Chameleon Alternative Market for Energy Assessment

Phase 2 Final Report

June 2025

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It should be noted that views and assessments made as part of this report reflect that of the project team only and are not indicative of DESNZ policy direction.

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List of Acronyms

Acronym	Meaning	Definition
AAHEDC	Assistance for Areas of High Electricity Distribution Costs	A charge that helps reduce electricity distribution costs in high-cost areas like the north of Scotland, funded through a GB-wide levy on suppliers.
AEM	Alternative Energy Markets	Non-traditional or emerging energy trading platforms and schemes that enable peer-to-peer trading, local energy markets, or innovative flexibility services outside the conventional wholesale market.
API	Application Programming Interface	A set of rules and tools that lets different software systems communicate and exchange data.
ASO	App Store Optimisation	The process of improving an app's visibility and ranking in app stores (like Apple App Store or Google Play) to increase downloads and user engagement.
B2C	Business to Consumer	A business model where companies sell products or services directly to individual customers.
BAU	Business as Usual	The standard or current way of operating without significant change or intervention.
BM	Balancing Mechanism	Used by the ESO to match supply and demand in real time.
BSUoS	Balancing Services Use of System	Charges for balancing the electricity system in real time, ensuring supply always meets demand.
BUS	Boiler Upgrade Scheme	The Boiler Upgrade Scheme is a UK government grant that provides financial support to households in England and Wales to replace fossil fuel heating systems with low-carbon alternatives like heat pumps
CAMEA	Chameleon Alternative Market for Energy Assessment	A platform designed to evaluate and facilitate participation in alternative energy markets, enabling flexible and innovative energy trading.
CfD	Contracts for Difference	A low-carbon support scheme guaranteeing a fixed price for renewable generators.
CM	Capacity Market	Ensures reliable electricity supply by paying providers to be available during peaks.

CTR	Click-Through Rate	A metric that measures the percentage of people who click on a link, ad, or call-to-action compared to the number who view it.
DC	Dynamic Containment	A fast-acting frequency response service that helps balance the grid by automatically adjusting power within seconds.
DCC	Data Communications Company	The organisation responsible for managing smart meter data communications across the UK's energy networks.
DESNZ	Department for Energy Security and Net Zero	UK government department focused on energy policy, security, and achieving net-zero emissions.
DFS	Demand Flexibility Service OR Dynamic Flexibility Service	Pays consumers to reduce use at peak times
DHaaS	District-Heat-as-a-Service	A business model delivering heating from a central source as a service.
DM	Dynamic Moderation	A service that manages and smooths out fluctuations in electricity demand or generation to maintain grid stability in real time.
DNO	Distribution Network Operator	Companies that own and maintain regional electricity networks.
DR	Dynamic Restoration	A rapid response service that helps restore the electricity system to normal operation after a disturbance or fault.
DSO	Distribution System Operators	Evolving role of DNOs to actively manage local supply and demand.
DSR	Demand Side Response	Incentivising consumers to shift or reduce electricity use during peak periods.
DUoS	Distribution Use of System	Charges paid by electricity suppliers (and indirectly by consumers) for using the local distribution networks (the lower-voltage grid)
ECO	Energy Company Obligation	A UK government energy efficiency scheme requiring energy suppliers to fund measures that improve household energy efficiency, especially for low-income and vulnerable households.
EFA	Electricity Forward Agreement	Market trading blocks (e.g., EFA blocks) dividing the day into 6 four-hour periods.

EPC	Energy Performance Certificate	Rating of a property's energy efficiency (required when selling/renting).
ESO	Electricity System Operator	Currently National Grid ESO – balances supply/demand in real time.
EV	Electric Vehicle	A vehicle powered entirely by electricity instead of traditional petrol or diesel.
FCA	Financial Conduct Authority	The UK regulator overseeing financial markets, firms, and services to ensure fairness, transparency, and consumer protection.
FFR	Firm Frequency Response	Grid-balancing service to maintain frequency stability.
FIT	Feed-In Tariff	Payments to small renewable energy producers for electricity generated and exported.
FMAR	Flexibility Market Asset Register	A database that records assets eligible to provide flexibility services in the energy market, helping grid operators manage supply and demand.
FR	Frequency Response	Automatic response to frequency deviations to stabilise the grid.
GDPR	General Data Protection Regulation	A UK and EU law that sets rules for how organisations collect, use, and protect personal data, giving individuals more control over their information.
HaaS	Heat-as-a-Service	Bundled services for heating, power, and efficiency – often subscription-based.
HEMS	Home Energy Management System	Smart system optimising household energy use.
HES	Home Electricity Survey	An assessment of a household's electricity usage patterns to identify opportunities for efficiency and demand flexibility.
HHS	Half Hourly Settled	A settlement method where electricity consumption or generation is measured and settled in 30-minute intervals.
HIU	Heat Interface Unit	A device that connects a building or home to a communal or district heating system, controlling heat delivery and metering consumption.
HLP	Heat Loss Parameter	A measure of the heat loss from a building, expressed per square metre, used to assess energy efficiency.
HP	Heat Pump	Low-carbon heating system extracting heat from air, ground, or water.

HTC	Heat Transfer Coefficient	Measure of heat loss through a building envelope.
IDNO	Independent Distribution Network Operator	Privately owned DNOs operating smaller networks within DNO territories.
IDSR	Interoperable Demand Side Response	where devices from different manufacturers can respond to grid signals seamlessly, enabling flexible energy use without vendor lock-in.
IHD	In Home Display	Device that shows real-time energy usage from a smart meter.
kWh	Kilowatt Hours	A unit of energy representing one kilowatt of power used for one hour.
LCM	Local Constraint Market	A market mechanism to manage and resolve local electricity network constraints by procuring flexibility services.
LCT	Low Carbon Technology	Technologies that produce little or no carbon emissions, such as heat pumps, electric vehicles, solar panels, and battery storage, used to support the transition to net zero.
MAP	Meter Asset Provider	A company responsible for owning, maintaining, and managing electricity meters.
MHHS	Market-wide Half Hourly Settlement	A reform programme introducing half-hourly settlement for all electricity consumers to improve accuracy and incentivise flexibility.
NESO	National Energy System Operator	Planned body to take over ESO responsibilities from National Grid.
NIV	Net Imbalance Volume	The total difference between electricity supply and demand in the market during a settlement period.
OFGEM	Office of Gas and Electricity Markets	The UK regulator for electricity and gas markets, overseeing competition and protecting consumer interests.
PAYS	Pay-as-you-Save	A financing scheme where customers repay energy efficiency improvements over time through savings on their energy bills.
PPM	Prepayment Meter	Energy meters that require users to pay for electricity or gas in advance, often using a key, card, or smart pay-as-you-go system.
RBAC	Role-Based Access Control	A security model that restricts system access based on a user's role within an organisation, ensuring users only have permissions necessary for their responsibilities.

RO	Renewables Obligation	Scheme requiring suppliers to source a portion of power from renewables (uses ROCs).
ROC	Renewable Obligation Certificate	A certificate issued to renewable energy generators as part of the Renewables Obligation scheme.
SAP	Standard Assessment Procedure	The UK government's methodology for assessing and rating the energy performance of residential buildings.
SOC	State of Charge	The current level of energy stored in a battery, expressed as a percentage of its total capacity.
STOR	Short Term Operating Reserve	National Grid contracts reserve providers for rapid response during supply shortfall.
TMY	Typical Meteorological Year	A data set representing average weather conditions over a year, used for building and energy system simulations.
TNUoS	Transmission Network Use of System	Charges paid by generators and suppliers for use of the high-voltage transmission system, managed by National Grid ESO.
ToU	Time-of-Use	Electricity pricing that varies based on time of day.
UX	User Experience	The overall experience and satisfaction a user has when interacting with a product or service.
VLP	Virtual Lead Party	An entity that coordinates and manages flexible energy resources to provide services to the grid.
WD	Weekday	Monday-Friday
WE	Weekend	Saturday and Sunday
WHD	Warm Home Discount	A UK government scheme providing discounts on energy bills to vulnerable and low-income households.
XaaS	Anything-as-a Service	A business model delivering a wide range of products or services (like energy, heating, mobility) on a subscription or pay-per-use basis, without the customer owning the underlying equipment.

Glossary

Tariff Element	Description
Wholesale Costs	The price that an Energy Supplier pays for the power they supply to their customers.
Distribution Costs	Primarily this is DUoS costs which are paid by the Energy Supplier to the relevant distribution company for the use of their network when delivering energy to end consumers.
Transmission Costs	Primarily TNUoS costs which are paid to the Transmission Operator for the use of their network in delivering energy to end consumers.
System Operator Costs	Primarily BSUoS costs which are levied by the System operator to cover the day-to-day operational costs involved in balancing the electricity network.
Environmental Levies	This covers the costs incurred to cover ROC, FIT and CfD schemes.
Electricity Forward Agreement (EFA) Blocks	A four hourly period commencing at 23:00 and ending at 23:00 the next day. Except for the period spanning the March and October clock change, in which the period will be one hour shorter or longer as necessary.
Social Levies	These are costs such as Warm Home Discount (WHD), Assistance for Areas of High Electricity Distribution Costs (AAHEDC) or the Energy Company Obligation which are levied across supplier’s entire portfolios to enable them to provide assistance to those most in need.

Balancing Risk	This is a risk premium applied to tariffs essentially to mitigate the risk that customers use energy in an unexpected manner. This would have the potential to cause the supplier to have too much/not enough power and be forced to call upon the balancing market and either buy or sell power an unknown cost.
Settlement Costs	The costs incurred for the use of Elexon and the settlement system.
Agent Costs	Suppliers must appoint agents (a meter operator, a data collector and a data aggregator) to every supply point they are responsible for. This element covers their costs.
Metering Costs	Most meter points will utilise a Meter Asset provider (MAP) to fund the meter which is installed there. This cost covers the rental of the MAP's asset.
Smart Costs	Suppliers have to pay for the Data Communications Company (DCC) and Smart Energy GB to advertise and promote the uptake of smart devices and their costs are built into energy tariffs.
Operational Costs	This cost covers a supplier's staff, systems and office costs.
Bad Debt	This is another risk premium which is added to all tariffs to cover the eventuality the supplier will be unable to recover a proportion of the money that they bill to consumers.
Margin	The profits made by the supplier.

1 Executive summary

1.1 Introduction

This report for the Chameleon Alternative Market for Energy Assessment (CAMEA) project brings together the full scope of work undertaken to explore the role of different market scenarios and bespoke propositions to encourage domestic flexibility in a decarbonised energy system, particularly through the use of low carbon technologies such as heat pumps and electric vehicles. The project was delivered under the Alternative Energy Markets (AEM) programme which forms part of the NZIP (Net Zero Innovation Portfolio), aiming to explore and demonstrate new market mechanisms that support flexibility, decarbonisation, and consumer participation in a future low-carbon energy system. The project sought to test whether different market conditions, time-varying price signals and novel service propositions could incentivise consumers to shift energy demand away from system peak periods, ultimately supporting more efficient use of network and generation infrastructure. At its core, CAMEA aimed to understand whether the scenarios could encourage new commercial models and could unlock consumer flexibility at scale, reducing costs for both consumers and the wider system, while maintaining comfort and delivering a positive customer experience.

This executive summary sets out the approach to the trial, the creation of bespoke tariffs, and the recruitment of treatment and comparison groups across a range of household types. The scenarios tested, supported by detailed modelling and operational signals, offered real-world insights into the value and feasibility of heat-as-a-service (HaaS) as a market proposition under the different market conditions. The findings, derived from both quantitative analysis and qualitative research, provide evidence of consumer behaviour in response to different pricing models and highlight the importance of user experience in enabling demand-side participation. This executive summary provides an overview of the results, with the full details available in the report below.

The project delivery partners were Chameleon Technology, Homely, Tomato Energy, Energy Systems Catapult, Passiv UK and Solo Energy, with Cornwall Insights and Revolution9 Consulting supporting as subcontractors.

1.2 Project overview

The AEM programme[1] created a series of potential future energy scenarios against which our 'Home Energy Management System (HEMS) as a Service' energy proposition in Phase 1 was evaluated to identify the strengths and weaknesses of each market.

[1] https://www.gov.uk/government/publications/alternative-energy-markets-innovation-programme

Findings from Phase 1 suggested Scenario 2b offered the greatest opportunity for customer value within the propositions, so this has been the basis for the testing in Phase 2. These are summarised as:

Scenario 1: A business-as-usual framework reflecting current 2024–25 market conditions, adjusted for half-hourly settlement.

Scenario 2b: An innovative tariff structure where policy levies and the Capacity Market (CM) charge varied dynamically based on system carbon intensity and margin conditions, providing stronger signals for flexible consumption.

1.3 Trial approach

To test the Phase 1 findings in real-world operation, CAMEA Phase 2 delivered a real-world trial with UK domestic consumers. It had the primary objective of assessing the impacts of the Scenarios and Phase 1 flexibility propositions to unlock additional flexibility in the electricity system. It supports the demonstration of demand side flexibility propositions within the context of a future energy system.

The project demonstrated a comprehensive Home Energy Management System (HEMS) as a Service solution comprised of several constituent propositions tailored/bundled to a customer's home, preferences and comfort levels. It also offered an EV miles bundle offer at fixed price points. Both were offered to a treatment group in a real-world simulation of Scenario 2b. The treatment group was split with a portion receiving Scenario 1 signals and a portion receiving Scenario 2b signals to demonstrate the additional value of flexibility unlocked by Scenario 2b for the solution. Both are compared to a comparison group to show the value of flexibility unlocked by the proposition itself.

API connections were created between the different partner systems to deliver the trial, with a bespoke front-end app which acted as the primary user interface. Price signals were constructed using real-time inputs from wholesale energy prices, policy levies, network charges, and system conditions. These signals were integrated and dispatched to assets in customer homes through automated scheduling systems developed by project partners (ivie for EVs and Homely for heat pumps). Data from asset usage and grid conditions was collected and analysed to measure responsiveness and flexibility. See section 5.4 for further details.

Flexibility was assessed through both modelled and actual behavioural responses, comparing forecast and real consumption across treatment and comparison groups. The study paid particular attention to the influence of distinct price signals (e.g. wholesale prices, CM levy, policy levies based on carbon intensity) and used exemplar periods to identify customer behaviour patterns.

1.3.1 Tariff development

The Energy Sure tariff was developed within practical and strategic constraints, notably excluding gas and export tariffs due to Tomato Energy's capabilities. The tariff comprised three components: fixed-price bundles for EV charging and heat via heat pumps, and a flat variable rate for all other electricity use. EV bundles were tiered by kWh per month, while heating tiers were defined by maximum comfort temperatures, with pricing semi-bespoke based on home assets and characteristics. No additional charges were applied for overuse; instead, usage monitoring allowed reassignment to more suitable service levels. The final structure offered predictable billing and behavioural incentives to support low-carbon goals, balancing technical feasibility, consumer comfort, and commercial viability.

The CAMEA project has used a pricing approach for the trial based on live, in-market prices - rather than the pricing which DESNZ provided as hypothetical 2030 profiles - to offer a more realistic view of how consumers would respond (see Section 5.4).

1.4 Approach to trial

The CAMEA trial involved offering HaaS and EV charging-as-a-service propositions to participants, managed through a HEMS combined with a bespoke Tomato Energy tariff. These propositions were offered to both treatment and comparison groups, with the comparison group comprising people with heat pumps and/or EVs and chargers who had expressed interest in taking part but either chose not to switch to the trial tariff, or had incompatible assets.

Triallists were provided with the HEMS solution, and they chose the maximum ‘comfort’ temperature they required for their house and/or number of kWh for charging (with approximated driving miles conversion) required per month, which set the rate for their bundle price. The HEMS solution automated the energy usage based on the restriction criteria, while minimising user costs and introducing opportunities for Tomato Energy to save energy supply costs. The results were then analysed to determine the outcomes achieved.

1.4.1 Treatment groups

The treatment group was created using participants who had a heat pump and/or EV charger/vehicle which was on our compatible technology list, who were willing to sign up for the tariff as part of the trial.

Users signed up to a new tariff with Tomato Energy, which matched the tariff offer outlined in section 4. The technical integrations described in section 3 enabled optimised decisions to be made based on the available flexibility, in order to minimise the electricity cost to supply.

Two different treatment groups were created.

In treatment group 1 (TG1), the user tariff and device control was delivered based on Scenario 1 conditions. This was used as it was a suitable baseline and most similar to existing conditions.

In treatment group 2 (TG2) the user tariff and device control was based on Scenario 2b market positions.

1.4.2 Comparison groups

The comparison group comprising people with heat pumps and/or EVs and chargers who had expressed interest in taking part but either chose not to switch to the trial tariff, or had incompatible assets.

The comparison groups were not on the trial tariff and were benchmarked based on Scenario 1 using their existing tariff and operation. The counterfactual for Scenario 2b conditions was tested through modelling.

1.4.3 Sample size

It has been acknowledged that while the overall sample sizes of the treatment group are statistically significant, when sub-sections of the treatment groups in each category are analysed, the results are not always statistically significant and, in these areas, the results may have low internal validity to be certain of cause-and-effect relationships and low external validity. This means some caution must be exercised when seeking to generalise these findings to the wider population.

1.5 Recruitment

1.5.1 Recruitment strategy

The recruitment strategy combined multiple approaches to ensure a diverse and representative group of households, with a particular focus on those with heat pumps, EVs, and other relevant technologies. Efforts were largely concentrated on targeting the existing customer bases of project partners, which provided a warm audience with a high potential for engagement. This was complemented by a comprehensive digital marketing campaign across various platforms and attendance at relevant conferences and events to raise awareness and encourage sign-ups. The multi-channel approach aimed to balance reach with quality, ensuring that participants were both eligible and motivated to take part in the trial.

The trial attracted a demographically skewed group — primarily older (71% aged 56+), male (86.1%), affluent, and highly educated participants — largely due to technology requirements and recruitment channels. The treatment group was older and more urban-based than the more mixed comparison group, with both groups showing high income and education levels. Recruitment was most successful through targeted email, SMS, and phone follow-ups based on asset compatibility, while digital ads drove traffic but had moderate conversion, highlighting the need for clearer benefit messaging.

1.5.2 Final recruitment results

Based on all the activity, the final recruitment outcomes can be summarised as follows:

- 750 people were eligible for the comparison group and have the ivie app, so their data can be seen.

- 217 people were eligible to be converted to treatment group (88 HP only, 110 EV only, 19 HP and EV).
- 61 people have converted to the treatment group (27 HP only, 30 EV only, 4 HP & EV).

Therefore, the trial total was 750 participants which included 61 in the treatment group and 689 in the comparison group.

1.6 Trial results and analysis of benefits

The results of the project were interpreted through to provide useful learnings on how successful the CAMEA project had been in re-dispatching customer assets to manage costs.

Consumption in each half-hour for each user profile was converted into an index, enabling easy comparison of consumption across households with widely differing sizes and usage levels. Throughout the remainder of the analysis, this metric was used as the principal basis for insight.

1.6.1 Performance results from trial based on dispatch results

The overall performance in terms of moving consumption found it was possible to create a heat pump consumption profile which is flat throughout most of the day, with higher consumption during the overnight period. The EV profile was generally low throughout the day, again being high overnight.

1.6.2 Time based variation in response

Participants' assets were automatically dispatched, with no behaviour-based differences, but dispatch signals varied between weekdays and weekends due to differing price scenarios and weather impacts, as warmer conditions increased heat asset flexibility. Weekdays showed sharper price signals with morning and evening peaks (plus a London-specific network peak) leading to higher overnight consumption and reduced usage during peak periods, while weekends lacked these peaks and showed lower overnight use. Over time, total heat pump consumption in the treatment group decreased from March to May, reflecting improved weather and more flexible consumption patterns, with May showing notably higher overnight use and reduced evening peak consumption.

1.6.3 Participant engagement and responsiveness to price signals change

Participants' assets were dispatched automatically, so there was no difference in responses. The key factor on participant engagement was driven by EV users' "boost" override function. Over half of EV users (53%) boosted at least once, accounting for 7% of total energy volumes. Boosting surged in May, mainly during midday and early evening, reflecting more users rather than increased use per user.

1.6.4 Impact of scenarios on results

For heat pumps, Scenario 1 showed strong flexibility responses, with consumption shifting heavily to overnight periods (80% above average) and significantly reduced during the evening peak (41% below average). Scenario 2b displayed a flatter daily consumption pattern, but still exhibited demand reduction of 32% during the peak and 24% higher usage overnight, indicating some flexible behaviour despite the more complex pricing signals.

For EVs, consumption patterns were broadly similar in both scenarios, with the majority of charging occurring overnight when electricity is cheapest. However, Scenario 2b showed increased afternoon and evening charging due to higher use of the manual "boost" function by users, which temporarily overrode automated scheduling. This led to lower evening charging volumes in Scenario 2b compared to Scenario 1, reflecting a more user-driven response to pricing under the more volatile tariff. Boost usage was particularly evident in the later parts of the day, as supported by the boost profile data.

1.6.5 Impact evaluation analysis of the trialled proposition

In this section, the results of homes are compared under the treatment groups for Scenarios 1 and 2b against the average consumption of wider system users under various scenarios, to demonstrate that the proposition has added flexibility to the system. The principal comparators are the Profile Class 1 consumption profile, representing average domestic users in GB, and members of the comparison group, representing highly engaged users with a range of low-carbon assets and in many cases active participation in novel energy market solutions.

The main benefit to consumers of the proposition is the fixed cost of the service which they are paying. The actual flexibility deployed benefits the supplier – allowing them to provide the proposition at a reduced cost and reduced level of risk – rather than directly providing benefits to the consumers. The consumer will benefit from peace of mind and, in the case of a cold winter, a reduced cost of heating. The proposition could be considered an insurance premium against the risk of a cold winter.

When compared to the national average Profile Class 1 (PC1), the treatment group in the CAMEA project significantly reduced electricity consumption during peak hours (4–7:30pm) and increased usage during off-peak hours (11pm–7am), especially in Scenario 1. While PC1 users used 20% of their electricity during peak times, Scenario 1 users used just 7%, and Scenario 2b users used 10%. Off-peak consumption was more than double the PC1 average under Scenario 1. This demonstrates strong success in shifting energy use away from high-demand periods, driven by automated asset dispatch and dynamic pricing. However, EV users were excluded from this comparison since PC1 does not reflect EV-related demand, making the profiles non-comparable.

Compared to a comparison group of users with similar technologies, the treatment group still showed markedly greater flexibility. For heat pumps, Scenario 1 participants used only 7% of their energy during peak periods versus 16% in the comparison group, and 52% off-peak versus 34%. This suggests more effective peak avoidance under dynamic scenarios. For EVs, differences were smaller, likely because two-thirds of the comparison group already used smart tariffs encouraging overnight charging. Nonetheless, Scenario 2b still achieved significantly lower peak-time EV consumption (7%) than the comparison group (12%), though off-peak usage was also lower due to fewer overnight charging volumes. Overall, these comparisons confirm that dynamic, flexible tariffs combined with automation can significantly improve load shifting beyond standard smart tariff use.

1.6.6 Flexibility provision impact compared to current market arrangements

Asset control offers, where suppliers manage in-home devices like EV chargers or heat pumps in exchange for lower unit prices, are now well-established through products like OVO's Charge Anytime and Octopus's Cosy Octopus. However, the market lacks fixed-price service models, such as HaaS or EV charging-as-a-service, that provide high price certainty by transferring consumption risk to the supplier. Introducing such fixed-payment offers could attract risk-averse users who prioritise predictability over flexibility. Since suppliers would bear the cost risk, they would be strongly motivated to optimise device usage efficiently, potentially unlocking greater flexibility based on cost avoidance rather than profit maximisation.

1.6.7 Reflections on breakdown of each price component within trial and seasonality impact

Network charges emerged as the most consistent and influential pricing signal in the CAMEA trial, particularly due to their strong incentives to avoid consumption during weekday evening "Red band" periods, where rates were significantly higher. These predictable patterns provided a clear market signal that encouraged users to shift their electricity use away from peak times. Wholesale electricity prices, while more volatile and influential over shorter timescales, played a secondary but still notable role in shaping user behaviour. The move from a stable, long-term hedging approach in March to a more variable, real-time pricing model in April and May highlighted significant fluctuations, with prices ranging from 4.37p/kWh to 29.82p/kWh during the latter months.

Policy levies, which differentiated Scenario 2b from Scenario 1, had only a limited impact on user behaviour due to their lower frequency and relatively modest size compared to other cost components. While these levies occasionally peaked at higher levels—such as 15.89p/kWh in late March—they occurred infrequently, and Capacity Market (CM) levies were not triggered at all during the trial period. As a result, these policy-driven signals had far less effect on consumption patterns than the more consistent and impactful signals from network and wholesale pricing.

Given the short duration of the trial and small numbers of triallists per region, the full extent of the locationally granular seasonal RAG times and rates has been difficult to prove with any certainty. Nevertheless, by comparing weekday periods with Red bands to weekends without them, the trial was able to provide evidence on the effectiveness of Red band pricing as a behavioural driver.

1.6.8 Potential opportunities in ESO/DSO revenue streams

Although ESO and DSO dispatch signals were not used in the project, their future integration is feasible, particularly for EVs. Heat pumps are less suitable for rapid-response or real-time services, but both technologies could support reserve and peak reduction services under the right conditions.

1.6.9 Proposition potential to meet the costs of running the electricity generation, transmission and distribution infrastructure in full

Cost recovery challenges arise when flexible consumption reduces revenue from network, policy, and capacity market charges. While wholesale markets handle variability well, fixed recovery models struggle when consumers shift usage to avoid charges. This is not unique to the CAMEA trial but reflects broader issues in demand-side flexibility.

Network charges are currently based on static usage assumptions. As consumers increasingly avoid peak charges, reforms may be needed to maintain fairness, similar to past changes like the Triad reform. Dynamic reform, though beyond this project's scope, will be key to ensuring equitable contributions.

Under Scenario 1, capacity market levies incentivise peak reduction, aligning with system needs. In Scenario 2b, linking policy levies to carbon intensity introduces uncertainty in fund recovery. Both scenarios highlight the need to reward flexibility without disadvantaging consumers less able to respond.

Maintaining fair cost distribution while encouraging flexible demand requires careful regulation. Avoiding overburdening non-flexible consumers and preventing under-recovery are critical to avoiding systemic imbalances.

1.7 Qualitative research

The qualitative research aimed to understand how consumers interact with the project propositions, exploring their motivations, concerns and how they experience the service in practice. A series of research activities were conducted at different stages of the project, which included a pre-trial survey, tariff selection approach research, interviews, diary exercises and a post-trial evaluation survey.

1.7.1 Key findings and insights

Participants in the Energy Sure trial valued automation when it offered both convenience and control. Those in the treatment group became more comfortable with automated EV and heat pump management, particularly appreciating the comfort of heat pump automation. However, the comparison group, lacking hands-on experience, remained sceptical. Across both groups, trust hinged on transparency—participants wanted visibility into how decisions were made and how their systems were being managed. While innovation sparked interest, ease of understanding and confidence in outcomes were critical, with some concerns emerging when users could not override settings or encountered unexpected system behaviours.

Cost savings were the primary motivator, especially for EV and heat pump users, but confidence was undermined by unclear pricing and a lack of transparency in how bundles were calculated. While some treatment group participants grew to appreciate the predictability and budgeting support of fixed-price offers, others felt they offered less value than existing deals. Familiar brands like ivie inspired trust, whereas uncertainty around lesser-known partners such as Tomato Energy reduced confidence. Clear, timely, and coordinated communication was essential but often inconsistent. Participants wanted better explanations of tariff structures, integration of solar and battery assets, and assurance around impacts on energy use, fairness, and long-term value.

1.8 Commercial viability of proposition

The trial of Tomato Energy's Energy Sure bundled tariff revealed differing levels of commercial viability across asset types. While EV usage consistently fell below bundle allowances, making EV tariffs financially favourable, heat pumps posed challenges due to high seasonal and household variability, particularly in winter, which led to significant forecast errors and cost risks. These insights underline the need for asset-specific bundles, refined forecasting, and customer segmentation. Scenario testing showed simpler fixed pricing worked well under stable signals (Scenario 1), whereas dynamic pricing (Scenario 2b) offered only modest savings but increased complexity and forecast error for heat pumps. To ensure commercial viability, future propositions should use hybrid pricing, seasonal smoothing, and personalised forecasts, especially for heating. Integrating other low-carbon technologies like solar and batteries, offering asset financing options, and keeping tariff structures simple and transparent will support scalability, trust, and long-term customer engagement.

1.9 Potential value of flexibility – comparison of supplier vs supplier-agnostic model

Flexibility in energy use and generation provides added value beyond optimised tariffs by enabling asset control and market participation, such as in Frequency Response or Demand Flexibility Services. Four main models combine supplier and customer actions to realise this value, with the most effective involving both asset state changes and supplier market actions. Success depends on controllable assets, smart metering, and customer behaviour. Regulatory changes, such as P415 and improvements to the Dynamic Flexibility Service, are expanding access and rewards for behind-the-meter assets. Looking ahead, coordinated national and local market reforms, combined with new digital tools and standards, aim to scale flexibility, reduce peak demand, and support the UK's clean energy goals. If this is successful, it opens more value streams to incentivise flexibility, which a greater number of organisations can access. This provides opportunities for supplier-agnostic business models which can offer consumers better value than if they are only available through the tariff, where the energy supplier can dictate the terms of the value sharing.

1.10 Heat-as-a-Service – wider opportunities

The HaaS model redefines home heating by charging for comfort outcomes, like maintaining set temperatures, rather than energy usage, offering predictable costs, reduced upfront investment, and simplified maintenance — particularly benefiting low-income and vulnerable households. For providers, it allows better system control, access to grid flexibility services, and stable revenues, aligning with net zero goals by accelerating heat pump adoption and improving energy resilience. Success depends on fair pricing, consumer trust, and regulatory support, as well as learning from past schemes and international models. Emerging HaaS offerings range from flat-rate subscriptions to performance-based pricing, with future potential tied to smart controls, inclusive access, and integration with wider energy services.

1.11 Barriers/challenges to real-world implementation in current market conditions

Market
Flexible, consumption-based pricing introduces significant commercial risks due to wholesale price volatility, exposing providers to potential losses during market spikes. HaaS models face regulatory limitations, as current government grants require volumetric charging, restricting non-volumetric outcome-based pricing despite proposed allowances for third-party ownership. While some policy changes may ease barriers to third-party ownership, the continued requirement for volumetric billing constrains widespread HaaS adoption, with medium-term uncertainty linked to the Boiler Upgrade Scheme's planned end in 2028.

Policy
Current regulations mandate billing based on actual energy consumption, complicating the adoption of outcome-based HaaS tariffs that charge for comfort rather than usage. Although some innovative tariffs are emerging, formal guidance from Ofgem is needed to clarify rules. The single-supplier model restricts consumers from using multiple providers for different assets, limiting HaaS flexibility, and policy levies based on consumption present challenges for non-volumetric pricing models, requiring alternative mechanisms to apply these charges fairly without blocking HaaS offerings.

Regulatory
Aggregators and flexibility coordinators may need supply licenses or partnerships with licensed suppliers, but regulatory frameworks for non-supplier providers remain underdeveloped, creating market entry barriers. Suppliers offering innovative tariffs face increased compliance obligations to ensure fairness and transparency, while meeting obligations under schemes like the Energy Price Guarantee complicates the application of non-standard tariff structures. This

regulatory complexity poses operational challenges for suppliers seeking to scale flexible and asset-specific pricing models.

Infrastructure
Half-hourly settlement, currently limited by most households not having appropriate smart metering, is a major barrier to dynamic pricing and demand response; Ofgem's MHHS program aims to make this universal within two years, enabling more flexible tariffs. Market fragmentation and proprietary asset systems limit interoperability of devices like heat pumps and EV chargers, restricting aggregated demand response and customer participation. Additionally, lack of sub-metering complicates fair cost allocation for individual assets, and the high capital costs of low-carbon technologies challenge the financial viability of flexible tariffs without innovative regulation and tariff designs.

Wider barriers
HaaS models relying on finance agreements may exclude consumers with poor credit or debt concerns despite regulatory protections, limiting access for vulnerable households. Pre-payment meter users face compatibility and regulatory challenges with non-volumetric pricing, risking efficiency and cost issues. Furthermore, fluctuating gas prices impact heat pump economics, and strict GDPR and consumer protection rules require robust consent and data controls, complicating the scaling of remote-controlled HaaS offerings beyond trial environments.

1.12 Conclusions

The CAMEA trial demonstrated that automated control of household assets such as heat pumps and EV chargers can deliver significant demand shifting, reducing peak-time consumption and increasing overnight use. Compared with both the national average and a comparison group of engaged low-carbon households, the trial showed that automation combined with dynamic pricing can substantially enhance system flexibility.

The research also highlighted the importance of simplicity and clarity in consumer propositions. While fixed-price offers provided cost certainty and budgeting benefits, complexity around service levels and unclear pricing undermined confidence. Trust depended on transparent communication and integration with wider assets, with familiar brands generally viewed more positively than new entrants.

From a market perspective, fixed-price service models shift risk from consumers to suppliers, incentivising them to optimise asset usage efficiently. However, regulatory, infrastructure, and policy barriers remain, particularly volumetric billing requirements, interoperability challenges, and limited half-hourly settlement. These issues must be addressed if flexibility propositions such as HaaS are to move from pilot stage to mainstream adoption.

Overall, the trial confirms both the potential of supplier-agnostic, automated models to deliver system and consumer benefits, and the need for regulatory and market reforms to enable their wider rollout. The insights gained provide valuable guidance for future innovation and commercialisation of flexible energy services.

2 Introduction

This final report of the Chameleon Alternative Market for Energy Assessment (CAMEA) project brings together the full scope of work undertaken to explore the role of different market scenarios and bespoke propositions to encourage domestic flexibility in a decarbonised energy system, particularly through the use of low carbon technologies such as heat pumps and electric vehicles. Delivered under the Alternative Energy Markets (AEM) programme[2], the project sought to test whether different market conditions, time-varying price signals and novel service propositions could incentivise consumers to shift energy demand away from system peak periods, ultimately supporting more efficient use of network and generation infrastructure. At its core, CAMEA aimed to understand whether the scenarios could encourage new commercial models could unlock consumer flexibility at scale — reducing costs for both consumers and the wider system — while maintaining comfort and delivering a positive customer experience.

This report sets out the design, delivery, and evaluation of the trial, which involved multiple technical integrations, the creation of bespoke tariffs, and the recruitment of treatment and comparison groups across a range of household types. The scenarios tested, supported by detailed modelling and operational signals, offered real-world insights into the value and feasibility of heat-as-a-service (HaaS) as a market proposition under the different market conditions. The findings, derived from both quantitative analysis and qualitative research, provide evidence of consumer behaviour in response to different pricing models and highlight the importance of user experience in enabling demand-side participation. Across a comprehensive set of themes — from technology deployment to market access and tariff impacts to long-term system benefits — this report outlines the key achievements and areas of interest which remains to be addressed in scaling up domestic flexibility.

Taken together, the results of the CAMEA project offer valuable lessons for industry, policymakers, and regulators seeking to accelerate the transition to a flexible, low-carbon electricity system. The report concludes with a discussion of the commercial viability of the proposition, a cost-benefit assessment, and a detailed look at the remaining barriers to wider adoption. These insights will inform the future development of market frameworks and consumer-facing propositions that are vital to the success of the UK's net zero ambitions.

2.1 Alternative Energy Market programme context

As published in the DESNZ competition guidance, the Alternative Energy Markets Innovation Programme seeks to support the design and demonstration of innovative domestic demand side flexibility propositions[3] in a future energy system. The programme seeks to quantify the additional flexibility available to the system and the benefits to participating consumers and

[2] https://www.gov.uk/government/publications/alternative-energy-markets-innovation-programme-projects
[3] Propositions in this context means the tariff offer, combined with the products and services to deliver an overall offer to the consumer

contribute to the evidence base for how the domestic flexibility market can be grown to inform future policy and regulatory decisions. The overall aim of the Alternative Energy Markets Innovation Programme is to stimulate and support the development and demonstration of innovative domestic demand side flexibility propositions in a future energy system. The objectives of the programme are to:

- Design and simulate innovative domestic flexibility propositions under potential alternative energy markets, quantifying the additional flexibility available to the system and the benefits to participating consumers.
- Contribute to the evidence base for how the domestic flexibility market can be grown and encouraged under a future energy system to inform future policy and regulatory decisions.
- Combine domestic flexibility propositions with low carbon distributed energy assets and other smart energy innovations to demonstrate how these innovative propositions could work in the real world to deliver a flexible energy system.

CAMEA Phase 2 delivers a real-world trial, which tests the demand side flexibility propositions developed in CAMEA Phase 1 project in a real-world setting. It supports the demonstration of demand side flexibility propositions within the context of a future energy system.

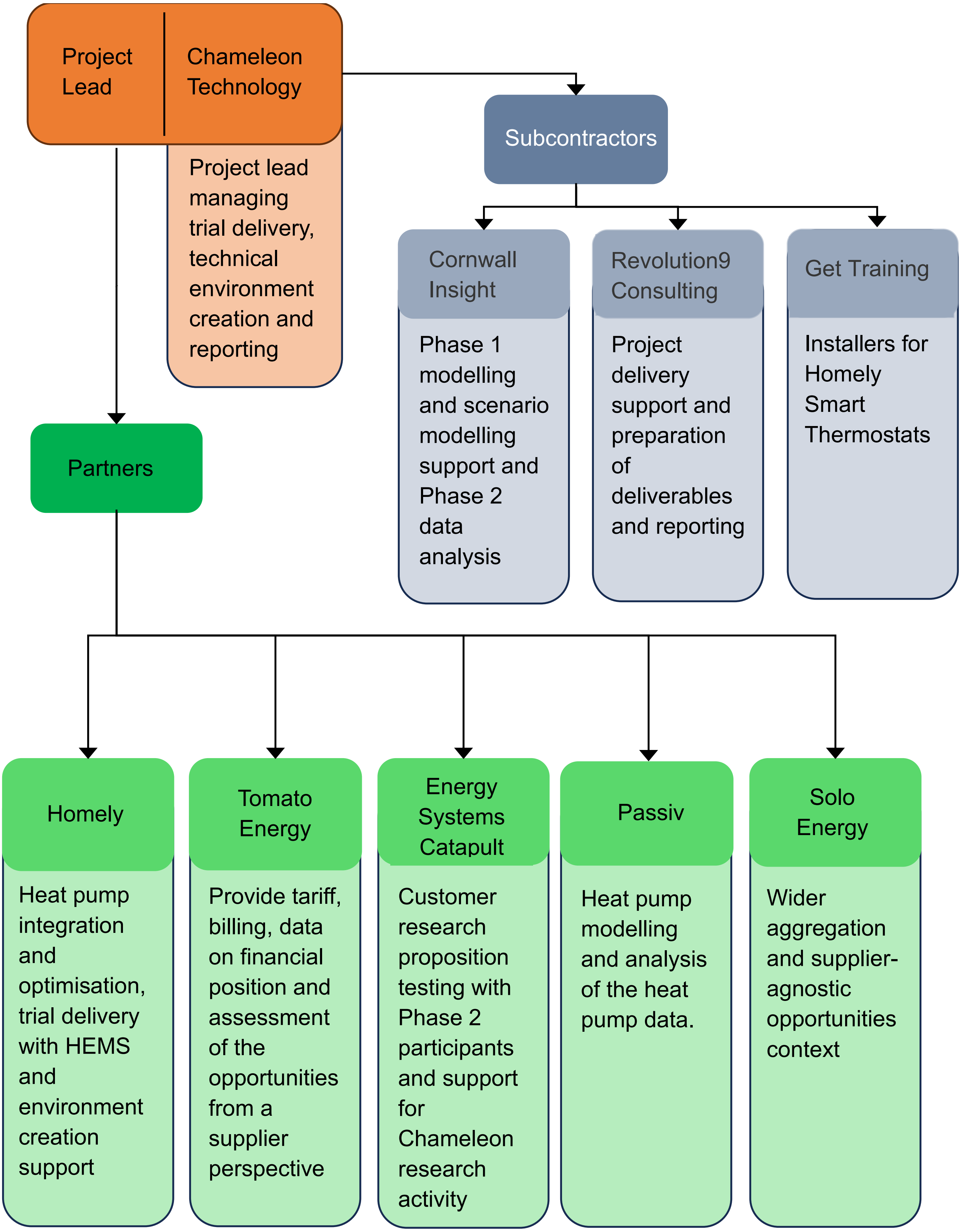
Following from Phase 1, the aims and objectives for Phase 2 of the CAMEA project include:

- Delivery of a real-world trial, to test demand side flexibility propositions developed in Phase 1 in a real-world setting to increase understanding of how such propositions work in practice and how consumers respond and participate.
- Demonstrate the impact of propositions and potential benefit to the electricity grid and to consumers.
- Support the demonstration of demand side flexibility propositions within the context of a future energy system.

2.2 Project partners

The CAMEA project has been delivered by a diverse consortium who brought complementary expertise to enable the delivery of the project. These are summarised in the organogram in Figure 1.

Figure 1. Project Partner Organogram



Chameleon Technology leads in smart energy technology, providing consumers with actionable energy insights, low carbon technologies and optimised connected home solutions. They are the project lead and managed the trial delivery, technical environment creation and overall project reporting. They have been responsible for creating the primary front-end user interface with the customers, optimising the EV charging and undertook a workstream in the qualitative customer research. They acted as first line of support for the trial.

Homely is a leading smart thermostat provider for heat pumps and offer the Homely optimisation system. They support heat pump integration, trial delivery with HEMS and environment creation. Their technology has interfaces to take as input the AEM price signals driven by the environment and provide optimised scheduling of the heat pump based on these price signals and user preferences.

Tomato Energy is an innovative energy supplier. They provided the tariff for the trial participants, billing, data on financial position, assessment of the opportunities from a supplier perspective and supported trial delivery. Triallists in the treatment group were required to switch to Tomato Energy as their energy supplier. They have replaced Green Energy UK, who were the original energy supplier in Phase 1 and the first stages of Phase 2 but were unable to complete the project due to staff availability constraints.

Energy Systems Catapult is a leading technology and innovation centre helping the UK navigate the transformation of our whole energy system. They support customer research proposition testing with the Phase 2 participants, supporting Chameleon research activity.

Passiv UK provide smart thermostats for heat pumps. They led with the heat pump modelling and provided supporting analysis of the heat pump data and assessing future opportunities in flexibility utilising the technology. Their models provided the basis for the construction of the tariffs delivered within the project.

Solo Energy is a leader in the UK smart meter rollout and has developed a FlexiGrid aggregation platform. They provide context on wider aggregation and supplier-agnostic opportunities.

Cornwall Insight are industry leaders in energy market intelligence. They supported the modelling in Phase 1 and supported scenario modelling and data analysis in Phase 2. They have extensive experience in modelling energy flexibility, applying understanding of relevant policy and regulations. They have helped to create the trial environment by providing real time network charges and levies to help construct the price signal, building an automated integration with Chameleon to do this.

Revolution9 Consulting are experts in the delivery and implementation of innovation projects. They supported the project delivery including preparation of the deliverables and reporting for the project.

2.3 Summary of Phase 1 findings

This project is a Phase 2 demonstration study which builds on the findings of an initial exploration in Phase 1. This delivered the initial research to determine the likely market barriers, opportunities and scenarios which offered most value. It enabled the development of a set of potential propositions which were tested with a range of potential customers and stakeholders. These findings were used to create the basis of the proposition delivered in this project[4].

Contextually for this report, the key findings from Phase 1 led to the recommendation of the following proposition to be taken forward to phase 2:

- Heat and Electric Vehicle (EV) charging tariff bundles through an energy supplier in partnership with ivie (Chameleon's business to consumer (B2C) brand).
- These bundles provide a fixed monthly cost for set temperature range and set number of EV miles.
- Consumer can choose heat bundles and/or EV charging bundles. A flat rate would be provided for all other electricity use.
- Bundle recommendation based on historical usage patterns.
- Heat pump, EV charger and (solar) battery optimisation through a HEMS.

The ivie app was used as the primary interface between the consumer and the proposition. It uses smart meter energy data to give personalised energy savings tips, reports and challenges.

The smart meter data helped in this proposition by giving the consumer a personalised tariff bundle option based on historical usage and an expected monthly saving against their current tariff.

Survey participants and interviewees in Phase 1 rated this proposition positively. The results suggested that the main motivation was cost and certainty of costs for some of the more expensive aspects of their bill. There remained some concern regarding whether the economics of the propositions can work positively for consumers in real-world usage, which the Phase 2 demonstration aimed to help resolve with proof points.

2.4 Alternative Energy Market scenarios

The Alternative Energy Markets (AEM) programme created a series of potential future energy scenarios as seen in Table 1. Each scenario reflected hypothetical changes to elements such as the wholesale market, network charging structures, and policy cost allocations, which were the basis of assessment to determine the opportunities such changes could make to the

[4] Full details of the Phase 1 study can be found here: https://s3.eu-west-2.amazonaws.com/chameleontechnology.co.uk/wp-content/uploads/2024/02/Chameleon-Alternative-Market-for-Energy-Assessment-Phase-1-Final-Report-2.4.pdf

energy market. Our ‘Home Energy Management System (HEMS) as a Service’ energy proposition in Phase 1 was evaluated against these to identify the strengths and weaknesses of each market.

Table 1. List of AEM Scenarios

Scenario	Wholesale market	DUoS forward looking charges	Policy costs
Scenario 1	Current arrangements	Current arrangements	Current arrangements
Scenario 2a	Current arrangements	More locationally granular annual RAG times and rates	General taxation
Scenario 2b	Current arrangements	More locationally granular seasonal RAG times and rates	Renewable support costs and capacity market costs moved to dynamic rates
Scenario 3	Generation-only nodal pricing, with opt-in to nodal pricing available for domestic consumers.	More locationally granular annual RAG times and rates	Current arrangements
Scenario 4	Changed to Scenario 5 and 6	Changed to Scenario 5 and 6	Changed to Scenario 5 and 6
Scenario 5	Current arrangements with upwards-revised price forecasts	Current arrangements	Current arrangements
Scenario 6	Current arrangements with upwards-revised price forecasts	More locationally granular seasonal RAG times and rates	Renewable support costs and capacity market costs moved to dynamic rates

For each of these Scenarios, DESNZ provided wholesale prices, network charges, policy levies, social levies and capacity market (CM) levies for each half-hourly settlement period in the year 2030, for three locations. These were described as a demand-dominated location (Location 1), a location with balanced generation and demand (Location 2), and a generation-dominated location (Location 3). The differences between these locations were reflected in network charges and, in Scenario 3, in wholesale power prices.

Findings from Phase 1[5] (see Section 6 of footnoted document) suggested Scenario 2b offered the greatest opportunity for customer value within the propositions, so this has been the basis for the testing in Phase 2. This has been tested against Scenario 1 as a counterfactual.

2.5 CAMEA Phase 2 approach and proposition

To test the Phase 1 findings in real-world operation, CAMEA Phase 2 delivered a real-world trial with UK domestic consumers. It had the primary objective of assessing the impacts of the Scenarios and Phase 1 flexibility propositions to unlock additional flexibility in the electricity system. It supports the demonstration of demand side flexibility propositions within future energy system contexts.

The project aimed to advance domestic demand-side response (DSR) beyond business-as-usual to best exploit the value from the Scenarios. The consortium utilised a proposition which both consumers and industry rated highest for both appeal and potential to increase flexibility for best value across the value chain. The trial utilised flexibility provision driven by price signals from alternative market arrangements. Wholesale, balancing and wider income streams are evaluated and optimised against while maintaining comfort and convenience.

Based on Phase 1 findings, the project developed propositions which best reflect the needs of the consumer and industry to meet the objectives outlined.

To achieve these results, the project demonstrated a comprehensive Home Energy Management System (HEMS) as a Service solution comprised of several constituent propositions tailored/bundled to a customer's home, preferences and comfort levels in a treatment group in a real-world simulation of Scenario 2b. The treatment group was split with a portion receiving Scenario 1 signals and a portion receiving Scenario 2b signals to demonstrate the additional value of flexibility unlocked by Scenario 2b for the solution. Both are compared to a comparison group to show the value of flexibility unlocked by the proposition itself.

The primary proposition, which is offered to the treatment group in the trial, is a semi-bespoke Tomato Energy tariff utilising a HEMS-as-a-Service model that offers fixed price bundles for heat and EV miles. These are detailed further in Section 3 below. The user was able to choose a 'comfort' maximum temperature service level for their heating and a maximum number of kWh per month for EV charging. The service level of the chosen bundle(s) set the rate for their bundle price. As part of the proposition, triallists needed to link up their assets to the ivie HEMS solution that then optimised the assets against user preferences (heating schedule, EV charging amount and required by time) and the AEM price signals to minimise cost to the supplier. The intention was that comfort for the triallists remained unaffected, they get to pay a low price for energy with a level of confidence that the amount is fixed for the bundles, all made possible by the optimisation for the energy supplier

[5] https://s3.eu-west-2.amazonaws.com/chameleontechnology.co.uk/wp-content/uploads/2024/02/Chameleon-Alternative-Market-for-Energy-Assessment-Phase-1-Final-Report-2.4.pdf

Triallists will only be offered bundles they are eligible for i.e. heat is they have a compatible heat pump, EV charging if they have a compatible EV charger/EV. Bundles are costed by taking into account details of the trialists homes included other assets such as solar/battery.

3 Creation of the trial environment

The creation of the trial environment required the seamless integration of multiple systems, including supplier platforms, smart home technologies, and third-party signal generators. These interfaces enabled the secure exchange of pricing signals, device control commands, and consumption data. This section outlines how the technical architecture was designed and implemented to support coordinated dispatch and user interaction throughout the trial.

3.1 Technical design and implementation of environment

The solution was built on the functionality of each of the core systems of each partner, such as the Homely heat control system and Chameleon energy assessment platforms, which are already robustly tested as part of the delivery of normal business activities for each organisation. The trial environment required a series of integrations and an overall front-end interface for triallists. The integrations were specified as follows:

- Cornwall Insight to Chameleon to provide price signals for levies and network costs to combine with wholesale energy costs from Tomato Energy as the overall supplier costs to optimise assets against for Scenario 1 and Scenario 2b.
- Tomato Energy to Chameleon to provide wholesale energy costs to combine with levies and network costs from Cornwall Insight as the overall supplier costs to optimise assets against for Scenario 1 and Scenario 2b.
- Homely to Chameleon interface to share the combined price signals for Homely to optimise the heat pump against. This also delivers 30-minute granularity heat pump usage to use for billing purposes.
- Homely interface required for account linking.
- Chameleon to Tomato Energy to provide details of users for tariff switching purposes.

The integrations were developed by partners and subcontractors on the CAMEA project who have independently tested their systems. To create the environment, wherever possible, integrations between systems were completed in sub production environments such that inputs can be controlled in line with test cases. Where this was not possible and APIs were already productionised, then some verification was completed in production with certain negative and failure case scenarios being tested separately using test stubs.

3.2 Integrations

Integrations for HEMS

As part of the CAMEA proposition, Chameleon acted as the central point for the Home Energy Management System. In order to optimise assets within service/comfort levels for cost to the energy supplier, Chameleon needed to receive the dynamic price signals on a daily basis.

Integration with Tomato Energy and Cornwall Insight was therefore crucial to receive these price signals daily (at least for the dynamic levy and network costing information from Cornwall Insight) such that the 48 half hour values for the following day can be received the previous day.

Chameleon then ensured these price signals were available to the parts of the system that would then optimise the assets. For EV charging, this used logic within the Chameleon optimisation engine. Homely enacted this role for heat pumps and needed access to the same AEM pricing signals being received from Cornwall Insight and Tomato Energy. Homely provided an interface to receive these signals from Chameleon.

Integrations for tariff switching and billing

In terms of tariff switching, an interface was created for Chameleon to confirm to Tomato Energy when users have requested the tariff switch and to update ivie on the statuses of the tariff switches, so Chameleon knew when to start optimising the assets against the AEM price signals.

In terms of billing, Tomato Energy had access to the full range of data which allowed them to split the bill between usage for the heat pump and EV charging which are covered by the fixed price bundles and the remaining variable 'everything else' usage. A direct debit was setup that was covered the fixed price bundles and expected everything else usage. The data could then show Tomato if their customers were in debit or credit and be able to adjust the billing accordingly.

Homely interface

The Homely interface was used for two main purposes: firstly so that Chameleon could provide the AEM price signals and secondly for Chameleon to request 30-minute heat pump usage information to then send through to Tomato Energy for billing purposes. In addition, there was also a need for ivie to link accounts with Homely.

3.3 Front end user app

The ivie app onboarding flow underwent thorough validation to ensure alignment with the defined screen designs and expected user journey. It welcomed the users to the trial and allowed them to pick the bundle which most suited their needs and make any adjustments to the recommendations before confirming and formally requesting the tariff switch through Tomato Energy.

The hand off to Tomato to switch tariff required a link to Tomato hosted pages to complete direct debit details. The amount of the direct debit was added later by the use of a master customer record shared between Chameleon and Tomato where MPAN was the primary identifier to link the 2 systems.

The app flow for the ivie Energy Sure trial onboarding process can be found as Figure 49. ivie Energy Sure Onboarding Process in the Appendix.

3.3.1 EV ChargePoint linking, smart charging and boosting

Once the tariff switch had been confirmed for triallists, they needed to link their charging point or vehicle to ivie so that ivie can control charging. Figure 2 shows the screen flow for linking a charger. It provided a guided set of prompts to help the user set up an Enode (3rd party used to dispatch the price signals) account and link this to the ivie account. It supported them to select their charger brand, log into the linked charger account to connect to Enode before adding the vehicle details and finally the charging preferences that could be changed at any time.

Figure 2. EV charger linking to Enode connection for charging control

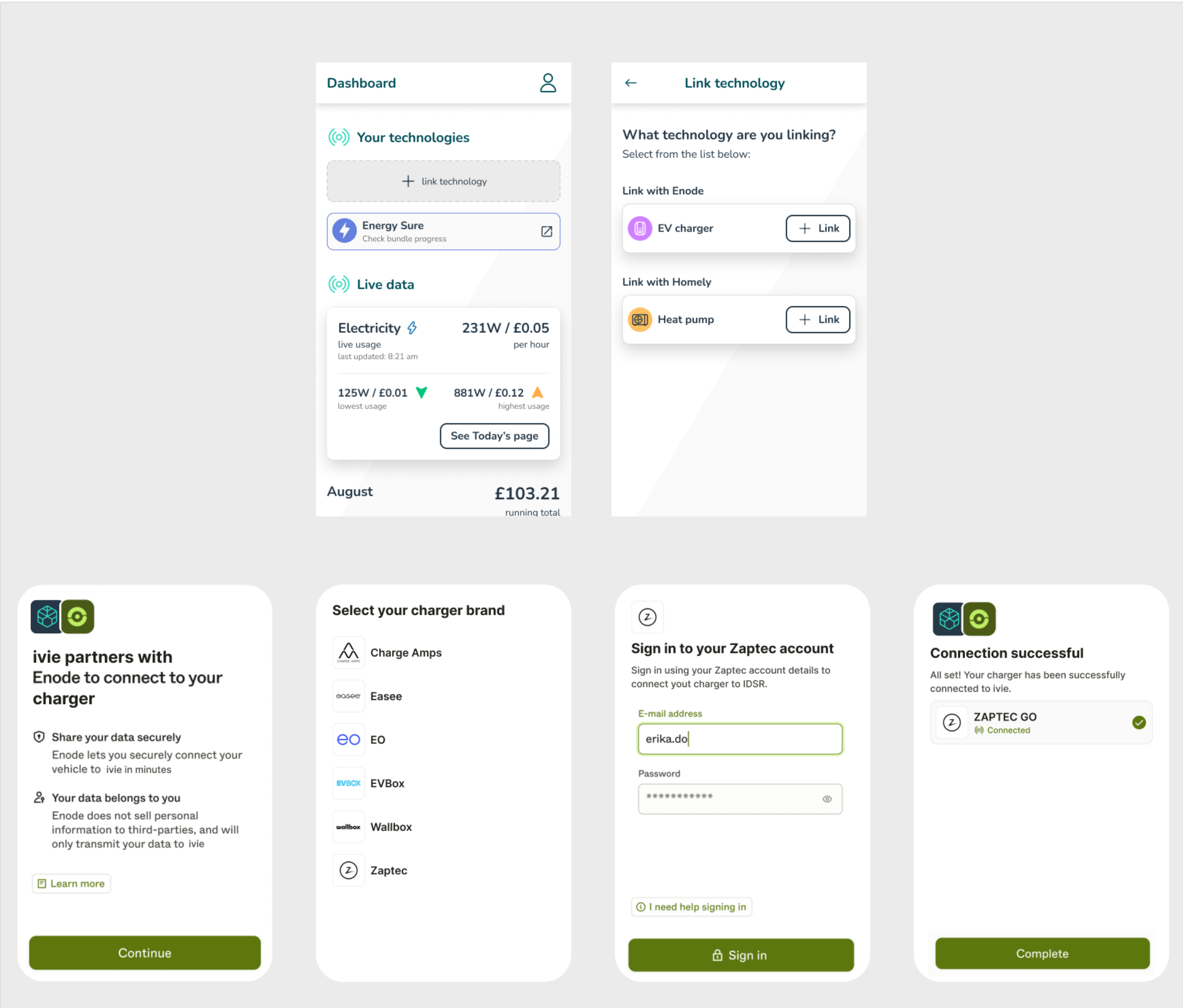


Figure 3 shows the process to enable smart charging. A series of screens were created to enable smart charging. Users were able to simply add in their preferences of their vehicle usage requirements and were guided to encourage flexibility in their charging times to maximise the flexibility which could be utilised.

Figure 3. Screen flow to enable smart charging permissions

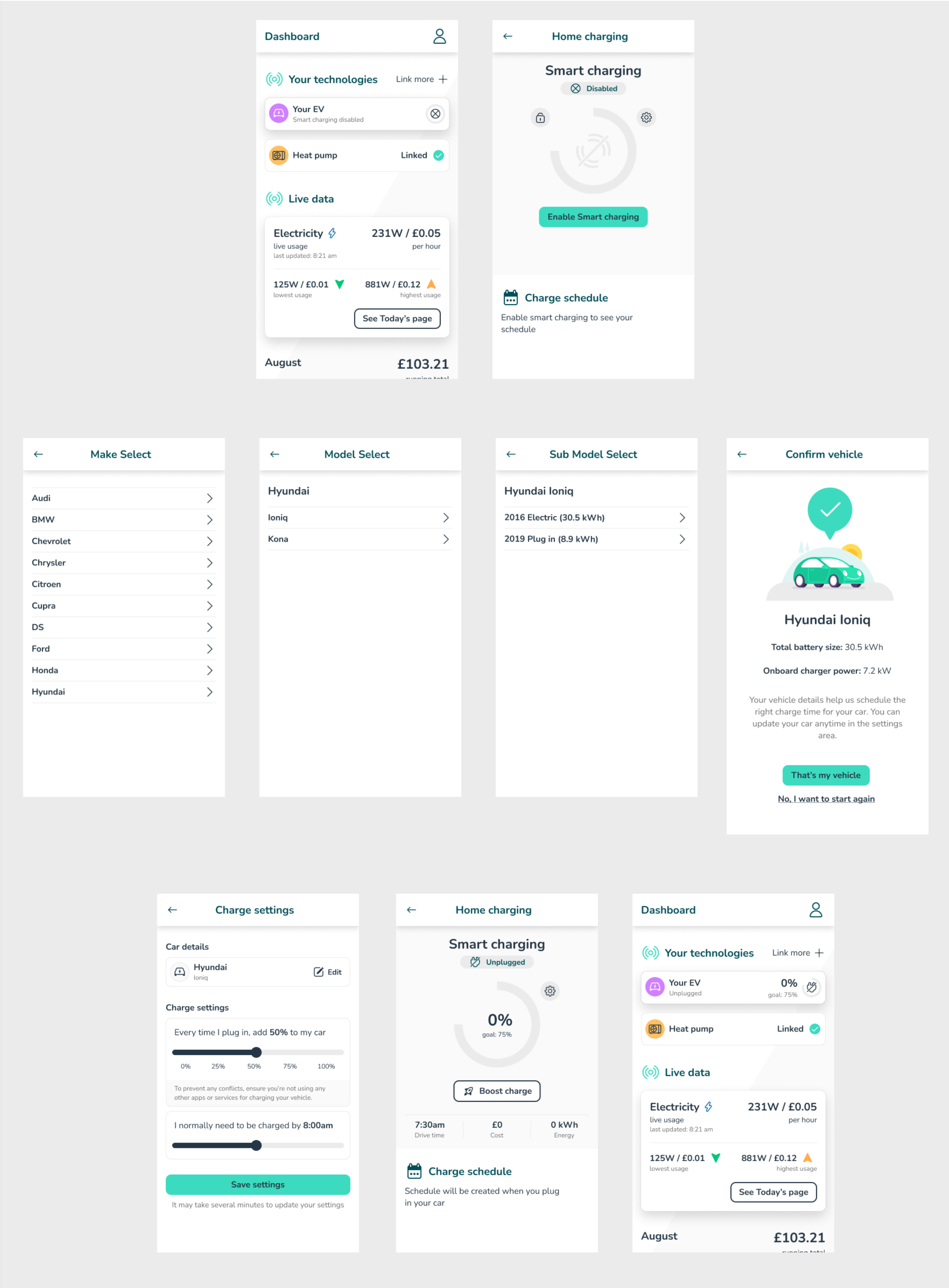
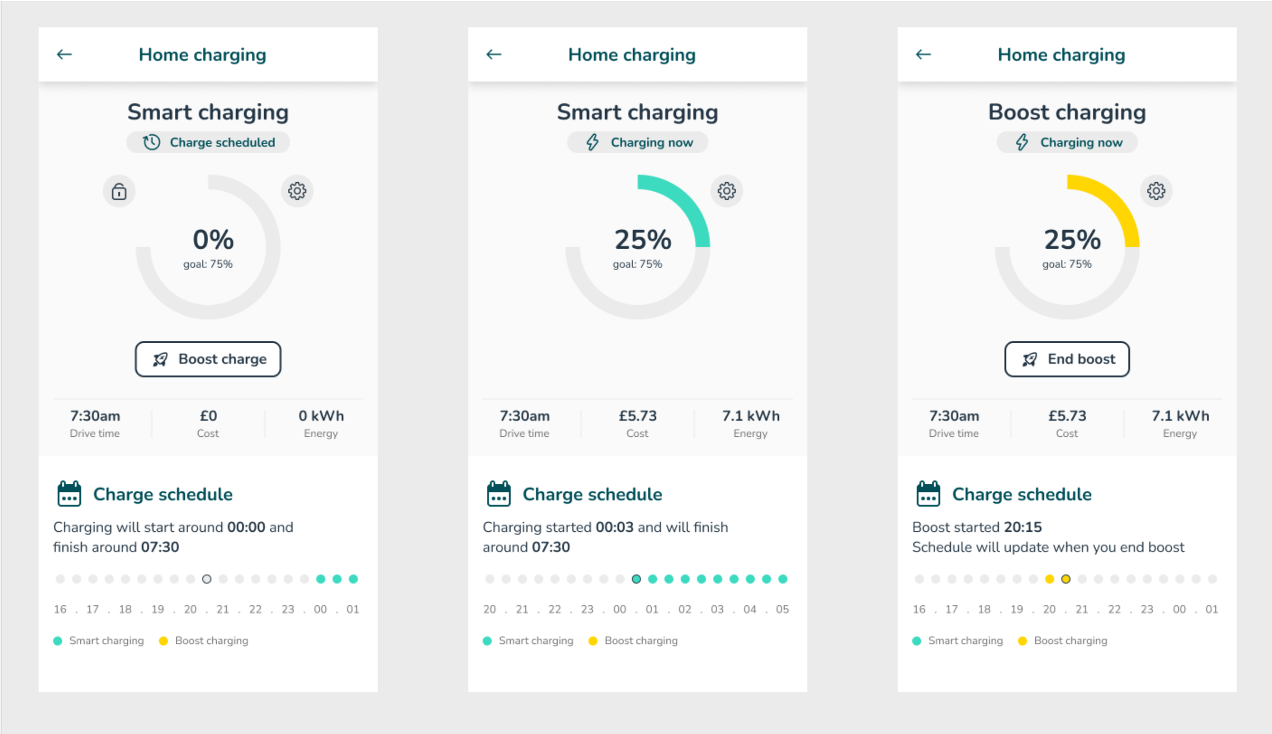


Figure 4 displays the user flow to trigger a charging boost outside of the flexible hours. The boost button on the charging schedule screen allowed them to override the planned approach if they needed charge urgently. No additional charges were made but these were noted and users were prompted of the impact in real-world use. Users were required to confirm their choices to ensure they carefully considered whether the boost was needed, with prompts to ask if they wanted to end the boost if they were taking considerable energy in peak times.

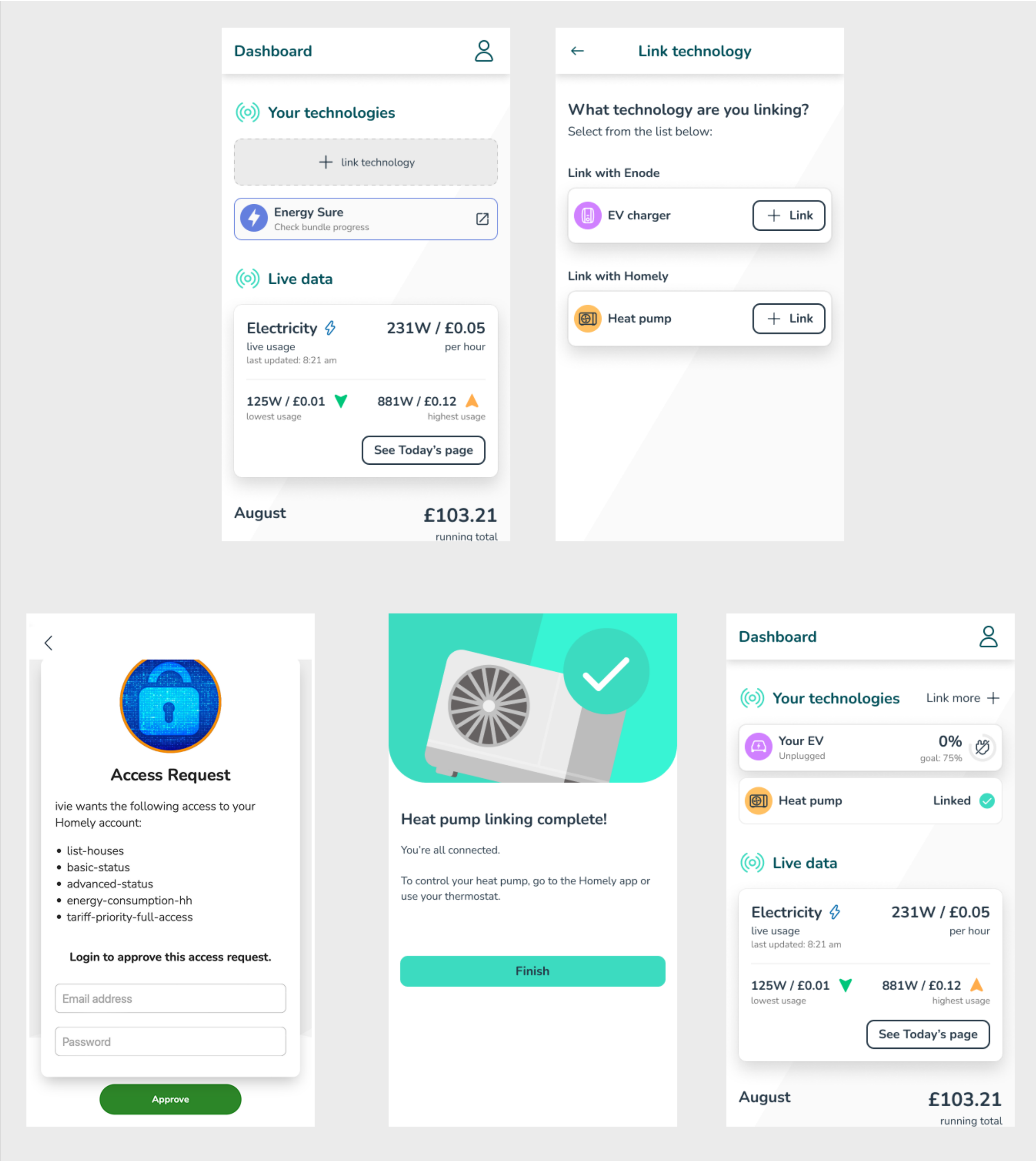
Figure 4. Boost charging



3.3.2 Heat pump linking

The app screens used for linking heat pumps are shown in Figure 5. Similar to the EV approach, it asks the user to select the type of device and triggers a login to their heat pump device account to validate their credentials. Once authentication is successfully completed, the app initiated the linking process. This was followed by a confirmation screen indicating the successful addition of the heat pump. Upon completion, the user was returned to the dashboard, where the updated status of the linked heat pump is displayed in the list of technologies.

Figure 5. Heat pump linking



3.3.3 Heating scheduling and boosting

Whereas the ivie app was used as the primary interface for EV charging control, other than for linking the ivie and Homely accounts to allow Homely to receive the AEM price signals, the Homely app remained the primary interface for heat pump control. The app allowed the user to set space heating and hot water schedules and also allowed them to boost both. For space heating the energy tariff service level determined a maximum temperature allowed in any scheduled. There was nothing automated to enforce this, so Homely provided an interface for

Chameleon to view users current schedules and also a history of boosting that could also be made available to Tomato for the purposes of reviewing fair use and service levels.

3.4 Installation of Homely devices

3.4.1 Installation process

For the heating bundle, the solution relied on technology provided by project partner Homely to optimise heat pump use against user-defined schedules and the AEM price signals. For this to work, the triallists who switched to the Energy Sure tariff and took a heating bundle needed to already have a heat pump installed that was compatible with Homely, and crucially, also required the additional Homely smart thermostat to be installed. During recruitment, the project attempted to find existing Homely customers to switch to the Energy Sure tariff. Of the 31 recruits who took a heating bundle, only 2 came from this category, meaning that 29 triallists needed to have a new Homely smart thermostat installed onto an existing heat pump installation as part of the project. It is worth noting that Homely smart thermostats would usually be installed as part of new heat pump installations. Even though it was understood to work in theory, there were significant unknowns and risks of initial performance issues associated with retrospectively integrating Homely devices with existing heat pumps which were explored in the project.

To get to the point of installation, the potential participants passed the eligibility checks and opted to change their tariff to the Energy Sure offer. The third and final part of the onboarding process was the installation of the smart thermostat. Where an installation was required, the detailed eligibility response was collated by Chameleon and processed with the installation provider, who then called the customer to arrange the work. The installation work was then carried out with regular status updates provided.

As part of the installation, the user was supported with setting up the Homely app as the primary interface for the user to control the heat pump as already described in this section. Once the installation was complete, the ability to link the asset in the ivie app was unlocked to enable Homely and ivie account linking (see 3.3.2 Heat pump linking). This linking triggered sending through the calculated AEM prices signals to individual linked Homely accounts on a daily basis. The Homely optimisation algorithm used these price signals to work out the cheapest (for the supplier) way of the heat pump operating within the user preferences set in the Homely app in terms of heating and hot water scheduling.

3.4.2 Installations learnings

For Daikin and Samsung heat pumps, extra hardware was required to install the Homely devices. These two brands accounted for the majority of heat pumps for which the Homely smart thermostat needed to be installed. Therefore, it was important to keep some stock of this hardware to avoid delays in requested installs.

The Homely smart thermostat needed its own power supply and, therefore, a nearby plug socket. Often, new plug sockets had to be wired in as part of the installation to accommodate this requirement.

Early in the project, some installs had to be aborted after it was discovered that the heat pump itself, or specifics about the installation, made the setup unsuitable for a Homely installation. This quickly led to additional questions being asked before an installation was attempted. In some cases, an additional on-site survey was carried out if there was still perceived risk that the setup would not be suitable, and if this was considered the most cost-efficient approach. Decisions were taken on a case-by-case basis, factoring in the installer's driving distance and the potential to combine with other nearby jobs.

On rare occasions, a choice had to be made about whether to 'fix' a previous installation to ensure that Homely would work effectively with the setup. This was only ever done with the full agreement of the consumer and with a risk-based approach to avoid additional costs or liabilities for the project.

Overall, it was found that retrofit installation of a smart thermostat to an existing heat pump installation comes with more challenges than had been expected at the outset. This was largely due to the different ways the heat pump was initially plumbed in and the overall quality of the install. Some complex existing setups that included additional integrated assets and existing multiple zones (areas defined in property for a specific heating need) were difficult as Homely currently only supports 1 to 2 zones. All these additional complexities often meant additional cost for the install, however extra screening questions, often without the need for a pre-site visit, did result in a high percentage of successful installs.

Installing the Homely with a new install is clearly simpler and more cost effective. As install of the heat pump itself was not part of the proposition then this was not an option. In future, a proposition like this could work well if partnered with an installer where the proposition could be offered on top of a heat pump installation a consumer has already requested. Better still, not having a dependency on extra hardware would be a far preferable path to increase eligibility, remove barriers for the consumer and provide an easier, more appealing process for consumers to gain the advantages of a proposition like the one tested in this project.

4 Tariff development

4.1 Approach to tariff development

The starting point for tariff development for CAMEA Phase 2 was the output of the proposition that was developed as part of CAMEA Phase 1. The CAMEA Phase 1 final report summarised this as:

- Heat and EV charging tariff bundles through supplier 100Green in partnership with ivie (Chameleon's business to consumer (B2C) brand)
- These bundles provide a fixed monthly cost for set temp range and set number of EV miles
- Consumer can choose heat bundles and/or EV charging bundles. Flat rate for all other electricity use
- Bundle recommendation based on historical usage patterns
- Heat pump, EV charger and (solar) battery optimisation through a HEMS
- 50% discounted install on all hardware installation

To then make this proposition 'real' as part of Phase 2, there was a need to work through the detail of the high level points that been previously been established. The approach to do this was to firstly confirm several key aspects of inclusion and exclusion. In terms of exclusion of the tariff proposition, two key decisions were firstly not to include gas, and secondly to not offer an export tariff. Therefore, any triallist looking to switch to the Energy Sure treatment had to stay with an existing/alternate supplier if they had gas and stay with an existing/alternate export tariff if they had solar. Not including gas made sense as the AEM programme is only interested in electricity. Not including an export tariff had more impactful ramifications, which are discussed in more detail in this section. At a high level, this is firstly that solar users may have been more reticent of joining the trial, as market leading export tariffs by other providers that were available to the general market at the time of the trial, only offer preferential rates if the consumer also took the import tariff from the same supplier. Secondly, for the HEMS system it means there could be some missing information in terms of export tariff rate or a conflict of interest where the system would be focussed on supplying the service level to the consumer for the cheapest cost to the supplier, which may then not maximise value overall to the consumer when considering the export tariff.

Other aspects considered as part of the approach to tariff development were in relation to which assets could be controlled as part of the overall HEMS system. Given the key pillars of the tariff proposition that there is a fixed price heat (for heat pumps) bundle and a fixed price EV charging bundle, then as minimum the HEMS needed to be able to optimise for heat pump and EV. Both against the AEM price signals and ideally each other. The other key component for consideration was battery and then indirectly solar. Ideally the project wanted to include some sort of battery integration in scope of the project. At the tariff design stage, it was decided that battery modelling would initially be completed by making several assumptions about the behaviour of an individual's setup. If this could be improved part way through the project by a battery integration that allows direct control of the battery, then that was an option available. Ultimately the project ran out of time to include the battery integration and so relied on assumptions with the battery part of the model underpinning the HEMS. Sections 4.2.1 and 4.2.2 provide further details and outputs of the models that includes battery as one of the inputs. Solar was included in the modelling, but it cannot be directly controlled. The key question was how much could be learned about each user's solar panel system, and how much needed to be assumed. This, along with weather data, was used to estimate solar generation in the model. Much of the discussion so far in this section is centred around what is not included in the tariff proposition. To give a greater focus to what was decided to be included in the tariff proposition as part of the overall approach, this was split into 3 parts. The proposition tariff is based around keeping as much of the bill 'fixed' as possible with constituent bundles for heating and for EV charging. Therefore, these are naturally 2 of the 3 components of the tariff that can both be 'fixed'. The third component is then all other home electricity consumption that has not been used for either heating (space and hot water) and EV charging. This part is variable as it is not possible to control the appliances that are consuming the electricity. Each of these tariff components are discussed in greater detail in the following subsection.

Once significant higher-level decisions had been made about what is and is not included in the tariff, then the crux of the approach to tariff development is how to cost the fixed price elements of the tariff. Several references have been made to modelling already, which was clearly needed to forecast how much energy was expected to be used by individual consumers for different service levels. In terms of deciding who in the project consortium should complete the modelling, there were first some decisions about whose systems would be dispatching the price signals.

As the lead partner, Chameleon were looking to provide the overall HEMS integrating with partner's systems where required to provide this service. For the heating part, the plan was for Chameleon to integrate systems provided by two of the project partners: Homely and Passiv. and the aim was to maximise eligibility for the HEMS as well as to test whether a consistent interface could be developed into multiple systems that could then dispatch based on input from a central HEMS. It became apparent early on that Passiv would not be able to complete the work required within the timelines of the project. As such their role switched to focus on the modelling side for the heat pump, while Homely focussed on the technical integration to be able to use their technology as part of the trial. This arrangement led to a greater specialisation of the partners, but it was noted from the outset that certain parameters in the Passiv modelling were based on the Passiv system, which would not necessarily be the same for the Homely system being used by the project. As Homely and Passiv are effectively competitors, it was acknowledged that there could only be limited data sharing and so this was a risk the project accepted.

With a decision for Passiv to complete the modelling there needed to be decisions around which combination of factors should be modelled in terms of housing type, number of occupants, heating schedules, weather data etc. The approach was to create archetypes based on onboarding questions to the ivie app, noting ivie is the direct-to-consumer brand of Chameleon and the effective supplier of the HEMS where under the proposition the triallists need to agree for Tomato Energy to provide the energy and their assets to be optimised by ivie. As much as possible, the plan was for Chameleon to provide real consumption data and metadata to Passiv to try and maximise the accuracy of the models to produce estimated annual (that could be broken down to monthly to apply just to the trial period) energy consumption for different archetypes for different service levels.

The approach to service levels for the heat pump came as a result of consumer research and consortium experience of similar propositions. Much of this came from Homely from Phase 1 of the project where they were able to see schedules from their population of live users. There was also much discussion about what was the defining factor of the heating service level, which was decided to be the maximum temperature in any schedule. This was communicated to users as their comfort temperature where they are permitted to set any schedule they like for comfort in line with their preferences, where they may want their home to be cooler overnight for instance. Further consideration for the heat part of the tariff design included whether there should be any disincentive if users went outside their service level. For example, if the maximum temperature allowed was exceeded and/or if they consistently boost their heat thus overriding cost modelling optimisations. It was acknowledged that either of these things should not be prevented, with a common example being if an elderly relative was visiting who needed a higher comfort temperature than the system would allow. Some ideas about penalties were whether including a limited number of boosts in a month, would incur a certain penalty per individual boost if exceeded. Also, a potential penalty in relation to the length of time a home was scheduled to be above the agreed service level temperature was considered. In the end all ideas were rejected and instead schedules and boosts were to be monitored and the trialist potentially moved to a new service level if it was clear the current one was not suitable for them. This gave several advantages of simplicity for explanation to the consumer (and to not put them off) as well as billing mechanism, and also allows room for changes in behaviour as customers enter new service types.

The modelling to calculate EV bundles was completed by Chameleon. The part of the HEMS system that creates EV charging schedules was purely within the control of Chameleon with the use of Enode as an effective sub-contractor in the arrangement. Therefore, it was logical for Chameleon to complete modelling for EV bundles. Several decisions needed to be made that in many ways mirror the decisions required for the heating bundle. Firstly, the same archetypes were used in the modelling as used for the heat pump model. Also, as far as possible, the same underlying assumptions. In terms of service levels, the approach was to offer a maximum number of kWh available to the trialists for EV charging per month. To communicate this to them an approximation to miles was also given. For most archetypes modelling was simpler than for heating as it was just a straight number of kWh used as opposed to having to forecast how many kWh would be required for a specific outcome in the case of heating. The complication came for people with solar as some people may have charged their car using self-generation and so it would have been unfair to penalise those people by charging the same amount as people who would have got the same service level but all energy coming from import. Again, considerations for penalties were considered. This was mainly what would happen if the user exceeded their bundle in terms of number of kWh of electricity used for charging in a month. The most likely implementation of a penalty would be to put all use exceeding the bundle to a category of 'everything else' usage, which would be getting charged at a higher rate. For the same reasons as for heating and to make the approaches to the bundles consistent, it was decided not to include any penalties. Like with heating, the plan was to monitor and move trialists to different service levels if they were clearly on the wrong one. This approach was reinforced by consumer research, see 11.2.4 Adjustability is non-negotiable – especially for EV owners. This subsection describes how consumers often find it difficult to work out their energy usage and what service level to choose. The possibility of penalties is then a big disincentive to sign up for a proposition such as this.

4.2 Key features of the tariff

In section 4.1, the considerations that were made when working out the consortium approach to tariff development were examined. In this section, conclusions are made that set out the tariff proposition specification. The following sections define the specifications as user-focused requirements. Noting the detailed statements referenced in the appendix use the following structure:

U = user requirement which are statements describing what is included in the proposition. These could be translated into user stories as part of product development process. They are in a format of 'you' or 'your', referring to someone using the service.

P = Product requirements such as: High level front end UX changes / considerations, primarily to the ivie app.

R = Research requirement which could include: gathering and analysing participant data sets (e.g. usage or chosen service levels typically by participant, which can then be aggregated for further analysis across participant population). Suggested research aims or tasks for the trial related to the product feature in ivie.

Also please see Figure 53 - Energy Sure website for how the tariff was communicated to consumers.

4.2.1 EV charging

The proposition summary is as follows:

- Pay a fixed price per month to charge your car with our EV charging energy service.
- The service includes a monthly allowance, or cap, for a number of kWh of car charging at home.
- With the service you can save up to 30% on your car charging costs compared to standard variable tariffs at the price cap.

- These savings are possible because the system will be charging your car at the cheapest times possible, usually overnight, and sharing those savings with you.
- You will also be able to budget better, because you will know how much your car charging will cost you.
- If you go significantly over your kWh allowance, Tomato Energy reserve the right to change service level under the 'fair use' policy but only after contacting you first.

See Appendix for FiguresFigure 35 toFigure 41 that define the product requirements in more detail:

4.2.2 Heat

The proposition summary is as follows:

- Pay a fixed price per month to be comfortable with low carbon heating.
- You will be as comfortable as you are today, but it will cost you less.
- You might not know it, but your home costs more to heat when its cold outside so you never really know how much your heating costs you.
- There are also more tariffs available for you to choose from, including ones that change price at different times of the day. You could save money with these tariffs, or be doing that already, but it can be hard to know for sure if you are saving.
- With this service you no longer need to worry about how much energy you are using for heating and how much it is costing you. You do not need to think about whether you are making the most of the cheapest times to heat your home - your price will be the same each month, but it will be cheaper than how much you pay today.
- When you buy the service, you choose your preferred maximum temperature level to include in your heating schedule. You are buying this temperature, or any temperature up to that in your schedule.
- You can boost your heating so it is hotter at times, but there are some restrictions as part of the 'fair use' policy.

See Appendix for Figures Figure 42 - Figure 48 that define the product requirements in more detail:

4.3 How costs were passed on to participants

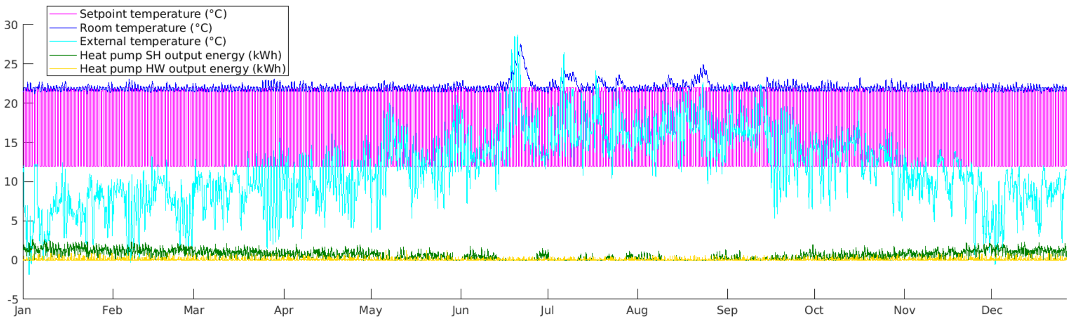
So far in this section, there has been exploration of the approach to development of the tariff proposition in Section 4.1. Then a definition of the tariff proposition itself primarily from a user point of view in Section 4.2. Next, the proposition more from a supplier perspective is considered, looking in detail about how it has been costed and how it will work from a commercial perspective. The consumer has a direct relationship with Tomato Energy as the supplier of the tariff. The supplier will always want to reduce risk and want to minimise variance in expected outcome. When offering the consumer fixed cost for a fixed outcome - where the amount of energy the supplier needs to buy and provide to the consumer can vary - can be difficult to achieve for the supplier. What this project wanted to test was whether modelling can be made accurate enough to minimise variance of outcome against prediction and that the spread of variance is such that there is still profit to be made by the supplier whilst offering a competitive market deal to the consumer while unlocking flexibility outcomes beneficial for all. Particularly there was strong interest to see whether the cost to supply a fixed outcome to a consumer could be minimised by a HEMS that the consumer needs to take as part of tariff deal to unlock value for both the consumer and the supplier.

4.3.1 Heat bundle

To examine the pricing structure, the different bundle types will be reviewed separately. Firstly, looking at the HaaS heating bundle, as previously stated the modelling was completed by Passiv. As an introduction to the modelling, it is first worth examining the tool Passiv developed for this purpose. This is something Passiv previously developed with an opportunity to use and potentially improve as part of this project. The technology available is an annual forecasting tool which can help to answer questions such as:

- What do typical electricity load profiles look like for a heat pump?
- How can a heat pump run optimally in combination with other low-carbon assets (EV/battery/solar)?
- How might smart controls shift these loads if the householder is on a time-of-use (ToU) tariff?
- How do the load profiles and costs vary between different houses and householders, and their choices such as heating setpoint?

Figure 6. An example plot of a subset of annual forecast outputs showing samples of the outputs of a year's run. The half-hourly values are forecasted for a whole year.



The Passiv annual forecasting tool made predictions about the performance of energy assets in the home over the course of a year, at half-hourly resolution. Each simulation used a 'digital twin' of a house, with randomised thermal dynamics and a heat transfer coefficient consistent with the house type, size and insulation level. The householders' choice of heating schedule and setpoints could be specified. The household consumption of hot water and other uses of electricity (baseload) were taken into account. The method assumed that Passiv smart controls were in place, providing coordinated optimisation of all assets. Load profiles and running costs could be predicted for different heating system options and low carbon technology configurations.

A key decision early on was what combinations to model. The general approach was to group consumers by archetype where models were run offline and so outcomes could easily and quickly be looked up when providing consumers with a semi-bespoke tariff. One alternative to this was to have an extended learning period, where the thermal characteristics of the individual property were learned as input to the Passiv forecasting tool before a fully bespoke quote was given. The potential upside to this, particularly for the supplier, is that it should have resulted in a more accurate output from the model creating confidence that actual heat pump usage would vary less. The downside of this approach was potentially an extended period of time for the consumer before they were provided their quote could make the decision to accept or reject it. Given the limited time for the trial this option was dismissed, however data was collected such that it would be possible to retrospectively work out if it was possible to provide an improved model. The intention was that HTC calculation technology that has been developed by Chameleon Technology as part of other grant projects could be used for this. Data sources required for this calculation included consumption data, external weather data and internal temperature data. The trial required all participants to download the ivie app, which collected consumption (with the user’s consent) and weather data as part of being able to provide the standard experience. Internal temperature data was provided by the ivie Bud, an in home display (IHD) with a temperature sensor. One of the incentives offered by the trial was a free ivie Bud, which was a standalone incentive in its own right but then had value to the project as it enabled this HTC calculation to be possible.

Once the decision to go with the archetype approach was taken, the next decision point was which archetypes to use. Effectively key inputs required by the Passiv model were:

- House Type
- Number of bedrooms
- HTC
- Floor area
- PV sizing
- Occupants

Naturally from the ivie app onboarding questions, the house type, number of bedrooms and occupants would be known. For some of these homes floor area was known (from an EPC integration) and HTC estimated (using the technology described earlier in this section). The ivie app already had tens of thousands of users and so a large enough sample to be able to use certain averages for the purpose of defining archetypes. Whereas a large number of archetypes could be defined, there was a limit on number of model runs possible just from a time perspective as part of this project. As such a selection was chosen that allowed interpolation to be possible when working out outcomes from archetypes not directly modelled. For example, energy consumption could be estimated for a 2 bed detached house by using the 1 and 3 bed detached simulations. The archetypes chosen were:

Table 2. The 9 archetypes modelled for the simulation runs discussed in this section.

	House Archetype	Approximate HTC (W/K)	Floor Area (m^2)	PV Sizing (kWp)	Occupants
1	1 bed apartment	83.4	55.6	2	1
2	1 bed terrace	95.8	63.9	2.2	1
3	1 bed bungalow	95.9	63.9	2.2	1
4	1 bed semi-detached	109.7	73.1	2.6	1
5	1 bed detached	125.9	84.0	2.9	1
6	4 bed terrace	133.0	88.7	3.1	4
7	4 bed semi-detached	154.4	102.9	3.6	4
8	3 bed detached	165.5	110.3	3.9	2
9	5 bed detached	192.4	128.3	4.5	4

Once the house archetypes had been chosen, other parameter that needed considering were setpoint (service level for bundle), tariff (the AEM price signals and any other pricing structure for comparison and combinations of other significant low carbon assets (solar, battery, EV) available in the household. When this decision was made it was not known what temperature setpoint service levels would be offered, so the modelling used values that ultimately proved more extreme — both lower than the minimum and higher than the maximum used. The reason for this was to ensure it gave the option and so intermediate values could be interpolated. For the tariff a run was made using the DESNZ imagined Scenario 2b price signals to compare a flat rate. Then finally the asset combinations most commonly seen in the ivie app were selected. Table 3 below confirms these choices, which provided 410 modelling combinations overall.

Table 3. The 410 combinations of parameters configured for the simulation runs discussed in this section.

House Archetype	Setpoint	Tariff	Assett combinations
9 archetypes	9 choices for Archetype 6: 16^{o}C, 17^{o}C, 18^{o}C, 19^{o}C, 20^{o}C, 21^{o}C, 22^{o}C, 23^{o}C, 24^{o}C 4 choices for other archetypes: 18^{o}C, 19^{o}C, 21^{o}C, 23^{o}C	1. Flat rate 2. Dynamic tariff ("DESNZ 2030 rates")	1. HP only 2. HP + solar 3. HP + battery + solar 4. HP + battery + EV + solar 5. HP + HP + EV + solar

Only Archetype 6 has a selection of different setpoints across runs because, from a combinatorics point of view, it was infeasible to run all relevant combinations of setpoints for all archetypes. Since the percentage change in electricity demand from adjusting the setpoint from 21°C to 22°C is consistent across archetypes, data from Archetype 6 can be used to interpolate values for the remaining archetypes.

Assumptions used in the modelling were as follows:

- Passiv use insulation levels to determine parameters in their house model which affect the ratio of HTC compared to other variables, such as floor area and solar gains. Here, all houses were assumed to have average insulation, when compared to a distribution of heat loss parameters (defined by HLP = HTC/floor area) observed in real homes.
- House thermal dynamics were randomised in line with partner experience of typical UK housing stock for houses of similar HTCs. The same sampled parameters were then used for each scenario, such that only one aspect changes at a time.
- Heat pumps were sized such that they are able to heat each house (to the desired room temperatures, at least). This prevents any under-sizing, where the house cannot be sufficiently heated, or over-sizing where the heat pump would be unrealistically large for the home and results would not be meaningful.
- The simulations included both space heating and domestic hot water production.
- Radiators were assumed to be upgraded as required for use with a heat pump. Assumptions were that the radiators at ~50°C were capable of maintaining a steady state temperature of 20°C at -10°C external temperature. Hence, even with the highest

setpoints, it could confidently be said to be capable of reaching setpoint during the winter.

- Householders' setpoints and schedules were assumed to remain constant throughout the year.
- Each home was assumed to have Passiv optimised controls in charge of the heat pump and the battery (where present).
- The heating schedule was assumed to be a SAP schedule (07:00-09:00 and 16:00-23:00 on weekdays, and 07:00-23:00 weekends), with this specifying when the house should be warm rather than when the heating should run.
- The location of Odiham was used to determine the weather data for all simulations, as a centrally located weather station.
- Typical Meteorological Year (TMY) weather data was used for the simulations. The TMY data was selected by analysing historical data and finding real months of data which best matched the long-term averages of daily min/max temperature and daily irradiation.
- Two tariffs were modelled:
    - A flat tariff with a unit rate of 24.66p/kWh, this is the current Flexible Octopus flat tariff rate for the Southern England region (Odiham) as of 18/06/24.
    - A half hourly dynamic time-of-use tariff based upon what was planned for the trial (at the time of modelling). This was provided by 100Green, but scaled such that its mean was in line with the flat tariff rate (24.66p/kWh). The tariff was based upon the cost to supply for the energy supplier. Noting that 100Green were the original supplier associated with the project, with Tomato Energy swapped in. The wholesale prices were reflective of 100Green's fairly conservative hedging strategy where they purchase all energy a number of months in advance.
- Standing charges were not considered, as it is not an element which the flexibility introduced by the solution can influence. Standing charges can be added on top of the modelling if needed, as they are fixed.
- No export tariff was modelled. Hence, for the case with solar panels and/or batteries, electricity was only exported when there was unused surplus solar. The project was not aware of the export tariffs customers will be on, so although the modelling can optimise to specific export tariffs, it was agreed that it was best to simply export when there is unused solar. Without an export tariff, there would never actively be an aim to export, and would only export in instances where there is excess solar and no other use for it.
- The Passiv model based the levels of hot water consumption and baseload electricity demand on the size of house and number of occupants living in the house.
- The number of occupants was approximated by the size of the house, such that there was a single occupant for all the 1 bed houses, a couple in the 3 bed house and families in the 4/5 bed houses.

- A hot water draw profile was then generated for each archetype using Passiv's hot water draw profile model (which utilised monitoring data from real homes together with assumptions from SAP).
- Baseload electricity usage (i.e. other than heating/hot water/battery/EV, from appliances in the home etc.) was estimated using Passiv's baseload model, based on data from the Home Electricity Survey, the floor area and the number of occupants.
- Solar panels were assigned proportionately to house size, with a 4.5kWp array for the largest (5 bed) house, and smaller arrays for the other houses. They were assumed to be south facing, with a tilt of 30°.
- The battery was assumed to have a capacity of 5kWh, a maximum charge rate of 2.5kW, and a maximum discharge rate of 2.5kW.
- The EV was assumed:
    - to have a capacity of 40kWh and an efficiency of 3.5miles/kWh. This was based on findings from previous innovation projects involving electric vehicles and EV Database based on a Nissan LEAF[6]- these were found to be reflective of typical values.
    - To be plugged in between 18:30-06:30 each night.
    - To be used every day with a constant daily mileage (totalling 8000 miles annually).

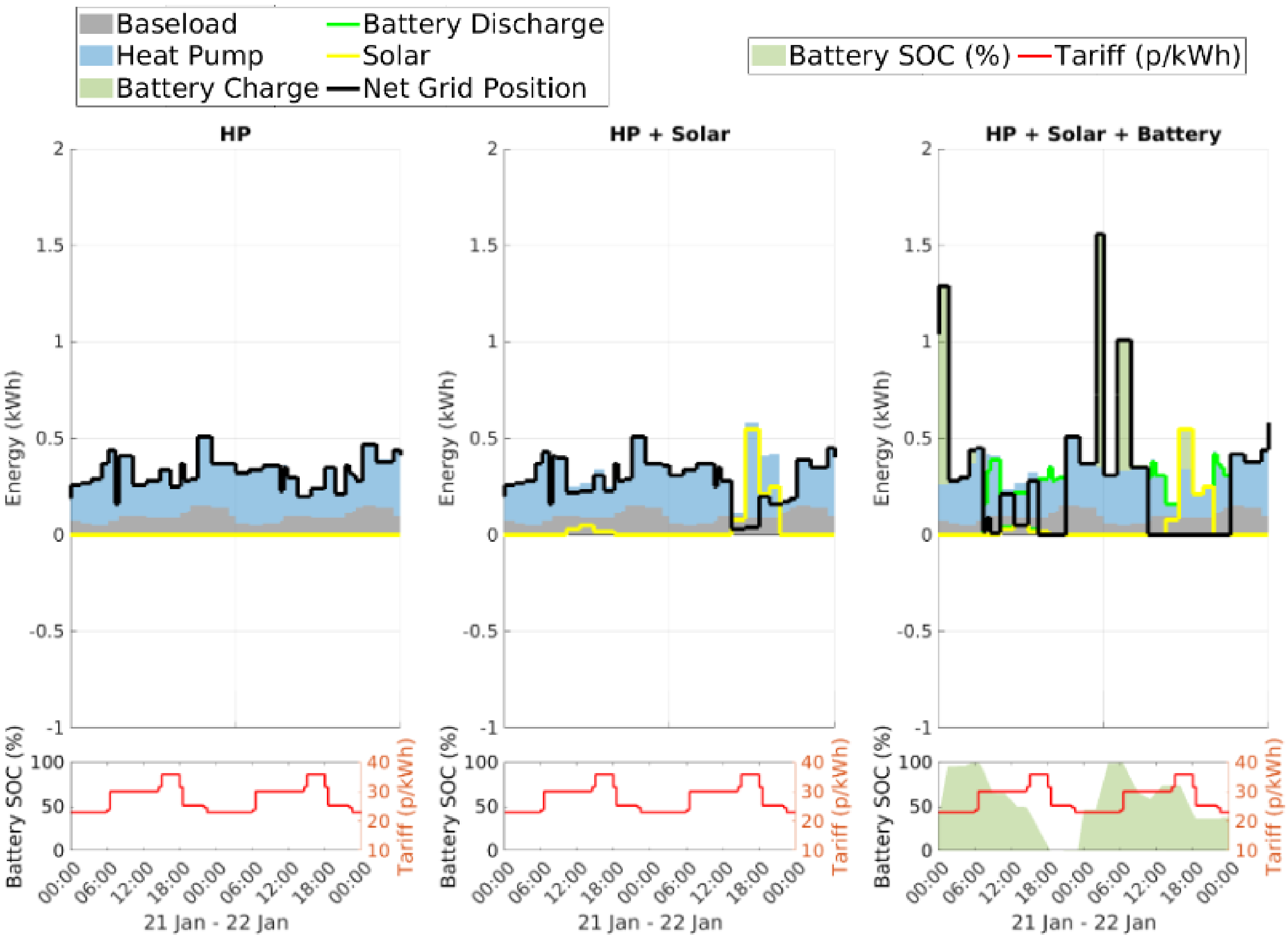
Figure 7, Figure 8, and Figure 9 show some sample outputs from the simulations. The difference in behaviour between 3 asset combinations (over 3 different seasons) are shown, which highlights the trade-offs made when optimising these assets together. The 2-day periods were selected to show typical behaviour for that time of year.

Any electrical usage (baseload/heat pump/battery charge) is shown by the shaded areas and is stacked on top of each other (such that they sum to the total usage) and where this is offset by (solar/battery discharge/grid) is shown by the lines.

Outputs shown are for winter, spring and summer – autumn is similar to spring (the other half of the heating shoulder season) so has not been included.

[6] https://ev-database.org/

Figure 7 – Winter Results - A typical 2-day period in January for Archetype 1 under the dynamic tariff, comparing different asset combinations, showing the battery state of charge (SOC) percentage, tariff prices, and the energy usage of the assets.



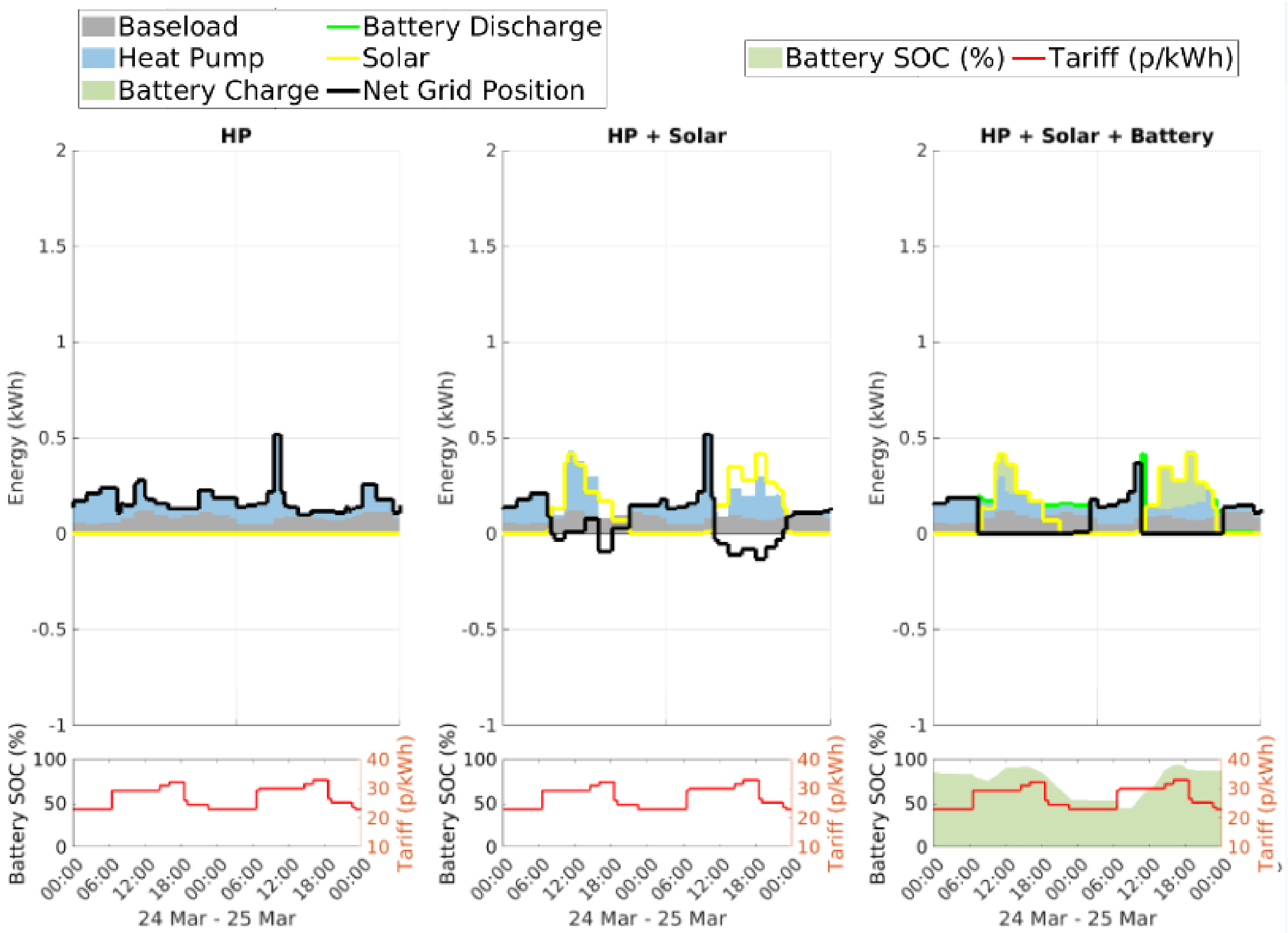
To provide further commentary on Figure 7, the heat pump runs constantly throughout the 2-day period to maintain comfort and maximum efficiency (running gently with low water temperatures). The temperatures were averaging ~35°C (with a peak of ~41°C) in these conditions. This was a house with large radiators (thus colder flow temperatures), but the same would apply if we simulated a house with smaller radiators, e.g. it might run at 40°C (with a peak of 45°C) instead of intermittently running harder at the maximum flow temperature of ~55°C. The key finding is that usage is relatively flat and consistent, irrespective of the exact numbers.

Passiv smart controls find the optimal way to run the assets at least cost under the dynamic time-of-use tariff, coordinating the operation of the battery and the heat pump.

In the winter there is not much solar generation, but where there is available solar, the heat pump tries to utilise the solar rather than exporting it.

The battery can be used in winter in combination with a time-of-use tariff to import from the grid and charge the battery at cheaper rates to be used later (when the tariff is more expensive).

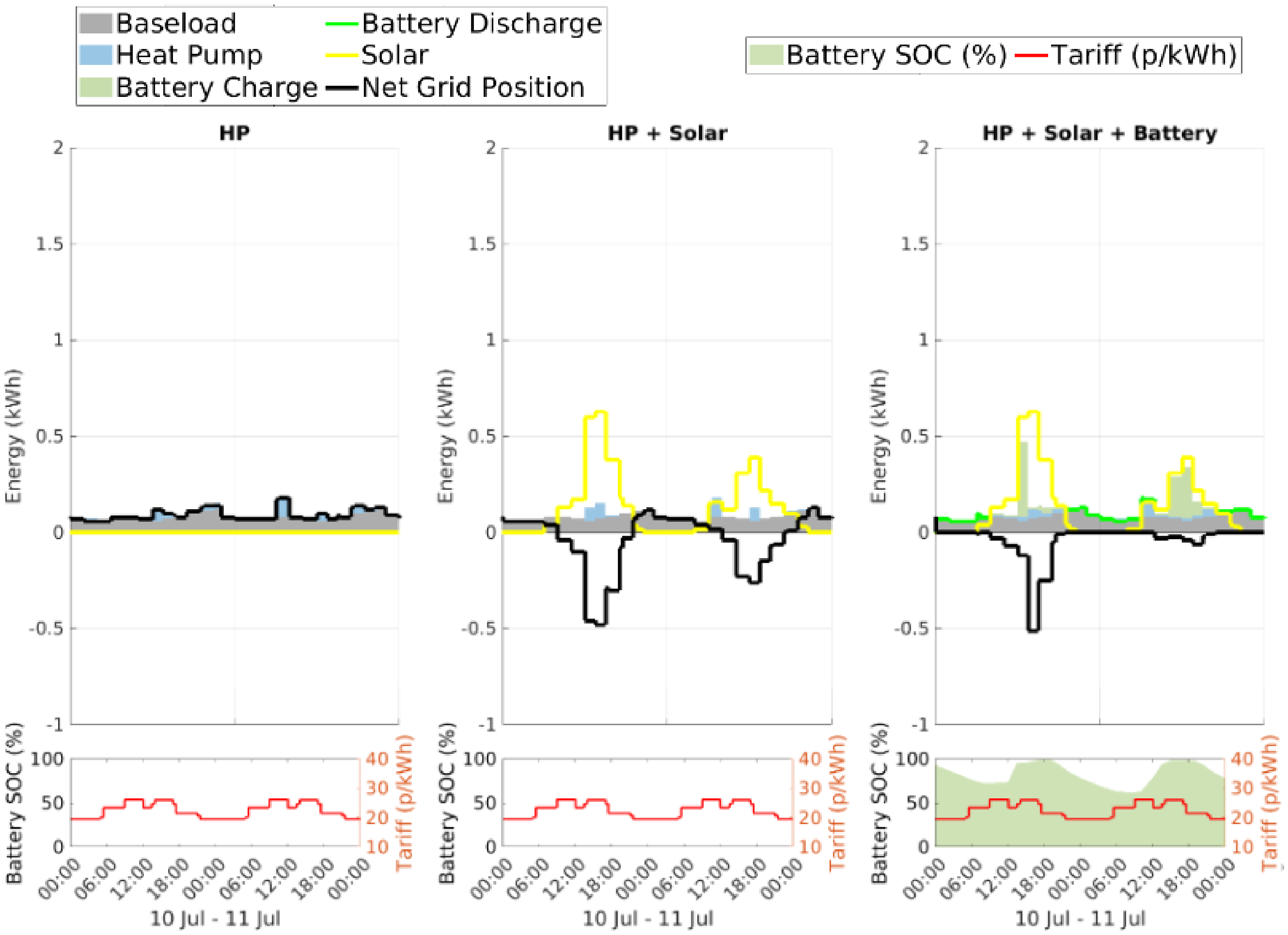
Figure 8 - Shoulder Season Results - A typical 2-day period in March for Archetype 1 under the dynamic tariff, comparing different asset combinations, showing the battery state of charge (SOC) percentage, tariff prices, and the energy usage of the assets.



In Figure 8, in shoulder season (the period between peak and off-peak seasons, typically in spring or autumn, when demand and prices are moderate), there is less heat pump usage, but there is more solar generation so heat pump operation can be shifted more where it makes sense against the householder's heating schedule.

The battery enables all the excess solar generation to be stored for later use and there is no import of electricity when the time-of-use tariff is at its most expensive.

Figure 9 – Summer Results - A typical 2-day period in July for Archetype 1, comparing different asset combinations, showing the battery state of charge (SOC) percentage, tariff prices, and the energy usage of the assets



To provide further commentary on Figure 9, in the summer, the heat pump is only used for hot water production and a high proportion of solar generation is exported. When a battery is added, much of the solar generation can be stored and discharged later when needed, making import rarely necessary.

Full year simulations for each of the modelling combinations specified in Table 3 were provided by Passiv using their modelling software. Once interpolation had taken place, then this allowed a first iteration of the heat bundle pricing to be available. These prices were based on averages over a whole year. The trial, however, was effectively over the winter months from November to March (as part of the original timescale). One of the many challenges with HaaS is that heating is very seasonable, so if the costing was averaged out over a year and a customer was able to leave mid-year, it would be difficult to calculate and communicate whether they were in credit or debit at that point. For this trial, which was just over 5 winter months, Tomato Energy requested that the models be run just over the months of the trial. This meant the average monthly price was much higher than over the 12 months as the heat pump may not be used at all for space heating over the summer months, but used the most intensively over the months the trial ran. As well as this adjustment, Tomato Energy reviewed the competitiveness of the offering against other tariffs current on the market and made some further minor adjustments based on this.

4.3.2 EV charging bundles

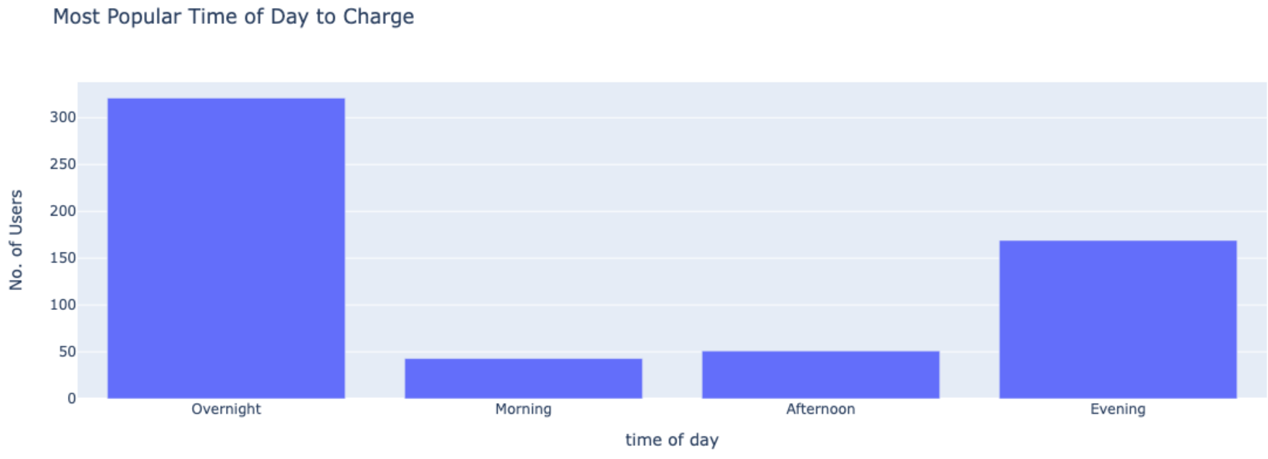
As already discussed, it was logical for Chameleon to complete the modelling for EV charging bundles given the same system would be used to complete the scheduling. As part of the input to the modelling, some key assumptions were made that reflected the ones made for heat pump as outlined in Section 4.3.1.

At the tariff design stage, one key area the project aimed to understand was whether the assumption that most triallists with an EV would be plugged in between 18:30-6:30 every night was a reasonable one to have made. That is because the project was using price signals that are only known the day before. To give the best chance that all the constituent parts of the price signals were available before making them available to the HEMs, then the Chameleon part of the system waited until a few hours after the time they should be available to allow for any slippage in delivery. In terms of the Homely heat pump optimisation, it was important to be sure that Chamelon provided the complete price signals before the heat pump scheduling was completed for the next day. For the EV scheduling optimisation, some additional thinking had to be made. This was particularly because the system works on creating a schedule on a plug-in event. If the AEM price signals had not been received by that point and the user wanted to charge by the following morning, then price signals past midnight would not be known at that point. To counter this, the plan was to then update the schedule once the next price signals had been received. Given this complication, the project aimed to understand users usual charging patterns to make sure the system designed had the best chance of optimising for the AEM price signals depending on when the user plugs in, how much charge they generally use and when they need the car for.

To investigate this, Chameleon used an existing data set available to them. This was the output of a disaggregation algorithm currently used in the ivie app that uses half hour granularity whole home consumption as input. EV usage is one of the categories that has been proven to be very accurate as this type of usage is one of the easiest to identify. The thinking here is that with a sample size of several hundred EV users and a use of a clustering algorithm, it was possible to see when people generally charge their EVs and be able to infer when they were likely plug in and how much energy they would put into the car battery on each plug-in event.

The results were initially that most users liked to charge their EVs overnight or during the evening. Morning and afternoon were the least popular times to charge their EV. This is shown in Figure 10 below.

Figure 10. Most popular time of day for ivie app users with EV to charge their car

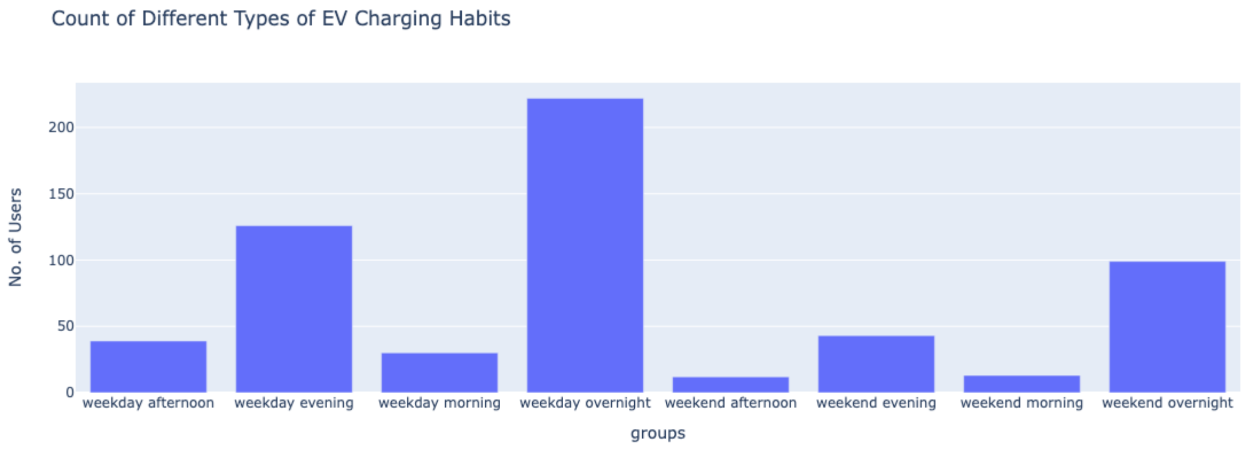


Morning: 6am - 12pm
Afternoon: 12pm - 5pm
Evening: 5pm - 11pm
Overnight: 11pm – 6am

When also adding weekdays as a possible output for the clusters, this showed that most users charged their EVs on weekdays between 11pm and 6am. Charging on weekdays between 5pm and 11pm was the next most popular with least common charging habit was on weekends between midday and 5pm. This is shown in Figure 11 below. Also, as a final point of interest, the analysis showed that users charged their EV for 2 hours on average each night.

Example: Count of Different Types of EV Charging Habits

Figure 11. Most popular time of day taking into account weekdays and weekends for ivie app users with EV to charge their car



These results gave some confidence to the important assumption that most users likely plugged in at some point in the evening and then charged overnight. As defined at the beginning of the section, this was an assumption made in the modelling and meant that there would likely be some value of flexibility to unlock where it was expected that the cheapest electricity would be available overnight. It also showed that the solution needed to be flexible in terms of plug in times and when the car needed to be ready for and potentially the need for behavioural changes around this if people were currently charging their car straight away because there was no benefit of waiting (assuming they were on a single rate tariff).

With the key modelling assumptions confirmed, Chameleon then ran simulations for the same archetypes as for the heating bundle against simulated AEM price signals and again used interpolation for the remaining archetypes not directly modelled. As with the heating bundles, Tomato Energy made a few tweaks to the exact pricing before finalising.

4.3.3 'Everything else' usage and standing charge

This element played a relatively minor role in the overall tariff development. It covered all other usage that was not EV charging or heat pump. Particularly for the time of year the trial was due to run (Winter 24/25), it was expected to be less than half the bill regardless of the other bundle choices. This usage could not be optimised, and so whereas the bundles are fixed, this part was designed to be variable. It consisted of a standing charge and price per kWh unit of electricity used. For the standing charge this was set just below the October 2024 price cap (60.99p) at 55p. For the price per kWh the same logic was applied where the October 2024 price cap was 24.5p the Energy Sure tariff offered 23.89p. The tariff was mainly designed around the heating and EV charging bundles with regards to the AEM price signals. Offering everything else usage and standing charge just below the price cap was more of a psychological move for potential consumers to show they would also save on other usage against the price cap as well as being offered cheap energy at a fixed cost for their EV and heating that was expected to be the main draw of the tariff.

4.3.4 Final tariff summary

The final tariff offered includes:

- Fixed cost EV charging if charger or car is compatible with the HEMS solution. The following service levels are offered, where each level represents a maximum number of kWh available for charging per month. Each level has a semi-bespoke pricing depending on whether home has solar AND/OR battery:
    a. 80, 160, 240. 320. 400. 480, 560, 640
- Fixed cost space and hot water heating if heat pump is compatible with Homely and a smart thermostat can be installed. The following service levels are offered, where each level represents a maximum temperature in degrees Celsius for any space heating schedule. Each level has a semi-bespoke pricing depending on type of home and number of bedrooms as well as whether the home has any of the following other assets: solar, battery, EV.
    b. 18, 19, 20, 21, 22, 23
- Flat single rate of 23.89p per kWh for 'everything else' usage. Standing charge of 23.89p per day

4.4 How differences between BAU and demonstrated propositions were calculated

As demonstrated in section 4.3 of this report, the tariff was very much designed against optimisation of assets against the Scenario 2b imagined 2030 price scenario. The expected extra flexibility unlocked would then allow the energy supplier to supply cheaper energy per optimised asset, packaged in a way that gave a fixed outcome to the consumer at a fixed price. The total cost for the consumer should be competitive against the market, as well as giving assurance in terms of consumers knowing exactly what they will pay each month. The main difference between BAU and this proposition is that it was being trialled against price signals that were different than how today's energy market works. The overall proposition gives opportunity/risk to the energy supplier where this position should be improved for this fixed price for a fixed outcome tariff as the volatility in price signals should mean it would be possible to provide the 'as a service' proposition for less cost for the energy supplier than BAU. Section 4.5 covers how the tariff was designed for pricing scenarios. In terms of measuring the exact differences compared to BAU, this is defined in the trial design section.

4.5 Rationale for the tariff approach

As well as describing the tariff approach, this section provides rationale for the decisions as different elements are discussed. As a summary here, a key part of the rationale for the tariff approach is that modelling has been extensively used to forecast outcomes for as many different archetypes as possible. As far as possible attempts have been made to validate assumptions against real data and real data has been used to try and improve accuracy of the models. As already described in this document, a key decision of how the project has interpreted the price signals is that it has used a formula to adjust them to be applicable to the current day, as opposed to how they may look in 2030. This has helped design a tariff to see how competitive it might be against other tariffs currently on the market today. Tomato Energy made an evaluation of the output of the models against other tariffs on the market to make adjustments if necessary, where they might accept more risk to be competitive and ensure switching as any energy supplier would when launching a new tariff. By making the treatment group fully switch to the tariff rather than simulate it, tests how attractive the proposition is to consumers. So that was very much considered with the tariff design as well as ensuring the modelled numbers gave a decent chance that the proposition would be shown to be commercially viable for the energy supplier.

5 Operational Phase set up

5.1 Summary of approach

The approach to the modelling and data aspects of running the trial are outlined in this section, including how signals for the customers to operate flexibility have been achieved and how flexibility is measured between Scenario 2b and the baseline Scenario 1 within the treatment group. Also, how flexibility is measured between the treatment group generally on the Energy Sure tariff and the comparison group on other tariffs currently available in the market.

During the operational phase, data has been collected on the response of assets to the AEM price signals. There were two stages – reviewing how the dispatch profiles created from the price signals differ from baseline dispatch and then looking at how outturn energy consumption differs from baseline energy consumption.

The project tested two potential energy market scenarios, developed from the previous phase of the project. These were based on DESNZ's scenarios initially defined in Phase 1 of the project and summarised at a high level in Section 2.4 of this report. They were:

- Scenario 1 – a "business as usual" scenario, where the current 2024-25 energy market parameters was applied, with the exception that all domestic customers were half-hourly settled.
    - This scenario will pertain for customers in the real world from late 2026, when the Market-wide Half Hourly Settlement (MHHS) programme reaches completion, or before if their supplier moves them to half-hourly settlement ahead of the deadline.
    - All elements of the customer end-bill continue at current 2024-25 levels, but the customer's actual consumption in each half hour replaces the current profile of consumption, Elexon's Profile Class 1[7]. Cornwall Insights's forecasts of levy costs will be used for RO, FiT, CfD and CM. These standard forecasts are currently used by a range of energy suppliers across the industry.
    - Customers will also be exposed to the CM levy directly, based on consumption during winter peak periods, rather than the current non-half-hourly settled approach of spreading CM cost across all annual consumption.
    - Current network charges will be used.
    - Wholesale prices will be provided by supplier Tomato Energy; who are understood to be looking to trade on a short-term, Day-Ahead and Intraday approach.
    - Other non-commodity charges and supplier costs will be included by Tomato Energy at current levels.

[7] https://www.elexon.co.uk/bsc/settlement/profiling/

    - Overall, Scenario 1 will deliver some signals, from variable network charges and wholesale prices, for moving consumption out of very predictable peak periods.
- Scenario 2b – a scenario where the current policy levy recovery methodology – flat £/MWh – was replaced by a methodology which took account of network conditions.
    - Wholesale costs and network charges continue at current levels, and customers are half-hourly settled as above.
    - RO, FiT and CfD levies are no longer recovered on a flat £/MWh basis across the year, but instead levied based on the grid carbon intensity in each half hour.
    - The current CM levy, which divides costs across all MWh consumed in the winter peak period (Nov-Feb, 4-7pm, weekdays) to the 200 half-hours of lowest system margin across the year, based on a pre-set threshold.
    - Overall, Scenario 2b will deliver very strong signals for moving consumption out of relatively hard to predict periods.

5.2 Constructing signals for customers to operate flexibility

During the Operational Phase, price signals were sent to asset optimisation engines for asset scheduling. The scheduling then resulted in direct control signals, automatically dispatching the EV charger and heat pump assets in the home to meet the needs of the consumer, while minimising the costs to which the supplier would be exposed. Asset scheduling was created by ivie for EV chargers and by Homely for heat pumps.

The AEM price signals had several constituent parts. These included network costs and levies generated by Cornwall Insight (CI) and passed to Chameleon on a daily basis. These were then combined with wholesale pricing from 100 Green/Tomato provided in advance from hedging to form the overall price signal. The overall process was fully automated and allowed for a final stage of distribution to the parties creating dispatch signals. The signals were issued directly to the assets in customer's homes and were scheduled on plug in events and a scheduled job for EV charging and a scheduled job for heat pump control, both with awareness of conditions in the period immediately following these signals, in order to maximise efficiency.

As alluded to above, wholesale prices came from two sources. During the initial phase of the project (until March 2024), they were supplied by ex-project participant 100Green, based on its long-term hedging strategy buying energy on a monthly/ quarterly basis. From April 2025, Tomato Energy issued information on the wholesale costs it experiences for the customers, based on its hedged position, and any short-term trades or adjustments to this position it undertakes.

Regarding the specific components of the retail cost stack provided by Cornwall Insight, these were based on existing published data or Cornwall Insight's own market forecasts. The elements were largely flat p/kWh rates for Scenario 1:

- Network charges were extracted from the relevant charging statements of the 14 Distribution Network Operators (DNOs).
    - Where relevant, also the IDNO charging statements for IDNO-connected domestic customers.
- The recovery of policy levies (RO, FiT, CfD) was based on Cornwall Insight's forecasts of these costs for the relevant period, and were flat rates across the day.
- The Capacity Market (CM) levy was based on Cornwall Insight's forecast of this levy, and costs were allocated on the current basis for half-hourly settled (HHS) consumers to the winter peak period – November to February, 4-7pm period on weekdays.

Under Scenario 2b, many of these elements became dynamic, based on system conditions. The methodologies used set out below are:

- The recovery of policy levies was made dynamic, based on system conditions. RO, FiT and CfD cost recovery was based on a methodology which considered the average grid carbon intensity of power generation in each half hour.
    - The methodology set the forecast average grid carbon intensity as the mid-point, where levies were recouped at the forecast level.
    - Levies were then recovered based on the indexed ratio of the carbon intensity of the individual half-hour, compared to the annual average. if the carbon emissions in the half-hour were half the annual average, then cost recovered is half; if emissions were double, then recovery is double.
    - Cornwall Insight used the short-term grid carbon intensity data published by National Energy System Operator (NESO) through the Carbon Intensity API to deliver daily forecasts for the coming 24 hours to project partners, which supported allocation of costs, analysis and scheduling of load.
- CM levies were also recovered in a more dynamic manner. They are currently recovered (for half-hourly settled consumers) during winter weekday evening peak periods – 4-7pm, Monday-Friday, November-February. For this scenario, they were targets to the 200 half-hours of lowest system margin, i.e., when the amount of available generation which could be activated to meet increased demand was lowest. This was based on DESNZ's Phase 1 methodology, which suggested recovery over the 100 hours of lowest system margin (it was not possible to precisely replicate this as system margin is reported on a half-hourly basis). This metric generally recovered costs over the periods of peak demand, but also targeted the periods when intermittent power generation was low, or a generator outage tightened margins. These periods are those which drive CM procurement, so it was appropriate to target costs to these to discourage consumption at these times.
    - The CM levy was recovered in periods when the forecast de-rated margin is below a specified, pre-set threshold.
    - This threshold was set to capture the lowest 200 half-hours of margin from the previous year (2023-24), based on outturn data.

    - Cornwall Insight used the De-rated Margin forecast published by Elexon through the Elexon Insights Solution.
- Cornwall Insight introduced reconciliation and updates to re-base levies on a quarterly basis, when Cornwall Insight updated its within-year forecasts of costs. A K-Factor was used to increase or decrease the cost to be recovered, based on updated forecasts and the outturn of carbon emissions against forecasts of carbon emissions. It was anticipated that costs were marginally over-recovered initially, based on the generally decreasing carbon emissions on the grid, allowing money to be returned to consumers over time.

During initial testing, it was demonstrated that a consumer taking power on the Profile Class 1 (PC1) profile – the standard domestic profile in GB – would pay the same policy and CM levies in 2023-24 under this methodology as the existing cost-recovery methodology.

NESO developed the service, and a discussion document outlining the winter 2024–25 service was published in June 2024.[8] This was followed by formal consultation in July, with submission to Ofgem for a final decision in September, Ofgem approval on 21 November and service go-live 26 November 2024. The service changed from an "enhanced action" to an "in-merit service". This means that it is ranked in economic terms alongside other actions NESO could take to manage the system, which reduced prices and therefore dispatch rates of the services within the trial.

5.3 Measurement of flexibility

Responses to signals were measured in two ways: by comparing the costs a supplier would be exposed to if no flexibility was deployed, based on the forecast consumption profile created by Passiv before price-weighting for signals is deployed, with the costs which a supplier would be exposed to under the scenarios using a modelling-based approach.

It was then possible to analyse the results of actual dispatch, against the profiles set out by Homely. The kWh actually consumed in each half-hour was compared against the forecast consumption, as well as examining the behaviour of consumers in terms of overriding the signals sent to their homes by Homely.

The response to key signals was regularly reviewed, in order to understand how consumption has been driven by the different elements of the flexibility stack. This was targeted against identified exemplar periods, rather than examining all periods, in order to derive meaningful lessons about that signal. For example, the project reviewed behaviour during example periods of very high overall costs and high costs due to specific aspects of the cost stack, primarily the signals set out below.

These signals were:

[8] https://www.neso.energy/document/362981/download

- Wholesale costs – examining consumption during a short period of very high wholesale costs, compared to the periods around this.
- Network charges – comparing consumption during peak and adjacent off-peak periods.
- Capacity Market levy – under Scenario 1, examining consumption in the winter peak 4-7pm period, compared to consumption before and after this; and under Scenario 2b, examining consumption in the 200 relevant CM levy half-hours and outside of these periods.
- Policy levies – under Scenario 2b only, examining a period of high carbon emissions (hence high levies) versus an adjacent period of low carbon emissions.
- Demand Flexibility Service (DFS) – while not one of the core signals being sent on a daily basis by the project partners, assets were dispatched to avoid consumption during DFS periods. The delivery periods were examined to see how this low-predictability but high-value service impacts on power consumption.

Some of these signals are correlated. For example, high wholesale costs and high carbon intensity often occur together because both are usually caused by the dispatch of gas-fired generation. Similarly, peak network charges and Capacity Market (CM) levies are both applied during the same 4–7 pm weekday window. Because of these overlaps, it was not always possible to examine each signal separately. These were benchmarked against the comparison group who did not receive any signals, providing the basis for comparison.

These methodologies were applied to both EV and HaaS propositions. Asset-level metering is required to precisely understand the demand of individual appliances like EV chargers and heat pumps, within the overall consumption of the home.

5.4 Pricing approach

This section describes how the CAMEA project has used a different pricing approach for the trial based on live, in-market prices rather than the exact pricing which DESNZ provided as imagined 2030 profiles.

Whereas the prices provided by DESNZ are significantly below current rates, the project tariffs will be built up from prices seen in the real world, for winter 2024-25. They were sourced as follows:

- Wholesale prices – provided by project supplier, Tomato Energy.
- Network charges – live, from DNO network charging statements, retrieved at start of project, which cover the financial year 2024-25.
- Policy levies – live, sourced from Cornwall Insight forecasts created for Q3-2024.

While the prices are different, there are no material differences in overall network charges or total policy levies, and the prices will send a similar signal to drive flexibility into dispatch decisions. The prices were correctly aligned with real world conditions such as weather and external temperatures, which had significant impacts on how participants use power, particularly power for heating.

DESNZ provided hypothetical network charge profiles for three regions, but these were not aligned with any of the 14 DNO regions currently used for setting network charges in GB. The project therefore used live DNO charges for all participants. This change traded off alignment with the DESNZ-provided hypothetical prices and scenario-specific methodologies for applicability into the overall delivered energy cost stack faced by participating customers. As it was not possible to map participating customers to the 3 generation and demand-dominated regional charge classifications used by DESNZ, it was thought that applying actual network charging represented a viable alternative that retains the presence of network charges within the cost stack and facilitates analysis their role in informing asset optimisation and flexible dispatch decision-making.

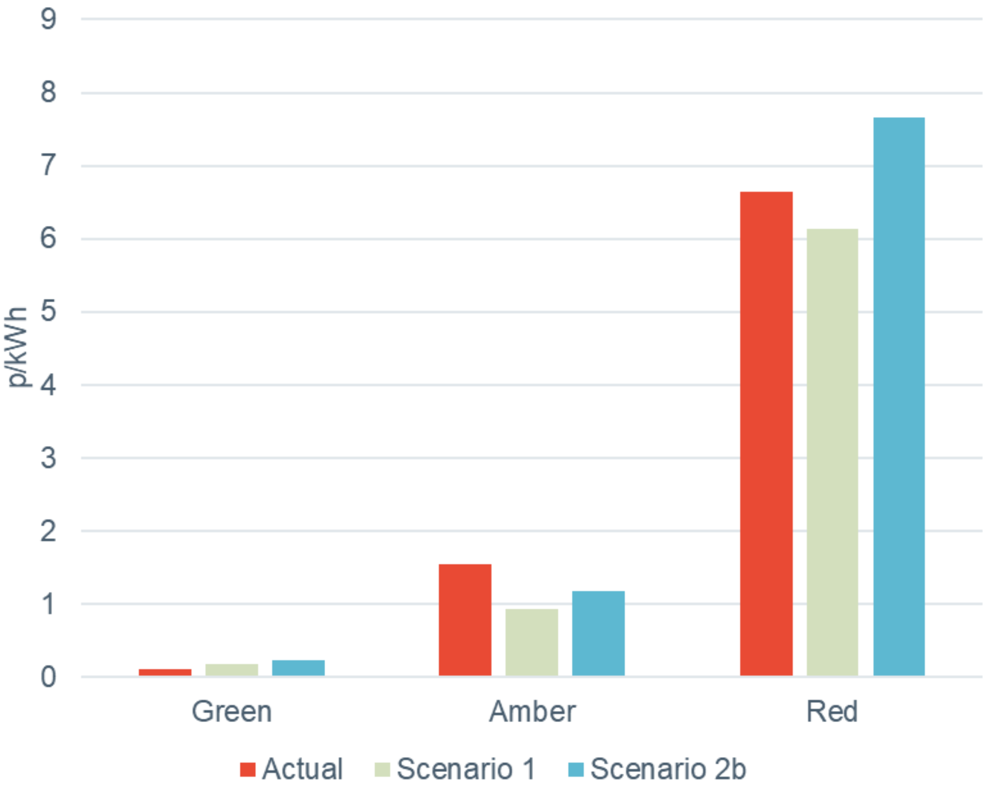
A comparison of DESNZ's hypothetical charges with live DNO charges for a potentially similar region indicated that they were similar in magnitude:

- Location 2, which was understood to represent a view from the centre of the country, was compared with East Midlands charges.
- The differences were minimal in terms of the overall tariff and their impact on asset dispatch decision-making.
- Green band charges were approximately 30–50% lower, though the difference was immaterial at around 0.06p/kWh.
- Amber band charges were 30–50% higher, but again this equated to less than 0.5p/kWh and was not considered material.
- Red band charges were closer in percentage terms, with a difference of around 10%, equating to a value difference of 0.5–1p/kWh.

This is show in Figure 12 below. Under the project's proposed approach, the escalating charges from Green to Red band rates were retained, as well as the magnitude of the delta between Amber-to-Green and Red-to-Amber charging bands. Approximating the charges in Green bands to 1 unit of cost, we then see an Amber band cost of around 10 units, and Red band costs in the range of 50-100 units or higher. We maintain this scale, which is the key test in being able to re-dispatch demand to avoid these high-cost periods.

Although the approach applied a different schedule of network cost signals to participating households, it maintained the overall disincentive for Red-band (peak time) power consumption under both Scenario 1 and Scenario 2b. Crucially, this approach enabled the evaluation of the proposition's ability to minimise cost exposure within the constraints of customer demand requirements.

Figure 12. A comparison of DESNZ's hypothetical charges with live DNO charges

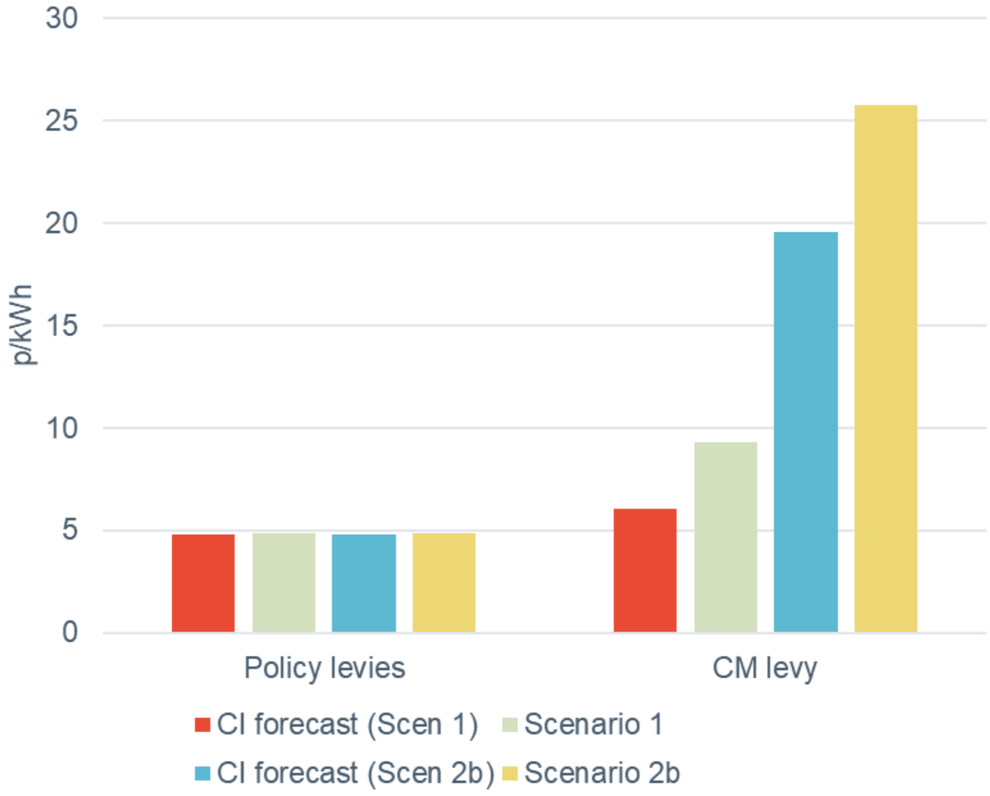


The project's use of levies was costed very close to DESNZ's forecast, although capacity market costs spanned a wider range.

- Cornwall Insight's forecasts of policy costs (Renewables Obligation, Feed-in Tariff, and Contracts for Difference) were closely aligned with DESNZ's 2030 forecast — 4.87p/kWh versus 4.8p/kWh, respectively.
    - This was applied on a flat basis in Scenario 1 (to all kWh), and on a variable basis in Scenario 2b, in line with DESNZ's description, averaging across the year at the same price.
    - At the overall policy cost level, no material trade-offs were observed with this approach. Reflections on the impacts of how these charges were distributed within a day were presented separately.
- Cornwall Insight's forecast of the Capacity Market (CM) levy was applied to domestic households on a peak basis in Scenario 1, consistent with the current process for half-hourly settled consumers, and on a 100-peak-hours basis in Scenario 2b, in accordance with DESNZ's scenario descriptions.
    - This resulted in a CM levy that was lower in both cases—approximately a third lower in Scenario 1 and a quarter lower in Scenario 2b.
    - Nevertheless, it continued to provide a strong signal to avoid consumption during these periods compared to the total tariff—adding about a quarter to costs in Scenario 1 and approximately 80% in Scenario 2b. This pricing signal served its intended purpose.

Figure 13 below shows a comparison of policy levies for CI forecast and DESNZ hypothetical values for Scenarios 1 and 2b.

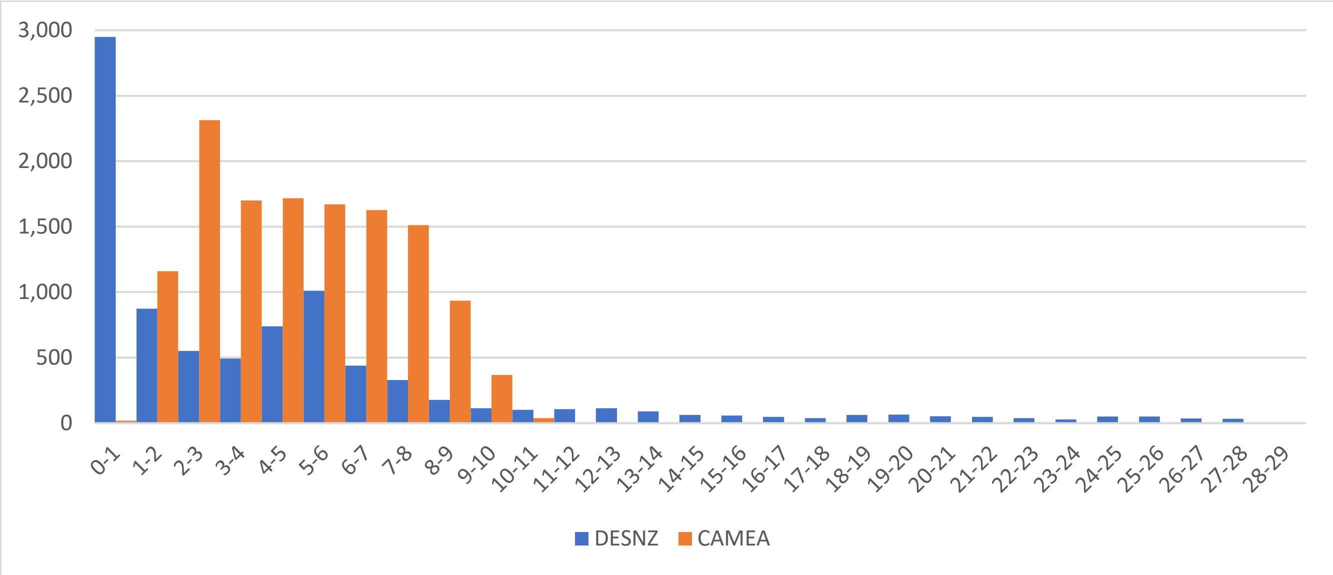
Figure 13. Comparison of p/kWh policy levies and CM levy



The distribution of policy levy charging events differed significantly. DESNZ's data showed a high proportion of events at the lower end of the cost spectrum, whereas the application of the methodology using real-world wholesale and system data resulted in a normal distribution of events. It was noted that during the winter trial period, a higher penetration of renewables was expected — due to the commissioning of additional plants compared to the 2023/24 values shown in Figure 14 — which would likely lead to a slightly less normal curve. The project considered the use of real-world data to offer more accurate evidence for how the tariff should respond to actual market conditions expected through to 2030, based on a real generation fleet and real weather conditions which impacted on heating demand as well as on intermittent renewable generation output (and hence market prices and, under Scenario 2b, policy levy recovery). This approach also provided a broader range of price signals for the tariff to react to, potentially generating a more insightful dataset for analysis.

Despite the differences in distribution, it was anticipated that the overall amount of flexibility enabled by each approach would remain unaffected. The same amount of physical capability was expected to be created in either case, and — since dispatch was automated — the physical flexibility dispatched in response to the price signal would remain consistent. This minimised any trade-offs in applying the Scenario 2b methodology to actual 2024–25 cost data as compared to using the projected 2030-based prices.

Figure 14. Comparison of distribution of policy levies, p/kWh (Left: Proposed solution as applied to 2023-24 wholesale prices. Right: DESNZ Scenario 2b in 2030).



To align trial results with the specific DESNZ 2030 price profiles which enabled DESNZ to compare outcomes across different projects within the programme, the CAMEA project tested its assumptions by conducting a modelling exercise using the 2030 price data. The models applied price signals through the project's dispatch algorithms to generate dispatch signals in the same way as those derived from live real-world prices, using the wholesale prices, network charges, and policy levies provided for Scenarios 1 and 2b.

The project then examined the dispatch signals generated from the 2030 prices against those produced using real-world pricing, to assess any observable differences in the resulting signals. Where significant differences were identified, the project quantified the divergence in flexibility enabled and analysed the underlying price components — such as wholesale prices, network charges, or policy levies — that contributed to the observed variations. This analysis also offered insight into the seasonal and time-of-day effects of using real-world versus forecast 2030 prices for the actual dispatch of customer loads.

The project's approach did not include assessing how customers might have responded to the hypothetical 2030 signals, particularly in terms of overriding heating controls. However, since the 2030 prices were not tied to the weather conditions expected during the 2024–25 winter, the project concluded that these signals would not offer meaningful insight into real-world customer behaviour. Using real-world pricing was deemed far more valuable for understanding customer responses to the signals sent.

As previously noted, the results of this analysis aimed to support DESNZ's understanding of what signals would have been issued under the 2030 price assumptions, and to serve as a comparative basis between the flexibility dispatch signals sent by the CAMEA project and those from other AEM initiatives. By combining real-world pricing with this comparison to DESNZ's hypothetical pricing, the project successfully met its objective to deliver real-world demonstrators to increase understanding of how such propositions may work in practice and how consumers respond and participate.

5.5 Data gathering approaches and methodology

The operational phase of the trial was heavily reliant on ensuring data was collected and made available to members of the project consortium who depended on it for analysis, in line with the trial design defined in Section 6. There were two key aspects to the approach: technical considerations to ensure that required data was stored at the correct level of granularity and retained for at least the duration of the project, and compliance with data protection requirements.

From a technical standpoint, it was decided that Chameleon would provide all the data required for analysis, as they had access to all relevant inputs by acting as the central point for operating an automated HEMS. As described in Section 3 of the report, Chameleon had an integration with Cornwall Insight for network charges and levies, and combined these with Tomato's wholesale energy costs to construct the overall price signals. These price signals were made available to the HEMS components responsible for dispatch and were also stored against the users for whom they were constructed. Chameleon had further integration with Homely, enabling them to access heat pump energy usage data at half-hour granularity, which was stored per individual user. For heat pumps, Chameleon also had access to usage data through an integration with Enode. It was possible to determine whether any half-hour segment of EV charging energy use was scheduled or overridden by the user. In the case of heat pumps, where Chameleon did not have direct access to this information, they relied on Homely as an alternative data source.

Chameleon also supplied other necessary data for analysis. All trial participants were required to download the ivie app (Chameleon's consumer-facing brand) and link their smart meter, which allowed whole-home consumption data to be collected for both treatment and comparison groups. Additionally, useful metadata was captured during ivie app onboarding. For the comparison group, tariff rate information was a particularly important data point. Other useful metadata collected for both groups included house type, number of bedrooms, number of occupants, energy sources used for heating, hot water, and cooking, and the presence of solar panels, batteries, heat pumps, or EVs. The geographical region was inferred from the first two digits of the MPAN, where available.

The data access and protection approach had two components. Firstly, Chameleon was responsible for providing data to the consortium monthly, shortly after the end of each month. This enabled interim analysis, early detection of data quality issues, and timely resolution of any problems with the HEMS for future data collection. Data was compiled into multiple files using a consistent format each month:

- Comparison group home profiles – Included all metadata from the ivie app, key indexes to link participants to whole-home consumption data, and current tariff rates.
- Comparison group whole-home consumption readings – Contained half-hourly electricity and gas usage data where available.
- Treatment group home profiles – Included all metadata from the ivie app, indexes to link to whole-home, heat pump, and EV consumption data.

- Treatment group whole-home consumption readings – Contained half-hourly electricity and gas usage data, along with AEM price signals provided to users.
- Treatment group EV charge blocks – Captured EV charging energy consumption at half-hour granularity and indicated whether it was scheduled or user-boosted.
- Treatment group heat pump consumption – Provided half-hourly heat pump energy usage data.
- Readme file – Served as a data dictionary for all files.

Throughout the project, data was handled with great care to minimise risk. A data minimisation approach was adopted, ensuring that only data necessary for achieving project objectives was collected. Role-Based Access Controls (RBAC) restricted access to data to those who needed it, and secure storage solutions compliant with ISO 27001 were used. Anonymisation or pseudonymisation techniques were applied to prevent personal data from being directly linked to individuals when shared. Best practices for handling, storing, and disposing of data were followed, aligned with key legal and regulatory frameworks such as the UK GDPR, the Data Protection Act 2018, and ISO 27001.

At the project's conclusion, a clear data retention policy determined how long data was to be stored before deletion, ensuring compliance with legal and contractual obligations. When no longer required, data was securely deleted using approved disposal methods. Data subject rights under GDPR were upheld, allowing participants to request the deletion of their data if desired. A record of all data disposal activities was maintained, and where appropriate, a certificate of destruction was issued to confirm compliance.

6 Trial methodology

6.1 Approach to trial

The CAMEA trial involved offering Heat-as-a-Service (HaaS) and EV charging-as-a-Service propositions to participants, managed through a Home Energy Management System (HEMS) combined with a bespoke Tomato Energy tariff. These propositions were offered to both treatment and comparison groups, with the comparison group comprising people with heat pumps and/or EVs and chargers who had expressed interest in taking part but either chose not to switch to the trial tariff, or had incompatible assets.

Triallists were provided with the HEMS solution, and they chose the maximum ‘comfort’ temperature they required for their house and/or number of kWh for charging (with approximated driving miles conversion) required per month, which set the rate for their bundle price, as described in Section 3.3. The HEMS solution automated the energy usage based on the restriction criteria, while minimising user costs and introducing opportunities for Tomato Energy to save energy supply costs.

The results were then analysed to determine the outcomes achieved. The quantitative data analysis is outlined in this section. The qualitative research with participants is described in detail in Section 11.

6.2 Treatment and comparison group approaches

6.2.1 Treatment groups

The treatment group was created using participants who had a heat pump and/or EV charger/vehicle which was on our compatible technology list, who were willing to sign up for the tariff as part of the trial.

Users signed up to a new tariff with Tomato Energy, which matched the tariff offer outlined in Section 4. The technical integrations described in Section 3.2 enabled optimised decisions to be made based on the available flexibility, in order to minimise the electricity cost to supply.

Two different treatment groups were created.

- In treatment group 1 (TG1), the user tariff and device control was delivered based on Scenario 1 conditions.
- In treatment group 2 (TG2) the user tariff and device control was based on Scenario 2b market positions.

6.2.2 Comparison groups

The comparison group comprising people with heat pumps and/or EVs and chargers who had expressed interest in taking part but either chose not to switch to the trial tariff, or had incompatible assets.

The comparison groups were not on the trial tariff and were benchmarked based on Scenario 1 using their existing tariff and operation. The counterfactual for Scenario 2b conditions was tested through modelling.

It should be noted that participants in the comparison group were assigned either because they declined the intervention or were not eligible to receive it. As such, this approach does not constitute a random allocation or quasi-experimental design for an independent control group. There is a risk of selection bias, as individuals in the comparison group may differ systematically from those who accepted the intervention, for example in terms of motivation, energy awareness, or household income. These differences may have influenced energy usage independently of the intervention, and no controls were in place within this study to adjust for the impact of such confounding factors.

6.2.3 Sample size

It has been acknowledged that while the overall sample sizes of the treatment group are statistically significant, when sub-sections of the treatment groups in each category are analysed, the results are not always statistically significant and in these areas, the results may have low internal validity to be certain of cause-and-effect relationships and low external validity. This means some caution must be exercised when seeking to generalise these findings to the wider population.

6.3 Approach to analysis

While the detailed questions are outlined below, the overarching questions research questions the project intended to answer, which matched with the DESNZ programme objectives, can be summarised as:

- Do the propositions, when paired with a future energy scenario, encourage more flexible consumption to the network and value to the supplier than currently available propositions in the current energy market?
- What is the impact of different energy scenarios on driving flexible consumption and value to the supplier?
- What is the impact of the proposition on releasing flexibility and value?
- What are the benefits to the consumer of the propositions?
- What is the appeal of these propositions to consumers? Do these propositions have the potential to increase/accelerate the uptake of low carbon technologies?

Assessing these high-level questions in more detail allowed us to plan the analysis approach effectively. In many cases, the research question was broken down into sub-questions which are outlined below, alongside the approach to analysing the data to answer the question.

6.3.1 Impact of future scenarios on flexibility and supplier value

The analysis assessed the impact of the propositions by comparing experimental groups under Scenarios 1 and 2b with matched non-experimental controls and current market conditions. Flexibility was measured as deviations from baseline energy use, expressed in percentage terms and kilowatt-hours shifted, while value was quantified as cost savings to the supplier. Comparisons were made both between scenarios and against standard market propositions to determine whether the propositions unlocked additional flexibility and delivered greater supplier value. Additionally, results were disaggregated by household technology combinations to explore how different asset mixes influenced both flexibility and value outcomes.

6.3.2 Impact of different energy scenarios on driving flexible consumption and delivering value to the supplier

Differences in flexibility and supplier value between scenarios were assessed by comparing participants on the proposition under Scenario 1 with those under Scenario 2b. Flexibility was measured by the volume of energy shifted from baseline patterns, while value was evaluated as the cost savings to suppliers relative to delivering the same service under current market prices.

6.3.3 What was the impact of the propositions on releasing flexibility and value?

Quantitative data collection followed methodologies outlined in 7.3.1 and 7.3.2.

Qualitative feedback from users was gathered through interviews to determine whether participants perceived that their decisions had changed due to the proposition details (e.g. whether use of wet appliances changed despite no pricing benefit in a bundled model).

6.3.4 Consumer experience of the propositions and benefits derived

Consumer benefits were assessed by comparing energy spending of participants using the propositions against the comparison group under both future energy scenarios and current market conditions. Additional insights into consumer appeal and experiences were gathered through qualitative research.

7 Recruitment

7.1 Recruitment approach

Recruiting trial participants was a critical foundation for the success of the CAMEA project. The recruitment strategy combined multiple approaches to ensure a diverse and representative group of households, with a particular focus on those with heat pumps, EVs, and other relevant technologies. Efforts were largely concentrated on targeting the existing customer bases of project partners, which provided a warm audience with a high potential for engagement. This was complemented by a comprehensive digital marketing campaign across various platforms and attendance at relevant conferences and events to raise awareness and encourage sign-ups. The multi-channel approach aimed to balance reach with quality, ensuring that participants were both eligible and motivated to take part in the trial.

7.1.1 Targeting existing customer bases

A key strand of the trial recruitment involved targeting existing customers of project partners through direct email marketing. This approach leveraged pre-established relationships and trust, offering a warm and highly relevant audience. Email campaigns were crafted to clearly explain the trial proposition, eligibility criteria, and potential benefits of participation, including access to innovative heat and EV service bundles, cutting-edge home energy technology, and the opportunity to contribute to a more flexible, sustainable energy system. Emails were personalised where possible and tailored to the customer base of each partner, increasing engagement and response rates.

A phased approach was taken to email communications, beginning with initial awareness-building messages, followed by more detailed invitations to sign up, and finally, targeted reminders for those who had shown interest but had not completed the onboarding process. Messaging was adapted over time in response to performance metrics and participant feedback, helping to refine content and improve clarity around the trial process. Email marketing proved to be an effective channel in driving early sign-ups and maintaining engagement throughout the recruitment period, particularly among customers already familiar with the partner brands and their energy-related offerings.

Example emails inviting those who registered interest to be part of the treatment or comparison group have been added as Figure 50 and Figure 51 to the Appendix.

7.1.2 Digital marketing channels

Most of the marketing for the project was allocated to digital marketing channels on social media, Google Play Store, and Google Search. It was chosen as an effective approach to generating trial participants for several reasons:

Social Media Advertising

- Targeted Audience: Social media platforms have sophisticated targeting options, allowing ads to be shown to users based on demographics, interests, behaviours, and previous interactions. This precision ensures that advertisements reach potential trial participants who are most likely to be interested and eligible.
- Engagement and Interaction: Social media platforms are designed for interaction. Ads can be crafted to encourage users to comment, share, or click through to learn more, facilitating a direct line of communication and engagement with potential participants.
- Visual and Interactive Content: Social media allows the use of rich media formats, such as videos, infographics, and interactive posts, which can effectively capture attention and convey the benefits and importance of participating in a trial.
- Community and Peer Influence: Social media fosters community engagement and peer influence. When users see their friends or people they trust engaging with or endorsing a trial, they are more likely to consider participating themselves.

Google Play Store Advertising

- Reaching Mobile Users: Many people use their mobile devices for information and apps. Advertising on the Google Play Store targets users who are already looking for apps, making it an ideal place to promote trial participation apps or related information.
- App Store Optimisation (ASO): Optimising trial-related apps for search within the Play Store can increase visibility and downloads. Effective ASO ensures that the app appears in relevant searches, attracting users interested in the trial.

Google Search Advertising

- Intent-Based Targeting: Google Search Ads reach users who are actively searching for information related to the trial. This intent-driven targeting means ads are shown to people who are already interested in or looking for related topics, making them more likely to participate.
- Keyword Optimisation: By using specific keywords related to the trial, ads can be shown to users searching for those exact terms. This precise targeting helps in reaching the most relevant audience.
- Geographical Targeting: Google Ads allows for location-based targeting, ensuring that ads are shown to users in specific regions where the trial is taking place. This is crucial for trials that require participants from certain areas.
- Measurable Results: Google Ads provides detailed analytics and reporting, allowing for the measurement of ad performance, conversion rates, and other key metrics. This data helps in optimising the campaigns for better results.

Combined Effectiveness

- Multi-Channel Presence: Using a combination of social media, Google Play Store, and Google Search ensures a broader reach across different platforms and touchpoints. Potential participants can be reached wherever they spend their time online, increasing the chances of engagement.
- Consistent Messaging: Consistent messaging across these platforms reinforces the trial's branding and key messages, increasing familiarity and trust among potential participants.
- Remarketing Opportunities: Users who interact with ads on any of these platforms can be retargeted with additional ads, reminding and encouraging them to take the next step toward participation.

Overall, digital market across these channels leverages advanced targeting, engagement, and measurement capabilities to effectively attract and recruit trial participants, making it a sensible strategy for reaching the desired audience for the trial. For an audience which was very specific in its interests and eligibility criteria, the ability to target those with the correct attributes (EVs/heat pumps or an interest in getting them) was made easier through the digital tools.

7.1.3 Events and conferences

The project team actively engaged with potential trial participants by attending and presenting at a range of industry events, conferences, and public-facing exhibitions, including Future Build, Installer Show and Everything Electric. Please see Figure 52. Everything Electric - Harrogate - A5 Flyerfor example marketing collateral used for these events. These in-person interactions provided valuable opportunities to directly communicate the aims of the CAMEA trial, showcase the propositions on offer, and build trust with prospective participants. It also allowed the opportunity to sign up potential participants and test their eligibility live on the day. Events with a focus on sustainability, technology, or home energy were prioritised, aligning with the target demographic of homeowners interested in low-carbon solutions. By taking stands and delivering presentations, the team was able to generate awareness, answer questions in real-time, and address any concerns or confusion about the trial process or technology involved.

This face-to-face engagement helped to humanise the trial, giving attendees a tangible understanding of what participation would entail and why their involvement mattered. Materials such as demonstration kits, visual guides, and interactive displays were used to bring the Home Energy Management System (HEMS) and bundled services to life. Conversations held at these events also provided valuable feedback that helped to shape later communications and clarify the proposition. Overall, events and conferences played an important supporting role in the broader recruitment strategy, particularly in reaching individuals who may not have been engaged through digital channels alone.

7.2 How control was communicated to customers

Control of assets was communicated to customers through a combination of onboarding materials, digital interfaces, and direct support, with clarity and transparency prioritised throughout. During onboarding, participants were provided with detailed documentation and FAQs explaining what automated asset control would involve — such as how and when their heat pumps or EV chargers might be scheduled or adjusted. Messaging focused on reassurance, emphasising that customer comfort and preferences would remain central, and that any control would operate within pre-agreed parameters set by the user. Where possible, examples of real-world scenarios (e.g., deferring EV charging by an hour) were used to contextualise the impact of automation.

In addition to written communications, digital tools like mobile apps and dashboards (as shown in section Front end user app) were used to visually reinforce how control was being applied. Participants could view scheduled activity, override automated decisions when necessary, and access historical data about how and when their devices were controlled. Customer service support via telephone and email was also available for anyone who wanted to discuss what the control might mean for them or to understand if they felt they were not receiving the benefits they expected.

7.3 How did the proposition response differ across different groups

7.3.1 Demographics – All participants

The trial group was predominantly male (86.1%) and older, with over 71% aged 56+. A large proportion were retired (60.6%), and the sample skewed toward higher household incomes, over half earn £50,000 or more annually. Education levels are high, with 74.3% holding at least a bachelor's degree.

Most participants lived in urban or suburban areas (85.3%), and in larger, owner-occupied homes: nearly 80% lived in detached or semi-detached houses, and over 80% had 3 or more bedrooms. Home ownership was very high (92.7%), with very few in rented accommodation.

Overall, the sample reflected a relatively affluent, highly educated, older, and home-owning demographic — well-suited to considering home energy technologies, though younger and lower-income groups were underrepresented. See section 7.6.2 for further details on difficulties with representation encountered by the project.

This profile was likely influenced by several factors:

- Technology ownership requirements - The trial required participants to have or install certain technologies (e.g., smart meters, heat pumps, EV chargers, or other low-carbon tech), which are more commonly found among higher-income and home-owning households.

- Recruitment channels - Participants were often recruited through channels more accessible to tech-engaged or energy-conscious individuals, which tend to correlate with higher income and education levels.
- Home ownership - Many of the trial's propositions required some level of control over the home's energy systems, making renters less eligible or willing to participate. With home ownership ages steadily rising due to higher house prices, this will have impacted the age spread of participants.
- Availability and motivation - Retired or older individuals may have had more time and interest in trial participation, particularly if they were already engaged in energy-saving behaviours or interested in new technologies.
- Risk appetite and financial resilience - Affluent participants may have been more willing to engage in a trial with variable pricing or flexible control, as the perceived financial risk or inconvenience was lower for them.
- The gender mix was similar to splits seen on previous projects but is difficult to explain. While males are stereotypically associated with interest in technology, there has been limited external research found to validate this to explain the skewed response. It is an area which will be explored in further studies.

These factors, while enabling trial delivery, contributed to a demographic skew that may limit generalisability to the broader population.

7.3.2 Demographics – Treatment vs comparison

The treatment group was older, with no participants under 46, while the comparison group included younger adults (18–45). Both groups were dominated by older age bands (56+), particularly in the treatment group.

Employment patterns reflect this: the treatment group had a higher proportion of retired participants, while the comparison group showed a more varied profile with more full-time employed and students.

Income levels in both groups skew higher, though the treatment group showed a slight concentration in the £50k–£100k range. Education levels were high in both groups, with the treatment group having a marginally greater proportion of postgraduate qualifications.

Participants in both groups mostly lived in semi-detached or detached homes that they own, with no major structural housing differences between groups. The treatment group was more concentrated in urban/suburban areas than the comparison.

7.4 Analysis of recruitment effectiveness

7.4.1 Digital advertising

Digital advertising worked well as a tool to bring high volume traffic to the landing page. META advertising targeting EV and HP owners was particularly successful in engagement and click-through rate.

Specifically, targeted META ads delivered strong performance metrics, achieving a click-through rate (CTR) of 2.59% for EV owners and 2.46% for HP owners—both significantly higher than the industry average of around 0.9%[9]. This indicates a strong relevance and resonance of the messaging with these audiences. Google Search advertising also contributed meaningfully, especially for HP-related queries, where users demonstrated active intent by seeking information on related products or services.

Despite the high volume of traffic generated through META and Google campaigns, the conversion rate from landing page views to sign-ups remained moderate. Analysis suggests that while many users were curious about the offer, some may have dropped off due to uncertainty about trial requirements or a lack of immediate perceived benefits. This suggests an opportunity to improve sign-up rates through enhanced landing page clarity, simplified messaging, or more visible benefits and testimonials.

In addition to the quantitative metrics, qualitative feedback gathered from triallists later in the project highlighted that users appreciated the straightforward design of the adverts and felt they were informative without being intrusive. Several participants recalled the ad content clearly, indicating high message retention. Going forward, similar campaigns could benefit from A/B testing different visual and more copy variants, particularly highlighting benefits such as cost savings or environmental impact, to further improve engagement and conversion performance.

7.4.2 Targeted email marketing

Targeted email campaigns to users with compatible assets were the most effective recruitment approach to achieve sign ups. This enabled the project team to reach individuals whose home technologies already met the trial requirements, making the messaging significantly more relevant and impactful. Additional personalised communications — such as SMS and phone calls — further boosted the conversion rate, as users were able to ask questions directly and gain a full understanding of the project before committing to onboard. The following Table 4 - recruitment conversion rate over time - shows how the overall conversion did improve over time. Note that 'General sign ups' refers to those people who completed the initial form on the website, 'Total Control' refers to those people who then went on to setup the ivie app and link their smart meter and 'Total Treatment' refers to those people who then signed up for the proposition itself. 'Total Trial Number' is the total of the comparison and treatment groups.

[9] https://www.wordstream.com/blog/ws/2019/11/12/facebook-ad-benchmarks

Table 4 - recruitment conversion rate over time

	End of Nov ‘24	End of Jan ‘25	End of March ‘25
General sign ups	1774	2194	2326
Total Comparison	464	588	689
Total Treatment	9	24	61
Total Trial Number	473	612	750
Overall conversion of eligible to treatment	12.5%	17.8%	28.1%

The strength of this method lay in its precision. By pre-filtering recipients based on known asset compatibility (e.g., heat pumps, EVs, smart meters), the emails avoided the common pitfall of irrelevant marketing, which often leads to low engagement. Instead, these messages could focus immediately on the benefits and next steps, which likely contributed to the higher sign-up rates observed in these segments. In several instances, participants noted that the specificity of the invitation — mentioning their devices by name — helped build confidence in the legitimacy and relevance of the opportunity.

The success of follow-up channels, such as SMS and phone calls, highlighted the importance of human contact in decision-making for technical or long-term trials. These touchpoints allowed prospective participants to raise concerns, clarify logistics, or simply feel reassured about data usage and trial expectations. Triallists who received a phone call were significantly more likely to complete onboarding compared to those who did not, suggesting that hybrid digital-personal outreach should be considered best practice for future similar recruitment efforts.

Feedback also suggested that the timing and tone of messages influenced response rates. For example, emails sent during weekday evenings had better open and click rates, likely aligning with when homeowners were available and attentive to non-work communications. Refining timing and tone further—along with leveraging personalised signposting based on user attributes—could enhance efficiency even more in future programmes.

7.5 Final recruitment results

Based on all the activity, the final recruitment outcomes can be summarised as follows:

- 2326 people signed up for interest in the trial.
- 2302 of those people could form at least part of the comparison group (have a heat pump and/or an EV charger).

- 750 people were eligible for the comparison group and have the ivie app, so their data can be seen.
- 217 people were eligible to be converted to treatment group (88 HP only, 110 EV only, 19 HP and EV).
- 61 people have converted to the treatment group (27 HP only, 30 EV only, 4 HP & EV).

Therefore, the trial total was 750 participants which included 61 in the treatment group and 689 in the comparison group.

7.6 Recruitment successes and challenges

7.6.1 Successes

The following areas were identified as successes within the recruitment process:

- Email marketing to existing ivie users proved to be a highly cost-effective recruitment channel during the early stages of the campaign in May 2024. It allowed the project to reach an already engaged audience who were familiar with the ivie ecosystem.
- Segmenting the ivie user base into groups based on asset ownership — such as heat pumps (HP), electric vehicles (EV), or both — enabled a tailored communication strategy. This personalised approach made messaging more relevant and impactful, particularly when paired with asset-specific incentives like free Homely thermostat installations for HP users.
- Messaging and creatives that led with incentives, such as cost savings or free installations, consistently performed best. These tangible benefits captured user attention and clearly communicated the value of participation.
- The use of relatable video content in META advertising significantly improved engagement. Videos allowed for more dynamic storytelling and helped build trust by demonstrating how users could benefit from the project in real-world terms.
- META ads outperformed other digital channels, successfully generating a high volume of interest registrations. Targeting capabilities within META platforms made it easier to reach users with specific assets like heat pumps and EV chargers.
- Targeting databases of users with compatible assets proved to be the most financially efficient strategy. Although the volume of traffic was lower compared to broader advertising, the conversion rates were significantly higher due to the relevance of the audience.
- Reaching out to existing customers of project partners also yielded strong results. For instance, Homely users who already had compatible heat pumps or had previously shown interest in Homely solutions were more receptive to joining the trial.
- Digital advertising in general worked well for driving traffic to the landing page. While not all traffic converted, it increased visibility and awareness of the project.

- Regular and personalised communication was key to maintaining user engagement. It helped build trust and kept potential participants informed throughout the onboarding process.
- Sending text messages to prospective participants to remind them of next steps proved especially effective. These timely nudges helped move users through the recruitment funnel and reduced drop-offs.
- There was a noticeably higher appetite for participation among heat pump owners, largely due to the generous incentives offered — specifically the free Homely smart thermostat and professional installation, worth over £500.
- Offering additional financial incentives to users with solar panels or batteries worked particularly well during the second wave of recruitment from March to June. This strategy helped attract more technically compatible participants during the spring season.

7.6.2 Challenges

The following areas were identified as challenges within the recruitment process:

- The complexity of the project created a need for extensive user communication to explain each stage of the process. Participants had to be guided through multiple steps, some of which were manual — such as completing an additional heat pump questionnaire. These manual steps often delayed further communications and created friction in the onboarding journey, making it more difficult for users to understand the process and confidently move to the next stage.
- Seasonality posed a significant challenge, particularly during the key retail period around Black Friday and Cyber Monday, extending into the Christmas season. During this time, digital advertising costs increased, and consumer attention was heavily focused on holiday shopping and promotions. These factors made recruitment efforts more expensive and less effective, reducing the overall efficiency of the campaign during a crucial window.
- Advertising through the Google Play Store and Apple Search Ads was designed to build brand familiarity and then convert users via follow-up email campaigns. While this approach had some success on a smaller scale with limited budget, attempts to scale it by significantly increasing spend did not yield proportional results. The rapid budget ramp-up contributed to inefficiencies, suggesting that gradual scaling or better optimisation would have been needed to sustain performance.
- Another challenge involved pricing strategy for the bundled energy services. Initially, the bundles offered savings of around 15% for heating and 30% for EV charging, but these figures were not compelling enough to drive higher recruitment or retain existing participants. A review and subsequent adjustment of the pricing increased the savings potential to 24% and 72% respectively, which made the offering significantly more attractive and helped improve both retention and conversion.

7.6.3 Lessons learned on the recruitment approaches

Building brand authority plays an important part in the process of recruitment for a new project. The low brand recognition of the ivie brand had an impact on overall conversions due to lack of trust and knowledge of the brand. This was also applicable to our energy supplier partner, Tomato Energy. As some users had not heard of the brands, they were hesitant to switch energy suppliers and give up their asset controls to a brand they did not know well enough.

Making communications more regular and timely through automation - improving the process of communications and automating some of the steps throughout the onboarding journey would have a positive impact on recruitment and conversion rates.

Using more messaging/personal communications sooner would have made more difference to the recruitment. Being available to chat over a Whatsapp message/SMS was particularly effective in answering questions around project complexities.

8 Trial results

The results of the project were interpreted through a number of lenses to provide useful learnings on how successful the CAMEA project had been in re-dispatching customer assets to manage costs.

To generate data that was comparable across a diverse range of users who were occupying homes of varying sizes and insulation levels, a “consumption index” was created. This index rated usage in each half-hourly settlement period as a share of total consumption over the period of available data for analysis.

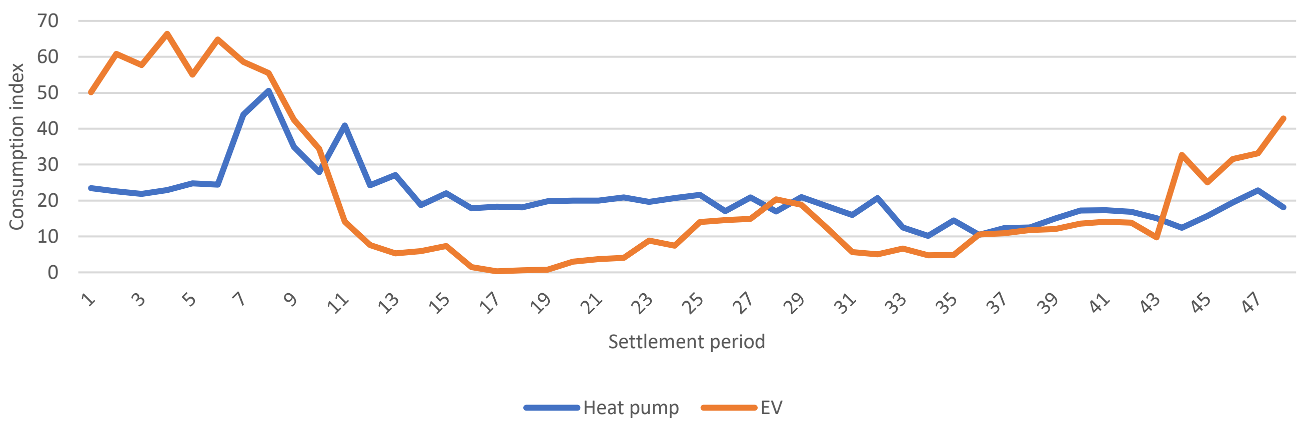
We used an index of 1,000 points to represent the total of each household’s consumption across the period they were part of the study, with these divided amongst all half-hours according to the level of consumption in that settlement period. This enabled easy comparison of consumption across households with widely differing sizes and usage levels. Throughout the remainder of the analysis, this metric was used as the principal basis for insight.

This approach allowed for level comparisons between the treatment group and comparison group, controlling for house size and building fabric, which was assumed to remain constant over the period.

8.1 Performance results from trial based on dispatch results

The overall performance in terms of moving consumption is demonstrated in Figure 15. The heat pump consumption profile is flat throughout most of the day, with higher consumption during the overnight period. The EV profile is in general low throughout the day, again being high overnight.

Figure 15. Heat pump and EV charging consumption indexes



Source: CAMEA project data

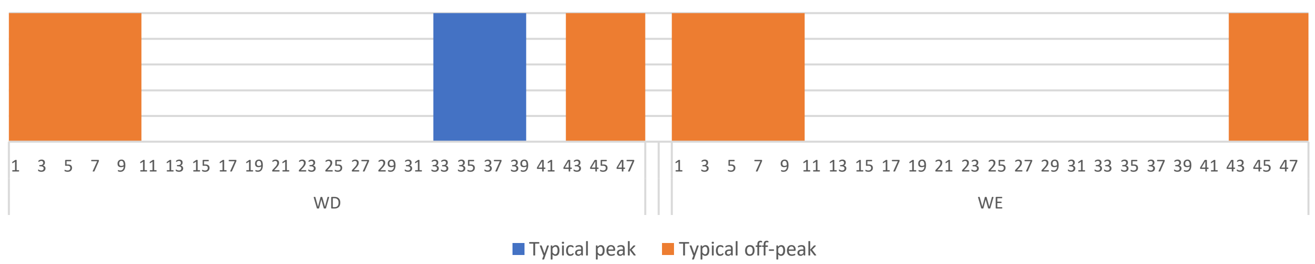
These high-level profiles provide some evidence, but conceal the detail, which will be expanded upon in the following sections.

8.2 Time based variation in response

Participants' assets were dispatched automatically, so there was no difference in responses based on participant behaviour changes. There were differences in dispatch signals sent between weekends and weekdays, due to the different prices provided by our scenarios. There was also a significant weather impact, with warmer weather offering more opportunity for heat assets to provide flexibility.

Comparing weekdays, which have sharper signals in terms of peak pricing, with weekends, we do see some areas of difference. Weekdays have an evening peak and a shoulder period throughout the day. Figure 16 shows typical peak and off-peak periods. There is also a morning wholesale peak, which is accompanied by a network charging peak in the London region only (where two users are located).

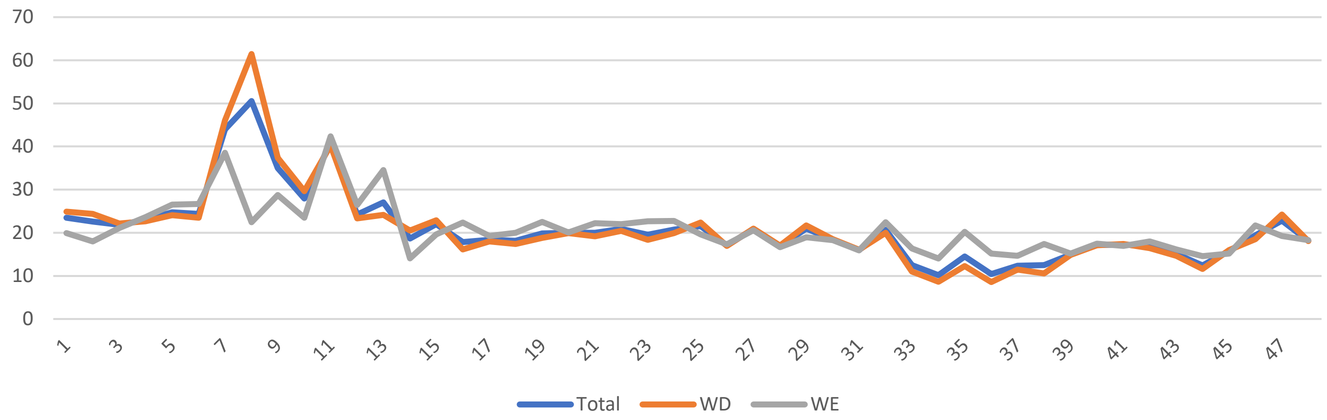
Figure 16. Weekday and weekend peak/ off-peak periods



Source: Cornwall Insight

These differing signals are reflected in different consumption patterns, as seen in Figure 17.Weekday and weekend heat pump consumption profiles Weekdays (WD) have higher overnight consumption, as power is used to mitigate consumption later in the day. There is also a noticeable dip in consumption during periods 33-38, reflecting avoidance of the evening peak. These are not visible in the weekend (WE) profile, which does not avoid either morning or evening peaks, and has consequentially lower consumption during the overnight period.

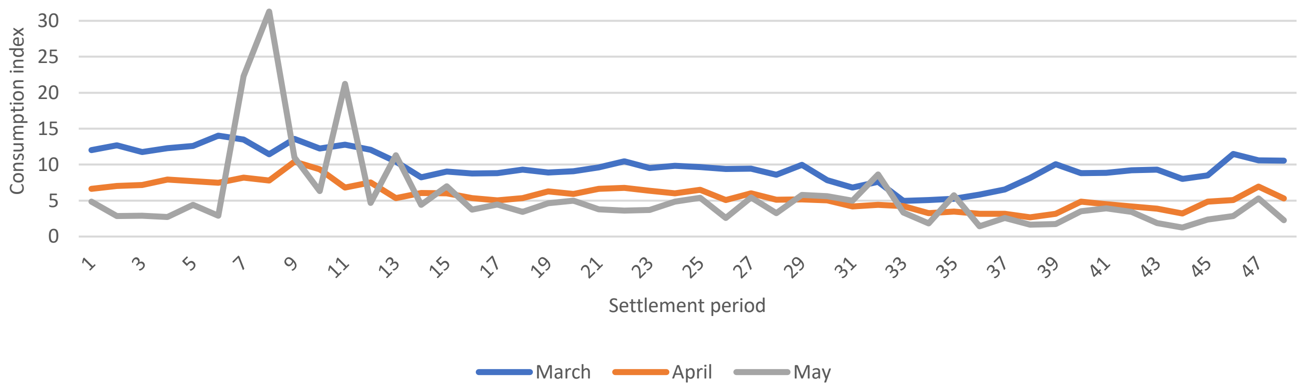
Figure 17.Weekday and weekend heat pump consumption profiles



Source: CAMEA project data

This is very clearly demonstrated in Figure 18, which presents the consumption profile by month. The total heat pump consumption volumes of the treatment group fell month-on-month, as weather conditions improved, from 6.5MWh in March to 4.2MWh in April and 2.5MWh in May. The lower consumption in May much more clearly reflects the use of flexible consumption, with high overnight consumption and relatively lower consumption during the evening peaks.

Figure 18.Heat pump consumption profile by month



Source: CAMEA project data

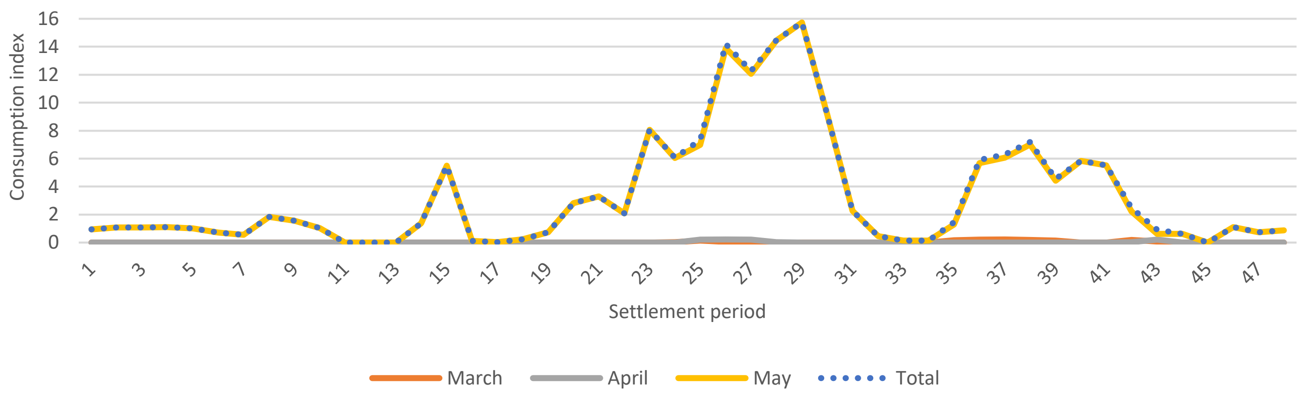
8.3 Participant engagement and responsiveness to price signals throughout the trial period

Participants' assets were dispatched automatically, so there was no difference in responses. In this sense, there was little need for the participant to engage in 'business-as-usual' responsiveness, only by exception. The key factor on participant engagement was therefore override actions taken by participants for EV charging, under a "boost" function which instructed immediate charging to be undertaken. In total, over half of the EV users boosted at least once, 53%, with a total boost over 143 periods. 7% of total volumes supplied were under the boost feature.

Boosting increased considerably in May, compared to March and April, with just under 200kWh charged under the Boost functionality in May, compared to 20kWh in March and 14kWh in April. This was 9% of volumes, compared with 3% in each of the other months.

Figure 19 shows when users chose to use boost. As might be expected, the principal uses were during the middle of the day (11am to 3pm) and early evening (6pm-9pm). Reflecting the volumes charged under boost, it should be noted that almost the entire boosted volume was in May, rather than earlier in the year.

Figure 19. Time of Use of boost feature



Source: CAMEA project data

This mostly reflects the much higher volumes in that month, due to the larger number of users in May, but also the higher number of users. While several of the new users joining in May were high users of the boost feature, no user increased their use of boost from month to month.

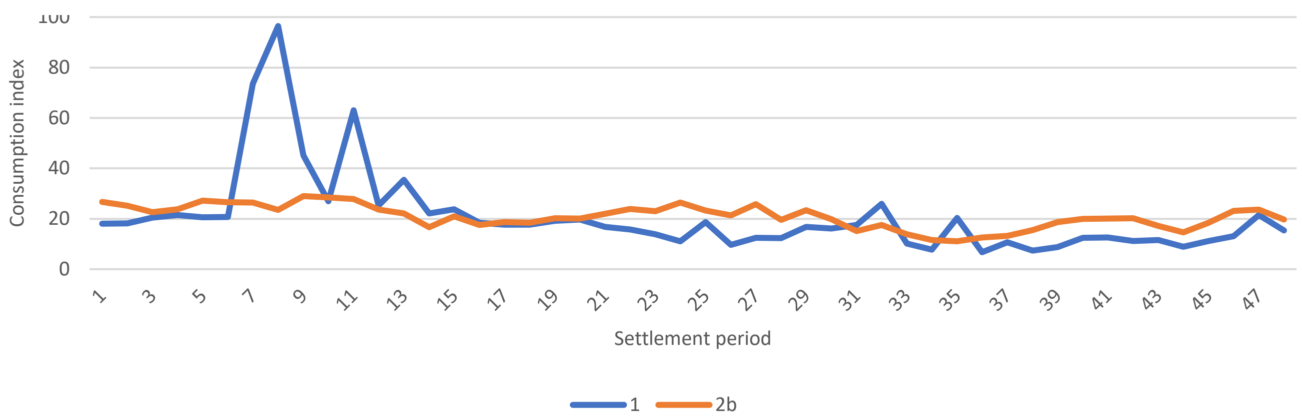
8.4 Impact of scenarios on results

CAMEA studied two different scenarios of pricing: Scenario 1, which saw wholesale and network charge variation only, and Scenario 2b, which added volatility of policy and capacity market levies. Scenario 1 was allocated 10 EV users and 10 heat pump users, while Scenario 2b was allocated 7 EV users and 17 heat pump users. These technologies have been examined separately.

8.4.1 Heat pumps

FiguresFigure 20. Heap pump consumption indexes for Scenarios 1 and 2b andFigure 21. Heap pump consumption indexes for Scenario 2b only shows the consumption indexes split out by scenario. Scenario 1 demonstrates high levels of flexibility, with high overnight consumption from the heat pumps and notable dips in consumption in the peak period, around settlement periods 33-36 (4:30-6pm). There is a spike in consumption before this, and a small spike in the middle as heat pumps are turned on to provide top-up heat where temperatures have fallen below the comfort level. Peak consumption averages are 41% below the average, and off-peak consumption is 80% above the average.

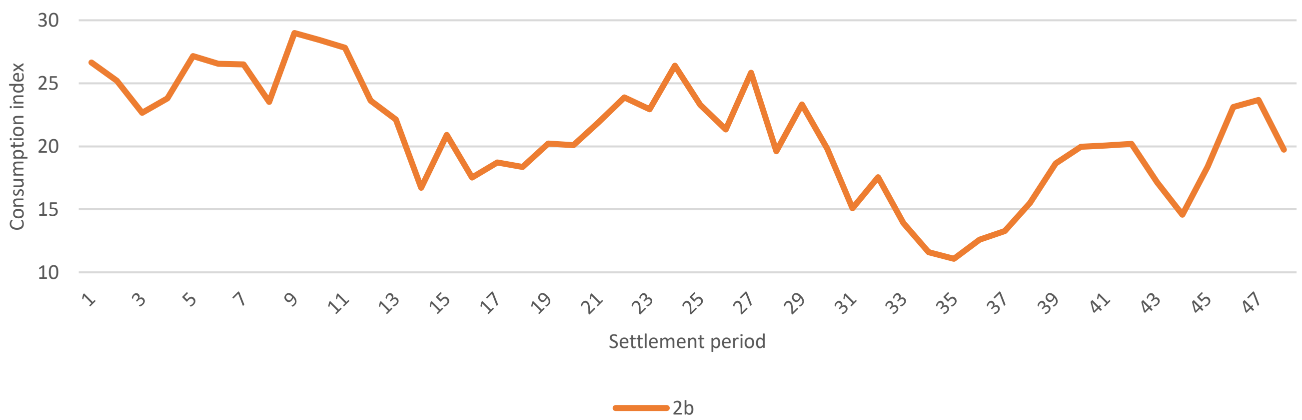
Figure 20. Heap pump consumption indexes for Scenarios 1 and 2b



Source: CAMEA project data

Scenario 2b, seen alone in Figure 21. Heap pump consumption indexes for Scenario 2b only to allow a closer view of variations across the day, does not show the same extreme variation as Scenario 1, with a relatively flat consumption of power for heat. Consumption is 32% lower than the average level, over the evening peak, where consumption would typically be expected to be higher in this period. There is also an overnight higher level of consumption, 24% higher than the average level, when consumption would be expected to be lower. There is a clear response to signals around the peak cost period.

Figure 21. Heap pump consumption indexes for Scenario 2b only

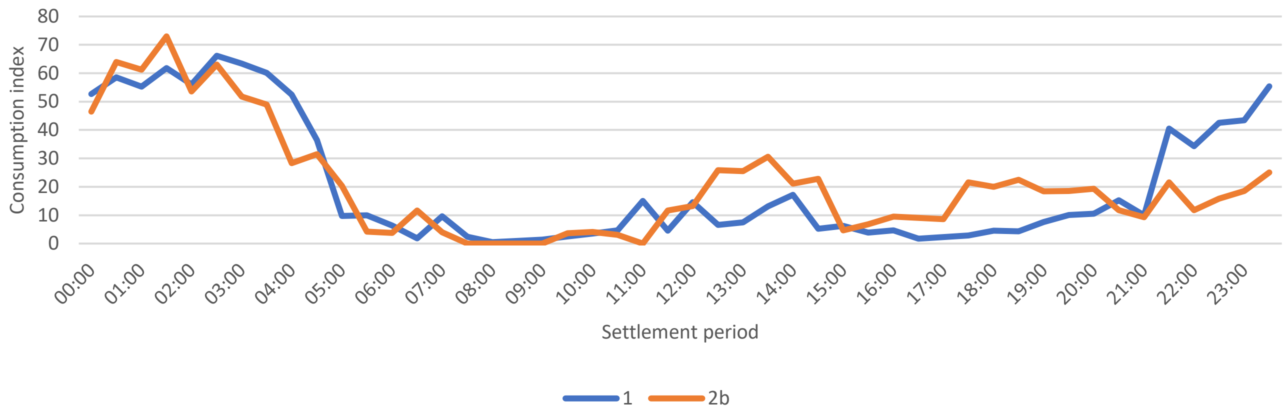


Source: CAMEA project data

8.4.2 EVs

Figure 22 shows the difference in consumption profile between Scenarios 1 and 2b. Behaviour is similar under both scenarios, though with more afternoon and evening charging under Scenario 2b. This is likely as a result of boosting by users in Scenario 2b, as shown in the following Figure 23. EV consumption indexes, Boosted charging, Scenarios 1 and 2b, though the small sample size makes it difficult to be certain. This higher boost charging under Scenario 2b results in lower evening charging than seen in Scenario 1. Both scenarios show high levels of charging overnight, during routinely low-cost periods, as expect.

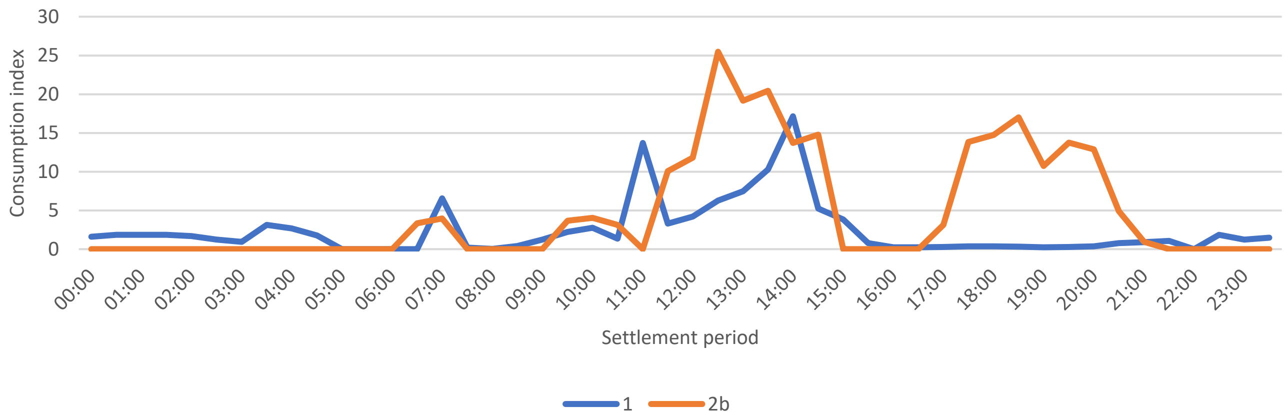
Figure 22. EV consumption indexes, Scenarios 1 and 2b



Source: CAMEA project data

Figure 23. EV consumption indexes, Boosted charging, Scenarios 1 and 2b shows the boost profiles, evidencing the increase boost consumption under Scenario 2b in the afternoon and evening.

Figure 23. EV consumption indexes, Boosted charging, Scenarios 1 and 2b



Source: CAMEA project data

9 Assessment of benefits and costs

9.1 Impact evaluation analysis of the trialled proposition

This section compares the consumption patterns of homes in the treatment groups under Scenarios 1 and 2b with those of typical system users, to show how the proposition delivered additional system flexibility. The main benchmarks used are:

- Profile Class 1 (PC1) profile, which reflects average domestic electricity usage across Great Britain, and
- comparison group, made up of highly engaged users who own various low-carbon technologies and, in many cases, actively participate in innovative energy market solutions.

9.1.1 Proposition and scenario benefits to the trial participants

The main benefit to consumers of the proposition is the fixed cost of the service which they are paying. The actual flexibility deployed benefits the supplier – allowing them to provide the proposition at a reduced cost and reduced level of risk – rather than directly providing benefits to the consumers. However, the consumer will benefit from peace of mind and, in the case of a cold winter, a reduced cost of heating. The proposition could be considered an insurance premium against the risk of a cold winter, and in general promises savings, automation, and improved comfort. Consumers are offered better energy control and overall ‘less hassle’.

9.1.2 Proposition and scenario impact on providing additional flexibility to the electricity system

On the initial basis presented discussed in previous sections, it appears that the peak-time reduction in power consumption is relatively modest, when compared to the average consumption over the period. In this section, the peak-time consumption of the treatment group is compared against the average domestic consumption profile and also the consumption of the comparison group. The deviation of the treatment group consumption patterns from these other groups provides evidence of the level of flexibility created by the proposition and the signals sent to users.

Compared to Profile Class 1

Profile Class 1 (PC1) is the standard assumption of domestic electricity consumption in GB, for standard meters. Around 2mn GB households are half-hourly settled for consumption as-of July 2025[10] – that is, settled according to their actual consumption – with over 90% settled based on this PC1 shape. There are other Profile Classes, notably PC2 (Economy 7

[10] https://statics.teams.cdn.office.net/evergreen-assets/safelinks/1/atp-safelinks.html

customers). This is less suitable for heat pump and EV connected households as it is designed only for storage-heater households.

A comparison of the indexed PC1 against the two treatment groups is presented in Figure 24, with key takeaways summarised in Table 5. Peak hours are defined as 4-7:30pm, and Off-peak as 11pm to 7am, in this table, reflecting standard assumptions and definitions. Remaining periods are “shoulder”, where prices (including wholesale, networks and time-weighted elements of policy levies) are neither exceptionally high nor low.

Figure 24: Comparison of Profile Class 1 and Treatment Group heat pump consumption indexes

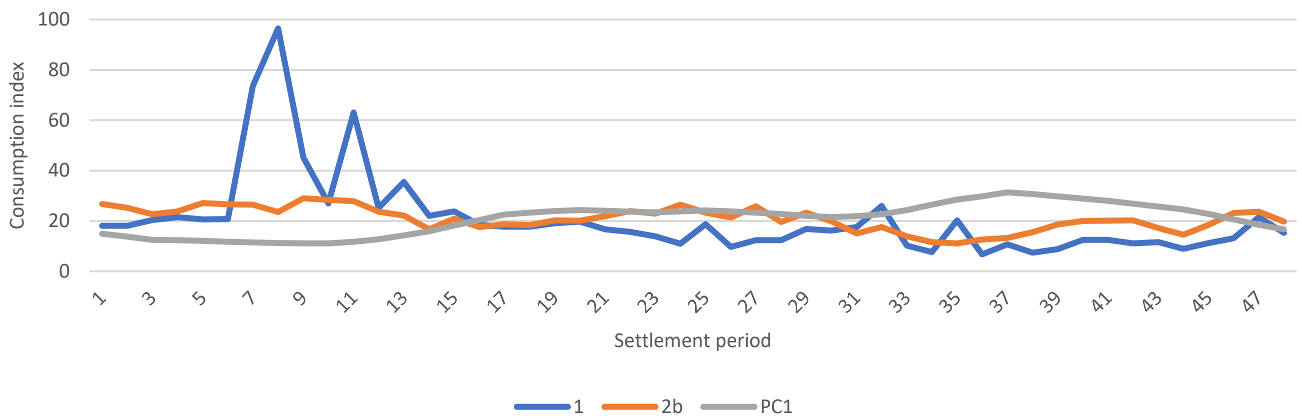


Table 5: Share of consumption in Peak and Off-peak hours, Scenarios 1 and 2b versus PC1

	Share of total hours	Total treatment	Scenario 1	Scenario 2b	PC1
Peak	15%	9%	7%	10%	20%
Off-peak	31%	43%	52%	38%	20%

Source: CAMEA project data and Elexon

This data shows that average consumption of the treatment group in the peak periods is at most half as much as the GB average, while the consumption in the Off-peak period is more than double the level. This indicates considerable success in moving consumption around the day by the project, under both scenarios, albeit with a limited sample size which has a high risk of impacting the findings.

Note that EV users have not been compared to the comparison group as PC1 does not include significant EV charging, given that PC1 is designed as a representative sample of GB domestic electricity consumption and very few households currently have EVs or at-home EV chargers. Therefore, the profiles are completely dissimilar and would provide spurious data if assessed.

Compared to the Comparison Group

The comparison group consists of 689 users who signed up to share their data with the project. 202 of these users have heat pumps and 387 have EVs.

After removing users who also had an EV, and some users who were missing some half hour whole home electricity consumption data, 47 heat pump users shared sufficient data to allow comparison. This is presented in Figure 25. As with the PC1, it is hard to get a sense of the shape of this from visual alone, so Table 6 extracts key metrics. This shows that Peak consumption is under half for Scenario 1 and under two-thirds for Scenario 2b, while Off-peak consumption is around a third higher and 10% higher respectively. The comparison group has relatively high overnight consumption, compared to the PC1 profile. Two-thirds of these users reported that they were on multi-rate tariffs, which would incentivise behaviour such as hot water production overnight.

Figure 25: Comparison of Comparison Group and Treatment Group heat pump consumption indexes

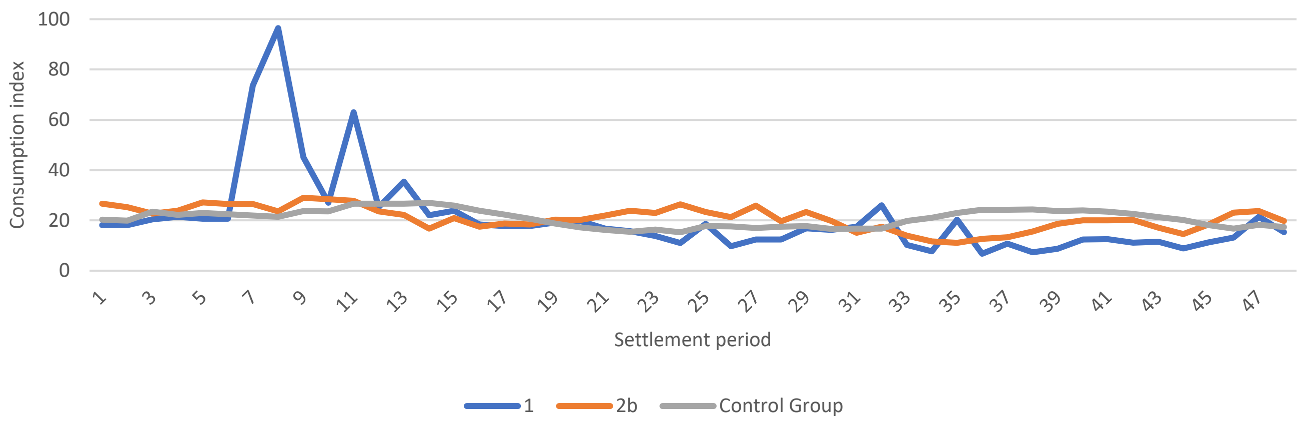


Table 6: Share of consumption in Peak and Off-peak hours, Scenarios 1 and 2b versus Comparison Group

	Share of total hours	Total treatment	Scenario 1	Scenario 2b	PC1
Peak	15%	9%	7%	10%	16%
Off-peak	31%	43%	52%	38%	34%

Source: CAMEA project data

Turning to EVs, there were 342 EV owners in the comparison group. 191 users remained after users with heat pumps and with missing data were excluded.

EV users displayed a measure of smart control in terms of charging behaviour, with significant overnight imports. Figure 26 shows the profile curves, while Table 7 provides key takeaways in terms of peak and off-peak consumption. Due to the smart control in place for many of the users – two-thirds of which are on smart tariffs – the differences are smaller between the comparison group and the treatment groups. Peak-time consumption was 12% of total, 20%

higher than Scenario 1 and 70% higher than Scenario 2b, while Off-peak consumption was the same level as Scenario 1 and 36% higher than Scenario 2b.

Figure 26: Comparison of Comparison Group and Treatment Group EV consumption indexes

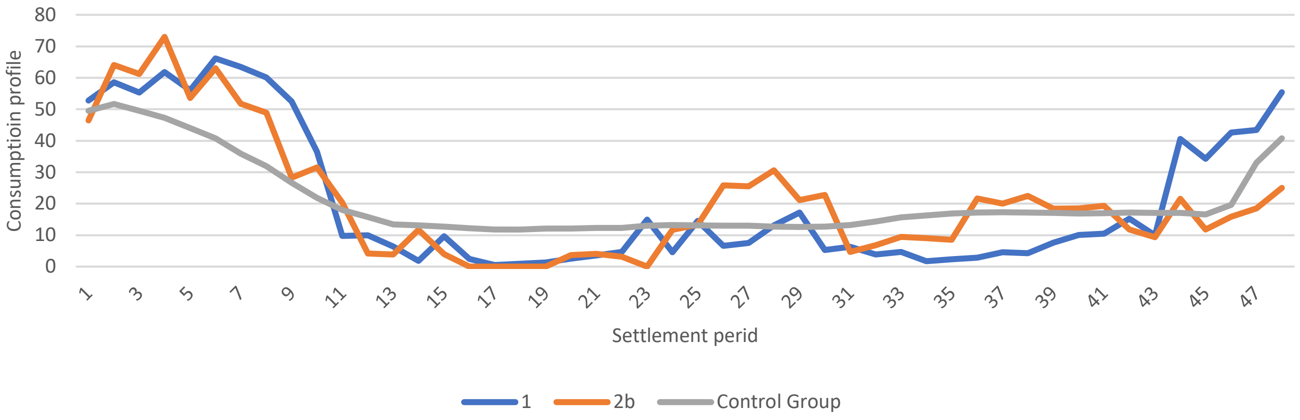


Table 7: Share of consumption in Peak and Off-peak hours, Scenarios 1 and 2b versus Comparison Group

	Share of total hours	Total treatment	Scenario 1	Scenario 2b	PC1
Peak	15%	9%	7%	10%	12%
Off-peak	31%	43%	52%	38%	52%

Source: CAMEA project data

It is noted that the comparison group readings also include other domestic consumption, which does muffle the peak/off-peak results. EV charge-point specific data was not available.

9.2 Flexibility provision impact compared to current market arrangements

An offer whereunder a supplier (or other third party) dispatches a customer's assets in the home, and offers an improved unit price for consumption, is now solidly established in the market for EVs and – to a lesser extent – heat pumps. Some tailored commercially available tariffs provide significant cost-reduction on unit-rates in return for taking a level of control of assets.

However, no heat-as-a-service or transport/ EV-charging-as- a-service offers, where a fixed monthly price is paid for the service received, are available in the current market. Creation of a new type of offer, which provides a high level of price certainty to users by transferring volume risk to the supplier, therefore may offer a new route into flexibility provision services for a type of user which is highly risk averse. This type of user may value certainty of cost and a predictable monthly bill, for example viewing this as a level of insurance against costs increasing during a very cold winter. This could be preferred by these users over a tariff which provide absolute minimum unit-rate costs, but which would result in higher costs during that cold winter.

As the supplier is taking on the risk of providing the defined service in return for the fixed payment, it is highly incentivised to manage the consumption of the devices to provide the service within or below the set budget. It will therefore look to manage costs under an avoided losses basis, rather than a profit maximisation basis, which may encourage greater flexibility to be unlocked. It will also encourage investment in the smart home and optimisation technologies which enable the maximum value and flexibility to be created.

The proposition therefore has minimal impact on the level of flexibility being created from any individual user, compared to existing flexibility dispatch services available in the market today. Potential impact on the total flexibility available across all users, by encouraging wider flexibility market engagement, is examined in the qualitative research section.

9.3 Reflections on breakdown of each price component within trial and seasonality impact

The most important regular and expected signal is network charges. The most important irregular short-term signal is wholesale charges. The impact of the policy levies is only marginal.

In terms of overall importance, the clearest signals received are from network charging, as an existing market signal, to avoid peak weekday evening consumption. Other signals tend to align with these existing market signals, reinforcing the drivers to avoid consumption during these periods. The weakest signal from this data snapshot is the variable policy levies.

9.3.1 Wholesale prices

Turning to wholesale prices, two approaches were taken during the project; during March, prices were based on a long-run hedging approach, while during April and May 2025, a short-run approach based on the actual costs Tomato energy was exposed to was used.

In March, wholesale prices ranged between 8.64p/kWh and 12.38p/kWh, with an average of 10.37p/kWh. This pattern, which was purchased nearly year-ahead, was the same each day with an off-peak, shoulder and peak element. In April and May, the more volatile wholesale prices ranged between 4.37p/kWh and 29.82p/kWh with an average of 8.54p/kWh.

Figure 27 shows the average price by settlement period – breaking out the predictable pattern in March and combining April and May, while Figure 28 shows the price for every settlement period. This highlights the predictable pattern of costs in March, while the volatility of pricing in April and May is shown.

Figure 27: Wholesale prices – average by settlement period

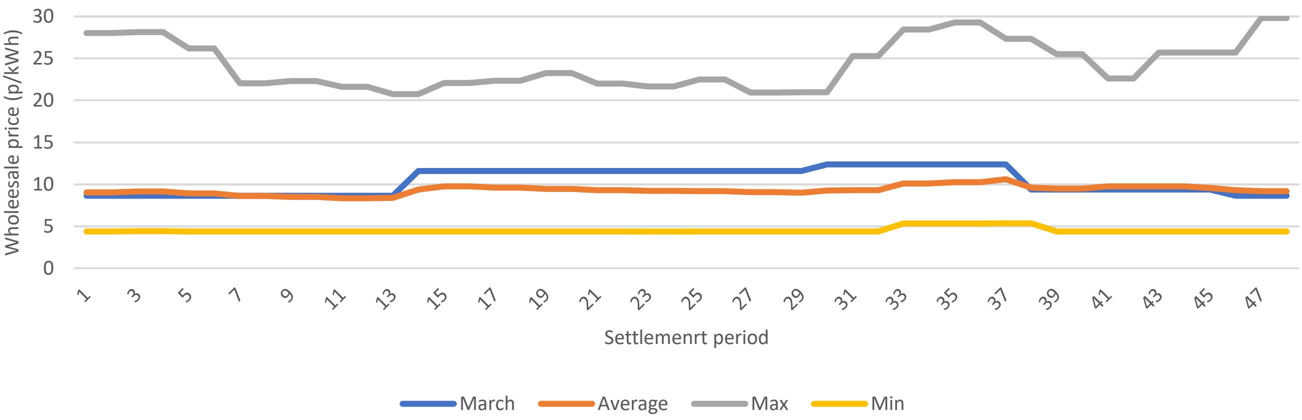
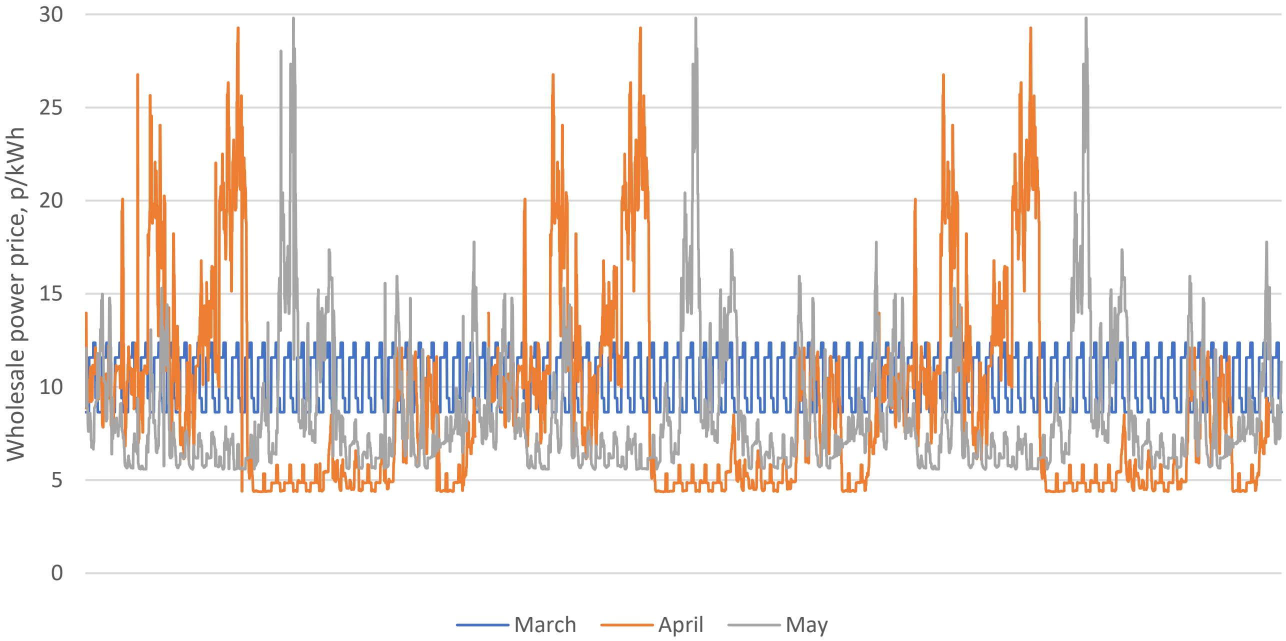


Figure 28: Wholesale prices – All periods



Source: CAMEA project data

Wholesale prices are the most material element of the cost-stack, as a single line-item and also in terms of volatility, where short-run costs (e.g., Day-Ahead Market costs) are used, as has been done by Tomato Energy in the April and May pricing.

9.3.2 Network charges

Network charges vary across the day on a regular pattern for each network region, with weekdays and weekends having different charging patterns. In Scenario 2b, DESNZ modelled stylised "regions" to reflect locational variation in charges rather than to replicate specific DNO areas. These regions were designed to test how propositions might respond under differing network and policy cost signals, with seasonal DUoS variation applied to further examine the impact of weakened or absent Red periods outside winter. As an example, charges in region

19 (South East England) are set out in Table 8. The Red band charges are two orders of magnitude higher than the green band, and nearly as great a multiple of the Amber band. This is not an unusually strong signal compared to other regions, with the range being around 20-60x higher, and provides a tremendously strong signal to avoid power consumption during Red band periods. The differential between Green and Amber period costs is much lower, and – compared to the differential to Red – is not significant.

Table 8: Region 19 (South Eastern Power Networks) domestic user volumetric charges

Period	FY 2024-25	FY 2025-26
Green – weekends, weekdays 11pm to 7am	0.244p/kWh	0.324p/kWh
Amber – weekdays 7am-3:30pm and 7-11pm	0.656p/kWh	0.719 p/kWh
Red – weekdays 4-7pm	17.480 p/kWh	20.274 p/kWh

Source: UKPN

This means, in terms of overall signals to deliver flexibility by reducing consumption during a period, the Red band presents a strong signal, but the difference between Green and Amber periods is minimal. The resulting outturn behaviour shows a dip in consumption during the Red band, but that little or no difference between Green and Amber periods is present.

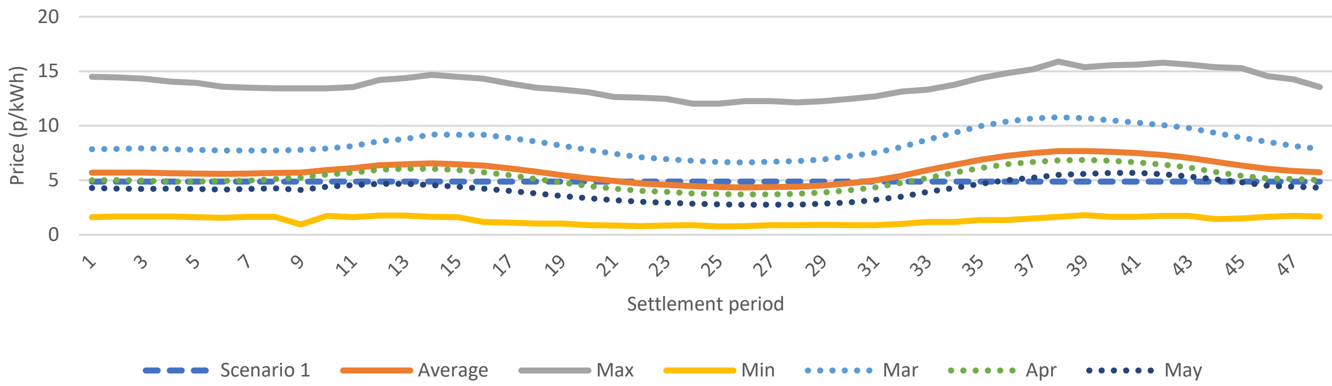
Note that DESNZ's original Scenario 2b included seasonality in volumetric charges in each of its 3 locations. This effectively "turned off" the Red band charges during spring and autumn in location 1, and during all periods other than winter (Nov-Feb) in locations 2 and 3. This was not considered useful to implement in the trial, as it would have largely prevented examination of the Red band signal as a driver of behaviour during the trial period. However, section 9.3.3 considers the difference in response between weekdays (which include a Red band) and weekend days (which do not), and therefore provides evidence on dispatch decisions related to the Red band. Findings demonstrate that the Red band is significant when deciding whether to reduce consumption during these periods.

Given the short duration of the trial and small numbers of triallists per region, the full extent of the locationally granular seasonal RAG times and rates has been difficult to prove with any certainty. Nevertheless, by comparing weekday periods with Red bands to weekends without them, the trial was able to provide evidence on the effectiveness of Red band pricing as a behavioural driver. Future research incorporating seasonal DUoS variation over a longer time period could further assess how the weakening of Red signals outside winter might limit flexibility potential, particularly in spring and autumn when heating demand is lower.

9.3.3 Policy levies

The key differentiator between Scenario 1 and Scenario 2b, policy levies providing additional volatility. Prices tend to peak in evenings, with a slightly lower peak in the morning and the very early morning. The highest price was seen on 29 March, at 6:30pm, and was 15.89p/kWh, while the lowest price was seen on 29 May at noon, at 0.76p/kWh. Charges were higher on average in March (8.40p/kWh) than April (5.21p/kWh), and lower still in May (4.15p/kWh). In May, average Scenario 2b prices were lower than Scenario 1 prices, which were flat year-round at 4.88p/kWh (note – charges are 4.87p/kWh in FY 2024-25, which includes March, and 4.89p/kWh in FY 2025-26, which includes April and May, but this is not material).

Figure 29: Comparison of Scenario 1 (flat) policy levies with Scenario 2b policy levies



Source: CAMEA project data

The single highest policy levy period saw prices at 15.89p/kWh, and the lowest at 0.76p/kWh. The first quartile was 3.52p/kWh, the second quartile was 5.37p/kWh and the third quartile was 7.83; only 11% of prices were over 10p/kWh.

Due to the time-period of signals being sent, no CM levies were collected, being allocated only from Nov-Feb under Scenario 1 and being only on the 100 lowest generation margin settlement periods, none of which occurred during the trial, under Scenario 2b. CM levies were set at a considerable level, particularly under Scenario 2b, and would have provided the strongest signal to avoid consumption in a period. However, these periods were extremely limited in duration.

While Scenario 2b introduced additional volatility through variable policy levies, the analysis indicates that their practical influence on consumer behaviour during the trial was limited. Even though the highest levy reached 15.89p/kWh, only 11% of periods exceeded 10p/kWh, and the majority of levies remained relatively low. Moreover, Capacity Market levies were not triggered during the trial period, removing a potentially strong driver of peak avoidance. This suggests that, despite the theoretical potential of policy levies to shape demand, their effectiveness in influencing automated or consumer-controlled asset dispatch under the conditions tested was marginal. Consequently, suppliers and system operators may need to consider whether levies of this scale and frequency are sufficient to meaningfully incentivise flexibility, or if alternative, more consistent price signals through network charges or wholesale price variability, offer a more reliable mechanism for behaviour change.

9.3.4 Overall findings

Comparing the different variable elements of the dispatch price, we find that under Scenario 1, the correlation between wholesale prices and the total price was 0.74, and the correlation between the network costs and the total price was 0.71. The policy levies, which were flat across the trial period, had effectively zero correlation to price, though we note that that this would not have been the case if the trial had included any periods eligible for CM levy costs (November to February).

Turning to Scenario 2b, the policy levies showed a high degree of correlation to the total cost, at 0.80, while wholesale prices had a correlation coefficient of 0.54 and network 0.56. Though, as expected, wholesale prices did tend to be high at times of high network charges, there were also extensive periods of high wholesale prices outside of the high network charge periods as well as periods where wholesale costs were low during the high network charge periods. The correlation between wholesale costs and network charges was negligible, at 0.06. The correlation between wholesale prices and levy costs was also low, at 0.12, and nearly as low between network charges and levy costs, at 0.19.

This indicates that all three elements were providing relatively unrelated signals, with the wholesale and network charging elements most important to dispatch signals sent to users under Scenario 1, and the levy costs being the most important under Scenario 2b.

9.4 How able are trial participants to respond accurately to signals?

As already stated in this document, this proposition is based on automation in terms of responding to price signals. The previous sub-section 8.3 reflects upon each component in the pricing structure to assess the degrees of magnitude each component has in terms of flexibility response. However, it is possible for trialists to override automation, and so participant behaviour also has a part to play. The intention was that the trialist would have no reason to override the automation as they will have set their preferences and schedules as a one-off at the onboarding stage. As discussed in Section 4, when designing the tariff, the project team decided against any additional charges or implications for ‘boosting’ i.e. overriding automation for EV charging or heating. This was for reasons of simplicity and to not be a reason for putting people off taking the tariff. Commercial success was based off minimal override that would negate any value otherwise created by flexibility and so ‘boosting’ was one of the things that was monitored throughout the project through data collection and consumer research.

Section 8.4.2 discusses that the effect of a relatively high level of boosting for EV charging in the early evening among some participants. This was seen particularly with the final batch of trialists joining at the beginning of May. Due to the finish date of the project, it was not possible to fully discover why this came about. A theory is that a significant number of the later trialists were new to EV charging and automation systems and may not have fully understood or possibly trusted the scheduling functionality made available to them in the ivie app. Based on an assumption of returning home from work in the early evening, it looks as though these trialists then manually started charging at that point. Some of the findings in section 11 support this theory, including firstly subsection 11.2.7. Secondly, and potentially most importantly for someone new to EV charging, section 11.2.4 discusses this subject in detail. It may have been with a level of guidance that over time we would have seen less boosting from this group. Furthermore, the fact the solution had limited functionality in terms of updating users during a charging session may also have contributed to this behaviour. This is discussed in more detail in sections 11.2.6 and 11.2.5.

Section 8.4.1 analyses the consumption index for heat pumps. There was less of an obvious effect of trial participants overriding automation for heat pumps compared to heat pumps. It seems trialists were comfortable with heating and hot water schedules and in general it gave them the comfort levels they desired. In a few cases, we know from consumer research (see 11.2.5) that boosting was occurring where the scheduled set point had not been met.

The conclusion is then that overall, while the trial proposition did not rely on trial participant behaviour to respond to price signals, it did require them not to override the automation that did reply to the price signals. There were several learnings to be had here, some successes and some improvements the project would have considered if the trial had continued for a longer period.

9.5 Potential opportunities in ESO/DSO revenue streams

Although the CAMEA project did not actively participate in ESO or DSO dispatch services, there is future potential for integration. ESO services are non-locational and typically require large volumes of flexibility, meaning individual households must be aggregated to meet entry thresholds. Some ESO services—such as the Balancing Mechanism—require real-time response, which is not compatible with heat pumps due to comfort concerns, but may suit EV charging. Other ESO services like Balancing Reserve and Dynamic Frequency Response (e.g. Containment and Regulation) are procured on a day-ahead basis in 4-hour blocks. Both EVs and heat pumps could potentially deliver these services, though it may conflict with household routines. These services are often delivered via portfolios that account for non-performance risk.

In contrast, DSO services are location-specific and typically require smaller volumes, making them more accessible to individual assets. Most DSOs procure flexibility on a six-month to two-year basis, though shorter-term procurement is expected as the market matures. Peak Reduction and Scheduled Utilisation services, which involve reducing demand at set times, are highly suitable for both EVs and heat pumps. Real-time Operational Utilisation services are less compatible with heat pumps but may suit EVs. More advanced DSO services—such as Scheduled or Variable Availability paired with Operational Utilisation—demand consistent availability and are generally unsuitable for heat pumps, but may be viable for managed EV charging.

9.6 Proposition potential to meet the costs of running the electricity generation, transmission and distribution infrastructure in full

There is a level of concern in cost-recovery of the costs of the system, when implementing high levels of flexible power consumption. This is not a concern for the wholesale market, which is a highly dynamic structure set up to deliver price discovery for variable volumes of generation and consumption. However, for network charges and, under Scenario 2b, for policy and capacity market levies, this is a concern.

It is noted that this is not an additional risk of the CAMEA proposition or indeed any particular implementation of higher levels of consumer flexibility, but a more general issue around demand-side flexibility compared to fixed cost-recovery processes.

9.6.1 Network charges

The cost recovery structure for network charges relies on assumptions around when customers consume power to drive recovery. These assumptions do not regularly change and network charge setting is not a dynamic process.

History has shown that when users are able to consistently avoid an element of network charges, regulatory reform was required to re-format these charges in order to ensure that costs are fairly recovered from users. As an example, the Triad element of the TNUoS charge was reformed in April 2022 to reduce time-of-use signals and increase fixed-price signals, due to the level of Triad avoidance which was occurring and the impact this was having on consumers which were not able to flex consumption.[11]

It is therefore expected that network charges, particularly at the distribution level, may need to be reformed if consumers are able to routinely avoid large amounts of network charges. Reforming charges to a more dynamic model is beyond the scope of this project, but finding a way to ensure that users pay a fair level of charges to reflect the costs which they impose on the system, while continuing to offer some value to avoiding peak consumption times, will be important to protecting network cost recovery.

9.6.2 Policy and capacity market levies

Under Scenario 1, capacity market levies are recovered from all users only during winter evening peaks (November to February, 4-7pm, weekdays). This is the current process for half-hourly settled consumers, which will include all domestic consumers following the completion of the marketwide half-hourly settlement programme currently expected in May 2027. The CM levy is a strong signal to minimise consumption during these periods.

CM levies are slightly different from other time-of-use costs in that reducing peak consumption should reduce the need for CM assets, and therefore reduce spend on the CM and

[11] https://www.ofgem.gov.uk/sites/default/files/2022-03/CMP343%20Decision.pdf

consequently the levy which must be recovered. This renders CM levy recovery a lesser issue compared to network charges and Scenario 2b levy recovery.

Under Scenario 2b, policy levies (the costs of the Feed-in Tariff, Renewables Obligation and Contracts for Difference scheme) are shifted. The current practice is to recover these at a flat rate from all power consumption; the revised process would be to tie this to grid carbon intensity, with charges higher during settlement periods of carbon intensity. This makes recovering the total levy required to make payments to subsidised generators relatively uncertain, if large amounts of consumption are shifted to low-carbon times.

The CM levy recovery is also shifted, to across only 200 half-hours in the year (1.14% of periods). This makes CM levies even more easy to avoid, and hence less likely to be recovered in full. However, this also enhances the potential fall in CM requirements and costs, which may balance the national position here.

As with network charge reform, balancing the provision of value to consumers who are able to offer flexibility, while also ensuring that the costs of the system are recovered and consumers who are not able to offer flexibility are protected, is a delicate balancing act with the potential for cost to rise considerably.

9.7 How did the proposition's success differ between different consumer segments

9.7.1 Segmentation by asset ownership

The main break down for consumer segments when assessing the proposition's success is whether the consumer has a compatible EV, a compatible heat pump or both. As already detailed in section Recruitment and section Trial methodology, the focus was to ensure there were at least 30 consumers able to take at least the EV bundle and at least 30 consumers able to take at least the heating bundle, ideally roughly equally distributed across the 3 consumer segments.

To take each consumer segment in turn and evaluate the proposition's success for each independently, firstly examining the EV group this was the most challenging for recruitment. Although this was the most represented group in terms of interest in the trial and within the comparison group, they had the lowest conversion rate to the treatment group. This was partially down to the fact that most of this group were already on an EV tariff, and it was hard for the proposition offered as part of the trial to compete and be significantly better to get people to switch energy supplier. There was also a challenge that compatibility rates with the solution were also significantly worse than for the heat pump group, as the solution only covered a relatively small number of EV charger manufacturers. Using early learnings from the project, these challenges were overcome by firstly targeting new EV owners who may have only recently had a charger installed and had not yet switched to a specific EV tariff. Also, to extend the scope of the solution to also allow certain EV manufacturers to be compatible regardless of charger by being able to communicate directly with the vehicle in addition to compatible chargers. Based on these statements, the solution could be deemed less successful than for the heat pump group from a consumer point of view. However, from a commercial viewpoint, the proposition had greater success with this group as consumers often significantly underused against their bundle.

Next, considering the heat pump group, they made up less of the comparison group, which likely reflects there being less people with heat pumps than EV's. The conversion rate to the treatment group was better than for the EV only group due to there being less competition currently in the heat pump tariff market and that HP compatibility rates for the proposition being higher than for the EV group. Consumer feedback was also generally more positive for this group than for the EV group where most HP users said Homely kept their homes at a consistent temperature — often warmer and more comfortable than they had ever experienced (see section 11.2.5). From a consumer point of view, it is reasonable to conclude that the proposition was more successful for the heat pump group than the EV group based on the details given in this section. The converse is true from the commercial point of view due to the high volatility between actual heat pump usage and the predicted usage the bundles were costed on. This puts a level of risk on the supplier that is currently too high to be able to launch this part of the proposition. For several customers, the supplier made a significant loss. The accuracy of the model would need to be improved to substantially reduce volatility for the proposition to be seen as a success from the supplier point of view for the heat pump group.

From amongst the assessed cohort of heat pump comparison users, a greater level of peak-time demand reduction was recorded for those with detached properties than terraced properties. Under Scenario 1, detached properties within this cohort recorded a 39% lower indexed consumption over peak periods, compared to the expected PC1 share of demand in these periods. This was largely aligned (-2pp) with the full-cohort average for assessed comparison-group heat pump properties. Whilst the terraced houses within this group recorded a 20% average reduction against typical demand levels, this was approximately half the level seen for amongst detached properties. Whilst a similar trend was observed amongst the Scenario 2b cohort, the difference was less pronounced, with peak time reduction amongst the terraced group only -4pp versus the detached property group. This suggests that, although still benefiting from the proposition, those customers within the terraced property segment saw less impact that those in detached segment. It should be noted, however, that these findings are based on very low sample sizes and treated with due caution.

The final group to consider are the people with both an EV and heat pump. For this group the success of the proposition can be broken down to the individual EV charging and heat bundles that have already been discussed in this section for the consumers taking these bundles individually. One specific element for this group in relation to the success of the proposition, is that there were several consumers who had both an EV and a heat pump, where only 1 of the assets were compatible with the solution and the other was not. That meant the other asset automatically fell in the 'everything else' usage that was considerably more expensive than taking the bundle. This led to the conversion rate for this group to be the worst of the 3 groups.

9.7.2 Further comment on consumer segmentation

92% of users who reported stated that they owned their properties, including 45% who owned outright without a mortgage. The average pre-tax annual income of those who reported was £60,000, versus a national average of £43,000. Looking at the comparison group members, most of these were owner-occupiers of their homes, with only a single rental member.

Due to the nature of the proposition – which required users to have an EV or heat pump – resulted in most trial participants being relatively affluent sections of the community, who have the financial resources to invest in these new and high-cost technologies. CAMEA originally intended to support investment in heat pumps and EV chargers, which may have supported participation among less-affluent consumers, but this proved impractical within the timelines of the trial period and was not pursued.

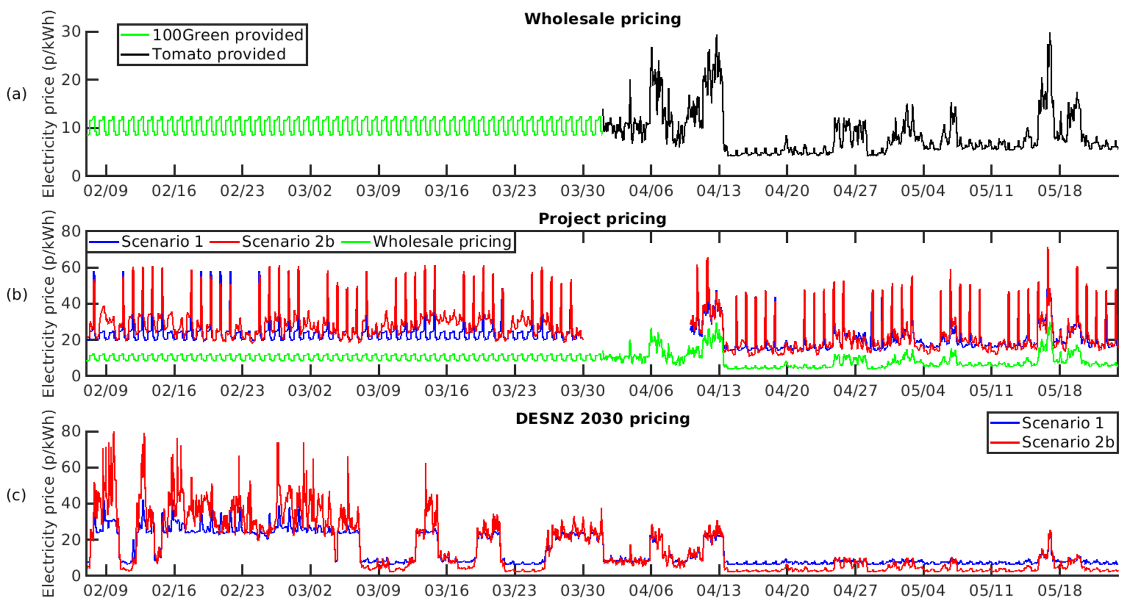
We did not collect data on whether consumers were (or considered themselves to be) fuel poor, but given the above considerations, we do not expect that this was the case for any consumers. Collection of this data would be a consideration in any future work. CAMEA would also consider seeking a partnership with a social landlord with an existing or planned heat pump fleet in order to test the proposition with their tenants.

10 Comparison of project pricing against DESNZ 2030 price profiles

In section 5.4, there was an explanation as to the project's approach to the DESNZ 2030 hypothetical price profiles. Here, a justification was given for applying a formula to translate the pricing for the chosen scenarios to make it more applicable to the trial period as opposed to using the raw hypothetical values supplied by DESNZ. The section also explained that the project would complete a modelling exercise to show how outcomes might differ when optimisations associated with the proposition tested are run using project pricing versus the DESNZ 2030 price profiles. This section provides details of the modelling exercise completed and an analysis of the results.

The focus of this section's analysis is the period of April and May 2025. Only 4 months of trial data (February to May) were available for analysis due to the delays in getting full treatment groups and completing the integrations after the energy supplier change. While the approach to creating the network charges and levies parts of the price signals was consistent throughout, due to a change of energy supplier partner, the approach to the wholesale prices differed from the February-March period to April-May period as described in Section 5.4. Figure 30 below provides a visual representation of this:

Figure 30 - Comparison of wholesale prices – a) Wholesale pricing was provided by 100Green (green) and Tomato Energy (black) respectively. b) A comparison of project pricing in scenario 1 and 2b over the complete period. c) A comparison of DESNZ 2030 pricing in scenario 1 and 2b over the trial period.



(a) 100Green's wholesale pricing data was used to calculate the project pricing for the initial period (February-March), whilst Tomato's pricing was used April onwards.

(b) The wholesale component of the project pricing is plotted in green, and aligns with part (a) of the figure. Note that project pricing data is missing for all homes from the 30th March – 10th April. This was caused when the wholesale prices were updated to cover April to June, and an issue occurred in the interface, meaning project price signals were not sent for this period. There are also some small data gaps in the project pricing in the trial extension period caused by a system update requirement based on the transition to wholesale prices provided by Tomato for the final stages of the project.

As shown in Figure 30 a, the wholesale pricing data provided by 100Green was very different to the data provided by Tomato Energy. This is due to contrasting hedging strategies, where Tomato's wholesale pricing used a mixed strategy, with some electricity bought on short-term on day-ahead and intraday markets, whilst 100Green provided a full year forecast of wholesale pricings in April 2024, reflecting what they would buy in long-term markets. Hence, the last quarter (January-March 2025) of wholesale data provided by 100Green repeats daily, whilst the wholesale data provided by Tomato has higher interday and intraday variability.

This results in the new wholesale pricing contributing to a larger proportion of the variability of the overall project pricing, as seen in Figure 30 (b). Hence, the incentivised behaviour is different in the April onwards than the earlier trial period. The daily pattern in the project pricing is less repetitive in April-May than in February-March in both scenarios, although the 4-7pm peak is still present every weekday.

As can be observed by comparing Figure 30 (b) and Figure 30 (c), the DESNZ 2030 pricing is much cheaper than the project pricing in the extended project timeframe for both scenarios. Scenarios 1 and 2b are also similar to each other in the project pricing, whereas, in the DESNZ 2030 pricing from mid-April onwards, Scenario 2b pricing is typically cheaper.

10.1 Modelling simulations

For the final report, the main focus of analysis has been given to the April-May period that uses wholesale pricing using a more sophisticated hedging strategy that is most appropriate to the proposition. The details of the modelling setup and methodology are described below:

- General
  - Passiv optimised controls were assumed to be in charge of all assets.
- House & Heating
  - House thermal dynamics were randomised in line with Passiv's experience of typical 3 bed detached houses. The same sampled parameters were then used for each scenario, such that only one aspect changes at once.
  - The house was assumed to have average insulation, when compared to a distribution of heat loss parameters (defined by HLP = HTC/floor area) observed in real homes.

- The heat pump was sized such that it was able to heat the house (to the desired room temperatures, at least).
- The simulations include both space heating and domestic hot water production.
- Radiators were assumed to be upgraded as required for use with a heat pump.
- Householders' setpoint was 21°C and schedules were assumed to remain constant throughout the simulation period.
- The heating schedules were either Morning/Evening (07-09:00 & 19-22:30) or Evening (19-22:30).

- Tariff
  - For DESNZ 2030 pricing, we used equivalent 2030 pricing for the same month that was simulated (February 7th to March 7th).
  - For project pricing, we used price data and location data from real trial participants.
  - Standing charges are not included. It was assumed there was no export tariff.
- Weather
  - The locations used for weather data were chosen to align with the tariff data:
  - DESNZ 2030 Location 1 (high demand) and its project pricing equivalent (South Eastern England DNO area) were mapped to Kenley weather station.
  - East Midlands project pricing was mapped to Waddington weather station.
  - Real weather data (irradiation and external temperatures) from the trial period was simulated.
- Baseload & Hot Water
  - The Passiv model bases the levels of hot water consumption and baseload electricity demand on the size of house and number of occupants living in the house.
  - The house was assumed to be occupied by a family.
  - A hot water draw profile was generated for each archetype using Passiv's hot water draw profile model (which uses monitoring data from real homes together with assumptions from SAP).
  - Baseload electricity usage (i.e. other than heating/hot water/battery/EV, from appliances in the home) has been estimated using Passiv's baseload model, based on data from the Household Electricity Survey, the floor area and the number of occupants.
- Solar PV
  - Solar panels were sized as 3kWp, and assumed to be south facing, with a tilt of 30°.
- Electric vehicle

    - Assumed to have a capacity of 40kWh and an efficiency of 3.5miles/kWh.
    - Assumed to be plugged in between 18:30-06:30 each night.
    - Assumed be used every day with a constant daily mileage (totalling 8000 miles annually).
- Battery
    - The battery was assumed to have a capacity of 5kWh, a maximum charge rate of 2.5kW, and a maximum discharge rate of 2.5kW.

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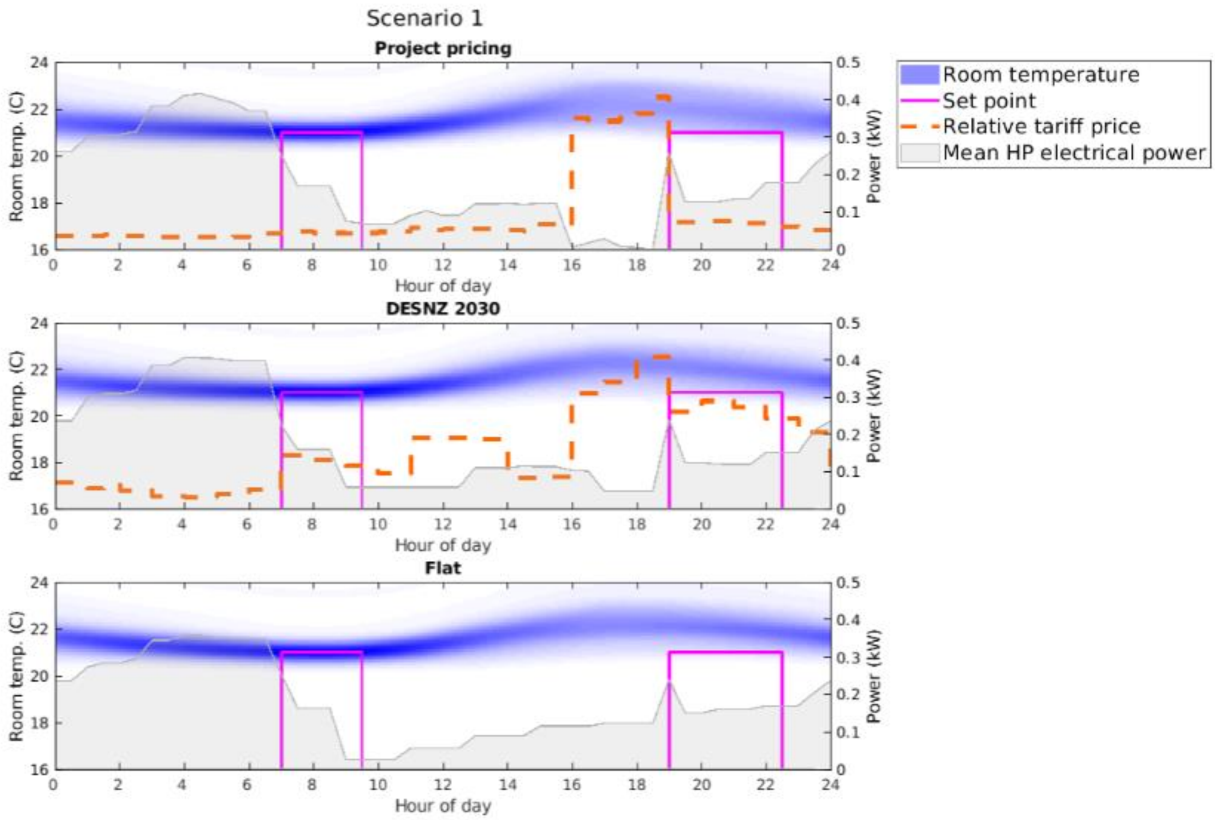
The approach is based on background IP from Passiv who had undertaken extensive quality assurance on the approach before utilising the approach in this project.

10.1.1 Heat pump optimisation

The output of the model is detailed in this section, where the base case of heat pump only i.e. no solar, batter or EV is considered. The model was run 6 times with project pricing, DESNZ 2030 pricing and a flat tariff for both Scenarios 1 and 2.

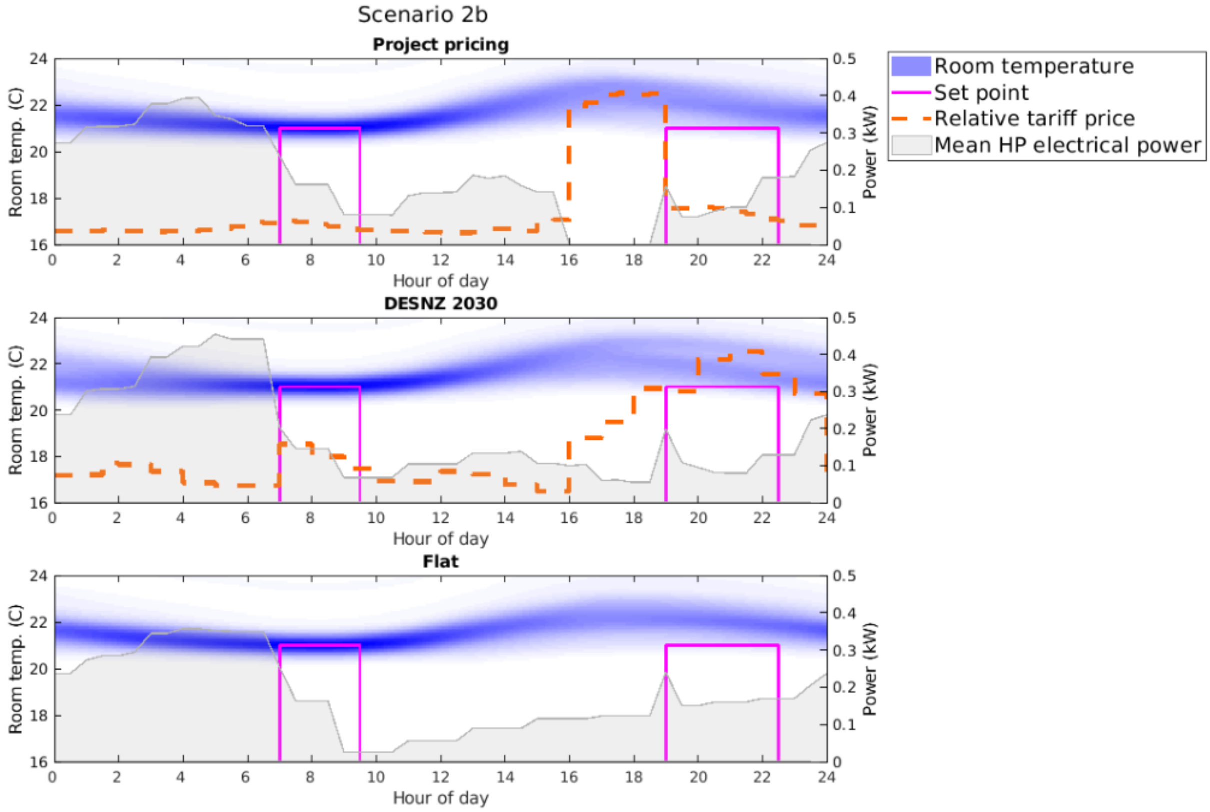
Firstly looking at Scenario 1, Figure 31 below shows the mean electrical powers and shape of price signals on weekdays for the extended project period (April onwards), and the corresponding set points and room temperatures achieved when optimising to project price signals, DESNZ 2030 price signals and a flat tariff in Scenario 1.

Figure 31 - Mean electrical powers and shape of price signals on weekdays for Scenario 1



Secondly, looking at Scenario 2b, Figure 32 below shows the mean electrical powers and shape of price signals on weekdays for the extended project period (April onwards), and the corresponding set points and room temperatures achieved when optimising to project price signals, DESNZ 2030 price signals and a flat tariff in Scenario 2b.

Figure 32 - Mean electrical powers and shape of price signals on weekdays for Scenario 2b



Despite the wholesale pricing having high interday and intraday variability, the higher costs during the 4-7pm local time peak remain an incentive to deter peak time usage, as observed in Figure 31 and Figure 32. Due to the lower heating requirements in April and May, in both scenario 1 and 2b the heat pump is able to almost entirely avoid running during peak tariff periods.

Comparing Figure 31 and Figure 32 shows only relatively minor differences in average consumption profiles between scenarios when optimising to either DESNZ pricing or project pricing.

Due to the highly variable wholesale component of the pricing, shifting away from the peak wholesale prices is rewarded. However, due to the high interday variability of the wholesale pricing, this does not result in a repeated pattern of load shifting at the same hours of each day.

10.1.2 Multi-asset optimisation

This section shows the output of the model, where we are just considering a home also with solar and battery. Again, the model is run 6 times with project pricing, DESNZ 2030 pricing and a flat tariff for both scenarios 1 and 2

Firstly, looking at Scenario 1, Figure 33 below shows an example usage profile of a home with solar PV, battery and a heat pump in a typical 2-day period in April, when optimised to the project price signals and DESNZ 2030 price signals in Scenario 2b, and to Intelligent Octopus Go.

Figure 33 - Example usage profile of a home with solar PV, battery and a heat pump in a typical 2-day period in April

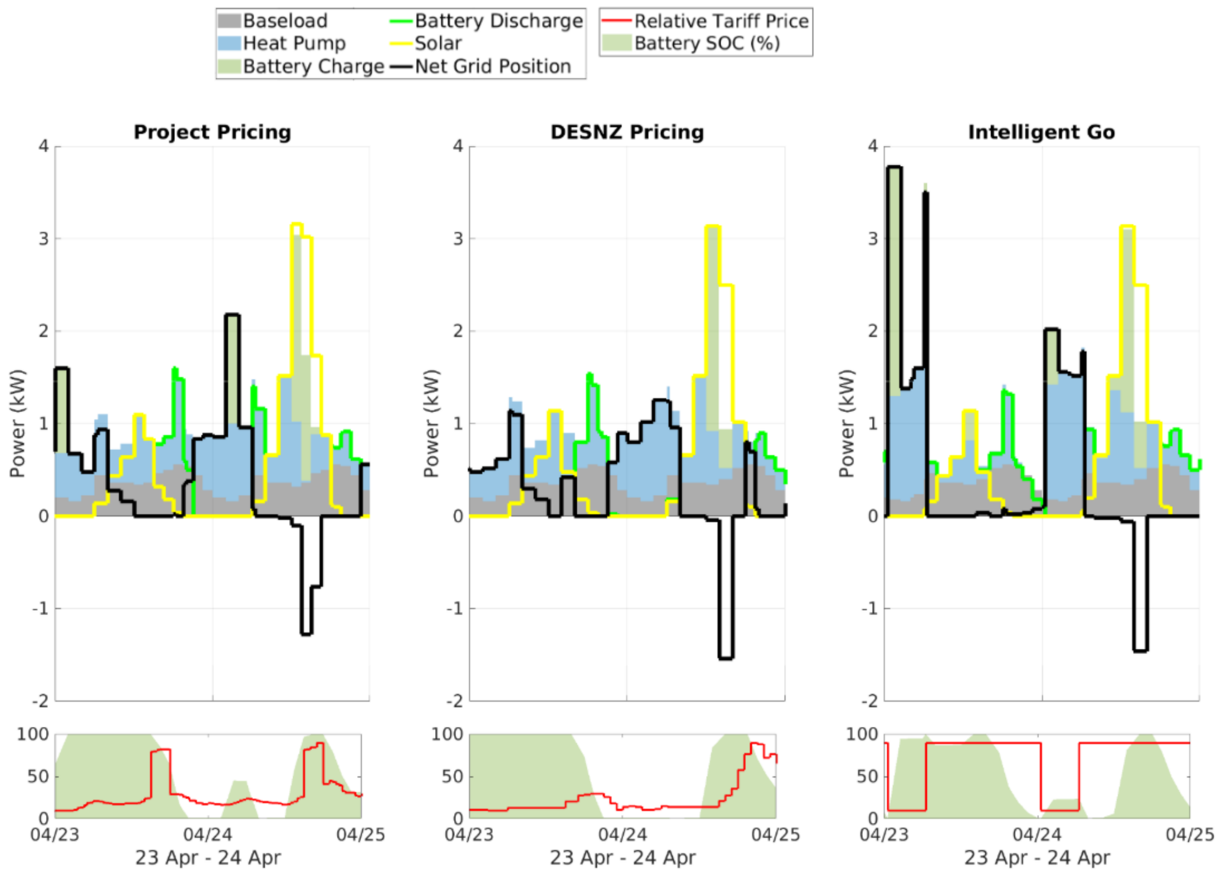
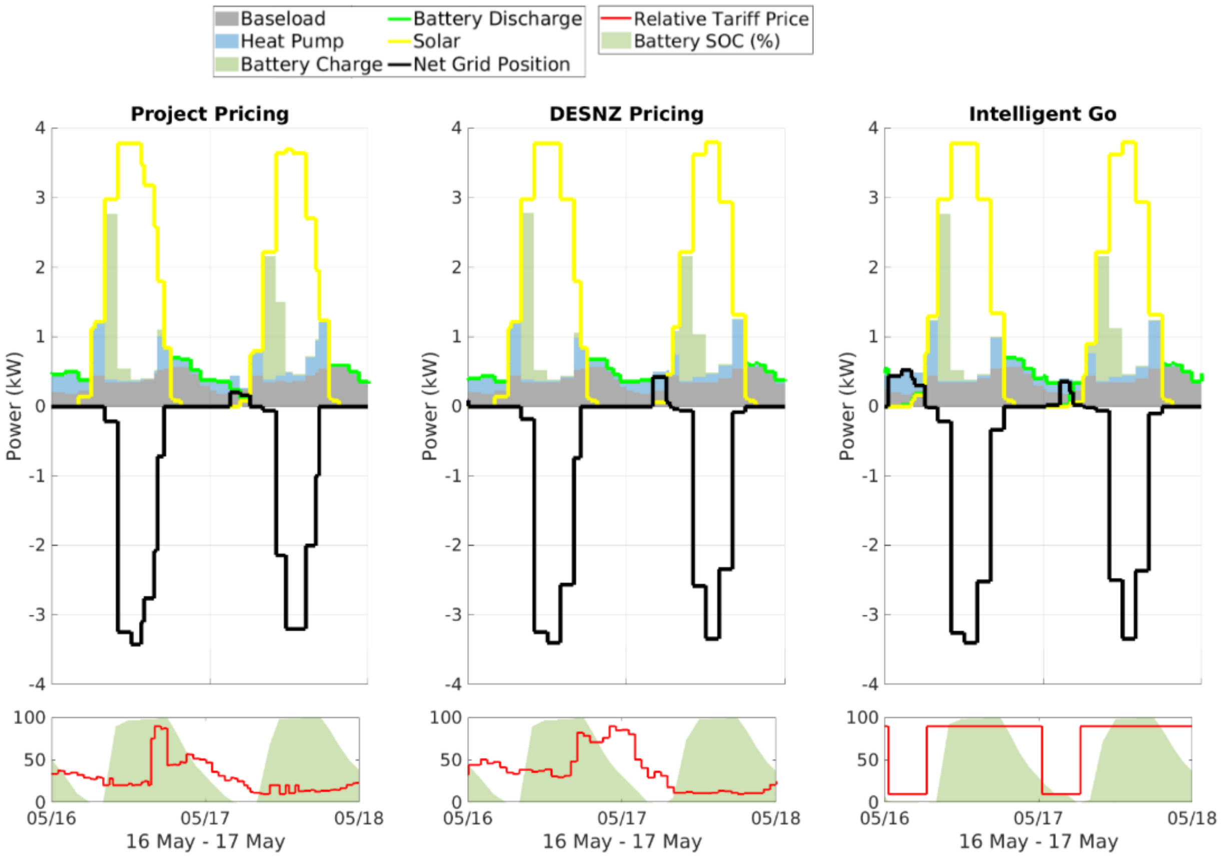


Figure 33 shows that the behaviour is quite similar between the DESNZ and project pricing. As before, the project pricing will attempt to avoid importing during the 4-7pm peak. Whereas, on the second day in the DESNZ pricing case, it is optimal to import during this period and hold charge in the battery until later in the evening, to avoid the higher late evening price signal. Here, in all cases, some of the load is exported in the second evening, as there has been high solar generation and there is insufficient spare capacity in the battery to store it all.

Firstly looking at Scenario 2, Figure 34 below shows an example usage profile of a home with solar PV, battery and a heat pump in a 2-day period with high solar generation, when optimised to the project price signals and DESNZ 2030 price signals in Scenario 2b, and to Intelligent Octopus Go.

Figure 34 - Example usage profile of a home with solar PV, battery and a heat pump in a 2-day period with high solar generation



Occasionally, when solar generation is high and heat pump usage is low, the home can almost entirely avoid importing, as seen in Figure 34. Here, the battery will fully charge via the free solar, and discharge throughout the evening and overnight. If small amounts of additional import are needed, they will be timed such that it is at the minimal import rate of the tariff. The majority of solar is exported in this case, as there's insufficient baseload, heating and hot water demands to fully utilise the solar, and the battery is using its full capacity.

The differences in optimal behaviour between scenarios 1 and 2b are reduced with high variability of wholesale pricing. This component of the project price signal is a key driver of the load shifting, although the wholesale variability does not occur at a consistent time each day. There is a recurrent daily pattern of load shifting at the 4-7pm peak, which is not always present in the DESNZ pricing.

11 Participant research

As energy systems become smarter, consumer trust, clarity, and ease of use are key to enabling widespread adoption of flexibility services. For consumers to confidently participate by shifting or reducing energy use in response to signals, they must clearly understand how it works, what the benefits are, and be assured that it would not negatively affect their comfort or control. It is important to understand consumers and place them at the centre of the journey — acknowledging that real-world uptake depends not just on what is offered, but how it is communicated, experienced, and supported.

The qualitative research aimed to understand how consumers interact with the project propositions, exploring their motivations, concerns and how they experience the service in practice. It looked at every stage of the journey: from pre-trial perceptions and decision-making to in-trial behaviour and post-trial reflections.

The goal was to generate actionable insights about what matters most to consumers, where the drop-offs happen, and what can be done to improve adoption, satisfaction, and trust.

11.1 Methodology

To understand participants' experiences and perspectives throughout the Energy Sure trial, a series of research activities were conducted at different stages of the project. These activities were designed to capture a complete picture of attitudes, behaviours, motivations, and decision-making across key touchpoints – before, during, and after the trial. Each activity used a different combination of qualitative and quantitative methods, allowing for the exploration of both breadth and depth.

11.1.1 Activity 1 – Pre-trial research

The pre-trial survey aimed to establish a baseline of participants' attitudes, behaviours, and energy usage habits. This helped build a profile of the households involved and understand their expectations before the trial began. The survey design was a mix of structured questions, option selections and Likert scales. It was distributed via email to an online survey system. Analysis was a mix of descriptive analysis, crosstabulation and comparative tests, with the appropriate method chosen based on the question type.

Survey 1 captured responses from 596 participants who expressed an interest in joining the trial, including:

- 312 participants with EVs only.
- 114 own solar panels.
- 73 own home battery.
- 88 with heat pumps only.

- 58 own solar panels.
- 30 own home battery.
- 119 who owned both EV and heat pump.
- 83 own solar panels.
- 64 own home battery.
- 57 who did not own any low-carbon technologies.

At the end of the survey, participants were invited to take part in a follow-up interview.

15 in-depth interviews were conducted:

- 6 with EV-only owners.
- 6 with HP-only owners.
- 3 with both EV and HP owners.

While these are small sample sizes, the aim of such activity is to get a greater depth of understanding from a smaller group of people.

This early-stage research provided a clear understanding of who participants were, what they cared about, and what they hoped to gain from the trial. Respondents were those who had expressed an interest in the trial and took up the offer of completing the survey.

11.1.2 Activity 2 – Selecting a fixed-price tariff offer

After signing up and downloading the ivie app, participants were invited to access a portal where they could enter a few simple choices — such as their expected monthly EV mileage and/or preferred home temperature. Based on these inputs, a personalised fixed-price tariff offer was calculated for them.

This activity explored how participants responded to the offer they received and what influenced their decision to accept or reject it. We used a second survey and follow-up interviews to better understand their decision-making process.

Survey 2 was completed by 109 participants, segmented into four groups:

- 35 participants who accepted the offer.
- 19 who were still considering it.
- 17 who rejected the offer.
- 38 who had not yet accessed the portal and seen the offer.

To explore these decisions further, two rounds of follow-up interviews were conducted.

- Interview 2a: 4 interviews with participants who rejected the offer, including:
    - 1 participant with an EV only.

    - 1 Participant with a heat pump only.
    - 2 Participants with both EV and heat pumps.
- Interview 2b: 15 interviews with participants who accepted the offer, including:
    - 9 with HP-only owners.
    - 7 with EV-only owners.
    - 2 with owners of both EV and HP.

This combination of quantitative and qualitative data helped explore not just what participants decided, but why they made those choices.

11.1.3 Activity 3 – Ongoing experience of the treatment group

To understand how participants experienced the trial in real life, follow-up research with members of the treatment group was conducted—some of whom were on the actual fixed-price tariff, while others were on a simulated version of it. Noting it was the intention for everyone in the treatment group to be on the actual tariff, however due to Ofgem issuing a provisional order to Tomato Energy temporarily stopping them taking on new customers, an alternative method of tariff simulation had to be quickly defined.

These small number of participants who accepted the offer were unable to complete the switch to the supplier's tariff during the trial period. To maintain continuity, they were placed on a simulated version: they remained with their existing supplier, continued paying their usual bills, and were reimbursed the difference between what they paid and what they would have paid under the fixed-price offer. Smart devices still needed to be connected and optimised via the ivie app.

This activity included:

- Six heat pump users, all on the actual fixed-price tariff:
    - Initial interview.
    - Four weeks of diary entries.
    - Final follow-up interview.
- Four EV users, on the simulated tariff:
    - Initial interview.
    - Final follow-up interview.

This longitudinal approach provided valuable insight into how participants' behaviours, attitudes, and expectations evolved during the trial, as well as how they responded personally and practically to the fixed-price offer over time. Interviews were semi-structured. The intention was to enable the user to provide a wide range of opinions so the full richness of learnings were obtained but framed based on the specific needs of the project. The interviews were a mix of telephone and video calls.

11.1.4 Activity 4 – Post-trial evaluation

At the end of the trial, a final survey (Survey 4) was carried out with participants from both the treatment and comparison groups, which are classified below. The aim was to assess the impact of the trial, participants perceived value of the fixed-price tariff, and any lasting changes in behaviour, attitudes, or engagement.

The survey repeated key elements from the pre-trial questionnaire (Survey 1), enabling direct comparisons over time to identify changes in behaviours, attitudes, and perceptions. It also included targeted questions designed to validate and expand on insights gathered through the ongoing experience research, providing a fuller picture of participants' journeys during the trial.

The comparative analysis between baseline and post-trial data and the comparison between participants in the treatment group with ones in the comparison group provided valuable insight into the trial's effectiveness across different participant segments. It helped us understand how the experience shaped participants' views, behaviours, and likelihood of adopting fixed-price tariffs going forward.

Together, these activities enabled the construction of a comprehensive and nuanced understanding of the participant experience – from first impressions to final reflections. This mixed-methods approach ensured it was possible to capture both large-scale trends and the personal stories behind them.

Survey 4 captured responses from 209 participants, including:

- 33 participants in the treatment group - classification;
    - Currently on either the Tomato Energy tariff or the simulation tariff.
    - Completed the tariff switch but did not continue in the trial.
- 176 participants in the comparison group - classification;
    - Accepted the fixed-price offer but not completed the switch or started the simulation tariff yet.
    - Accepted the fixed-price offer but did not switch, or were unable to switch, to the fixed price tariff or simulated tariff.
    - Accessed the Energy Sure portal but rejected the offer and did not progress further in the trial.
    - Not eligible because they did not have an EV or heat pump.
    - EV or heat pump was not compatible for the trial.
    - Lost interestefixed in continuing with the trial after signing up.
    - Did not continue with the trial for other reasons after signing up.

11.1.5 Analytical approach

All qualitative interviews and diary entries were transcribed and coded thematically. Data was clustered in Miro to identify patterns and surface key insights. Quantitative survey data were analysed descriptively and comparatively across time points and participant segments to triangulate findings and identify meaningful behavioural shifts.

11.1.6 Ethical considerations

Both the quantitative survey and the qualitative interviews were conducted in line with recognised ethical standards for social research. All participants were provided with clear information about the purpose of the study, the nature of their involvement, and how their data would be used. Informed consent was obtained prior to participation, with individuals given the opportunity to decline without consequence. Participants were reminded that they could withdraw from the research at any stage, and any data already collected would be removed if requested.

Data protection was also a central consideration. All personal data were handled in compliance with the UK General Data Protection Regulation (UK GDPR) and the Data Protection Act 2018. Identifiable information was minimised, anonymised where possible, and stored securely, with access restricted to authorised members of the research team. Findings have been reported in aggregate form to ensure that no individual participant can be identified. These measures ensured that the research upheld principles of transparency, confidentiality, and respect for participants throughout.

11.2 Key findings and insights

This section brings together the learnings about participants' experiences before, during and after the trial. Together, these provide insights to understand participants' motivations, behaviours, and expectations over time—and what helped or hindered their confidence in the fixed-price tariff offer.

11.2.1 Automation must be paired with choice and visibility — or it risks feeling like a loss of control

Across activities, participants made clear that automation must come with choice and visibility. When people do not understand what's happening — or feel unable to step in — it quickly feels like a loss of control, even when systems are working.

In the post-trial survey, participants in the treatment group reported increased comfort with and confidence in the automation of both EVs and heat pumps. Overall, they found HP automation more convenient — likely because heating requires continuous comfort, whereas EV charging depends more on variable, real-life driving routines.

Participants in the comparison group, who did not directly experience automation during the trial, remained more sceptical and less trusting of automation overall. In contrast, direct experience during the trial helped build trust among treatment group participants.

Many participants saw better, smarter automation as essential to making time-based tariffs and smart energy services appealing in the future. However, transparent optimisation remains an area of need. Even among those in the treatment group, opinions were split regarding the extent to which they trusted third parties to manage their devices with maximum efficiency and in their best interests. Among the comparison group who had no experience of automation during the trial, the majority were unsure about whether third parties would operate their devices at optimal efficiency.

11.2.2 Savings matter most — but clarity is key to confidence

Participants were largely motivated by the potential to save money — especially on EV charging and heat pump use. In Survey 1, nearly half (46%, 275 respondents) were concerned with getting a better deal, and 38% had budgeting worries. Interviews confirmed this: people said they already charged or heated their homes at off-peak times and saw the trial as a way to improve control and reduce bills. Some also hoped to gain better personal insights into their energy usage. Results from Survey 1 showed that cost clarity is particularly important to EV owners, with 67% (210 respondents) of EV-only owners and 57% (68 respondents) of EV and heat pump (EV&HP) owners requesting cost-related information, such as unit rates, cost comparisons, and full breakdowns.

But when they saw the actual fixed-price tariff offer calculated based on their required EV charging and heat pump temperature (Survey 2), cost remained a sticking point. 70.5% of those who rejected the offer said it did not provide better value than their current tariff. Even some of those who accepted said they did not fully understand the pricing or were confused by invoices (Interview 2b). HP owners appreciated predictability in winter (Activity 3), but worried the value would not hold up in summer. EV owners noted that trial costs were often comparable or higher than their current deals, particularly when compared to known options like Octopus Intelligent Go.

Participants across activities said they lacked visibility into how their monthly prices were calculated — both for heating and EV charging under the fixed-rate tariff — and did not know what they would pay for other energy use. This uncertainty, before any billing took place, made it harder for them to feel confident the trial would lead to real savings.

Over the course of the trial, treatment group participants' focus shifted as shown in the results from Survey 4. Initially drawn in by headline savings (e.g. 30% off EV charging, 15% off heat pump heating), they gradually came to value more practical benefits such as support with budgeting and greater control over their tariff. They also grew more confident in their ability to achieve savings. In contrast, the comparison group remained focused on the headline savings but continued to express doubts about whether those savings could be realised.

Across both groups, cost savings remained the primary motivator (79%). However, clarity around tariffs and energy costs was a key concern—highlighting that confidence depends not just on the promise of savings, but on understanding how they can be achieved.

11.2.3 Innovation draws interest — but only if it is easy to understand

Participants were curious about new technologies and more sustainable ways of using energy. For HP owners, the offer of a free smart thermostat added appeal. Survey 1 and Interview 1 showed that taking part in an innovative research trial was a key motivator but that interest did not always convert into action.

In Interview 2a, participants who rejected the offer described confusion around the value proposition — particularly a lack of clear cost comparisons, scattered information, and uncertainty about how bundles worked. Participants wanted simple, easy-to-understand information about what they were signing up for. Without this, even those excited by innovation were hesitant to proceed.

Interestingly, participants in Activity 3 had accepted the offer despite experiencing similar confusion. Even after joining, many remained unsure about how systems like Homely worked day-to-day, reflecting persistent gaps in clarity.

Post-trial data from Survey 4 suggests that participants in the treatment group became more open to trying new technology sooner, rather than waiting for it to become mainstream. In contrast, participants in the comparison group remained more cautious — more of them said they would wait until a technology was widely adopted before trying it themselves.

11.2.4 Adjustability is non-negotiable — especially for EV owners

EV owners in particular needed room to adjust. In Survey 1, 47% of EV-only participants said they worried about fixed usage not matching real life. Interviews 1 and 2a reinforced this: participants found it hard to estimate their energy use and did not want to be penalised for exceeding a bundle — or pay for unused energy.

Survey 2 showed that fixed mileage options (e.g. 200 or 400 miles) did not reflect real-life driving routines. Even those who accepted the offer (Interview 2b) felt constrained by limited options and the inability to revisit decisions. Activity 3 confirmed that EV charging and heating needs varied widely — and people wanted more adjustability, especially when plans changed.

11.2.5 People want to stay in control — even if they accept automation

Heat pump (HP) owners were generally more comfortable with fixed pricing and automation—especially if it meant a more efficient, hands-off way to manage heating. Survey 1 and Interviews 1 and 2b showed strong interest in Homely's promise of comfort and simplicity.

In Activity 3, most HP users said Homely kept their homes at a consistent temperature — often warmer and more comfortable than they had ever experienced. But problems arose when they could not override settings or access performance data. For example, some could not get hot water during cold snaps — despite using the boost function — while others experienced overheating during the night. Without visibility into how the system made decisions — or a way to intervene — it became more difficult to trust the system, especially when its logic was opaque or when outcomes did not match expectations.

EV owners wanted to monitor charge levels and session data — something the ivie app did not support. In Activity 3, some described having to do manual calculations or use another app just to check if their car would be ready.

11.2.6 Trust can make or break the decision

Trust played a central role throughout the trial journey. Participants felt more confident when they recognised brands like ivie — but were less sure when unfamiliar names like Tomato Energy were introduced. Survey 2 and Interviews 2a and 2b showed that confusion around supplier switching, unclear messaging, and uncertainty about who was providing what often led to drop-off.

Activity 3 confirmed that while ivie's support was generally praised for being responsive and proactive, Tomato's was sometimes seen as inconsistent or hard to reach. However, it was not always about the individual organisations — participants were often not sure who to contact for different aspects of the trial. This shows that when services are delivered as a bundle, clear roles and joined-up communication are essential to maintain trust.

Findings from the post-trial survey reinforced this. Trust emerged as a key enabler for the uptake of smart tariffs, automation, and third-party energy management — but it needed to be built through direct experience and transparent communication. Participants in the treatment group, who had first-hand experience, were generally more positive across a range of measures:

- 66% were comfortable with third-party automation (vs 50% in the comparison group).
- 62% were confident their EV or heat pump was running optimally (vs 26% in the comparison group).
- 66% valued fixed price plans more (vs 32% in the comparison group).

These figures suggest that experience played a key role in building confidence in the service's value and performance. In contrast, comparison group participants — who had not experienced the service — remained more sceptical and uncertain. Their responses highlighted a need for more information and transparency.

11.2.7 Clear communication makes the difference

Gaps in communication undermined confidence at every stage. Survey 1 and Interviews 1 and 2a showed that people wanted clearer explanations of pricing, tariff structure, and what they were signing up for. Survey 2 participants who rejected the offer often said it was not clear or easy to understand.

In Activity 3, communication problems continued. Participants were unsure how decisions were made, when to expect updates, or who was responsible for solving issues. Some were concerned that Homely might affect heat pump warranties, or did not know how seasonal energy use was factored in. Clear, timely, and joined-up communication was consistently missing.

11.2.8 Predictable pricing is appealing — but needs more explanation

The idea of a fixed monthly cost was reassuring for many — especially HP owners who faced high winter bills. Participants appreciated knowing what to expect and felt it gave them peace of mind.

However, across all activities, participants said they needed a better explanation of how their bundle price had been calculated. People were curious about which factors were considered, including whether it their home's size or energy performance, their previous tariff, their chosen indoor temperature or EV mileage, or wider factors. Without this clarity, some were left uncertain about the fairness or accuracy of the offer they received.

Participants also wanted a more detailed breakdown of what their bundle covered and what would happen if they exceeded it. For example, EV owners were sometimes unclear about whether the kWh allowance or the mileage was the limiting factor, and what the consequences were if they went over. Similarly, several people said they would have valued visibility of how energy use was split across different parts of the home (e.g. EV, heating, other electricity use).

Some participants — particularly EV owners — were unsure whether the offer actually gave them better value than their previous tariff. While heat pump owners generally liked the predictability in winter, several questioned whether the cost would still feel fair during warmer months. Many said they would prefer seasonal bundles or a way to adjust their bundles as usage changed over time.

11.2.9 Solar and battery users need clearer integration

Participants with solar panels or home batteries wanted assurance that these systems would work well with the trial tariff. Survey 2 and Interviews 2a and 2b showed that missing export rates or unclear compatibility were barriers to sign-up.

In Activity 3, participants raised similar concerns. Some wanted export rates to make the offer viable. Others said they needed better visibility into how solar and battery usage affected their bills or interacted with automation.

Together, these findings paint a clear picture: people are excited by innovation, drawn in by cost savings, and ready to try something new — but only if it feels understandable, flexible, and trustworthy. Over time, as the offer became more tangible, the gaps in clarity, visibility, and customer experience became harder to overlook. Making the experience simpler, more transparent, and easier to navigate could turn early interest into lasting engagement.

11.3 Summary findings for key research questions

11.3.1 Consumer experience of propositions and the benefits offered

Participants were primarily drawn by the promise of savings, automation, and improved comfort. Many heat pump users said their homes felt warmer and more consistent than before. EV owners appreciated not having to manually manage every charging session. These benefits largely matched expectations of "less hassle" and better energy control.

However, there were also challenges. Many participants struggled to understand how automation worked, especially with systems like Homely and smart EV charging — and felt they lacked the tools to monitor or override decisions. Comfort was sometimes undermined by issues like overheating at night or no access to hot water. These experiences point to a clear need for better transparency, more visibility into how systems operate, and the ability to stay in control even when automation is in place.

Survey 4 highlighted that the fixed-price offer made clarity about monthly costs feel more tangible for the treatment group. Two-thirds (65.6%) of treatment participants said that knowing the cost of running their EV or heat pump was a benefit — compared to only 32% of the comparison group, who did not have access to the offer. Nearly 70% of the treatment group also said they felt free to use appliances at any time without worrying about cost. These findings suggest that the fixed tariff helped reduce friction and brought greater ease to everyday energy decisions.

11.3.2 Appeal of these propositions to consumers

The biggest drivers of interest were the potential for savings and interest in innovation. People liked the idea of a fixed price — particularly in winter months — and were open to trying new smarter and greener systems that promised more control and less effort. But complexity, confusion, and unfamiliar suppliers held many back. Many dropped out simply because they did not understand the offer, did not see it in the app, or were not sure who to contact with questions.

A key theme was adaptability. Rigid bundle structures, particularly for EV charging, did not fit well with real-life routines. People needed options that could adjust to their changing habits, and the reassurance that they would not be penalised for using more — or paying for energy they did not use.

11.3.3 Requirements to successfully deliver propositions

Participants consistently requested three things: more control, better visibility, and joined-up support. They wanted clear, detailed billing that showed exactly what they were paying for. They wanted access to real-time energy data, particularly for their heat pump usage. They wanted to understand how automation was making decisions and how their own behaviour influenced their bills.

The onboarding experience was also critical. When communication was clear and support was proactive — as was often the case with ivie’s team — participants felt reassured. However, when gaps in communication or unclear roles emerged, trust suffered.

In summary, the Energy Sure trial was most successful when it felt transparent, flexible, and tailored to people’s needs. Cost savings and comfort were strong motivators, but keeping people engaged depended on clear communication, a sense of control, and the confidence that the service would adapt to their circumstances. These lessons offer a strong foundation for shaping future energy propositions that not only attract but also support and retain consumer engagement.

12 Commercial viability of proposition

12.1 Strategic summary of findings and commercial viability outlook

This section explores the commercial viability of the proposition tested from the viewpoint of the energy supplier providing it to consumers. Tomato Energy were the provider of the Energy Sure tariff where triallists in the treatment group switched to have Tomato as their supplier and were billed as if this was a real tariff on the market today. Having made the proposition fully 'real' rather than simulated allowed greater value learnings than if the tariff had been simulated. This section discusses the success of the proposition from a commercial perspective against current and future hypothetical pricing scenarios, breaking the analysis down into the different tariff components. Reflections are made as to what could be improved and what changes may be needed to fully launch such a proposition in today's or a future energy market.

12.1.1 Key insights

Heat Pumps (HPs) responded to time-of-use signals but displayed high seasonal and household-level variability. Forecast errors in winter months exceeded 60% on average in some cases, with outliers reaching over 190% above forecasted usage. This introduced material cost risk under fixed pricing models.

Electric Vehicles (EVs) were generally underutilised. Most participants used significantly less than their bundle allowance, resulting in positive commercial outcomes. This suggests that the EV proposition may remain financially robust even if tariffs are made more competitive or attractively priced.

The combination of predictable EV demand and highly variable HP usage indicates that the commercial design of bundled fixed-price offers must be asset-specific, with more cautious assumptions regarding heating load and enhanced forecast calibration tools in place.

Based on savings delivered by the value of flexibility in the scenarios, it is likely that commercial viability of the proposition will be driven by bundling with other services (e.g. asset finance) leveraging the cost certainty/predictability for the consumer.

12.1.2 Commercial viability outlook

The trial confirms that the Energy Sure bundled proposition can be commercially viable if targeted refinements are made:

- HP bundle viability depends on seasonal smoothing, improved forecasting methods, and customer segmentation to identify lower-risk profiles.
- EV bundles appear resilient and commercially optimistic under both pricing scenarios, particularly where telemetry is available.

- If all other consumption is treated as pass-through, commercial viability is determined by the supplier's ability to model and price the fixed-cost elements accurately.

The data reinforces the necessity of asset-level differentiation, enhanced customer onboarding intelligence, and hybrid pricing strategies that strike a balance between predictability and flexibility. These enhancements will be crucial for sustainably scaling bundled energy services.

It is also important to note that although forecast deviations were significant in certain months, particularly during peak winter heating periods, many households showed a natural balancing effect over the entire trial duration. Overconsumption during colder months was often counterbalanced by lower usage in milder periods, which helped reduce cumulative variance. If the trial had concluded earlier, for instance, at the end of March, the outcomes might have overstated the long-term risk and understated the viability of the proposition. This highlights the importance of designing and evaluating bundled offers over complete seasonal cycles.

12.2 Scenario performance overview

12.2.1 Scenario 1 – Baseline AEM signals

Scenario 1 demonstrated stable consumption patterns, showing a relatively close alignment to forecasts. Most households stayed within ±100 kWh of monthly projections during April and May, supporting the use of fixed-cost propositions for customers with consistent usage or low engagement. The lower volatility observed made Scenario 1 ideal for a simplified, predictable pricing model, minimising the risk of over- or under-recovery of costs.

12.2.2 Scenario 2b – Dynamic signals

Scenario 2bwas designed to unlock greater system value by exposing customers to detailed, real-time price signals. In theory, this would enable households to optimise heat pump (HP) and electric vehicle (EV) consumption according to market price trends, thereby reducing supplier cost exposure and enhancing overall system flexibility.

Across the treatment group, some optimisation was observed, particularly among households with connected devices and regular consumption patterns. However, the results were highly variable, especially in homes with both HP and EVs. The actual benefits realised were modest and unevenly distributed.

12.2.3 Estimated cost savings

Estimated supplier cost savings for Scenario 2b participants ranged from 0.4% to 1.2%. These savings were primarily derived from:

- Wholesale cost avoidance, where flexible asset usage (primarily heat pumps) was shifted into lower-priced periods.
- Avoidance of peak system pricing, particularly for well-optimised homes responding effectively to tariff signals.

- Efficient load scheduling by platforms such as Passiv and Homely, which helped reduce consumption during high-cost intervals.

These figures were derived from portfolio-level comparisons between observed usage patterns and forecasted load curves. However, they should be regarded with caution, as the forecasting methods employed during the trial did not utilise historical smart meter data, and data quality varied across households.

12.2.4 Segmented data observations – EV vs HP

With scenario-specific data available, a clear difference emerged in asset behaviour:

- EV usage under Scenario 2B was consistently below bundle allowances. This suggests either low charging frequency or issues with data completeness. Consequently, this led to favourable cost outcomes for the supplier, as many customers underused their pre-paid energy volumes.
- HP usage, in contrast, displayed high volatility, with several homes showing usage up to 190% above forecast in January alone. Forecast error rates in Scenario 2B households surpassed those in Scenario 1, particularly during colder months, thereby elevating supplier risk under fixed-cost models.

These differences underscore a key consideration for future product design: EV bundles seem commercially resilient under dynamic pricing due to low variability and underuse, whereas HP bundles necessitate more active management through seasonal adjustments, enhanced forecasting, or hybrid pricing structures.

12.2.5 Limitations of the analysis

It is essential to note that although households were assigned to scenarios, the final evaluation in the original trial report was based on aggregated data from the treatment groups. The scenario-level breakdown presented here has been reconstructed from subsequent analyses using separate datasets.

Furthermore, the forecasting models used during the trial relied on static archetypes (e.g. house type, occupancy) due to limitations in the integration time between Tomato's internal systems and Chameleon's optimisation tools. This constrained the use of historical data, which could have enhanced forecast precision, particularly for HP demand in the winter months.

12.3 Recommendations and design considerations

The trial has provided critical insights into the design of fixed-price, asset-led energy propositions. While the results are not without challenges, they strongly support the potential for scalable, commercially sustainable models — provided they are designed with care and flexibility.

The following recommendations are structured as design considerations rather than prescriptive next steps, reflecting the fact that the trial concludes in June. These insights are intended to inform future iterations of bundled energy services and guide any commercial rollout.

12.3.1 Personalised forecasting using historical data

Recommendation: Move away from archetype-based forecasting to personalised models that use real smart meter history and telemetry from devices.

Why it matters: The trial relied on static assumptions about household size and occupancy, which led to significant forecast error, particularly for HPs in winter.

What to consider: Integrate 12 months of historical consumption where available. Ensure early interoperability between forecasting tools and optimisation platforms during project setup.

Impact: Enhances cost prediction, mitigates under-pricing risk, and facilitates more effective tariff structuring.

12.3.2 EV bundle refinement with tiered pricing

Recommendation: Continue to offer pre-paid EV energy bundles, but introduce lower-tier, lower-cost options based on observed usage.

Why it matters: Most trial participants used significantly less than their bundle allowance. This created a favourable margin for the supplier but may not reflect perceived value for the customer.

What to consider: Design bundles in 50–100–200 kWh tiers. Use charger integration or declared mileage to suggest the right bundle tier during onboarding.

Impact: Enhances uptake, avoids overprovisioning, and preserves commercial benefit.

12.3.3 Heat pump tariff structuring with seasonal smoothing

Recommendation: Apply seasonal adjustments or hybrid structures to better reflect heating demand.

Why it matters: HP load was much higher in winter, with deviations of up to 190%. Flat pricing creates risk concentration in colder months.

What to consider: Use local temperature data and heating degree days to shape monthly caps or flexible thresholds.

Impact: Reduces seasonal exposure while maintaining monthly predictability for the customer.

Additional Insight: Although some households showed large monthly deviations, the overall trend across five to six months was often self-correcting. This suggests that tariff viability may improve over longer durations, particularly when seasonality is factored into the pricing structure.

12.3.4 Control and integration of additional LCTs

Recommendation: Ensure future propositions are designed to integrate new low-carbon technologies (LCTs) like batteries and solar PV.

Why it matters: These technologies can reshape household load and reduce grid draw, but were not actively integrated during this trial.

What to consider: Require customers to connect new LCTs to supplier-side controls or data-sharing platforms where possible. This will ensure they are able to access more opportunities, and new propositions have a greater chance of market success.

Impact: Strengthens system visibility and unlocks additional value from flexibility and optimisation.

12.3.5 Whole-home simplicity and customer experience

Recommendation: Preserve simplicity in pricing by including the cost of "everything else" in the customer's fixed charge, when feasible.

Why it matters: Tomato Energy made a deliberate choice to include non-bundled energy costs in the fixed price during this trial to reduce customer confusion and avoid mid-month billing shocks.

What to consider: Fixed-price simplicity supports customer trust and satisfaction. Conservative pricing buffers may help mitigate supplier risk in future designs.

Impact: Encourages long-term engagement and supports brand differentiation as a service-first energy provider.

12.3.6 Usage transparency and feedback loops

Recommendation: Provide customers with regular feedback on their usage vs forecast.

Why it matters: Most customers had no visibility into whether they were within or outside their bundle limits. Without feedback, proactive behaviour is unlikely.

What to consider: Monthly email summaries or app push alerts showing "You've used 85% of your bundle this month" or "You're on track for £x savings" can drive engagement.

Impact: Reduces bill shock, builds trust, and encourages more efficient energy use.

12.3.7 Bundling of asset purchase/finance or other complimentary services with the proposition

Recommendation: Improve commercial viability by stacking additional revenue streams that leverage the predictable cost (to the consumers) elements of the proposition.

Why it matters: To price the tariff competitively against tariffs where some of the (wholesale) price volatility and usage volatility is shared with the consumer leaves little margin for the energy supplier.

What to consider: Asset linked services such as financing, insurance and maintenance that can be bundled into a predictable monthly package facilitated by the proposition.

Impact: Improves margin, consumer appeal and commercial viability.

13 Potential value of flexibility – comparison of supplier vs supplier-agnostic model

This section takes a wider view of the market beyond the AEM market hypothesis to determine whether the value of flexibility can help to unlock wider models outside of the supplier-based concept in the core proposition in this project. It takes a wider look at the flexibility market and considers the key literature which will shape the opportunities of supplier-agnostic solutions. There is the opportunity that any potential value to customers from the flexibility of their assets will come in addition to, as opposed to through, participation in an optimised tariff. Flexibility may be part of an optimised tariff solution, but careful consideration must be given to how flexibility actions are integrated into the tariff as presented to customers. This has been considered an interesting area for the project to explore further as it has the potential to unlock new opportunities with propositions and business models beyond the core offer within the tariff being tested. This area of work helps to determine the scale of opportunity and how a proposition could look post-project to build on the value of the existing proposition.

13.1 Overview of flexibility

Every possible type of flexibility action and market can be broken down into two classes of action:

- Change of state:
    - The customer’s asset increases demand/reduces generation.
    - The customer’s asset decreases demand/increases generation.
- Change of market position:
    - Power is bought on behalf of the customer.
    - Power is sold on behalf of the customer.

Any given flexibility service is some combination of these options. The speed at which the customer assets are turned up or down, the duration of that action, the frequency at which the actions are called upon – these are some of the factors which set different services apart, such as Frequency Response (FR), Demand Flexibility Service (DFS), Short Term Operating Reserve (STOR), Balancing Mechanism (BM), etc.

In the case where there is a ‘change of market position’ action, there does not necessarily have to be a ‘change of state’ of customer assets. There can be a related action taken – say, by assets in a Virtual Lead Party (VLP) in the Balancing Mechanism (BM) to match a P415 Wholesale Trade and avoid Imbalance Charges. But there may be cases where a VLP is targeting Net Imbalance Volume (NIV) and engaging in so-called ‘NIV chasing’ which may involve purposely unfulfilled trades.

13.2 Combinations of flexibility actions

In the case where a pool of customers under a given tariff have elected to pay a fixed price for a set amount of energy – the aim of which is to direct a portion of that set amount to transportation, a portion to space heating, and so forth – then there are a set of related flexibility options open to the supplier, the manager of that tariff, to enable the provision of power at the agreed price while still making a profit:

- Change of market position actions are taken to optimise the tariff, and no change of state actions are taken by customers.
- Both change of market position actions and change of state actions are taken alongside each other to optimise and manage the tariff.
- No change of market position action is taken and only change of state actions are taken.
- Change of market positions are taken as the main part of tariff optimisation, and the management of the tariff is augmented with change of state actions where possible.

In the first option above, the tariff is optimised at the supplier end only. The supplier will make a detailed assessment of the customer base and forecast at the half-hourly levels the amount of power needed to meet the forecasted demand. The supplier will then take change of market position actions in the Futures, Day Ahead, and Intraday markets to meet this forecasted need. No interaction from customers is expected.

In the second option above, the tariff is optimised by a combination of both types of flexibility action. The supplier will engage in detailed forecasting and change of market position actions as in the first option, and customers will also be active in change of state actions to augment the market actions, or to permit them.

- In this case, customer flexibility actions will involve a combination of Wholesale Market actions and participation in various Flexibility Markets.
    - The Wholesale Market actions may take various forms:
        - There may be customer change of state actions to match the supplier's change of market position actions, meaning short term trades taken at the Day Ahead or Intraday timescales to take advantage of arbitrage opportunities.
        - There may be change of state actions to match standard change of market position actions, meaning where the Supplier procures the total energy demand in the most cost-effective way possible and then conforms customer demand to match.
        - There may be change of state actions taken to avoid taxes, tariffs, or system charges which have a time-of-day component.
- It is important to note at this point that a distinction should be made between Balancing Services and Wholesale Market actions:

- Customers may offer their flexibility up to actions such as time-shifting their demand to accommodate Wholesale arbitrage, or they may offer them up to dispatchable Balancing Services, such as Frequency Response, or Demand Flexibility Service.
- Balancing Services usually require customer action to be contained within 4-hour Electricity Forward Agreement (EFA) Blocks, whilst Wholesale Market options can be done at the EFA Block level, or Hourly, or Half Hourly depending on the market.

In the third option above the tariff would be optimised wholly by the taking of change of state actions with no change of market position actions taken at all by the relevant supplier, in any of the fashions outlined above for the second option. In this case, the value of the tariff will only be realised through the active and continued participation by each customer in various Balancing Service markets, the Balancing Mechanism, the Capacity Market, and in the Wholesale Markets. Each customer would be required to be an active and ongoing market participant.

In the fourth option above the tariff would be optimised in the main as per option one, but extra revenue would be sought where available and where possible from customer participation in change of state actions in the various balancing services markets.

13.3 Assessment of requirements

To model the potential value of flexibility, the assessment would be underpinned with certain assumptions:

- Which of the four optimisation options above will be deployed by the supplier.
- For a supplier-agnostic model, clarity would have to be sought on the rights to aggregate the tariff customers into Units, which can be put into the various markets as blocks. Individual customers cannot generally operate as single entities in the various Wholesale or Balancing markets without being very large (>1MW).
- For a supplier-specific model, and for certain iterations of the supplier-agnostic model, the optimisation model would have to be centralised and clear lines of communication between the optimiser and the dispatching flexibility providers would have to be clearly laid out. For instance, actions would have to be blocked out by EFA Block at the day ahead stage for most flexibility services. EFA Blocks are six four-hour windows each day, which are the standard trading windows for wholesale power, and are also used at the procurement periods for many balancing services by NESO.

For a proper assessment of the benefits of various combination of change of state and change of market position actions, for the purpose of tariff optimisation, a full assessment of the asset base of the customer cohort would be needed. Controllable assets will be needed for all combinations requiring change of state actions to achieve the tariff prices sold to customers. In such a situation, this would mean that new customers would be excluded from the tariff if they did not possess a suitable asset that was suitably controllable. It would not be possible to earn the necessary revenue to support fixed prices from a customer base that was not able to be flexible.

The supplier – specific or agnostic – must be aware that various factors affect the potential levels of flexibility from a customer. These include, but are not limited to, the following:

- Boundary meter – must in most cases be a half hourly smart meter.
- Asset – not all assets can be flexible or can be made to be flexible. Some cannot react fast enough, some are not available to be flexible at peak times of day, some cannot react for long enough. Assets must be matched to the appropriate market.
- Asset control – the DSR aggregator must be able to integrate with the asset, which may be done with an API, or other control infrastructure. If not there, control may not be feasible.
- Half Hourly Settlement – not all Suppliers will settle their customers at the half hourly level. The lack of Half Hourly settlement will exclude customers from many flexibility markets.
- Customer usage patterns – change of state actions require a change to happen. If a flexibility market regularly requires an action which is a reduction in demand, then a set of assets which are more often than not off cannot turn more off. Some general usage patterns do not lend themselves to all markets equally.

13.4 Flexibility value overview

In general, the value of markets will vary. Table 9 below gives an approximation for the values per year or a per kW basis for a set of balancing services. The reasoning for arriving at each service value and the assumptions made at each stage are set out.

The management of the tariff should consider not only the possible expected revenues from any given flexibility service, but also from the interaction between these services and the stacking rules which apply. The updated proposed design for DFS will now enable stacking of some services but not with others e.g. stacking will be allowed with DSO services.

Table 9. Flexibility revenue potential for EV Chargers, Heat Pumps and Batteries across multiple flexibility markets, with a rough approximation for the values per year or a per kW basis for a set of balancing services.

		Low	Med	High
Demand Flexibility Service	Battery	£8.28	£43.24	£78.20
	Heat Pump	£3.60	£22.20	£40.80
	EV charging	£1.80	£11.10	£20.40
Balancing Mechanism	Battery	£6.79	£8.32	£9.86
	Heat Pump	£1.55	£1.90	£2.25
	EV charging	£0.55	£0.68	£0.80
Dynamic Regulation	Battery	£5.11	£17.16	£29.20
	Heat Pump	NA	NA	NA
	EV charging	NA	NA	NA
Dynamic Moderation	Battery	£1.46	£8.03	£14.60
	Heat Pump	NA	NA	NA
	EV charging	NA	NA	NA
Dynamic Containment	Battery	£1.46	£8.76	£16.06
	Heat Pump	NA	NA	NA
	EV charging	NA	NA	NA
Static FFR	Battery	£5.84	£11.68	£17.52
	Heat Pump	£0.40	£0.80	£1.20
	EV charging	£0.20	£0.40	£0.60
Local Constraint Market	Battery	£7.20	£15.60	£24.00
	Heat Pump	£3.29	£7.12	£10.96
	EV charging	£1.17	£2.54	£3.91
Local Flexibility (DNO)	Battery	10.00	£20.00	30.00
	Heat Pump	1.14	£2.28	3.42
	EV charging	0.41	£0.82	1.22

Tariff Optimisation (to customer)	Battery	£91.25	£118.63	£365.00
	Heat Pump	£36.50	£218.25	£146.00
	EV charging	£100.00	£100.00	£400.00

In general, three asset classes are assumed in the table above: Battery, Heat Pump, and an EV charger. This is merely to illustrate that different asset types may have access to different markets, and some may not be suited to all Flexibility markets. Each is presented as a 1kW asset, so that the relative values can be trivially scaled to any given real asset of n kW in size. In each case, the medium prices are the averages of the low and high prices. The EV tariff numbers are based upon an average tariff gain of £0.1 on the low end and £0.2 on the high end. The average EV charge volume was rounded up from c. 19KWh low and 38KWh high per week.

- Demand Flexibility Service (DFS)
    - The low and high prices achieved in the market by Solo Energy over the 2023/24 delivery period are used.
    - The difference in size between asset types is down to estimates of asset availability over the DFS delivery period, with greater delivery availability leading to larger potential revenues.
- Balancing Mechanism (BM)
    - The BM was assessed for Units which were dispatching strictly within the standard 4 hour Electricity Forward Arrangement (EFA) Block time windows. Only Virtual Lead Party and smaller Supplier BM units were assessed as well.
    - Average annual values were obtained only for selected BM Units which obtained a market value in at least 8 out of the last 12 months.
    - Low and high values reflect anticipated dispatch BM revenues.
    - Differences in asset classes represent differing assessments of general asset availability – some assets will be available for dispatch more than others.
- Dynamic Containment (DC), Dynamic Moderation (DM), and Dynamic Restoration (DR)
    - These are fast acting Frequency Response markets which operate pay-as-clear auctions in which all successful participants get the same payment.
    - Only battery assets were deemed fast enough in their response speeds to be able to participate.
    - The prices reflect the range of prices for the last 12 months.
- Static FFR
    - Static FFR is a Firm Frequency Response contract which used to be a monthly contract and is now an EFA Block (4 hour) duration contract.
    - It is a slower acting service than DC/DM/DR and so all assessed assets could potentially participate.
    - Prices reflect the market returns over the last 12 months.
    - Not all assets will be available to participate in every EFA Block, like the DC/DM/DR participation.
- Local Constraint Market (LCM)

- As with the services above, not all assets will generally have equal amounts of availability to participate in the LCM market, hence the differences in values over different asset classes.
  - The prices are reflective of the market values over the current life of the LCM.
- Local Flexibility (DNO)
  - Batteries are much better suited to Local DNO services, due to the longer durations of the dispatches.
  - The range of values presented above are reflective of this difference. The £/kw/yr was decided after reviewing DNO flex markets.
  - The market prices over a range of suitable DNO markets are used to generate value estimates.
  - Caution should be exercised with DNO services for the following reasons:
    - DNO Services are highly geographically specific and may not persist in the same location for extended periods.
    - DNO markets expect the dispatching of assets at generally longer durations than domestic assets are suited to. They are more suited to larger purpose-built batteries or diesel peaking plant.
- Tariff Optimisation (based upon expected ranges of price improvement for moving energy consumption from periods of high cost to low cost throughout the year)
  - These figures are based on different assessments of the availability of the different asset types for dispatch.
  - For instance, an asset which may be able to dispatch once or twice per day will not be as valuable as an asset able to shift consumption over multiple hours multiple times per day.
  - The values come from analysis of the last 12 months of Day Ahead Wholesale auction data.
  - Extreme caution should be exercised with this data by way of predictions for future value as markets can move a lot.
  - The values presented are at best a rule of thumb as to the range of values that an active asset may earn if participating to its full extent in favourable (i.e. volatile) market conditions.

13.5 Market access update for behind-the-meter flexibility

During the project, there was progress in making it easier and more rewarding for behind-the-meter flexibility assets to participate in and earn value from its flexibility. Key developments focused on improving market access, enabling asset owners to unlock new opportunities for revenue generation, and facilitating the integration of these assets into the broader energy system. Notably, changes to market rules and the introduction of new initiatives have increased access to the GB Wholesale Energy Market, enhanced coordination between various markets, and supported the growth of flexibility. There are still many barriers to unlocking the full value of flexibility, most notably the new and continuing delays to Mandatory Half Hourly Settlement programme of works. Still, the improved outlook for flexibility is expected to continue accelerating as the UK works toward its Clean Power 2030 and Future Energy Scenario targets.

NESO's Clean Power 2030 report[12], released in November, projects a four-to-fivefold increase in demand flexibility by 2030, driven by measures such as smart charging for electric vehicles, flexible electric heating solution and industrial demand-side response. This will provide 10-12 GW of peak flexibility, allowing the system to shift demand away from peak periods, reduce reliance on fossil fuels, and lower system costs. Clean Power 2030 emphasises the important role of smart flexible appliances, dynamic tariffs, and automation in enabling effortless consumer participation, supported by improved digital infrastructure and regulatory reforms.

In July 2024, Ofgem announced the appointment of Elexon as the Market Facilitator[13] to support the transition to a more flexible energy system. Local flexibility markets are currently fragmented and uncoordinated, which creates barriers for providers and slows the development of a flexible energy system.

To address these challenges, Ofgem's appointment of a Market Facilitator aims to:

- Develop more open, coordinated, and transparent local flexibility markets.
- Align national flexibility markets managed by the Electricity System Operator (ESO) with local markets managed by Distribution System Operators (DSOs).
- Support the strategic and whole-system approach required to meet the ambitious clean power goals.

This aligns with the broader goals of accelerating the UK's transition to a clean, flexible, and consumer-focused energy system. The Market Facilitator is expected to be operational by early 2026.

Ofgem carried out a consultation on the proposed Flexibility Market Asset Register (FMAR) aimed at streamlining the registration and integration of distributed flexibility assets, into the electricity market. Proposed as part Ofgem's vision for a Flexibility Digital Infrastructure, the FMAR seeks to act as a single source of truth for all flexibility assets, particularly those under 1 MW. This register is intended to simplify market entry for flexibility service providers by replacing the current fragmented system, where providers must register with individual markets separately. The FMAR will play a crucial role in enabling distributed flexibility by providing better visibility and coordination for small-scale assets to participate in local and national energy markets. It will facilitate greater asset participation, reducing costs and supporting grid stability. Elexon, as the market facilitator, will oversee the initial design and rules for the

[12] https://www.neso.energy/document/346651/download
[13] https://www.ofgem.gov.uk/decision/decision-market-facilitator-policy-framework

register, ensuring it supports innovation while providing transparency and standardisation for asset registration and market operations.

Work is continuing on ensuring that new sources of behind the meter flexibility can integrate effectively into a flexible, consumer-focused, and decarbonised energy system. Most notable, the Interoperable Demand Side Response (IDSR) testing initiative, is a UK government-backed program aimed at validating and demonstrating the effectiveness of smart, flexible device's ability to participate in demand-side response. This initiative supports the UK's transition to a low-carbon, flexible energy system by ensuring that smart technologies can respond dynamically to grid signals and consumer preferences, as outlined in the PAS 1878[14] and PAS 1879[15] standards.

Within the project timeline, significant progress has been made in improving access to the Wholesale Energy Market for behind-the-meter flexibility assets. Previously, owners of such assets could only participate in the GB Wholesale Energy Market through their electricity supplier. However, the implementation of Modification P415 ('Facilitating access to wholesale markets for flexibility dispatched by Virtual Lead Parties') has amended the Balancing and Settlement Code. This modification now enables independent aggregators (Virtual Lead Parties) to access the Wholesale Market directly. By allowing more participants, P415 increases competition in the wholesale market, potentially driving down energy prices for consumer.

As of September 2024, 37 million smart meters have been installed across GB, covering 65% of all meters. Of these, 58% are fully operational in smart mode. However, there have been delays in the implementation of the Market-wide Half Hourly Settlement (MHHS) Programme. The latest approved programme change (November 2024) has introduced a delay of 6.5 months to the overall schedule. The delays to MHHS continue to be a significant blocker in the participation of behind the meter assets in flexibility markets.

The latest iteration of the Dynamic Flexibility Service (DFS) has gone live in GB following a comprehensive consultation period earlier this year. This is an important step as DFS has been a big success story for flexibility over the last two years. The service saw 2.6 million registered MPANs taking part in winter 2023-24. There have been amendments to the service design including:

- The service has moved from an enhanced action model to an in-merit service. This is expected to have the impact of reducing the value of the service as flexibility offered within DFS competes with other sources of flexibility. However, this move is also expected to increase the overall number of events available to participate in.
- Providers can now stack DFS with other services, leading to more flexibility and efficiency. Previously this was a significant blocker of value generation from flexibility as

[14] https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-1878-energy-smart-appliances-system-functionality-and-architecture/
[15] https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-1879-energy-smart-appliances-demand-side-response-operation/

flexibility could not be included in DFS if it was already participating in DSO flexibility markets or the Capacity Market.

- The notice period for DFS events will be reduced, such that there is only within day notices for DFS events. The notice period is still longer than given in other flexibility markets such as the balancing mechanism. The derogation received from Ofgem for this is set to last until March 2027.
- The requirement for boundary meters to be half-hourly settled has been removed if the asset meter is used for DFS. This move will make it easier for flexibility assets to unlock value from DFS.

14 Heat-as-a-Service – wider opportunities

Within the project, a wider assessment of the HaaS market and potential opportunities has been undertaken. This section summarises the key findings which provide further context for considering next steps in the commercial potential of similar propositions and their impact on the market.

14.1 HaaS context

Most domestic consumers currently heat their homes through gas boilers or electric storage heaters, where the consumer is directly responsible for paying the upfront cost of the heating equipment and its installation, then paying for its ongoing maintenance and servicing, and then paying for the fuel used by the heating appliance (in kWh). Under HaaS, the operational model is different. Instead of the consumer paying per kWh, they pay for the outcome i.e. a pre-agreed temperature or level of comfort. An example of this would be a consumer paying a fixed amount for an agreed amount of time for their home to be heated to a certain temperature; this is often known as 'Warm Hours'. In an offering such as this, the consumer is paying for the outcome of using the heating system (a warm environment), rather than the energy input provided to the heating equipment.

There are several areas in which HaaS offerings could be superior to current energy offerings, not only from the perspective of the consumer but also from the service provider. These include, but are not limited to the following:

14.1.1 Consumer

HaaS offers significant benefits for consumers by removing the need for large upfront payments, instead spreading costs over time to make low carbon technologies more accessible and budgeting more predictable. It provides a guaranteed level of comfort at a stable price, supported by smart heating controls and hassle-free maintenance. This can be especially valuable for low-income or vulnerable households by removing financial and technical barriers to clean heat. Regular servicing ensures systems remain safe and efficient. Additionally, HaaS can be tailored to suit different property types, tenures, and technologies, offering a more personalised experience. By placing responsibility for technical decisions with the provider, HaaS also simplifies the user experience and reduces anxiety around unfamiliar or complex heating systems.

14.1.2 Provider

For providers, HaaS enables greater control over heating system efficiency and opens up opportunities to participate in grid flexibility services. It also offers the potential for stable, long-term revenue streams and improved financial certainty compared to traditional one-off sales models.

14.1.3 Wider society

HaaS can play a key role in accelerating the adoption of low carbon heating technologies, supporting the UK’s transition toward Net Zero. By enabling demand-side flexibility, it also contributes to a more resilient and efficient electricity grid. Additionally, HaaS models have the potential to reduce fuel poverty by making clean heat more accessible and affordable, with associated improvements in public health and wellbeing.

14.2 Servitisation models in adjacent services

By looking at servitisation models in adjacent services[16], HaaS can take key learnings to inform future development. Customers generally value the outcomes a service delivers rather than the product itself, although through Phase 1 of the AEM CAMEA project this was found not to apply to heating systems where leasing options were not favourable to consumers. Ownership models were preferred whether that was through buying the asset upfront or through regular payments against the capital cost (allowing them to keep the asset once all payments are made). This feeds into the next consideration of lowering upfront costs.

In residential heating, the upfront costs are a well-known barrier to the uptake in adoption of low carbon technologies. Heat pumps can be between 2-10 times more expensive than fossil fuel boilers once ancillary equipment and upgraded heating systems have been included. By removing this cost and spreading it over time through a service fee, HaaS has the opportunity to unlock parts of the market that have so far been unable to engage, for example households who do not have the means to cover the upfront costs or who are unwilling to use available funds to do so.

Systems, and heating systems in particular, are becoming smarter both in their level of automation and their flexibility potential, which also makes them more technically complex. Customers however ultimately want the same type of outcome they get now (warmth and comfort), meaning HaaS has the potential to provide a layer of simplicity and engagement between them and the complex system and language used such as flow-and-return temperatures, weather compensation curves and refrigeration cycles. Through intuitive interfaces and easy-to-understand propositions, HaaS can shield users from the technical

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[16] EaaS Initiative. (2024) ‘Accelerating Light as a Service and Circular Economy with Signify’. Available at: https://www.eaas-initiative.org/case-study/accelerating-light-as-a-service-and-circular-economy-with-signify/
One Planet Network (2022) *Lighting installation as a service*. Available at: https://www.oneplanetnetwork.org/knowledge-centre/resources/lighting-installation-service
The Advanced Services Group (2023) *Schneider Electric: Energy as a Service case study*. Birmingham: Aston Business School. Available at: https://www.advancedservicesgroup.co.uk/
Rolls-Royce (2012) *The hour: Rolls-Royce introduces engine leasing service*. Available at: https://www.rolls-royce.com/media/press-releases-archive/yr-2012/121030-the-hour.aspx
Pearce, T.P. and Musson, E. (2021) *From invention to services innovation: Xerox and its design journey with Intelligent Workplace Services*. Birmingham: The Advanced Services Group, Aston Business School. Available at: https://www.advancedservicesgroup.co.uk/
Sunsave (2025) *Sunsave Plus*. Available at: https://www.sunsave.energy/sunsave-plus

complexity of smart heating systems, making the experience more user-friendly and accessible.

By tying service payments to performance, such as energy savings, a strong incentive for providers to optimise system efficiency is created, aligning customer and provider interests to be mutually beneficial. HaaS models such as Pay-as-you-Save (PAYS) or with pricing structures linked to performance have the potential to build customer trust, however these models must be transparent, fair, and easy to understand in order to be effective. Past initiatives like the Green Deal[17] highlight the risks of poor design, with issues such as high interest rates and complex ownership transfers undermining public confidence and underscoring the need for more robust and user-friendly implementation.

There is a need for a cultural change from selling a product to selling a service which is likely to take time for many energy retailers before HaaS enters the mainstream. It is almost certain that the regulatory and policy change that is required will be slower than the pace of innovation of future market propositions. These barriers are fully expanded upon in Section 15. Consumer protections may also be slow to develop, leaving consumers at risk of service shortcomings or loopholes being exploited.

By integrating the learnings from XaaS offerings in other sectors, HaaS providers will be able to deliver greater value and likely accelerate the transition to low carbon heating. Specifically, HaaS offerings can:

- Enable zero-CAPEX adoption of low carbon heating technologies.
- Simplify the customer experience by taking on complexity and maintenance.
- Offer flexible pricing models aligned to performance and customer outcomes.
- Support low income and vulnerable households with reliable heating and reduced financial risk.

More research will be required however to fully understand the needs of the consumer around their willingness to lease the heating equipment compared to ownership either via upfront payments or by paying for the equipment over time by adding the cost to the heating bill.

14.3 Current & emerging HaaS business models

There are several evolving business models within HaaS which represent different approaches to delivering heating in a way that prioritises outcomes, predictability, and efficiency.

Outcome-based billing models focus on delivering comfort outcomes rather than charging for energy consumed (kWh). An example is the "Warm Hours" model, in which customers pay for their home to be maintained at a predetermined comfort level for specified hours or schedules.

[17] https://www.gov.uk/green-deal-energy-saving-measures

This approach shifts risk from consumers to service providers, incentivising efficient operation and management of heating systems.

Flat-rate subscription models charge a fixed monthly or annual fee for a comprehensive heating service, typically including equipment installation, maintenance, and energy supply. This model provides predictable costs for consumers and simplified billing, while providers benefit from steady and reliable revenue streams. Such models encourage consumer adoption by eliminating upfront costs and reducing uncertainty around fluctuating energy prices.

Bundled models package heating services with complementary offerings, such as energy efficiency retrofits, solar PV installations, battery storage, or electric vehicle charging solutions provide an additional model. This holistic approach can deliver greater overall value, improve system performance, and further reduce carbon emissions. Bundling also allows providers to capitalise on multiple revenue streams and offer more competitive and attractive packages to consumers.

Performance-based and flexible pricing models link consumer payments directly to the actual performance and efficiency of the heating system. These models may include dynamic tariffs reflecting real-time energy market conditions or discounts based on demonstrated energy efficiency improvements or measured performance of technology. This encourages both providers and consumers to optimise system performance, manage peak demand effectively, and align incentives towards shared sustainability goals.

Outside of the UK, we have seen HaaS applied to district heating in Denmark, creating another variant of HaaS offering in the form of District Heat-as-a-Service (DHaaS)[18]. All the costs associated with district heating (domestic heating appliance, installation, network connections, maintenance, servicing) are bundled into one, resulting in a single monthly payment for the consumer that continues over the lifespan of the appliance, which in this case is a Heat Interface Unit (HIU). The monthly payment is calculated based upon three main factors:

- A fixed conversion fee, covering the change from a gas boiler to heat network connection.
- A fixed subscription fee, covering maintenance and capital costs of the HIU.
- A variable fee, depending on the amount of heat used in a billing period.

This subscription model differs from that offered in the Bristol Energy trial as the monthly price is dictated by the amount of heat used, which is directly related to the consumption that is controlled by the user. This is similar to traditional volumetric billing that is seen in the UK, whereas in the Warm Hour model, the energy input has no bearing on the cost to the consumer during the billing period once the Warm Hour price has been agreed.

[18] EnergiRaven (2024) How District Heat-as-a-Service Can Solve Our Fuel Poverty Crisis. [PDF] Available on request.

14.4 Opportunities and challenges for future HaaS offerings

There are many different avenues that could be taken when considering the future of HaaS offerings in the UK and beyond, as well as a variety of new challenges that may arise over the lifespan of a service. The most prominent opportunities and challenges are grouped into several key topic areas and summarised here:

- Flexibility - Smart heating controls allow providers to optimise schedules, reduce peak demand, and align heating with renewable energy. This flexibility creates new revenue opportunities and supports decarbonisation. Managing complex systems at scale brings the challenge of maintaining reliability and could introduce coordination issues like device herding, which is where many systems respond in the same way at the same time, potentially creating new demand spikes and undermining grid stability.
- Supporting Net Zero Efforts – HaaS has the potential to accelerate the UK’s transition to Net Zero by lowering the upfront costs of heat pump installations and simplifying the customer experience. Bundling with energy-saving measures and local renewables could further boost value and margins. Although careful integration will be required to coordinate the multiple asset types and financing mechanisms which may be limited by existing policy constraints.
- Energy Policy and Regulatory Conditions – The success of HaaS will depend on alignment with energy regulation. Current regulations favour kWh-based billing, limiting HaaS model flexibility. Further policy support will be needed to enable the full range of HaaS propositions, including mechanisms to fairly recover policy costs and apply consumer protections but in the short term, regulatory uncertainty continues to inhibit innovation and investor confidence.
- Inclusion and Equity Considerations - HaaS could address energy poverty by offering stable, outcome-based heating especially for those who are currently struggling to pay. With guaranteed comfort levels rather than kWh consumption, HaaS could shift the focus from managing costs to maintaining wellbeing. However, financial exclusion (e.g., among prepayment customers) and credit checks may limit access. Socially inclusive models and safeguards will be needed to prevent widening inequalities.
- Consumer Acceptance and Behaviour - Trust, simplicity, and value are key to consumer adoption but consumers are sensitive to unclear pricing and control limitations. While automation and comfort appeal to early adopters, broader engagement needs better communication and clear pricing. Tenants face added complications around landlord permissions and asset ownership, with few HaaS propositions directly targeting tenants in the private rental sector.
- Provider and Market Readiness - HaaS requires providers to manage installation, maintenance, and long-term performance. This opens stable revenue opportunities but also increases operational risk. HaaS providers will need to work with energy networks to use system flexibility for balancing supply and demand, helping to ensure reliable service for consumers. They will also need to plan for risks tied to long-term contracts, such as customers moving home or unexpected cost increases from extreme weather.

While flexibility markets, bundled offerings (e.g. EV miles), and external funding mechanisms provide opportunities to diversify risk and increase resilience, risk modelling, asset financing, and regulatory confidence all need to mature to support commercial viability at scale.

HaaS represents a significant shift in how heating can be delivered, moving from traditional energy supply models to outcome-focused services. By addressing key barriers such as upfront costs, technical complexity, and system inefficiency, HaaS has the potential to drive the uptake of low carbon heating solutions across the UK. While the concept is still evolving, early examples and adjacent sector learnings suggest that, with the right policy support and market conditions, HaaS could play a central role in delivering affordable, comfortable, and sustainable heat to households.

15 Barriers/challenges to real-world implementation in current market conditions

15.1 Market

15.1.1 Commercial/risk allocation for suppliers based on projected consumption levels

The commercial and risk implications of offering flexible, consumption-based pricing — versus traditional fixed tariffs — are significant for both providers and consumers. With a consumption-indexed approach, providers expose themselves to volatility in user behaviour and real-time market conditions. While this model can better align price signals with actual system conditions, such as demand peaks or renewable generation availability, it carries a greater forecasting and hedging risk. If participants respond unpredictably or not at all to price signals, providers may struggle to achieve desired load-shifting outcomes, leading to financial exposure in wholesale and balancing markets. This dynamic introduces a layer of uncertainty that must be carefully managed through robust modelling and customer segmentation.

From a customer perspective, variable consumption-based pricing could appear less predictable and harder to budget for, especially in homes with complex energy needs or limited flexibility. In contrast, fixed-price tariffs provide stability and are easier to communicate, but they weaken behavioural signals that are essential for decarbonisation and system efficiency. Commercially, there is also a risk in incentivising participation through rewards or subsidies (e.g. free thermostats), which may not be offset by the cost savings achieved through user flexibility unless participation and responsiveness levels are high. Balancing the cost of customer acquisition, equipment installation, and ongoing support with the financial and carbon benefits of flexibility remains a central challenge in making these innovative tariff models commercially viable at scale.

15.1.2 Wholesale price volatility impact

One of the key commercial risks in implementing dynamic, consumption-based tariffs is the inherent volatility of wholesale energy prices. In extreme market conditions — such as supply shortages, geopolitical events, or cold snaps — wholesale prices can spike dramatically with little warning. If a provider has committed to passing through dynamic price signals or has offered significant fixed incentives based on assumed average costs, they could be left heavily exposed when prices surge. Unlike traditional fixed tariffs where risk is priced in, a real-time or near-real-time model offers little buffer, making it difficult to insulate the provider from sudden and steep increases. This could result in delivering energy at a cost far exceeding the compensation received from customers, creating immediate and significant financial losses.

Moreover, these spikes in wholesale prices may occur at precisely the times when customers are least willing or able to reduce consumption—such as during extreme weather when heating or cooling is essential. In such scenarios, even a well-designed price signal might fail to induce sufficient behavioural change, undermining the very value proposition of the dynamic tariff. This limits the provider's ability to mitigate exposure through demand flexibility. Additionally, if these surges occur frequently or unpredictably, they can erode customer trust in the tariff model, reducing future participation and threatening the commercial sustainability of the programme. Providers must therefore develop sophisticated hedging strategies or risk mitigation tools — such as caps, floors, or capacity reserves — to balance the promise of flexibility with the very real danger of unmanageable wholesale price volatility.

15.1.3 HaaS models that use non-volumetric charging are not permitted to access government grants for heat pump adoption

In May 2025, the Department for Energy Security and Net Zero (DESNZ) published proposals for allowing third-party ownership agreements to be accessed alongside the Boiler Upgrade Scheme (BUS), which may facilitate some aspects of the Heat-as-a-Service models explored to date.[19] However, the changes do not enable non-volumetric charging, limiting the scope of the models.

The consultation states that DESNZ "is not considering allowing heat-as-a-service models alongside the BUS at this stage but will keep their longer-term role under review". DESNZ's view is that HaaS models are new and innovative and that the industry is not yet ready to offer such agreements. It characterises 'Heat-as-a-Service' as follows:

- The property owner pays a monthly fee linked to the amount of heat produced by the heating system rather than the energy consumed (either per unit of warmth produced or to maintain the property at an agreed temperature).
- The monthly fee typically includes the cost of the heating system, a maintenance package and an energy tariff.
- The provider owns the low carbon heating system throughout the term of the contract and there is typically no option for the property owner to own the low carbon heating system at any stage.

However, they are proposing to allow other third-party ownership models which do not represent a move away from volumetric charging. The proposed changes would enable scheme recipients to access hire purchase or conditional sale agreements. The consultation proposes:

- This would allow hire-purchase or conditional sale agreements to be bundled with an energy tariff alongside the BUS.

[19] Department for Energy Security and Net Zero. (2025) *Boiler Upgrade Scheme and Certification Requirements Consultation*. Available at: https://assets.publishing.service.gov.uk/media/6811d47bddb2b0afb5e04242/boiler-upgrade-scheme-and-certification-requirements-consultation.pdf (Accessed: May 2025).

- These must constitute two separate contracts to enable the consumer to switch provider or tariff should they wish without losing their heating system, but the provider could bundle them together into one monthly payment.
- The energy tariff must be billed in kWh to ensure property owners are able to more easily understand the price comparison between this and other payment models.
- Hire-purchase or conditional sale agreements would adhere to relevant consumer protections, while Ofgem licensing conditions would apply in respect of the energy tariff.

The consultation also seeks views on whether consumer hire agreements should be permitted alongside the BUS. In consumer hire agreements the consumer never owns the low carbon heating system, but instead leases the equipment for a specific period of time set out in the contract. The consumer pays a regular leasing fee.

The proposed changes may address some barriers for HaaS propositions to use third party ownership models, however there remains a barrier in terms of the ability of suppliers to move away from volumetric to outcome-based pricing.

The consultation is currently ongoing and therefore there is opportunity for prospective HaaS providers to influence the final design of the policy.

It is also important to note that the BUS is currently expected to end in 2028 and beyond this date the availability of grants to support the switch to low carbon heating technology is uncertain, although more detail on future policy may be included in the upcoming Warm Homes Plan. Therefore, any propositions that depend on the BUS for their viability may be vulnerable in the medium term.

15.2 Policy

15.2.1 Suppliers are required to bill consumers based on meter readings.

Domestic energy supply must be metered unless it is technically unfeasible to do so.[20] Condition 21B requires suppliers to take all reasonable steps to reflect meter readings in customers' bills or statement of account; in cases where access to remote meter readings is available, the supplier must provide accurate monthly billing information based on consumption.

This may present a barrier to HaaS propositions where the consumer is not charged based on a unit rate for energy consumed. However, it may be possible for HaaS suppliers to navigate this requirement by reflecting the meter readings in the bill while charging based on the

[20] The Electricity (Unmetered Supply) Regulations 2001 set strict criteria to decide what is eligible for an unmetered connection:

- The load must be predictable and either less than 500W; or
- It is impractical for the supply to be metered either technically, financially or for legal reasons (for example under Health and Safety law).

Typically, unmetered supply is limited to appliances such as street lighting or traffic lights that meet these criteria.

outcome. Regulatory uncertainty over whether this is permitted practice may present a barrier to development of innovative propositions.

Condition 22A requires suppliers to ensure that all charges are incorporated into:

- Zero or more Standing Charge(s); and/or
- Zero or more Unit Rates (or Time of Use Rates).

The inclusion of the wording "and/or" suggests that a supplier could choose to charge only a standing charge which could enable a consumer to be charged a fixed price independent of their energy consumption. Further clarifications may be required to confirm this. The condition limits the ability of HaaS providers to set rates based on outcomes delivered because these would not be considered either standing charges or unit rates.

Some tariffs available on the market charge consumers a fixed rate independent of the units of energy consumed. For example, Octopus launched its Intelligent Drive Pack in April 2025.[21] This tariff charges electric vehicle owners a fixed price of £30 per month for unlimited charging for one vehicle, with the supplier scheduling charging. Consumers must also have a separate Octopus tariff for their general household electricity supply.

Other tariffs bill consumers a different rate for energy used for heating compared to energy used for general household use. For example, the Ovo Heat Pump Plus tariff add-on charges consumers 15p per kWh for electricity used to power a heat pump, enabled by the heat pump API collecting data on the equipment's energy usage.[22]

15.2.2 Only one electricity supplier per household is permitted, meaning consumers must switch provider for all energy use to enter HaaS contract

If the bundle approach was split or a supplier agnostic model was offered, the HaaS offerings could be facilitated by households having a secondary supplier for their electrified heating, separate to the supply of other energy use. Current rules mean that only one company can supply electricity to a property at once (though a household can have different suppliers for gas and electricity). A proposal to introduce reform allowing multiple suppliers (Balancing and Settlement Code modification P379) was withdrawn in 2021 following a cost benefit analysis that identified a range of potential costs but with insufficient evidence of benefits.[23]

Studies are proceeding to determine whether it is feasible and desirable for households to have a secondary energy supplier that could be dedicated to specific assets, such as EV chargers.[24]

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[21] Octopus Energy. (2025) *Intelligent Drive Pack*. Available at: https://octopus.energy/smart/intelligent-drive-pack/ (Accessed: May 2025).
[22] OVO Energy. (2025) *Heat Pump Plus*. Available at: https://www.ovoenergy.com/heat-pump-plus (Accessed: May 2025).
[23] CEPA. (2020) *P379 Impact Assessment for Elexon*. Available at: https://www.elexon.co.uk/documents/change/modifications/p351-p400/p379-final-cost-benefit-analysis-report/ (Accessed: May 2025).
[24] Energy Systems Catapult. (2025) *Breaking the One Supplier Rule*. Available at: https://es.catapult.org.uk/project/breaking-the-one-supplier-rule/ (Accessed: May 2025).

15.2.3 Suppliers are required to provide information enabling consumers to compare and switch supplier

Licence condition 31F requires the electricity supplier to promote positive engagement by encouraging each customer to consider switching supplier and understand and manage the costs associated with that tariff and the electricity they consume.

Ofgem's Confidence Code for price comparison websites sets out requirements for websites providing gas and electricity tariff price comparison.[25] The Code does not require comparison of unit prices and therefore this would not present a direct barrier to HaaS propositions such as the one delivered on this project. However, thought would need to be given to the presentation of HaaS tariffs to allow consumers to compare them to traditional tariffs.

15.2.4 Some policy levies are recouped from energy bills through the unit price

16% of the final price of electricity is made up of policy costs. These raised £5.9bn from household energy bills in 2024. These levies fund schemes including: the Renewables Obligation, Feed-in Tariffs, the Energy Company Obligation, Warm Home Discount, and Assistance for Areas with High Electricity Distribution Costs. The Green Gas Levy is applied to gas prices.[26]

HaaS propositions that charge consumers for the outcome of a warm home rather than per unit of energy used would need to find an alternative way to apply these policy costs to consumer bills. This may make the implementation of HaaS more complex but would not prevent the products being offered.

15.3 Regulatory

15.3.1 Licensing and market participation rules

Entities that coordinate or dispatch flexibility, such as aggregators, may require a supply licence or need to partner with licensed suppliers to operate in the market. The regulatory framework for non-supplier flexibility providers (like aggregators or tech platforms) is still developing, and questions remain over responsibilities for balancing, settlement, and customer billing. Ofgem is progressing its work on a 'flexibility market reform', but current market arrangements may still create barriers for third-party participation.

[25] Ofgem. (2017) *Publication of the Revised Ofgem Confidence Code December 2017*. Available at: https://www.ofgem.gov.uk/sites/default/files/docs/2018/02/publication_of_the_revised_ofgem_confidence_code_december_2017.pdf (Accessed: May 2025).
[26] Nesta. (2025) *Household energy bills include green levies. What are they and why do we need to pay them?* Available at: https://www.nesta.org.uk/project/finding-ways-to-deliver-cheaper-electricity-by-rebalancing-levies/household-energy-bills-green-levies/ (Accessed: May 2025).

15.3.2 Tariff innovation and supplier obligation

Energy suppliers who offer non-standard, asset-specific or dynamic tariffs must demonstrate compliance with Ofgem's principles-based regulation, including fairness, transparency, and ensuring customers are not disadvantaged. This places a significant operational and regulatory burden on suppliers looking to launch new tariff models outside of trials. Additionally, suppliers must meet obligations under schemes like the Energy Price Guarantee and Warm Home Discount, which may not be straightforward to apply under innovative tariff structures.

15.4 Infrastructure

15.4.1 Half-hourly settlement

A primary barrier to enabling dynamic or granular time-of-use pricing models in the domestic energy sector is that the majority of households are not currently settled on a half-hourly basis. This means that their electricity usage is not reconciled against wholesale market prices in discrete 30-minute intervals, limiting the ability of suppliers to pass through real-time price signals or accurately reward flexible consumption behaviour. Without half-hourly settlement, the financial incentives intended to encourage customers to shift demand away from peak periods or toward times of system abundance are significantly weakened or delayed. This undermines the potential effectiveness of demand-side response strategies that rely on accurate temporal alignment between customer behaviour and system needs.

However, the technical capability for half-hourly settlement already exists for any domestic customer equipped with a smart meter. Under current regulatory arrangements, it is at the discretion of the energy supplier to enrol customers into half-hourly settlement arrangements, and many suppliers have begun doing so for segments of their customer base. More significantly, market-wide half-hourly settlement is set to become mandatory across Great Britain within the next two years, as per Ofgem's Market-Wide Half-Hourly Settlement (MHHS) programme. Once implemented, this change will facilitate much greater responsiveness in tariff design and system operation by ensuring all domestic electricity consumption is recorded and settled in alignment with actual half-hourly usage. This regulatory shift is expected to accelerate the rollout of innovative time-varying tariffs, enable more accurate price-based flexibility services, and better align consumer behaviour with the needs of a decarbonised, renewables-led electricity system.

15.4.2 Interoperability of assets

A key enabler for wider adoption and scalability of smart energy flexibility programmes is improved interoperability of domestic energy assets such as heat pumps, electric vehicle (EV) chargers, and battery storage systems. Currently, the market is fragmented, with many devices operating on proprietary communication protocols or being locked into specific software ecosystems. This limits the ability of aggregators and energy service providers to integrate assets efficiently, deliver consistent demand response services, and offer universal solutions across diverse brands and installations. If interoperability standards were more robust and universally adopted, it would greatly reduce technical integration barriers, allow for a wider pool of eligible devices, and accelerate participation in flexibility trials and commercial offerings.

This was a major limiting factor to conversion of users to the treatment group in this project. While numerous interfaces had been created and introduced using third-party support to maximise reach, there were still large parts of the market which were not able to be controlled. This will severely limit both uptake of propositions and also customer confidence in their potential success, as they may be attracted by offers which they are not technically able to access.

15.4.3 Limited penetration of compatible low carbon technologies

The potential for scale is fundamentally constrained by the limited penetration of compatible low-carbon technologies in the domestic sector. While adoption of EVs and heat pumps is growing, the absolute number of homes equipped with such assets remains relatively low, making recruitment for flexibility initiatives more resource-intensive and regionally uneven. As asset ownership becomes more widespread – driven by policy incentives, cost reductions, and decarbonisation targets – the addressable market for domestic flexibility services will expand accordingly. This growing base, when combined with improved technical integration, will enable more seamless and cost-effective scaling of smart grid initiatives, allowing suppliers and system operators to unlock the full value of domestic flexibility at a national level.

15.4.4 Billing resolution

A significant challenge in implementing accurate billing for smart energy flexibility schemes lies in the granularity and attribution of consumption data. Standard smart meters typically record total household electricity usage, making it difficult to distinguish the specific energy consumed by individual assets such as heat pumps or electric vehicle (EV) chargers. This lack of visibility creates complications when attempting to apply differentiated tariffs, assess savings, or allocate incentives based on asset-specific usage. Without precise data separation, customers may not receive accurate billing reflective of their participation or load-shifting contributions, and suppliers may be unable to reliably quantify demand response outcomes.

To address this, the deployment of sub-metering solutions has emerged as a potential requirement. Sub-meters can isolate and measure the consumption of individual devices, enabling more accurate and transparent billing processes. However, their integration raises several issues, including installation complexity, cost implications, customer acceptance, and data handling requirements. As the industry moves toward more sophisticated time-of-use and asset-specific pricing models, resolving these metering challenges will be essential to ensure fair compensation for participants and the financial viability of such programmes for suppliers and aggregators. Broader adoption of interoperable metering infrastructure and clear regulatory guidance will be critical in overcoming this barrier.

15.4.5 Technology cost

The commercial attractiveness of a proposition which requires significant capital spending to deploy remains uncertain. It can be assumed that a level of technological improvement in solar and battery assets in the period to 2030 can be assumed in terms of kWp density of solar panels and kWh density of typical domestic battery units. However, it is difficult to forecast the potential cost of these assets or the investment returns which could be available to consumers over the asset lifetimes, to pay the installation costs. The findings in this project do not show a simple route for return-on-investment if the asset cost is compared directly to the savings, though further innovation in the tariff to incorporate such pricing may be possible in future.

15.5 Wider barriers

15.5.1 HaaS models including finance products may be inaccessible for consumers with low credit scores

Regulated hire purchase and conditional sale agreements (proposed to be permitted in BUS) are regulated credit agreements protected by Financial Conduct Authority (FCA) regulations and the Consumer Credit Act 1974. This brings benefits for consumer protection e.g. firms would be required to carry out appropriate affordability assessments, deliver good outcomes for consumers, and would be subject to rules on the treatment of borrowers in financial difficulty. However, consumers are likely to be subject to credit checks in order to access these agreements, which may limit the ability of some low income and vulnerable consumers to access HaaS. Other consumers may pass credit checks but be unwilling to enter credit arrangements because of previous negative experiences of debt or credit arrangements. Consideration could be given to enabling these consumer groups to access these services while also maintaining high levels of consumer protection.

Around 4 million households currently pay for their energy through pre-payment meters[27] (PPMs), purchasing credit in advance of energy use. PPM customers are charged standing charges and unit rates and both smart and analogue prepayment meters are in use.

The suitability of heat pumps for PPM customers (and vice versa) has not been extensively researched, however there are potential risks around cost, efficiency and long-term health of the equipment. PPMs are often installed in properties as a response to customer debt. Customers can request a PPM, or an energy supplier can apply for a PPM to be installed without the consent of the householder. Current Ofgem guidance sets out rules that energy suppliers must follow before a PPM can be involuntarily installed.

It is not clear how Heat-as-a-Service propositions would be impacted by policy relating to PPMs. However, it seems unlikely that PPM customers would be able to access Heat-as-a-Service contracts which are reliant on access to credit and there may be technical barriers to applying non-volumetric charges to PPMs.

[27] https://www.ofgem.gov.uk/press-release/ofgem-sets-prepayment-price-cap-protect-over-four-million-households-least-able-benefit-competition

15.5.2 Gas wholesale prices

The core heating proposition assumes that consumers have already taken the decision to switch away from a gas-fired central heating system to an electric heat pump. Gas prices are, however, expected to be a key driver of electricity wholesale prices for the foreseeable future[28]. Fluctuating gas wholesale prices will, in combination with renewable generation availability, be a key determinant of short-run electricity wholesale prices, which will feed into domestic energy bills costs.

15.5.3 Consumer protection and consent

Any programme that involves remote control or automation of customer assets must comply with strict GDPR and consumer protection regulations. Explicit and informed customer consent must be obtained for data sharing, remote control, and billing based on dynamic pricing. Ofgem requires that energy suppliers clearly explain the terms of any smart tariffs or automation, and that customers retain control. These rules are more stringent under commercial conditions than in controlled trials and may slow down or complicate implementation at scale.

[28] Unless market reforms from the Review of Electricity Market Arrangements programme change the underlying basis of the electricity wholesale market. DESNZ: Review of Electricity Market Arrangements webpage – https://www.gov.uk/government/consultations/review-of-electricity-market-arrangements

16 Project reflections

At the conclusion of the project, all partners participated in a retrospective session to evaluate its overall performance. The objective was to identify and share which aspects of the trial were successful and why, to uncover and understand the key challenges and barriers encountered, and to generate practical ideas for improvement while defining priorities for the next phase. To structure the discussion, the retrospective was organised into key focus areas: trial design and modelling, technical integration, recruitment and participant support, and consumer research.

Capturing these insights is intended to enhance future projects by applying successful practices and avoiding recurring challenges.

16.1 Technical

16.1.1 Successes

Overall, the system performed effectively throughout the project. With the number of partners and integrations with complex data needs and analysis, it was a significant technical challenge to create the environment and conditions for users to experience the real-world trial. The changes to the energy supplier partner midway through the project, after the interfaces had been built with the original partner, meant significant rework of the solution, but this was successfully managed.

The level of service from dispatch partners was strong. When issues were identified, they were quickly analysed and resolved, to minimise the impact on the overall trial. The integration with Cornwall Insight systems for receiving components of the price signal, a key component of the overall solution, ran smoothly and delivered effective results from the first testing phase. This helped to keep the technical aspects of the project moving forwards. Similarly, initial integration with chargers was a successful process.

16.1.2 Challenges

While the solutions operated effectively, there were some early challenges with data quality which needed additional effort in validity checking before it could be used for the analysis tasks. This was only fully exposed when a larger number of participants were onboarded in the trial, which made resolution harder than if it had been found earlier in the process.

It proved to be difficult to forecast monthly heat pump energy consumption using the more simplistic archetype groupings which had been used at the outset. In future, it would be better to use HTCs or other similar metrics to improve the forecasting performance. An additional level of learning of home thermal characteristics before giving quote for HaaS would improve the overall outcomes. The analysis showed that, while the overall totals of energy used on the heating element were relatively accurate within a grouping, there were significant differences between the actual and predicted use of individual properties. A proxy based on bedrooms and build type of the house were used but was found to be inaccurate due to the large variation in house size for properties with the same number of bedrooms. If a HaaS proposition with a fixed monthly cost were to be taken further, it could be improved by using historical data to forecast the average monthly usage on an individual home basis.

At the start of the trial, there were some issues in getting dispatch signals turned into dispatch in a timely manner. Further testing with a larger pilot group would have improved our ability to identify these challenges earlier. It would also have helped to have consistent partners throughout, which would have enabled a unified integration test phase.

There were some difficulties in securing all dispatch data, particularly around the wholesale market. This was in part of product of redesigning the systems for different approaches to wholesale market data between suppliers but added to the intricacies of the analysis.

16.1.3 Key lessons learned

The availability of historical data for participants is essential for improving the accuracy of the offers. Where none was available or the data was incomplete, the delta between the offer made and potential optimal results was more significant. This is particularly important for the HaaS modelling. More time for a learning phase within a current or previous winter month would have improved predicted energy use.

Heat pump optimisation improved by giving the system additional pricing forecast data. Despite only ever having 48 half-hour periods available at any point, adding an approximation for a further 48 half-hour periods allowed for improvements in the optimisation. While the additional prices were estimates and may not be entirely accurate to the figures which came (as the figures beyond the day ahead were unknown), it helped to identify trends and improve optimisation decision making.

Overall, despite some challenges, the project has provided the technical viability of delivering such a solution, which creates a whole range of opportunities for innovative tariffs, technology offers and crucially flexibility in the future.

Closer battery integration provides an opportunity for future projects. While partially considered on this project, there were limits to the assets that were possible to integrate in the timelines. Batteries did change the opportunity within the tariff and could be explored further to find the optimal approach for the proposition in those conditions.

16.2 Recruitment and support

16.2.1 Successes

One of the key successes of the project was the ability of all participating parties to adapt quickly and respond flexibly to emerging challenges. As technical, operational, or recruitment issues arose, project partners collaborated effectively to adjust timelines, modify elements of the trial recruitment, and re-prioritise activities without compromising the overall objectives.

This adaptability was crucial in maintaining momentum and ensuring that the trial remained relevant and robust in the face of unforeseen constraints, including delays in data availability, integration complexities, and shifts in participant engagement levels.

Another notable success was the high level of enthusiasm shown by participants, particularly in relation to their data being used to support the trial. Many participants expressed a strong interest in how their involvement could help shape future energy solutions and were motivated by the idea that their real-world usage patterns could inform more sustainable, flexible energy systems. This positive engagement not only helped ensure consistent participation but also fostered a sense of shared purpose between households and the project team, contributing to the overall success and integrity of the trial. Participants were both excited and intrigued by the trial when providing feedback and keen to support new solutions.

There was excellent engagement for recruiting participants to be part of the overall trial. While the conversion to the treatment group had challenges, the overall cohort size including the comparison group was very successful. Digital marketing advertising was highly effective to achieve high numbers of user registrations on top of the funnel, with video content producing increased engagement.

Targeting specific user groups which had the key equipment required to be part of the trial with bespoke messaging also brought positive results. This was especially notable with the Homely database (for those with existing compatible heat pumps) and Tesla drivers once the direct to vehicle connection was in place.

Increasing the regularity of user communications helped to maintain the engagement. This was particularly important when there were changes (such as the change of energy supplier partner on the project), which delayed the ability of potential treatment group members to sign up.

Finally, in the final recruitment push, a new marketing agency was used. They had a strong client base in the market which had a transformational impact in the conversion of the final users to the treatment group. Taking the learnings from their approach, particularly the final conversion of participants through to trial participants, will be vital for future projects. Their success built on the effectiveness of the approaches to gaining initial interest and traction from other channels.

16.2.2 Challenges

Conversion from the initial interest or comparison groups to treatment groups was far more challenging than had been anticipated at the outset. A combination of factors including incompatible devices for control, needing to change energy supplier, the relatively short timelines of the trial and inertia in taking the next steps contributed to those issues. Gathering additional data earlier and potentially taking a group further through the process earlier might have helped to reduce the issues, though changes within the project may have meant this approach would have created different challenges. The digital marketing approaches which had proven successful to generate the initial interest did not prove to be as successful in the treatment group conversion phase. Alternative approaches were required which could potentially have been enacted sooner.

OFGEM's unexpected investigation into Tomato Energy[29] which subsequently meant it was not possible to onboard treatment group customers directly onto their tariff presented a major challenge late in the project. This was successfully mitigated by enabling them to stay on their existing tariff and refund them the difference which would have been saved on the Energy Sure tariff.

A key recruitment challenge encountered was the impact of seasonality on digital marketing efforts. Campaigns launched during warmer months saw lower engagement levels, likely due to reduced interest in heating-related propositions when demand is low. This seasonal mismatch made it harder to capture attention and convey the relevance of the trial, highlighting the importance of aligning recruitment timing with consumer needs and behaviours.

The marketing support from some partners was more limited than had been expected at project commencement. This meant that some of the routes to generating warm leads were not as readily available as expected. More upfront planning on 'art of the possible' with partner recruitment, including seeking more definite commitment of activities and targets, would have been advantageous.

Twitter and Reddit advertising proved to be less effective channels for recruitment than anticipated. Despite targeted messaging and audience segmentation, engagement rates were low, and conversions did not justify the investment. This suggests that these platforms may not be well suited for promoting technical or energy-focused trials to mainstream audiences, especially where deeper engagement or trust is required.

Changes to tariff structures and supplier approaches during the recruitment period created uncertainty and delays in the onboarding process. Potential participants were sometimes hesitant to commit while details were being clarified or revised, and in some cases, revised propositions required re-engagement or additional explanation. This slowed down the overall speed to conversion and introduced friction into the customer journey.

Greater benchmarking to existing tariffs on the market would have improved the overall offer to potential participants. While the overall bundles were likely to save money, some aspects of existing tariffs appeared too similar or more attractive which increased reticence to sign up. More detailed analysis of the tariffs would have helped to inform the messaging to overcome objections to sign ups.

16.2.3 Key lessons learned

The time taken to recruit participants for trial is always longer than anyone expects. Locking down an offer quicker and maximising the time to promote the scheme would be helpful to deliver similar projects in the future. Linked to this, having the ability to test the full onboarding journey sooner and understand drop off points would have helped to reduce the barriers and increase uptake.

[29] https://www.ofgem.gov.uk/publications/tomato-energy-limited-provisional-order

Specific targeting with bespoke messaging to distinct user bases that fit participant profiles is an effective tactic. While it is more time consuming to produce, the results prove worthwhile, and it is worth the investment to achieve this. Utilising specialist marketing agencies with an immediate route into likely customer bases can also save time seeking the same groups independently.

Using historical energy usage data to create more tailored, 'bespoke' bundles for participants attracts better results. Providing propositions that reflected customers' actual consumption patterns helped increase relevance, improve trust, and made the offer feel more personalised. This approach is likely to enhance engagement and conversion in future trials or commercial rollouts.

The non-heat pump and EV usage became a significant factor in the viability of the proposition. Supporting wider energy savings tips and more tailored content to help participants to stay within their bundle, or move to lower bundle options through better information, would increase the overall value of the full service.

If the trial was to be run for a longer period of time, there would be a need to be clearer on the value for heat pump users over the summer months. This would help them to determine the likely value they would receive from the offer.

16.3 Consumer research

16.3.1 Successes

The project achieved several key successes in the customer research area, contributing to a comprehensive understanding of participant experience and behaviour. One of the most valuable elements was the diary study, which offered rich, real-time insights into participants' day-to-day interactions with the trial and the technologies involved. This method helped researchers capture nuanced emotional and behavioural responses that would have been difficult to obtain through more traditional research methods alone.

The use of Mural as a collaborative planning tool also proved highly effective in mapping the overall research approach against the project's research questions. This ensured alignment across teams and helped maintain focus on core objectives throughout the trial. Collaboration between consumer researchers from both Energy Systems Catapult and Chameleon was seamless and productive, enabling consistent delivery of insights and a shared understanding of emerging themes.

A wide variety of research methodologies — both qualitative and quantitative — were deployed, ensuring a well-rounded evidence base. Regular research touchpoints were embedded throughout the participant journey, allowing for longitudinal insight and adaptive learning as the trial progressed. Encouragingly, participant engagement remained strong, with good levels of take-up and continued involvement, helping to validate the relevance and accessibility of the research approach.

A notable strength of the customer research was the enthusiasm and keenness of participants to actively share their ideas, experiences, and feedback. Many participants expressed a strong sense of purpose and engagement, seeing their involvement as a meaningful contribution to shaping the future of energy use and low-carbon living. This willingness translated into rich qualitative input during interviews, diary entries, and surveys, with participants often going beyond what was required to offer suggestions for improvement and reflections on their experience. Their openness and constructive feedback significantly enhanced the depth and quality of the research findings and underscored the value of involving end-users early and meaningfully in innovation projects.

16.3.2 Challenges

The ambitious scope of the trial created a complex customer journey, which, in hindsight, could have been simplified without compromising the ability to answer the majority of the research questions. While the intention was to test an end-to-end proposition as realistically as possible, the layered technical, tariff, and behavioural elements sometimes created friction for participants, which informed some of the responses in the participant research. Streamlining the journey may have reduced cognitive load on participants and helped focus more precisely on key behaviours and attitudes.

Recruitment delays significantly compressed the time available for consumer research activities. With some participants onboarded later than planned, there was reduced opportunity to observe and engage them over a sustained period, limiting the ability to track behavioural change or satisfaction over time. This curtailed the richness of longitudinal insights and necessitated a more reactive rather than exploratory research approach in some cases.

There were challenges with elements of the customer journey and customer support, which in turn had a knock-on effect on the research. Instances of delayed or unclear communication, unresolved queries, or inconsistent support sometimes led to frustration for participants, which understandably shaped their feedback. These operational issues added noise to the research findings, making it harder to separate insights about the proposition from those related to service delivery.

Communications to customers were variable in tone, clarity, and timing across different stages of the trial. While some participants felt well informed, others reported confusion or missed messages, particularly around switching requirements or the purpose of certain steps. This inconsistency affected not only customer confidence but also their ability to fully engage with the proposition and, by extension, the research activities.

Limitations of demographic diversity within the treatment group, particularly the underrepresentation of younger, lower-income, and ethnically diverse participants potentially impacted the overall market perceptions of the proposition. The majority of trial participants were older, affluent, highly educated, and owner-occupiers, who are groups more likely to have the required technologies and the time or financial flexibility to engage with an innovation trial. While this demographic was well-suited to testing the proposition, it limited the ability to explore the needs, behaviours, and barriers faced by other consumer segments. As a result, insights from the qualitative research may not fully reflect the wider public's attitudes toward automation, pricing structures, or trust in third-party control. Addressing this imbalance in future trials will be essential to ensure that flexible energy propositions are designed to be inclusive, accessible, and appealing across the full range of household types and lived experiences.

16.3.3 Key lessons learned

Several key lessons emerged regarding the customer experience and delivery of the user journey. First, while the web portal underwent usability testing, other critical components of the user experience — such as the app interface and smart charging setup — did not receive the same level of user feedback before deployment. Future trials would benefit from more comprehensive usability testing across all user-facing elements, helping to identify friction points and ensure a more seamless experience from end to end.

Simplifying the customer journey is also a priority. The project highlighted the importance of making the onboarding process as straightforward as possible to increase uptake, particularly in a trial context where users are more forgiving of limitations but expect clarity and ease. Embracing the fact that it is a trial and designing communications and interactions accordingly can help to manage participant expectations and foster greater engagement.

Running the trial for a full year would provide a more robust basis for both behavioural and consumption data. It would also allow researchers to observe seasonal variations in energy use and provide a longer runway for participant engagement, improving the richness and reliability of findings. A longer duration would support better planning and iteration, especially in a live environment. It would also open the potential to pilot new model, bundles or features based on the user feedback and potential solutions which factor in the HaaS benefits over the warmer months.

Developing a cross-team customer communications plan emerged as a critical lesson. Participants received messages from multiple parties at different points in the journey, which sometimes led to confusion or gaps in information. A unified communications approach, co-designed by all project partners, would help deliver a consistent and coherent experience across all customer touchpoints.

The focus of the research was on the treatment and comparison groups which had the relevant low carbon technologies to take part in the trial. Conducting further research with those who do not have the technology would allow more insights to the areas of both the proposition and technology which they would need to encourage adoption.

Lastly, better coordination of the user journey touchpoints across different teams would strengthen the overall experience. Mapping and aligning each interaction from recruitment to participation across all delivery partners ensures consistency and helps avoid duplications, conflicting information, or dropped steps in the process. A unified view of the customer journey enables smoother delivery and more effective evaluation.

17 Conclusion and next steps

In this final CAMEA report, there has been detailed analysis of the design, delivery, and evaluation of the trial, which involved multiple technical integrations, the creation of bespoke tariffs, and the recruitment of treatment and comparison groups across a range of household types. To wrap up the report, this section aims to make some general conclusion points and set out some next steps.

Flexibility unlocked by complexity of offer was challenging

To start with the points of conclusion, the hypothetical scenarios did allow some additional value of flexibility to be unlocked, which was a positive for the proposition tested, however it was not the single factor identified for allowing the proposition to be commercially viable or not. Instead, there were several other factors that consistently came up that had a greater impact on commercial success. Firstly, overall complexity was a problem for all parties but crucially including the consumer. The project was very aware from the outset that we needed to take as much complexity away from the consumer proposition, so that people could understand what is being sold to them. We had some success with this but ultimately it proved a significant barrier. One idea already discussed in this report that could help solve this problem is offering a full 'energy as a service' proposition. This would mean the entire energy bill is fixed, where our proposition had some fixed parts and some variable parts.

The need for the consumer to choose their service level was another complication that we would look to address as next steps to refine the proposition. For the EV group, consumers found it difficult to identify how many kWh they needed per month for charging and often ended up choosing a service level above what was needed. During the trial, Octopus launched 'intelligent drive pack', which offers unlimited charging per month for a single EV with no other strings attached. In the CAMEA trial, consumers were often unsure about penalties related with going over the allowance or from boosting and so this is one way we could have overcome this challenge. Equally with the heating bundle, 'maximum' or 'comfort' temperature was often a challenging concept for triallists. There could be other options here that do not involve maximum temperature but perhaps just include 2 or 3 heating schedules as choices for the consumer.

Capturing new installations will help future trials

Another key conclusion was that the proposition would work much better when combined with new installs than for consumers with existing low carbon technologies. Although this was not a specific area that was tested as part of the trial, it did become clear that trying to target people already with assets came with many challenges. These included that engaged consumers already with kit, often already had sophisticated setups they were happy with and a tariff that allowed them to take advantage of their setups. Trying to create a tariff proposition significantly better than what these consumers already to tempt them to switch and still worked commercially, proved a major challenge. This was particularly true for the EV group where there are already several cheap specialised tariff options on the market today. Where the project encountered consumers who may have recently bought assets or were in the process of doing so, they were much more receptive to our proposition and made up a significant proportion of the trialists particularly towards the end of the recruitment period. The fixed price nature of the tariff combined with a fixed price asset would lend itself well to a proposition that could also include some kind of financing element. This would also take away the financial barrier of acquiring the asset, supporting DESNZ's aim to roll out more LCTs in the UK. Given more time, this is the direction the project would move towards for both EV chargers and heat pumps.

Recruitment conclusions

Looking at the project's recruitment challenges; we did start to make improvements around eligibility, particularly for the EV bundle by extending the solution to work directly with EVs as well as chargers. A different approach with heat pumps such that a software integration could then allow Chameleon to have the ability to control multiple different manufacturers of smart thermostat, is also something the consortium would be keen to explore. This would be particularly beneficial as the proposition would not then need to include hardware installation such as the Homely thermostat required in the CAMEA trial. Retrospectively installing a smart thermostat with an existing heat pump installation proved difficult and expensive and so something to be avoided going forwards. If the smart thermostat install had been included with a fresh heat pump installation as part of the proposition, this would have proved easier than installing retrospectively as another option to a more generic software integration.

Supplier agnostic solutions

Furthermore, a more significant change to trial an agnostic solution that does not require an energy supplier is an additional avenue the project would want to explore. This takes the barrier of switching energy supplier away and again should give far greater eligibility for the proposition. Current regulatory barriers mean this still does not remain a realistic possibility in the short term. Ultimately, the value of flexibility extends well beyond optimised tariffs, with controllable assets and market participation enabling services such as Frequency Response and Demand Flexibility. While success depends on assets, smart metering, and consumer engagement, regulatory reforms such as P415 and enhancements to the Dynamic Flexibility Service are already widening access for behind-the-meter resources.

Looking ahead, national and local market reforms, supported by digital tools and common standards, will be critical in scaling flexibility, reducing peaks, and advancing decarbonisation. If achieved, these changes will unlock more diverse value streams, creating opportunities for supplier-agnostic business models that can share benefits more equitably with consumers, rather than leaving value solely in the control of energy suppliers.

Integration with batteries

Regardless of some of the bigger changes, improving the HEMS solution to also integrate with batteries is another clear next step. While we are still at the early adopter stage for these types of propositions, it disproportionately attracts people who already have multiple assets including solar and battery. Not being able to control the battery as part of the HEMS solution either means the energy supplier has to charge more than needed to compensate for the risk or otherwise loses out on the opportunity to supply the service at a cheaper cost for this group.

Currently the heating bundle has too much volatility in terms of how well the model can predict energy usage of the heat pump. One way this could be improved is by using technology to better identify thermal characteristics before a bespoke price for the bundle is given. This is possible with minimal intrusion to the consumer by using HTC calculations, for example, that just need one additional piece of hardware in the home to read internal temperature. This combined with other data sources that can easily be made available without too much action on the user, would allow a better understanding of the home's thermal performance. However,, this concept does come with other challenges to overcome, including the length of time users would have to wait before getting a quote and at certain times of year the technology may not work as well. Despite these challenges, it is something the consortium would be interested in pursuing and there is confidence it would significantly improve accuracy of the heat pump models to reduce risk for the supplier.

Customer perceptions

The qualitative research highlighted both the opportunities and challenges of engaging consumers with innovative energy propositions. Participants in the treatment group generally grew more comfortable with automated control of EVs and heat pumps, particularly valuing the comfort and convenience provided by heat pump automation. However, those without direct experience remained sceptical, with trust heavily dependent on transparency and clear communication. Across all groups, confidence was undermined where pricing lacked clarity or system behaviours were unexpected and difficult to override.

While cost savings remained the strongest motivator, fixed-price offers divided opinion, with some appreciating budgeting support and others perceiving limited value compared to existing deals. Trust was also shaped by brand recognition, with familiar providers inspiring greater confidence than newer entrants. Overall, the research underscored the importance of clear communication, visibility of system decision-making, and integration with wider assets such as solar and storage to build trust, deliver perceived fairness, and enhance long-term value for consumers.

Barriers

Barriers to the widespread adoption of HaaS and the proposition in true market conditions faces include market, regulatory, and infrastructure challenges. Volumetric billing rules restrict outcome-based tariffs, while wholesale price volatility increases commercial risks for suppliers. Although some policy changes may support third-party ownership, uncertainty remains, particularly with the planned end of the Boiler Upgrade Scheme in 2028.

Further barriers include unclear regulatory frameworks for non-supplier providers, limited interoperability between household assets, and the lack of universal half-hourly settlement, all of which constrain demand response and fair cost allocation. Vulnerable consumers may also be excluded, such as those on pre-payment meters or with poor credit, while fluctuating gas prices continue to affect heat pump competitiveness. Taken together, these factors highlight the need for regulatory clarity, market reform, and improved infrastructure before HaaS can transition from pilot projects to mainstream adoption.

Closing summary

Overall, the CAMEA trial demonstrated that automated dispatch of household assets can deliver meaningful shifts in electricity demand, particularly for heat pumps and EVs. Heat pump usage was successfully flattened across the day with overnight consumption increases, while

EV charging was concentrated in low-cost night-time periods. Scenario comparisons confirmed that dynamic, automated propositions achieved greater reductions in peak demand than both the national Profile Class 1 average and a comparison group of engaged low-carbon households, highlighting the added value of automation in enhancing flexibility.

The trial further showed that fixed-price service models offer reassurance to consumers, providing cost certainty and protection against market volatility, while shifting cost risk to suppliers. This incentivises suppliers to optimise asset use on an avoided-cost basis, unlocking flexibility that benefits the wider system. Market signals, particularly network charges, were the strongest drivers of behaviour, while wholesale volatility and policy levies had more limited effects.

It is possible that supplier-led control models could be extended to ESO and DSO flexibility markets, creating new revenue opportunities. However, the findings also underline the challenge of ensuring fair cost recovery as flexible consumers increasingly avoid policy and network charges. Regulatory reforms will be essential to maintain equitable contributions while enabling demand-side flexibility to scale, ensuring system costs are shared fairly and that the benefits of flexibility are accessible to all.

The learnings from this trial can help industry and other organisations considering such propositions.

18 Appendix

Figure 35 Choosing charging allowance

U1.1	I can choose the number of kWh I want in my service, based on multiples of a kWh minimum, which broadly equate to an estimated range of miles:
P1.1	Create a 'quoting tool' that helps users set the service levels (kWh allowance) they want in their contract, gives them the price to buy it, and an option to choose / buy it. Users can see both kWh and miles for their allowance, to help them understand how many miles their kWh allowance may typically cover.
R1.1	Determine whether they chose the optimum bundle based on their use and whether the learning in the trial would change their choice next time.

U1.2	I can choose my allowance based on the price, similarly based on multiples of a kWh minimum
P1.2	Show savings for overall quote (including 'everything else' usage and potentially 'heat pump' usage) against price cap Create pricing strategy for service cost per kWh, e.g. based on assumed (modelled) AEM retail price of power according to a typical overnight charging schedule with some additional savings for committing to fixed price. For users without solar/battery price per customer will be the same. For users with solar/battery, the amount of energy likely coming from consumption/generation for EV charging will be modelled to calculate the fixed price
R1.2	Capture data on chosen service price for each participant.

U1.3	You cannot rollover your kWh allowance
P1.3	Ensure users are aware they cannot rollover their allowance so the level they choose should be as suitable as possible. As per 2.1, users are updated on unused allowance to the user, so they can adjust how often they charge during the month.
R1.3	Using allowance usage data (2.1) explore with people why they have not been using their allowance / what could be better.

U1.4	Ideally, users do not change their service level (allowance) during your contract period.

P1.4	Ensure users are generally dissuaded from changing their allowance but are given a single opportunity during the trial. Try to maintain them on the same allowance, only amending more than once if we think it will have a likely outcome of them leaving the trial.
R1.4	Capture opportunities for changes in a real-life scenario – a goal is to determine whether the ivie app can support energy usage reduction, so the users need to be rewarded in a real-world operation if they are making those changes

Figure 36. Exceeding allowances

U2.1	If I regularly, significantly go over my kWh allowance, Tomato Energy reserve the right to change service level.
P2.1	Provide users with real-time status on allowance remaining. Be transparent in the 'fair use' policy being used for the trial.
R2.1	Capture data on usage above the allowance for each participant. Understand why some people are exceeding their allowances and gather their feedback on why/what could be better.

Figure 37. "Fair use / what you need to do"

U3.1	We ask you to keep your car plugged in when you're at home. This means we can charge your car and the cheapest times and ensure our service saves you and others money. Also to set standard charging settings (see 4. Charge level).
P3.1	Explain this as part of registration for trial and agreement when buying the contract. Identify when car is plugged in and ideally show to user if it is or is not (to help them know if they can set a charge / remind them to keep it plugged in). Send reminders to customers who are not keeping their cars plugged in to ensure maximum flexibility is unlocked. Also, to those who have not set their standard charge settings (see 4. Charge level).
R3.1	Capture when people are plugging their car in. Determine how much flexibility is unlocked compared to the comparison group. Analyse proportion of time spent with car plugged in, for each participant. Understand why people may not be plugging their car in (for those that did not much) and why it was not a problem for others.

Figure 38. Charge level

U4.1	We'll add the amount of charge you want, and by the time you want to add the charge.

P4.1	Ability to have a ‘set and forget’ default to minimise the need for users to be updating constantly on ‘typical’ days. Allow users to set and change preferred charge level and time ready.
R4.1	Capture allowances used each month for each participant. Capture EV charging usage each month. Understand why participants exceeded / did not exceed their allowances and gather feedback.

Figure 39. “Boosting”

U5.1	In case of emergencies you can boost your car charge (set to charge immediately) at any time.
P5.1	Allow users to boost through the ivie app. If boosts are being used extensively then send reminder to users to review their standard charging settings (see 4. Charge level).
R5.1	Capture boosts requested by participant with a time stamp and duration to understand often were people boosting, how long for and when were they boosting. Understand from participants why they were boosting / not boosting.

Figure 40. Other consumption

U6.1	Your other energy consumption (e.g. lighting, appliances etc) will be charged based on kWh and your Tomato Energy tariff. This includes heating if you are not using our heat service.
P6.1	Calculate EV energy (and heat pump usage) to provide to Tomato Energy for final reconciliation of billing changes.
R6.1	Provide update on ‘everything else’ usage to triallists at least once during the trial to see if they are currently in credit/debit and see if behaviour changes.

Figure 41. Contract duration

U6.1	Your service will run until the end of the trial (end of March 2025)
P6.1	Confirmation of the start and end date of the trial for each participant is needed. Explain to users that they will only pay for their service until the end of the trial. People can leave before the end of the trial but may be billed for any free equipment installation gained from the trial (will be clearly set out in the T&C’s). At the end of the trial the users will automatically switch to a standard Tomato Energy tariff where they will be free to switch to any tariff in the market if they wish.
R6.1	n/a

Figure 42. Choosing a heat allowance

U1.1	I can choose a maximum (target) temperature in my service, from 18 to 23°C
P1.1	Create a 'quoting tool' that helps users set the service levels (maximum temperature) they want in their contract, a price for this service level, and an option to choose / buy it. The price needs to change as the maximum temp is changed. Maximum setpoints can be selected in 1°C intervals. This is a maximum target temperature, though we may choose to overheat from this temperature if it fits better with the optimisation schedule and saves costs overall to an agreed limit of +2°C. A pricing strategy and method needs to be developed. Key principles include: • The price is 'bespoke' for each home, based on the archetype. This includes taking into account whether the user has solar/battery. • An algorithm would need to (automatically) price the service, and allow users to see a new price as they change their maximum temp level on the app. • This maximum temperature 'allowance' means participants can set a schedule of different temperatures at different times of the day if they wish. Previous research from ESC shows how people do value variation in temperatures at different times, sometimes in different spaces (if control is available). Having a 'range' means people can set a schedule.
R1.1	Capture data on the final chosen temperature for each participant Explore through interviews reasons for differences between recommended and chosen. Capture data comparing the time spent at each set point compared to chosen max temperature allowance (how much to people stick to the maximum temperature allowance they chose). It could be expected that some users may "take advantage" of the maximum set point and set a 24/7 schedule at the maximum, whilst others may not. We want to know how likely it is this happens to understand the differences in comfort that people set vs their allowance. Analyse "profit" (difference between heat pump running cost and service revenue) for each participant, with the likelihood of time spent at the maximum temperature allowance. Do those people that spend more time at their maximum temperature allowance result in less profit / higher cost to serve i.e. is it a problem if people spend more time at max temp?.

U1.2	Your service includes keeping your home at or above a defined minimum temperature, unless you have scheduled it to be warmer, or set boosts / overrides. Your heating control schedule app may not show this, but it's part of the smart programming to make sure your heat pump is operating in the most efficient way.

P1.2	This will be using default Homely behaviour, and so we can use existing documentation to explain the principle to participants, and how the heating controller operates its optimisation accordingly.
R1.2	Capture data on the final chosen temperature for each participant. Determine the flexibility unlocked across the temperature bands. Explore through interviews reasons for differences between recommended max temp and chosen max temp.

U1.3	Your heating controls will aim to reach your service maximum temperature – we're not guaranteeing your home will reach that temperature as each home is different in how it can be heated.
P1.3	User needs to be made aware that their max temperature level is not the actual, but a setpoint. Users also need to know that their setpoint is based on the thermostat(s) in their home, positioned in the rooms as advised by the heating controller. They should be told these thermostats should not be moved.
R1.3	n/a

U2.1	You get “unlimited” hot water for a fixed price, based on how much hot water you typically use.
P2.1	A pricing strategy and method for hot water is required, which could be based on based on average energy consumption for hot water for different archetypes. Savings due to any access to flexibility could be applied, but it’s understood that the opportunity for flex with hot water may be limited. The Homely app allows the user to schedule water heating. The Homely app allows the user to boost water heating.
R2.1	n/a

U2.2	You can boost your hot water in case you run out for no extra cost, as hot water is unlimited in your service
P2.2	Users should ideally be aware that boosting hot water can mean their heating will not operate whilst water is being heated. Hot water boosts should be limited to a time period (as per Homely UI)
R2.2	Capture number and duration of hot water boosts for each participant. Through qual interviews explore hot water boosting preferences / behaviour to understand why they did it and how satisfied they were with their hot water levels, and the understanding of it being unlimited.

Figure 43. (Space) Heating Boosts

U3.1	You can boost / override your heating in case you are not warm enough.
P3.1	Allow users to boost through the Homely app. Users will be contacted if they consistently use the boost function or exceed the maximum service temperature. See 5 'fair use'
R3.1	Capture number and duration of heating boosts for each participant (who were the boosters, how much did they boost). Through qualitative interviews explore boosting preferences / behaviour to understand why they did it and how satisfied they were with their boosting.

Figure 44. (Space) Heating Schedule

U4.1	You can create a heating schedule (as long as all setpoints are at or below max temperature in heating service level purchased)
P4.1	Through the Homely app, ability to have a 'set and forget' default to minimise the need for users to be updating constantly on 'typical' days. Allow users to create heating setpoints at different times of the day/week
R4.1	Capture allowances used each month for each participant.

Figure 45. Applying flexibility

U5.1	We may sometimes heat your home up to 2°C higher than your maximum chosen temperature level, with the aim of aligning as closely as possible to your scheduled temperature setpoints. This may typically be overnight, and it's done to use the cheapest, greenest energy possible and get your fixed price energy service savings.
P5.1	Explain this principle as part of the service terms Apply Homely optimisation control
R5.1	Identify when "flexibility events" occur and how long for – represented as a proportion of time that the home was heated higher than the set point Understand if people noticed the temperature increase, and any problems / concerns with it (e.g overheating overnight).

Figure 46. Fair use

U6.1	Please be fair with your maximum temperature – we're keeping an eye on your schedule and if you're going above your maximum more than we expect, we may contact you to change the price of your plan.
P6.1	Monitor set points vs maximum service temperature level and flag if exceeded e.g. exceeding max service setpoint temp level for more than 5 hours in a week. Provide tips to ensure users are clear on how to maintain the temperatures e.g. keeping doors and windows shut except for reasonable ventilation

R6.1	Use maximum temperature monitoring report to explore with those exceeding the max temp regularly why they are doing that and suggest a new service price and get feedback. For example would they buy the new level?

Figure 47.Other energy consumption

U7.1	Your other energy consumption (e.g. lighting, appliances etc) will be charged based on kWh and your Tomato Energy tariff. This includes EV charging if you are not using our heat service.
P7.1	Calculate heatpump energy (and EV charging energy) use to provide to Tomato Energy for final reconciliation of billing changes.
R7.1	Provide update on 'everything else' usage to triallists at least once during the trial to see if they are currently in credit/debit and see if behaviour changes.

Figure 48. Contract duration

U8.1	Your heat contract will be for the duration of the trial. Cost per month will be based if the tariff were to be applied over a 12-month period. As the trial will just be run over the Winter this is to the advantage of the consumer and they would not be expected to pay any balancing costs for the trial to take this bias into account.
P8.1	Requires some explanation for this, but should allow for representative pricing if we were to launch the tariff for real and support signups in terms of better savings over the Winter period. Confirmation of the start and end date of the trial for each participant is needed. Explain to users that they will only pay for their service until the end of the trial. People can leave before the end of the trial but may be billed for any free equipment installation gained from the trial (will be clearly set out in the T&C's) At the end of the trial the users will automatically switch to a standard Tomato Energy tariff where they will be free to switch to any tariff in the market if they wish
R8.1	Capture start / end date of each participant contract

Figure 49. ivie Energy Sure Onboarding Process

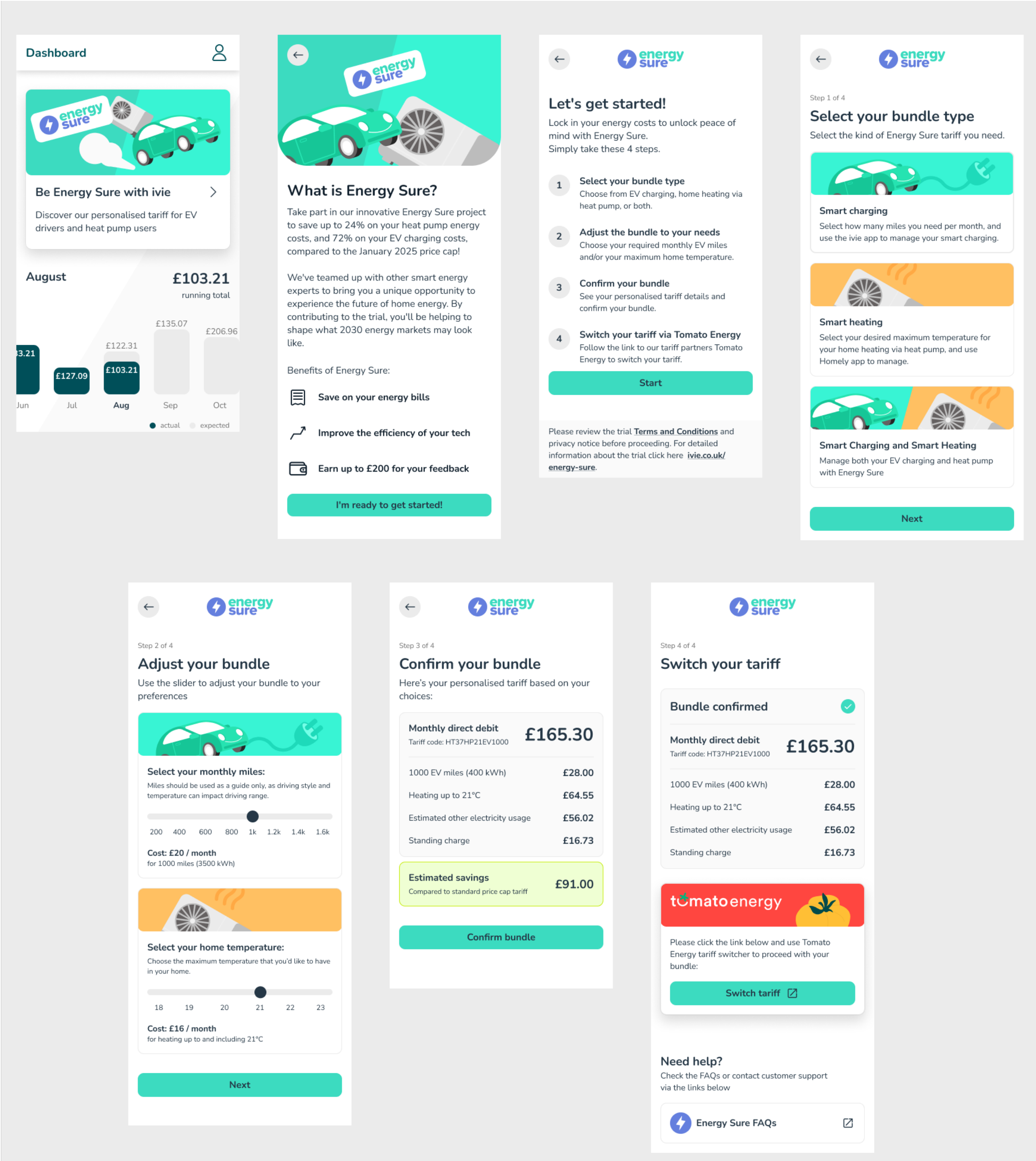


Figure 50. Treatment group email

Hey 👋

Thanks for your interest in the ivie Energy Sure project. We're reaching out to let you know that we have started to assign **the free ivie Bud** in-home energy displays, worth £49.99, to Energy Sure participants.

In order to claim your free ivie Bud, you need to have signed up to the free ivie app and linked your smart meter to your app account.

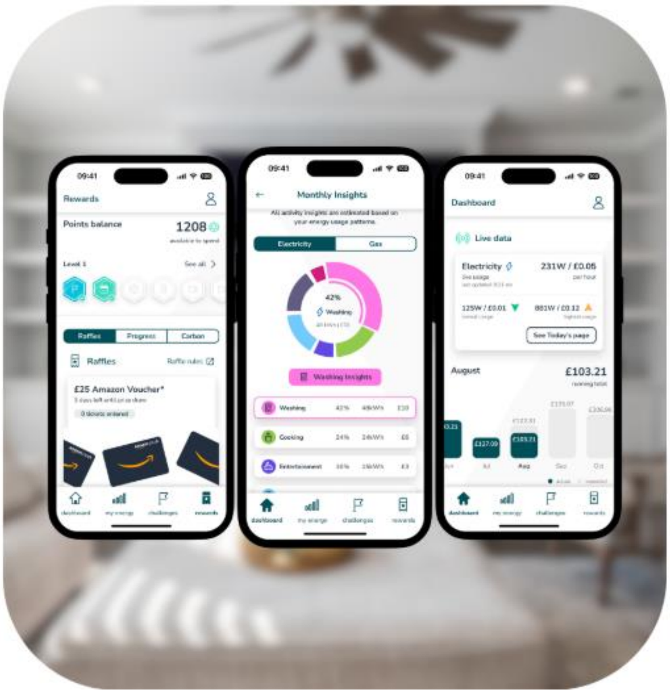
Download the free ivie app now

Available on the App Store | GET IT ON Google Play

Once we can see your app account linked to this email account, you will be contacted with details on how to claim your free ivie Bud. Without creating an ivie app account, you won't be able to claim your ivie Bud.

If you have already got the ivie app, but signed up using a different email address, please contact us HERE so we can make a note in our records of your existing account.

Decode smart meter data with the free ivie app



Getting started with the free ivie app is quick and easy. You'll be asked to make an account, and to add a few details to your home profile – such as how many people live in your home, and what kind of energy tariff you're currently using.

If you are currently on a multi-rate tariff that is not currently supported by the ivie app, such as Octopus Agile, simply select the default single-rate tariff choice.

This won't affect your consumption data inflow – you will still be able to see how much energy you're using at home, with our Activity Insights breaking down your energy use into different categories. However it will mean the listed cost of your energy will be incorrect.

We're working on adding more tariffs to the ivie app. For the purpose of this trial, selecting a single-rate or two-rate tariff will still allow you to use the app and connect to your smart meter, and enable you to claim your ivie Bud.

If you need some help or have any questions, please check out our useful blog about the ivie app HERE, or get in touch with our Customer Care team HERE.

On average, ivie app users save 18% on their electricity usage, and 24% on their gas usage!

Not only does the ivie app help you understand your energy data and give you personalised suggestions on how to save, but it also rewards you for your efforts! Receive ivie points for saving energy, and use these points to enter weekly raffles for the chance to win prizes.

See real-time, live data in the ivie app only with the ivie Bud in-home display. Once you have the ivie app, you can claim and connect your ivie Bud to unlock real-time energy data in the app for even more accurate energy usage info.

If you have any questions you can always email us at hello@ivie.co.uk.

Thank you so much for your time and support.

Best wishes,
The team at ivie

Figure 51. Comparison group email

ivie

Be Energy Sure

Hi,

Thank you again for signing up to hear more about the ivie Energy Sure project.

Our team has been working hard over the past few months to lay the foundations and build the digital architecture needed to trial a brand new style of home energy tariff.

We're now able to lay out the roadmap of the ivie Energy Sure project, and what that could mean for your involvement.

A quick reminder

With ivie Energy Sure, we are trialling the concept of fixed-cost energy tariffs, regardless of how much energy you use. Think of it more like a Spotify or Sky TV subscription, but for home energy.

Unlike variable tariffs priced by time or demand, we suspect fixed-cost tariffs that are coupled with optimising low-carbon technologies, such as heat pumps and electric vehicles (EVs), will be the most effective way to manage energy use as the UK shifts away from fossil fuel reliance.

Customers get the assurance of cheaper energy bills, and knowing what they will pay each month, without having to change their lifestyle or give up any home comforts.

We are running this trial with a cohort of other brands, as part of a wider project with funding from the government's Department of Energy Security and Net Zero, over the 2024-25 winter period to test our hypothesis.

Your low-carbon technology is not currently eligible

When signing up to hear more about the project, we asked you about what low carbon technologies you have at home.

According to your answers, your home's EV charger and/or heat pump is not currently compatible with our system. Unfortunately this means that your participation in the project would be limited, as you would not be able to link your assets to the ivie app and qualify to switch to the project's special energy tariff.

However, you can still participate in the trial and become part of our project's **Control Group**.

About the ivie Energy Sure Control Group

Even if you're not compatible with the Energy Sure system that would enable access to the special tariff, we would like to invite you to form part of our Control Group.

This will allow us to compare the data from trial participants on this new tariff to homes on existing tariffs, and help us learn whether Energy Sure provides the benefits we hope it will.

Being a part of the Control Group would require little to no effort on your part, while also giving you the opportunity to help shape the project and receive incentives.

Being a part of the Control Group means that...

– You will be invited to participate in an additional consumer survey with a cash incentive for completion.

– Your energy usage data will be anonymously used as a baseline, to help the learnings of the project.

As your assets are not compatible with the project, that means that you will **not** need to:

– Link your EV charger or heat pump via the ivie app.

– Switch energy supplier or tariff.

Next steps

All you would need to do to become a part of the Control Group is to download the free ivie app, if you don't have it already, and link your smart meter. You can track and analyse your home energy use via the app, and receive rewards when you use less energy than expected.

Download the free ivie app here

The Energy Sure trial will officially begin on **1st November 2024,** and conclude at the end of **March 2025.**

We understand that you may be disappointed that you won't be able to switch to the Energy Sure tariff, but becoming a part of the Control Group would still contribute to the trial in a huge way.

There are still some great incentives for joining, and the group is a crucial piece of the wider puzzle of this trial. The Control Group will go a long way to helping us build a better understanding of the tariff's effect, and contribute to the research supporting the UK's wider targets for decarbonisation.

If you do not wish to be part of the ivie Energy Sure Control Group, please let us know by emailing us at hello@ivie.co.uk. We will then confirm via email that you have been removed from the group.

If you do not contact us then we will automatically enrol you in the Control Group.

If you have any additional questions about ivie Energy Sure please do let us know.

Best wishes,
The team at ivie

Getting started with the free ivie app is quick and easy. You'll be asked to make an account, and to add a few details to your home profile – such as how many people live in your home, and what kind of energy tariff you're currently using.

If you are currently on a multi-rate tariff that is not currently supported by the ivie app, such as Octopus Agile, simply select the default single-rate tariff choice.

This won't affect your consumption data inflow – you will still be able to see how much energy you're using at home, with our Activity Insights breaking down your energy use into different categories. However it will mean the listed cost of your energy will be incorrect.

We're working on adding more tariffs to the ivie app. For the purpose of this trial, selecting a single-rate or two-rate tariff will still allow you to use the app and connect to your smart meter, and enable you to claim your ivie Bud.

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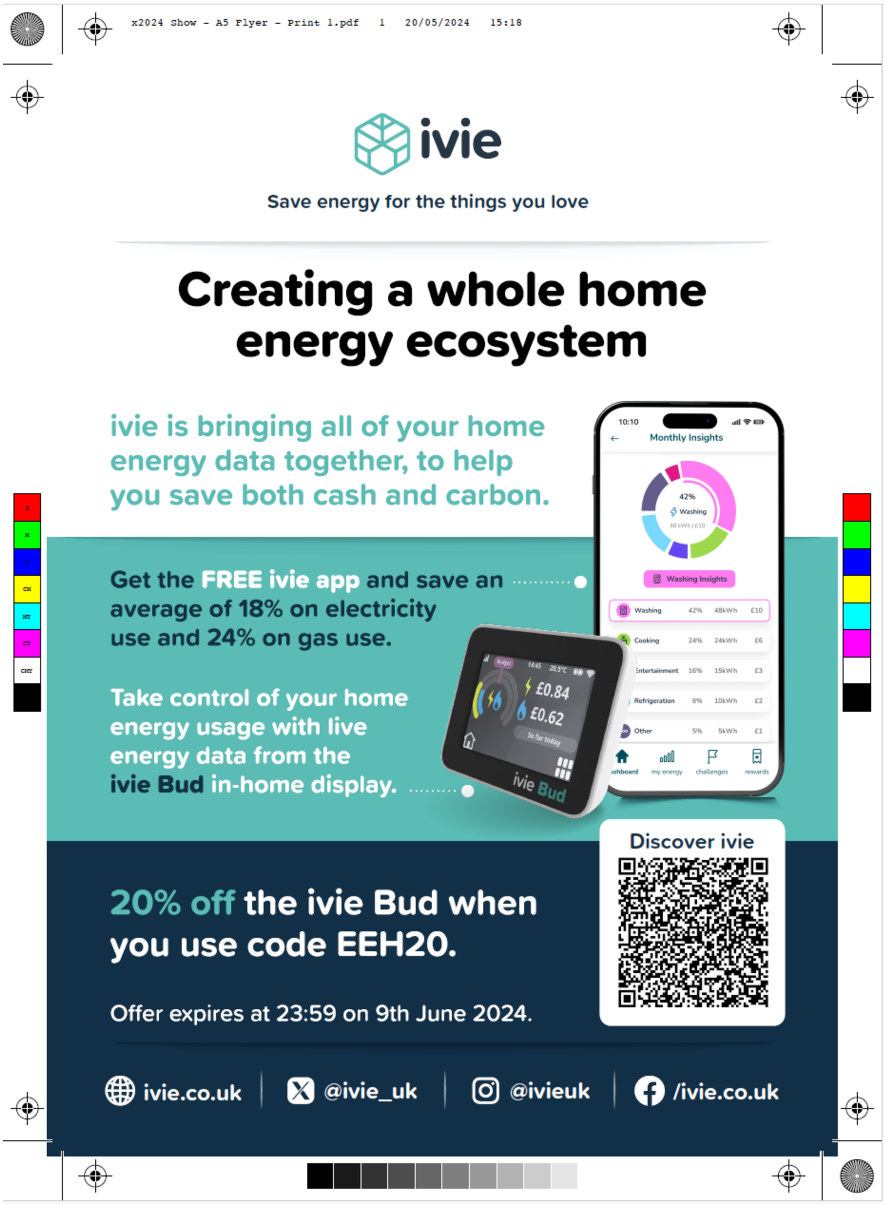
If you have any questions you can always email us at hello@ivie.co.uk.

Thank you so much for your time and support.

Best wishes,
The team at ivie

Figure 52. Everything Electric - Harrogate - A5 Flyer



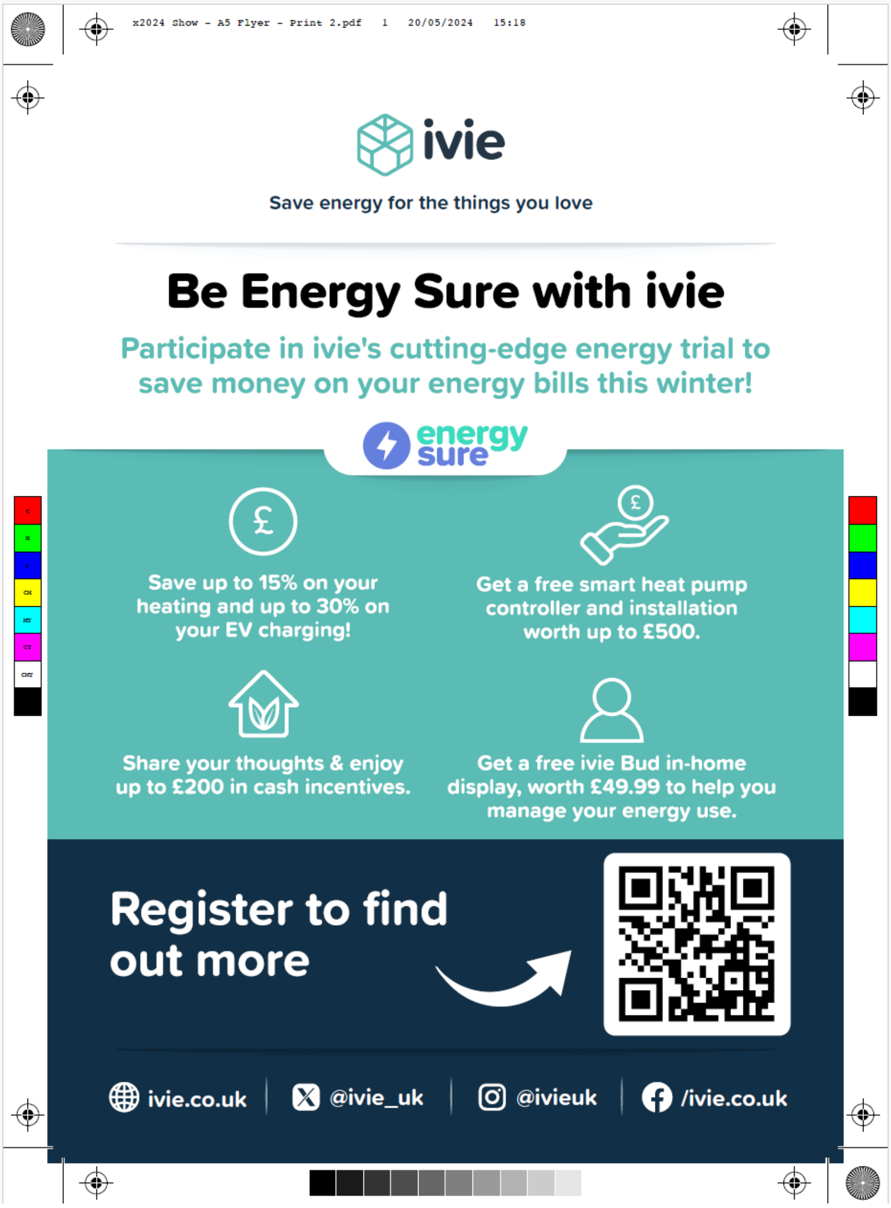

x2024 Show - A5 Flyer - Print 2.pdf 1 20/05/2024 15:18
ivie
Save energy for the things you love
Be Energy Sure with ivie
Participate in ivie's cutting-edge energy trial to save money on your energy bills this winter!
energy sure
Save up to 15% on your heating and up to 30% on your EV charging!
Get a free smart heat pump controller and installation worth up to £500.
Share your thoughts & enjoy up to £200 in cash incentives.
Get a free ivie Bud in-home display, worth £49.99 to help you manage your energy use.
Register to find out more
ivie.co.uk
@ivie_uk
@ivieuk
/ivie.co.uk

Figure 53 - Energy Sure website