EQUINOX

Transforming DNOs Heat Electrification Challenges into Innovative Solutions

Energy Innovation Summit

1st November 2023

Ryan Huxtable

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Agenda

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


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**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?

- **2022/2023**
  - **1st Winter Trial 2022/2023**
  - First trial took place between December 2022 and March 2023
  - Over 350 households participated
  - These participants were not fully representative of the UK demographic, but we are building on this for future trials.

- **Summer 2023**
  - Planning for Trial 2

- **Current focus**
  - **2nd Winter Trial 2023/2024**
  - Designing new commercial arrangements
  - Updating trial design
  - Carrying out recruitment
  - Plan to kickoff trial in November 2023
  - Expect over 600 households to participate

- **2024/2025**
  - **3rd Winter Trial 2024/2025**
  - Expect over 1000 households to participate

- **Deploy Solutions to Unlock Domestic Heating Flexibility Across Great Britain**
  - National Grid Energy Innovation Summit – 1st November 2023

- **6th Winter Trial 2023/2024**
  - Summer 2023
Trial One Design
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.
Event days were chosen a week in advance with the goal of achieving a wide temperature spread.

- **22 events:**
  - 2 warm events (>10°C)
  - 10 mild events (5-10°C)
  - 8 cold events (0-5°C)
  - 2 very cold events (<0°C)

- Events were scheduled based on forecasted temperature
- Wanted to see whether there was a correlation between turndown and temperature
- The winter was mild and had few very cold days (<0°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.
Trial One Findings
Households were able to provide significant turndown when asked to shift their domestic heating habits

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

Octopus: Half hourly household 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.
Turndown had an inverse linear relationship with temperature. A colder day meant higher flexibility.

- 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

**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**

- 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 10°C 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

- All
- Octopus (Self-Reported Participants)
- Octopus (Measurable Participants)
- Sero
- All (Trend)

Event-by-event participation rates by payment type

- Pay Monthly (Self-Reported Participants)
- Pay per Event (Self-Reported Participants)
Customers with vulnerabilities did not seem to be less able to participate or more likely to experience discomfort

- 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%).

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

<table>
<thead>
<tr>
<th></th>
<th>Non-Vulnerable</th>
<th>Vulnerable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>42%</td>
<td>42%</td>
</tr>
<tr>
<td>Don’t Know</td>
<td>57%</td>
<td>55%</td>
</tr>
<tr>
<td>No</td>
<td>1%</td>
<td>2%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Non-Vulnerable</th>
<th>Vulnerable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Sometimes</td>
<td>5%</td>
<td>52%</td>
</tr>
<tr>
<td>About half the time</td>
<td>0%</td>
<td>52%</td>
</tr>
<tr>
<td>Most of the time</td>
<td>42%</td>
<td>44%</td>
</tr>
<tr>
<td>Always</td>
<td>5%</td>
<td>1%</td>
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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

- Extremely satisfied: 60%
- Moderately satisfied: 32%
- Slightly satisfied: 6%
- Neither satisfied nor dissatisfied: 6%
- Slightly dissatisfied: 6%
- Moderately dissatisfied: 6%
- Extremely dissatisfied: 6%
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4

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

<table>
<thead>
<tr>
<th>Variables to test</th>
<th>Additional factors</th>
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</thead>
<tbody>
<tr>
<td>1 Payment amounts: households will be paid per kWh oftdown</td>
<td>Vulnerability: recruit from a wider demographic pool to ensure customers with vulnerabilities can participate equitably in the flexibility market</td>
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<tr>
<td>2 Notice period: households will receive varied notice periods that align with different DNO flexibility services</td>
<td>Snapback: turn heat pumps down instead of off to minimise high energy demand immediately post-event</td>
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<td>3 Control method: more aggregator control homes are expected to participate</td>
<td>Hot water: optimise the timings of hot water heating cycles to reduce snapback post-event</td>
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<tr>
<td>4 Time of day: events will still last two hours, but could be scheduled any time between 4-8pm</td>
<td>Energy efficiency: investigate how differing levels of energy efficiency impact flexibility from domestic heating</td>
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<td></td>
<td>Cluster analysis: analyse trial findings based on clusters to simulate constraint management zones (CMZs)</td>
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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.