Electricity Distribution

Webinar: Initial insights from project EQUINOX

August 2023

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Introductions

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Agenda

- **Project Overview**: Ryan Huxtable
- **Research Findings**: Luke Harker & Callum Coghlan
- **Next Steps**: Luke Harker
- **Q&A**

Housekeeping

- Please raise your hand if you wish to ask a question during the Q&A
- You can also put your questions in the Q&A box throughout the presentation

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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

Why is EQUINOX important?

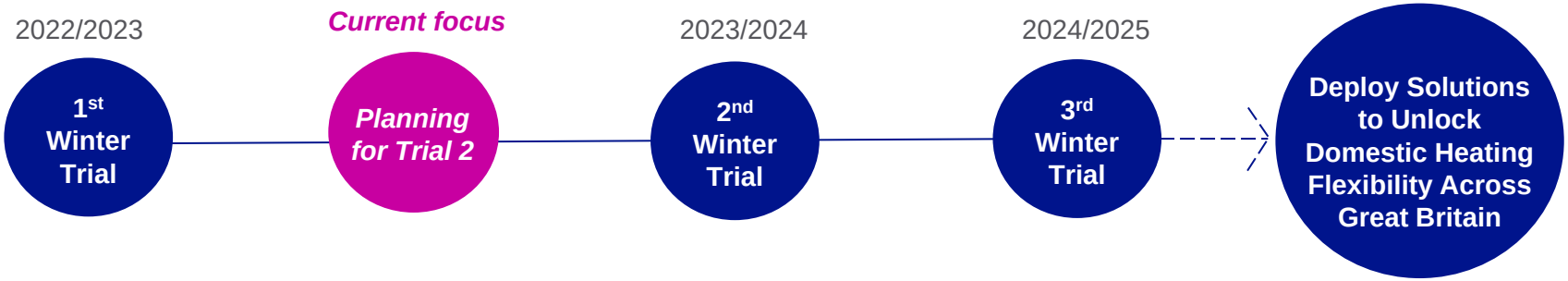
Expect an increase in about 600,000 heat pumps to connect to National Grid's distribution grid, meaning a significant increase in electricity peak demand

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?



- First trial took place between December 2022 and March 2023
- Over 350 households participated

- Designing new commercial arrangements
- Updating trial design
- Preparing for recruitment

- Plan to kickoff trial in November 2023
- Expect over 600 households to participate

- Expect over 1000 households to participate

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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:

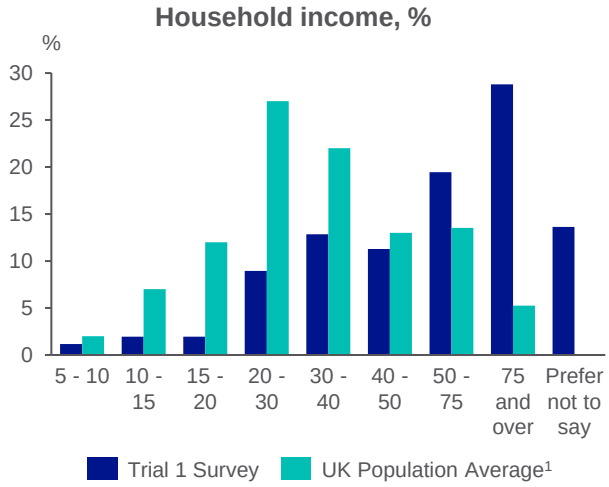
Network flexibility

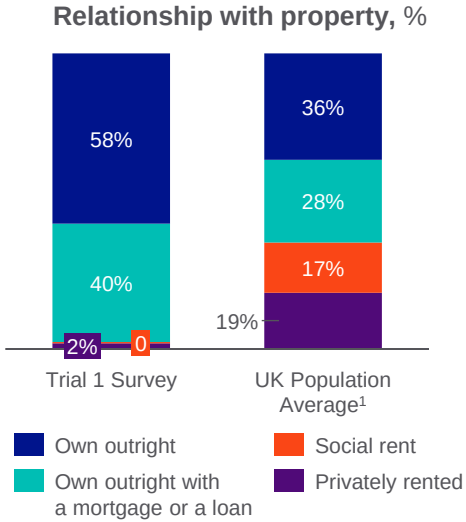
- Uncover the **amount of aggregated flexibility** which can be procured from domestic heat pumps **without compromising** customer comfort and safety
- Assess the **predictability** of the aggregated flexibility provided by households **as a whole**, and in **different conditions**
- Assess whether 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

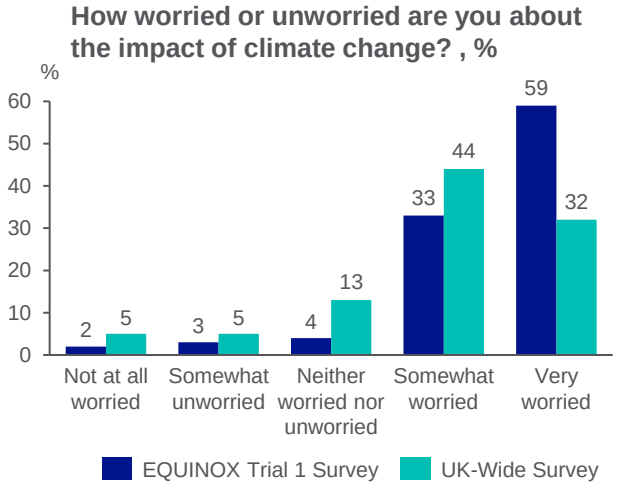
Customer experience

- 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

Trial one participants (386) were not representative of the UK. We aim to have more representative sample in trial two.







- Most households are **from higher income brackets**
- Almost all households **owned their property**, above the national average

- On average, participants tended **to be more worried about the impact of climate change**

Source: [1]Office for National Statistics, Census 2021; [2] EQUINOX UK-Wide Survey August 2022

Participants were segmented by payment type and control method

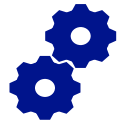
Held 22 “EQUINOX Events”

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

Payment types

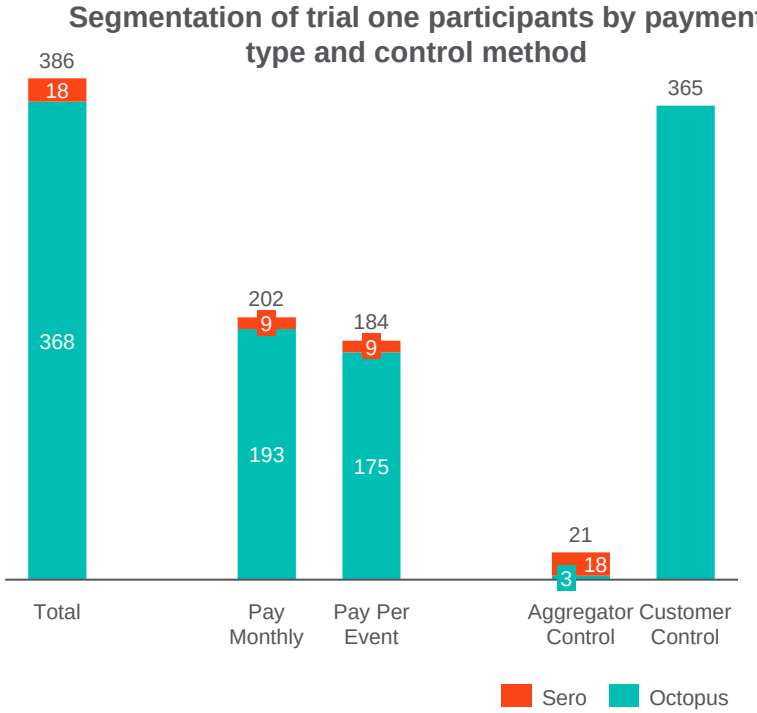
1. **Pay Monthly:** participants paid four fixed £25 monthly installments in advance of their participation in that month’s events
2. **Pay per Event:** participants paid up to £6 after each event for their participation

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.

While segmentation was generally even across payment type, control method was skewed heavily towards customer control



- **386** participating households
- All **Sero** households were **aggregator controlled (18)**
- Nearly all **Octopus** households were **customer controlled (365)**
- Additional data collected during the trial showed how customer controlled customers managed their heat pumps:

It was an almost event split between customers who manually adjusted their heat pump or thermostats and customers who controlled their heat pump using an app or other technology (i.e., smart thermostats)

We collected data through the following mechanisms:

Measuring network flexibility

octopus energy

Half hourly **smart meter** whole household electricity consumption data

- \+ No additional hardware needed
- − Not possible to disaggregate heat pump data

sero

Smart meter, temperature sensors, and heat-pump system data from Sero households' **advanced sensors**

- \+ Disaggregated heat pump data
- \+ 1 to 5 minute resolution

Tracking customer experience

1. Post-event survey

- 2 to 5 question survey
- Average participation rate was 91%

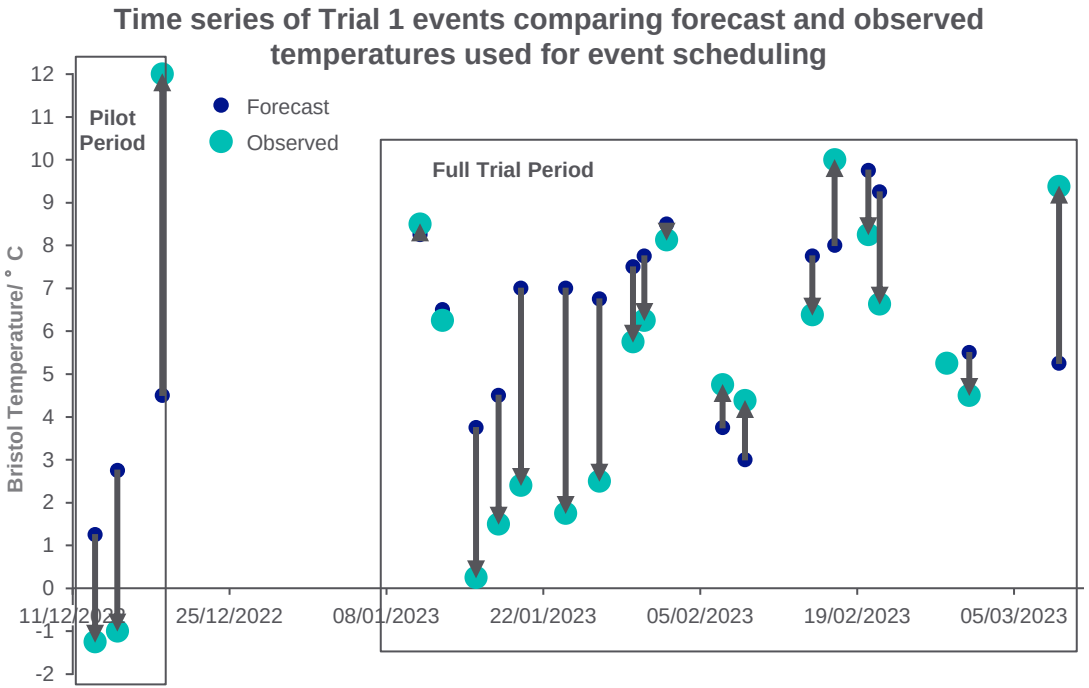
2. End of trial survey

- Longer survey to capture experience and satisfaction
- Participation rate was 96%

3. Focus groups and interviews

- Post trial, segmented by control type, payment type, and vulnerability indicator
- Nine one-to-one interviews
- Three focus groups

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



- **22 events**:
  - 2 warm events (>10C)
  - 10 mild events (5-10C)
  - 8 cold events (0-5C)
  - 2 very cold events (<0C)
- Events were scheduled based on **forecasted temperature**[1]
- Wanted to see whether there was a **correlation** between turndown and temperature
- The winter was mild and had **few very cold days (<0C)**
- 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 termperatures.

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Trial One Findings

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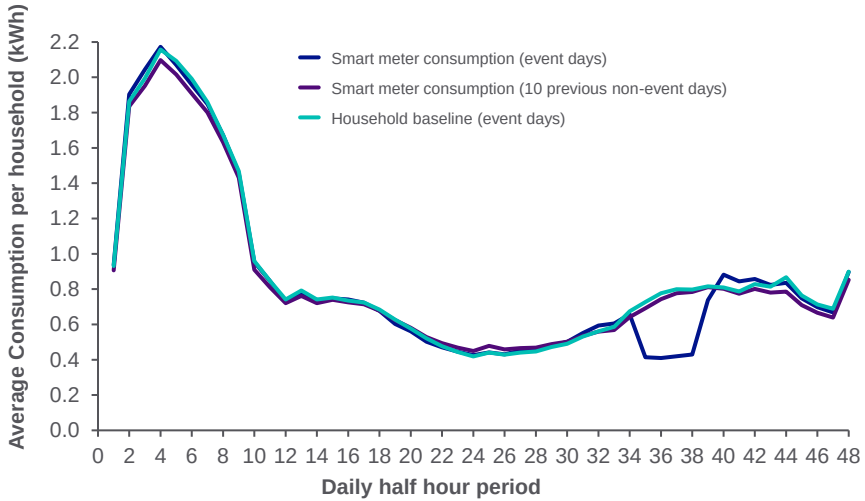
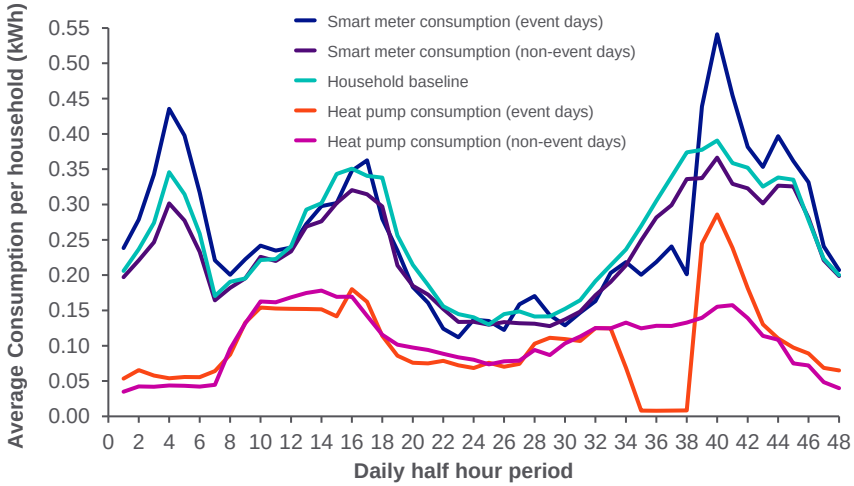
Finding 1: Households were able to provide significant turndown when asked to shift their domestic heating habits

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 event participant

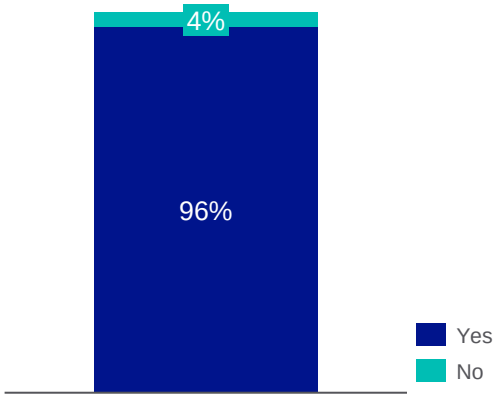
Sero: Half hourly whole household and heat pump kWh consumption averaged across the trial period



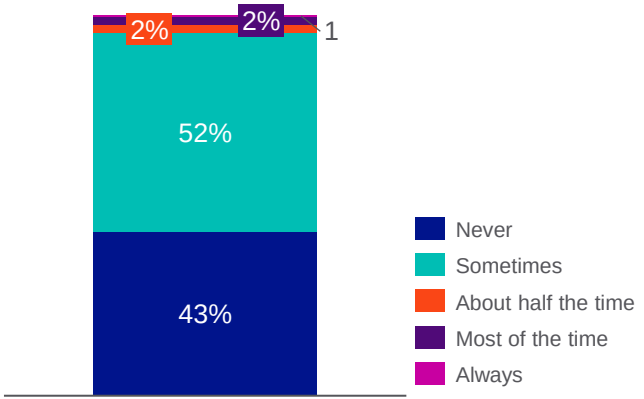
- Average decrease in **heat pump consumption** of 0.61 kWh per participant per event (86% reduction; 191 kWh total)
- Average decrease in **smart meter consumption** of 0.38 kWh per participant per event (23% reduction)
- Visible snapback at 7pm (43% increase from 7pm to 12am)

Finding 2: Customers felt in control of their heating and generally did not feel thermal discomfort

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



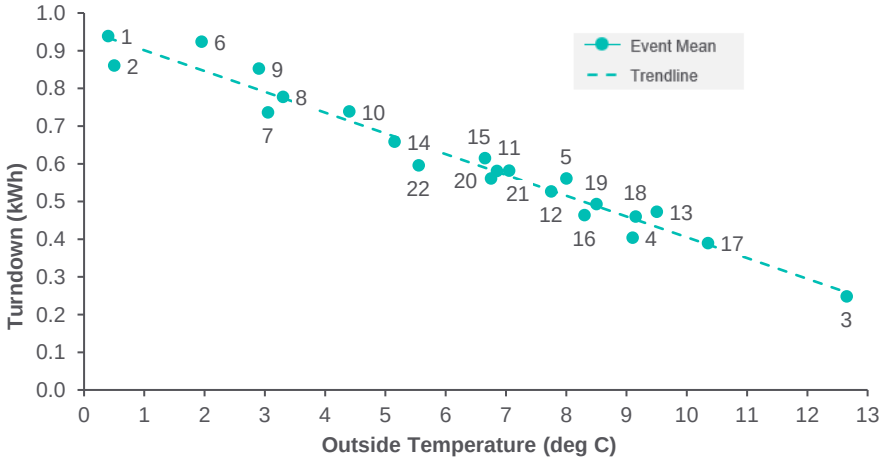
How frequently has participating in events caused any discomfort for you or someone else in the household?



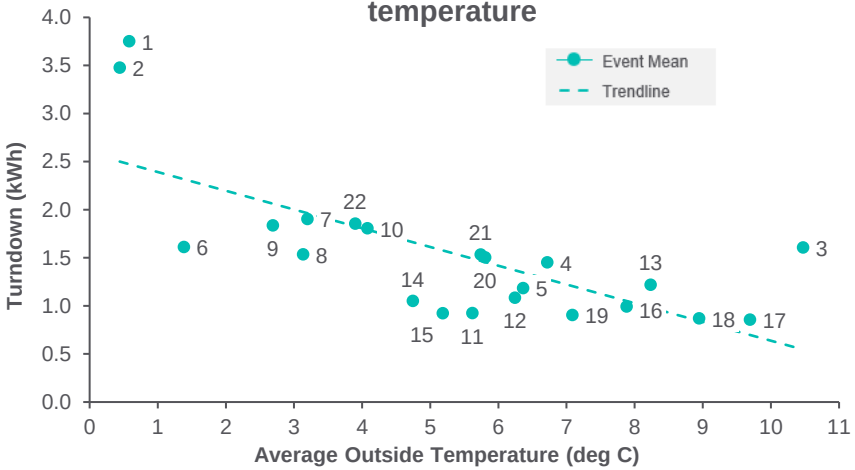
All aggregator control households felt in control of their heating throughout the trial; 96% of all participating households felt in control. 95% of households never or only sometimes felt discomfort during events.

Finding 3: 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



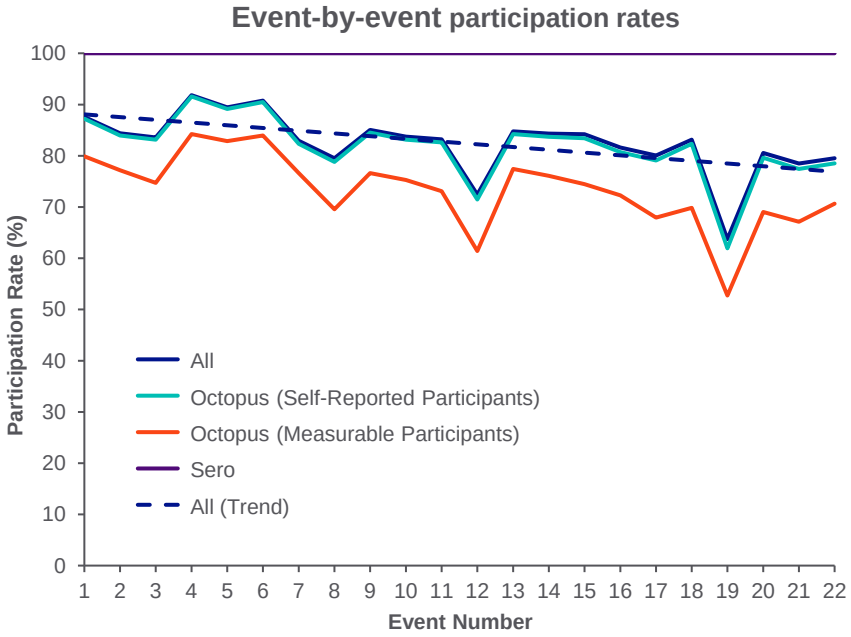
Octopus: Mean event household turndown per participating household across 5-7pm vs average outside temperature



- 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

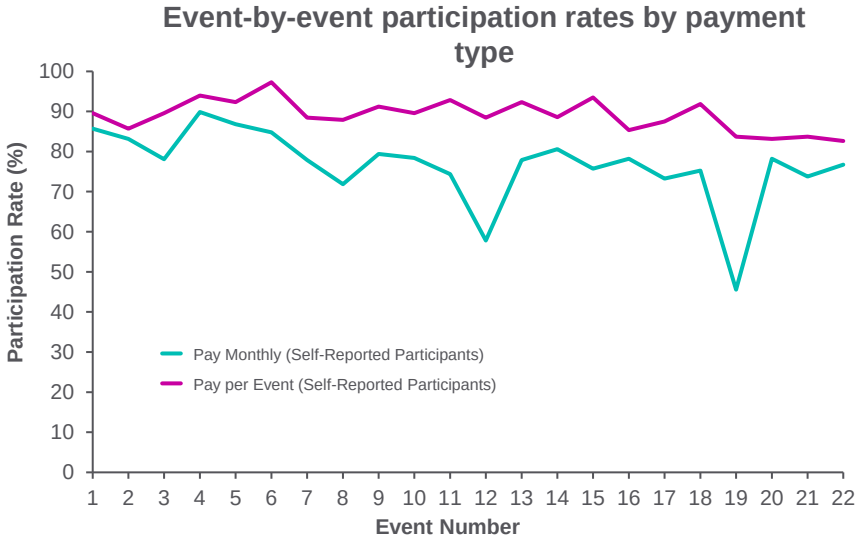
- Trend **holds** at smart meter level for Octopus homes
- First two trial events were also coincidentally the coldest. It is unclear what exactly has caused the non-linearity here
- Event 3 occurred on a day **10C warmer** than expected, hence the baseline struggled to adjust.

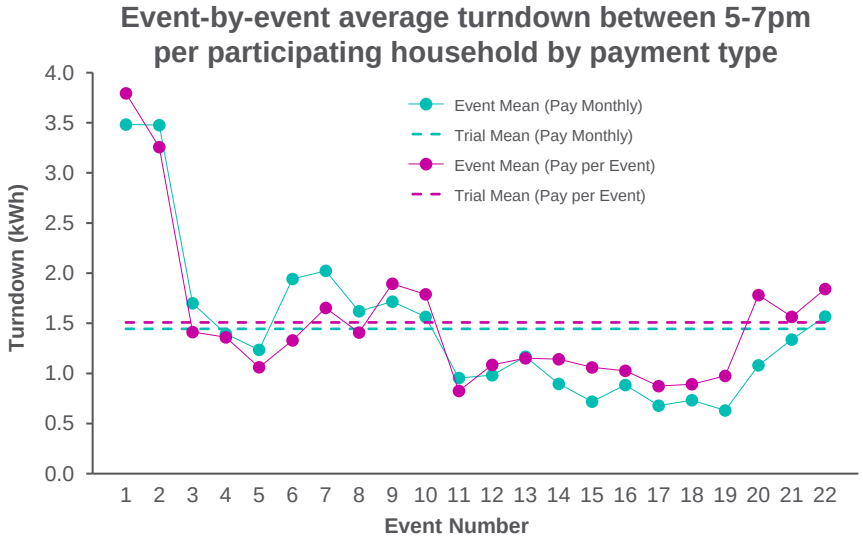
Finding 4: Household participation was consistently high throughout the trial, with minimal fatigue observed



- An average of **82% of households** participated in events by turning off / down their heat pumps
- Maximum event participation was **92%**, minimum was **64%**
- Participation **trended down** from 88% at the start to 77% by the end of the trial
- **58%** of households participated in **all** 22 events
- **89%** of households who **chose to participate** in an event kept their heat pump **off** for the **full two-hour** event window
- **85%** of those surveyed felt that two hours was an **appropriate** event length

Finding 5: Paying households per event incentivised more reliable participation than upfront payment, but did not yield more turndown



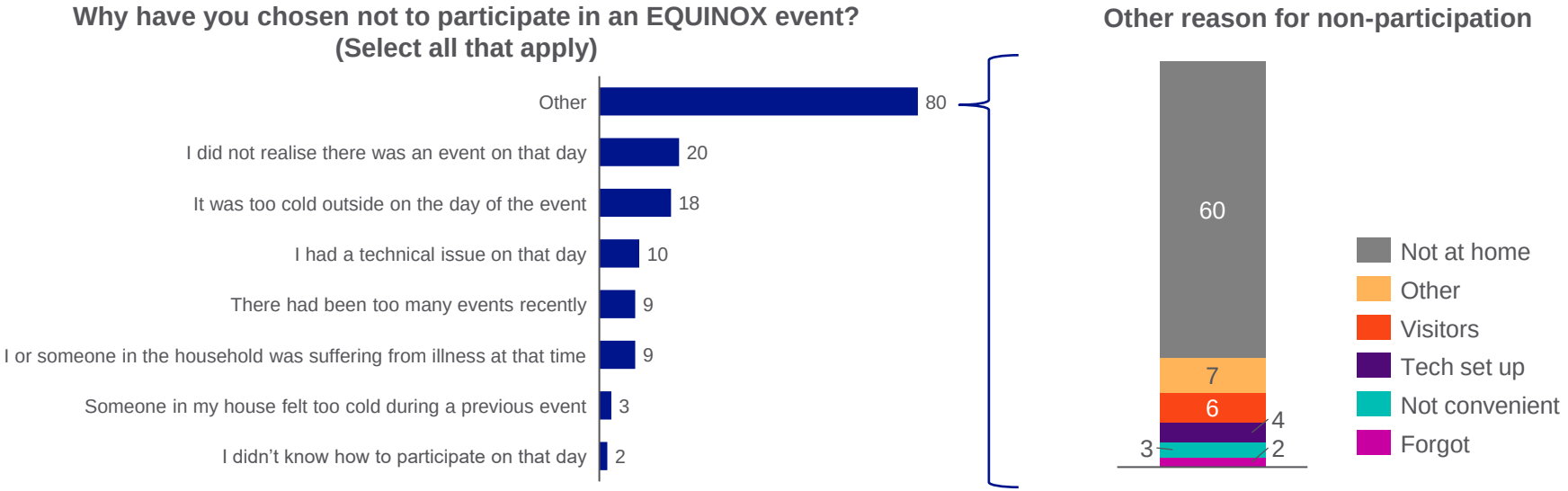


- Pay per event participation was **consistently higher** than pay monthly
- Note that the **dips** for consecutive day events (12 & 19) only seem to impact pay monthly group participation rate

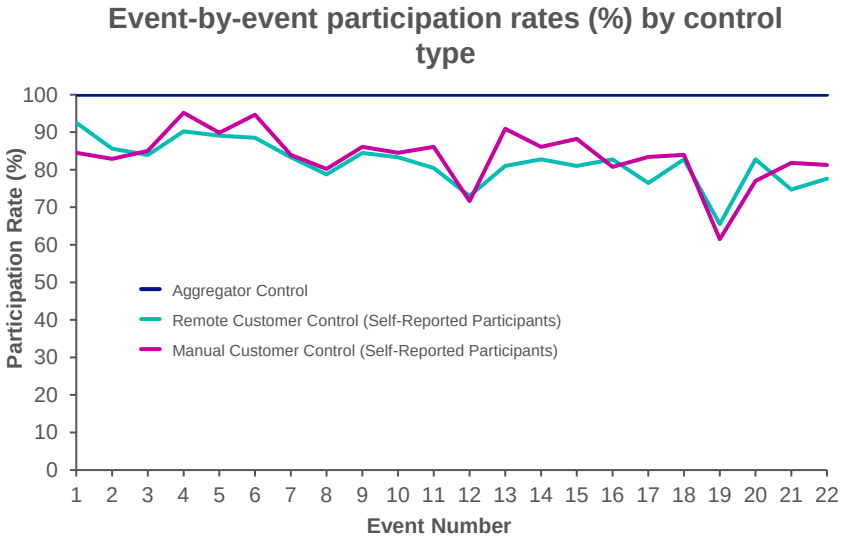
- Across the trial, participating pay per event households only provided **marginally** more turndown than pay monthly households
- This holds even when accounting for non-participating households

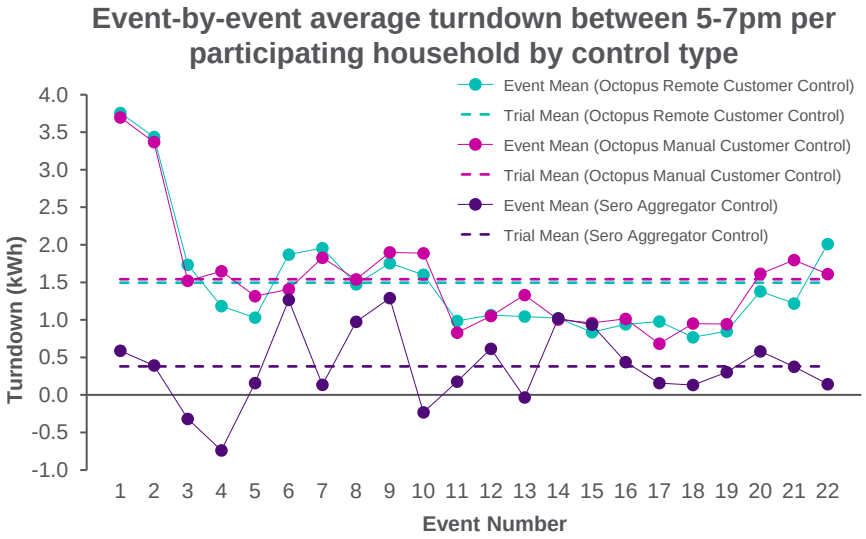
Finding 6: The most common reason for non-participation was no one being home to action heat pump turndown

Not realising there was an event and it being too cold outside were also commonly cited reasons



Finding 7: Aggregator-controlled heat pump participation was more reliable than customer-controlled, but turndown impact is unclear

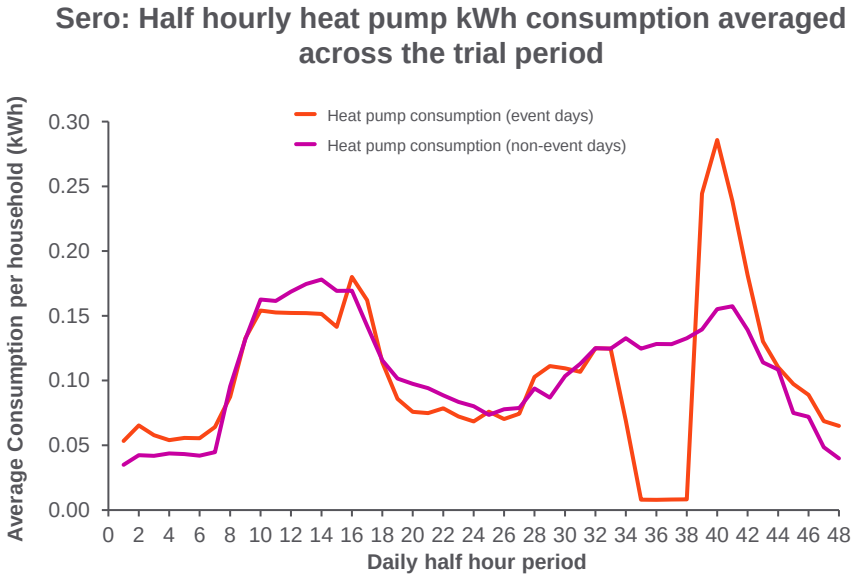




- **100%** aggregator control participation
- Manual customer control participation rate (84%) **insignificantly** higher than remote customer control participation rate (82%)

- Turndown was **smaller** for aggregator-controlled homes than customer-controlled although these results are not comparable due to household differences (e.g., EPC ratings) and the small sample size for aggregator control.
- Manual and remote customer control homes provided the **same amount** of turndown

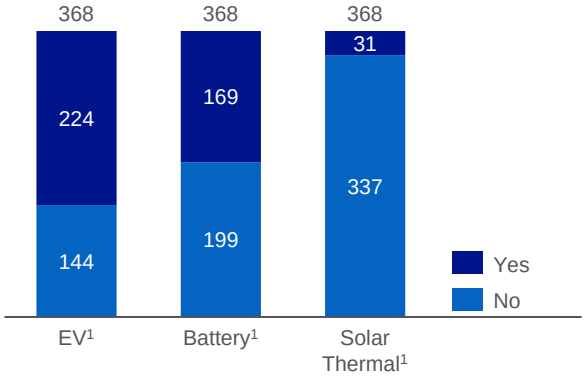
Finding 8: Demand snapback was more pronounced in aggregator controlled homes. Trial two will explore how to reduce it.



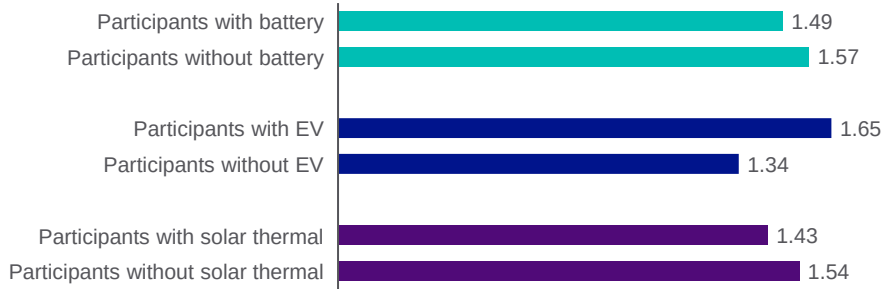
- Sharp increase in heat pump kWh demand immediately post-event for aggregator controlled homes vs non-event days (peak of 85%). Also seen at household level (peak of +50%)
- kWh demand continues to trend above non-event day demand from 9pm to 2am
- Far smaller effect observed in Octopus' customer controlled homes (peak of +9%)
- Hypotheses for the pronounced aggregator control snapback include:
  - Sero's aggregator control involved fully switching the heat pump off, resulting in a large instantaneous energy need once the compressor turned back on.
  - Sero household hot water settings resulted in water needing to be heated immediately post-event, increasing immediate heat pump demands. There was no automated pre-heating period built in to account for the events.
- Trial 2 will explore how to reduce this 'snapback'

Finding 9: About half of participating households had additional LCTs. More data is needed from future trials to understand impact

Octopus: Participants with additional LCTs



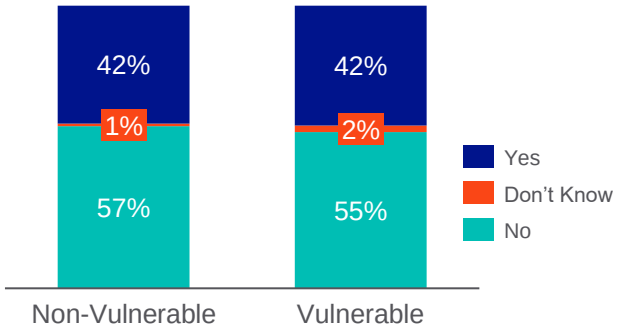
Octopus: Average kWh turndown per event per participating household segmented by LCT ownership



- Households with EVs provided a higher per event average turndown than those without.
- For solar thermal, there was an insignificant difference between households with and without the technology.
- Owning a battery also appeared to have an insignificant impact on turndown. Some homes (~40) during at least half of the events were already using their battery and therefore provided zero grid turndown despite turning off / down their heat pump.

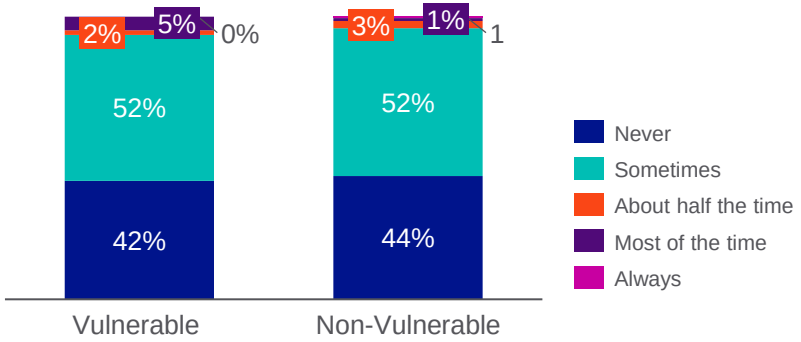
Finding 10: Customers with vulnerabilities did not seem to be less able to participate or more likely to experience discomfort

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



- Trial one households with residents with potential vulnerabilities were as **likely to report non-participation as customers without vulnerabilities.**

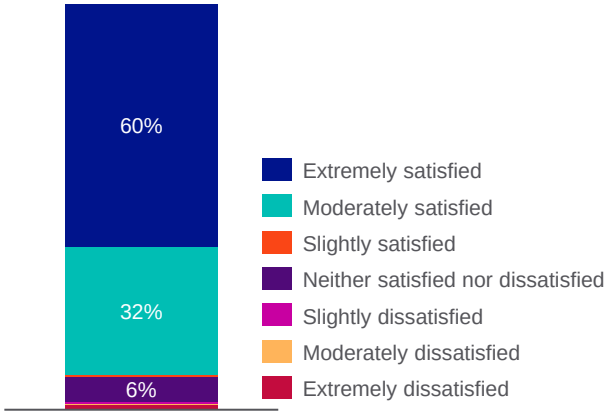
How frequently has participating in events caused any discomfort for you or someone else in the household?



- Around half of participants expressed discomfort within their household during events at some point during the trial. This seemed to **impact customers with and without vulnerabilities similarly**, although customers with vulnerabilities were slightly more likely to feel regular discomfort (7%) than those without (4%).

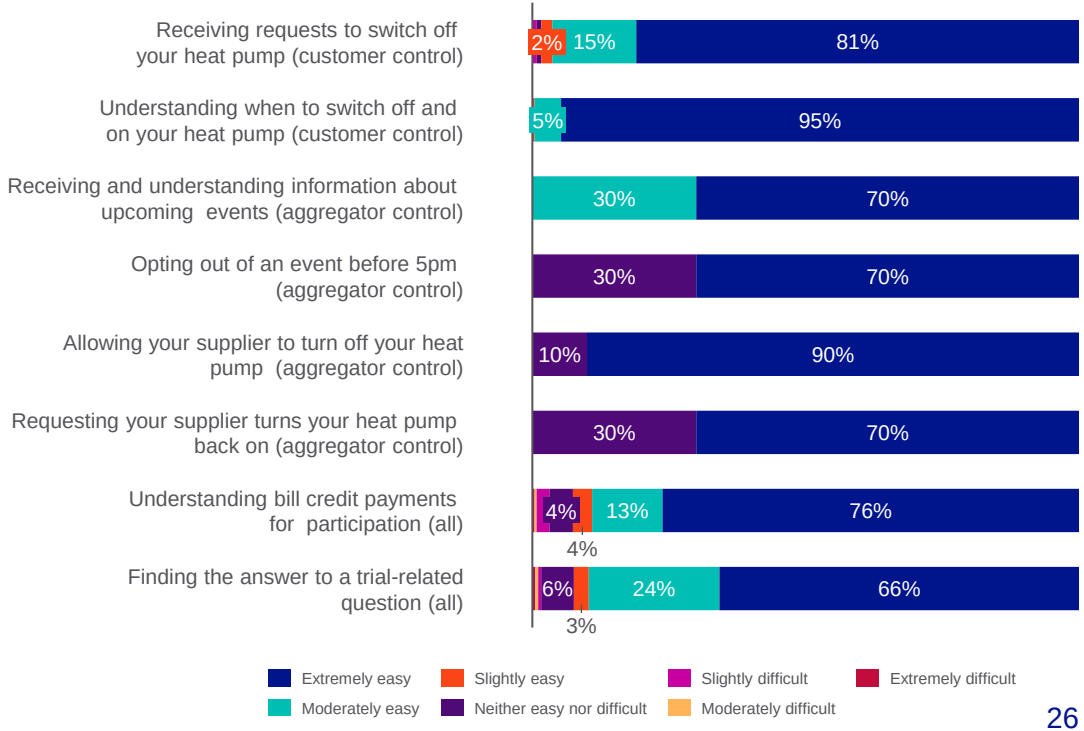
Finding 11: General satisfaction was high across all variables and trial participants found it easy to navigate

Overall satisfaction



- Over 90% of customers were extremely or moderately satisfied with EQUINOX.
- Less than 2% of trial participants reported being dissatisfied.

How easy have you found the following elements of participating in EQUINOX?



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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

Additionally, trial two will investigate factors that arose in trial one and required further probing

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)

Q&A

We look forward to continuing to share with you!

Full research findings are available here:

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

Recruitment for trial 2 will begin in September.

If you have any additional questions, please feel free to contact us at **NGED.Innovation@nationalgrid.co.uk**

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