Electricity Distribution

EQUINOX Horizon Scan

Tracking relevant developments and learnings from previous/ongoing projects, initiatives, and policies

Q1 2024

nationalgrid

Guidehouse

Horizon Scan contents

Document Details	
Version	v1.1
Authors	Callum Coghlan, Ewan Steen (Guidehouse)
Reviewers	Ryan Huxtable (National Grid)
Dated	10/6/2024

Links to previous Horizon Scans

Q4 2022
Q1 2023
Q2 2023
Q3 2023

Electricity Distribution

1

Introduction

Document purpose, contents, scope, usage

nationalgrid Guidehouse

Context and Purpose: What is this Horizon Scan and why is it needed?

This Horizon Scan is a tracker of projects, policies, market design and regulation relevant to EQUINOX

EQUINOX is unfolding to a backdrop of **three years of policy and regulatory change** in many areas **relevant to project delivery** like flexibility market design and heat pump roll out.

As a **condition of Ofgem funding**, EQUINOX must **directly acknowledge** and **build upon** other innovation projects relating to electrification of heat and flexibility by **UK DNOs** and others.

To ensure EQUINOX tests commercial arrangements **which reflect reality**, it is important to **keep abreast of current and upcoming** policies and regulations.

Collating all relevant projects facilitates the identification of opportunities to **disseminate EQUINOX learnings** to other projects who can benefit from them, fulfilling **another Ofgem funding condition.**

Guide: What is included within this Horizon Scan?

This Horizon Scan collates and summarises research and innovation projects, plus regulations and policy, which are deemed relevant to the delivery of the EQUINOX project and the wider domestic flexibility market. The document is split into two main parts

Innovation projects from the UK and abroad

Summary of Coverage

Section Contents

- Scope of projects covered.
- List of the projects (45 collated so far) and countries (7) covered.
- Collated and themed summary of most relevant key learnings for EQUINOX.
- Project deep dives for more information.

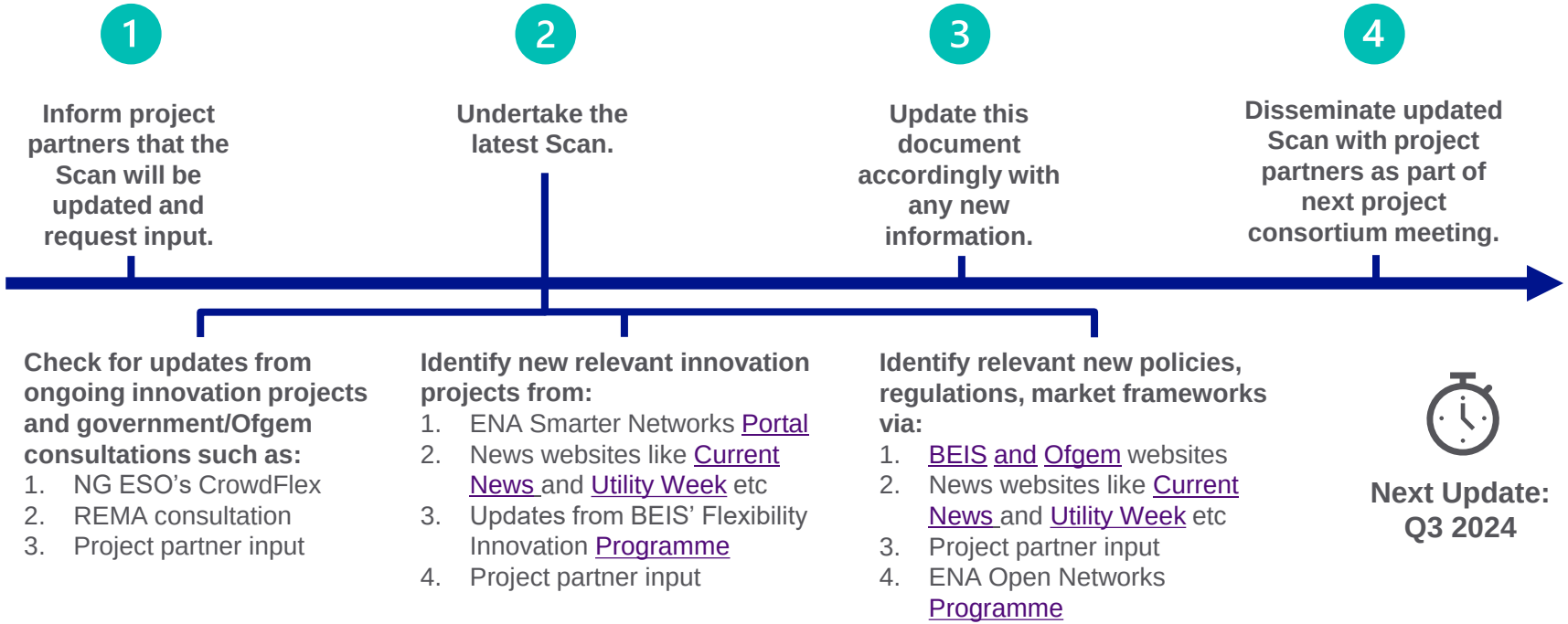
UK policy, regulation, strategy and markets

Summary of Coverage

Section Contents

- Coverage within the latest iteration.
- UK flexibility strategy and innovations.
- UK technology strategy and rollout.
- The UK's approach to energy bills.
- Future flexibility market arrangements.

Guide: The Horizon Scan will be updated periodically via the following process



Horizon Scan Coverage: Innovation projects from the UK and abroad

Go to section

The scan pools insights and learnings from completed and ongoing innovation projects across the following themes: [1]

1 Domestic energy flexibility

Projects focusing on innovation in domestic flexibility from any source, not exclusively low carbon heat.

Relevance for EQUINOX
Learnings on the approach towards domestic consumers, modelled and experimental aggregated flexibility provided.

2 Commercial trials at scale

Projects focusing on a larger scale (1000+ participating households) trial of an innovative flexibility proposition.

Relevance for EQUINOX
Learnings on customer recruitment, minimising dropouts, regularity of engagement, results analysis.

3 Low carbon heating innovation

Projects focusing on domestic low-carbon heating, not necessarily from a flexibility perspective.

Relevance for EQUINOX
Learnings on customer preferences, experience with remote control, common heat pumps concerns.

Projects found via:

1. Smarter Networks Portal
2. Flexibility Innovation Programme
3. News sites

4. Input from project partners

[1] Not mutually exclusive

Horizon Scan Coverage: UK policy, regulation, strategy and markets

Go to section

The scan extensively covers the UK's current and proposed approach towards:

1	2	3	4
UK flexibility build-out	**UK technology roll-out**	**UK approach to energy bills**	**UK future flexibility market**
Track progress towards and changes to the UK's flexibility strategy/ targets/ product deployment.	Track strategy, regulation, and progress for heat pump & smart meter rollout.	Track UK energy costs and government support measures.	Track the options being considered for future market operation in the UK.
Relevance for EQUINOX EQUINOX must align with UK high level strategy.	**Relevance for EQUINOX** Project must react based on regulation for and pace of heat pump /smart meter rollout.	**Relevance for EQUINOX** Trial design and incentives must reflect the current and future energy costs landscape.	**Relevance for EQUINOX** Final BaU-ready commercial offering must fit within the UK's realigned electricity market.

Major sources include: Department for Business, Energy & Industrial Strategy; ofgem; Climate Change Committee; nationalgridESO; ena energynetworks association

Electricity Distribution

2

Innovation Projects

Projects covering domestic flexibility, low carbon heating innovation, and commercial trials at scale

nationalgrid Guidehouse

Horizon Scan coverage: innovation projects from the UK and abroad

The scan pools insights and learnings from completed and ongoing innovation projects across the following themes: [1]

1 Domestic Energy Flexibility

Projects focusing on innovation in domestic flexibility from any source, not exclusively low carbon heat.

Relevance for EQUINOX
Learnings on the approach towards domestic consumers, modelled and experimental aggregated flexibility provided.

2 Commercial Trials at Scale

Projects focusing on a larger scale (1000+ participating households) trial of an innovative flexibility proposition.

Relevance for EQUINOX
Learnings on customer recruitment, minimising dropouts, regularity of engagement, results analysis.

3 Low Carbon Heating Innovation

Projects focusing on domestic low-carbon heating, not necessarily from a flexibility perspective.

Relevance for EQUINOX
Learnings on customer preferences, experience with remote control, common heat pumps concerns.

Projects found via:

1. Smarter Networks Portal
2. Flexibility Innovation Programme
3. News sites
4. Other sources like EQUINOX project partners, IEA, etc.

[1] Not mutually exclusive

EQUINOX is UK-based so the scan primarily focuses on the UK, although large-scale projects abroad are included

Country			
Key project leads	nationalgrid, UK Power Networks, octopus energy, Scottish & Southern Electricity Networks, SP ENERGY NETWORKS, nationalgridESO, OVO energy	TenneT, IBM, VIESMANN, ENERGINET.DK, POWEO	alectra, London Hydro, DUKE ENERGY
Reason for inclusion	As a UK-based project, EQUINOX stands to gain from key learnings coming out of other UK innovation projects, particularly those by other suppliers and DNOs. They can provide insights into UK consumer behaviour and preferences towards heat pumps and flexibility.	Germany, France, Switzerland and Denmark have some of the highest heat pump installation rates in Europe, so can offer insights on commercial scale domestic heating flexibility innovation trials and programmes.	Project partner Guidehouse has experience with projects in the USA and Canada which have a similar premise to EQUINOX – namely large-scale commercial trials of domestic heating/cooling flexibility.

Key learnings from 45+ projects have been summarised within seven buckets

1

Customer Offering

How to achieve a compelling proposition.

2

Flexibility Impact

How to ascertain the overall flex benefits.

3

Recruitment

How to maximise and maintain participation.

4

Customer Preference

How to meet participant needs.

5

Engagement Strategy

How to optimise engagement throughout the trials.

6

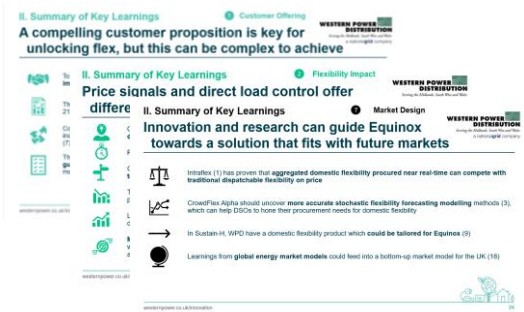
Trial Design

How to design and analyse the trials being undertaken.

7

Market Design

How to ensure EQUINOX is ready for business as usual.



A compelling customer proposition is key for unlocking flex, but this can be complex to achieve

To maximise uptake of demand side response (DSR) / flex services, focus on **financial concerns of participating households** by **improving customer proposition** (Projects 4, 13, 30, 37 on project list). This proposition should be adapted based on prevailing market conditions (37).

To maximise flex potential, increase the uptake of eligible heating technologies **across demographics and buildings with lower penetration** e.g. social housing residents and multi-occupancy buildings (41, 44, 45).

There are **many ways of reimbursing customers** for flexibility, from **different tariffs** (5, 21, 22, 28, 33), **bill rebates** (6, 23, 25), and **per kWh payments** (24). **Sign up bonuses** are also common for trials (12, 21, 23, 24).

Complexities of contract approval process and service design can **present delays and challenges** (13), including concerns about **personal data sharing** (24), **explicit consent requirements** (9), **authentication** (7), etc.

The service summary from NGED's Sustain-H domestic flexibility product, which came out of the Future Flex project, **provides guide elements** which need to be considered for EQUINOX commercial arrangements (9). An element that made this service proposition successful was its **simplicity**.

Price signals and direct load control offer different flexibility benefits for networks

Critical peak pricing can motivate changes in space heating **even when there is no direct price signal to do so** (projects 20 on project list). i.e. price signals can induce **wider behavioural change and flexibility.**

Participants can **respond at short notice** to price signals (2, 6, 21, 22), with high participation rates (26).

Giving participants control over temperature limits results in **hugely varying flex potential**, with households **tending towards the extremes** of min and max flex provision (22).

Time of use tariffs and turn-down events can **significantly reduce peak demand** (2, 5). Turn down can induce increases elsewhere (4, 26) but overall energy consumption across the day remains similar (33).

Large-scale **turn-up trials** have also demonstrated that there is **significant flexibility potential** from domestic assets when consumers are asked to increase their usage (2, 6).

Modelling project results aid understanding of the role HP turn-down could play in a peak 1-in-20-year winter (10), how HP turn-up can reduce wind curtailment (11), and the flexibility potential of aggregated low carbon domestic heating assets (3, 16).

Recruitment requires proactive engagement and careful consideration of incentives

Risk-free aspect of trials can be a **crucial incentive to enrol customers** (22 on project list). Conversely, other trials saw a **lack of awareness** from participants that incentives had been made available to them (23).

Working with a **trusted third party** (e.g. charity) **adds legitimacy** to recruitment efforts, with **face-to-face interactions** important for building trust and engagement **with vulnerable customers** (4). A voluntary compliance scheme will help build consumer and DNO/ESO trust in domestic flexibility (20).

Customers need **support and resources** to understand new systems, tariffs, etc, and to encourage the switch to **new routines** (5, 7, 13, 14).

Initial concerns for V2G centred around general EV price and operational concerns like charging time (7).

Interactive diagrams and videos are a great resource for making recruitment **more accessible** (8, 24).

Cost of heat pump and accompanying required retrofits can be **prohibitively high barrier** to hitting recruitment targets (12, 27, 45), though this is expected to change over time as costs fall.

Targeted recruitment is useful for trials with specific eligibility criteria to **reduce screening time** (28, 29).

Acknowledging and aligning with customer preferences is necessary for success

Opt-out flexibility initiatives offer **more flex** than opt-in, provided the **incentive is sufficiently high** (5 on project list).

Unacceptable noise from hybrid/ heat pump systems for participants in some trials (14).

Ease of use, comfort, **reliability**, and upfront and running costs are the primary aspects of a heating system that customers **value** (18).

Do not overpromise: on one trial, many customers did not achieve the bill savings they were promised, with some actually paying more (13).

One trial allows customers to **block times** for which they would not like to have their heat pump remotely controlled (25). There is typically very high satisfaction amongst remote control participants (23, 25, 26, 33).

Simple technology is preferred e.g. a one-app solution (7) or a simple proposition (9).

Cost savings and **revenue opportunities from domestic DSR need to stack together** for consumers to create a range of incentives to help **overcome barriers** arising from **consumer preferences** and technical limitations of heat flex (40).

Active and continuous engagement better guarantee longer-term participation

Customers can be initially **highly concerned** about **changing their routine**, so must be **guided** through the early behaviour change (5, 7 on project list). Personalised tracking and advice empowers participants (8, 26).

Engaging through existing channels such as **organisations representing the community energy/community groups** is effective in improving consumer engagement (21, 37).

Without **continuous engagement**, participation dropped off in certain trials (4), and has been shown to be higher **directly after engagement**. This must be balanced with **messaging fatigue** which causes disengagement (5). Furthermore, contractual documentation should be simple and easy to understand (37).

Large-scale domestic flexibility trials have generally seen **large and enduring buy-in**. For one SPEN trial, **almost 100%** of participants found the experience easy and beneficial. ~70% said they would consider managing their energy use **at least three days per week** (6).

In CrowdFlex, participants who switched to a flex price signal tariff **consistently changed their demand profile** over the six months of the trial (3).

Ongoing communication between members of project staff is key to successful external communication (32).

Various projects assist the setting of ambitious trial objectives and robust impact evaluation

Large scale heating flexibility trials in the UK (3), Germany (24, 25 on project list), Canada (21, 22), and USA (23) all offer **slightly varied trial designs**.

Standard event time for customers is a **maximum of two hours** (2, 6, 24), though other trials went with four hours (5) and one hour (25).

If designed well, direct load control can occur **without participants even noticing** when there has been a control event (13, 23, 33).

Projects like Right to Heat (15) can provide insights to accompany Sero data on **how heat pump use interacts with other low carbon technologies** like solar PV, thus how to account for these in the trial design.

The Modelec trial in France introduced **gamification as an engagement tool** (26), rewarding 'better consumption' with points.

Innovation and research can guide EQUINOX towards a solution that fits with future markets

Intraflex (1 on project list) has proven that **aggregated domestic flexibility procured near real-time can compete with traditional dispatchable flexibility on price.**

CrowdFlex Alpha's work on the statistical nature of domestic flexibility **highlighted the opportunity for, and commercial value of, probabilistic forecasting to increase reliability** (3), which can help DSOs hone their procurement needs for domestic flexibility.

NGED have existing flexibility products which **could be tailored for EQUINOX** (9).

Learnings from **global energy market models** could feed into a bottom-up market model for the UK (19).

GOFLEX has created a data services platform to provide **localised estimation and short-term predictions of energy demand/generation**, which will help create the market for distributed flexibilities and automated dynamic pricing (31).

Commander (34) is exploring stackability and primacy rules for UK system operator flexibility services.

The Universal Smart Energy Framework (USEF) and domestic flexibility Code of Conduct (20) can promote residential participation and reliability in the delivery of flexibility (38).

Projects for key learnings – Horizon Scan Q1 2024[1]

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
41. Net Zero Terrace SIF Alpha		electricity north west	Explores how to decarbonise a terraced street using a network-integrated smart local energy system.	✓		✓	Oct 2023 – Apr 2024
42. Whole Energy System Accelerator		CATAPULT Energy Systems	Utilises real-time customer electricity usage data to inform, design and simulate future networks, and send real-time price signals to customers.	✓		✓	Jan 2023 onwards
43. CrowdFlex SIF BETA		nationalgridESO	Trials ESO capability to procure flexibility from domestic customers through availability and utilisation payments.	✓	✓		Dec 2023 – Jan 2026
44. Heat Risers		UK Power Networks	Aims to overcome network connection barriers that hold back multi-occupancy building heating decarbonisation.			✓	Oct 2023 – Apr 2024
45. SHIELD		UK Power Networks	Aims to develop low-cost low-carbon heating solutions for vulnerable customers and social housing tenants using waste heat recovery from small distributed data centres.	✓		✓	Oct 2023 – Apr 2024

[1] Project Deep Dive List 1-40 can be found here

41: Net Zero Terrace (NZT) Alpha

1 Customer Offering
2 Flexibility Impact
3 Recruitment
4 Customer Preference
5 Engagement Strategy
6 Trial Design
7 Market Design

Project Overview

Description	• SIF Alpha project aiming to decarbonize a terraced street using a Smart Local Energy System (SLES) that is integrated with the network, optimised, affordable to consumers, and replicable. More info.
Project Dates	Oct 2023 – Apr 2024
Project Partners	electricity north west / NORTHERN POWERGRID; BURO HAPPOLD; north east & yorkshire NET ZERO HUB; Rossendale BOROUGH COUNCIL

Project Scope/Methodology

- Aims to tackle challenges of deploying low carbon heating solutions for terraced housing, which is impacted by space and noise constraints.
- Aims to create a Smart Local Energy System (SLES) comprised of ambient loop ground source heat pumps (GSHPs), community-provided storage and solar PV, and local peer-to-peer Power Purchase Agreements (PPAs) controlled by optimisation software.
- Will provide a replicable model that integrates with the electricity network, reduces bills, and defers the need for reinforcement.
- Innovative in working across mixed-ownership buildings for the first time, making use of the DNO network.

Learnings for EQUINOX and heat decarbonisation

- Learnings will become apparent as the project unfolds.
- Highlights a potential methodology for implementing affordable low-carbon domestic heating within **community-owned heat systems.**
- NZT's Alpha phase involves a techno-economic model driven by property data. This could prove useful in determining a business case for addressing this target group from an economic perspective.
- From a commercial perspective, NZT plans to collect primary stakeholder engagement data on the likes of the Local Electricity Bill campaign and heat service provider regulations. This will be used to understand and influence potential **policy and regulation barriers**. The outcomes of this may be relevant to post-EQUINOX implementation.
- Potential lessons on **implementing at scale** post-EQUINOX, given that the NZT aims to be deployable GB wide.

42: Whole Energy System Accelerator

1 Customer Offering
2 Flexibility Impact
3 Recruitment
4 Customer Preference
5 Engagement Strategy
6 Trial Design
7 Market Design

Project Overview

Description	• Use real-time household energy consumption data to inform network planning and develop real-time price signals to encourage changes in energy use More info.
Project Dates	2023 onwards
Project Partners	CATAPULT Energy Systems; LIVING LAB; PNDC University of Strathclyde

Project Scope/Methodology

- WESA involves real-time electricity use data being supplied to Power Network Design Centres (PNDC) from Energy Systems Catapult's (ESC) Living Lab's 2,000 digitally connected households.
- PNDC uses this data to undertake network designs and simulations based on different usage characteristics of end consumers. PNDC also simulate the electricity loads supplied by Living Lab using their own local test network in Glasgow. WESA therefore aims to validate and de-risk future network design.
- Network impact data is fed into ESC's market emulator to test future energy market systems. The emulator also produces a price signal, which is sent out to consumers in real-time to encourage behavioral change.

Learnings for EQUINOX and heat decarbonisation

- WESA is a product designed around continually synthesising consumer data to inform and reiterate across future network and market designs.
- WESA enables flexibility strategies trialed in Living Lab to be used inform network design simulations.
- Results could help DNOs better understand how different low carbon technologies, including low carbon heating, interact with each other to stress the system, and how customers respond to real-time market signals to change their behaviour.

43: CrowdFlex SIF Beta

Project Overview

Description	• Strategic Innovation Funding (SIF) project to better understand system needs for domestic asset flexibility. More info • Plan a test of multiple flex services in a real-world trial to explore stacking opportunities
Project Dates	December 2023 – January 2026
Project Partners	nationalgridESO, nationalgrid, Smith institute, Scottish & Southern Electricity Networks, centre for sustainable energy, elementenergy, energy, aws, Ohme, octopus energy

Project Scope

Follows from SIF Alpha phase. The project looks to:

- Develop comprehensive understanding of domestic flexibility by building forecasting models of domestic demand and flexibility, integrated into the VirtualES, and improve ESO confidence in domestic flexibility.
- Demonstrate that simple incentives can reduce complexity, bureaucracy, and barriers to entry for aggregators to deliver domestic flexibility.
- Trial consumer interventions targeting different system challenges to clarify consumers preferences and inform future market designs.
- Trial the service primacy rules developed by ESO and DSOs to improve coordination between networks and other system participants.

Learnings for EQUINOX and heat decarbonisation

- Learnings will become apparent as the project unfolds.
- CrowdFlex and EQUINOX are both undertaking large scale commercial trials, so can **share learnings between one another.**
- CrowdFlex should develop useful learnings on **system challenges** like peak demand, constraints, and potential balancing solutions which domestic assets can provide.
- Learnings can feed into a **potential role for the ESO** within EQUINOX and provide evidence for EQUINOX commercial arrangement **use cases.**
- CrowdFlex's flexibility stochastic modelling could aid understanding around **future flexibility procurement**, whether/how DSO and ESO flexibility needs **complement** or **compete**, and what **stacking opportunities** are available.

44: Heat Risers

Project Overview

Description	• Strategic Innovation Fund (SIF) Alpha project aiming to remove blockages to heat decarbonisation of multi-occupancy buildings (MOBs). More info
Project Dates	Oct 2023 – Apr 2024
Project Partners	UK Power Networks

Project Scope

- Discovery demonstrated a one-size-fits-all approach is not appropriate for MOBs given the diversity of characteristics and local network constraints.
- Subsequent phases aim to develop and test a decision-making framework, recommend new funding and incentive mechanisms, and boundaries of responsibility.
- Alpha explores the value of providing a self-serve planning tool for building owners and managers to give a clearer view of how to decarbonise their portfolio of buildings.
- The focus is on developing solutions to unlock connection cost barriers.

Learnings for EQUINOX and heat decarbonisation

- Multi-occupancy buildings may not transition to low carbon heating technologies at the same rate as single-household occupancy buildings. This should be taken into account when estimating future domestic flexibility capacity.
- It is possible multi-occupancy buildings can provide flexibility, yet additional complications come into play, for instance when non-single household heat pumps serving heat networks are implemented as the main technology lever.

45: SHIELD

Project Overview

Description	• Strategic Innovation Fund (SIF) Alpha project aiming to develop low-cost low-carbon heating solutions for vulnerable customers and social housing tenants. More info
Project Dates	Oct 2023 – Apr 2024
Project Partners	UK Power Networks, Power Circle, thermify, Essex County Council, Citizens Advice Essex, Eastlight Community Homes, CW community works

Project Scope

- SHIELD installs distributed data centres (HeatHubs) into peoples' homes, focusing on vulnerable and/or social housing tenants. These data centres provide heat as a by-product. The project aims to test whether this is a commercially efficient way of providing:

1. An additional heat source for homeowners - the hubs adjust activities based on household temperature e.g., to avoid overheating in summer.
2. A reliable revenue stream for manufacturer Thermify - they use the hubs to provide data services to clients.
3. A source of flexible supply and demand for networks - the hubs are connected to SLES to provide flexibility and balancing services.

Learnings for EQUINOX and heat decarbonisation

- HeatHubs could potentially provide flexibility services if SHIELD achieves implementation phase, reaching a demographic of vulnerable and/or social housing customers otherwise challenging to reach given their low penetration of heat pump ownership. This could increase the pool of domestic customers available to offer flexibility services.
- However, the heat recovery and storage capabilities that the HeatHub offer would indicate its customers could not provide flexibility services in the same way as other low carbon heating technologies such as heat pumps.

Electricity Distribution

3

Policy, Strategy, Markets and Regulation

Relevant policy and market designs and reviews relevant to EQUINOX

nationalgrid Guidehouse

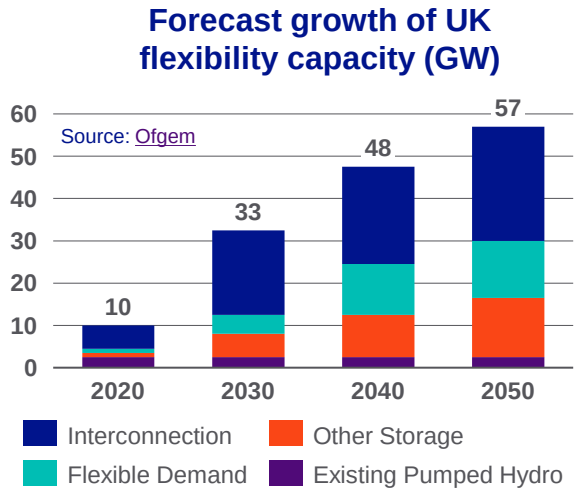
Horizon Scan Coverage: UK policy, regulation, strategy and markets

The scan extensively covers the UK's current and proposed approach towards:

1	2	3	4
UK flexibility build-out	**UK technology roll-out**	**UK approach to energy bills**	**UK future flexibility market**
Track progress towards and changes to the UK's flexibility strategy/ targets/ product deployment.	Track strategy, regulation, and progress for heat pump & smart meter rollout.	Track UK energy costs and government support measures.	Track the options being considered for future market operation in the UK.
Relevance for EQUINOX EQUINOX must align with UK high level strategy.	**Relevance for EQUINOX** Project must react based on regulation for and pace of heat pump /smart meter rollout.	**Relevance for EQUINOX** Trial design and incentives must reflect the current and future energy costs landscape.	**Relevance for EQUINOX** Final BaU-ready commercial offering must fit within the UK's realigned electricity market.

Major sources include: Department for Business, Energy & Industrial Strategy; ofgem; Climate Change Committee; nationalgridESO; ena energynetworks association

Ofgem expects 4GW of flexible demand needed by 2030, en route to 57GW total flexibility capacity by 2050



Interconnection is expected to be the major source of flexibility capacity, but flexible demand grows enormously.

To progress towards these goals, Ofgem's Smart Systems and Flexibility Plan sets out a vision for the mid 2020s.

It expects that all flexibility technologies will have improved access to flexibility markets and can stack revenues across multiple value sources. Innovative products, smart tech and rewards for demand response are encouraged.

Smart meters penetration should be near-100% for smaller scale consumers. Market-wide half-hourly settlement by October 2025 will incentivise energy suppliers to develop new tariffs encouraging demand response.

Ofgem's significant code review (SCR) aims to change the cost-reflectivity of network usage to a way that better reflects variations in network costs associated with location and time of use.

RELEVANCE TO EQUINOX

- EQUINOX will deliver its BaU product by the end of 2025 – it is important to ensure that this is consistent with Ofgem's vision for flexible consumer demand in the UK.
- Elements like the SCR should be tracked closely to see what BaU will look like from a regulatory perspective by 2025.

DSOs procure four broad flexibility products, but this will soon change as parameters are standardised

Sustain (Pre-Fault)

Provides a scheduled response to prevent network constraints.

Assets help manage network constraints by providing additional capacity and capability according to a schedule agreed at the point of contract.

Secure (Pre-Fault)

Provides a scheduled response to manage network loading.

Assets are available to help manage network constraints by providing additional capacity and capability and are utilised depending on requirements established a week ahead.

Dynamic (Post-Fault)

Keeps the power flowing during an unplanned network event.

Assets are available for certain windows depending on needs established week ahead. Provide immediate response in the event of specific fault conditions like maintenance.

Restore (Post-Fault)

Gets the lights back on following an unplanned network event.

Assets are available and provide an immediate response to help restore supply following rare fault conditions, such as the failure of equipment.

RELEVANCE TO EQUINOX

- These four products offer different potential routes for domestic assets to access the flexibility market.
- It is essential to understand how DSOs define parameters such as minimum capacity, utilisation, and notice period for each flexibility product to develop a product that is interoperable between networks in a BaU scenario.
- Note that DNOs are currently finalising efforts to create a set of flexibility products with standardised parameters, replacing the four on this slide.

National Grid ESO's Demand Flexibility Service cut more than 3.6GWh of peak electricity use in winter 2023/24

Demand Flexibility Service (DFS[1]) has continued as an enhanced service to focus on maximising volumes, incentivise new demand flexibility and bridge the gap to market-wide half-hourly settlement and entry into ESO's Ancillary services

Requirements for participation

- Respond for a minimum of 30 minutes.
- Providers must provide relevant HH metering & baselining data to demonstrate demand reduction.

Assets are excluded if they…

- Are dispatchable via the Balancing Mechanism.
- Participate in Ancillary services or DNO services.
- Have a Capacity Market contract.

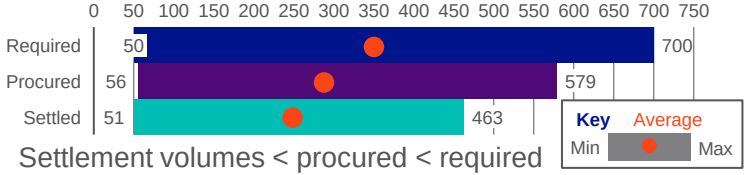
Basic service details

- 26 HH test windows from Nov 2023 to Mar 2024.
- 6 HH live windows on 29th Nov, 1st Dec.
- Within day dispatch options – closer to real time.
- Guaranteed Acceptance Price (GAP) at £3,000/ MWh for test events until Feb 2024. No GAP for live events. Lower settlement prices post-Feb.

31 Domestic Providers, incl.[2]

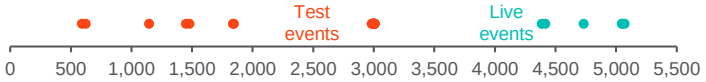
octopus energy, equiwatt, ivie, loop, SMS, EDF, e.on next, energy, utilita, Ohme, British Gas, ecotricity

DFS volume (MW) spread for 32 half hour events[3]



Settlement volumes < procured < required

Price (£/MWh) spread for 32 half hour events[3]



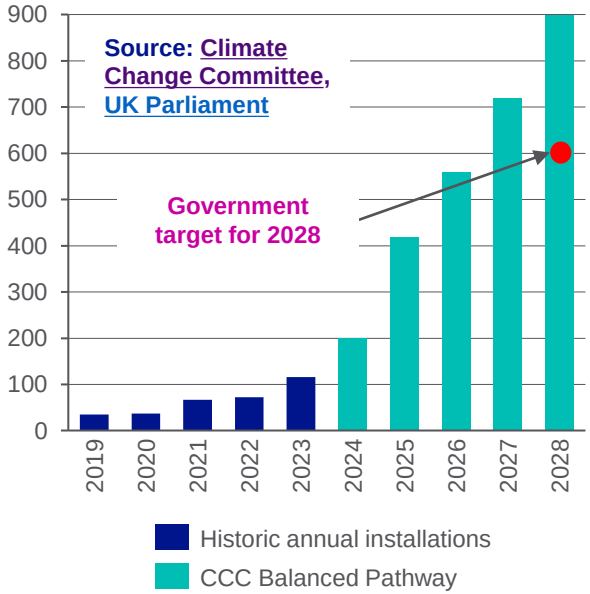
RELEVANCE TO EQUINOX

- This service provides details on how residential flexibility is valued by the ESO, improved baselining methodologies for calculating demand reduction, and will serve the discussion on ESO and DSO product stacking.

[1] National Grid ESO For more details on DFS 2022/23 results and 2023/24 conditions, see previous Horizon Scan; [2] ESO; [3] ESO Data

The UK is making slow progress towards an ambitious 2028 goal of 600k/year heat pump installations

Historic and required UK annual installations of residential heat pumps (100s of thousands)



The UK is **well behind** in its current rollout – There are 4.1 installations per 1,000 people compared to 30.7 in Europe. 15.3 is the required rate.

The UK's 2035 ban on new gas boiler sales was scaled back to an 80% phase out by 2035 in September 2023.

UK govt aims to **reduce** hardware and installation **costs by 25-50% by 2025**, and **parity with gas boilers by 2030.**

Boiler Upgrade Scheme (BUS) provides £7,500 for ASHPs and GSHPs **since 23 October 2023**, up from £5,000 and £6,000, respectively. £1.5 billion extra funding announced for 2025-2028, on top of initial £450 million.

Future Homes Standard will from 2025 mandate heat pumps in all new build properties. Clean Heat Market Mechanism[1] currently slated for 2025 launch, penalising manufacturers for missing heat pump production targets.

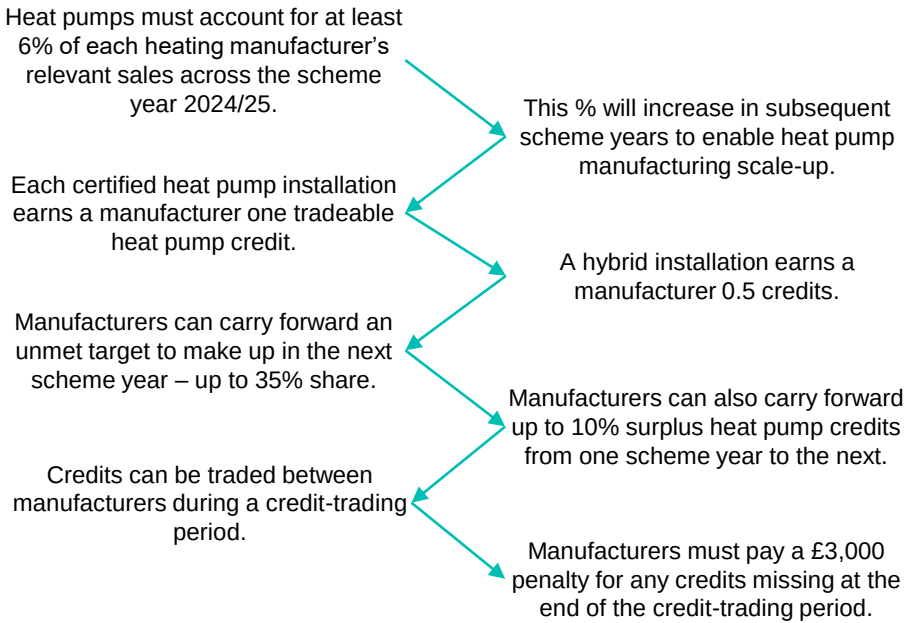
RELEVANCE TO EQUINOX

- Project will need to track rollout progress to understand how quickly recruitment pool is expanding, for both the winter trials and the BaU product.

[1] See Slide 32 for more details

The Clean Heat Market Mechanism is a market approach to scaling up heat pump deployment by manufacturers

How the Clean Heat Market Mechanism will work



The government has shifted the mechanism's start date from April 2024 to April 2025 to give businesses more time to prepare.

Manufacturers are not requested to produce supply chain plans to keep reporting and administrative burdens to a minimum in early scheme years.

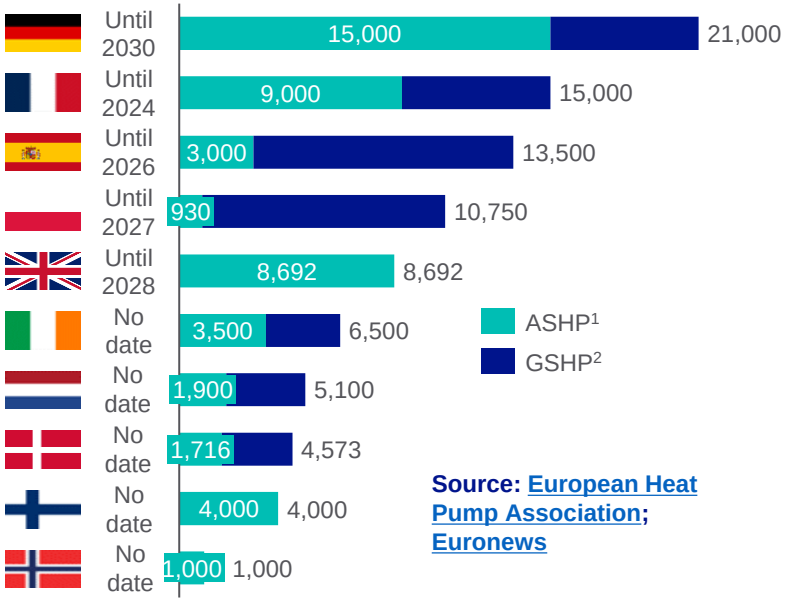
The scheme will be managed and regulated by the Environment Agency (EA)

RELEVANCE TO EQUINOX

- The delayed rollout of the scheme is indicative of the slow ramp up of heat pump production in the UK – this limits the pool of customers for EQUINOX's final year of trials.

UK offers generous grants for ASHPs compared to most European peers, bar France & Germany

Grants available for heat pump installations in selected European countries (Euros)



Source: European Heat Pump Association; Euronews

Italy offered a 110% tax break on heat pump installations. However, its long-term effects were less beneficial.

France have indicated they will boost heat pump subsidies to equal gas heater costs for low-income families. They also aim to build capacity for making 1 million pumps per year.

Legislation in Germany mandates new-build houses to be heated by >65% renewable energy from 2024 (essentially a heat pump or hybrid system) and for the same in existing homes from 2026 or 2028, depending on the municipality.

The UK's BUS has so far received more than 33,000 applications. Applications have risen sharply since the government increased the subsidy by 50% in October 2023.

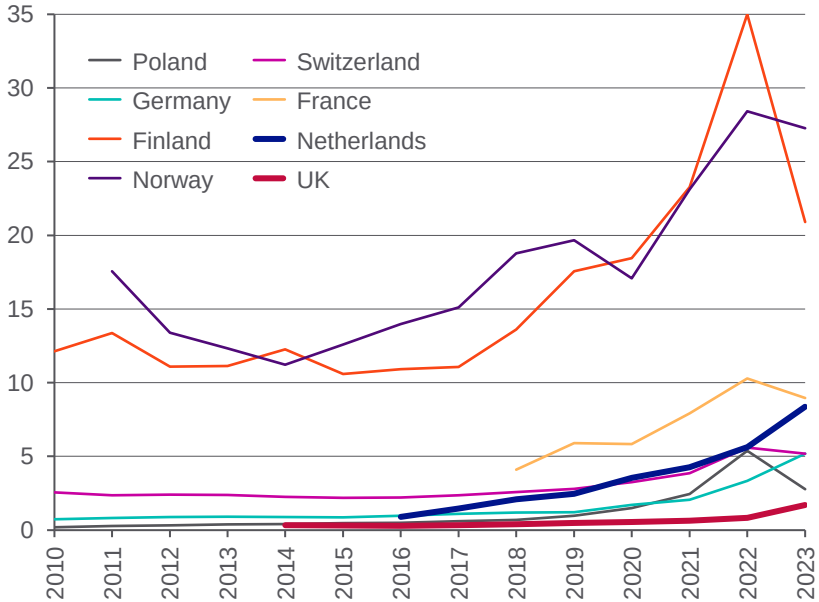
RELEVANCE TO EQUINOX

- Being aware of policies in place elsewhere indicates how new or amended UK policies may change UK heat pump installation rates, which impacts the reach of EQUINOX's BaU arrangements.

[1] Minimum grant for an ASHP; [2] Maximum grant for a GSHP

Even as European heat pump growth stalled in 2023, the UK remains behind on per capita installations

Annual installations of residential heat pumps per 1,000 capita for selected European countries[1]



Case Study: The Netherlands vs the UK[2]

The Netherlands is **as reliant as the UK** on natural gas for domestic heating. Nevertheless, it is clearly accelerating low-carbon heating far quicker. A few key reasons:

Bans on new homes being connected to the gas grid: Since the Netherlands initiated a ban in mid-2018, per capita heat pump installations have sky-rocketed. The UK's is currently not intended to begin until 2025.

Local approach: Municipalities expected to drive push to low carbon heating through local Heat Transition Plans developed with housing associations, DSOs and local citizens. UK local schemes are more fractured, held back by a very centralised government.

Tax incentives: Since 2020, Netherlands have been gradually shifting the tax burden from electricity to natural gas for households, incentivising electrification. Households in the UK are currently mainly taxed on their electricity usage.

Building standards: In 2012, Netherlands set a target for the average social rental home to have an EPC rating of B by 2021. Renting poorly insulated homes in private and social sector to be banned from 2030. The UK has been slower: since 2018, only homes with EPC below E are banned from private renting.

RELEVANCE TO EQUINOX

- As heat pumps proliferate elsewhere, there will be more at-scale flex. projects from which EQUINOX can take and apply learnings

[1] Sources for annual heat pump installations: Poland; Germany' Finland; Norway; Switzerland; France; Netherlands; UK. Population data to calculate per capita from The World Bank; [2] Adapted from Bruel & Rosenow, 2023

New partnerships and incentives intended to accelerate the heat pump roll out (Q1 2024)

New apprenticeship funding scheme for heat pump installers

The Department of Education aims to train 57,000 heat pump installers between 2023-2030.

The Low-Carbon Heating Technician Apprenticeship will provide funding to colleges of up to £22,000 per apprentice. The scheme was developed by the Microgeneration Certification Scheme (MCS) and the Institute for Apprenticeships and Technical Education.

Octopus partnership to build energy bill-free homes

Octopus aims to partner with housebuilders to deliver 50,000 ‘Zero Bills’ homes globally by 2025. These houses aim to be bills-free for five years, guaranteed. Each house is fitted with low carbon technologies, optimised by the Kraken tech platform.

Octopus has partnered with the Hill Group to develop 89 homes such homes in Essex, and with Bellway to develop 250 homes in Bedfordshire.

New low-carbon heating trainee scheme

Manufacturer Daikin UK has partnered with the Green Skill Academy and Quantum Group to train green heating tutors at nine Greater Manchester colleges.

The ‘Train the Green Trainer’ programme aims to upskill 50 heating and plumbing tutors to install low-carbon heating technologies by April 2024.

National Grid and Octopus partner to speed up installations

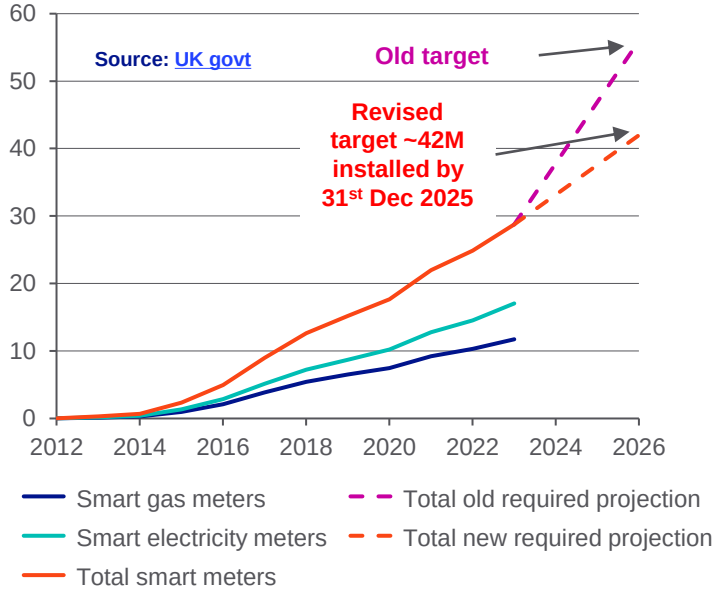
Octopus and National Grid have partnered to allow Octopus engineers to upgrade customer fuses themselves during installations of EVs, heat pumps and solar panels.

National Grid has already assessed the impact of future heat pump installations on its license areas to ensure the extra power can be accommodated.

[1] See Q2 2023 and Q3 2023 updates, see previous Horizon Scan

Smart meters targeted for all homes by the end of 2025, requiring accelerated rollout

Historic and required UK cumulative rollout of domestic smart meters operated in smart mode (millions)



Target to install a smart meter in 100% of domestic properties by the end of 2025 was scaled back to 74.5% in July 2023.

Since January 2022, all suppliers have had **binding annual install targets** through to 2025. Targets will be **reset annually** based on the proportion of a supplier's customer base **still with a non-smart meter.**

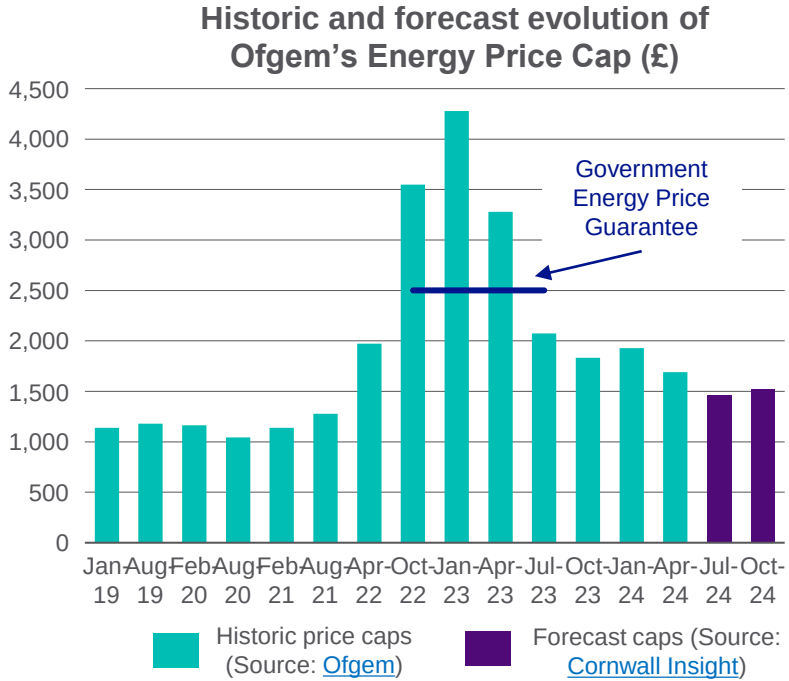
Installation trend is on track for revised 2025 target. This will still leave one in four homes without a smart meter.

SSEN are the first DNO to publish full smart meter half-hourly consumption datasets. All UK DNOs have collaborated on interoperable sharing method.

RELEVANCE TO EQUINOX

- Project close, and thus recommendations for business-as-usual commercial arrangements, is also scheduled for the end of 2025.
- Only customers with a smart meter can participate in EQUNIOX, so understanding the pace of the smart meter rollout helps with forecasting potential future reach for the service.

Ofgem are looking to evolve their price cap as flexible electricity consumption becomes more normalised



Ofgem's price cap has since 2019 limited the rate an energy supplier can charge for default tariffs, with the aim of protecting UK customers from overpaying for energy.

The cap shifted from twice-yearly to quarterly changes in 2022 to enable the cap to respond quicker to changes in wholesale prices.

Ofgem has launched a consultation on developing the price cap as the energy market evolves to a smarter, more flexible system.

Half hourly settlements will be introduced in 2025, giving customers more flexibility in using and paying for electricity. This is expected to lead to a growth in smarter time-of-use tariffs.

RELEVANCE TO EQUINOX

- Understanding what consumers are paying for their bills will impact the incentive payments that they receive to participate in EQUINOX, offer up their data for analysis, and ultimately turn off their heat pump

The Review of Electricity Market Arrangements (REMA) has reached its second consultation stage

What is the purpose of and timeline for REMA?

- Government consultation reviewing how to **reduce reliance on fossil fuels** and enabling **abundant and cheap renewables** to drive the design of the future electricity markets.
- Concerns reform to all **non-retail electricity markets**, including wholesale market, balancing mechanism, and flexibility markets.
- REMA began in 2022. The first consultation closed in 2023. The government have just published its second consultation.

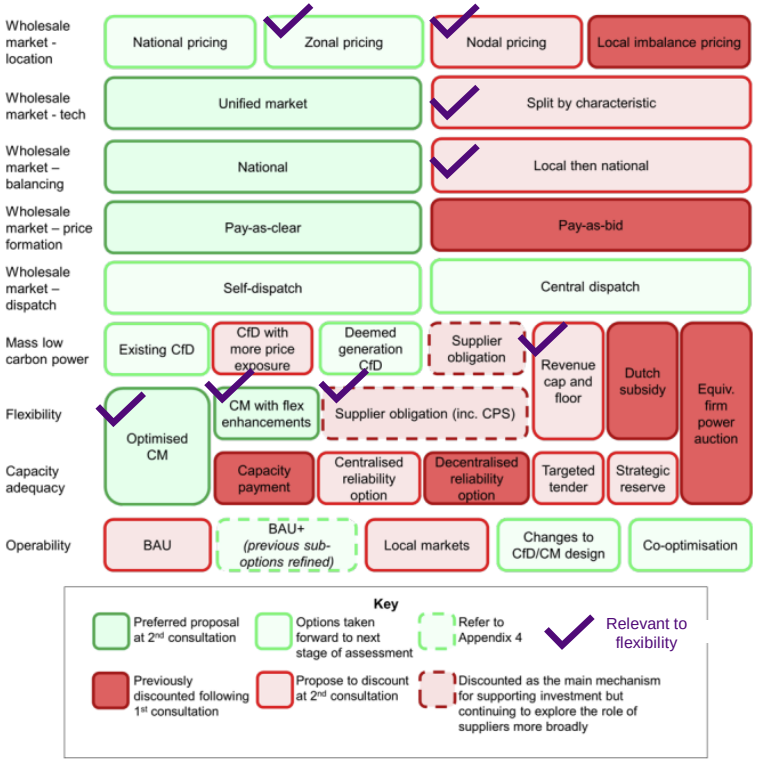
REMA addresses the following challenges seen in the current market set-up

1. Passing through the value of a renewables-based system to consumers: marginal pricing, Corporate Power Purchase Agreements (CPPAs) and demand reduction.
2. Investing to create a renewables-based system at pace: reforming Contracts for Difference (CfDs).
3. Transitioning away from an unabated gas-based system to a flexible, resilient, decarbonised electricity system: delivering flexibility and security of supply.
4. Operating and optimising a renewables-based system, cost-effectively: improving locational and temporal signals, balancing, ancillary services and local and national coordination.

RELEVANCE TO EQUINOX

- The REMA outcome will narrow the electricity market options, including flex markets, which will be considered for the UK going forwards. This impacts the future BaU market operation with which EQUINOX will have to be consistent

REMA – summary of second government consultation



- This figure illustrates the range of options upon which the second consultation aims to gauge views.
- They are not mutually exclusive and can be stacked.
- Responses to the second consultation will be summarised in summer 2024. REMA policy development phase will conclude in mid-2025.
- The supplier obligation option was discounted after the first consultation. For more details, see previous Horizon Scan.
- The government's proposed approach on locational pricing, an optimised capacity market and revenue cap and floor are discussed on the next four slides.

RELEVANCE TO EQUINOX

- At this stage in the consultation process, a high-level understanding of the options still being considered is useful.
- Once the chosen options are being further developed, it will be important to gain a deeper appreciation for the impacts this will have on flexibility market and market participants' behaviour.

Locational pricing: Government proposes discounting nodal pricing and comparing zonal and national pricing

Of respondents to the first consultation:

55% thought that neither, or only one, of nodal and zonal market designs should be considered.

35% thought that nodal and zonal market designs should both be considered.

Respondents noted that zonal pricing:

- Provides some benefits of nodal pricing with less complexity.
- Avoids need for central dispatch.
- Already **precedented** in continental Europe.

Respondents noted that nodal pricing:

- Most accurately reflects marginal cost of meeting demand and would increase transparency.
- Is more complex and likely offers reduced liquidity.

In the second consultation, the government:

- Proposes to discount nodal pricing as the risks to investor confidence and the 2035 power decarbonisation target are deemed too high.
- Believes zonal pricing could take 5+ years to implement with either self-dispatch or central dispatch.
- Commits to exploring key design parameters of zonal pricing.
- Identifies four alternatives to locational pricing, all of which they intend to take forward to the next phase of REMA:

1. Using Ofgem's pre-existing network charging reform programme for transmission and distribution system charges.
2. Reviewing Ofgem's transmission network access arrangements, including changing access rights.
3. Expanding measures for constraint management, such as expanded local constraints markets, improved congestion forecasting, storage-based solutions and before day-ahead constraint price signal.
4. Optimising the use of cross-border interconnectors.

This difference of viewpoint on locational price signals extends beyond the REMA consultation

Both Energy Systems Catapult and National Grid ESO have named nodal pricing as an attractive solution to reduce consumer costs

1. The current wholesale market pricing is contributing to inefficiencies in balancing the network while undermining the capability to deliver demand side flexibility.
2. If left unchecked, it will impose excessive and unnecessary costs on consumers.
3. Locational Marginal Pricing can be the foundation to a net zero system and can be enhanced if coupled with policies that create a 'demand pull' for clean energy investments.
4. It could also facilitate the efficient management of the system and help incentivise flexible assets to locate and operate the optimal way for the electricity system.

Other members of the energy sector expressed fears of loss of revenue for generators and disparity in consumer electricity prices based on location

1. Increased risk to investors in new generation energy capacity and the inflated cost of capital in implementing a locational marginal pricing system could negate any potential benefits. Without investors, progress is impossible.
2. Potential of a 'postcode lottery' where homes near generators will experience reduced costs while homes far from generators may experience increased costs.
3. Some suggest that investing in new energy storage to increase grid flexibility and to balance the availability of renewably generated power is a better route to bringing down consumer costs.

Capacity Market (CM): Consultation proposes optimising CM by introducing a minimum procurement target

Of respondents to the first consultation[1]:

68% thought that the capacity market should be reformed to some extent.

- Majority agreed that reforms enabling greater levels of carbon flexible assets are needed.
- Many felt short-term markets and ancillary services were best positioned to appropriately reward flexible characteristics closer to real-time system needs.

11% were not in favour of adding additional layers of complexity to the capacity market.

- Some doubted that ancillary services could provide a sustained investment signal for flexible assets.
- Some felt that adjusting capacity market parameters to bring forward investment in low carbon flexibility could lead to suboptimal results and ineffective market distortions.
- Some suggested that flexibility auctions or applying multipliers would be required to guarantee the correct types and required volumes of low carbon flexible assets are built.

In the second consultation, the government proposes:

1. Retaining CM as primary mechanism for ensuring capacity adequacy. No other option provides better value for money.
2. Optimising CM by introducing minimum procurement target (minima) into auctions to better support investment in low carbon flexible technologies.
3. Considering how minima should be defined and set.
4. Discounting multipliers for technologies with desirable characteristics competing in the auction.
5. Ensuring the reliability standard is fit for purpose.
6. Validating proposed emissions limits for refurbishing and new build CM Units on long-term contracts from 2026 auctions on.

[1] For more details on what was consulted on regarding the Capacity Market, see previous Horizon Scan

Revenue cap and floor: Government proposes discounting for flexibility due to gaming risks and incentive distortions

Of respondents to the first consultation[1]:

48% thought that the Government should continue to consider a revenue cap and floor for flexibility.

- Suggestions that it could be effective in deploying flexible assets by de-risking investment, especially where assets have high capital costs.
- Majority highlighted the suitability of a cap and floor mechanism in de-risking investment in long duration storage, and the need for government to bring forward such a mechanism at pace.

38% thought that the Government should not continue to consider a revenue cap and floor for flexibility.

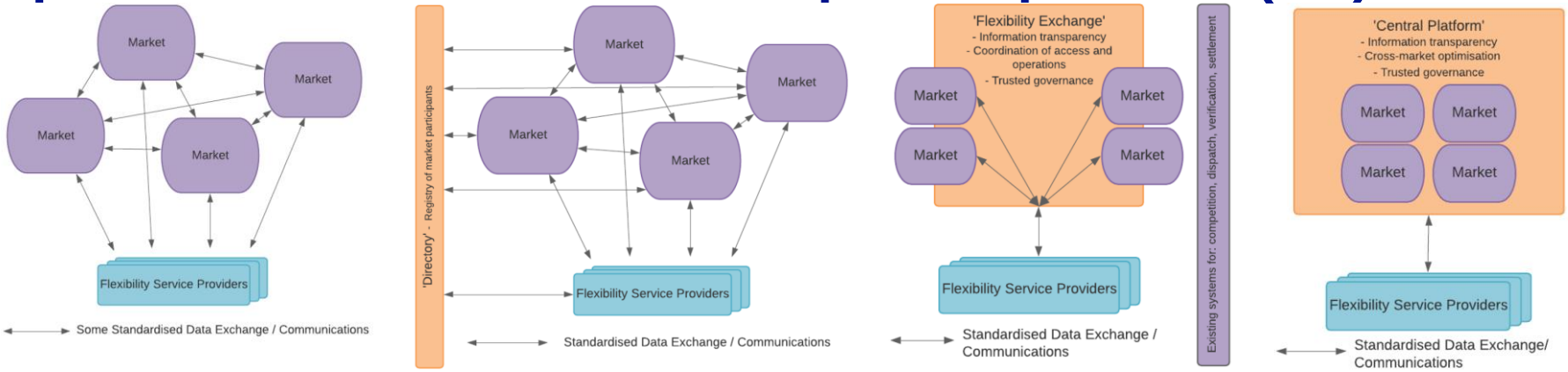
- Suggestions that a cap and floor could distort other parts of the market by improving the investment case for high-CAPEX flexibility ahead of other assets such as demand side response and batteries.
- Some felt there would be a high administrative cost of implementing the regime.

In the second consultation, the government proposes:

1. Discounting the revenue cap and floor as it has several design flaws that could lead to significant gaming risk or distort incentives for generators to operate efficiently.
2. Gaming risk: potential for generators to maniputate or reduce revenues reported under the cap and floor regime.
3. This results in greater payment being received if revenues are below the floor or reducing the required repayment amount if above the cap.
4. Operational distortions: if generators anticipated earning revenues below the floor over the reconciliation period, they would lose incentives to generate.
5. Likelihood of earning revenues below the floor would be high given price cannibalisation.

[1] For more details on what was consulted on regarding the revenue cap and floor, see previous Horizon Scan

Ofgem's Future of Distributed Flexibility presented four options for future market set-up and operation (1/2)



1. Business as usual: markets lack any consistent means of coordination. Flexibility service providers (FSPs) must engage individually with each market. Markets might coordinate bilaterally if their outcomes affect each other.

2. Thin Archetype: Minimal intervention. Open access to a directory which lists market operators and flexibility providers. However, no common point of access to join markets, nor an established or governed coordination mechanism between markets. Markets and participants are blind to one another unless they take specific action to establish bilateral data sharing agreements. Without that, buyers and sellers would have no idea whether there were market conflicts until real time operational disfunction.

3. Medium archetype: An exchange platform which hosts multiple markets to facilitate/ coordinate participation/ operation. Markets coordinated under a known governance framework but continue to retain their own market designs, platforms, and systems. Exchange acts as common point of access and increases visibility across markets for buyers and sellers. Availability and dispatch takes place 'off-exchange', with the exchange hosting all ex-post data for transparency.

4. Thick archetype: Highest intervention. A central platform for end-to-end delivery of distributed flexibility with multiple markets, undertaking all process steps. Unlikely to leave any service provision with existing systems. All information is presented centrally. Because the platform is clearing all markets, it can co-optimise across them all for whole system operation.

63% of consultation respondents stated a preference for a hybrid thin-medium or thick medium archetype (2/2)

Key views from respondents

- 93% of respondents agreed that to address the market failures of at scale distributed flexibility, there is a strong case for policy/ market design changes.
- Most respondents were supportive of creating a common digital energy infrastructure (CDEI) for flex markets for transparency, coordination, and trust to enable distributed flexibility to be procured at scale.
- 63% of respondents supported iterative development of the medium archetype, including a thin-medium or thick-medium design.
- Near universal consensus on the need to deliver the enablers needed to facilitate the participation of distributed energy resources and consumer energy resources in multiple flexibility markets.

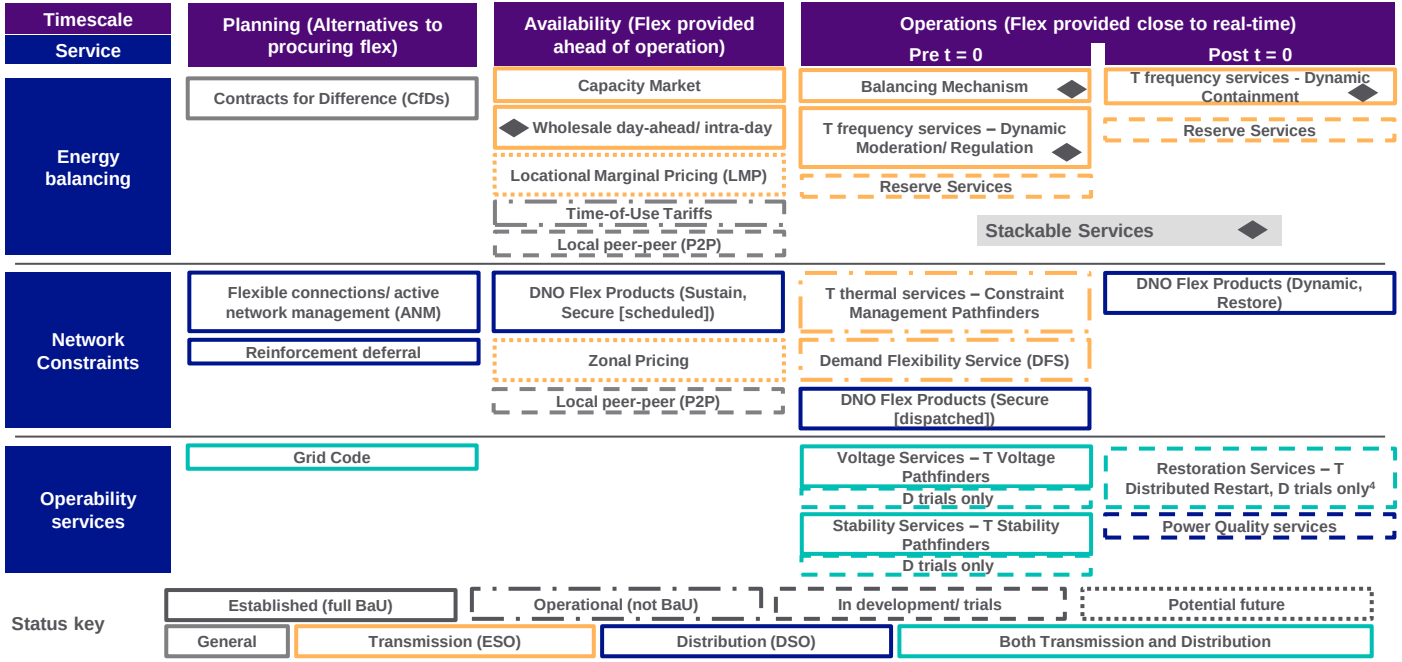
Next Steps

- Stakeholder workshops will be hosted to delve deeper into these areas and inform a future consultation.
- The potential governance arrangements as well as enablers needed for a CDEI being delivered at scale will be considered in greater detail.
- Forward work will be aligned with Ofgem's proposals on a Market Facilitator Role as part of Local Governance Reforms and overall digital architecture vision.

RELEVANCE TO EQUINOX

- The BAU product which comes out of the EQUINOX project will ultimately slot into whatever UK flexibility market structure is chosen by Ofgem, as informed by the wider stakeholder community. Being aware of these consultation findings is therefore important across any flexibility-focussed innovation projects.

DSOs and ESO are developing many more products which could provide stacking opportunities



RELEVANCE TO EQUINOX

- It will be important for EQUINOX to keep track of which ESO products can be stacked with each other, and with DNO flexibility products
- This will enable the project to appreciate whether/when/how DNO requirements should be prioritised over ESO ones (and vice versa)

The ENA has been exploring primacy of ESO and DSO flexibility as part of its Open Networks project

1. The interaction between the ESO's Short Term Operating Reserve (STOR) and DNO Active Network Management (ANM) was **initially explored**, highlighting **several complex trade-offs** with potential impacts on various market participants.
2. Primacy Rules development focus changed to **the simpler interactions between ESO and DNO procured flexibility services.**
3. The ENA's report focused on the delivery of the **Transmission Constraint Management (TCM) Service** and the **DNO active power services (other than Restore),** and assessed how several use cases within the Balancing Mechanism may interact with DNO services.
4. DNO Flexibility Services are **more geographically constrained** than ESO products, so the conclusion was that in the above cases **the DNO should receive primacy**, with **two 'DNO priority' rules proposed** with **different timescales for the sharing of data and the consideration/or not of outages.**

1a: Basic data sharing ahead of real time – this rule has been selected for trial and roll out with NGED as part of the South-West Regional development Programme (RDP) specifically for the TCM use case.

1b: More extensive sharing of data – further investigation into design by UKPN and National Grid ESO to see whether it could be trialled in the South-East RDP, also for the TCM use case.

The development of the rules highlighted the need for a **robust planning process** to assess the benefits of actively managing conflicts**.**

These will need to **identify** and then **balance** the costs and benefits of active conflict management **against alternative options** to ensure the **most efficient outcome**.

This will ensure that the operational decision making developed in the primacy rules continues to deliver an operable and economic whole system.

RELEVANCE TO EQUINOX

- The ENA's ongoing work will help to drive conversations in the EQUINOX project regarding primacy of heat pump flexibility procured from customers through various services.

Electricity Distribution

A1

List of Previous Projects Identified and Selected Updated Deep Dives

nationalgrid Guidehouse

Projects for key learnings 1/5[1]

Dates in bold indicate that this project's deep dive slide is in this Appendix because there has been an update since a previous Horizon Scan

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
1. Intraflex		nationalgrid	First close to real-time trading of domestic flex, allowing market to determine price.	✓	✓		Oct 2019 - Nov 2021
2. Crowdflex NIA		nationalgridESO	Large-scale commercial trial to understand the domestic flexibility across various LCTs.	✓	✓		Apr 2021 - Mar 2022
3. Crowdflex SIF Alpha		nationalgridESO	Deeper dive into the system role of domestic flexibility, plus potential stacking opportunities.	✓	✓		**Aug 2022 - Jan 2023**
4. Energywise		UK Power Networks	Understand and trial energy efficiency and commercial arrangements with fuel poor customers.	✓	✓		Jan 2014 - Sep 2018
5. SAVE		Scottish & Southern Electricity Networks	Understand whether price signals can impact household peak demand.	✓	✓		Jan 2014 - Jun 2019
6. Flexibility Demand Shift Trial		SP ENERGY NETWORKS	Turn-up trial where consumers were rewarded with free energy for using abundant renewables.	✓	✓		Mar 2022 – Apr 2022
7. Powerloop		octopus electric vehicles	Residential V2G trial with Nissan Leafs.	✓	✓		Mar 2018 - Mar 2022
8. Vehicle-to-Grid Trial		ovo energy	Use bidirectional charging to balance the grid and improve energy efficiency.	✓	✓		Jan 2021 - Jan 2023
9. Future Flex		nationalgrid	Design and trial a new flexibility product for unlocking domestic flexibility.	✓	✓		Nov 2021- Mar 2023

[1] Link to previous Horizon Scan iteration for deep dives on full list of projects 1 - 34

Projects for key learnings 2/5[1]

Dates in bold indicate that this project's deep dive slide is in this Appendix because there has been an update since a previous Horizon Scan

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
10. Peak Heat		nationalgrid	Desktop modelling study to better understand impact/ flexibility of HPs.	✓		✓	Feb 2021 - May 2022
11. 4D heat		Scottish & Southern Electricity Networks	Flexible residential heating demand to absorb wind power that would otherwise have been curtailed.	✓		✓	May 2020 - Nov 2020
12. LEO – Smart Flex		LEO Local Energy Oxfordshire	Understand the potential for flexibility services to help enable a zero-carbon future for rural communities with planning constraints.	✓		✓	Jan 2022 - Jun 2023
13. No Regrets		passivSYSTEMS	Bring a novel hybrid HP commercial offer to market, and experiment with DSR viability.	✓		✓	Oct 2018 - Apr 2019
14. HyCompact		UK Power Networks	Trial of 7 new single unit hybrid heating systems.	✓		✓	Aug 2020 - Jun 2022
15. Right to Heat		UK Power Networks	Develop best practice decarbonising heat and decreasing bills in gas grid connected urban social housing.	✓		✓	Feb 2022 - Jul 2023
16. Neighbourhood Green		UK Power Networks	Propose an industry standard view on diversity factors for heat, understand flex potential.	✓		✓	**Feb 2022 - Feb 2024**
17. CommuniHeat		UK Power Networks	Developing a roadmap for how rural communities can switch to low carbon heat.	✓		✓	Oct 2020 - Jun 2022

[1]Link to previous Horizon Scan iteration for deep dives on full list of projects 1 - 34

Projects for key learnings 3/5[1]

Dates in bold indicate that this project's deep dive slide is in this Appendix because there has been an update since a previous Horizon Scan

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
18. Freedom		nationalgrid	Balancing networks through optimising use of HHPs.			✓	Oct 2016 - Jan 2019
19. Redmast		nationalgrid	Evaluating current energy market set-up to investigate future market designs.	✓			Jan 2022 - Aug 2022
20. HOMEflex		Scottish & Southern Electricity Networks	Development of a Code of Conduct to build trust in domestic flexibility market and support consumer engagement.	✓		✓	**June 2022 – May 2024**
21. Regulated Power Pricing pilot		London Hydro	Critical peak pricing trial of cooling flex with & without real time data.	✓			May 2016 - Apr 2019
22. Advantage Power Pricing Pilot		alectra	Tests response of technology-enabled residents to dynamic price signals.	✓	✓	✓	Nov 2015 - Aug 2019
23. EnergyWise Home		DUKE ENERGY	Residential trial of direct load consumption for heating/cooling.	✓	✓	✓	Jan 2014 - Sep 2018
24. Viflex		VIESMANN	Test how reduced HP demand can stabilise transmission system.	✓	✓	✓	Dec 2020 - Ongoing
25. HeatFlex		TenneT	DNO cooperation to intelligently use flexibility from distributed heat pumps to avoid grid bottlenecks.	✓	✓	✓	Jul 2018 - Jun 2020
26. Modelec		POWEO	Test load shedding models for consumers in response to different demand responses.	✓	✓	✓	Jan 2011 - Jul 2014

[1] Link to previous Horizon Scan iteration for deep dives on full list of projects 1 - 34

Projects for key learnings 4/5[1]

Dates in bold indicate that this project's deep dive slide is in this Appendix because there has been an update since a previous Horizon Scan

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
27. Electrification of Heat		CATAPULT Energy Systems	Technical and practical feasibility of a large-scale heat pump rollout into existing British homes.		✓	✓	June 2020 – Dec 2022
28. NeatHeat		UK Power Networks	Test how Zero Emission Boilers (ZEB) interacts with the electricity network.	✓		✓	**Sep 2022 – Feb 2024**
29. ReHeat		SP ENERGY NETWORKS	Trial network solutions to mitigate the effects of increased demand from domestic electrical heating on the distribution network.	✓	✓	✓	**June 2021 – Oct 2024**
30. Flexible Tower		SP ENERGY NETWORKS	Demonstrating ability of electric storage heaters to shift demand.	✓			Feb 2021 – May 2022
31. GOFLEX		IBM	Technology solutions for distributed flexibilities and automated dynamic pricing market.	✓	✓		Nov 2016 – Feb 2020
32. EcoGrid EU		ENERGINET.DK	Using market mechanisms and smart control of electricity to balance the energy system.	✓	✓		2011-2015
33. HeatFlex UK		Centre for Net Zero Powered by Octopus Energy	Improve understanding of heat pump flexibility potential and circumstances for participating in flexibility events.	✓	✓	✓	**Sept 2022 – Sept 2024**
34. Commander		nationalgridESO	Method for coordinating stackability and primacy for ESO/DSO flexibility.	✓			**Oct 2022 – Jan 2024**

[1]Link to previous Horizon Scan iteration for deep dives on full list of projects 1 - 34

Projects for key learnings 5/5[1]

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
35. Net Zero Terrace		electricity north west	Explores how to decarbonise a terraced street using a network-integrated smart local energy system.	✓		✓	Apr 2023 – June 2023
36. Community DSO		NORTHERN POWERGRID	Initial assessment into the feasibility of smart local energy systems as a future option.	✓	✓		Jan 2022– Dec 2027
37. Transition		Scottish & Southern Electricity Networks	Aims to adapt electricity infrastructure as system moves towards a more distributed and flexible network.	✓	✓		Jan 2018 – Jul 2021
38. Fusion		SP ENERGY NETWORKS	Trial of local demand-side flex through a structured and competitive market to unlock the value of network flexibility.	✓			Oct 2018 – Dec 2023
39. Flex Heat Networks		UK Power Networks	Investigates how all-electric heat network could affect the network and how DNOs can manage them flexibly.	✓		✓	Jul 2023 – Aug 2025
40. Watt Heat		UK Power Networks	Investigates potential of thermal storage technologies to mitigate peak electricity load growth from domestic heat.	✓		✓	Apr 2023 – Jul 2023

[1] Link to previous Horizon Scan iteration for deep dives on full list of projects 35 - 40

3: CrowdFlex SIF Alpha

Project Overview

Description	• Strategic Innovation Funding (SIF) project to better understand system needs for domestic asset flexibility. More info. • Plan a test of multiple flex services in a real-world trial to explore stacking opportunities.
Project Dates	August 2022 – January 2023
Project Partners	nationalgridESO, elementenergy, nationalgrid, Ohme, Scottish & Southern Electricity Networks, octopus energy

Project Scope

Follows from SIF Discovery phase in early 2022. The project looked to:

- Understand system needs and utilization of domestic assets.
- Plan for real-world trials of flex services, including stacking.
- Improve clarity around data needs and stochastic (rather than current deterministic) statistical approaches to forecast flex.
- Better understand potential regulatory barriers.
- Engage successfully with consumers to incentivize behaviour change so that the trials can deliver expected commercial and CO2 reduction benefits.

Learnings for EQUINOX

- CrowdFlex Alpha identified Thermal Constraint Management (transmission and distribution) and Energy Balancing as key use cases to be tested in the Beta project.
- CrowdFlex Alpha's work on the statistical nature of domestic flexibility has highlighted the opportunity for, and commercial value of, probabilistic forecasting to increase reliability. This is critical to the Virtual energy system (ES) and will improve the economics of existing network assets and target future system investments through reliable modelling of domestic demand and flexibility.

16: Neighbourhood Green

Project Overview

Description	Better understand future After Diversity Maximum Demand (ADMD) when low carbon technologies for heating are clustered; propose an **industry standard view on diversity factors for** heat, understand flex potential. More info
Project Dates	February 2022 - February 2024
Project Partners	UK Power Networks; CATAPULT Energy Systems; University of Strathclyde Engineering

Project methodology

- Monitored data from homes across the UK with electric heating and other low carbon technologies (LCTs) in different weather conditions.
- Analysed data to understand load profile of different heating technologies when coupled with other LCTs.
- Performed network testing on different topologies (rural, urban, etc.).
- Aimed to form an industry standard view on diversity factors for heat and better understand the clustering effect of LCTs.

Learnings for EQUINOX and heat decarbonisation

- The project concluded that heat pump flexibility will be weather dependent.
- Heat pumps are not as flexible as other technologies within the home due to their long running hours and load profile throughout the day.
- Heat pump demand is highest when it is coldest. Fewer customers may be willing to provide flexibility.
- Electric heating may change transformer and cable loading. As the daily load profile becomes flatter due to heat pumps, the transformer and cable will be used differently. DNOs may look to size them considering their continuous rating instead of their cyclical ratings.
- Security of supply and planning standards will need to evolve to support the electrification of heat.
- The network will need to support the highest demands in the coldest weather and be ready to support the electrification of heat.

20: HOMEflex

Project Overview

Description More info	Develop a **Code of Conduct** to create an **inclusive, fair, and transparent marketplace** for domestic flexibility services.
Project Dates	June 2022 – May 2024
Project Partners	Scottish & Southern Electricity Networks; Flex Assure; centre for sustainable energy

Project Methodology

- Develop Code of Conduct by mapping emerging business models, identifying actors/relationships, and considering how to treat different parties under this Code.
- Establish steering committee composed of key stakeholders to provide input to and oversight of project.
- Engage consumers by undertaking four focus group sessions throughout the project to inform drafting of Code of Conduct and assess potential impact of voluntary compliance scheme on market take up.
- Establish frameworks for a voluntary compliance scheme, including a dispute resolution mechanism.

Learnings for EQUINOX and heat decarbonisation

- First draft Code of Conduct released in June 2023. It sets out common standards of practice for companies delivering energy flexibility services to domestic and microbusiness customers, encouraging good practice and accountability.
- EQUINOX can use this Code when designing trial and BaU services.

Key elements of the Code of Conduct

Sales and marketing: sales materials must be accurate. Sales reps must behave with honestly and integrity.

Ethical conduct: Providers must ensure that their products are as inclusive as possible and that vulnerable customers are accounted for.

Complaints: Complaints and Dispute Resolution Mechanism must be clear to customers.

Customer contracts: Contract must clearly state benefits, risks, liabilities, expectations and obligations associated with the service being provided.

Cyber security/ safety: Providers must adhere to best data protection practices and ensure any asset installations are safe & professional.

28: NeatHeat

1 Customer Offering
2 Flexibility Impact
3 Recruitment
4 Customer Preference
5 Engagement Strategy
6 Trial Design
7 Market Design

Project Overview

Description	• Test how tepeo's innovative Zero Emission Boiler (ZEB) interacts with the electricity network, allowing DNOs to use existing infrastructure in a smarter way and suppliers to develop new offerings which reduce customer costs More info
Project Dates	September 2022 – February 2024
Project Partners	UK Power Networks, OVO energy, tepeo

Learnings for EQUINOX and heat decarbonisation

- When gauging project eligibility, the project team discovered that customer understanding of their existing heating systems is limited (e.g., is it conventional or combi?). The team switched to asking simply whether they have a hot water tank during first-stage eligibility as this is more widely known.
- For trials with specific eligibility criteria, a targeted campaign would reduce the number of unsuitable candidates signing up to the trial and reduce time spent removing ineligible customers from the recruitment pot.
- Learnings from testing of the 'type-of-use-Tariff' could feed into EQUINOX's commercial arrangement design.
- The project will test whether the ZEB would only ever have to operate off-peak to charge its internal storage system which could then heat the space.

Project Methodology

- Installed tepeo's ZEB in 8+ households for free, replacing current heating system, assessing compatibility and the challenges that arise.
- Monitored ZEB performance throughout the trial to understand the charging pattern and test various optimisation mechanisms that will provide flexibility to the network.
- Engaged with participants throughout the process to gather feedback and understand customer needs.
- Tested first of its kind 'Type-of-use-Tariff' that allows customers to use clean heat at a lower cost.

More about ZEBs

- ZEBs provide the same heating service as gas or oil boilers without the associated emissions.
- They work like a battery to store heat efficiently, charging at the cheapest and greenest times of the day.
- ZEBs could be particularly useful in space-constrained housing archetypes which might struggle with heat pump installations.
- 'Type-of-Use-Tariff' removes burden off customers when it comes to heating their home. Energy supplier can work with the DSO to optimise ZEB charging.

29: ReHeat

1 Customer Offering
2 Flexibility Impact
3 Recruitment
4 Customer Preference
5 Engagement Strategy
6 Trial Design
7 Market Design

Project Overview

Description	• Trial network solutions to mitigate the effects of increased demand from domestic electrical heating on the distribution network, with a focus on the transition to electric heating in off-gas grid More info
Project Dates	June 2021 – October 2024
Project Partners	SP ENERGY NETWORKS; Scottish & Southern Electricity Networks; e·on

Learnings for EQUINOX and heat decarbonisation

- High dropout rate during customer journey from initial expression of interest through to signing of final contract. Reasons include eligibility for local authority funding and property suitability (e.g., insufficient space for heat batteries).
- DLC is expected to play a greater role in heat pump demand response. ReHeat's platform will play an important role in understanding how DLC can be leveraged to optimise heat pump flexibility.

Project Methodology

- Developed network planning tools; now progressed to testing phase.
- Installed 30+ smart controls and thermal storage systems.
- Developed direct load control (DLC) platform to prototype stage, ready to be trialled with the Home Energy Management System (HEMS.
- Installed heat pumps and thermal batteries in several pilot homes. 600 customers have expressed interest to E.on to date.
- Continued developing DNO network modelling capabilities on the NAVI platform. API developed to facilitate monitoring and load control between the DNO and DLC.

Objectives

- Facilitate the deployment of low carbon electrified heating by avoiding delays and costs created by the need for network reinforcement
- Develop DSO tools for assessing the network impact of heat load and for evaluating alternative solutions
- Assess the effectiveness and reliability of PCM thermal storage as flexibility to the network and on customer acceptance, comfort, and satisfaction through trials
- Evaluate the technical and commercial models used in the trial to understand their effectiveness and costs/benefits compared to conventional reinforcement

33: HeatFlex UK

1 Customer Offering
2 Flexibility Impact
3 Recruitment
4 Customer Preference
5 Engagement Strategy
6 Trial Design
7 Market Design

Project Overview

Description	• Improve understanding of potential of heat pumps as a flexibility asset and the circumstances in which households would want to participate in heat flexibility events More info; More info
Project Dates	September 2022 – June 2023
Project Partners	Centre for Net Zero Powered by Octopus Energy; nesta

Project Methodology

- Ran pilot in 2022/23 remotely controlling household heat pumps via smart thermostat. Tracked whether peak electricity demand shifted and whether households remained in thermal comfort.
- Ran 20 events, including pre-heating. Participants completed surveys after each event. CNZ also conducted interviews.
- Now running large scale randomised control trial for winter 2023/24. Examining how remote control impact varies by household and property characteristics.

Learnings for EQUINOX and heat decarbonisation

- Installing physical devices into participant homes as part of a trial can be challenging. The smart thermostat being used does not work in every home. Some brands of heat pump are not compatible with it. For HeatFlex, this meant a smaller and less representative sample than hoped.
- Nesta used home floorplans as a way of personalising interviews, offering insights about insulation levels throughout the home, placement of the smart thermostat and household behaviour which may not have been collected otherwise.
- Electricity consumption could be moved to other times of day in a way that participants found acceptable.
- 9 out of 10 found automation of their heating acceptable.
- Days with events appeared to have similar overall electricity consumption as days without events.
- Most temperatures that participants self-reported at the end of the pre-heating window were greater than their normal thermostat setpoints. This suggests broadly that pre-heating worked.
- Some participants changed behaviour to maintain thermal comfort, such as wearing additional clothing or using additional heating sources such as a log burner.
- These findings closely track the findings from EQUINOX trials.

34: COMMANDER

Project Overview

Description	• Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources • Considering ways to improve coordination between DSOs and ESO by developing a roadmap of coordination scenarios for flexibility services
Project Dates	Still in Development
Project Partners	nationalgridESO, Electricity Distribution, WSP

Learnings for EQUINOX and heat decarbonisation

- Innovation projects tackling complex subjects like this need clarity at the start of the project and adaptable project partners representing multiple viewpoints.
- A greater understanding of future ESO/DSO coordination schemes and how they could potentially be applicable to the GB system could help develop stacking of flexibility solutions.

Project Challenge

- There is uncertainty around DSO and ESO roles and responsibilities in the rapidly developing, smart, more flexible electricity system.
- The roadmap developed in COMMANER will include clearly defined ESO/DSO roles and responsibilities and potential coordination options for accessing and managing the services of distributed energy resources (DERs) connected to the distribution networks.

Potential Benefits

- Existing ESO Regional Development Programmes (RDP) will deliver whole system benefits using a trial by doing approach.
- Commander seeks to accelerate work to understand how these concepts can be scaled through future RDP functionality across broader range of ESO and DSO activities.
- This project should unlock a series of tangible options that could be deployed across various BAU processes and activities to further enhance coordination.

Electricity Distribution

A2

Abbreviations

nationalgrid Guidehouse

List of abbreviations

Abbreviation	Means
BaU	Business as Usual
BEIS	Department for Business, Energy and Industrial Strategy
CMZ	Constraint Managed Zone
CPP	Critical Peak Pricing
DFS	Demand Flexibility Service
DLC	Direct Load Control
DNO	Distribution Network Operator
DSO	Distribution System Operator
DSR	Demand Side Response
ENA	Energy Networks Association
ESO	Electricity System Operator

Abbreviation	Means
EV	Electric Vehicle
HP	Heat Pump
LCT	Low Carbon Technology
OFGEM	Office of Gas and Electricity Markets
PV	Photovoltaic
REMA	Review of Electricity Market Arrangements
RT	Real Time
SIF	Strategic Innovation Fund
SLES	Smart Local Energy Systems
ToU	Time of Use
V2G	Vehicle to grid

nationalgrid