

EQUINOX

Transforming DNOs Heat Electrification Challenges into Innovative Solutions

Energy Innovation Summit

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Agenda

1. Project Overview
2. Trial Design
3. Research Findings
4. Next Steps
5. Q&A

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Project Overview

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What is EQUINOX?



Scope: EQUINOX is testing new commercial and technical arrangements to reward households with heat pumps for temporarily altering their heating choices without compromising on comfort



Funding: EQUINOX is supported by the energy regulator Ofgem and funded through the regulator's Network Innovation Competition



Lead: EQUINOX is led by National Grid Electricity Distribution (National Grid), who are the Distribution Network Operator (DNO) for the East and West Midlands, the South West and South Wales



Partners and Collaborators: Octopus Energy, Sero, Scottish Power Energy Retail, Passiv UK, SP Energy Networks, Welsh Government, West Midlands Combined Authority, National Energy Action, and Guidehouse

Key Facts



- Equinox will run from 2022 to 2025
- The project's first trial took place between December 2022 and March 2023.
- Over 1,000 households that have heat pumps within National Grid's distribution region will take part over 4 years.
- Over 350 signed up for the first trial in winter 2022-2023.
- EQUINOX trials aim to include households from all sectors of society, ensuring that commercial and technical arrangements are designed equitably.

Why is EQUINOX Important?



- All DNOs expect significant increase in heat pumps to connect, meaning a significant increase in electricity peak demand



- Heating load and flexibility not yet proven in trials

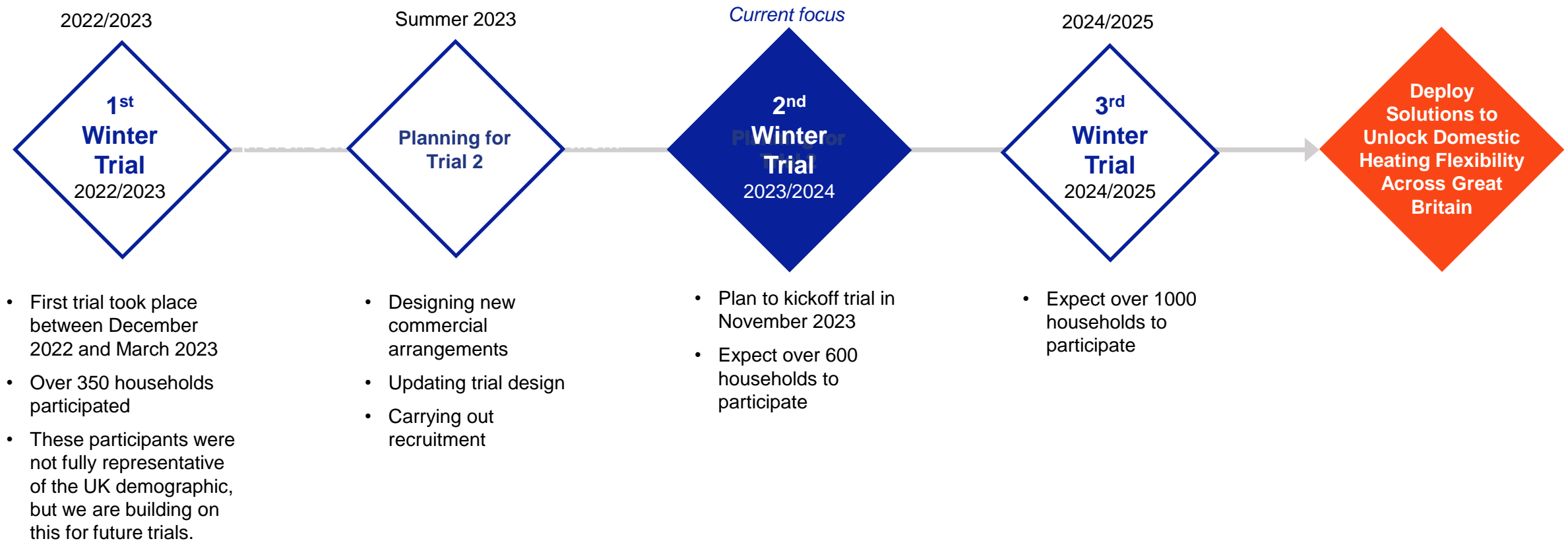


- No proven solutions enable DNOs to unlock flexibility from residential electric heat reliably and cost-effectively



- Vital that all customers, including **2.4 million** households in fuel poverty, access and benefit from smart solutions

Where is the project now?



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Trial One Design

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Equinox trial one represented a proof of concept for heat pump flexibility. Below were the trials key goals:



Network flexibility

- Uncover the **amount of aggregated flexibility** which can be procured from domestic heat pumps without compromising customer comfort and safety
- Assess the **predictability** of the aggregated flexibility provided by households **as a whole**, and in **different conditions**
- Assess whether and how the amount and predictability of aggregated flexibility differ between heat pump **control methods**
- Assess whether and how the amount and predictability of aggregated flexibility differ between **commercial arrangements**
- Assess whether flexibility from domestic heat pumps is a **viable option** for the DNO



Customer experience

- Assess whether aggregated flexibility can be procured in an **equitable way** that does not unduly bias against underrepresented households
- **Promote** domestic heat pump flexibility as a **valuable product** for the network and for customers
- **Understand** the main reasons for participants choosing not to/ being unable to participate in flexibility events
- **Develop** and stress test the **systems and processes** that make this procurement of aggregated flexibility possible

Held 22 “EQUINOX Events”

- Trial events occurred from December to March
- Scheduled for two hours from 5-7pm
- Events up to 3 times per week

Participants were split by:

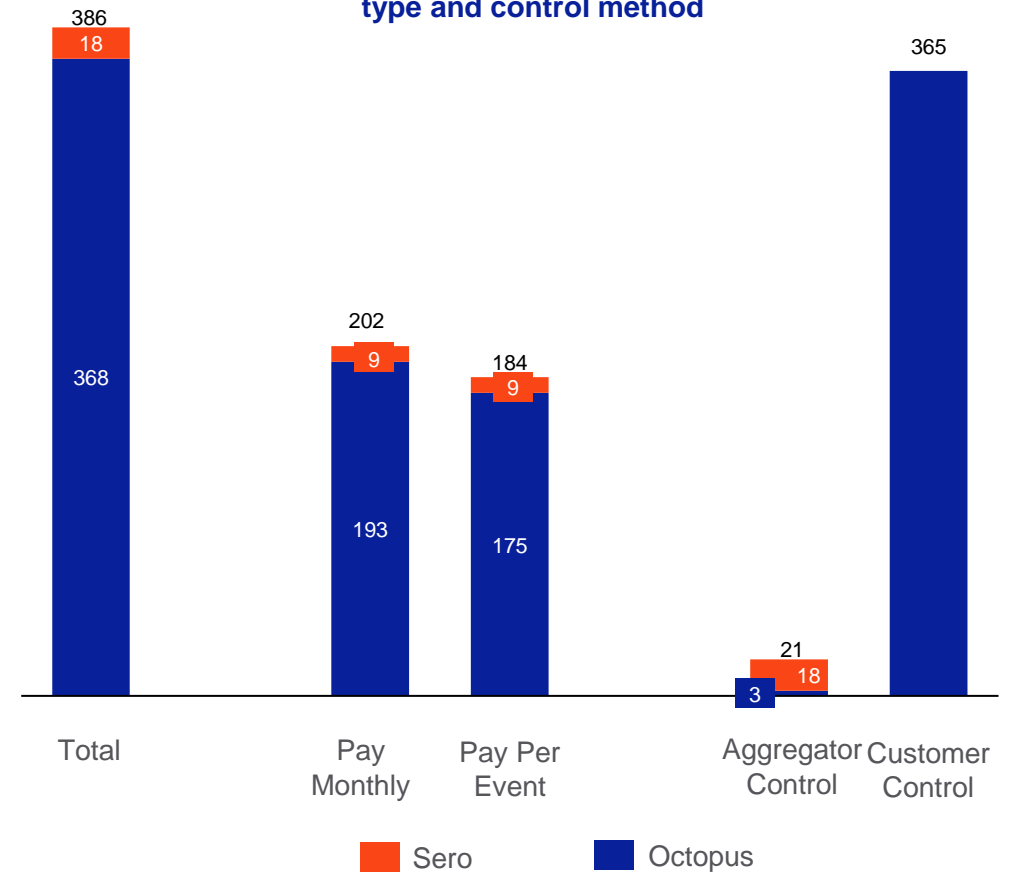
Payment Types

1. **Pay Monthly:** participants paid four fixed £25 monthly instalments in advance of their participation in that month's events
2. **Pay per Event:** participants paid up to £6 after each event for their participation

Control Methods

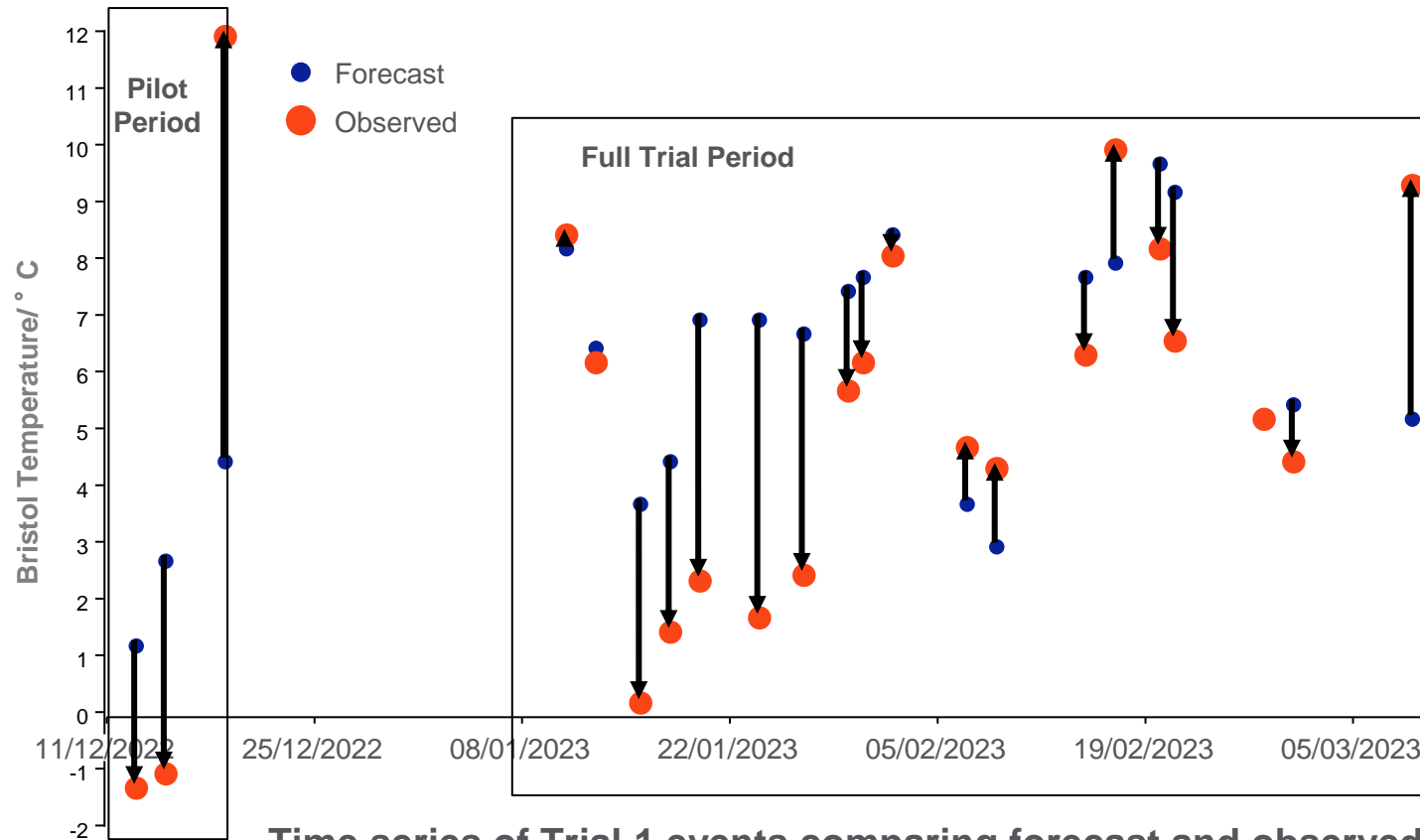
1. **Aggregator Control:** participants allowed suppliers to control heat pumps remotely, but could opt out before or during events.
2. **Customer Control:** participants asked to turn off or down their own heat pumps. These were split between manual and remote customers.

Segmentation of trial one participants by payment type and control method



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Event days were chosen a week in advance with the goal of achieving a wide temperature spread



Time series of Trial 1 events comparing forecast and observed temperatures used for event scheduling

- 22 events:
 - 2 warm events ($>10^{\circ}\text{C}$)
 - 10 mild events ($5\text{--}10^{\circ}\text{C}$)
 - 8 cold events ($0\text{--}5^{\circ}\text{C}$)
 - 2 very cold events ($<0^{\circ}\text{C}$)
- Events were scheduled based on forecasted temperature¹
- Wanted to see whether there was a correlation between turndown and temperature
- The winter was mild and had few very cold days ($<0^{\circ}\text{C}$)
- Observed temperature was consistently cooler than forecasted

¹ Forecast for Bristol was used for event scheduling purposes – this was deemed a central point across the spread of participating households. Observed external temperature varied hugely across the participating households. Analysis of turndown accounted for localised temperatures.

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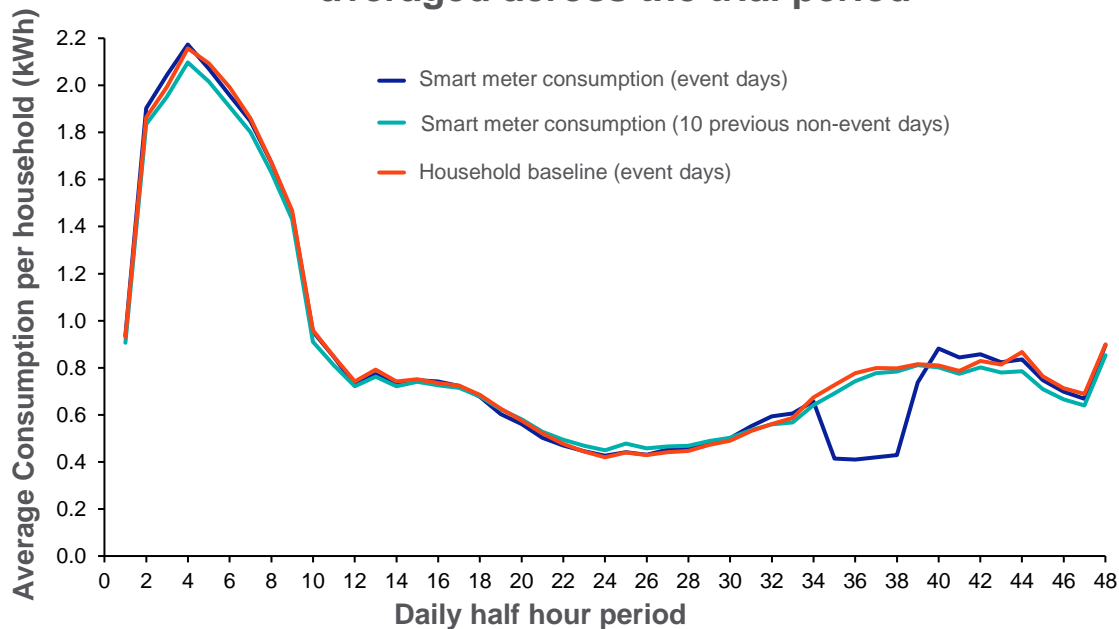
Trial One Findings

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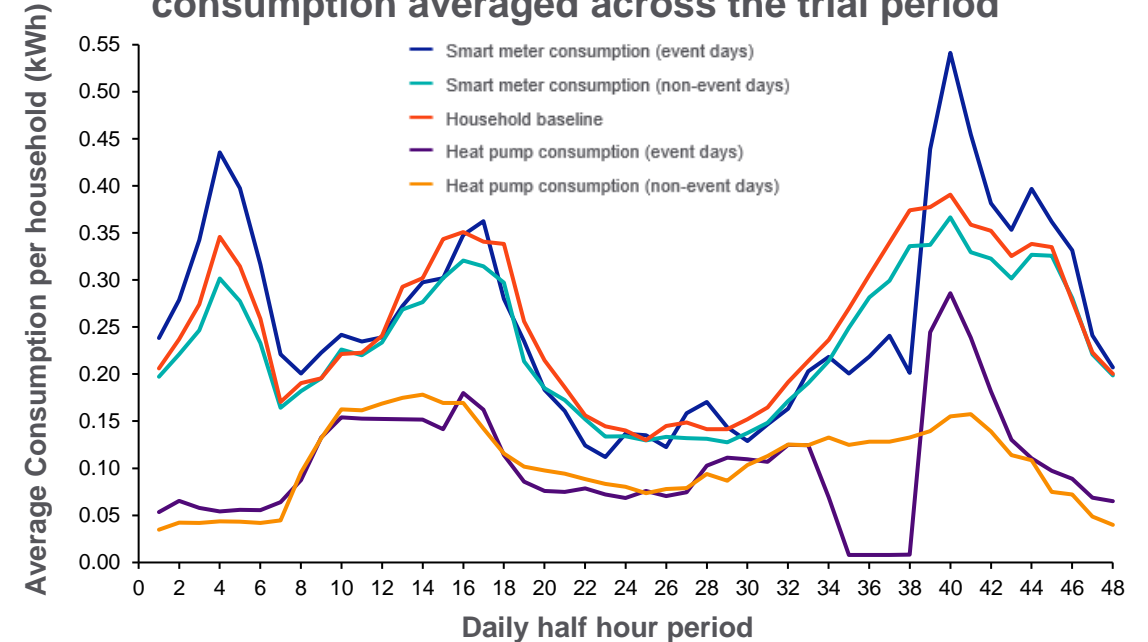
Households were able to provide significant turndown when asked to shift their domestic heating habits

Octopus: Half hourly household kWh consumption averaged across the trial period



- 9.25 MWh of measurable **turndown** provided by participants across 22 events
- On average, 1.53 kWh per event per participant

Sero: Half hourly whole household and heat pump kWh consumption averaged across the trial period

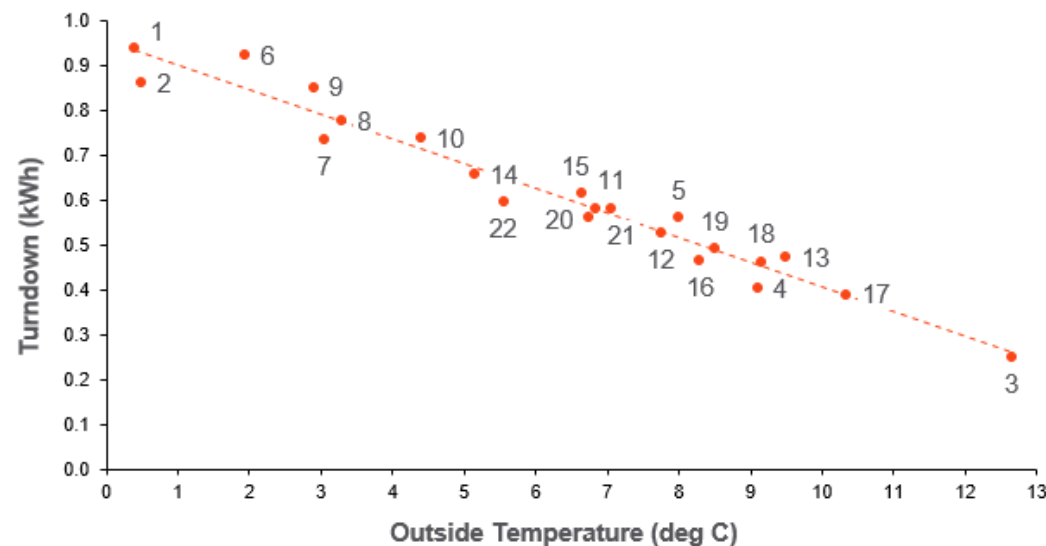


- Average decrease in **heat pump consumption** of 0.61 kWh per participant per event (86% reduction; 191 kWh total)
- Greater 'snapback' was seen in the aggregator controlled homes, this is something we are looking to reduce for trial 2.

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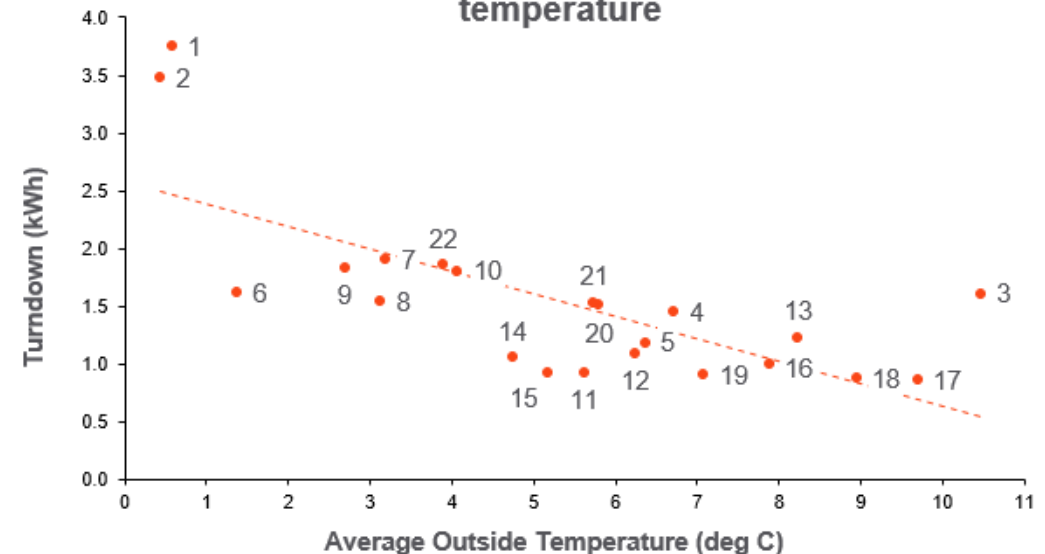
Turndown had an inverse linear relationship with temperature. A colder day meant higher flexibility

Sero: Mean event heat pump turndown per participating household across 5-7pm vs average outside temperature



- Almost perfect **inverse linear** relationship between Sero home heat pump turndown and outside temperature
- Reflects heat pump having to work **harder** in **colder** conditions
- **7pm** snapback was not necessarily higher for lower temperatures

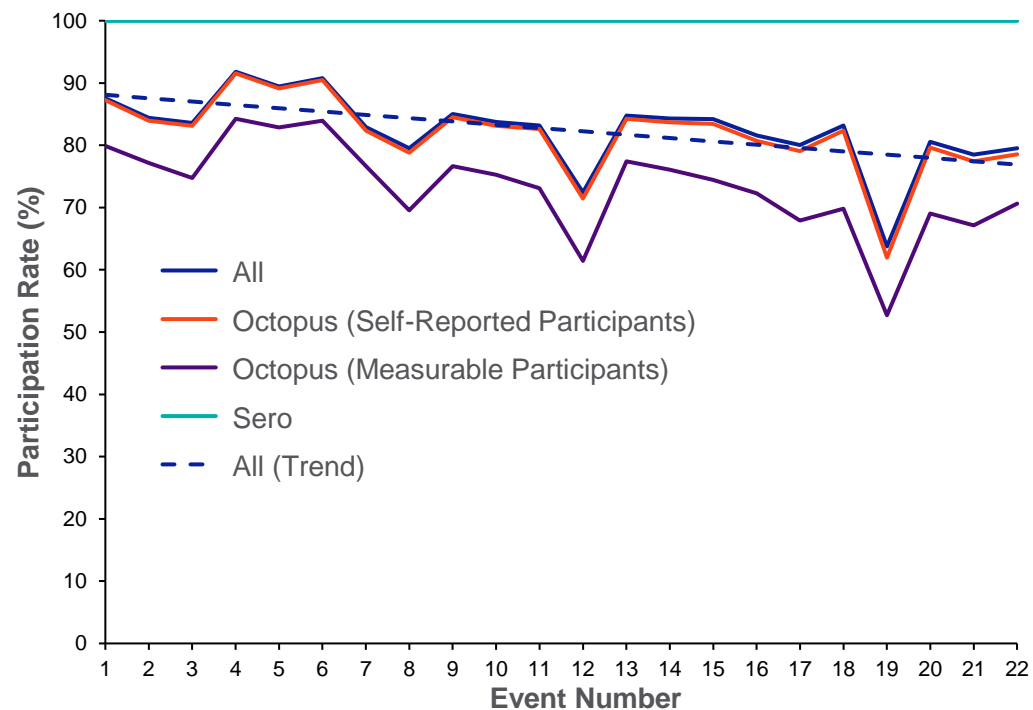
Octopus: Mean event household turndown per participating household across 5-7pm vs average outside temperature



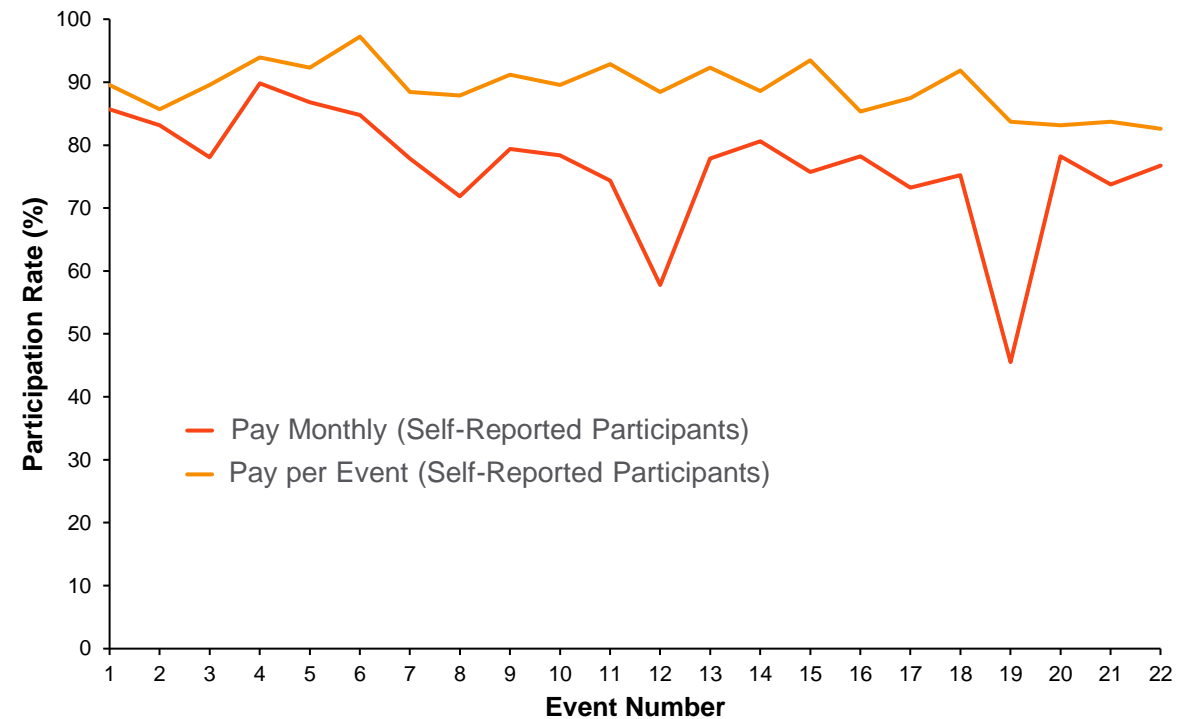
- Trend **holds** at smart meter level for Octopus homes
- First two trial events were also coincidentally the coldest. It is unclear what exactly has caused the non-linearity here
- Event 3 occurred on a day **10C warmer** than expected, hence the baseline struggled to adjust.

Household participation was consistently high throughout the trial, with minimal fatigue observed

Event-by-event participation rates

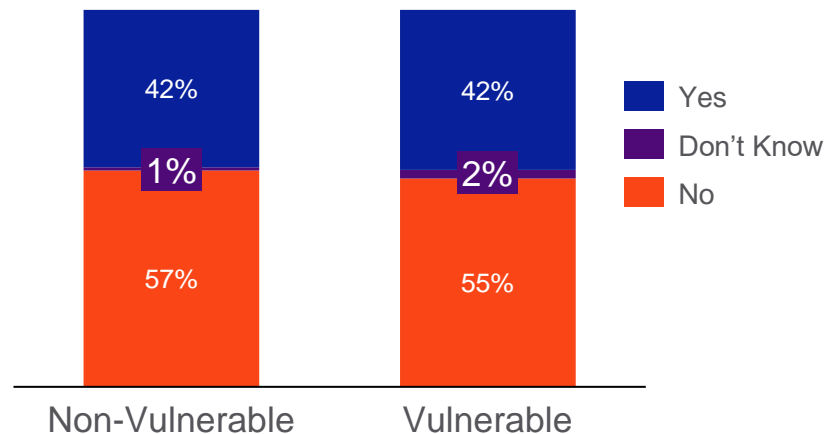


Event-by-event participation rates by payment type

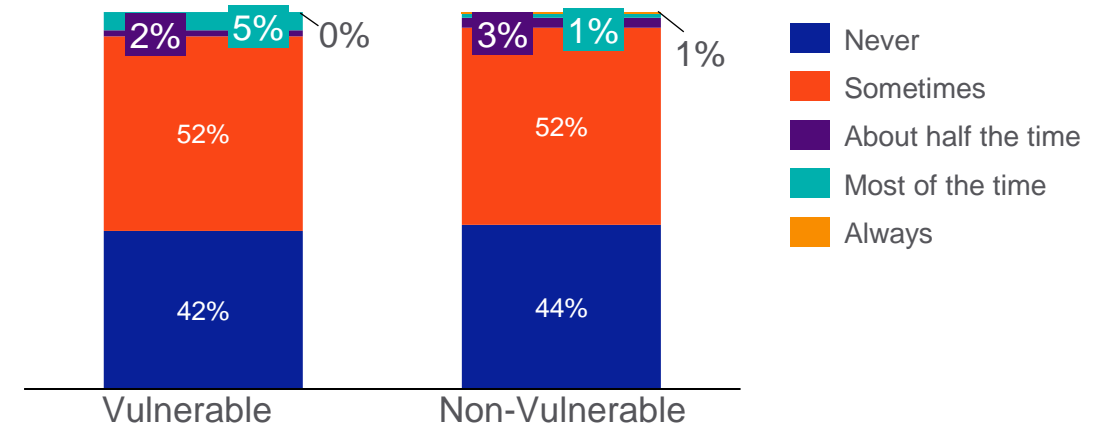


Customers with vulnerabilities did not seem to be less able to participate or more likely to experience discomfort

Have you chosen not to participate in at least one EQUINOX event?



How frequently has participating in events caused any discomfort for you or someone else in the household?

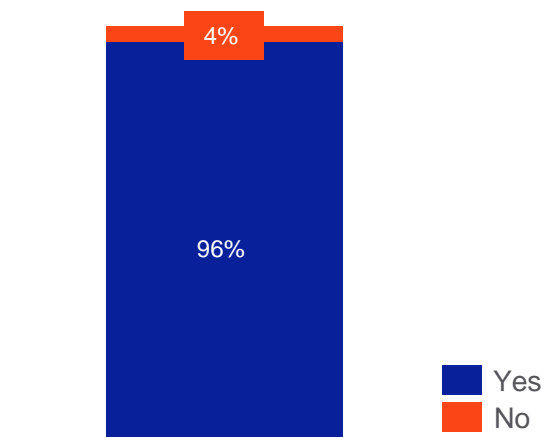


- Trial one households with residents with potential vulnerabilities were as likely to report non-participation as customers without vulnerabilities.
- Around half of participants expressed discomfort within their household during events at some point during the trial. This seemed to impact customers with vulnerabilities and customers without similarly. Although customers with vulnerabilities were slightly more likely to feel regular discomfort (7%) than those without (4%).

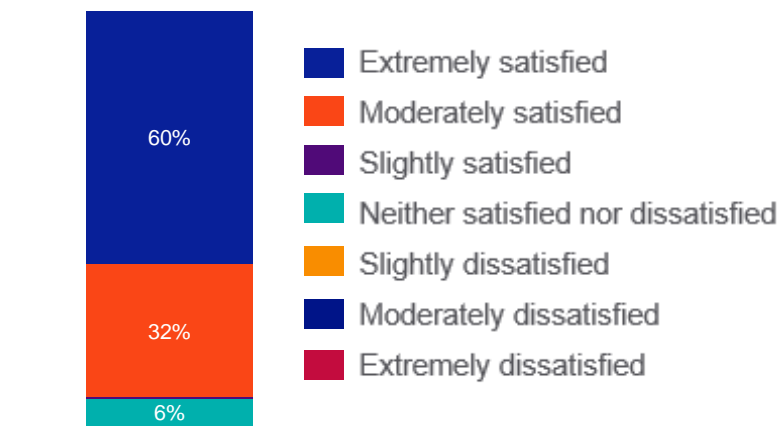
Other trial findings include:

- Customers felt in control of their heating and generally did not feel thermal discomfort.
- The most common reason for non-participation was no one being home to action heat pump turndown
- Around half of participating households had additional LCTs. More data is needed from future trials to understand impact
- General satisfaction was high across all variables and trial participants found it easy to navigate
- Aggregator-controlled heat pump participation was more reliable than customer-controlled, but turndown impact is unclear

Have you felt sufficiently in control of your heating during the EQUINOX trial?



Overall satisfaction



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Next Steps

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Building on trial one findings, trial two aims to test a closer to BaU setup to probe how domestic heating flexibility can help DNOs

Variables to test

- 1 Payment amounts: households will be paid per kWh of turndown
- 2 Notice period: households will receive varied notice periods that align with different DNO flexibility services
- 3 Control method: more aggregator control homes are expected to participate
- 4 Time of day: events will still last two hours, but could be scheduled any time between 4-8pm

Additional factors



Vulnerability: recruit from a wider demographic pool to ensure customers with vulnerabilities can participate equitably in the flexibility market



Snapback: turn heat pumps down instead of off to minimise high energy demand immediately post-event



Hot water: optimise the timings of hot water heating cycles to reduce snapback post-event



Energy efficiency: investigate how differing levels of energy efficiency impact flexibility from domestic heating



Cluster analysis: analyse trial findings based on clusters to simulate constraint management zones (CMZs)

We look forward to continuing to share with you!

Full research findings from EQUINOX trial 1 are available here:

<https://www.nationalgrid.co.uk/downloads-view-reciteme/639583>

If you have any additional questions, please feel free to contact us at nged.innovation@nationalgrid.co.uk.



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