

EQUINOX



Learnings from Trial three: Morning heat pump flexibility events

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1. Glossary of terms

- **Constraint Managed Zones:** Areas of the electricity network where demand or generation is actively managed to avoid network constraints and maintain system stability
- **Customers:** term EQUINOX uses when referring to customers of energy suppliers generally
- **Demand response:** A strategy that adjusts electricity usage by consumers in response to supply conditions, such as price signals or grid needs
- **Demand turn up:** demand response when more electricity is consumed relative to a baseline
- **Demand turndown:** demand response when less electricity is consumed relative to a baseline
- **Difference-in-Differences:** A method that compares changes over time between a treatment and control group to estimate the effect of an intervention
- **Dynamic:** an NGED flexibility product procured to support unscheduled maintenance, with a duration from between 30 mins to several hours, on a single day
- **Distribution Network Operator:** company licensed to operate the electricity distribution network in a specific region of the UK
- **Equitable novel flexibility exchange (EQUINOX):** the name of the project
- **Events:** periods of the day when EQUINOX trial participants were asked to provide demand response
- **Heat pump homes:** households with heat pumps
- **National Grid Electricity Distribution:** the UK's largest regional Distribution Network Operator
- **Network Innovation Competition:** a programme that funded energy network innovation projects
- **The Office of Gas and Electricity Markets:** the UK's energy regulator responsible for protecting consumers and ensuring a secure, sustainable, and affordable energy system
- **Participants:** term EQUINOX uses when referring to customers enrolled in the EQUINOX trials
- **Randomised Control Trial:** A study where participants are randomly assigned to a treatment group (receives the intervention) or a control group (used for comparison) to measure an intervention's effect
- **Secure:** an NGED flexibility product procured for peak load management, with a duration from between 30 mins to several hours, on a single day
- **The Office of Gas and Electricity Markets:** the UK's energy regulator responsible for protecting consumers and ensuring a secure, sustainable, and affordable energy system

- **United Kingdom:** The United Kingdom of Great Britain and Northern Ireland

2. Introduction to EQUINOX

Equitable Novel Flexibility Exchange (EQUINOX) is a Network Innovation Competition (NIC) project funded by the Office of Gas and Electricity Markets (Ofgem). It is led by National Grid Electricity Distribution (NGED), the UK’s largest regional Distribution Network Operator (DNO) and supported by multiple project partners¹. It is developing, trialling, and where proven, implementing suitable arrangements at scale that can maximise participation of domestic heat pumps in DNO procured flexibility² while meeting the needs of all customers, including those with potential vulnerabilities.

Heat pumps are expected to become a mainstream choice to decarbonise home heating in the United Kingdom (UK). The National Energy System Operator (NESO) forecasts an increase in annual heat pump installations from 95,000 in 2024 to more than 1.1 million by 2035³. The electrification of heat therefore stands to substantially increase electricity demand. If this new demand coincides with existing demand peaks, demand may more frequently exceed the capacity of DNO infrastructure e.g. substations and cables. Increased demand could exacerbate existing constraints or create new ones. Constraints are ultimately resolved through network reinforcement but can also be managed in the short- to medium- term through procurement of flexibility. In many instances, it is more cost-effective for DNOs to defer reinforcement by procuring flexibility, rather than reinforcing immediately.

EQUINOX is iteratively testing novel commercial arrangements for heat pump flexibility across three trial periods between 2022-25 (Figure 1 Fig.1). The trials measure demand response from heat pumps to better understand the customer experience of heat pump flexibility.

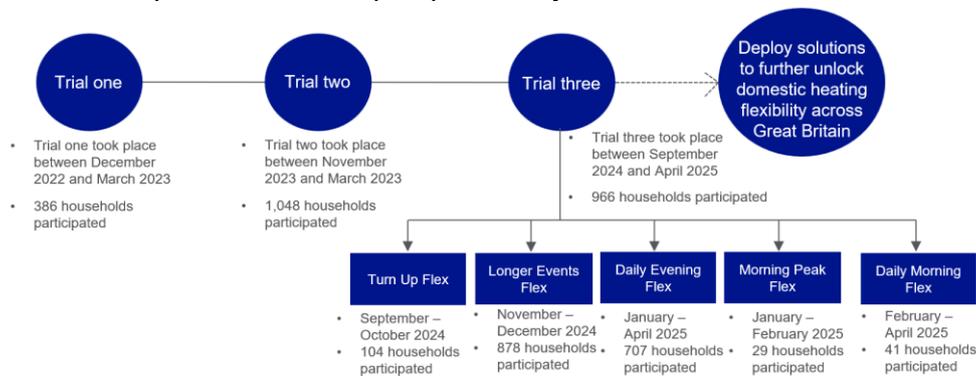


Figure 1: EQUINOX project overview

¹ A full list of project partners can be found in [Appendix A](#).

² As defined by NGED, flexibility is reducing loads on the network by using customers’ ability to change their usage patterns by either reducing consumption, changing their electricity habits, or (at a larger commercial scale) switching on generators. [Flex In Five An Overview of Flexibility](#)

³ NESO records show over 95,000 annual heat pump installations in 2024, rising to 1.13 million to 1.46 million by 2035 across its three net zero compatible Future Energy Scenarios (FES): Hydrogen Evolution, Electric Engagement, and Holistic Transition. [Future Energy Scenarios 2025 Data Workbook V001](#)

Trial one⁴ ran across winter 2022-23 with almost 400 participating households (“participants”) and was a successful proof of concept for heat pump flexibility. Trial two⁵ (winter 2023-24) iterated on the results of trial one, increasing the participants pool to over 1,000 customers. This increased scale permitted closer analysis of demand response volumes and used commercial arrangements that more closely mimicked existing DNO flexibility products typically used for unlocking flexibility from electric vehicle charging or other assets. Trial three, held between September 2024 and April 2025, built on the results of trial one and two to investigate additional opportunities for heat pump flexibility to support networks. Specifically, trial three aimed to:

- Test potential for domestic heat pump flexibility during the morning peak as well as the evening peak.
- Uncover the potential for domestic heat pump homes to offer daily flexibility.
- Explore longer heat pump flexibility events, beyond the two-hours tested in trials one and two.
- Test the customer proposition for stacking flexibility from heat pump homes through EQUINOX with an active flexibility product run by NESO. Stacking offers the prospect for customers to unlock greater rewards from flexibility participation and the opportunity for DNOs and NESO to procure flexibility services from the same assets⁶.
- Improve understanding of how customer vulnerability should be defined in the context of heating flexibility.

To achieve these aims, we split trial three into five mini-trials each focusing on different aspects of demand response and customer experience.

2.2 Trial three mini-trials

Each mini-trial focused on different aspects of heat pump flexibility:

- **Heat pump turn up flexibility (‘Turn Up Flex’):** demand turn up⁷ events on non-consecutive days, between 11am - 1pm.
- **Longer heat pump flexibility events (‘Longer Events Flex’):** demand turndown⁸ events of differing lengths, on non-consecutive days, between 4-8pm.
- **Daily evening heat pump flexibility (‘Daily Evening Flex’):** ‘everyday’ demand turndown events on weekdays, across consecutive weeks and occurring between 4-8pm.
- **Morning heat pump flexibility events (‘Morning Peak Flex’):** demand turndown events on non-consecutive days, between 8-10am.
- **Daily morning heat pump flexibility (‘Daily Morning Flex’):** daily demand turndown events on weekdays, across consecutive weeks and between both 8-10am and 5-7pm of the same day.

This report focuses on Morning Peak Flex.

3. Morning Peak Flex trial design

⁴ Trial one report: [Initial Insights on the Effectiveness of Commercial Methods](#)

⁵ Trial two report: [Learning from trialling novel commercial methods Project deliverable 4](#)

⁶ Stacking is when assets provide flexibility to more than one flexibility service. See the Energy Network Association’s report: [Revenue Stacking Explainer and FAQ’s](#).

⁷ Demand response when more electricity is consumed relative to a baseline.

⁸ Demand response when less electricity is consumed relative to a baseline.

3.1 Context and aims

EQUINOX trial one (winter 2022-3) and trial two (winter 2023-4) demonstrated heat pump flexibility could help reduce electricity demand during the weekday evening during peak times for networks between 4-8pm. They tested 2-hour turndown events at a rate of two to three times per week on non-consecutive weekdays, in a format aligned to NGED's Secure and Dynamic flexibility products⁹.

Trial three aimed to assess the feasibility of heat pumps to support networks in additional ways not tested in trials one and two. This included trialling for the first time in EQUINOX events in the morning time between 8-10am, which is another period of high electricity demand for networks. There are several constraints within NGED's licence areas that have this specific need for flexibility. We used the Morning Peak Flex mini-trial to assess customer acceptance, comfort levels and feasibility of morning events between 8-10am. This trial laid the groundwork for Daily Morning Flex, which followed immediately after, and aimed to test daily flexibility from 8-10am, Monday to Friday.

In Morning Peak Flex we therefore aimed to assess:

- Whether heat pump homes can deliver daily demand response during the morning peak.
- Whether this daily demand response can be achieved alongside high rates of participant satisfaction and minimal impact on comfort – including for those with potential vulnerabilities.

3.2 Trial structure

Morning Peak Flex was carried out over two weeks from 27th January to 7th February 2025. The timing was selected to enable data collection during the heating season, and ahead of the Daily Morning Flex trial scheduled for February 10th to April 4th. 29 customers of ScottishPower took part in Morning Peak Flex, with all allocated to the treatment group.

Treatment participants were asked to reduce their heat pump electricity consumption during five morning flexibility events (8–10am), held two to three times per week. We did not recruit a control group but instead, for comparison purposes, used the aggregate electricity consumption of anonymised ScottishPower customers with heat pumps that were not signed up to the trial.

3.3 Participant details

3.3.1 Trial eligibility

To be eligible for the trial, we required that all participants be:

- Customers of ScottishPower.
- Have a pre-installed air-to-water or ground-to-water heat pump as their primary method for home heating.
- Be in NGED's or Scottish Power Energy Networks' (SPEN) license areas.
- Have a pre-installed smart meter that was consistently providing half-hourly meter reads.

⁹ Secure, procured for peak load management, and Dynamic, procured for unscheduled maintenance, are both scheduled from between 30 mins to several hours, on a single day. Note that when trial three was designed these products were still actively procured by NGED. They have now been largely replaced by Operational Utilisation, which procures short-term flexibility lasting for a single day. See NGED's report on the new products formalisation:

[Distribution Flexibility Services Procurement Statement](#).

- Be using an electricity import tariff (“tariff”) that does not have different prices for electricity between 8am and 10pm (e.g. a tariff with an off-peak price 1300 – 1600 is not permitted)¹⁰.

3.3.2 Recruitment approach

Customer recruitment was led by ScottishPower and was conducted via emails which included messaging about the trial objectives, a description of what would be requested of customers participating, and potential financial benefits of taking part. Scottish Power’s recruitment pool covered approximately 800 customers across the NGED and SPEN license areas who had installed heat pumps through the Energy Company Obligation (ECO4)¹¹. ScottishPower sent these customers a trial recruitment email, with a follow-up email sent to those who hadn’t opened the email a few days later. This recruitment campaign resulted in 29 customers signing up and participating in Morning Peak Flex.

Due to the small number of customers recruited, all were assigned to the treatment group that would be asked to reduce their heat pumps’ electricity consumption during event times. We did not assign any of the recruited customers to a control group – a group of trial participants that would not be asked to turndown their heat pump but instead allow their electricity consumption data to be used for data comparison purposes. As explained in Section 3.2, for data comparison purposes ScottishPower used aggregated anonymised data from other customers with heat pumps.

3.3.3 Demographics

Of the 29 recruited participants, 18 completed the start of trial survey which captured key demographic details like household characteristics, property details and potential vulnerability factors.

For trial three we refined our approach to categorise, identify, and account for potential vulnerabilities. This involved considering a higher number of individual and combined potential vulnerability factors, identified through a bespoke Equitable Participation Framework (EPF)¹². We identified eight self-reported factors¹³ that would contribute to whether a participating household was considered potentially vulnerable or non-vulnerable.

We classified participants as potentially vulnerable only if they met one of the following three circumstances:

¹⁰ Customers were eligible if on a tariff with a fixed price across each 24-hour period, or if on a tariff with a fixed daytime price but reduced or variable prices overnight. We included this eligibility criteria because in trial two we saw that participants with a tariff with multiple daytime unit rates were already providing daily flexibility for up to 3-hours Monday to Friday – likely in response to their tariffs price signal. For this mini-trial we wanted participants to not have a pre-existing incentive to turn down, so any turndown they did achieve could be attributed to the mini-trial.

¹¹ ECO is an obligation placed on energy suppliers to deliver energy efficiency measures to households in fuel poverty. ECO4 is the 4th iteration of this scheme. [Energy Company Obligation - Ofgem](#)

¹² See “[Project Deliverable 5: Learnings from Engaging Customers](#)” for detailed explanation of the customer engagement approach, including how vulnerability factors are considered

¹³ The eight vulnerability factors included: Having a health condition exacerbated by the cold, having a disability or long-term health condition, having children under 5 years old in the home, having individuals over the age of 75 in the home, home being poorly insulated, living alone, being a lone parent, and meeting the low-income threshold.

- The household was defined as having a low income¹⁴ according to their household composition. Households were also removed from the vulnerability segmentation if they were classified as low income, but self-reported that they were able to regularly afford their energy bills.
- Someone within the household self-reported having a health condition exacerbated by the cold; or
- The household met at least two of the self-reported EPF vulnerability factors such as having individuals in the home of a certain age, home being poorly insulated or single occupancy.

Figure 2 shows that 72% (13 participants) of the start of trial survey respondents could be classed as potentially vulnerable. Additionally, 44% (eight participants) were classified as low income or in fuel poverty – a higher figure than the UK national average of 36%¹⁵. Given that recruitment targeted ECO4 scheme recipients, it could be likely that some of the 11 non-respondents would also meet the potential vulnerability criteria.

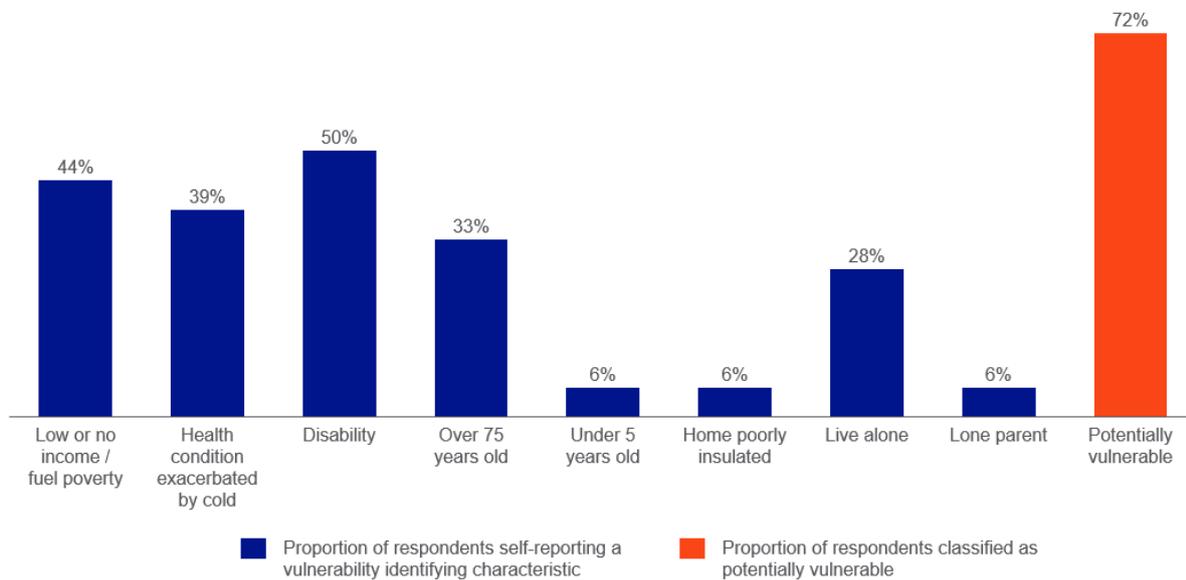


Figure 2: Proportion of potentially vulnerable participants in Morning Peak Flex (n=18)

¹⁴ Households were classified as low income based on their household composition and annual household income, in alignment with the [UK minimum income standard](#).

¹⁵ The Minimum Income Standard sets out what the public agree is needed to live in dignity and the income require to meet this standard. [Minimum income standard - Joseph Rowntree Foundation](#)

3.4 Commercial arrangements

To assess the potential of heat pump homes to participate in longer flexibility events in this mini-trial, commercial arrangements and event design emulated expected network flexibility needs where possible and otherwise prioritised simplicity and customer convenience. Design of the commercial arrangements and events are summarised in Table 1.

Table 1: Morning Peak Flex participants' commercial arrangements

Item	Participant
Payment structure	£5 for completion of recruitment survey £5 for completion of start of trial survey £5 for completion of end of trial survey £1.50 per event upon completion of post-event survey
Control type	Manual customer control
Notice period - day ahead	Day ahead
Eligible supplier tariffs	No tariff with multiple unit rates between 8am and 10pm – which might incentivise load shifting during the daytime. Any other tariff accepted
Event duration	Two hours
Event timing	2 hours between 8-10am
Event frequency	Two to three events per week
Supplier notice	Informed by NGED on Wednesday of the preceding week

As shown in

Table 1, we rewarded participants for completing post-event surveys. We did not reward participants on a utilisation basis since we were more concerned with obtaining feedback on their experience of morning events than with how much turndown they could achieve.

Morning Peak Flex events were all held at 8-10am at a rate of two to three events per week on weekdays. We gave participants day ahead notice of events, based on positive feedback on this notice period during both trial two and Turn Up Flex. ScottishPower, however, was notified of events on the preceding Wednesday to simplify operational delivery of the mini-trial.

We held events primarily on non-consecutive days to avoid any potential issues of demand turn up on an event day subsequently impacting demand turn up activity on the following day. The exception was the final

day of the trial, when another event was scheduled to increase the number of trial days. This extra event was scheduled because a previous event was cancelled due to a storm event. It wasn't considered appropriate to ask customers to participate in a demand reduction event as some of them may have been subject to power outages and priority is given to maintaining supplies.

All participants controlled their own heat pumps during events, with no third party-controlled demand response. For simplicity, demand response was only considered for home electricity import, and changes in any potential export volume were not measured.

Participants did not need to opt into individual events and were eligible for £1.50 post-event survey payments so long as they completed them. Participants in the treatment group were also rewarded up to £15 for completing recruitment, start of trial and end of trial surveys.

3.5 Analysis approach

Following industry best practice for evaluating trial programmes, suppliers leveraged a Difference-in-Difference (DiD) approach for calculating demand response. DiD approaches provide an estimate of programme demand response when energy consumption from the entire treatment group is compared to the entire control group for each event. We then used the Root Mean Square (RMS) method to calculate aggregate errors¹⁶.

We did not have a formal control group, but we used the consumption data of anonymised ScottishPower customers with heat pumps. We selected these customers based on how closely their historic consumption patterns matched those of the recruited treatment group. This matching allowed us to reasonably attribute any differences in consumption during event periods to the effects of the programme treatment.

Throughout all the mini-trials including, Morning Peak Flex, we prioritised equitable access and participation for all customers, including those experiencing vulnerability or fuel poverty. Participant experience was evaluated through a series of surveys. These aimed to capture further information on customer perspectives, self-reported behavioural change during events, and satisfaction with the overall experience. These were:

- End of trial survey.
- Five short post-event surveys that were sent out following each event.

¹⁶ The full DiD and RMS approach is provided in Appendix B.

4. Results

Section 4 presents findings aligned with our research aims. Section 4.1 examines whether heat pump homes can deliver statistically significant demand response during morning periods, while Section 4.2 explores whether this response can be achieved with high customer satisfaction and minimal comfort impacts. Within Section 4.2, we report self-reported participation in events (4.2.1), satisfaction with morning events (4.2.2), comfort levels (4.2.3), and insights on the value of sending reminders when an event ends (4.2.4).

4.1 Demand response

Our DiD analysis did not yield statistically significant turndown greater than 0 kW during any of the events. We believe this is due to the small trial sample size leading to large confidence intervals overlapping the 0 kW mark meaning we cannot conclude that demand turndown greater than 0 kW was achieved. Based on the customer experience findings below, we anticipate that it would have been possible to detect demand response had the trial sample size been larger.

4.2 Customer experience

Throughout all the mini-trials including, Morning Peak Flex, we have prioritised equitable access and participation for all customers, including those experiencing vulnerability or fuel poverty. We employed a mix-methods approach, combining quantitative surveys with qualitative interviews and focus groups to explore customer willingness to engage in heat pump flexibility and understand the experiences and barriers for potentially vulnerable customers.

Directly engaging participants underpinned the customer research conducted in Morning Peak Flex. This research predominately included surveys, whereby participants who agreed to data sharing with Guidehouse completed three surveys. One survey at the start of the trial, post-event surveys that were issued immediately following the events, and an end of trial survey. 62% completed the start of trial survey, 63% completed the post-event surveys, and 72% completed the end of trial survey.

4.2.1 Participation

Post-event survey results suggest that despite the inconclusive DiD results, participants did provide demand response. Figure 3 shows that 50% (15 participants) self-reported full or partial participation on average across all five events¹⁷. 38% (11 participants) did not complete the post-event surveys, thus we cannot determine whether those participants provided demand response. Nevertheless, the self-reported participation rate did not decrease throughout the week and even reached a trial maximum of 59% on the final event day. It is important to note that there was no penalty for not taking part in events or for participating in only part of an event. Participants were encouraged to only participate in events for as long as it made sense to them based on individual preferences and circumstances including comfort.

¹⁷ Post-event survey question stated: "Was your heat pump turned down (or off) for today's event? if your heating was already down or off and you left it that way, that counts! Please select one option."

The average 50% self-reported participation rate for Morning Peak Flex was in line with that of the trial two average at 47%. This suggests customer acceptance of morning peak heat pump flexibility could be similar to that of the evening peak, though we acknowledge this is tempered by the comparatively small trial sample size of Morning Peak Flex. Overall, the participation rates reflect a clear willingness from participants to try morning events.

Additionally, we did not observe a meaningful variation between self-reported participation rates of potentially vulnerable participants and non-vulnerable participants, indicating that morning peak flexibility could be possible for a variety of customers.

4.2.2 Satisfaction with morning events

Participants reported high satisfaction with the time of the morning events when question in the end of trial survey¹⁸. Figure 4 shows that 67% (14 participants) were satisfied, and only 5% (one participant) dissatisfied with the timing of events. We saw no meaningful variation in satisfaction rates between potentially vulnerable and non-vulnerable participants, indicating morning peak flexibility could be possible for a variety of customers. We are encouraged by customer appetite to participate in a range of novel commercial offerings while also being able to maintain high customer satisfaction. This highlights the success of our customer-centric trial design approach.

Participants also gave information on their satisfaction with the morning time of events through free text responses, providing additional context on why customers might be able to participate in morning events.

71% (15 participants) of those who completed the end of trial survey provided a free text response, and as shown in Figure 5, 93% indicated satisfaction with the trial. 53% reported satisfaction based on the morning period aligning well to their schedule, while 35% reported satisfaction based on being able to sufficiently pre-

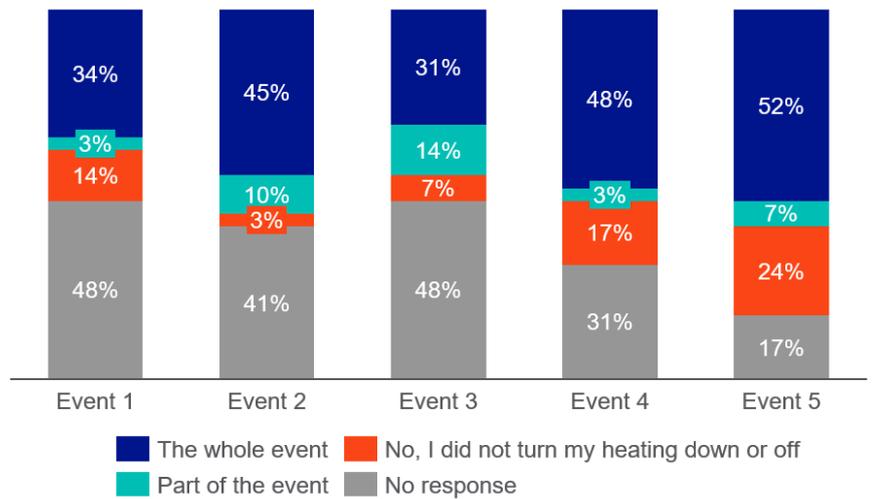


Figure 3: Self-reported event participation rate in post-event surveys (n=29)

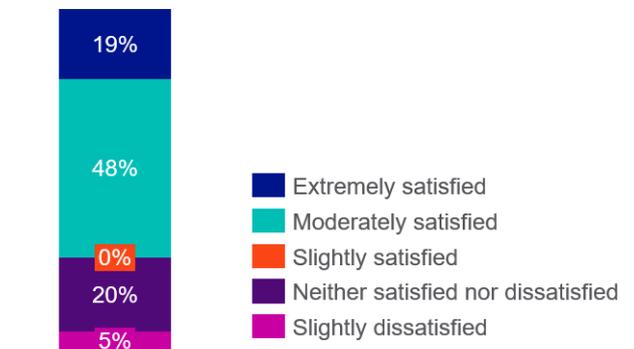


Figure 4: Participants' satisfaction with the morning time of events in end of trial survey

¹⁸End of trial survey question stated: "How satisfied were you with the morning time of the events?"

heat their home to be able to comfortably stay turned down during the event. Just one participant reported dissatisfaction with the morning events, citing a preference for afternoon events instead.

Selected responses	
Positive relating to schedule (8 responses)	<ul style="list-style-type: none"> It's the best time for me as I am on a school run so don't have leave heating on too warm. Fewer individuals at home so no disruption.
Positive relating to pre-heating (5 responses)	<ul style="list-style-type: none"> I set the heating to come on earlier and since my house is well insulated it retain the heat during the trial period. My heating is already up to temperature by 08:00. So far, the Equinox event between 08:00 and 10:00, has not had a major impact on the comfort levels of our home.
Negative (1 response)	<ul style="list-style-type: none"> With my work pattern it would be better if it was closer to afternoon.

Figure 5: Selected free text responses on morning time of events, from end of trial survey

4.2.3 Comfort

Comfort was a key consideration when testing morning events during Morning Peak Flex. To safeguard against potential underheating, there was no penalty for not taking part in events or for participating in only part of an event. An important result of the trial was that most participants reported no change or only a minor change in comfort during the events in the end of trial survey¹⁹. As shown in Figure 6, amongst 21 respondents, 10 reported a neutral or no change in comfort levels, eight reported that it made their home feel slightly cool and two reported it made their home cool. There was no significant difference in responses between potentially vulnerable and non-vulnerable participants. Only one participant indicated that the events made their home too cold, and this participant was not potentially vulnerable.

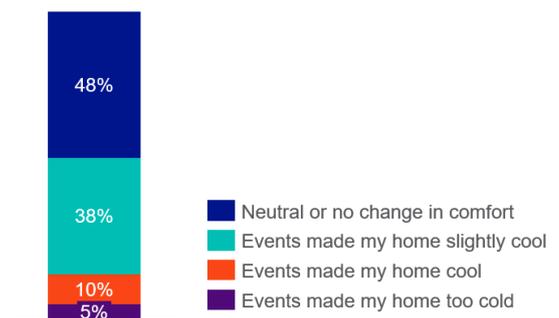


Figure 6: Participants' self-reported impact on comfort in the end of trial survey (n=21)

These results suggest customers can participate in morning events for commercial flexibility offerings without feeling significant discomfort.

¹⁹ End of trial survey question stated: "How much, if at all, did the Morning Peak Flex events impact the comfort levels of your home?"

4.2.4 Reminders

Participants received a notification to complete a post-event survey at the end of each event. This notification served two purposes. Firstly, it encouraged completion of the survey and secondly, it provided a reminder that the Equinox event had ended and that participants should turn their heating back on if they wished. We implemented this to help mitigate participants turning down their heating for longer than necessary. Figure 7

shows participant responses to the end of trial survey question: “Did the email about the post-event survey help remind you to turn your heating back on?” 18% of non-vulnerable participants who completed the survey (two participants) found the reminder helpful for turning their heating back on. However, amongst participants that we identified as potentially vulnerable, 50% (five participants) found the reminder helpful. These results indicate that when implementing domestic flexibility services for heat pump homes it is important to consider a reminder at the end of events to mitigate potential discomfort – especially for potentially vulnerable participants.

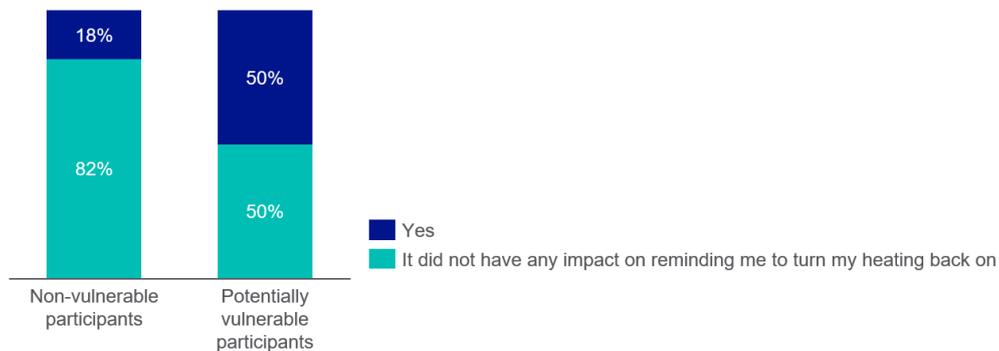


Figure 7: Non-vulnerable participants responses in end of trial survey on whether the post-event survey email helped remind them to turn their heating back on (n=11) compared to potentially vulnerable participants (n=10)

5. Summary

The results of the Morning Peak Flex mini-trial indicate definite potential for heat pump homes to participate in morning peak flexibility. The key takeaways from the trial are summarised below:

1. **Heat pump homes are willing to provide flexibility in the morning.** Despite inconclusive DiD results, an average of 50% of participants self-reported participating in all or part of the events in the post-event surveys.
2. **Providing morning peak demand turndown will not overly inconvenience customers.** 67% of participants reported satisfaction with the morning events. Most participants reported that alignment with their schedule was the primary reason for liking morning event times, as they were not home or were able to easily heat their homes before the events.
3. **Providing morning peak demand turndown will not significantly discomfort customers.** 86% of participants reported experiencing no change or a slight change in comfort. Just 5% (one participant) reported feeling too cold during events and that person was not potentially vulnerable. These results indicate that the majority of customers can participate in morning peak events without experiencing discomfort.
4. **Sending a reminder that an event has ended could be especially important for potentially vulnerable customers.** Participants received a notification to complete a post-event survey at the end of each event, which also served as a reminder to turn their heating back on. 35% of all participants and 50% of potentially vulnerable participants reported that this notification reminded them to turn their heating back on.

Overall, the results of the Morning Peak Flex mini-trial are encouraging. The mini-trial represents EQUINOX's first investigation into morning peak flexibility. We are encouraged that participants, both potentially vulnerable and non-vulnerable, reported positive experiences of the trial. This highlights the potential for morning peak flexibility to be implemented at scale. We also recognise the value of these learnings for broader participation of heat pumps in flexibility services – not just those procured by DNOs. This trial indicates heat pump homes could additionally provide morning peak demand response for National Energy System Operator (NESO) through their own flexibility services, providing still greater value to GB.

6. Appendix A: Project partners

EQUINOX is led by NGED, along with multiple project partners and collaborators, as detailed in Table 2.

Table 2. List of EQUINOX partners and collaborators

Name	Project function	Role
NGED	DNO	Project lead. Responsible for running the technical integration, trial design, and project management and knowledge workstreams.
Guidehouse	Consultancy	Partner. Responsible for supporting the commercial arrangement design and customer engagement workstreams. Supporting on trial design, data analysis, project management, and knowledge dissemination.
Octopus Energy	Energy supplier	Partners. Responsible for planning and delivering EQUINOX trials with participants from their customer base. Supporting all project workstreams as commercial flexibility service providers and customer experts.
Sero	Energy supplier ²⁰	
ScottishPower	Energy supplier	
Passiv UK	Smart technology company	Partner. Responsible for simulating the flexibility impacts for different intervention strategies and household archetypes.
West Midlands Combined Authority	Local government	Partner. Responsible for coordinating a social housing heat pump installation programme which can contribute customers to trials two and three. Also advising on equitable participation.
Welsh Government	Government	Partner. Responsible for running a social housing heat pump installation programme which can contribute customers to trial three.
National Energy Action	Charity	Collaborator. Responsible for running participant focus groups to understand trial perceptions. NEA will ensure that the needs of customers with vulnerabilities are accounted for in the trial design.
SP Energy Networks	DNO	Partner. A DNO brought on board to ensure that the design is interoperable for all DNOs. SPEN's license areas will join trial three.
National Energy System Operator	NESO	Collaborator. Responsible for sharing learnings between EQUINOX and other ESO flexibility programmes.

²⁰ Sero is not an energy supplier but assuming the role for the purpose of trials one and two.

7. Appendix B: Difference in Difference approach

As detailed in Section 3.5, we used the DiD approach to determine the treatment effect during Morning Peak Flex.

Equation 1 below provides the DiD specification used to calculate an estimate of demand response for each event.

Equation 2 details the calculation of uncertainty (standard error). Equation 3 details the calculation we used to aggregate the standard errors to generate an overall average demand response impact across multiple events.

Equation 1: DiD demand response calculation²¹

$$\text{Demand response} = [\text{mean}(\text{observed demand}_{\text{treatment, event}}) - \text{mean}(\text{observed demand}_{\text{control, event}})] - [\text{mean}(\text{observed demand}_{\text{treatment, non-event}}) - \text{mean}(\text{observed demand}_{\text{control, non-event}})]$$

Equation 2: DiD standard error calculation²²

Demand response standard error

$$= \sqrt{\frac{\text{Variance}(\text{observed demand}_{\text{treatment, event}})}{\text{Customer count}_{\text{treatment, event}}} + \frac{\text{Variance}(\text{observed demand}_{\text{control, event}})}{\text{Customer count}_{\text{control, event}}} + \frac{\text{Variance}(\text{observed demand}_{\text{treatment, non-event}})}{\text{Customer count}_{\text{treatment, non-event}}} + \frac{\text{Variance}(\text{observed demand}_{\text{control, non-event}})}{\text{Customer count}_{\text{control, non-event}}}}$$

The treatment group participants were deemed to have delivered demand response for an event if they decreased their energy consumption during the event as per Equation 1.

²¹ Observed Demand = household consumption in kWh; Treatment = group of customers called to participate during an event; Control = group of customers not called to participate; Event = time frame during which consumption was averaged across the treatment or control group of customers on event days; Non-event = time frame during which consumption was averaged across the treatment or control group of customers on non-event days.

²² Variance = statistical measure quantifying estimate uncertainty; Customer count = number of customers called during event.

As detailed in Section 3.5, the RMS approach was used to determine the aggregated standard error during Morning Peak Flex. Equation 3 below provides the RMS specification used to calculate an estimated standard error grouped across events.

Equation 3. RMS standard error calculation²³

$$\text{Root Mean Square (RMS)} = \sqrt{\frac{1}{N} \sum_{i=1}^N (SE_i)^2}$$

²³ SE_i = standard error from event i ; N = total number of events.

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