EQUINOX

Transition of learning to Business as Usual

Project Deliverable 6

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1. Foreword

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I am delighted to share with our stakeholders not only the key learning from the EQUINOX project but, more importantly, the outcomes that will shape our business and the wider flexibility landscape.

EQUINOX has been a pivotal project for National Grid Electricity Distribution (NGED). The electrification of domestic heat represents a fundamental shift, not only in how electricity is consumed but also in how it impacts the day-to-day operation of our networks. At the same time, it offers a significant untapped resource for the more efficient management of our local distribution networks.

As highlighted in the CP2030 Action Plan and the Clean Flexibility Roadmap (2025) [1], flexibility will play a critical role in achieving Net Zero, with an ambition to increase capacity to between 51GW and 66GW by 2030. Domestic heat pumps will form a key part of this capability. While substantial investment in infrastructure is essential, networks must also take a more active role in optimising demand and supply, supported by market reforms that enable greater customer participation. The EQUINOX project was conceived with this ambition in mind: to explore whether domestic customers could actively contribute to network flexibility by adjusting their heat pump usage during periods of high demand. This was both a technical and behavioural hurdle: Customers had never before been asked to adapt their heating for network management purposes.

The challenges to unlocking this resource were clear: uncertainty around reliability, commercial viability, and consumer appetite. These were the reasons we undertook EQUINOX – to understand what is truly possible.

The results are compelling. EQUINOX has already driven change within NGED, including the adoption of new demand profiles and improved planning assumptions. As the Distribution System Operator, we are committed to embedding these insights into our operations, ensuring flexibility from heat pumps is utilised wherever possible to manage the system cost-effectively. Today, more than 8,000 heat pumps are directly providing system flexibility, and this number will only grow.

This report also highlights how EQUINOX has shaped our thinking on customer vulnerability and engagement, through collaboration with our project partners. For example, a key achievement was the development of the Equitable Participation Framework (EPF), which we believe will serve as a valuable tool for the wider industry, helping to target support effectively and ensure all customers can benefit from flexibility services. EQUINOX has shown that both vulnerable and non-vulnerable customers can successfully engage in flexibility services.

EQUINOX is more than a project, it is a clear demonstration for a smarter, more resilient energy system. By demonstrating that customers can participate in flexibility without sacrificing comfort, and that networks can integrate this capability seamlessly, EQUINOX provides confidence in the role of domestic flexibility as a cornerstone of the UK's Net Zero future. These insights have already accelerated the integration of domestic flexibility into Business as Usual operations and will continue to shape innovation and policy across the sector.

2. Executive summary

The EQUINOX project, awarded in December 2021, set out with a tangible objective: to determine whether domestic customers would engage in providing Demand Response (DR) services through heat pump flexibility during colder months, in response to network needs. This challenge is significant for network operators, as customers have historically not been asked to adjust their heating for network management purposes.

Over three consecutive winters (2022-2025), EQUINOX adopted a "test and learn" approach, with each trial building on the insights of the previous one. This iterative methodology proved highly effective, generating robust learnings that are documented in this report.

This report first summarises the EQUINOX project and then details, for each trial, the key learnings and recommendations for Business as Usual (BaU). It addresses the following Ofgem project direction requirements:

1. Updates to flexibility simulation models using trial data (this alone is addressed in a series of separate reports contained with Appendix A).
2. A description of the recommended commercial arrangements, procurement strategy and technical integration to unlock maximum flexibility from domestic customers.
3. An overview of any regulatory or policy change needed to enable efficient roll out.
4. An update of the project business case that considers project learning.
5. A product roadmap will be produced for all elements of the EQUINOX commercial offerings that are proven to be viable as future Flexibility Products.

Each area is assessed for its business impact, with the report also presenting implementations to date, identifying gaps for future work, and providing an updated business case. Additional simulation work is referenced and available separately within this report as appendices.

The EQUINOX project generated a range of important insights, demonstrating both the technical and practical viability of integrating domestic heat pump flexibility into network operations. These findings inform recommendations to embed heat pumps into BaU flexibility:

- **Heat pumps as reliable flexibility assets:** Domestic heat pumps demonstrated the ability to provide meaningful, reliable flexibility to support network management, with high participation and measurable demand reductions—especially during colder periods.

- **Scalability and commercial viability:** EQUINOX has proven that flexibility from heat pump homes can be procured very similarly to other types of domestic flexibility. Therefore, the established standard flexibility products remain effective and do not require modification in consideration of EQUINOX findings.

- **Customer experience and equity:** High levels of customer satisfaction and comfort were maintained throughout, including among potentially vulnerable participants. The EQUINOX trials have demonstrated

that DSOs can procure heat pump flexibility without negatively impacting customers, and FSPs can be confident that customer experience will remain positive.

- **Technical integration and readiness:** The project leveraged existing BaU platforms and processes, demonstrating that heat pump flexibility can be integrated into current flexibility markets without the need for bespoke products or significant technical changes. This helps provide confidence for a more agile delivery into BaU.

- **Policy and regulatory insights:** EQUINOX provides robust evidence to inform policy on accelerating heat pump adoption, supporting smart-ready installations, and ensuring equitable participation.

The EQUINOX project has demonstrated that domestic heat pump flexibility is a credible, scalable, and customer-friendly solution for supporting the UK's net zero ambitions. The project's key findings confirm that heat pumps can reliably deliver meaningful flexibility, can be integrated into existing BaU operations, and are well-received by customers, including those who are potentially vulnerable. The trials have shown that commercial and technical barriers can be overcome, and that policy and regulatory frameworks can be informed by robust, real-world evidence. These learnings have already influenced NGED's network planning and flexibility operations. Additionally, these findings have allowed suppliers to build confidence in heat pump flexibility and innovate their customer engagement strategies.

The project's findings additionally underpin a revised business case aligned with ED3 guidance, shifting from reinforcement deferral to enabling new connections sooner through additional headroom. This updated approach demonstrates that the cost of procuring flexibility is far outweighed by the system and economic benefits, confirming EQUINOX as a viable, scalable solution. EQUINOX will unlock additional headroom, enabling new connections sooner.

Building on the learning from the trials, we recommend the integration of heat pumps into commercial-scale flexibility services across GB. To achieve this, we have developed a cyclical roadmap designed to facilitate the adoption of domestic heat pumps into BaU flexibility markets at scale leveraging the learnings gathered over the four-year EQUINOX project. This roadmap includes:

- Flexibility service providers strengthening engagement with customers to boost participation in flexibility services.
- Networks building confidence in the flexibility potential of heat pump households in areas with identified flexibility needs.
- Networks recognising that flexibility service providers bidding with heat pumps can reliably deliver flexibility when called upon.
- Policy interventions to accelerate heat pump deployment, speed up smart meter installations, and enhance cyber security standards.

While some gaps remain, particularly around extreme winter scenarios not experienced during the projects lifecycle and demand turn up services, the overall results provide a clear roadmap for embedding heat pump flexibility into network operations, delivering system benefits, and guiding future innovation and policy development.

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3. Report purpose and context

3.1 Report purpose and structure

The purpose of this report is to define how learnings from the Equitable Novel Flexibility Exchange (EQUINOX) project can be adopted into Business-as-Usual (BaU) procurement of heat pump flexibility.

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 partners[1]. Between 2022-2025, EQUINOX has developed and trialled arrangements at scale to maximise participation of domestic heat pumps in DNO procured flexibility[2] while meeting the needs of all customers, including those with potential vulnerabilities.

The EQUINOX project designed, implemented and evaluated three successive years of heat pump flexibility trials. The trials measured demand response from heat pumps in order to better understand the extent to which customers with heat pumps can provide flexibility, as well as the customer appetite for and experience of doing so. In addition, the trials captured overall flexibility volumes, offering insights into potential future volumes as heat pump adoption becomes more widespread.

This report collates key learnings across all three years of trials to define next steps for the implementation of heat pump flexibility into commercially procured flexibility services. It addresses the following Ofgem project direction requirements:

1. Updates to flexibility simulation models using trial data (this requirement is addressed in a series of simulation reports contained within appendix A).
2. A description of the recommended commercial arrangements, procurement strategy and technical integration to unlock maximum flexibility from domestic customers.
3. An overview of any regulatory or policy change needed to enable efficient roll out.
4. An update of the project business case that considers project learning.
5. A product roadmap will be produced for all elements of the EQUINOX commercial offerings that are proven to be viable as future Flexibility Products.

To meet these requirements, this report is structured as follows:

- Section 3 summarises the context to the EQUINOX trials.
- Section 4 provides an overview of the trials and their participants.

[1] EQUINOX project partners and collaborators are Guidehouse, Octopus Energy, Sero, ScottishPower, Passiv UK, West Midlands Combined Authority, Welsh Government, SP Energy Network. National Energy Action and National Energy System Operator.
[2] As defined by NGED: flexibility is about 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

- Section 5 sets out EQUINOX learning outcomes and recommendations for implementing commercial scale heat pump flexibility programmes.
- Section 6 outlines the EQUINOX learnings implemented to date.
- Section 7 highlights remaining gaps and future opportunities for engaging heat pumps in flexibility.
- Section 8 presents the EQUINOX business case, and the benefits of commercial scale heat pump flexibility.
- Section 9 outlines the roadmap for translating EQUINOX into BaU.
- Appendix A presents the simulation work undertaken.

3.2 Background to the project

The UK has committed to a legally binding target of achieving net zero greenhouse gas emissions by 2050, with interim milestones of a 68% reduction by 2030 and 81% by 2035 compared to 1990 levels. Heating homes currently accounts for approximately 18% of the UK's total greenhouse gas emissions[3]. This makes the electrification of heat crucial to decarbonisation. In addition to the carbon benefits of moving away from fossil fuel heating sources, heat pumps can be particularly advantageous for homes as they are highly efficient and can contribute to the reduction of energy bills.

Heat pumps are expected to become a mainstream choice to decarbonise home heating in the United Kingdom (UK). NGED's Distribution Future Energy Scenarios incorporate a rise in total heat pumps from 158,000 in 2025 to 1.1 million in 2035 across its four license areas[4], while The Climate Change Committee (CCC) recommends that half of all UK homes should be equipped with heat pumps by 2040[5]. The electrification of heat therefore stands to substantially increase electricity demand. If this new demand coincides with existing network demand peaks, demand may more frequently exceed the capacity of DNO infrastructure such as substations and cables. Increased demand could exacerbate existing constraints or create new ones.

To manage these challenges, National Grid DSO (Distribution System Operator) operates Flexibility Markets to efficiently maximise the security of the network. Flexibility services help shape loads by shifting demand outside of peaks times or matching electricity demand with times of peak electricity generation. We achieve this by financially incentivising customers to change their usage patterns, either reducing or increasing consumption or (at a larger commercial scale) switching on or off generation.

EQUINOX has explored how these benefits can be expanded through specifically heat pump flexibility, while exploring how engaging with flexibility can be accessible and equitable to all customers, including potentially vulnerable customers. EQUINOX is the first large-scale initiative in the UK to test heat pump flexibility at scale, as a commercial-scale solution for active network management.

[3] Decarbonising home heating, National Audit Office
[4] Average installed heat pump count across Hydrogen Evolution, Electric Engagement, and Holistic Transition. DFES Volume Projections by Electricity Supply Area, NGED.
[5] The seventh carbon budget, Climate Change Committee

4. Overview of the trials

This section is split into two main categories:

- Section 4.1 which summarises the objectives and testing arrangements for each of the EQUINOX trials.
- Section 4.2, which focuses on the demographics of participating customers.

4.1 EQUINOX trials objectives and testing arrangements

The EQUINOX trials were delivered between 2022 and 2025, structured across three winters or annual phases, each building upon insights from the previous. Collectively, the trials explored the potential of domestic heat pump flexibility across a technical, commercial, and customer experience lens, establishing evidence for the role of heat pumps as reliable flexibility assets to support GB networks.

Figure 1 below provides an overview of the EQUINOX project, illustrating the timeline, participant numbers, and scope of each annual phase.
Table 1 summarises the design and focus of each trial, highlighting the evolution in objectives, event structures, and customer engagement features. It is noted that the commercial arrangements for flexibility in the all the trials made up a portion of the overall incentive participants received for engaging with the trials. Participants also received incentives for participating in surveys, focus groups and interviews.

Trial one served as the UK's first large-scale demonstration of domestic heat pump flexibility:

- Over winter 2022–23, around 400 households took part in 22 two-hour "turndown" events on non-consecutive weekdays between 5–7pm, aligning with the GB evening peak.
- Participants were asked to reduce their heat pump electricity use and were rewarded through either a "pay in advance" model (upfront reward for anticipated turndown) or "pay as you earn" (reward per event based on achieved turndown).
- Participants were Octopus Energy and Sero customers located in NGED's license areas.

Trial two expanded the scope (based on learning gathered in trial one), scale, and commercial realism of EQUINOX:

- Conducted over winter 2023–24, more than 1,000 households participated in 36 two-hour events held between 4–8pm, with varying notice periods to assess responsiveness.
- Incentives were based on utilisation payments (£/kWh) for verified demand reduction[6] against a P376 historical baseline, which compares actual and forecasted consumption over equivalent prior weekdays.

[6] Verification of demand reduction against their P376 baseline. This method uses the last 10 non-event weekdays to generate an average consumption value per settlement period, resulting in a half-hourly baseline demand profile for an event day. A

- A small cohort of third party-controlled participants additionally received an availability payment. Payment rates were aligned with NGED's Secure and Dynamic flexibility products to test response to commercial incentive levels.
- Participants were Octopus Energy, Sero, and ScottishPower customers located in NGED's license areas.

The Week of Consecutive Events mini-trial ran immediately after trial two, engaging the same participants in daily 2-our turndown events (6–8pm) across a single week to assess customer tolerance of daily flexibility events. In the lead up to trial three, a network impact analysis was also conducted. Scaling the impact of trial two performance per participant by the number of forecasted heat pumps at the NGED Hayle-Camborne flexibility zone highlighted that heat pumps would be most effective in supporting constraint resolution when dispatched in a daily schedule Monday to Friday, as opposed to the 2-3 times a week trialled in trials one and two, this would be an important schedule to therefore test in trial three.

Trial three extended EQUINOX's scope by building on the post-trial two impact analysis, including testing daily flexibility and a new use case: turn up events. It was divided across five mini-trials exploring varied event types, durations, and timings:

- **Turn Up Flex** – Events encouraging demand turn up during periods of network oversupply (e.g. high solar generation). Participants were incentivised with free electricity consumption during events.
- **Longer Events Flex** – 3–4-hour demand turndown events assessing household tolerance for extended participation, with incentives provided via survey completion.
- **Morning Peak Flex** – Demand turndown events held between 8–10am, testing flexibility potential outside the traditional evening peak, also rewarded through survey completion.
- **Daily Evening Flex and Daily Morning Flex** – Consecutive-day participation trials assessing customer engagement with multi-day demand turndown services. Participants received fixed rewards for achieving turndown on 4 out of 5 consecutive weekdays, measured against personalised baselines derived from prior winter consumption data.

To gather insights on the customer proposition for stacking flexibility services or products, Daily Evening Flex participants were permitted to take part in NESO's Demand Flexibility Service (DFS) concurrently with the EQUINOX trial if they chose to. Any participation in DFS was notified and settled by NESO (DFS). EQUINOX focused on gathering customer feedback on taking part in both offerings. Daily Morning Flex simulated DFS-style events, with EQUINOX providing direct payments to replicate commercial conditions and evaluate engagement.
These designs enabled EQUINOX to explore service stacking and understand customer engagement when multiple flexibility opportunities, through both DSO and NESO mechanisms, were available. Participants were Octopus Energy and ScottishPower customers across NGED and SP Energy Networks license areas.

participant's demand response is calculated by deducting their observed electricity consumption from their baseline consumption.

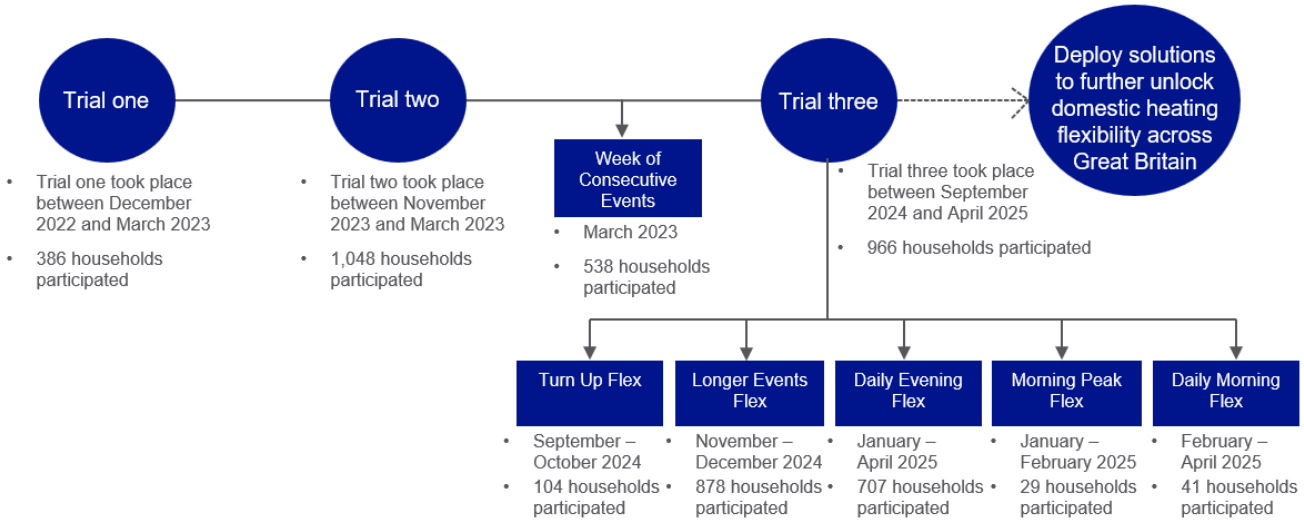

Figure 1: Timeline of EQUINOX trials 2022-5

Table 1: Summary of EQUINOX trials

Trial / Mini-trial	Objective / Focus	License areas and suppliers	Events Structure	Commercial Arrangements (not including other trial incentives)
Trial one	Proof of concept. Establish feasibility of domestic heat-pump flexibility and test incentive models	NGED license area, customers of Octopus Energy and Sero	22 × 2-hour events (5–7pm) on non-consecutive weekdays	Half of participants were rewarded through "pay in advance": 4 x £25 monthly instalments. Half of participants rewarded through "pay as you earn": up to £6 per event.
Trial two	Expansion and refinement upon trial one	NGED license area, customers of Octopus Energy, Sero, ScottishPower	36 × 2-hour events (4–8pm) on non-consecutive weekdays	Participants split across three groups and rewarded for turndown against their baseline. M1 49% of cohort: £0.80-£2.40/kWh M2 49% of cohort: £0.40-£1.20/kWh M3 2% of cohort: £0.50-£1.50/kWh per event, £8 up-front at start of trial
Week of Consecutive Events	Post-trial two mini-trial, with same customers; limited assessment of consecutive day flexibility.	NGED license area, customers of Octopus Energy, Sero, ScottishPower	5 × 2-hour events (Mon–Fri, 6–8pm)	Participants split across same groups they participated in for trial two: M1: £0.80/kWh M2: £0.40/kWh M3: £0.50/kWh

Trial three	Explore new flexibility types, and customer appetite for DSO/ NESO service stacking.	N/A – specific to each mini-trial	Five mini-trials (Sept 2024 – Apr 2025)	N/A – specific to each mini-trial
Turn Up Flex	Test household capability to participate in demand turn up services.	NGED license area, customers of Octopus Energy	1–3 events per week (11am-1pm)	Free electricity for event duration.
Longer Events Flex	Assess household ability to participate in flexibility across 3–4-hour events.	NGED license area, customers of Octopus Energy	1–3 events per week (2-4 h each)	£1.50 for completion of survey following each event.
Morning Peak Flex	Test participation during morning demand peaks.	NGED & SPEN license area, customers of ScottishPower	8–10am events	£2.50 for completion of survey following each event.
Daily Evening Flex	Test potential for daily evening flexibility, and customer appetite for participation in stacked DSO/ NESO services.	NGED & SPEN license area, customers of Octopus Energy	A group: 2-hours Monday to Friday 5-7pm B group: 4-hours Monday to Friday 4-8pm	£1 a week for providing turndown 4/5 days per week below a pre-defined baseline calculated as the average of their unabated consumption during November/December 2024. Participants were able to take part in Demand Flexibility Service (DFS) events if they chose to, in response for DFS reward incentives.
Daily Morning Flex	Examine combined morning and evening daily participation and stacking potential.	NGED & SPEN license area, customers of ScottishPower	Weeks 1–4 (8–10am); Weeks 5–8 (8–10 am + 5–7pm)	£2 a week for first 4-weeks, then £3 a week for providing turndown 4/5 days per week below a pre-defined baseline calculated as the average of their unabated consumption during November/December 2024 Participants also awarded £0.30/kWh for participating in simulated DFS events.

4.2 EQUINOX trials participant details

This section describes trial participant demographics across all three trials. Wider customer representation is important especially within the EQUINOX context of testing scalable and equitable flexibility of heat pumps. Although heat pumps are most commonly present in owner-occupied properties at this time, they are expected to become the mainstream heating technology for all property types.

Across all three trials, EQUINOX collectively onboarded over 2,000 participants. Importantly, 88% of these participants continue to engage in some form of flexibility product today, demonstrating ongoing interest and confidence in flexibility services from participants following the EQUINOX trials.

Trial one served as a foundation for refining the customer engagement strategy and methods for capturing vulnerability. We wanted to be able to test the customer willingness to participate in heat pump flexibility while monitoring customer comfort and accessibility. Trial two was at a much larger scale and engaged over 1,000 participants. Trial two built on trial one learnings, evolving how to assess vulnerability while ensuring that a wider participant pool maintained high levels of satisfaction and comfort across the trial.

Building on the success of trial two, trial three delved deeper into the experiences of potentially vulnerable participants. This included developing a broader definition of vulnerability and tailored communications. Trial three expanded recruitment further by including customers from the SPEN area, whereas trials one and two were limited to the NGED region. Additionally, ahead of trial three ScottishPower installed a significant number of heat pumps as part of the ECO4 (Energy Company Obligation) Government Obligation. Recruitment for the ScottishPower trial three cohort was targeted at these customers. Due to the eligibility criteria for ECO4, there was a greater proportion of low income and potentially vulnerable participants in this group compared to the overall EQUINOX participant pool which provided an opportunity for additional equitability learnings in the trial.

4.2.1 Energy affordability

Energy affordability is a widespread concern in GB following the energy crisis that commenced in autumn 2021. Across all three trials, information was collected on customers' pre-trial perspectives on energy affordability. Figure 2 shows trial three participants' self-reported ability to pay their energy bills compared to the responses from a UK wide survey undertaken in 2024[7]. 58% of trial three participants reported always being able to afford their energy bills, compared to the UK average of 33%. This was a similar distribution to trial two[8]. However, both were more aligned to the UK average when compared to trial one.

[7] This survey was developed and conducted by Accent to act as a comparison for the insights gathered through the survey distributed to EQUINOX participants.

[8] UK-wide survey and start of trial survey question stated: "Many people are struggling to pay their household bills due to the current economic situation. Which of the following best describes how affordable you find your energy bills (energy costs if you do not receive a bill) and other household bills?"

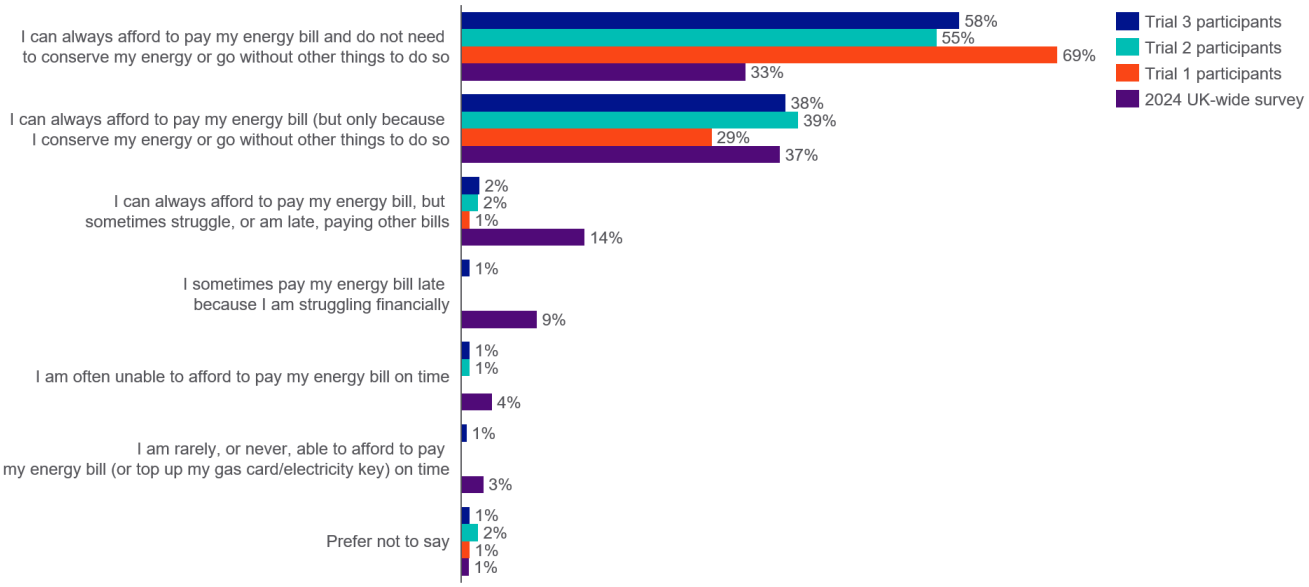

Figure 2: Trial three participants self-reported (in a pre-trial survey) their ability to pay their energy bills (n=602), compared to the wider UK survey (n=2404)

4.2.2 Housing tenure

Most trial participants across all three trials owned their home, as shown in Figure 3. While the proportion of homeowners remained consistent across all three trials, there was increased participation from customers living in social housing. This increased from a negligible number in trial one to 9% of the total participant pool in trial three. Although this is still below the UK average of 17%[9], it is consistent with our understanding that homeowners tend to have more control over altering their home heating, making heat pump installations more viable for them compared to tenants.

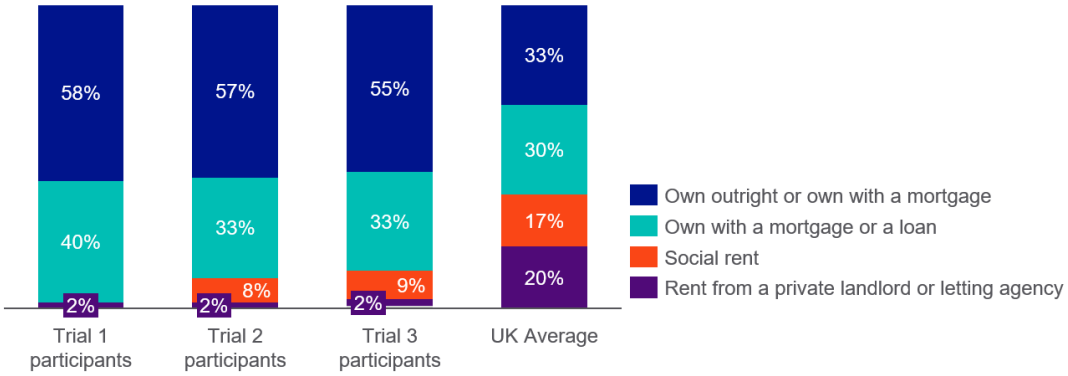

Figure 3: Trial one (n=256), two (n=732) and three (n=602) participants' home status alongside the UK average

[9] Office for National Statistics, Census 2021.

4.2.3 Vulnerability

Segmenting for vulnerability allowed us to compare the experiences and outcomes of potentially vulnerable participants against the broader participant pool. This was used for understanding how different customers perceived key trial performance metrics, including satisfaction with financial incentives and comfort levels. The EQUINOX project recognises that vulnerability is multifaceted and can be influenced by different factors, and these factors interact in complex ways. Therefore, developing and iterating how vulnerability was assessed was crucial for understanding how heat flexibility can benefit different customer groups, including potentially vulnerable customers[10].

In trial one customers were segmented as potentially vulnerable if they were considered low income, self-reported that they were sometimes, often and/or rarely/never able to afford their energy bills and other household bills or indicated that someone in the home had a disability or long-term health condition.

In trial two customers were categorised as vulnerable if they self-reported that they or someone in the home had a disability and/or a disability that was exacerbated by the cold, or if they indicated they had difficulties with energy affordability.

Trial three took a broader approach to segmentation by including more vulnerability indicators. This involved considering a higher number of individual and combined potential vulnerability factors, identified through a bespoke Equitable Participation Framework (EPF)[11] developed as part of the EQUINOX project. To minimise the risk that the segmentation methodology for trial three may be over-representative, consideration was made that there are many interacting factors that determine how a vulnerability factor affects a household. It was considered that some households who meet one vulnerability factor may have this factor mitigated by income or other factors. Moreover, customers classified as low-income were removed from the vulnerability segmentation if they self-reported that they never had problems paying their energy bills.

Households were therefore classed as vulnerable only if they met one of the following three circumstances:

1. The household was defined as having a low income[12] according to their household composition[13].
2. Someone within the household self-reported having a health condition exacerbated by the cold.
3. The household met at least two of the other EPF indicators.

This resulted in 47% of participants being classed as potentially vulnerable in trial three. This compares to only 22% and 20% of trial one and trial two participants, respectively.

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[10] Following customer segmentation, we classified customers who met the vulnerability classification as potentially vulnerable rather than just vulnerable, as customers did not self-disclose that they were vulnerable and whilst our methodologies try to accurately capture vulnerabilities it may include customers who would not consider themselves to have vulnerabilities. The approach also reflected the complexity and intersecting nature of vulnerability and that it may be transient or longer-term, determined in complex ways to customer characteristics or changing circumstances.

[11] See "Project Deliverable 5: Learnings from Engaging Customers" for detailed explanation of the customer engagement approach, including how vulnerability factors are considered

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

[13] 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.

Applying trial two's vulnerability classification methodology to trial three's participants, only 33% of customers were classified as potentially vulnerable. This could suggest that the vulnerability methodology used in trials one and two may have under-represented vulnerability, emphasising the importance of considering all facets of vulnerability in relation to heating flexibility. However, it is important to note that this refinement in methodology does not disadvantage earlier trial results; rather, it reflects an evolving understanding of vulnerability that builds on previous learnings.

5. Learning outcomes and recommendations

This section focuses on summarising learning outcomes and recommendations from the EQUINOX trials:

- Section 5.1 addresses learnings and recommendations for the development of commercial arrangements to engage households with heat pumps in flexibility services.
- Section 5.2 addresses learnings and recommendations relevant for customer satisfaction, comfort and equitable participation when engaging households with heat pumps in flexibility programmes.
- Section 5.3 addresses learnings and recommendations relevant for future procurement of flexibility, in terms of which products heat pumps are best suited for, based on performance in EQUINOX trials.
- Section 5.4 addresses technical integration learnings and recommendations, in terms of the flexibility procurement process from DSO to FSP, and to end consumer. Additionally, it addresses the role of automation in heat pump flexibility.
- Section 5.5 addresses policy and regulation learnings and recommendations, in terms of potential changes that could accelerate heat pump uptake and improve heat pump flexibility participation and commercialisation.

5.1 Commercial arrangements

Section 5.1 summarises EQUINOX trial learnings relevant for designing commercial arrangements that engage domestic heat pump owners in flexibility services:

- Section 5.1.1 outlines the procurement process of heat pump flexibility during the trials, from DSO through to end consumer.
- Section 5.1.2 outlines findings from trial one, which was a proof-of-concept for heat pump flexibility.
- Section 5.1.3 outlines findings from trial two, which aimed for increased scale and accuracy.
- Section 5.1.4 outlines the findings for trial three, which aimed to address the remaining evidence gaps.
- Section 5.1.5 outlines the recommendations for commercial arrangements, building off the trial findings.

5.1.1 End-to-end commercial procurement

Commercial arrangements in the EQUINOX trials aimed to mimic commercial procurement of residential flexibility services. Across all three trial phases NGED notified end customers of flexibility events through their electricity supplier. The trials were set up as tenders for a simulated flexibility zone on Flexible Power without procurement costs. Only Flexibility Service Providers Octopus Energy, ScottishPower and SERO received dispatch signals to provide flexibility for this simulated flexibility zone; as in commercial procurement of flexibility they additionally managed engagement with participating households. This structure mimicked commercial procurement of flexibility in BaU as far as was possible while still respecting project-specific administrative requirements.

As outlined in Section 4, across trials one, two and three a variety of commercial arrangements were tested, with domestic heat pump owners asked to reduce or increase their electricity consumption upon receipt of flexibility event signals they received from their energy supplier, for a variety of impact and participation-based payment incentives.

Delivery of the EQUINOX trials has not indicated there should be any break from this DNO to supplier to customer notification process when commercially procuring heat pumps in BaU. This is a useful learning point for BaU planning as it helps with the sustainability of existing procurement practices.

5.1.2 Trial one – proof of concept

Trial one was the initial proving for heat pump flexibility as a viable customer asset for network management. It showed that domestic heat pumps represent a valuable flexibility asset-base and provided lessons learnt for optimising participation in flexibility programmes.

Table 2 summarises the key results: the larger Octopus cohort achieved an average 0.77 kW demand reduction per 2-hour event, compared with 0.31 kW amongst the higher energy efficiency Sero homes, and across both cohorts 83% of participants responded when called. It is important to note that in trial one, this volume was measured against historical baselines rather than a control group as in trials two and three. The accuracy of this baseline presented an obstacle to reliable measurement of demand response volumes in trial one and was therefore updated in trials two and three. This demonstrates that households with heat pumps can deliver reliable, meaningful load reduction, and the scale of response may be higher in lower efficiency homes.

Households provided the most flexibility during colder periods, as there was more demand to abate. However, full switch-offs risked snapback effects, suggesting turn-down requests to be preferable. Finally, a pay-per-event commercial model also drove higher engagement than monthly payments, suggesting it to be the more effective model for customer engagement in BaU.

Table 2: Key findings from trial one

Factor	Finding	Implications for heat pump flexibility procurement
Demand response	• On average, 0.77 kW/ 1.53 kWh of demand response detected over 2 for Octopus customers with manual/remote control heat pumps, and typical household insulation. • On average, 0.31 kW / 0.61 kWh for Sero customers with automated control heat pumps, and high household insulation.	• Initial evidence that heat pumps can provide flexibility to support networks, across all control method types. • Households with high energy efficiency, i.e. Sero homes, most likely offer comparatively lower flexibility since there is already less demand to reduce. Nevertheless, these homes have the potential to offer longer turndown periods.
Participation rate	• 82% of households participated per event by turning down/off their heat pumps during events when asked to do so (or not turning them back up/on in case of Sero homes).	• Strong initial evidence base that high proportion of households with heat pumps could be relied upon to take part in heat pump flexibility.

Temperature	• Temperature had an inverse relationship with demand response: for Octopus customers 4 kWh turndown observed at 0.5°C, reducing to 1 kWh at 13°C; Sero cohort 1 kWh reducing to 0.3 kWh.	• Strong initial evidence base that heat pumps provide much greater demand response at colder temperatures, since there is more demand to reduce.
Demand Snapback	• 9% increase in demand relative to baseline immediately following an event for Octopus homes; 50% increase for Sero homes.	• Evidence that for heat pumps "turn off" request may be less effective than a "turn down" request, particularly for automated control where the switch can be instantaneous.
Payment method	• Customers on Pay per Event had a higher participation rate than those on Pay Monthly (88% vs. 77%)	• Indicative that consumer engagement is more effective for rewards per event than rewards per month.

5.1.3 Trial two – expansion and refinement

Trial two was larger and more comprehensive than trial one. It produced more detailed findings for the potential scalability of domestic heat pump flexibility, including detailed lessons learnt for effective engagement of customers and the optimal way that heat pumps can be dispatched to support networks.

Table 3 summarises trial two's key results. It shows that trial two confirmed that heat pumps can provide reliable, scalable flexibility to support distribution networks. Participants achieved an average 0.61 kW (1.2 kWh) demand reduction per event, around 48% of peak demand, with 47% of households engaging and an average external temperature of 6.1C. Colder temperatures produced greater response, and no significant snapback effects were observed, showing that turndown requests are more effective than full turn-off events. Trial two utilised a crossover randomised control group approach to more accurately measure demand response volumes than the baseline approach used in trial one, and these demand response measurements are considered to be the most accurate generated across all three trial phases.

Payment levels reflected real NGED product rates (Secure and Dynamic[14]), demonstrating that heat pump flexibility is achievable at commercially viable costs, with negligible differences between payment groups, suggesting the lower rate may be sufficient to sustain participation within the context of the trial. Tariff type was also critical: households on flat daytime tariffs provided measurable event response, while those on time-of-use tariffs that included cheaper hours within the day were already shifting heating demand, indicating both mechanisms can effectively support peak reduction. Notably, all automated control heat pumps had such time of use tariffs.

[14] When trial two was designed, Secure and Dynamic were a commercial flexibility product procured by NGED. Flexibility products have since been updated and standardised across DSO markets. The payments in trial two were considered in relation to previous products but focused on structural aspects of flexibility that remain relevant to network needs.

Finally, the network impact analysis showed that heat pumps are most effective when participating in daily flexibility programmes, rather than the 2–3-day-per-week format tested in trial two, highlighting their potential as a dependable, everyday flexibility resource for network operators.

Table 3: Key findings from trial two

Factor	Finding	Implications for heat pump flexibility procurement
Demand response	• On average, 0.61 kW / 1.2 kWh demand response per participant across 36 events, equivalent to 48% of the average participating home's peak demand.	• Further evidence that heat pumps can provide meaningful flexibility to support networks, based on robust analysis of a larger trial (than trial one).
Participation rate	• 47% of households participated per event by turning down their heat pump during events and achieving demand reduction as compared to their baseline.	• Further evidence that high proportion of households with heat pumps could be relied upon to take part in heat pump flexibility.
Temperature	• Temperature had an inverse relationship with demand response: 0.07 kW increase/reduction in demand response per 1℃ drop/increase in external temperature (from the 6.1℃ trial average).	• Further evidence that heat pumps provide much greater demand response at colder temperatures, since there is more demand to reduce.
Demand Snapback	• None observed for Octopus and ScottishPower customers with manual or remote control heat pumps – slight effect observed for Sero third-party controlled customers.	• Further evidence that for heat pumps a turndown request is more effective than a turn off request.
Payment method	• Customers on M1 and M2 payment amounts had negligible variation in demand response or participation (both set within the bounds of Secure and Dynamic product incentives. • M3 not applicable due to tariff impact (see next point).	• Customer participation in BaU flexibility services may not differ according to whether customers are awarded M1 or M2 payment amounts.
Tariff type	• Only participants with tariff types that had a flat price during the daytime had additional heating demand response to offer during the events.	• Explicit flexibility services and time of use tariffs can each be an effective tool for eliciting heat pump demand shift from peak times to support networks.

	• Participants with time of use tariffs that incentivise demand shifting during the day were already providing demand response regardless of whether an EQUINOX event was called. • Automated control Sero customers all had time of use tariffs that incentivise demand shifting during the day and were automatically being optimised to avoid peak pricing. This meant by default they had limited additional flexibility to be measured during EQUINOX events.	• Indicative that automated control heat pumps will be optimised around time of use tariffs by default – and may be providing implicit flexibility at a greater level than previously assumed in network planning.
Notice period	• Trial participants provided the same level of demand response, and participated at the same rates, whether they were notified of an event a day in advance, the morning of the event, or 2-hours in advance.	• Evidence that end consumers can be given a notice period within one day to 2-hours' notice and deliver the same response. It is noted that this is within the trial group who self-selected to participate.
Event times	• Trial participants provided the same level of demand response, and participated at the same rates, for events held at 4-6pm, 5-7pm and 5-8pm.	• Evidence that end consumers can be called upon to provide turndown during any 2-hour period between 4-8pm and deliver the same response.
Network impact	• Network impact analysis undertaken after trial two highlighted that when applying trial two results to forecasted heat pump volumes at the NGED Hayle-Camborne flexibility zone, heat pumps could abate 20% of the predicted peak exceedance by 2028, but only when dispatched daily as opposed to the 2-3 day format in trial two. Dispatching heat pumps at lower frequency may result in the need to stagger groups in 2-hour blocks to meet longer requirements, diluting the overall magnitude at any given time.	• The network impact analysis highlighted that heat pumps can optimally support networks when dispatched in a daily-flexibility role, as with the former NGED Sustain product (now Scheduled Utilisation), rather than in the 2-3 day per week setup trialled in trial two.

5.1.3 Trial three – filling in the gaps

Trial three sought to address the remaining evidence gaps in defining the potential of heat pump flexibility at scale. Its scope was divided across five mini-trials with different focuses, and its findings are summarised in Table 4.

Turn Up Flex participants achieved an average of 0.88 kW of demand response over 3 events when asked to turn up only their heat pumps, and an average of 1.35 kW over an additional 3 events when asked to turn up any device. These results highlight that there is strong potential for residential customers to participate in turn up flexibility to support networks, and that the amount of flexibility they can offer increases substantially if they have a heat pump.

Longer Events Flex participants' demand response rates were broadly consistent with those observed in trial two. Though, the mini-trial's emphasis was on participants' preferences for event duration as opposed to defining turndown magnitude. Around half of participants favoured 2-hour events, while substantial minorities indicated they could comfortably accommodate events lasting 3- or even 4-hours. These findings suggest that networks can treat 2 hours as the typical flexibility event length for heat pump homes, while also acknowledging that there may be a meaningful proportion of customers who can safely choose to participate in longer events.

Morning Peak Flex demand response results were inconclusive, but around half of participants reported engaging in the events and in some cases expressed a preference for morning events. This suggests that morning flexibility from heat pump homes could be viable at scale.

Daily Evening Flex demonstrated the potential for daily participation, with strong early turndown effects. Unseasonably warm, weather is thought to be responsible for the minimal turndown measured during the final half of the mini-trial in late February through April, though self-reported participation remained above 50% during all check-in surveys – indicating participants were turning down consistently as requested. The findings indicate that the daily turndown behaviour modelled as optimal for heat pumps in the post-trial two network impact analysis is likely achievable in practice – and heat pump homes can likely be expected to participate in daily flexibility-type products to best support networks, most customers for 2-hours daily but some for up to 4-hours. Participation in both the mini-trial and the DFS also highlights customer appetite for taking part in future stacked flexibility opportunities. Of note, customers using time of use tariffs that incentivise heat demand response during the day were not eligible to participate in Daily Evening Flex and so findings may represent an under-reporting of the potential for daily heat pump flexibility.

Daily Morning Flex additionally confirmed that households can deliver daily flexibility across morning and evening periods. While turndown data was not conclusive in the first half of the mini-trial, self-reported participation remained stable, suggesting participants were turning down as requested. Finally, with over half of participants also engaging in the simulated DFS events, further evidence was obtained of customer willingness to take part in stacked services.

Overall, the mini-trials show that heat pumps can reliably provide both upward and downward flexibility on a daily basis, with two-hour events emerging as an effective standard duration, though with a substantial proportion of households capable of sustained participation when required.

EQUINOX energy suppliers noted that some customers already owned multiple low-carbon technologies, introducing complexity in how asset-specific demand response is quantified. As the cost of these technologies decrease, a larger proportion of customers are likely to adopt them, which could expand both participation rates and the range of flexibility services they are able to offer. A broader customer base provides DSOs and NESO with greater confidence that sufficient flexibility can be delivered consistently, supporting the transition of EQUINOX trial learnings into a BaU model.

Table 4: Key findings from trial three

Mini-trial	Findings	Implications for heat pump flexibility procurement
Turn Up Flex	• On average, 0.88 kW / 1.76 kWh demand turn up per participant across 3 heat pumps only events. • On average, 1.35 kW / 2.7 kWh demand turn up per participant across 3 events permitting turn up from any home device.	• Evidence that residential consumers can provide meaningful demand turn up flexibility to support networks, particularly through their heating, e.g. during periods of over-supply of renewable generation.
Longer Events Flex	• Turndown magnitude was in line with trial two for 2-hour and 4-hour events, but inconclusive for 3-hour events. • When asked about their preferred event length, 46% of participants preferred 2-hour events, 32% preferred 3-hour events, and 22% either preferred 4-hour events or had no preference.	• Evidence that that networks can treat 2 hours as the typical flexibility event length for heat pump homes, while also expecting a significant share of participants to remain responsive during longer events.
Morning Peak Flex	• Inconclusive demand response results, likely due to small trial cohort. • An average of 50% of participants self-reported participating in all or part of the events in the post-event surveys.	• While the turndown data was not conclusive, positive customer engagement survey results provide evidence that morning peak flexibility is achievable from heat pump homes.
Daily Evening Flex	• Demand turndown was detected for the 2-hour group in weeks 1-6, and week 10, at magnitude in line with trial two results, but not weeks 7-9 or week 11. >50% of participants self-reported turning down during 3 check-in surveys spread across the mini-trial.	• Evidence that daily participation in flexibility services is achievable for heat pump homes, with default expectation of 2-hour participation except in cases where customers elect to participate for longer.

	• Demand turndown was detected for the 4-hour group in weeks 1-5, in line with trial two results; demand turn up was detected for weeks 6-11. >50% of participants self-reported turning down during 3 check-in surveys. • Likely unseasonably warm winter affected turndown results for both groups. • Participants successfully participated in DFS, alongside the mini-trial, earning £96 across the entire group for doing so.	• Note the unexpected turndown results (2-hour group inconclusive and 4-hour group negative second half of mini-trial) likely due to unseasonably warm weather and many homes no longer feeling the need to heat regardless of the events. • This highlights that the optimal value-case for engaging heat pump homes in flexibility identified in the post-trial two network impact analysis is likely achievable – heat pump homes are likely able to participate in Sustain/Scheduled Utilisation style products. • Customers' choice to participate in DFS while also taking part in the mini-trial is indicative of the customer appetite for taking part in stacked flexibility services.
Daily Morning Flex	• Demand turndown detected during morning and evening periods weeks 5-8, at rates in line with trial two, but not in weeks 1-4 during the morning only period. • Self-reported turndown participation in surveys remained stable averaging 39% for each half of the mini-trial. • 54% of treatment participants self-reported participating in simulated DFS events.	• Evidence that daily participation in flexibility services is achievable for heat pump homes in both mornings and evenings. The lack of definitive turndown data for the first 4-weeks is considered likely a result of the small sample size, especially considering customers' stable self-reported participation rates. • Customers' choice to participate in simulated DFS events while also taking part in the mini-trial is indicative of the customer appetite for taking parted in stacked flexibility services.

5.1.5 Recommendations

To maximize the effectiveness of heat pump flexibility services, we recommend adopting commercial arrangements that reflect the strongest learnings from the EQUINOX trials. Firstly, networks should standardise 2 hours as the typical flexibility event length for heat pump homes, while also expecting a significant share of participants to remain responsive during longer events. Second, heat pumps are best placed to provide daily flexibility for network needs.

Heat pump homes can provide flexibility through both daily and dynamic[15] style events; however, network impact analysis from trial two indicates that heat pumps most effectively support networks when engaged in a daily flexibility role. Specific products to enable these arrangements are discussed further in Section 5.3.

5.2 Customer experience

Throughout all three EQUINOX trials, centring customer experience was a key consideration during the trial design phase. Throughout the trials, the flexibility service providers collaborating on the project, Octopus Energy, Sero and ScottishPower, owned the relationship with their customers. This section outlines key customer and service learnings from the trials and how they can be translated into BaU:

- Section 5.2.1 outlines customer satisfaction throughout all three trials.
- Section 5.2.2 outlines customer comfort across all three trials.
- Section 5.2.3 outlines considerations for potentially vulnerable customers.
- Section 5.2.4 outlines how key household characteristics such as insulation or control method may influence preferences and experiences of heat pump flexibility.
- Section 5.2.5 outlines the notice period found to be sufficient for heat pump flexibility.
- Section 5.2.6 outlines the benefit of sending post event notifications.
- Section 5.2.7 outlines the communications methods used during the trial and recommendations for customer communications in BaU.
- Section 5.2.8 outlines the overall recommendations to maximise customer experience in BaU.

Throughout EQUINOX we captured experiences and perceptions of trial participants through surveys, interviews and focus groups. This allowed us to evaluate key factors that influence heat pump households' participation in flexibility services, including comfort and overall satisfaction. By testing these factors, EQUINOX aimed to understand not only the technical feasibility of heat pump flexibility but also the behavioural and experiential aspects that drive customer participation.

5.2.1 Satisfaction

Customer satisfaction remained high across all trials, demonstrating strong engagement and willingness amongst heat pump households to participate in flexibility programmes across a variety of arrangements. Centring customer experience as a key consideration during the trial design phase contributed to high levels of customer satisfaction.

- Trial 1: 92% (n=255) of participants reported being satisfied with the trial[16].
- Trial 2: 79% (n=636) of participants reported being satisfied with the trial[16].
- Trial 3: 79% (n=552) of participants reported being satisfied with the trial on average across all five mini-trials[16].

[15] Defined as a DNO flexibility product that is designed to respond to network needs in near real-time.
[16] Participants were asked 'Overall, how satisfied were you with the EQUINOX trial?' in the trial one, trial two and trial three end of trial surveys.

The satisfaction rate is encouragingly consistent across all three trials, given the range of novel commercial offerings tested across the three trials. 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 that there are heat pump homes that are not only willing to engage in flexibility initiatives but also maintain positive perceptions of it. For BaU, these results provide confidence that networks can reliably procure flexibility from heat pump homes without compromising satisfaction, bolstering the commercial arrangements findings provided in Section 4.

5.2.2 Comfort

Comfort was a key consideration when assessing the customer experience of heat pump flexibility. To safeguard against potential underheating during events, there was no penalty for not taking part in events or for participating in only part of an event. Participation in each event remained entirely voluntary, and customers were encouraged to engage only when it suited them. The messaging throughout the trials made clear that there was no penalty for partial participation. If a customer was deemed to be at risk of underheating from responses in surveys or focus groups, suppliers promptly followed up to address concerns. This approach ensured that customers retained full control over their comfort levels throughout the trial.

Across all three trials, the vast majority of households never or only sometimes felt a change in comfort during events:

- In trial 1: 95% (n=255) of households never or only sometimes felt a change in comfort during events[17].
- In trial 2: 92% (n=636) of households never or only sometimes felt a change in comfort during events[17].
- In trial 3: 88% (n=552) of households reported no or slight impact on the comfort of their home[18].

Qualitative feedback from free text survey responses, focus groups, and interviews reinforced these findings. Participants commonly reported that they would use additional heating or wear additional layers if there were changes in household comfort levels beyond what was comfortable.

These results support our wider findings that all customers, including potentially vulnerable customers, who choose to engage with heat flexibility can typically do so comfortably. For DNOs and flexibility service providers, this is an important insight: customers can be asked to turn down their heat pumps during events without sacrificing comfort, provided that participation remains voluntary and appropriate safeguards are in place. It is important that BaU heat pump flexibility programmes prioritise practices such as voluntary participation, transparent communication, and avoiding penalties for opting out. This ensures that customers are empowered to take part without causing a change in comfort.

5.2.3 Vulnerability

Throughout all three trials, comfort and satisfaction levels were consistent between potentially vulnerable and non-vulnerable groups. In trial three, 47% of trial participants were classified as potentially vulnerable customers and

[17] Participants were asked 'How frequently did participating in EQUINOX events cause any discomfort for you or someone else in the household?' in the trial one and trial two end of trial surveys.
[18] Participants were asked 'How much, if at all, did the EQUINOX events impact the comfort levels of your home?' in the trial three end of trial survey. The result is averaged across all five trial three mini trials.

demonstrated similar levels of participation, trial satisfaction, comfort and engagement as non-vulnerable participants. 82% of potentially vulnerable participants reported no or slight impact on the comfort of their home, which is closely aligned with 88% of all households. This was also consistent across trial one and trial two.

The EQUINOX trials have demonstrated strong evidence that some potentially vulnerable groups, including those who could be at risk of fuel poverty, are interested in taking part in heat pump flexibility and can equitably benefit from taking part. The EQUINOX trials reinforce that heat pump flexibility can encourage participation and engagement from all participants, including vulnerable customers.

It is therefore critical that flexibility programmes have customers in mind from the outset and use simple measures like voluntary participation, clear communication and not penalising customer opt-out to ensure all customers, including those who are potentially vulnerable, are empowered to take part in flexibility programmes if they want to. With such measures in place, direct participation in, and benefit from, flexibility programmes should be an option for all customers in BaU, including those with potential vulnerabilities.

5.2.4 Key household characteristics

In trial three, we additionally tested various event configurations including longer events and daily events[19]. We assessed how household factors like insulation, presence of additional LCTs, or potentially vulnerable households, would respond to these various event configurations that represent different aspects of existing DNO flexibility services.

To explore the reasons behind participants' event length preferences, we analysed their responses based on household characteristics we considered might affect their ability to participate in longer events. Varying event lengths were explored in Longer Events Flex mini-trial where customers were invited to participate in events up to 4h long if they felt that it may be suitable for their home and household. There was no penalty for not taking part in events or for participating in only part of an event. Customer incentives were based on survey participation, with the aim of identifying which event length each participant felt best suited them. Overall, we found that nearly half of trial participants preferred 2-hour events, though 32% preferred 3-hour events, 6% preferred 4-hour events and 16% had no event length preference, who were also happy with 4-hour events. We tested how these preferences related to specific home demographic factors that we hypothesised might impact their preference towards longer events, as seen in Figure 4[20]. Most notably, amongst participants with poor insulation[21], none preferred 4-hour events and only 10% reported no preference. Across other factors such as home battery ownership, access to additional heating and potential vulnerability, there was no deviation from the overall group on event length preference. This suggests that except for insulation, which may impact a participant's event length preference, any other variation in event length preference is likely due to individual customers' personal preferences rather than driven by specific household characteristics.

[19] Daily events refer to events that occurred for five consecutive days in a week.
[20] Treatment participants' responses to "Of the two-, three- and four-hour event lengths, which event length did you prefer?"
[21] Start of trial survey question stated: "How would you describe the quality of your home insulation?" If they selected "My home is not very well insulated and impacts the way I heat my home", they would be classified as "poorly insulated".

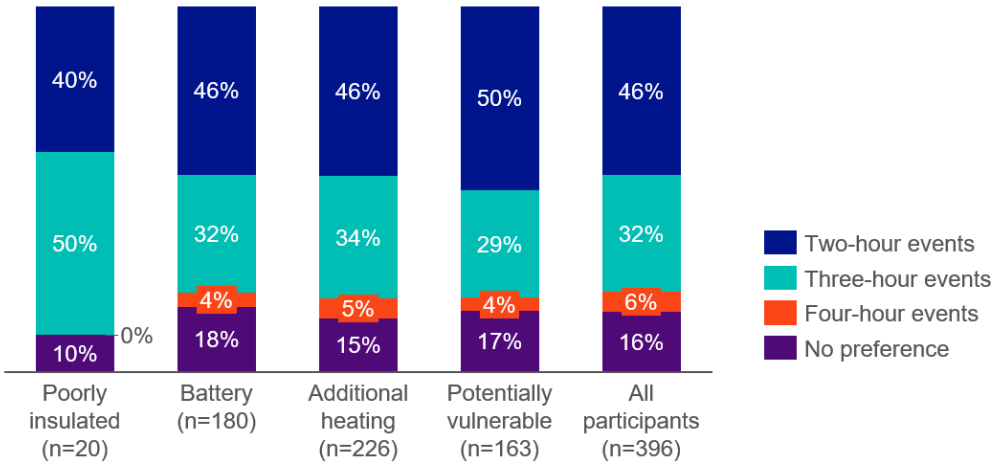

Figure 4: Trial three participants' event length preference segmented by household factors reported in start of trial survey (n=396)

In the Daily Evening Flex and Daily Morning Flex mini-trials, the ability to control a heat pump remotely via an app or by setting a schedule ahead of time was a key factor for trial satisfaction. Participants views on daily events were segmented by their control type, as shown in Figure 5[22]. Notably, 84% of participants (108 participants) with remote control found events on a daily basis to be just right or too little compared to 63% of participants (83 participants) with manual control. These findings are reinforced by insights shared during focus groups:

- One participant using manual control explained that they couldn't participate daily due to the nature of their control method: "I don't mind how often the events are, but I didn't do them all, because it was so often and because I have to manually [turndown]."
- In contrast, a participant with remote control noted that the daily frequency enabled them to establish a consistent routine from the start of the trial: "It's not difficult. You just program the heat pump to do that. It doesn't matter whether it's a weekend or a weekday; we've just left it the same."

Overall, these results suggest an advantage of remote control capabilities in supporting consecutive day flexibility, especially for daily events. The results suggest that the control technology customers use to operate and schedule their heat pumps may play an important role in how well different types of flexibility services are tolerated by customers.

One caveat to these findings is that customers who were already using a time of use tariff that incentivises everyday flexibility during the day (not just overnight) were not eligible to participate in the Daily Evening and Morning Flex mini-trials. These EQUINOX findings may therefore represent an under-reporting of impact or satisfaction, since the customers taking part in the daily flexibility mini-trials had already chosen not to sign up for a time of use tariff that incentivises similar behaviours.

[22] Treatment participants' responses to "During the EQUINOX daily morning and evening mini-trials, there was events daily for 5 consecutive days. What is your view on this frequency?"

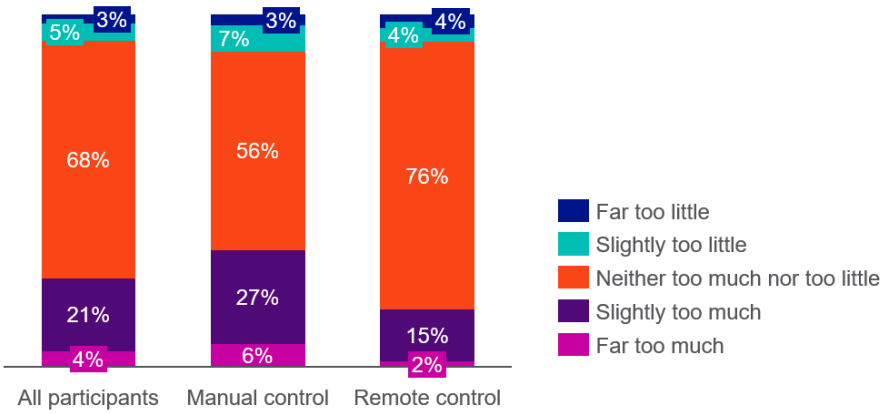

Figure 5: Participants' preference on daily event frequency split by manual control (n=124) and remote-control participants (n=129)

Understanding the factors that enable customers to participate more easily and comfortably in flexibility services is essential for ensuring equitable access for all. Complementary initiatives can support customers who choose to engage in heat pump flexibility programmes and may influence how well different types of flexibility events are tolerated. As these services transition into BaU, customer propositions should recognise that flexibility events will be experienced differently across households, particularly where specific characteristics or indicators of vulnerability are present.

5.2.5 Notice periods

In each of the trials, customers were given varying advance warning of an event. In trial two, customers were notified about EQUINOX events either the day before the event, the morning of the event, or two hours prior to the event. The most preferred notice period (38%) for EQUINOX events was day ahead and the least preferred (7%) was two hours before an EQUINOX event. However, 62% indicated that the different notice periods did not impact their ability to participate.

This finding was further tested in trial three and an important result was determining that day ahead notice periods are an adequate event notice period for all participants. Participants received day ahead notice of events in the Morning Peak Flex, Longer Events Flex, and Turn Up Flex mini-trials. 91% of participants self-reported being satisfied with the day ahead notice period in trial three, and there was no meaningful difference to notice period preferences of potentially vulnerable participants relative to other participants. These results indicate that day ahead notice is sufficient for all customers, including those who are potentially vulnerable. Overall, for FSP's these findings underscore that while day-ahead notice periods should be the preferred standard for heat pump homes, customers remain highly adaptable.

5.2.6 Post event notifications

Trial three included email reminders sent immediately after each event to prompt participants to switch their heating back on, with the aim of reducing the risk of underheating, particularly among potentially vulnerable customers. For Morning Peak Flex and Longer Events Flex, participants also received a post-event survey

notification, which served both as a survey reminder and confirmation that the event had ended. Survey responses show that 45% of participants found these reminders helpful, rising to 51% among those identified as potentially vulnerable. This indicates that post-event notifications could act as an effective safeguard against unintentional underheating in manual, non-daily flexibility events in BaU, with particular benefit for customers who may be more vulnerable.

5.2.7 Customer communications

Octopus Energy and ScottishPower engaged EQUINOX customers through their existing communication channels. They sent invitations, notifications, and surveys by email, and they delivered some event notifications through mobile apps. This approach mirrors the BaU model, where customers interact with their flexibility service provider rather than the DNO. Engagement in EQUINOX occurred more frequently than it would in BaU to enable ongoing feedback on customer experience throughout the trials. The teams kept messages to a minimum and designed them to be clear and concise. They adapted messaging based on participant feedback, especially when the same questions appeared repeatedly.

By using familiar communication methods and ensuring that messages were concise and relevant, the trials achieved high customer satisfaction across all three cohorts. The results show that customers are willing to participate in heat pump flexibility when communication feels straightforward and familiar. The trials demonstrated that simplicity, consistency, and trusted channels drive participation and help maintain customer confidence in heat pump flexibility. BaU models should replicate these principles by prioritising clarity, relevance, and familiarity, rather than introducing unnecessary complexity or unfamiliar communication pathways. This approach will help sustain high engagement and satisfaction at scale.

As energy suppliers were an important part of the project, we have detailed below some additional learnings provided by them directly:

- Customers seem to generally treat heat pump flexibility in the same way as other forms of manual flexibility. As long as they remain comfortable convenience appears to become the dominant factor shaping their experience. Notably, satisfaction with payments correlates strongly with how much effort customers feel is required to deliver the requested flexibility.
- It is particularly promising that day-ahead notification works well for customers and aligns with their expectations of convenience and predictability. This approach is also beneficial for the DSO and may create additional value for FSPs.

5.2.8 Recommendations

The EQUINOX trials provide a proven model that clear, familiar communications, voluntary participation, and practical safeguards ensure high engagement, satisfaction and comfort for all participants including those who are potentially vulnerable. The EQUINOX trials have demonstrated that DSOs can procure heat pump flexibility without negatively impacting customers, and FSPs can be confident that customer experience will remain positive.

5.3 Flexibility procurement strategy

This section presents how the EQUINOX trial learnings can be incorporated into Flexibility Procurement Strategy in BaU.

- Section 5.3.1 discusses learnings relevant for commercial procurement process from DSO to consumer.
- Section 5.3.2 discuss learnings for optimal flexibility product engagement for heat pumps.
- Section 5.3.3 discusses learnings for explicit flexibility (services) and implicit flexibility (time of use tariffs).
- Section 5.3.4 discusses recommendations for flexibility procurement in BaU.

5.3.1 Commercial procurement process from DSO to Consumer

Prior to and during the EQUINOX trials it has been standard practice for DSOs to procure flexibility from end consumers through a FSP intermediary. Those intermediaries in turn own the end consumer relationship. Beyond EQUINOX with transition of learnings into BaU, there is no indication this process needs to be updated.

Existing aggregator platforms such as Flexible Power and PICLO, used in the trials, are adequate as a method of notifying FSPs of DSO flexibility needs for heat pump flexibility, and managing settlement for delivery. Additionally, EQUINOX has demonstrated that FSP intermediaries which own the end consumer commercial relationship are best placed to mobilise consumers for engagement in flexibility services.

5.3.2 Optimal flexibility product engagement for heat pumps

The trials collectively demonstrate that domestic heat pumps are a dependable network flexibility asset, capable of both demand turndown and turn up when required. Their participation rates and measurable response confirm they can meaningfully contribute to network peak management, network maintenance, and balancing supply and demand.

- Trial one was a proof of concept: heat pumps can reliably provide flexibility during the evening peak, especially during colder periods when demand is higher.
- Trial two confirmed scalability and commercial viability, showing consistent response magnitudes across large samples, and the network impact analysis performed highlighted the value-proposition for daily events.
- Trial three validated the ability for daily demand turndown event participation, both in evening and morning formats, as well as demonstrated potential for turn up flexibility participation.

Across all three trial years heat pumps have been demonstrated as assets able to fill a variety of flexibility roles to support network operators, delivering short-duration, predictable load reductions or increases to manage system stress and optimise grid performance, to suit single-day or sustained delivery needs.

Table 5 summarises the suitability of heat pumps for standard Energy Networks Association (ENA) flexibility products, based on EQUINOX trial results. The findings indicate that heat pumps are potentially suitable across three product categories.

Operational Utilisation (OU) typically procures flexibility for single-day events at a premium price. OU-type events were tested extensively in trials one, two and three. These results demonstrate that heat pumps can successfully participate in this product in a BaU setting. As outlined in section 5.1, the EQUINOX trial one, two and three findings have provided valuable insights into the responsiveness and reliability of flexibility services, giving NGED the confidence to procure OU in a BaU setting.

Scheduled Utilisation (SU), which typically procures flexibility on a daily basis for a lower price, appears to be the most optimal use-case for heat pumps. Post-trial two network impact analysis showed that heat pumps can be most effectively engaged to manage constraints when participating in such a daily format. This approach was validated during trial three's Daily Evening Flex and Daily Morning Flex mini-trials, confirming heat pumps' suitability for this role and building on evidence of existing heat demand load shifting incentivised by time-of-use tariffs that was observed in trial two.

Scheduled Availability + Operational Utilisation (SAOU), which provides availability payments with utilisation only when required, was not directly tested during the EQUINOX trials. However, trial evidence indicates that heat pumps could feasibly participate in this product due to their demonstrated ability to turn down at short notice, either for single-day or daily events.

Additionally, EQUINOX identified that heat pumps can meaningfully engage in Demand Turn Up services. These findings are promising for meeting flexibility requirements that include NGED's newly introduced Demand Turn Up (DTU) service.

Finally, depending on product duration (hours per event), it may be necessary to aggregate groups of heat pumps to cover full flexibility windows that are longer than two hours. This does not present a network challenge provided sufficient heat pumps or other flexible assets are available to meet the requirement. In practice, FSPs are expected to continue procuring multi-asset portfolios combining domestic, commercial, and industrial participants to meet specific product needs, based on available assets in any given procurement flexibility zone.

Table 5: NGED flexibility products and suitability of heat pumps based on EQUINOX findings

Product	Description	Suitability of heat pumps
OU	• A service that supports power restoration following rare fault conditions. It offers a premium utilisation payment. Typical contracts are a few hours of a single day.	• EQUINOX has demonstrated domestic heat pumps can engage in this type of product. This flexibility format was tested in trial one, trial two, and trial three's Longer Events Flex and Morning Events Flex mini-trials. The payment rates additionally aligned broadly to NGED commercial product rates for trial two, and trial three's mini-trials. These results have given NGED the confidence to procure OU in a BaU setting.

SU	• A scheduled constraint management service with fixed delivery periods. It offers a utilisation only payment. Typical contracts are the same few hours per day Monday to Friday, for several weeks in a row.	• EQUINOX has demonstrated heat pumps can engage in this type of product, and it may be their most effective use-case. This format of daily flexibility, tested in both morning and evening peak times, was observed from time of use tariff customers in trial two and tested successfully in trial three's Evening Peak and Morning Peak Flex, at payment rates within the range offered by NGED for the real product. Based on the post-network impact analysis findings. This may be the optimal use-case for heat pump homes.
SAOU	• A service developed to support the network in the event of specific fault conditions, such as during maintenance work. It offers an availability and utilisation payment. Typical contracts are the same few hours per day Monday to Friday, for several weeks in a row.	• EQUINOX did not test these arrangements separately from the SU arrangements, though the trial results broadly indicate heat pumps would be suitable given that in trial three customers were willing to participate in a daily flexibility service.
DTU	• EQUINOX's initial proof of concept provided NGED with the confidence to launch a larger DTU product. The needs-case for turn up flexibility is likely to grow given the temporal imbalances between intermittent renewables and demand.	• EQUINOX has demonstrated heat pumps can engage in this type of service. EQUINOX trial three's Turn Up Flex mini-trial successfully tested DTU flexibility and demonstrated that heat pumps can meaningfully engage in DTU events and make a valuable contribution to flexibility services. Therefore DTU services via Heat Pumps can fit seamlessly into NGED existing products. From a supplier perspective there is support for the use of fixed baselines which enable customers to stack DSO flexibility with their ToU tariffs.

5.3.3 Implicit flexibility (such as time of use tariffs)

Additionally, as described in section 5.1, EQUINOX trial two found that participants with time of use tariffs that incentivise demand shifting during the day were already providing demand response regardless of whether an EQUINOX event was called. Participants on these tariffs had limited additional demand response to offer through EQUINOX events as their demand shifting behavior was already embedded in their consumption patterns and evident in their baselines. In trial two, 25% of participants were on these tariffs.

These insights are particularly valuable for DSOs when forecasting demand and planning network operations, as greater uptake of time-of-use tariffs could influence assumptions about future flexibility needs. For flexibility procurement, this means that customers on these tariffs can provide flexibility to the grid, even when a formal flexibility event is not called.

It is important to note, however, that current implicit flexibility largely depends on supplier incentives encouraging shifting of customer demand away from peak periods for networks. In future supplier incentives for shifting demand may not fully align with the times that networks require flexibility, unless DSOs actively engage with suppliers offering these tariffs.

At present, DSOs do not consider implicit flexibility when undertaking network planning or determining how much flexibility is needed to manage constraints. DSOs should continue to consider developments in implicit flexibility when planning their networks and engaging with energy suppliers. Looking ahead, a mixture of both implicit and explicit flexibility will be needed to meet system flexibility needs. Implicit flexibility is useful for exploiting wholesale market signals and softening peak demand periods, but it does not necessarily address all system requirements such as localised network constraints. Explicit flexibility, therefore, is expected to play a significant role alongside implicit price signals to ensure network reliability and resilience.

5.3.4 Recommendations

EQUINOX has proven that flexibility from heat pump homes can be procured very similarly to other types of domestic flexibility. Therefore, the established standard flexibility products remain effective and do not require modification in consideration of EQUINOX findings. The trials' findings additionally support the conclusion that domestic heat pumps can participate in existing flexibility service offerings, without new services needing to be implemented.

5.4 Technical integration

This section summarises the technical integration approach adopted for EQUINOX and is structured as follows:

- Section 5.4.1 provides an overview of the technical approach and integration methods used.
- Section 5.4.2 outlines the key outcomes derived from using existing BaU systems and processes.
- Section 5.4.3 describes the implementation of the technical solution across the three trials, including the technical requirements introduced in later phases.
- Section 5.4.4 summarises the cybersecurity considerations and provides a view on the final readiness of the technical solution for BaU adoption.

5.4.1 Overview of technical approach for EQUINOX

EQUINOX adopted a BaU aligned technical approach by utilising established platforms, primarily Flexible Power and Piclo, to manage operational interactions with Flexibility Service Providers (FSPs). This approach reduced barriers for customers and suppliers, minimised new development requirements, and ensured consistency with existing flexibility procurement practices.

Technical development was therefore focused only on areas where previous trials identified integration gaps or where suppliers required additional onboarding support, particularly for Sero and ScottishPower. Across the trials, Octopus Energy used Kraken, Sero used its Building Energy Engine (BEE), and ScottishPower used its Power Saver App. This reduced the amount of additional technical integration by the partners and NGED in order to carry out the trials.

5.4.2 Key outcomes

Using familiar BaU systems enabled EQUINOX to demonstrate that:

- Households can reliably provide meaningful turndown, even within a developing DTU service.
- Customer participation and satisfaction remained consistently high, supported by the use of familiar processes and interfaces.
- Third party-led automated control delivered more consistent outcomes than manual customer action, particularly in trial one.
- Automation can ensure dependable and repeatable delivery, although it is not essential for heat pump flexibility.
- By utilising the existing embedded solutions within the industry the project was able to create a friction free route to enable heat pump flexibility. The approach enabled the team to maximise the outcomes and therefore have a stronger chance to being embedded into BaU without significant rework at both the DNO end and FSP end of the supply chain

Sero's approach was to provide a holistic home energy management service to the homes included in the EQUINOX project, which spanned from the resident setting their heating schedule within Sero's app, through to the supply and billing of their energy (as a third-party intermediary). This model meant that integration of flexibility (down or up) could be included in the "heat-as-a-service" as an automation, once resident consent had been obtained, and is different to current 'smart thermostat' models in that it directly integrates the monetary savings with the heating outcomes. This differed from the other suppliers in that the management of the event was wholly down to Sero and therefore from a customer perspective was largely silent to them. Leveraging this sort of inhouse capability further adds to the friction free access to these services for customers.

Additionally, the outcomes of EQUINOX, aligned with another NGED project that was undertaken that looked at how residential customers generally could be incentivised to participate in flexibility events. One of the FutureFlex key deliverables was a report on what measures needed to be in place to ensure that homes could be notionally "DSO Ready", that is able to participate in flexibility services[23]. It considered Energy Efficiency in the main but also touched on home energy automation. In addition, it also considered the role of DNOs in energy efficiency [24,25]. These matters are important in the wider consideration of technology to support the transition and also integration of them with DSO services. This is covered a little more in the Policy section of this report.

[23] Western Power Distribution: DSO ready homes: definitions
[24] Western Power Distribution: Realising the value of domestic energy efficiency in GB electricity distribution
[25] Western Power Distribution: Energy Efficiency: What is the DNO role?

5.4.3 Trial implementation

Trial one provided the first opportunity to apply the EQUINOX technical integration approach in a live setting. Given the lack of an established reference model, the design prioritised simplicity and stability. This trial set the technical and commercial foundations for later phases.

Trials two and three built upon trial one and moved the integration approach closer to a full BaU model. Flexible Power remained the central integration platform, but updated commercial arrangements introduced new variables: notice periods, payment methods, and time-of-day considerations, that required additional technical configuration.

To reflect the expanded commercial groupings, additional Meterable Units (MUs[26]) and Dispatch Group's(DG's[27]) were created for each supplier (these being part of the existing process of Flexible Power participation). Because these components already existed within Flexible Power, implementation was straightforward and required minimal development. Given the scale of changes and the onboarding of an additional supplier, the testing approach developed for trial one was reused to validate system reliability across both trial two and trial three.

5.4.4 Cybersecurity and final readiness

Cybersecurity due diligence was undertaken throughout the trials to ensure compliance with applicable standards and assess any implications for the technical integration of EQUINOX events. Further detail is provided in EQUINOX Project Deliverable 3[28].

Across all three trials, the technical integration approach matured significantly, with the help of the partners and has now reached a point where it is ready for BaU adoption. The solution proved scalable, reliable, and interoperable across suppliers and platforms, while supporting multiple commercial configurations in a robust and repeatable manner. In conclusion the EQUINOX approach to keep things as aligned to existing practices seems to have worked well. This means that the enablement of domestic heat pump flexibility into BaU should be as friction free as possible.

5.5 Policy and regulatory development

The EQUINOX trials provide critical evidence that can help shape policies that accelerate heat pump adoption and enable equitable participation of heat pumps in flexibility markets. This section outlines the policy and regulatory matters that are or have the potential to impact wider take up of Heat Flexibility services:

- Section 5.5.1 recommends utilising technical integration to enable flexibility participation
- Section 5.5.2 emphasises the need for tailored advice to help heat pump households operate heat pumps and engage confidently in flexibility services.
- Section 5.5.3 outlines policy measures to support heat pump adoption including energy efficiency and electricity pricing reform.

[26] Meterable Units are made up of one of more flexibility assets behind a single metering feed. Baselining is applied at this level.
[27] Dispatch Groups are higher level components made up of one of more MU's and used for Trade Response, dispatch and settlement
[28] https://commercial.nationalgrid.co.uk/innovation/projects/equinox-equitable-novel-flexibility-exchange

- Section 5.5.4 recommends area-based delivery models to integrate heat pump deployment with energy efficiency upgrades and flexibility services.

To support the transition to low-carbon heating, particularly for fuel-poor households[29] the UK Government has introduced several funding mechanisms. These include:

- The Warm Homes Plan, a nearly £15 billion investment running from 2025 to 2030, aimed at upgrading 5 million homes with a strong emphasis on heat pump deployment.
- The Boiler Upgrade Scheme, which provides support for "able-to-pay" households to switch from gas boilers to heat pumps, with grants of up to £7,500 per installation.

As of June 2025, 46,423 heat pumps were installed under these government backed schemes: 60% funded through the Boiler Upgrade Scheme and the remaining 40% installed through schemes targeting fuel-poor households[30], including ECO4, the Warm Homes: Local Grant, and the Warm Homes: Social Housing Fund.

This distribution highlights that while the "able-to-pay" market consists of the majority of retrofit installations, a significant proportion of uptake is among fuel-poor households, underscoring the need to better understand the specific conditions and support mechanisms required for fuel-poor customers to adopt heat pumps successfully. EQUINOX directly addresses this need by focusing on heat pump flexibility and enabling all customers to benefit from heat pump flexibility, including potentially vulnerable and fuel-poor customers.

As outlined in Section 5.2, potentially vulnerable groups are both willing and able to engage in heat pump flexibility. EQUINOX has demonstrated that participation in heat pump flexibility can be equitable and inclusive, particularly when the approach is voluntary, communication is clear, and customers face no penalties for opting out. These principles help ensure that all customers, including those who are potentially vulnerable, feel confident and supported in participating in flexibility programmes.

5.5.1 Technology integration

To maximise the flexibility benefits of heat pumps, those installed through schemes such as the Boiler Upgrade Scheme should be sold as smart-ready. The Government is consulting on the Smart Secure Electricity Systems Programme[31], which aims to introduce standards for interoperability and smart system readiness to support flexibility. For heat pumps, this includes requirements for smart-ready capability, mirroring existing regulations for EV chargers. Findings from EQUINOX trial two show that, while third-party control is not essential for delivering flexibility, automation significantly improves customer acceptance and participation. Future policy should build on these insights to ensure heat pumps are consistently installed with smart-ready functionality. Embedding interoperability and automation from the outset will make participation in flexibility easier for customers and more reliable at scale.

[29] A household is considered fuel-poor if they are living in a property with an EPC of band D or below and when they when they spend the required amount to heat their home, they are left with a residual income below the official poverty line.
[30] Heat pump deployment statistics: June 2025, Department for Energy Security and Net Zero.
[31] Smart Secure Electricity Systems Programme consultation, Department for Energy Security and Net Zero.

Additionally, heat pump installations should include a communications hub that is non-proprietary and interoperable across suppliers, ensuring customers can participate regardless of who they choose as their energy provider. This approach builds trust and avoids vendor lock-in, supporting a fair and competitive market.

5.5.2 Heat pump guidance

To maximize the benefits of smart-ready heat pumps and flexibility services, households need clear, accessible advice on operating heat pumps, using smart thermostats, and understanding flexibility events. Evidence from the EQUINOX project indicates that 72%[32] of participants would find additional guidance helpful for operating their heat pump. While this figure is lower among social housing tenants (56%)[33], it still represents a majority, underscoring the importance of tailored support.

As heat pump deployment accelerates, targeted guidance, particularly for potentially vulnerable households, should complement technical measures. This approach ensures that these customers are not excluded from the benefits of low-carbon heating and flexibility offerings. Providing practical, user-friendly information will empower households to make informed choices, feel in control of their heating, and engage confidently with heat pump flexibility.

5.5.3 Heat pump adoption

The age and condition of the UK housing stock present a significant barrier to heat pump adoption, making it essential for policy to address these structural limitations. Supporting the rollout of heat pumps in optimal ways will also broaden access to flexibility services, which are critical for a decarbonized energy system.

Upfront grants through schemes like the Boiler Upgrade Scheme play a key role in accelerating deployment and driving down installation costs over time. It is important to provide clear, long-term funding commitments to maintain market confidence and encourage sustained investment in heat pump technologies.

In terms of making further progress on buildings decarbonisation, making electricity relatively cheaper will be key to supporting consumers to make the shift to heat pumps and other low carbon electric technologies. Ending the distortion whereby policy costs fall disproportionately on electricity bills, negating the efficiency benefits of technologies like heat pumps, will be key to improving the running cost of heat pumps. The use of flexibility within heat pumps should be encouraged to support running costs, protect grid capacity and deliver greater carbon savings. The introduction of appropriate electricity tariffs designed to support the uptake of electrified heating will additionally be important. Time-of-use tariffs can incentivise consumers to shift demand to periods of lower grid stress, reducing costs and improving system efficiency.

5.5.4 Local area and partnership delivery

To accelerate heat pump adoption and ensure equitable access to flexibility services, policy should promote area-based delivery models that integrate heat pump installation with energy efficiency upgrades. These models should be underpinned by strong local partnerships between housing associations, local authorities, energy suppliers, and

[32] This was asked in a survey to control group participants who didn't take part in events. Respondents were asked: "What kind of guidance or information would help you better use your heat pump?"
[33] This was asked in a survey to social housing tenants who were not enrolled in the EQUINOX trial. Respondents were asked: "What kind of guidance or information would help you better use your heat pump?"

community organisations, enabling coordinated interventions at scale. By aligning heat pump deployment with additional energy efficiency measures like insulation, such partnerships can reduce running costs, improve comfort, and target fuel-poor households effectively. Pooling resources from schemes such as the Warm Homes Plan and local grants will maximise funding efficiency and deliver holistic solutions rather than piecemeal upgrades. Area-based approaches also build trust through community engagement and ensure smart-ready integration from the outset, supporting participation in flexibility markets. Additionally, this model will also enhance the ability for DNOs to anticipate and manage demand changes at specific substations. This enables DSOs to make informed decisions on connection viability and reinforcement planning. Embedding this model in national policy frameworks, with clear guidance and incentives, will help prioritise regions with high fuel poverty and poor housing stock while reducing delivery costs and supply chain challenges.

Moreover, findings from the social housing survey conducted by WMCA in partnership with Bromford Housing Group indicate the value of working via trusted intermediaries to engage households in heating flexibility and other market engagement mechanisms[34]. Such local partnerships can enable and support this.

34 A high response rate to the social hosing survey was observed (198 households of 810 contacted a response rate of over 24%), demonstrating the value of working via trusted intermediaries to engage households in heating flexibility and other market engagement mechanisms, as well as in the energy transition generally.

6. Implementation of EQUINOX learnings to date

EQUINOX has operated across three winters, with a strong emphasis on governance and continuous learning. Throughout the project lifecycle, insights have been shared across NGED, including through the Project Review Group, comprised of senior leaders within the DSO, who have actively engaged with findings and integrated them into operational decision-making. Additionally, the energy suppliers collaborating on the project, Octopus Energy, Sero and ScottishPower, have actively applied EQUINOX learnings to enhance their flexibility offerings, technical solutions, and customer engagement strategies, embedding these insights into their BaU operations.

From the outset of EQUINOX, there was uncertainty about whether customers would accept flexibility of their heat pump use. The concern was that participation might compromise home comfort during flexibility events, making heat pumps less suitable for demand side response. EQUINOX has delivered robust evidence that heat pumps can provide measurable demand response. Importantly, all customers, including those who are potentially vulnerable, who choose to participate in heat flexibility programs can typically do so without sacrificing comfort. The learning from EQUINOX will be valuable in encouraging more suppliers and aggregators to consider heat pumps for participation in flexibility markets.

This section outlines the key learnings from the EQUINOX project that have been implemented by NGED and suppliers, highlighting how trial insights have shaped business-as-usual practices.

- Section 6.1 outlines key learnings implemented by NGED.
- Section 6.2 outlines key learnings implemented by suppliers.

6.1. Learnings implemented by NGED

EQUINOX has enabled NGED to translate trial insights into tangible improvements in flexibility operations and strategic planning. The following learnings highlight how project outcomes have shaped NGED's approach to heat pump flexibility.

1. **There has been a significant increase in heat pump asset registration in response to EQUINOX.** Following trial one results, we began to see heat pump participation in BaU flexibility offerings. Since EQUINOX's inception, 8761 heat pump assets have been registered in NGED's BaU market. As the installed base of heat pumps grows, their role in supporting networks through flexibility will expand.

2. **The results of the EQUINOX trials have provided valuable inputs into network planning assumptions.** Trials results allow the DSO to more accurately calculate fixed baselines for heat pumps. Unlike baselines that rely on historic load data, which can understate delivered response for customers on time-of-use tariffs as found in EQUINOX trial two, fixed baselines ensure that suppliers can continue to offer attractive TOU tariffs, confident that incentives for flexibility participation remain available.

3. **EQUINOX findings have demonstrated that tailored market designs for heat pumps are not necessary.** Heat pumps can participate successfully in existing flexibility markets alongside other technologies, such as electric vehicles (EVs) and home batteries. This streamlines market integration of heat pumps and supports scalability.

4. **EQUINOX trial three's Turn Up Flex trial demonstrated that domestic DTU from heat pump homes could be a promising tool for networks**. Building on this insight, NGED first launched DTU as part of BAU in its long-term tender in 2024, initially covering three zones. Today, DTU procurement is embedded in NGED's FlexUp service, covering over 50% of the network. This progression reflects the growing confidence in DTU as a valuable resource for DSOs that are managing increasing volumes of renewable generation.

Together, these learnings have strengthened NGED's ability to integrate heat pumps into flexibility markets.

6.2. Learnings implemented by suppliers

Suppliers have leveraged EQUINOX findings to build confidence in heat pump flexibility and to innovate their technical and customer engagement strategies. Key learnings include:

1. **EQUINOX has established heat pump flexibility as a credible and valuable market offering.** EQUINOX has helped suppliers develop confidence in heat pump flexibility as an offering with value for customers, flexibility providers, and the wider flexibility market.

2. **There is a strong customer interest in being able to take part in heat pump flexibility, including from potentially vulnerable customers.** Although interest levels may vary amongst different customer groups once heat pumps are the mainstream heating technology, it is encouraging to know that there are not broad customer factors that limit the addressable market for such products.

3. **Heating a comfort are highly personalised, and customers should be empowered to make their own decisions on what flexibility products may be suitable for their household.** Trial three examined how different factors interact to make a customer potentially vulnerable, building on qualitative insights from focus groups and interviews. These findings reinforce that heating and comfort vary widely, underscoring the importance of centring customer choice in flexibility programs.

4. **Consistently high satisfaction amongst trial participants shows that simple, customer-centric measures drive engagement.** Simple measures such as voluntary participation, ability to opt-out without penalty and clear communications can empower customers to actively engage in heat pump flexibility.

5. **ScottishPower has successfully transitioned EQUINOX technical integration into a business-as-usual solution**. ScottishPower developed and implemented a technical solution and associated customer proposition to deliver turn down flexibility events. This has been adopted as the ScottishPower BaU solution for delivery of externally initiated flexibility events including DFS and DNO flexibility events.

Through EQUINOX learnings, suppliers have been given the confidence to consider heat pumps for flexibility participation. Collectively, EQUINOX has provided actionable insights that are now embedded in both NGED's and suppliers' business-as-usual operations.

7. Opportunities for future research

EQUINOX has demonstrated the value of heat pump flexibility at scale. Based on the EQUINOX learnings, as the number of heat pumps installed across the UK increases, there is an opportunity to encourage more suppliers and aggregators to bring heat pumps into flexibility markets. Currently, electric vehicle (EV) charging dominates domestic flexibility, reflecting the general progress of electrification of transport as compared to electrification of heat. However, with 231,078 EVs and 8,761 heat pumps registered in the NGED flexibility market, there is significant room for growth in heat pump participation.

EQUINOX learnings have additionally supported the need for further research to explore the potential of heat pumps flexibility during extreme cold and heat pump's participation in demand turn up, building on work done in EQUINOX.

7.1 Peak winter scenario

During the EQUINOX trials, the coldest day observed was and average temperature of –1.4 °C during trial two. While this provided useful insights, it did not represent a true peak-winter scenario. Cold snaps present both challenges and opportunities for heat pump flexibility, as these periods are when flexibility is most valuable and when the electricity system experiences the greatest strain.

Trial two showed that heat pumps deliver a larger demand response in colder temperatures, both on an individual basis and on a collective basis. Results from trial one and from trial two indicated that decreases in participation from customers choosing not to take part in colder weather were more than offset by the increased volume of demand response from those who did take part. This is a promising indication that heat pumps can be a valuable network asset even in colder weather, but it is not known if this result would persist beyond the minimum temperatures observed during EQUINOX trials.

Future innovation projects could therefore focus on understanding how customers behave during severe cold spells to better assess the achievable level of heat pump flexibility in extreme conditions. It will also be essential to ensure robust customer care, support, and advice are in place so that potentially vulnerable customers are not put at risk during extreme weather events. Building a detailed evidence base on household responses to flexibility events in peak-winter scenarios will help quantify the true potential of heat pumps when demand is at its highest. Additionally, further investigation can be made into automated control to schedule customers into flexibility events at these temperatures whilst making use of pre-heating and post-heating cycles to mitigate comfort impacts. It will also be important to consider how other low-carbon technologies interact during extreme cold. Technologies including electric vehicles may offer additional flexibility under a '1-in-20' peak-winter event where heat pump response alone may be insufficient. Understanding these cross-technology dynamics will be essential for robust network planning and ensuring resilience under the most challenging conditions.

7.2 Demand turn up

DTU is be a valuable flexibility resource for DSOs that are managing increasing volumes of renewable generation. Using heat pumps in this way could be an exciting opportunity to boost affordability of home heating, while providing a network benefit. EQUINOX trial three's Turn Up Flex trial demonstrated that domestic DTU from heat pump homes can be a promising tool for networks. This initial proof of concept trial suggested that heat pump homes could deliver measurable turn up demand response for network services. As discussed in section 6.1, This initial proof of concept has provided NGED with the confidence to launch a larger DTU scheme and knowing that heat pumps can meaningfully engage in DTU events and make a valuable contribution to flexibility services, helping to unlock low-carbon technologies for system balancing.

Nevertheless, the trial was small in scale, and further research could help to validate the impact of heat pump homes participating in DTU offerings at a system level. Further research will help quantify impact and explore how heat pumps can reliably support DTU as part of future flexibility strategies. Ongoing consideration of heat pumps for turn up events should remain a priority for DSOs, ensuring networks can leverage heat pumps not only for demand reduction but also for demand increase.

7.3 Opportunities to inform NESO RESP planning

As part of wider industry information sharing, the learning from EQUINOX in respect of heat pump customers we feel will be invaluable for NESO in respect of Regional Energy Strategic Planning (RESP), the ability to have some confidence that customers with heat pumps can and will provide a flexibility service in the winter will be essential to planning the energy system of the future.

7.4 Multi-asset profiles

We have seen throughout the EQUINOX trials that customers are able and willing to participate in heat pump flexibility events.

There were also interesting insights provided when heat pumps were combined with other low carbon technologies in the home. The interaction between having a heat pump coupled with an EV charger and in home battery storage provided additional insights, and in particular we think that battery storage linked to a heat pump allowed some customers to prolong their turn down period. We believe that two outcomes may come from this. Firstly, we believe that additional research may be valuable in this area, carrying out a deeper dive into customer behaviour and the interactions between differing technologies. Secondly, this may then provide additional opportunities around the profiles to customers with these technologies, allow changes to some of the assumptions where these technologies co-exist.

8. EQUINOX business case

This section presents the updated EQUINOX business case, developed using trial findings and an enhanced methodology aligned with RIIO-ED3 guidance. The business case aims to demonstrate the potential benefits to GB of heat pump flexibility being implemented in line with EQUINOX trial results.

- Section 8.1 presents the business case scope.
- Section 8.2 presents the business case methodology assumptions.
- Section 8.3 presents the business case results.

8.1 Business case scope

The original Full Submission Proforma[35] provided an estimation of the potential benefits of scaling-up heat pump flexibility in GB. The calculated benefits were based on an assessment of reinforcement needs to accommodate the future uptake of non-flexible heat pumps across GB, and the capability to defer or avoid this reinforcement by procuring flexibility from those customers with heat pumps. The assessment considered that procuring flexibility from heat pumps would enable their peak demand contribution to be reduced, resulting in increased substation headroom. This assessment was based on ED2 guidance and the use of flexibility to defer or avoid reinforcement.

The updated 2025 business case follows the same core principle of modelling scaled-up heat-pump flexibility to reduce peak demand and increase substation headroom. However, the application of this additional headroom has been realigned to reflect ED3 guidance. Rather than emphasising substation reinforcement deferral, the business case now focuses on enabling new connections that would otherwise need to be delayed until reinforcement is completed.

There are multiple use-cases for heat pump flexibility, including the use of demand turndown to create substation headroom, but also the use of demand turndown to support fault maintenance or demand turn up to support supply-demand imbalances. This business case focuses solely on the substation headroom benefits case, though highlights these additional use-cases for heat pump flexibility can provide substantial value to the GB energy system.

8.2 Business case methodology and assumptions

The business case analysis focused on developing and comparing two scenarios for heat pumps up to 2050: a Counterfactual scenario, where no forecasted heat pumps participate in flexibility, and an EQUINOX scenario, where a proportion of forecasted heat pumps participate in two-hour flexibility events in line with the EQUINOX trial results. In the EQUINOX scenario, headroom additions are valued to demonstrate the system benefits of heat pump flexibility.

[35] EQUINOX, Making heat flexible to DNOs and beneficial to customers, NGED

8.2.1 Data sources

Data sources for the business case are drawn directly from the EQUINOX trial results or were provided by NGED. They are listed in full in Table 6.

The NGED data sources include the following:

- Headroom forecasts for primary and secondary substations.
- Heat pump count forecasts indicating expected ASHP and GSHP uptake.
- NGED winter peak load profiles per heat pump, representing maximum expected demand during very cold weather (which is used to inform network planning for heat pump peak load).
- NGED's WACC, used for investment case evaluation.

The EQUINOX trial data is as follows:

- Participation behaviour observed during trial two's cold-weather events at –1.4°C.
- Default two-hour event duration identified in the trial three Longer Events Flex mini-trial.
- Whole-home turndown measurements during trial two's coldest weather event at –1.4°C.

An additional data source is NERA/SSEN's report, which quantifies the value of headroom per MVA per year being freed up on the network.

Table 6: Key assumptions that informed the updated business case

Data	Assumption	Source
Substation headroom forecasts	This dataset shows the capacity limit of each NGED substation and their forecasted peak load from 2025-2050.	• NGED Network Headroom Report for primary substations[36]. Data provided by NGED for secondary substations.
Heat pump count forecasts	This dataset shows the number of heat pumps forecasted to be connected to each primary substation.	• NGED Distribution Future Energy Scenarios for primary substations[37]. Data provided by NGED for secondary substations.
Peak load contribution of heat pumps	ASHP: 0.002791 MW GSHP: 0.00236 MW	• 2025 After Diversity Maximum Demand profiles for heat pumps, provided by NGED.
Peak load reduction from heat pumps as a	39%	• Based on demand response volumes achieved on the coldest day of EQUINOX trial two[38].

[36] Network Headroom Report, National Grid
[37] Distribution Future Energy Scenarios, National Grid
[38] See full report: Deliverable 4: Learning from trialling novel commercial methods

proportion of total load at -1.4°C		
Heat pump customer flexibility participation rate at -1.4°C	40%	• Based on participation rate seen on the coldest day of EQUINOX trial two[39].
Proportion of heat pumps who flexibility is procured from every two-hour period	50%	• Based on EQUINOX Longer Events Flex mini-trial three findings that most households prefer two-hour long events[40].
Value of headroom £/MVA/year	£397,999/MVA/year	• This figure represents the cost incurred to enable connections to still occur despite a constraint, by setting up back-up generation[41].
Cost of funding flexibility	£20/heat pump/year	• Based on EQUINOX trial three Daily Evening Peak settlement amount, based on an average of Sustain payments offered by NGED[42].
Cost of EQUINOX funding	£6,980,000	• EQUINOX project direction[43].
WACC	4.8%	• Provided by NGED.
Scale up to GB	1/ (4/14)	• Number of DNO license areas operated by NGED relative to total GB DNO license areas.

8.2.2 Counterfactual scenario

[39] See full report: Deliverable 4: Learning from trialling novel commercial methods
[40] See full report: Learning from trial three: Longer heat pump flexibility events
[41] Review of the Regulatory Framework for Strategic Network Investment, NERA
[42] See full report: Learning from trial three: Daily evening heat pump flexibility
[43] See full report: EQUINOX Project Direction

The Counterfactual scenario analysis assumes the view state with no heat pump flexibility. Reinforcement need is identified as the year in which a substation's headroom projection falls negative, and no headroom benefits are quantified.

8.2.3 EQUINOX scenario

The EQUINOX scenario assumes that a proportion of heat pumps will participate in flexibility, drawing on both the participation rates and the magnitude of turndown observed in the EQUINOX trials. For each substation and year, the non-flexed peak load contribution from heat pumps is first calculated by multiplying NGED's forecasted heat pump count by NGED's peak winter load values of 0.002791 MW for ASHPs and 0.00236 MW for GSHPs.

This baseline peak load is then reduced according to trial-based flexibility performance. Consistent with the performance observed in trial two during the coldest weather days (–1.4°C), the analysis assumes that 40% of customers will participate in flexibility each day and that they will achieve a 39% reduction in their peak load when doing so. Participating customers are distributed across two-hour windows from 4–6pm and 6–8pm, Monday to Friday, ensuring coverage of the traditional evening peak.

The resulting reduction in peak heat pump demand is added back to NGED's headroom datasets to simulate the impact of flexibility. In many substations, this increases available headroom—and in some cases restores headroom to a positive value where it would otherwise be negative—representing additional network capacity created through flexibility, which is the value quantified as headroom benefits due to EQUINOX.

Daily participation is assumed in the analysis based on findings from the post-trial two network impact analysis, which demonstrated that routine, daily deployment of heat pump flexibility provides the highest network value. Although flexibility could also be procured at other times, these alternative deployment patterns are not modelled within the analysis.

This method is applied consistently across all Primary and Secondary substations out to 2050.

8.2.3 Valuation method for headroom

For each substation, the Counterfactual trajectory identifies when reinforcement would be required without heat pump flexibility. The EQUINOX-derived reduction in peak heat pump load is then added to the headroom dataset to determine how long flexibility can keep headroom above 0 MVA. Headroom benefits are quantified only for the years from when flexibility is first needed to maintain positive headroom to the final year in which it remains sufficient to do so.

Headroom benefits are valued using the NERA/SSEN rate of £397,999 per MVA per year, multiplied by the MVA freed up in each applicable year. The method is applied across all Primary and Secondary substations, with total benefits aggregated across NGED's four licence areas.

8.2.4 Costs of flexibility and NPV calculation

Flexibility procurement costs are based on £20 per winter per participating heat pump, aligned with trial three's Daily Evening Flex payment rate. EQUINOX project funding costs are also considered. A Net Present Value (NPV)

calculation compares total flexibility costs against the value of freed up headroom to demonstrate the system value of heat pump flexibility.

8.2.5 Scale up to GB

The final step is scaling up the total benefits of EQUINOX in NGED's area to that of GB. This is undertaken on the basis of dividing the results by 4/14 – the total number of DNO license areas operated by NGED relative to those across GB.

8.3 Business case results

Applying the methodology outlined enabled estimation of substantial benefits to GB if heat pump flexibility is implemented at scale. As shown in Figure 6, the forecasted cumulative headroom that would be created by EQUINOX between 2026-2050 is 6,014 MVA at primary substations and 3,750 MVA at secondary substations across Great Britain (GB). It is important to note that this headroom is temporary—available only in years where flexibility procurement maintains positive headroom—until reinforcement ultimately removes these benefits. As a result, capacity gains are distributed across the timeline rather than permanent.

The forecasted net financial benefits of EQUINOX at GB scale reaches approximately £1,154m for primary substations only, £719m for secondary substations only and a combined figure of £1,879m in 2050. These results are shown in Figure 7[44]. It is important to note that the combined view between primary and secondary substations may be overstated, as there are likely cases where there are duplicate benefits across the two. Nevertheless, the results show clear financial and system value to procuring heat pump flexibility at scale at both primary and secondary substations.

[44] All figures are presented in real terms using 2025 prices.

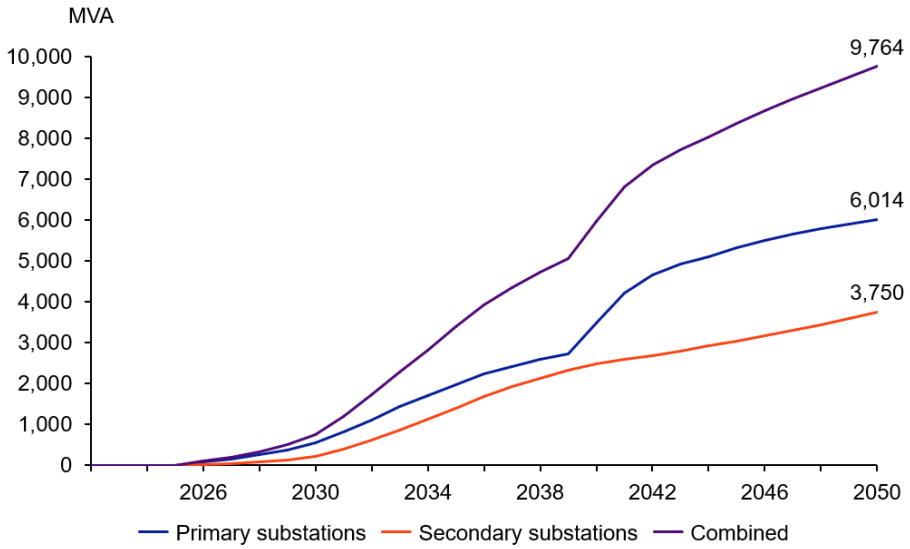

Figure 6: Forecasted cumulative headroom benefits of EQUINOX at GB scale

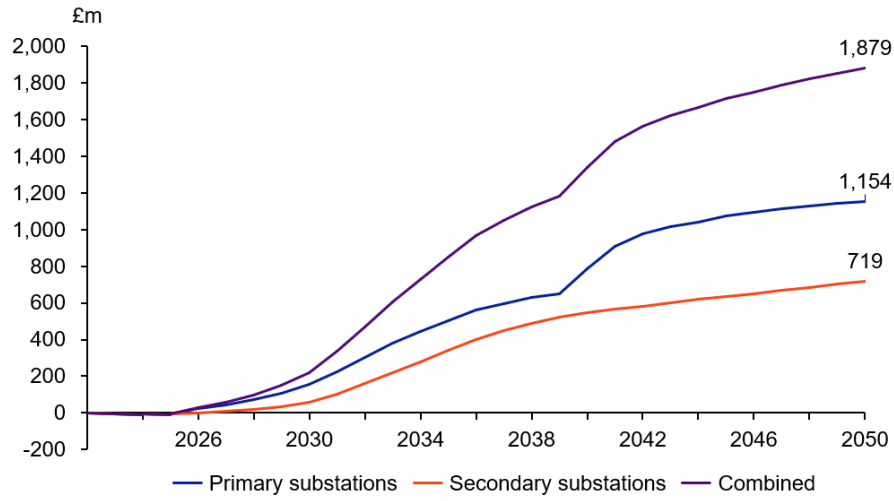

Figure 7: Forecasted net financial benefits of EQUINOX at GB scale

These results highlight that heat pump flexibility delivers considerable system and financial value by creating additional headroom to enable new load to connect sooner at a lower cost. The results differ from the previous business case analysis undertaken in 2021, which is explained by the differing methodology. Aligned with ED2 guidance, the previous business case focused largely on deferring costs – resulting in a financial saving when discounted using NGED's WACC. Better aligned to ED3, the new business case's focus on enabling new connections to occur more swiftly results in comparatively greater benefits to GB.

Ultimately, the results of this updated business case strongly demonstrate that the cost of procuring flexibility is far outweighed by the economic and system benefits, highlighting the benefits heat pump flexibility being procured at scale.

9. Roadmap for implementation of heat pump flexibility into BaU

Prior to, during and beyond the conclusion of the EQUINOX trials the project has envisaged a roadmap for the progression of heat pump flexibility from concept into commercial implementation at scale. As shown in Figure 8, the project operated across five key stages, beginning with Conception and ending in Transition to BaU.

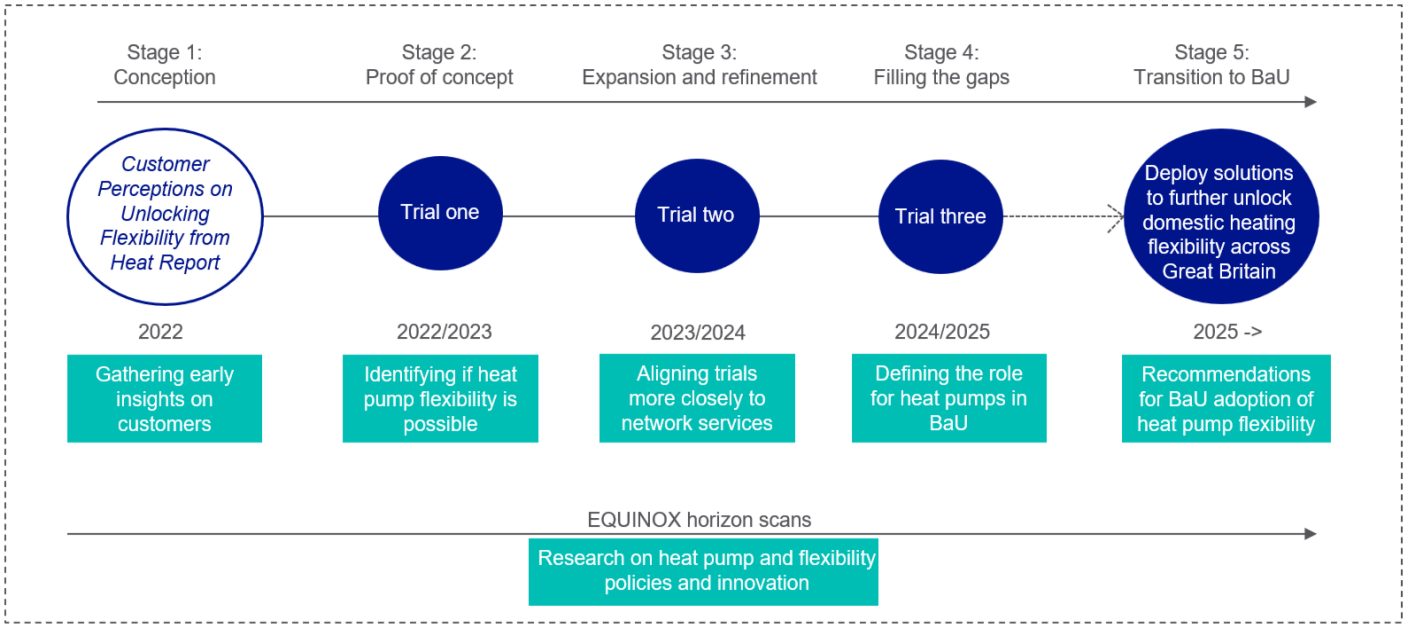

Figure 8: EQUINOX roadmap

Stage 1: Conception

Prior to trial one heat pump flexibility was in the conception stage. The EQUINOX project focused on gaining understanding of public perceptions of heat pump flexibility to inform future trials design and ensure testing criteria would be acceptable to customers. The primary deliverable was the Accent Survey of Customer Perceptions on Unlocking Flexibility from Heat Report.

Stage 2: Proof of concept

Building from the initial insights gathered from the Customer Perceptions report, the EQUINOX project moved into Proof of Concept stage, focused on trial one design, delivery and analysis. At the beginning of this stage the EQUINOX project was poised to deliver the first UK trial of heat pump flexibility at scale. The project anticipated successful heat pump flexibility adoption could require automation, and eventually a heat pump specific flexibility

product might be needed to engage customers. It was uncertain whether customers would be able to sustain a 2-hour flexibility window.

As trial one concluded the project observed high rates of satisfaction and participation, with limited to no participant feedback of concerns of the cold, demonstrating high potential for heat pump flexibility as a scalable solution to support networks. Automation was additionally observed to be helpful but not essential for securing customer engagement.

Stage 3: Expansion and refinement

Building on trial one, the project next elected to trial testing conditions more closely aligned to real network flexibility products. The project also sought to more carefully consider which types of customers could participate in flexibility and their preferred conditions for doing so. Trial two's design was heavily influenced by real NGED flexibility products, with participants notified and paid in arrangements representative of those products. Participants' performance was also tracked across multiple factors ranging from ownership of other LCTs to whether they were potentially vulnerable, to the type of electricity tariff they had.

With trial two's conclusion it was observed that heat pump flexibility could be reliably and procured from customers, when they were settled at payment rates in line with that offered by NGED for procurement of real flexibility products with similar delivery conditions. The project also recognised that explicit flexibility, procured services, and implicit flexibility, time of use tariffs, could both be used to de-load networks at peak times. Post-trial analysis also highlighted that heat pumps would be most valuably engaged in flexibility programmes when participating on a daily basis as opposed to the 2-3 day a week format incorporated into the design of trials one and two.

These insights led the project team to revise early assumptions. Instead of requiring a bespoke heat pump product, heat pump households, there was the expectation that domestic heat pumps can participate through general flexibility events using their heat pump or other household devices. The expectation that automation would be required shifted to recognition that participation can be delivered manually or with customer or third party remote control.

Stage 4: Filling the gaps

As the EQUINOX project moved into trial three, it was important to consider gaps that the project could cover on behalf the DSO business. In consultation with the DSO Flexibility Team a series of trials were designed (mini-trials) to further illicit the insights needed to provide confidence in the procurement of Heat Pump Flexibility, as well as gather insights on forms of flexibility not yet tested in trials one or two.

The testing criteria expanded to demand turn up to longer duration evening turndown flexibility, to morning flexibility, and to daily turndown flexibility in the mornings and evenings. Customers were also permitted to take part in NESO's DFS service while participating in the EQUINOX trials, to gather feedback on the customer appetite for participation in stacked services. There was additionally a much deeper consideration of potential vulnerability, from indicators to tracking experiences of potentially vulnerable participants.

On analysis of trial three the EQUINOX project draws several important learnings and recommendations on the role for domestic heat pumps in flexibility, as shown in Figure 9 and expanded upon below:

- Participants provided demand turn-up as requested, meaning domestic heat pumps can be a viable asset class for DTU services.
- Around half of participants preferred two-hour flexibility, though many were open to 3–4 hour events. 2-hours therefore should be the default, but longer durations are possible based on customer preferences.
- Morning flexibility was found to be feasible meaning domestic heat pumps can be considered eligible for morning flexibility needs as well.
- Daily flexibility was acceptable to participants, indicating that domestic heat pumps can participate in the way found to be most effective in the project network impact analysis. Though, as demonstrated in trial two heat pumps can also participate reliably in services flexibility services fulfilling a single-day duration need.
- There was positive participant feedback on stacked services, highlighting that networks may consider domestic heat pumps as viable assets for stacked services.
- Customer experience did not differ for potentially vulnerable participants, indicating such customers should be invited to participate in flexibility services alongside other customers, and be permitted to participate if they express interest in doing so.

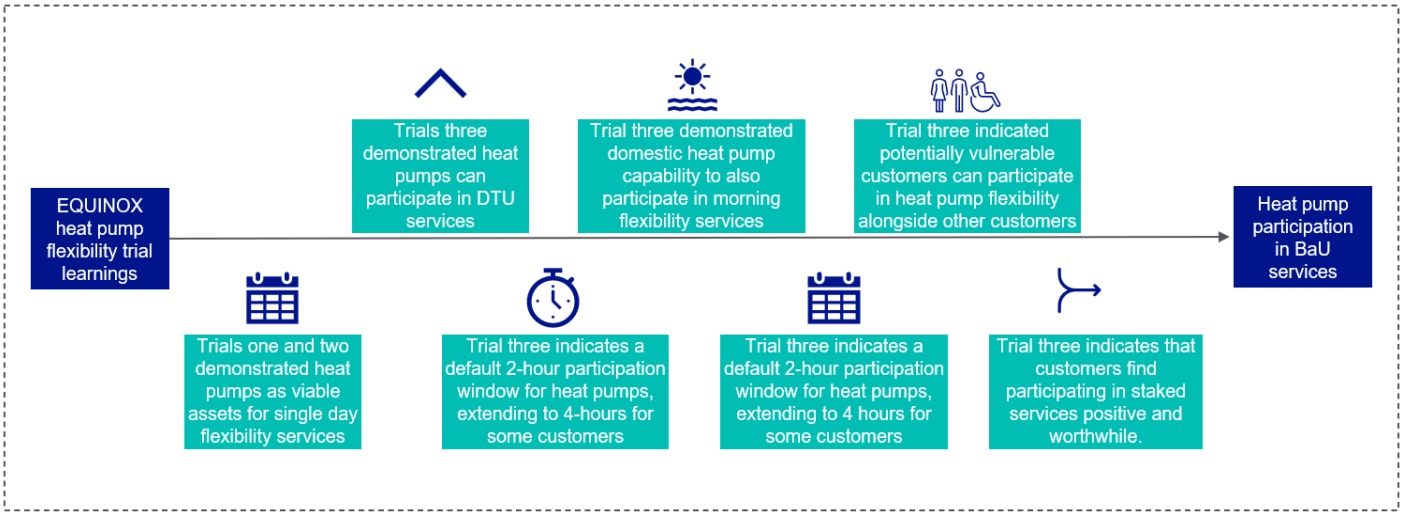

Figure 9: Roadmap for evolution of learnings across trials one, two and three into BaU procured services

On the back of the results from trial three, the EQUINOX team shared its findings with the DSO Flexibility Team and this forms the basis of the report and the roadmap contained herein.

Stage 5: Transition to BaU

As the project enters its final stage, the focus has been on dissemination of learnings and recommendations for their successful implementation into commercial-scale adoption of heat pump flexibility.

As summarised in Figure 10 the project now envisages a roadmap for increased heat pump participation in flexibility services in BaU, leveraging all the learnings and recommendations developed over the 4-year project. These will operate in a cyclical manner that further accelerates the scale-up of heat pump flexibility.

- Flexibility service providers strengthening their engagement with customers to increase their participation in flexibility services;
- Networks building confidence in the flexibility potential of heat pump households in locations with a flexibility need;
- Networks recognising that flexibility service providers who bid using heat pumps can be relied upon to deliver flexibility when called upon;
- Policy interventions that accelerate heat pump deployment, speed up smart meter installation, and improve cyber security standards.

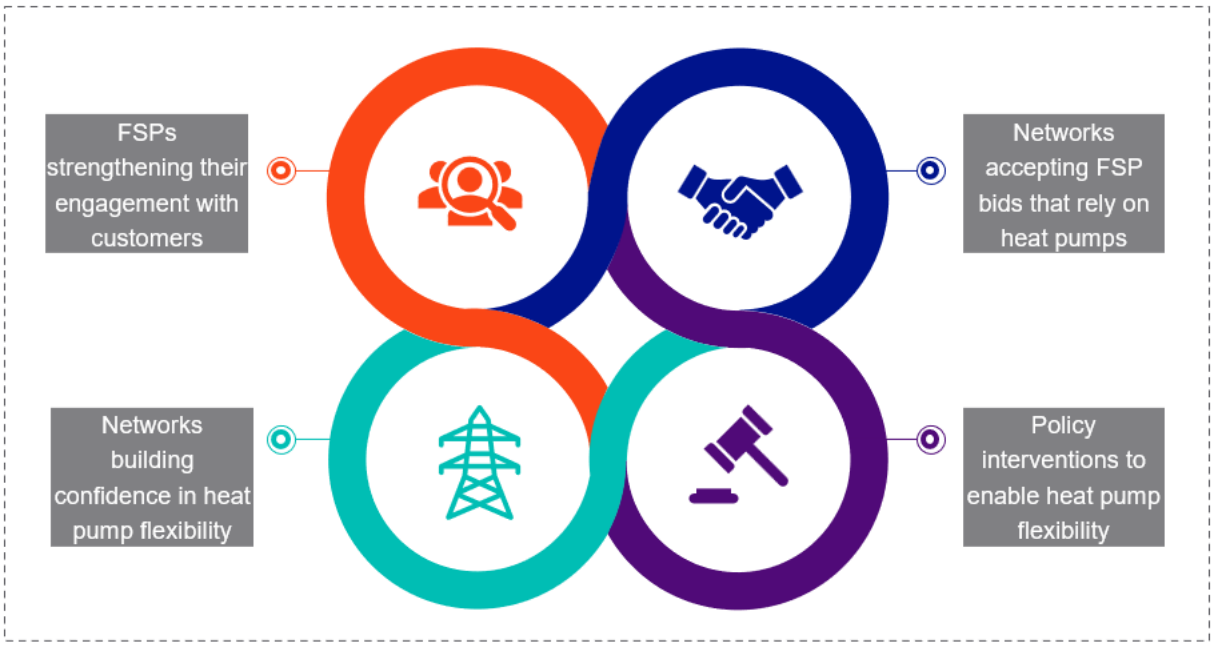

Figure 10: Cyclical roadmap for increasing the adoption of domestic heat pumps into BaU flexibility services

Collectively, these actions will help scale heat pump participation, support a more mature flexibility market, and continue to embed EQUINOX learnings into BaU operations.

In the meantime, the results of EQUINOX, including those around participation and moreover around DTU services have provided a strong basis from which the business can continue to embed heat pumps into their products, gaining confidence as more and more customers adopt them and are offered the opportunity through their FSP (including Energy Supplier) to participate in these services (and this also includes vulnerable and non-vulnerable customers further enabling the potential for maximum participation in these emerging services).

Appendix A- Updates to Simulations

Background

As part of the project delivery modelling and simulation of heat pumps has been carried out to inform the reporting throughout its lifecycle. This has been done for two specific reasons, one to validate the analysis of the trials to ensure that there is some verification of the results and then secondly, to update those results to inform the outputs, where possible, of the business case and transition (including any policy points).

As part of this Deliverable 6, we include two reports which focus on a number of key interesting areas. These are summarised below.

Summary of areas and findings

The updates focus on a number of key areas as follows:

Focus Area	Purpose	High level findings
How the EQUINOX Multi Home Model is matched to the Trial (Report 1)	The report explains the approach to the modelling undertaken through these reports with some insights around how the modelling compared to the trials	• There was potential evidence that some customers run their heat pumps all the time • There was potential evidence that some customers did not turn their heat pumps back on post event
Impact of EQUINOX events on Carbon Emissions (Report 2)	This area seeks to model the CO_2 impact of EQUINOX events	• Reduction in CO_2 of 0.5% during events • If events had been coordinated with drop off in carbon intensity this would have reduced CO_2 by 2.8%
Setpoint and Internal Home Temperatures (Report2)	This area explores the effect of different set point choices can impact the turndown	• Users with higher setpoints can deliver higher amounts of flexibility
Extreme Cold Weather (Report 2)	This report explores the effect of cold weather on the flexibility provided from heat pumps	• A linear increase in turndown at lower external temperatures was seen with a relation to the results seen in trials

		• Trade-off between keeping internal temperatures accepted and providing flexibility for heating related services in extreme cold events
Heating schedule selection (Report 2)	This report explores the effects of differing control strategies within the home	• Heat pumps that are controlled according to a schedule can have significant peaks in demand and so therefore the available turn down depends on the overlap of the event period with the peaks in demand
Demand Turn-up (Report 2)	The Trial 3 turn-up mini trial report concluded that there were two areas where the field trial could not provide definitive conclusions: • Whether demand was shifted or created during the trial (whether average whole day consumption was increased on event days). • What the impact on customer comfort was.	• The simulation modelling predicts similar levels of demand turn up to that observed in the EQUINOX Trial 3 mini-trial. • Turn up is likely to have been limited by weather compensation settings for most homes, with the models predicting a 30% reduction compared to unrestricted heat pump operation.

Report Attachments

Report	PDF
Simulations Report 1: How the multi-home model is matched to trial outputs	
Simulations Report 2: Scenarios to Build on Trial Results and inform BaU	