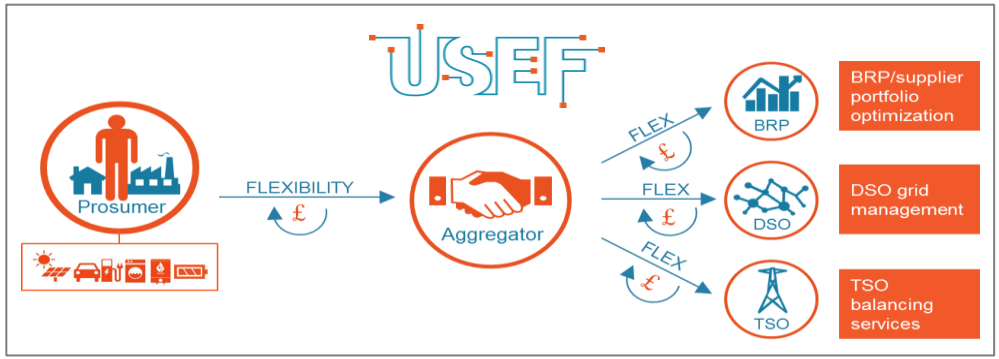


FUSION

Structured and competitive local flexibility market
Trial in East Fife, evidence-based approach to trial requirements
USEF-based flexibility market, harnessing over £19m USEF investments

USEF defines:

- Market roles
- Processes
- Agreements
- Data exchanges
- Data interfaces



Complementary to existing flexibility arrangements
Competitive and coordinated to deliver value for money

January 2018-December 2022
Total project cost: £5.97m; NIC funding request: £5.29m

Collaboration Outcomes – Coordination

Group	Description
Open Networks	This will avoid duplication in activities such as consulting on proposals.
National Grid	Combining engagement is expected to save 30 days compared to the original plans
Other Stakeholders	Holding joint events will enable stakeholders to be updated on related projects making better use of time / travel costs.

Collaboration Outcomes – Shared learning and reduced costs

Item	Description
Shared learning	Forecasting work will use data from all projects with all projects contributing to the scope and selection.
Reduced trials	The total number of trials areas has been reduced reflecting the likely overlap of market models.
Stage Gate	The projects have a combined Stage Gate after the design phase is complete where additional savings can be assessed and continued relevance confirmed.

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