Electricity Distribution

EQUINOX Horizon Scan

Tracking relevant developments and learnings from previous/ongoing projects, initiatives, and policies
Q3 2023.

nationalgrid

Guidehouse

Version Control

Version Number	Last Edited/Reviewed By	Version Dated	Next revision
v1.0	Rohit Thota, Callum Coghlan, Alex Jakeman	6/10/23	
v1.1	Nina C. Harrington	12/10/23	
v1.2	Rohit Thota, Callum Coghlan	13/10/23	

Horizon Scan Contents

Electricity Distribution

1

Introduction

Document purpose, contents, scope, and usage.

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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 (40 in this iteration) and countries (7 in this iteration) covered.
- Collated and themed summary of the most relevant key learnings for EQUINOX.
- Project deep dives for more information.

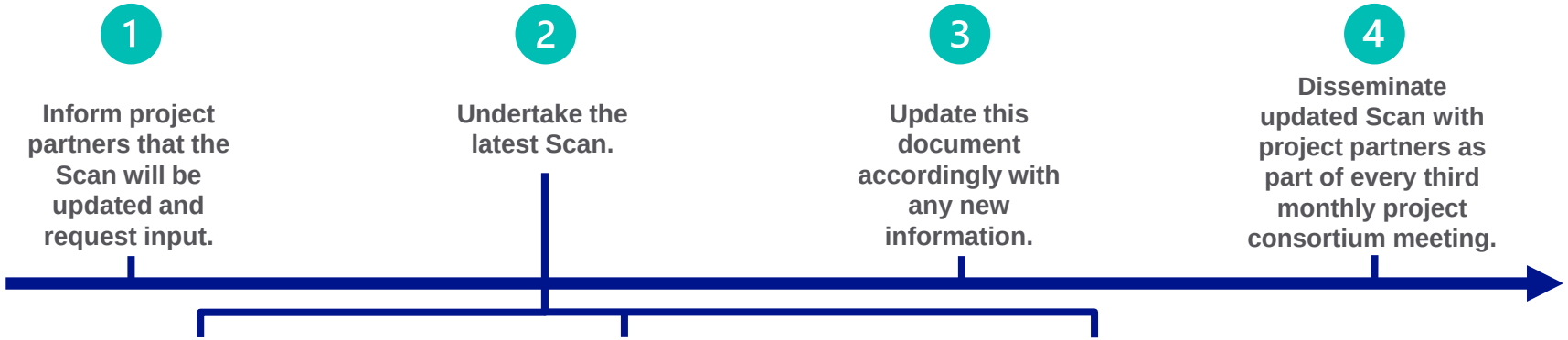
UK policy, regulation, strategy, and markets.

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 every three months 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 Flexibility Strategy and Targets.

- Vision/high-level targets.
- Existing arrangements.
- Forecast capacity.
- New BaU offerings.

Relevance for EQUINOX
EQUINOX must align with UK high level strategy.

2 Heat Pump/Smart Meter Policy and Regulation.

- Historic/targeted rates of installation, rollout strategy.
- Targeted installation rates.

Relevance for EQUINOX
Project must react based on regulation for and pace of heat pump/smart meter rollout.

3 Energy Bill Policy and Regulation.

- Price cap forecasts.
- Current and proposed support packages for bills.

Relevance for EQUINOX
Trial design and incentives must reflect the current and future energy costs landscape.

4 Potential Future Electricity Market Arrangements.

- Related to structure of flexibility markets.
- Related to functioning of flexibility markets.

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

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Innovation Projects

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

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Horizon Scan Coverage: Innovation projects from the UK and abroad

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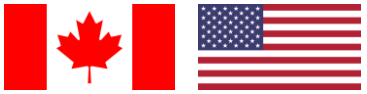
Projects found via:

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 flex.

Key learnings from 40 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

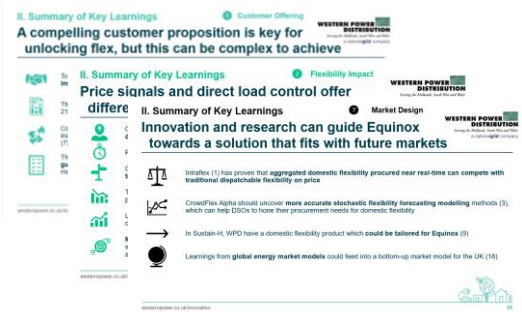
Trial Design

How to design and analyse the trials being undertaken.

7

Market Design

How to ensure EQUINOX is ready for BaU.



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).

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** (project 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), though specific potential for UK heat pumps **remains unclear** (2). Turn down can induce increases elsewhere (4, 26).

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 will aid understanding 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) – could EQUINOX find a similar relation between heating flexibility and more general heat pump concerns?

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), though this is expected to change over time as costs fall.

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 paying more (13).

One trial allows customers to **block times** for which they would not like to have their heat pump remotely controlled (25).

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 (2).

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 Germany (24, 25 on project list), Canada (21, 22), and USA (23) all offer **slightly varied trial designs** from which EQUINOX can cherry-pick.

Optimum event time for customers is a **maximum of two hours** (2, 6, 24), although other trials were 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).

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 should uncover **more accurate stochastic flexibility forecasting modelling** methods (3), which can help DSOs to hone their procurement needs for domestic flexibility.

In Sustain-H, NGED have a domestic flexibility product 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 different system operator flexibility services in the UK.

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

Projects for key learnings 1/5[1]

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]

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]

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]

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 – June 2023
34. Commander		nationalgridESO	Method for coordinating stackability and primacy for ESO/DSO flexibility.	✓			TBC

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

Projects for key learnings 5/5

Project	Country	Lead	Description	Domestic flexibility	Trials at scale	Low carbon heat	Project dates
35. Net Zero Terrace		electricity north west	Explore how to decarbonise a terraced street using a network-integrated smart local energy system.	✓		✓	Apr 2023 – June 2023
36. Community DSO (NIA Project)		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 the electricity infrastructure as we move towards a more distributed and flexible network.	✓	✓		Jan 2018 – Sep 2023
38. Fusion		SP ENERGY NETWORKS	Trial of local demand-side flexibility 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

Electricity Distribution

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Policy, Strategy, Markets, and Regulation

Relevant policy and market designs, and reviews relevant to EQUINOX.

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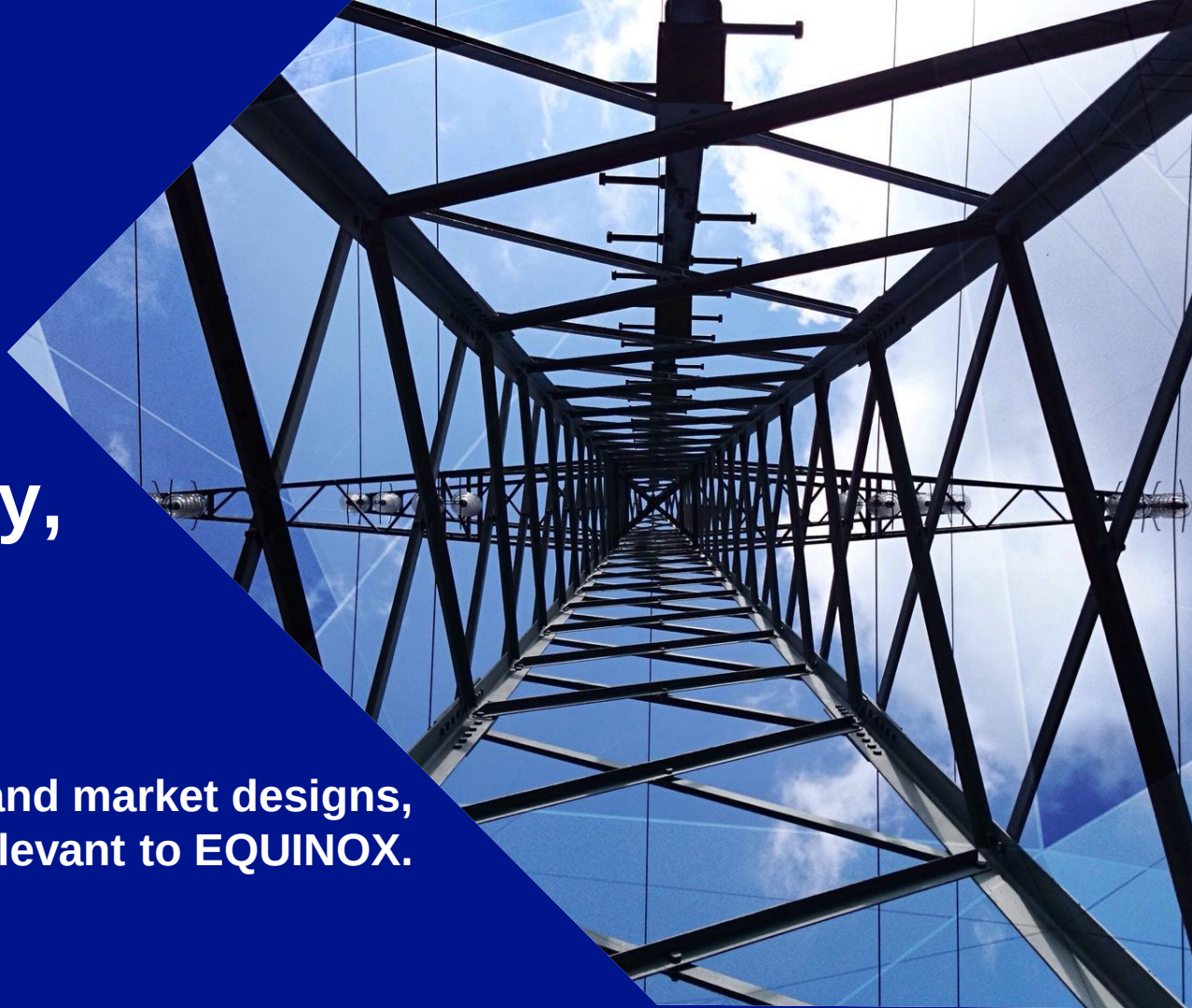


Horizon Scan Coverage: UK policy, regulation, strategy, and markets

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

1	2	3	4
Flexibility Strategy and Targets.	**Heat Pump/Smart Meter Policy and Regulation.**	**Energy Bill Policy and Regulation.**	**Potential Future Electricity Market Arrangements.**
• Vision/high-level targets • Existing arrangements • Forecast capacity • New BaU offerings	• Historic/targeted rates of installation, rollout strategy • Current and suggested policies and regulations	• Price cap forecasts • Current and proposed support packages for bills	• Related to structure of flexibility markets • Related to functioning of flexibility markets
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.

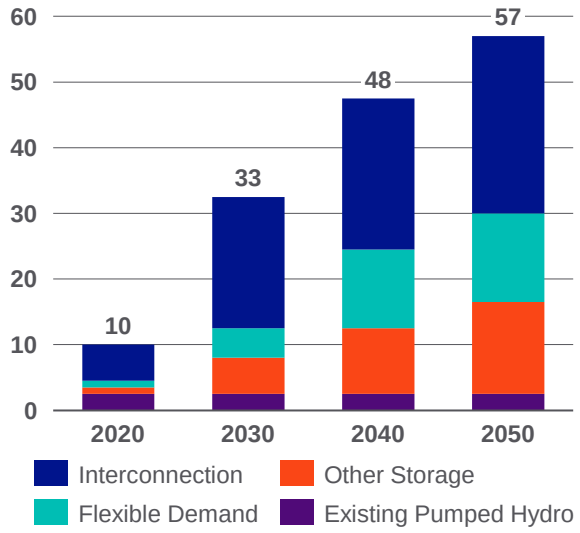
Major sources include: Department for Business, Energy & Industrial Strategy; ofgem; Climate Change Committee; nationalgridESO; ena energynetworks association

An overview of UK policy, regulation, strategy, and market reform relevant to EQUINOX

Sub-Section	1 Flexibility build-out	2 Technology strategy	3 Approach to energy bills	4 Future flexibility market
Horizon Scan Goal	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.
What is covered in this version?	• Vision and targets. • Historic and forecast capacity. • BaU products like Demand Flexibility Service.	• Historic and targeted. installation rates for smart meters/heat pumps. • Current/recommended policies and regulations. • Wider industry efforts to expand low carbon heat.	• Price cap forecasts. • Government support packages for bills. • Proposed Ofgem regs for vulnerable customers.	• Heat Pump Experts Workshop recommendations. • REMA consultation & ENA Open Networks recommendations. • National Grid ESO suite of products and recommendations.
Main Sources	Ofgem	UK Govt, CCC, Ofgem	Ofgem, UK Govt	UK Govt, ENA, NG ESO

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

Forecast growth of UK flexibility capacity (GW).



Source: Ofgem

Interconnection is expected to be the major source of flexibility capacity, but **flexible demand continues to grow 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 sources of value (where this enables whole system optimisation).

Flexibility is preferred to new network build and renewables curtailment, and is expected to play a bigger role in securing supply through participation in the Capacity Market.

There should be stronger investment signals for flexibility, such as changes to Contracts for Difference to balance system needs with large-scale deployment of low-carbon generation.

Carbon reporting and monitoring should be BaU, with the carbon intensity of flexibility markets compatible with net zero targets.

Ofgem's vision also contains ideals for growing flexible demand from household consumers

Regulation should be in place to enable **all consumers to provide system flexibility**, regardless of the size of their contribution, leading to a mature market for aggregated **consumer flexibility.**

Innovative product selection, **rewarded participation for demand side response**, and smart tech should be incorporated across **all government policies** relevant to energy efficiency, heating, and fuel poverty.

Smart meter penetration should be **near-100%** for smaller scale consumers.

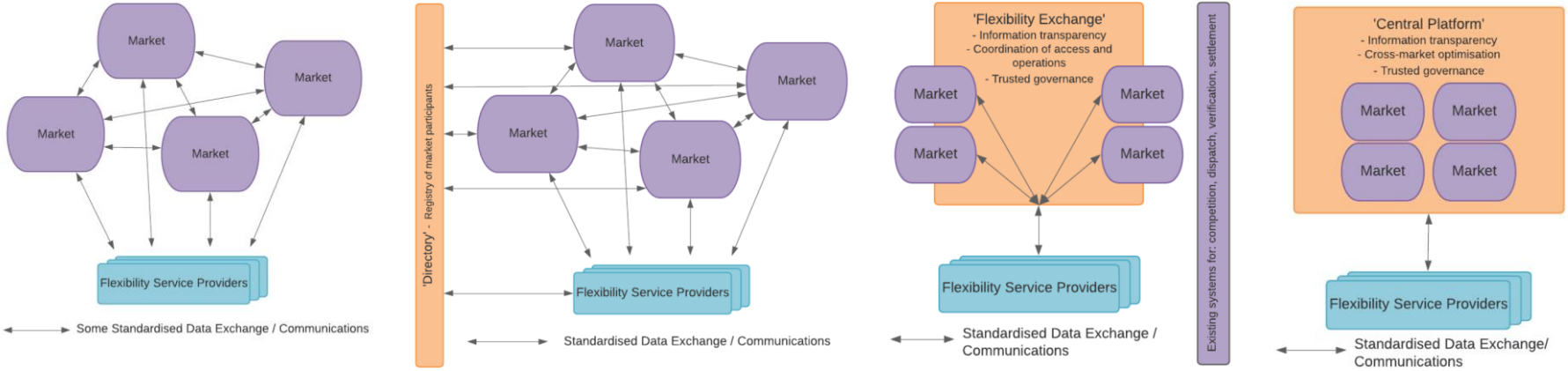
Market-wide half-hourly settlement by October 2025 to incentivise energy suppliers to develop new tariffs encouraging consumers to **shift consumption** to when clean electricity is plentiful (and hence lower their costs).

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 is expected to 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. Section 3.IV of this document details potential future flexibility market set-ups which could be actualised by the SCR.

Ofgem's Future of Distributed Flexibility consultation 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-focused innovation projects.

DSOs procure four standard flexibility products, but there is a lack of standardisation in parameters across DSOs

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.

National Grid ESO's Demand Flexibility Service is back for winter 2023/24[1] with significant updates in 5 broad areas

Demand Flexibility Service (DFS) will continue 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.

Procurement

- Added within-day dispatch options as an alternative to day-ahead, bringing DFS closer to real-time dispatch.

Delivery and Process

- Removed the domestic in-day baseline adjustment to mitigate peverse incentives
- Allowing opt-out (net reduction settled) as well as opt-in (only positive reduction settled).

Tests

- Replaced 'onboarding' and 'regular' tests with 'DFS tests' for all providers on the same day.
- (GAP) of £3000MWh/£3kWh for at least 6 of the 12 tests. No GAP for live uses of the service, with the ESO set to take the lowest available bids to manage the networks.

Automation

- MPAN duplication.
- Introducing automation option for bid submission.

Participation

- Allowing asset metering in place of boundary metering, where certain criteria and conditions are met.
- Requiring HH-settlement for all meters except providers participating on a domestic boundary meter.

RELEVANCE TO EQUINOX

- The DFS will be running parallel to the second EQUINOX trial this winter, so the success of these new DFS design elements can be tracked and compared to the design of trial two.

[1] National Grid ESO

National Grid ESO's Demand Flexibility Service cut more than 3.3GWh of peak electricity use in winter 2022/23[1]

Demand Flexibility Service (DFS) developed to allow ESO to access additional flexibility when national demand is at its highest. Over winter 2022, this service has demonstrated the interest of UK consumers and businesses in playing a more active role in balancing the country's energy needs.

Requirements for participation

- Assets must have half-hourly (HH) metering
- Respond for a minimum of 30 minutes
- Aggregated unit size 1 MW to 100 MW
- 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.

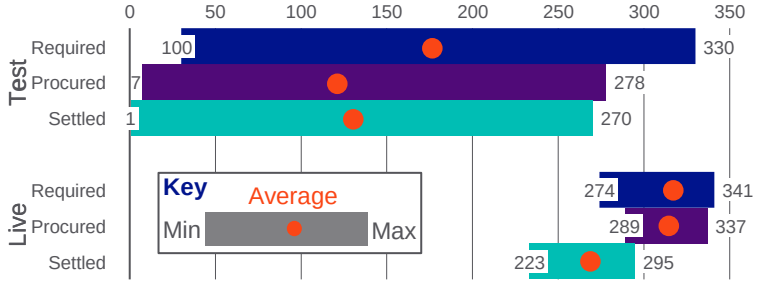
Basic service details

- 18 test events from November 2022 to March 2023.
- Two live events (23rd, 24th January).
- Tender submissions are Pay as Bid.
- Guaranteed Acceptance Price set at £3,000/MWh.

19 Domestic Providers, incl.[2]

octopus energy, myenergi, loop, SMS, EDF, e.on next, ovo energy, utilita, Shell ENERGY, British Gas, ev energy

Half hourly DFS volumes (MW) for 18 test and 2 live events.[3]



Settlement volumes were generally lower than those procured.

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] Current; [2] National Grid ESO; [3] ESO Data

Average household earnings from participating in flexibility trials during winter 2022/23 varied

Saving Sessions by Octopus Energy

- Octopus customers **collectively shifted 1.86 GWh of electricity demand** throughout 13 Saving Sessions last winter.
- **Projected savings** for customers who participated in 12 Saving Sessions and saved 1 kWh on average per session was **£36.**
- **£5.3 million was paid in total** to customers, with the top 5% of participants **saving an average of £41.24** over the winter.

Power Move by OVO Energy

- Ovo customers **collectively shifted 164,179 KWh of electricity demand** out of peak times last winter.
- Customers were encouraged to reduce their electricity use to **less than 12.5%** during peak teams.
- Customers were paid **£20 a month**, which amounted to **£100** by the end of the winter.

Peak Save by British Gas

- British Gas customers **collectively shifted 147 MWh of energy demand** last winter.
- **Over 200,000 customers** signed up, and 98% of those surveyed said they would take part again.
- **£1.8 million was paid in total** to customers, with an **average of £28.56** saved per customer including a triple payment for participation in the final event.

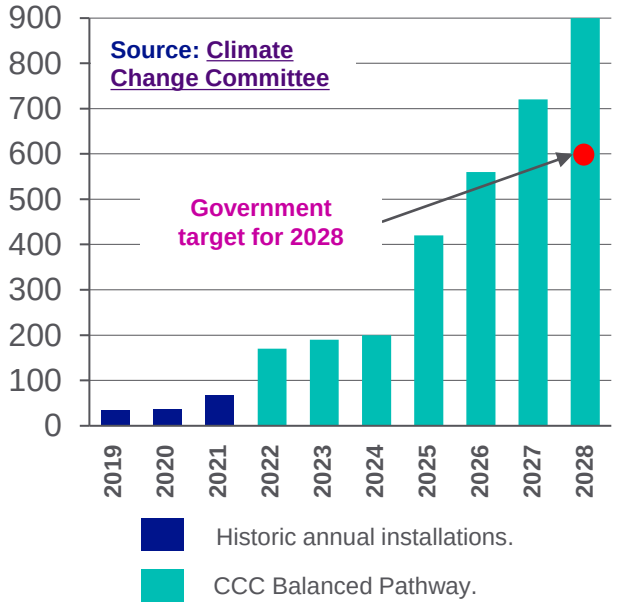
RELEVANCE TO EQUINOX

- Understanding what customers were paid for participating in flexibility trials over the winter helps calibrate the EQUINOX commercial arrangements.

Saving Sessions; Power Move, British Gas

UK Heat Pump (HP) Roll-Out: slow progress towards an ambitious 600k/year 2028 goal

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



The UK is **well behind** in its current rollout – 4.12 installations per 1,000 households in 2023 compared to 30.68 in the EU. 15.3 is the required rate.

Factors inhibiting rollout include: **high upfront/operating costs**, **lack of engineers**, efficiency concerns, manufacturers **not pushing HPs enough.**

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

£450m Boiler Upgrade Scheme provides **£5,000** towards new ASHP, or **£6,000** towards GSHP. To be increased to **£7,500** from 23 October 2023.

CCC's key recommendations are to **rebalance gas and electricity prices** to ensure HPs are **cheaper to operate** than gas boilers, and for BEIS to publish its plans for a **market-based mechanism** for HP growth, which should include **obligations on manufacturers** to produce an increasing proportion of HPs.

RELEVANCE TO EQUINOX

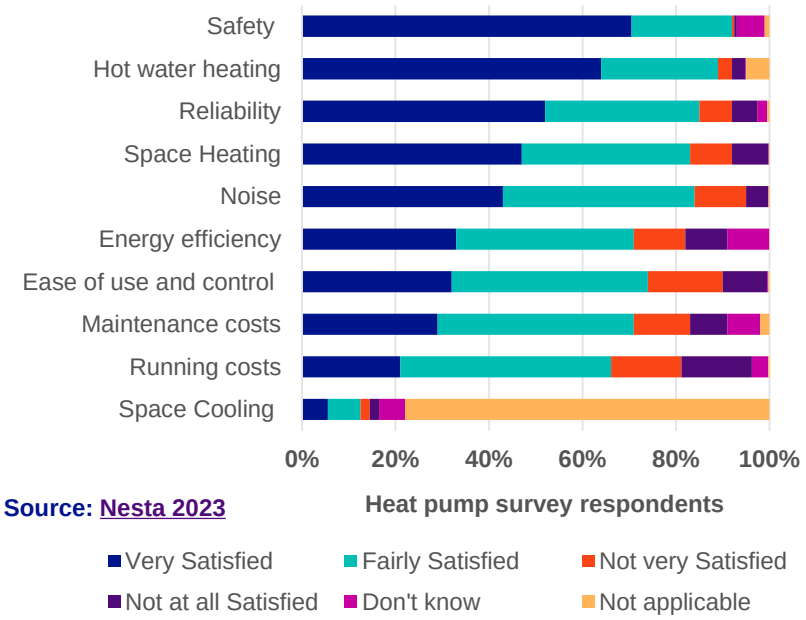
- Project will need to track rollout progress to understand how quickly recruitment pool is expanding, for both the winter trials and the BaU product.
- Need to ensure that the project is not left behind should the rollout accelerate.

UK Boiler Upgrade Scheme (BUS) offers generous grants compared to most European peers, bar France & Germany

	**£5000** off GSHP, **£6000** off ASHP. To be raised to **£7500** from 23 October 2023 until 2028.
	Up to **€4000** in grants and 40%-60% of the costs are tax deductible.
	Up to **€15000** in grants for GSHP, up to **€9000** for ASHP until 2024.
	Up to **€18,000** for GSHP and up to **€15,000** for ASHP until 2030.
	**€3,500** for air-to-air heat pumps for all house types, **€4,500** for air-to-water and ground-source heat pumps in apartments. **€6,500** for other house types.
	Grants up to **€3,750** for ASHP, **€5,100** for GSHP, and **€3,000** for hybrid heat pumps.
	**€1,000** for GSHP only.
	Grants of up to **€1,600** for ASGP and domestic hot water heat pumps when combined with a PV system and storage.

2023 Nesta survey findings reveal heat pump consumer satisfaction is on par with gas boiler satisfaction

Level of satisfaction with various heat pump attributes.[1]



Source: Nesta 2023

>70% of respondents were either 'very satisfied' or 'fairly satisfied' with 8 of the 10 heat pump operational attributes.

- Key winners were **safety** (92%), **hot water heating capabilities** (89%), **reliability** (85%), and **space heating capabilities** (83%).

73% of users reported the same (14%) or higher (59%) levels of satisfaction with their heat pump compared to their previous heating system.

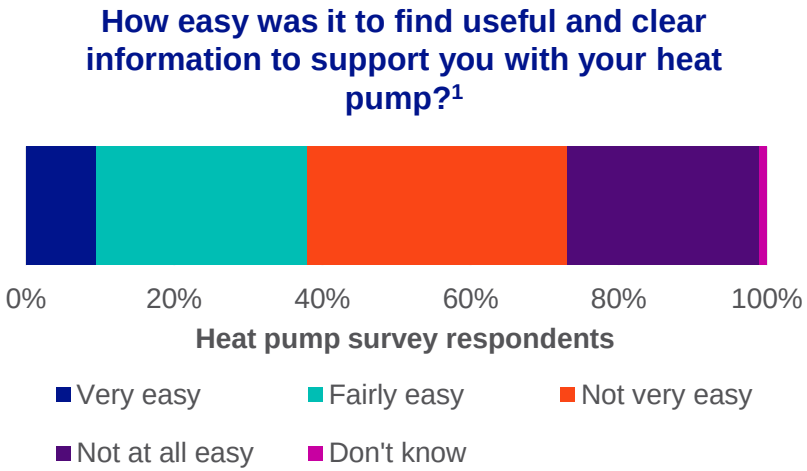
- Groups reporting significantly higher satisfaction were **ground source heat pump users**, users who **chose to install within an existing property**, and **Scottish users.**
- No significant variation in satisfaction across property age ranges.

Of respondents who installed a heat pump in their own home, 85% made planned installations, compared with only 51% of gas boiler users.

- Key information sources when deciding whether to install included **discussions with manufacturers/installers** (70%), **government websites** (45%), and **existing knowledge** (44%).

[1] This graph is a recreation of a figure included within Nesta's heat pump user survey. However, as Nesta does not include raw data within its report, this graph is merely a visual placeholder for illustrative purposes only

However, the Nesta survey also found that installation and a lack of information on operation remain key challenges



Source: Nesta 2023

Installation is lengthy and issues are common:

- The modal time for heat pump installation was **one to two months** after agreeing to the installation – this compares with less than one month for gas boilers.
- Only 37% of heat pump users encountered **no problems during installation**, compared with 76% of gas boiler users. The most common issues were **disruption to homes and/or gardens** (36%), **time delays** (19%), and **incorrect control set-up** (17%).
- "Heat pumps are only as good as the people designing and installing the system. There needs to be **more detailed training and accreditation for installers** to enable the best efficiency and uses of these systems." – Heat Pump user, England 2022.

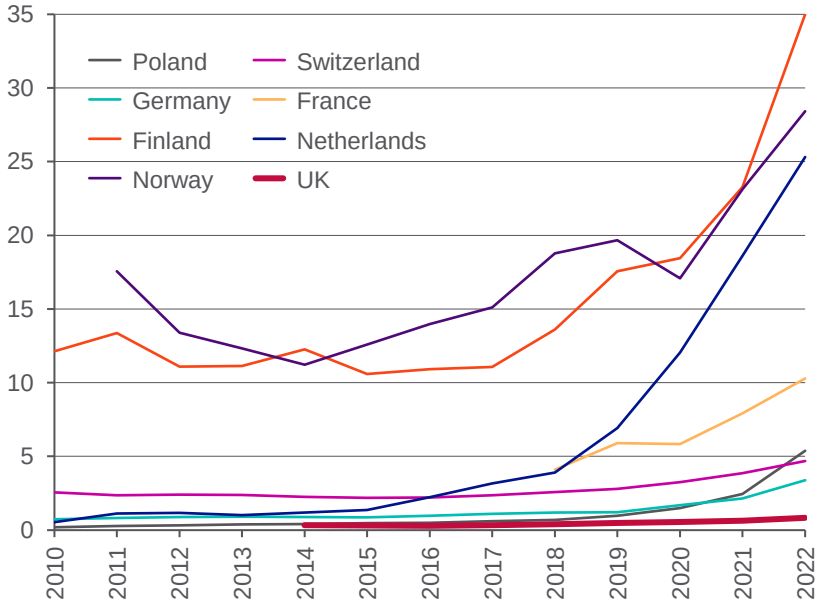
Accessible and clear information on Heat Pumps is lacking:

- 44% of heat pump 'inheritors' **received no advice on how to use their heat pump** when moving into a property.
- Only 37% of heat pump inheritors found it **easy to identify useful and clear information** to support them with their heat pump.
- The **two foremost sources of information were both verbal,** namely 'discussion with the heat pump manufacturer/installer' (53%) and 'previous property owners' (28%)
- "Our air source heat pump came with an **instruction manual that was only one page long** and it's really hard to get your head around." – Heat Pump user, England 2022.

[1] This graph is a recreation of a figure included within Nesta's heat pump user survey. However, as Nesta does not include raw data within its report, this graph is merely a visual placeholder for illustrative purposes only.

Whilst other European roll-outs hit the accelerator, multiple factors are holding the UK back

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 flexibility 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 (Q2 2023)

New training academy for upskilling heat pump installers.

There is currently a **lack of qualified UK heat pump installers** (4,000 vs 100,000 for gas boilers).

This partnership between three companies comprises a **range of BPEC and Daikin accredited courses**. Once qualified, installers can continue to access support from the partners.

British Gas offers 'lowest price guarantee' for heat pumps.

The company will **match any price** offered by another company for a MCS credited installation.

Prices start at £3k for a standard ASHP.

The scheme was influenced by its Gas Net Zero Index finding that **only 14% of homeowners would replace their existing boiler with a heat pump.**

Scheme enables mortgage borrowing to finance HP installation.

Halifax **mortgage borrowers** can install a heat pump through Octopus Energy's service for **as little as £2k** (vs £8k via the Boiler Upgrade Scheme).

Octopus' cheapest install price is £3k, with customers eligible to earn £1k back through the **Lloyds Green Living Reward.**

'Heat pump talk' guide to assist installers with customers.

Energy Systems Catapult have released a guide to **facilitate effective conversations between customers and installers throughout the heat pump installation process.**

Installers are guided on how to answer **typical consumer questions** and respond in **simple language**. The guide was informed by discussions with '**Electrification of Heat**' project participants and installers **about their installation experiences.**

New partnerships and incentives intended to accelerate the heat pump roll out (Q3 2023)

New low-carbon heating trainee scheme.

There is currently a **lack of qualified UK heat pump installers** (3,000 vs 130,000 for gas boilers).

Samsung will provide training, support, and product awareness to trainees over the course of two years. Participants will learn to install low carbon heating solutions, drawing on electrical, plumbing, technical, design, software, sales, and customer service skills.

Govt-proposed measures to simplify heat pump installations.

60-70% of heat pump owners are happy with the technology, yet only 22% of BUS vouchers have been issued as of August 2023.

Proposed measures could see varying levels of grants made available in accordance with a customer's property type or existing fuel source, making heat pumps affordable to more households and small businesses.

Ovo cuts heat pump costs and partners with Heat Geek.

Ovo has launched Heat Pump Plus – cutting running costs by 50% to just 15p/kWh in partnership with HeatGreek, making it cheaper than a gas boiler.

Ovo research reveals 45% of population would install a heat pump if running costs were 40% cheaper than current rates – 12.7 million homes, surpassing the government's targets.

Octopus Energy announces launch of its Cosy 6 heat pump.

First heating eco-system which integrates heat pump, controls, and room sensors.

Utilises the Kraken platform to offer the best performance at the cheapest and greenest times, allowing customers to save money on heating bills.

Heat Pump Ready programme has allocated £15m to 24 projects aiming to reduce installation costs & challenges

Heat Pump Ready programme is a £60m **UK government initiative** to support the target of 600,000 heat pumps installed per year from 2028.

£15m has been allocated to 37 SMEs for **24 projects** across stream 2 of the programme – projects focused on **reducing costs and alleviating current difficulties holding back heat pumps installs.**

Three main project types are:

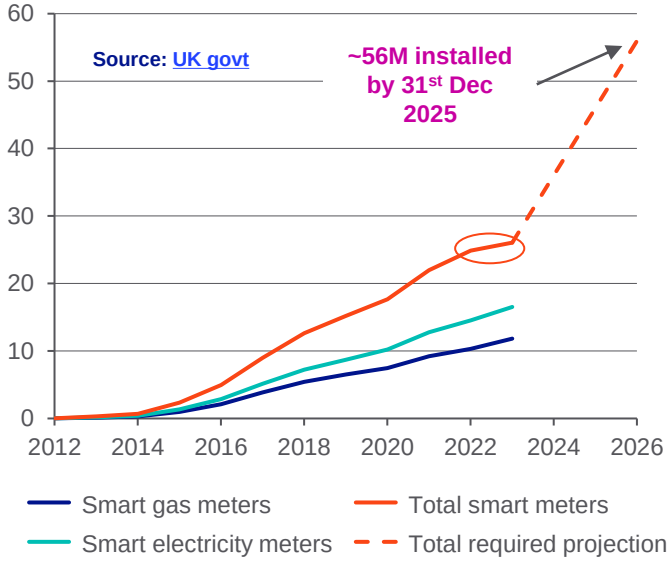
- Digital customer-facing solutions for sizing and/or install.
- New commercial offerings combining installations with other services.
- Improving heat pump efficiency.

Selected group of stream 2 projects which have received funding

Project Title	Lead org.	Description
Catalyst – Accelerating the heat pump journey.	EDF	Simplify heat pump installation process through a customer-centric digital platform to support customers through the whole installation.
Advanced Modelling for Heat as a Service.	CITY SCIENCE	Provide scalable approach to heat pump financing and deployment through prototyping, deploying, and testing Heat-as-a-Service solutions.
Integrated Comfort and Billing Service.	energie sprong	Develop and test offering combining retrofit and heat pump install as a fee-based 'Comfort Plan'.
Guru Smart Heat Pumps.	guru	Developing tools for social housing landlords to enable heat pump installation at scale across the UK.
Highly Flexible Storage Heat Pump (HFSHP).	Kensa Group	Combine electrically-driven heat pumps with heat storing batteries to shift heat production from peak demand times.
Free Heat Pump Home Survey & Design Tool.	q-bot	Tool to help consumers confidently match heat pump to thermal demand of the house on a case-by-case basis.
Archetypal Heat Pump Retrofit for Non-Trads.	R.J. BARWICK	Develop optimum standardised whole house retrofit solutions for four of the most challenging and/or common non-traditional home archetypes across 175,000 sites in West Kent.
Intelligent airsourcing to net zero.	wondrwall	Reduce running costs and improve user acceptance by optimising energy management via AI-based advanced time-shifting strategies.

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).



Ofgem's target for suppliers is to install a smart meter in **every domestic property by the end of 2025.**

Since January 2022, all suppliers have had **binding annual installation targets** through to 2025.

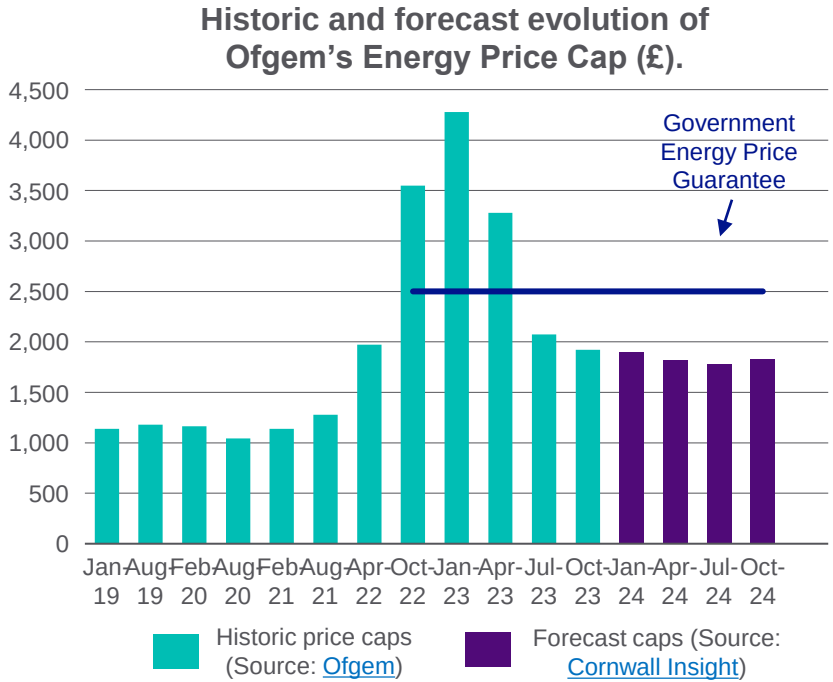
Targets will be **reset annually** based on the proportion of a supplier's customer base **still with a non-smart meter.**

Decrease in pace of installations of smart meters – 7% down from last quarter and 4% down YTD – poses threat to 2025 target.

RELEVANCE TO EQUINOX

- Project close, and thus recommendations for BaU 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 serivce.

Ofgem's price cap remains quarterly, aiming to pass lower wholesale prices to consumers as soon as possible



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 had been **reviewed** every **six months**, but shifted in 2022 to **quarterly** to enable the cap to respond quicker to changes in wholesale prices.

Maximum prices are set by the lower of the Energy Price Guarantee (EPG) and the price cap, so if Ofgem sets a price cap that is above the EPG, consumer prices will not fall.

July 2023 marked the first time the price cap is below the Energy Price Guarantee – this is forecast to continue throughout 2024.

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.

Announced UK government support measures for energy bills in winter 2023/24

Energy Price Guarantee: Automatic limit on amount consumers can be charged per unit of gas or electricity. Will remain in place as a safety net should energy prices increase above £3000 per year. Currently, Ofgem price cap is lower than Energy Price Guarantee level.

Energy Bills Discount Scheme: Offers a **discount on non-domestic gas and electricity unit rates** above a minimum threshold.

Cost of living payment: One-off £650 payment for households on **means tested benefits, paid in two lump sums of ~£325.**

Pensioner cost of living payment: Households entitled to winter fuel payments get an extra £150 - £300 alongside their usual winter fuel payments from November 2023.

Disability Cost of Living Payment: A one-off **£150** will be paid to anyone in receipt of various benefits for disabled people and veterans, such as attendance allowance and disability living allowance.

Winter fuel payment: £150-300 available to people born before the 25/9/1956. Exact amount depends on various factors including age, marital status, living situation, etc.

RELEVANCE TO EQUINOX

- Understanding how much assistance UK billpayers will be receiving through government support will help to pitch the incentive amounts for EQUINOX participants.

Heat Pump flexibility is expected to become widespread and highly automated, as per a multi-stakeholder workshop

Heat pump manufacturers, electricity DNO and TSOs, energy suppliers, trade associations, government, consultancy, and academia representatives attempted to define the role heat pumps will play in providing flexibility in a decarbonized electricity system by 2035 in a workshop hosted by CREDS and Net Zero Research Network. More info.

Key use cases for heat pump flexibility (HPF)	• Balancing supply and demand on a several-hourly basis. • Closer-to-real-time electricity network balancing.
HPF coverage by 2035	• Widespread participation: 50-90% of domestic heat pumps. • This could aggregate to several GW depending on heat pump uptake and coincidence of flexibility participation.
HPF characteristics	• Highly automated system that could shift heat pump demand a couple of hours in return for a financial incentive, except at the coldest time of the year.
Accounting for customers	To ensure participation, the system should: • Deliver hot water at the right time. • Ensure participants are comfortable by operating in the background. • Be informed by household's preferences and requirements.
Implications for heat pumps and heating systems	• No significant change in heat pump design. • Changes are envisaged in how heat pumps are run and by whom they are controlled, as well as a need to set up the whole heating system for flexibility.

KEY CONCLUSIONS

- Heat pump flexibility (HPF) will be widespread and highly automated but will be limited by not negatively affecting thermal comfort.
- Electricity prices will be the key HPF driver. Key use cases will be network management & hourly energy arbitrage
- The role of enabling technologies such as thermal stores, equity issues, and level of customer involvement remain up for debate.
- More work is needed to understand how to balance flexibility and efficient operation of heat pumps to ensure they do not become more expensive to run.

Review of Electricity Market Arrangements (REMA) – Overview

What is the purpose of and timeline for REMA?

BEIS 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.

The consultation aimed to narrow down the current plethora of future market options presented.

Closed October 2022, BEIS response published in **March 2023.**

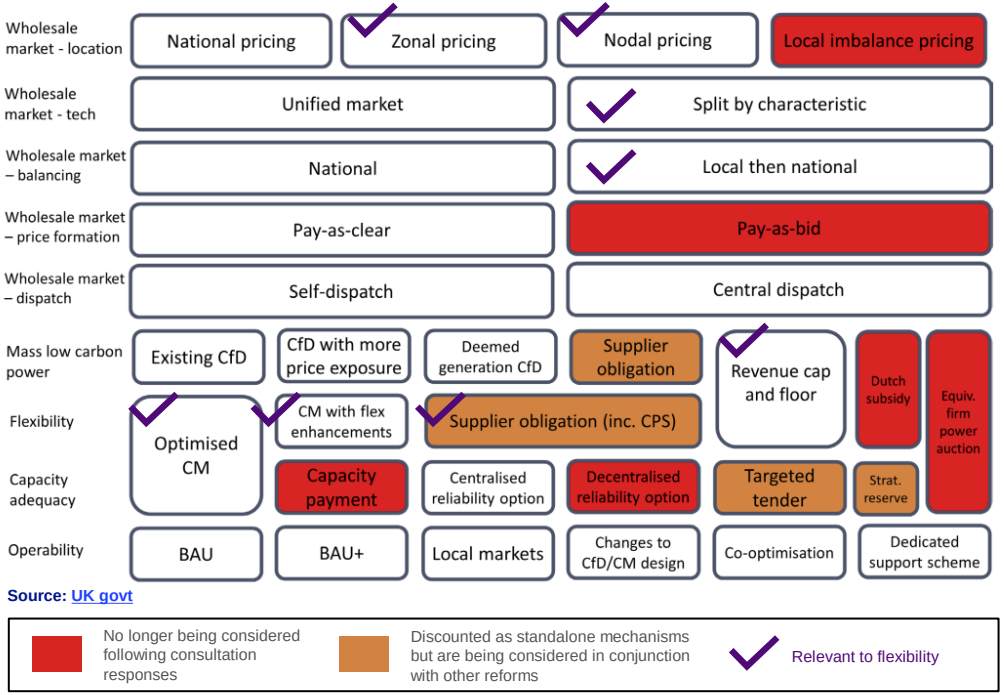
REMA addresses the following challenges seen in the current market set-up

1. **Reliance on support schemes** to drive renewable investment currently **disincentivises** generating plants to **operate more flexibly.**
2. **Lack of investment signals** for low carbon flexibility assets, which will require **more revenue streams** outside Capacity Market to **expand at required pace.**
3. The current single national wholesale price leads to the system **missing the low-price benefits of renewables** due to the marginal pricing method which allows expensive fossil fuels to set the electricity price.
4. **Limited temporal signals** for flexibility which we know will reduce system costs.

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 – Consulted options and government response



- This figure illustrates the **range of options** upon which the consultation aims to gauge views.
- They are **not mutually exclusive** and can be **stacked.**
- Those **relevant to flexibility** are discussed on subsequent slides.

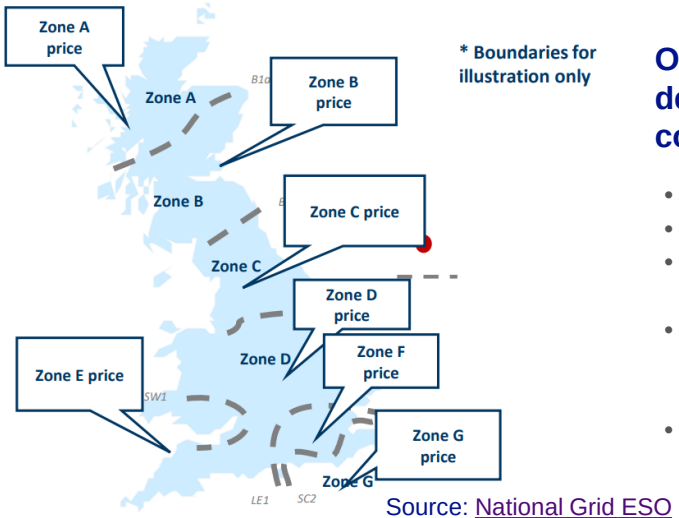
RELEVANCE TO EQUINOX

- At this stage in the consultation process, a high-level understanding of the options 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.

REMA – Zonal/Nodal Wholesale Pricing (1/2)

Problem with national pricing: The wholesale price does not send signals to market participants that incentivise them to operate and locate in a way that is consistent with the physical needs of the system. This leads to operational and balancing issues e.g. increased network constraint costs

Potential solution: Introduce more granular locational signals into wholesale electricity prices



Source: National Grid ESO

Option 1: Zonal Pricing - The network system **is split into clearly defined zones**. The boundaries are defined by **major transmission constraints**

- This is an **established arrangement** in the **internal European energy market**
- Each zone has single price which assumes no network constraints within zone
- Applies on both supply and demand side, but supplier pays for energy at the same price it receives for selling energy within a single zone
- Where the price differs between two zones, the supplier pays difference between price in generation zone and price in supply zone. Cost difference is the cost of network congestion between the two zones
- Market internalises cost of network congestion and losses to some degree

REMA – Zonal/Nodal Wholesale Pricing (2/2)

Source: National grid ESO

Option 2: Nodal pricing - Price in each location in transmission network represents **locational value of energy**. Physical network constraints (capacity, losses) **reflected in market clearing process**

- Implemented in several US states, Ontario, New Zealand, Singapore. Some expose **only supply** to locational prices; **others expose demand too**
- **'Unlikely to be practical to extend nodal pricing to the distribution network**, so it would be important to **ensure coherence between nodal pricing on the transmission network and actions taken locally, such as local flexibility markets**.'
- Would require careful implementation to **safeguard inflexible, vulnerable, and fuel poor consumers** from **disproportionate impacts**
- Fully nodal system: wholesale market itself would resolve network congestion. **Lower compensation payments** to generators leads to consumer savings

RELEVANCE TO EQUINOX

- Locational wholesale prices would provide enhanced price signals to all market participants – could enable greater participation of DSR and distributed energy resources
- Plenty of challenges to overcome: concerns about liquidity and market uncertainty, distributional demand-side impacts, defining zonal boundaries, new IT systems for continuous nodal pricing calcs

There was strong divergence on stakeholder consultation responses to zonal and nodal wholesale pricing (1/2)

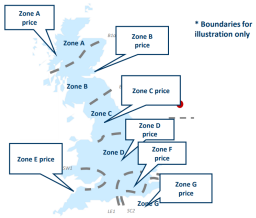
Of the **146 respondents** to the consultation:

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

- Respondents against both felt they would **undermine investor confidence** in renewables, potentially hindering the energy transition and outweighing any potential benefits.
- Identified **less disruptive alternatives**, such as reforming Transmission Network Use of System charges, adding locational signals to the Contracts for Difference scheme, or speeding up transmission network development.
- Some felt **nodal pricing** would be **more likely to result in an investor hiatus** and so only zonal pricing should be considered.

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

- Whilst respondents acknowledged associated challenges, they argued both options should be retained due to significant **benefits to end-consumers** from greater operational efficiency and reduced costs; an **incentivised deployment of renewables**, and **reduction in the complexity of system operation.**



Respondents noted that **zonal pricing**:

- Provides 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.**
- Complex with reduced liquidity.
- Should **transition** from zonal to nodal pricing.

This difference of viewpoint on locational price signals extends beyond the REMA consultation (2/2)

Both Energy Systems Catapult and National Grid ESO have named Nodal Pricing as an attractive solution to reduce consumer costs.

- The current wholesale market pricing is contributing to inefficiencies in balancing the network while undermining the capability to deliver demand side flexibility.
- If left unchecked, it will impose excessive and unnecessary costs on consumers.
- 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.
- 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.

- 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.
- Potential of a 'postcode lottery' where homes near generators will experience reduced costs while homes far from generators may experience increased costs.
- 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.

REMA – Capacity Market Reform (1/2)

Option 1: Running specific auctions for flexibility.

- Each auction would procure specific flex characteristics and be open to all eligible LCTs.
- May increase complexity and reduce liquidity of the market, thus increasing clearing prices.
- Setting auction parameters to support innovative technologies while ensuring adequate volumes are procured could prove challenging.

Option 2: Introducing multipliers to the clearing price for certain flexible attributes.

- Only for low carbon capacity assets meeting flex criteria.
- Multipliers would be applied to their clearing price valuing flexibility characteristics like response time, duration, and location, thus rewarding specific flex needs.
- Risk of multipliers being mis-calibrated, outcomes may be misaligned with system needs.

Option 3: Optimised Capacity Market.

- Directly targets generators with low carbon or new build characteristics.
- Offers low carbon capacity assets ways to participate without competing directly with established assets.
- Possible drawbacks include increased price volatility increased complexity around volume and parameter setting, and reduced predictability.

RELEVANCE TO EQUINOX

- **Option 1:** Will see flexibility providers competing to provide networks with services like EQUINOX within a far smaller market – this could require an updated business case.
- **Option 2**: EQUINOX could help uncover what the most valued flexibility characteristics are for networks and whether these can be derived from domestic heating.
- **Option 3:** Less relevant to EQUINOX currently given the focus on generators.

Each option will impact EQUINOX to a different degree.

REMA – Capacity Market Reform (2/2)

Of the **101 respondents** to the consultation:

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

- Majority of respondents agreed that **reforms enabling greater levels of carbon flexible assets** are necessary.
- Suggested **short-term markets** and **ancillary services** were best positioned to appropriately reward flexible characteristics closer to real-time system needs.
- Some respondents thought that adjusting capacity market parameters to bring forward investment in low carbon flexibility could lead to **suboptimal results** and **ineffective market distortions.**

On the other hand;

- Many respondents 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 at a pace and scale for **effective decarbonisation.**
- Concerns were raised over the ability of ancillary service markets to provide a **sustained investment signal** for flexible assets.
- Concerns were also raised over the wholesale market's **missing money problem hindering the required scale of deployment.**

21% stated a **deeper analysis of alternative options** would be required to make a decision.

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

- Reforms such as automating pre-qualification and reforming secondary trading were preferred.

REMA – Supplier Obligation (1/2)

Decentralised, market-led approach placing a **legal requirement on suppliers to achieve a flexibility target** set by the government.

Precedent internationally – 31 US states have Renewable Portfolio Standards.

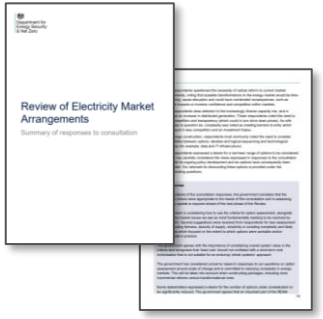
This approach could provide **'stronger investment and operational signals for flexibility, particularly for demand side and small-scale flexibility'.**

But there are **risks around financing and delivery**. Capital cost is likely to increase if suppliers play a more significant role in determining the capacity mix. Wider questions around **supplier suitability** to lead in bringing forward investment in the longer term.

RELEVANCE TO EQUINOX

- BEIS is considering this as a supplementary mechanism to contribute to investment case for small-scale flex with lower upfront costs like DSR. This could impact the EQUINOX business case/incentive for suppliers and aggregators.

REMA – Supplier Obligation (2/2)



Of the **106 respondents** to the consultation:

51% thought that the Government should **no longer consider** a supplier obligation for flexibility

- Some respondents felt such an obligation would place an **inappropriate level of risk on suppliers.**
- The importance of **aligning the REMA programme with retail market reform** was highlighted.
- Noted that suppliers could play a key role in enabling **demand side response** (for example, time of use tariffs).

31% agreed that the Government should **continue to consider** a supplier obligation for flexibility

- Suggested an obligation could be particularly effective in providing **strong operational and investment signals** for demand side and small-scale flexibility, enabling **competition** across technologies, and improving **liquidity** in local flexibility markets.
- Some respondents believed that the obligation could provide an opportunity for the **flexibility aggregation market** to develop.

Key concerns raised:

- **Majority not in support** – high risk on suppliers.
- Suppliers having to rely on **centralised definitions** of the capacity required.
- Approach **designed to reduce emissions at peak times** rather than incentivising shifting demand out of peak periods.
- Could result in excessive investment in certain technologies, making it very **difficult to predict peak periods.**

As a result:

The Government have decided **not to pursue a supplier obligation for flexibility as the main mechanism for flexibility in the short-term**. The role of suppliers in bringing the demand side flexibility will continue to be explored.

REMA – Revenue Cap and Floor (1/2)

Flexibility assets would **compete** for a **guaranteed minimum revenue** (floor) from the government for each period (such as **already exists in GB for interconnectors**).

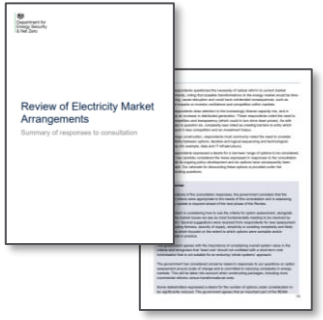
Guaranteed revenue would **provide certainty** to investors, while still **exposing assets to operational signals** across all the markets in which they would be expected to compete.

Maximum revenue cap could also be introduced **to protect consumers from excessive profits**. Designed with **additional incentives** (e.g. availability payment) to ensure plants **keep responding** to operational signals **even once the cap has been reached.**

RELEVANCE TO EQUINOX

- BEIS note that 'such a mechanism has to date been applied to medium and large assets, and therefore may not be appropriate (or indeed needed if operational signals are stronger) for aggregated portfolios of smaller scale assets' such as heat pumps. Therefore, this mechanism is perhaps less relevant to EQUINOX specifically.

REMA – Revenue Cap and Floor (2/2)



Of the **101 respondents** to the consultation:

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

- Suggested that the mechanism could be **effective in deploying flexible assets** through de-risking investment, especially in cases where assets have high capital costs.
- Majority of respondents highlighted the suitability of a revenue 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.**

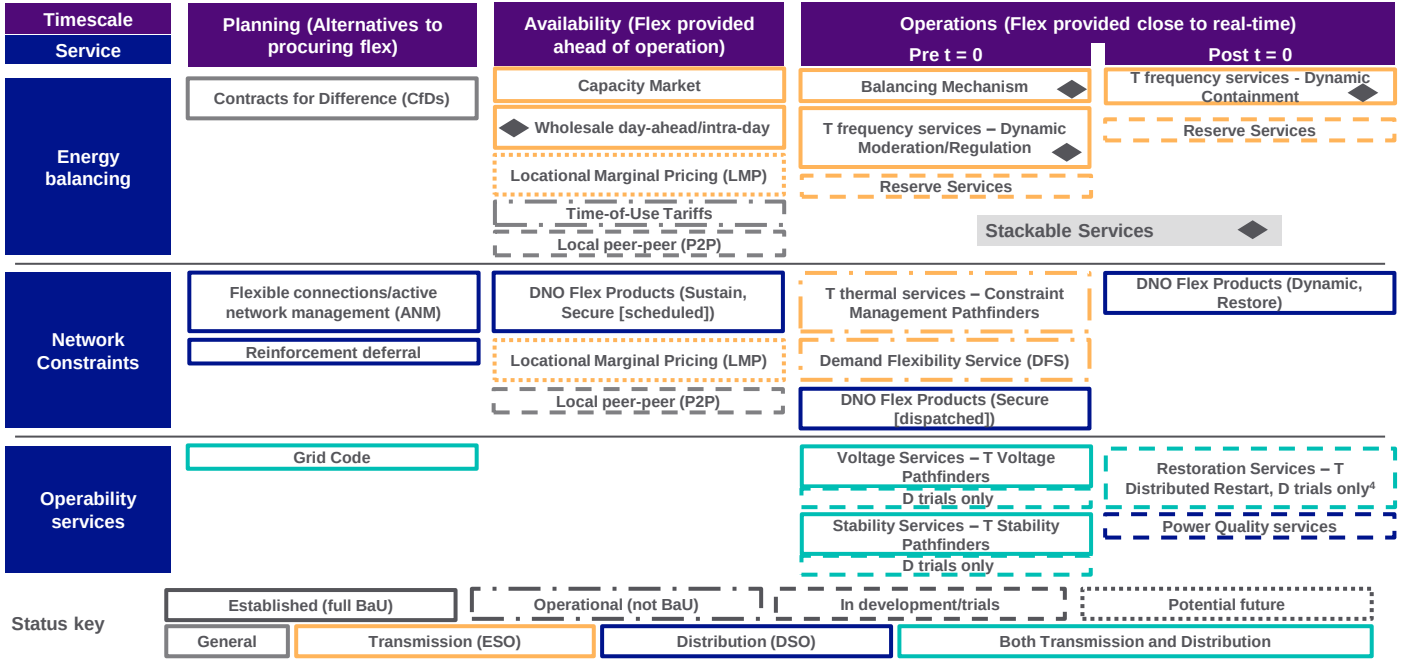
38% thought that the Government should **not continue to consider** a revenue cap and floor for flexibility.

- Suggested that a revenue 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 respondents felt there would be a **high administrative cost of implementing the regime.**

Key design ideas to ensure value for money:

- Some respondents suggested that the revenue cap and floor should be implemented in the **same way as the existing interconnector regime**, although this was argued to become bureaucratic if open to a large number of low carbon assets.
- It was suggested that **providers should meet a minimum level of performance**, with others suggesting that the floor should be based on **project size.**
- Some believed that a '**soft cap**' could ensure value for money whilst still incentivising technologies to provide system services post-cap.

NG ESO is 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. The focus of Primacy Rules development was thus 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

Innovation Project Deep Dives (Q2 2023)

Deep dives for the previous 34 projects can be found here.

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35: Net Zero Terrace

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

Project Overview

Description	• SIF Discovery project aiming to decarbonize a terraced street using a SLES that is integrated with the network, optimised, affordable to consumers, and replicable throughout the UK. More info.
Project Dates	April 2023 – June 2023.
Project Partners	electricity north west / NORTHERN POWERGRID; BURO HAPPOLD; north east & yorkshire NET ZERO HUB; Rossendale BOROUGH COUNCIL

Project Scope/Methodology

- Looks 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 optimization software.
- Will provide a replicable model that integrates with the electricity network, reduces bills, and defers the need for reinforcement
- Utilises DNO network for fair distribution of generation and provision of flexibility.
- Innovative in working across mixed-ownership buildings for the first time, making use of the DNO network.

Key Learnings

- Learnings will become apparent as the project unfolds.
- Highlights a methodology for implementing affordable low-carbon domestic heating within **community-owned heat systems** – relevant to trial 2 as we look to expand the range of target groups and understand their preferences.
- NZT's discovery 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.

36: Community DSO

Project Overview

Description	• Hosting four distinct energy communities over five years to explore opportunities that could be enabled by taking a community approach to the design, planning, and operation of their Smart Local Energy Systems (SLES). More Info.
Project Dates	Jan 2022 – Dec 2027.
Project Partners	NORTHERN POWERGRID. tnei LCPDelta

Project Scope/Methodology

- Defined a range of Smart Local Energy Systems (SLES) solutions and typologies representing a broad part of the community energy market replicable across most of the UK market.
- Identified possible solutions for delivering LES schemes and hierarchical cellular control structure looking at existing innovation and schemes/trials across the UK and Europe.
- Explored overarching technical and commercial architectures which could be tested in a trial.
- Assessed the value of and market potential for roll-out of the method.
- Next steps are to demonstrate and test the concept over four trial stages between 2024-2027.

Key Learnings

- Numerous solution providers exist and can deliver one or more components of a functioning energy community. There is a clear opportunity to build on these existing solutions to create additional values for communities as they support the DSO transition.
- There is an appetite for the community DSO concept, but benefits to the engaged stakeholders need to quantifiable and explicit where possible to ensure continued participation.
- Engaging through existing channels such as organizations representing the community energy/community groups, while challenging, is effective in improving consumer engagement in such projects.
- Increasing levels of consumer participation in flexibility initiatives has an exponential effect on the benefits realized from these schemes.
- A customer benefit of £160 million under relatively conservate assumptions suggests that there is a sufficiently strong case to justify further investigation of the Community DSO concept.

37: TRANSITION

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

Project Overview

Description	• An OFGEM NIC project which, based on the outputs of Open Networks, aimed to inform on the design for DSO systems and a flexible marketplace facilitated by the DSO. More Info.
Project Dates	Jan 2018 – Sep 2023.
Project Partners	Scottish & Southern Electricity Networks; Origami; electricity north west; CGI; ATKINS

Project Methodology

- Inform the design requirements for the Neutral Market Facilitator (NMF) and Whole System Coordinator (WSC) platform.
- Develop the roles and responsibilities within the marketplace.
- Develop the rules required for the trials in areas of Oxfordshire.
- Implement and test the concept of the systems by means of three stages of trials in Oxfordshire in conjunction with Project LEO.

Key Learnings

- Significant rise in fuel prices due to the invasion of Ukraine made costs of participation significant relative to reward, affecting market participation. Future innovation projects should consider suitable financial mechanisms to encourage participation.
- Contractual documentation should be kept simple, concise, and developed with stakeholders to ensure maximum customer engagement.
- Future innovation projects should ensure language is tailored and information is relevant to each stakeholder group.

Overview of Project Achievements

Market Trials (Nov 21 - Feb 23)	Technical Trials (Mar 23 – May 23)
• Contracted 180 flexibility contracts at day ahead and season ahead level. • Added Season ahead, week ahead and day ahead auctions. • Increased diversity of participating DERs and market participants, including those providing flex from domestic appliances and HVAC. • Delivered 3078.2kW of flexibility.	• Advanced the technical capabilities, processes, data and tools required for a flex market. • Tested the above in an integrated manner. • Procured contracts based off real-time data. • Procured flexibility using sensitivity factors.

38: FUSION

Project Overview

Description	• Trialling the use of commoditised local demand-side flexibility through a structured and competitive market **based on** the Universal Smart Energy Framework (USEF)[1]. More Info.
Project Dates	Oct 2018 – Jan 2023.
Project Partners	SP ENERGY NETWORKS, DNV·GL, Origami, passivSYSTEMS, Imperial College London, SRUC, University of St Andrews, Fife

Project Scope/Methodology

- Assessed the available flexibility in East Fife, mapped the potential flexibility, and determined specific trial locations.
- Conducted a due diligence of USEF against the current and future GB market and developed an implementation plan for USEF in the GB energy market for this project.
- Tendered for long-term flexibility availability, developed the FUSION flexibility platform, implemented USEF processes with successful aggregators and conducted end-end testing and commissioning.
- Conducted 18-month trials testing the framework.
- Produced learnings reports every 6 months and annual progress reports as well.

Key Results and Learnings

- 1.5 MW of capacity was contracted across 2 primary substations and 5 11kW feeders. 80% of capacity was residential.
- 26% of capacity was batteries and solar PV. 34% from EVs. 20% from CHP.
- Across over 500 dispatches, delivery reliability was 80% (86% for residential) as 49 MWh of flexibility was delivered at an average utilisation cost of £0.60 per kWh and an average availability cost of £14.30 per kWh.
- Aggregators continued to overdeliver on the volume of flexibility ordered to mitigate against the penalties of under delivery.
- The free bidding (Flexibility offers which aggregators send in response to a flexibility request outside of their contracted availability window or above their contracted power capacity) concept works but the current market and system is not mature enough yet to leverage it.
- High uptake of residential flexibility was observed in the trials. This was hypothesised to be down to both the USEF mechanism being attractive to residential participants and targeted campaigning to recruit residential customers.

1. Note: Framework developed was based off USEF, USEF was not developed for this project

39: Flex Heat Networks

Project Overview

Description	• Investigating how all-electric heat networks could affect the grid and how DNOs can manage them flexibly by freeing up capacity in the network using a smarter design. More Info.
Project Dates	Jul 2023 – Sep 2025.
Project Partners	UK Power Networks

Project Scope/Methodology

- Identify a heat network developer/operator to partner with.
- Desk analysis and engagement with heat network developers to identify pain points, understand typical load profiles and key design and operational variable of a heat network.
- Develop an optimisation methodology for support the design of heat networks and validate it via a technoeconomic assessment of an example heat network.
- Engage with DSO control team and network planners to determine the impact of the optimised heat network electrical profiles.
- Develop a trial strategy and run a one-year trial within the heat network sit. Understand results and using key learnings, develop a clear BaU transition plan.

Key Learnings

- Learnings will become apparent as the project unfolds.

40: Watt Heat

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

Project Overview

Description	• SIF Discovery project investigating the potential of thermal storage technologies to mitigate peak electricity load growth from domestic heat, capture low energy prices, and provide wider DSO flex. More info.
Project Dates	April 2023 – July 2023.
Project Partners	UK Power Networks, Baringa, passiv, tepeo, Greater London Authority

Project Approach – Discovery Phase

- The peak load, electrical energy load and hours of shift of 5 variations with Air Source Heat Pumps (ASHPs) primary space heating solution and 3 variations with the Zero Emissions Boiler (ZEB) technology combination were estimated by comparing the storage enabled power draw against the on-demand operation of the assets.

Project Planned Next Steps – Alpha Phase

- Define DSO services potential and how thermal storage can participate in DSO services
- Understand how DSO, ESO, and wholesale ToU services may interact, how a variety of thermal storage solutions might behave in combination, and identify highest value opportunities for customers.
- Understand customer appetite and needs relating to thermal storage and develop customer propositions for the beta phase to make an investment case to support the cost of thermal storage solutions for customers.

Key Learnings

- The ideal thermal storage asset for flexibility would fully decouple heat demand from electricity demand in 24 hours.
- The specific features of building types impact the suitability of different thermal storage systems due to factors such as space, household size, and peak heat energy demand.
- Cost savings and revenue opportunities from domestic DSR need to stack together for customers to create a range of incentives that help overcome barriers arising from consumer preferences and technical limitations of heat flexibility.
- The combination of Time of Use (ToU) and DSO Sustain is the primary source of revenue for all technology combinations, with additional potential in aggregated DSR access into ESO markets, but conflicts and synergies exist between market opportunities.
- The value of flex provided varies by technology combinations. ZEB options vs. an electric flow boiler can realise the highest cost savings and revenues of c.£600, though this is in part driven by higher running costs vs. ASHPs (i.e. greater costs can be offset). Higher up-front CAPEX, means payback periods are longer though there are wider benefits of this product (e.g. ease of boiler replacement).

Electricity Distribution

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Abbreviations

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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.

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