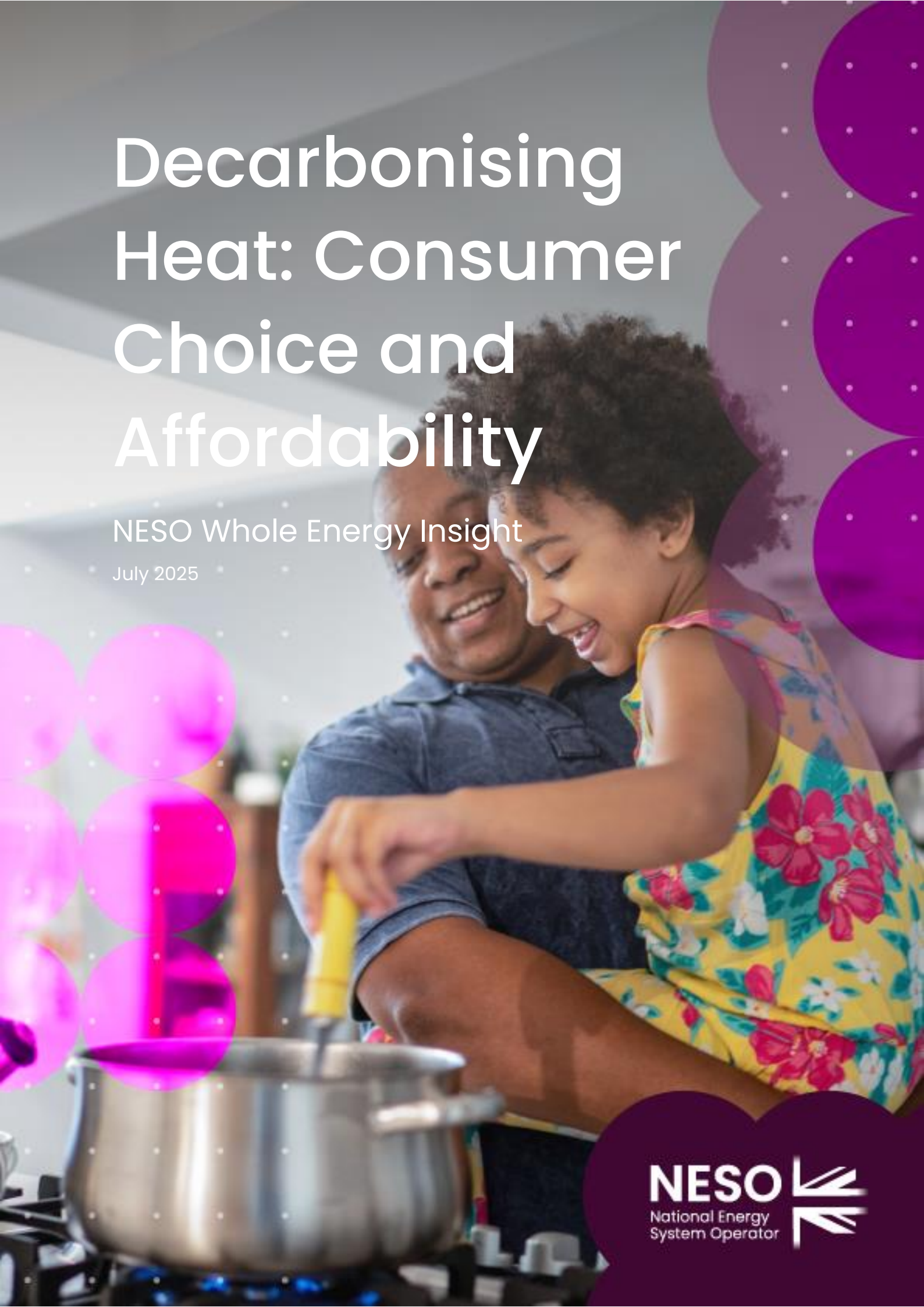
Decarbonising Heat: Consumer Choice and Affordability

NESO Whole Energy Insight

July 2025



NESO
National Energy System Operator

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Executive summary

The decarbonisation of residential heat is one of the biggest challenges to achieving net zero. This insight draws on a nationally representative survey of nearly 10,000 households conducted by Public First on NESO's behalf. It explores how people choose, operate and afford their heating systems, and how those choices affect the broader energy system.

From our survey, we draw out three barriers to the uptake of low carbon heating:

- **Low consumer familiarity** with alternative technologies and available support
- **High upfront-capital cost** compared to direct replacement of existing systems
- **Longer payback** period relative to like-for-like replacement

The study findings point to important equity concerns and difficult trade-offs during the current financial climate. Low-income households are at risk of being locked into poor value options. Without tailored support, vulnerable households may invest in systems that may be financially palatable in the short term but could result in higher bills, and higher long-term system costs – for example lower upfront cost systems such as direct electric. More support is needed in the early stages of adoption to help households move away from gas boiler replacements to choices that will deliver a cost-efficient pathway.

Despite the challenges, this research points to several areas of opportunity, suggesting a pathway to adoption is possible if the right support is in place.

- Many households are unfamiliar with the range of low carbon heating technologies available. Tackling this begins with targeted awareness campaigns, focused on potential early adopters, and trusted intermediaries, like installers.
- Clear long-term signals on the need to transition away from natural gas can build consumer confidence in low-carbon choices. Grants and finance options that reflect household tenure, income, and the system value of efficient, flexible and clean heating can support the participation of those consumers who will benefit the most.
- Consumers want short payback periods. Lowering bills via flexible tariffs, attractive to many households, can provide benefits to consumers and the system, alongside bringing down the cost of electricity relative to gas to improve the economics of electrified heating.
- Landlords were found to be relatively open to investing in low-carbon systems. Supporting this group could familiarise renters, normalising low-carbon heating and accelerating uptake among renters who will go on to become homeowners.

Heating choices influence far more than emissions. By integrating behavioural insights into energy system planning, NESO can support the alignment of household choices and system outcomes, helping to make the heat transition not only technically feasible, but deliverable at scale.

1 What have we learnt from our survey?

1.1 The challenge of decarbonising residential heat

The transition to low-carbon heating is fundamental to reaching the legislated target of net zero emissions by 2050. Great Britain has made significant progress in reducing carbon emissions, largely driven by the phase-out of coal generation and increased deployment of renewables. However, residential buildings continue to contribute a large proportion of domestic emissions.

The residential building sector is the second-highest emitting sector in the UK, totalling 12% of UK emissions in 2023 (52.2 MtCO2e). Most combustion emissions from residential buildings are driven by using fossil fuels for heating and hot water (96%). To decarbonise home heating in GB, homes will need to switch away from fossil fuel-based heating systems, such as gas or oil boilers, to mainly electrified systems. Heat pumps, whether installed in a property directly or as part of a heat network, are expected to be the dominant low carbon heating technology. For example, the Climate Change Committee's (CCC) Balanced Pathway assumes 80% of homes will have a heat pump by 2050, and the remaining 20% of homes will use a different electrified heating system, including heat networks or direct electric heating. NESO's Future Energy Scenarios see significant heat pump deployment, alongside other low carbon technologies.

However, there is still a long way to go to decarbonise home heating in GB. There are approximately 24 million gas boilers and 1.4 million oil boilers in GB comprising around 87% of home heating systems. Low carbon ready heating accounts for around 10% of homes. The majority of this is electric heating (such as storage heaters, electric boilers and heat pumps) with low carbon district heat and biomass boilers accounting for around 0.6% and 0.2% of homes respectively.

The heating systems consumers choose to install between now and 2050 will have a significant impact on how we operate and plan GB's energy system of the future. Growing electricity demand from heat could create a more substantial load on the system at peak times, but ensuring efficient systems and flexible operation will help minimise this. There remains uncertainty over the role of hydrogen for heating and the potential investment required or spending to decommission parts of the gas network. As fossil fuel heating installations decrease, we need to understand what heating systems consumers are likely to install in their homes over the next 25 years, how consumers might choose to operate their heating systems, and how those trends might be influenced.

Decarbonising residential heat happens at the household level and relies on consumers being motivated and supported to choose low-carbon alternatives to fossil fuel options. However, studies show that awareness of low-carbon alternatives needed to support uptake, is relatively low. There are many different factors which influence heating system choices, including installation and operating cost, system lifetime and whether the

purchase is in response to a system breakdown. To add to this, there will be a variety of low carbon heating options to choose from.

NESO worked with Public First to conduct a representative survey of approximately 10,000 respondents and eight focus groups, across GB.[1] Given there is a wide range of heating options available to consumers; to keep the survey manageable, we selected a subset to represent all the key technology groups available today. You can find further information on the approach to the survey, focus groups and results in the accompanying report: 'Domestic Heat Decarbonisation Insight: Final report'.

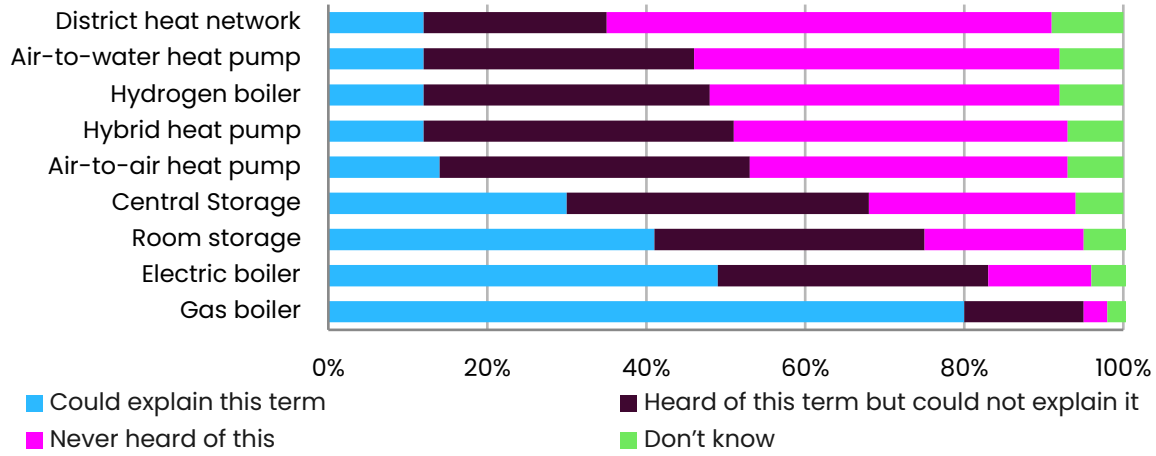
1.2 Low familiarity of low carbon heating risks delaying decarbonisation of heat

The survey results demonstrated a lack of familiarity of low carbon heating systems as well as the impact that home heating has on the environment. For example, whether somebody had a gas boiler was only considered the most important factor impacting how environmentally friendly a person's lifestyle was by 21% of respondents, despite the contribution they make to emissions.

Familiarity and knowledge surrounding different low carbon heating systems was relatively low. When asked to report on their understanding of different heating technologies, 95% of adults were familiar with gas boilers (Figure 1). Electric boilers were relatively familiar (80%) and almost half of respondents also felt they could explain what an electric boiler is. However, for all types of heat pump system included or hydrogen boilers, over 40% of adults had "never heard of this term". District heat networks fared even worse with 56% of adults having "never heard of this term". If low levels of familiarity persist, consumers will be less likely to seek out low carbon alternatives to their existing heating systems, slowing adoption and potentially impacting on the ability to meet carbon budgets.

[1] Underlying data provided on request. For any questions please contact: box.fes@neso.energy

Figure 1: Reported familiarity with different heating technologies.

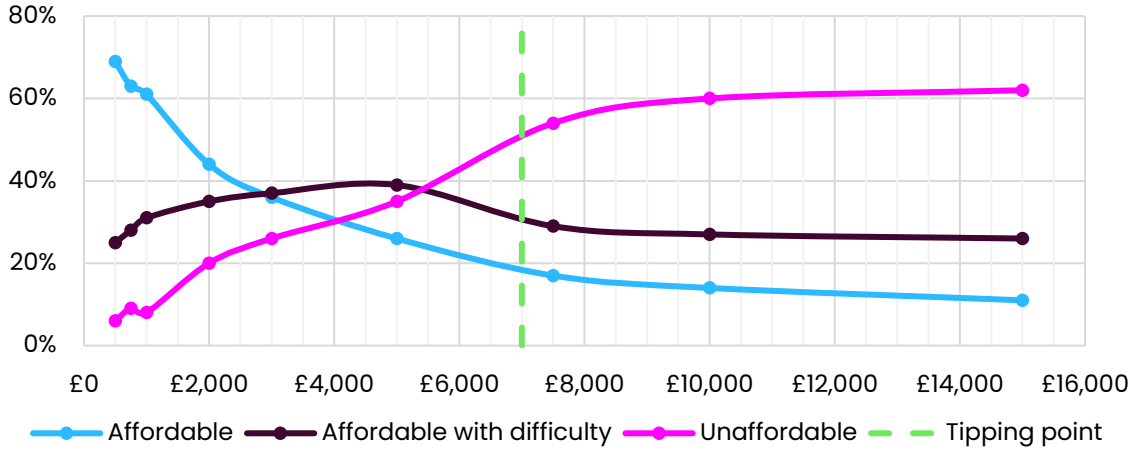


Survey question: How familiar are you with the following types of heating systems? Note: Percentages represent the proportion of respondents who selected each option.

1.3 High upfront costs are a major barrier to adoption

Once familiarity and confidence in the available options increases, installation cost becomes a key factor for consideration. When looking at the impact of upfront cost, the reason why consumers install a new system should be considered. Wider analysis suggests that a heating system purchase is often a result of breakdown, meaning that installation costs may not be explored in advance. We have therefore characterised this barrier as the 'sticker shock' barrier.

Figure 2: Homeowner affordability of a technology-agnostic heating system at different levels of upfront cost.



Survey Question: Imagine your heating system needs replacing, and the best value for money replacement you could find was £X, which of the following comes closest to your view? Note: Percentages represent the proportion of respondents who selected each option.

In the future, when their heating system needs replacing, consumers will have to decide whether to adopt a low carbon heating technology or replace a gas or oil boiler like-for-

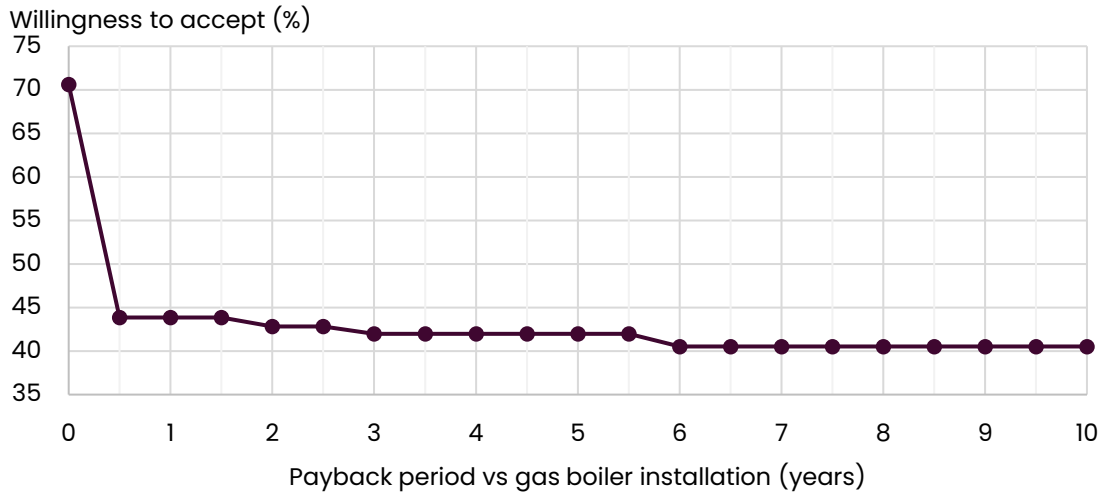
like. As familiarity with different low carbon heating systems becomes more widespread, upfront cost will become a key barrier. Under a technology-agnostic scenario, the survey demonstrated a majority of homeowners (65% total) found an upfront cost of £5,000 either "affordable" or "affordable with difficulty". The tipping point occurred at £7,000, above which more than 50% of homeowners found this cost "unaffordable".

1.4 Once upfront costs are acceptable, a clear operating cost benefit is needed

Even when the familiarity and sticker shock barriers are addressed, payback period remains a critical hurdle. The payback period of a low carbon heating system is the time taken to recoup the upfront investment in the system through lower running costs relative to the price of a like-for-like heating system replacement.

The survey showed that the majority of consumers seek payback in well under a year. Willingness to accept the payback period drops significantly after this point (from 71% to 44%) but remains consistent as the payback period increases. This suggests that whilst around 40% of the population would accept longer payback periods, provided that the upfront cost of the heating system is within a manageable level, the remaining 60% are likely to want to see a clearer benefit from switching to a low carbon system. For context, the payback of a well performing heat pump on a special tariff[2] is currently around four years; payback extends to over ten years on standard winter 2024-2025 tariffs.

Figure 3: Willingness to accept payback periods relative to a gas boiler replacement.



Survey question: Would you be willing to purchase a new heating system with an initial installation cost of £X and a monthly operating expense of £X (£X yearly)? Survey answer: Yes, I would be willing to purchase it. Note: payback period derived from survey question.

[2] "Special tariff" refers to heat-pump specific tariffs such as the Cosy Octopus tariff or OVO Heat Pump Plus.

2 How will heating choices affect consumers and the energy system?

During the 2030s and 2040s, there will be increasing numbers of low carbon heating installations. In this period, the choices consumers make about which heating systems to install at a household level will impact how we plan and operate the energy system on a national scale.

Three key barriers demonstrated by the survey results will determine what heating systems consumers choose to install now and in the future:

- Barrier 1: Familiarity - lack of understanding or trust in the options available.
- Barrier 2: Sticker shock - lack of affordability or willingness to invest in higher upfront cost heating systems which are more efficient or flexible.
- Barrier 3: Payback period - lack of willingness to accept longer payback periods relative to installing a gas boiler.

Over the coming decades, many households will be faced with the choice of what to install once their gas boiler requires replacement. Familiarity with the options available, willingness and ability to afford, and payback period will contribute to the choices made.

Figure 4: Representative consumer perspective of the three barriers and resulting outcomes.

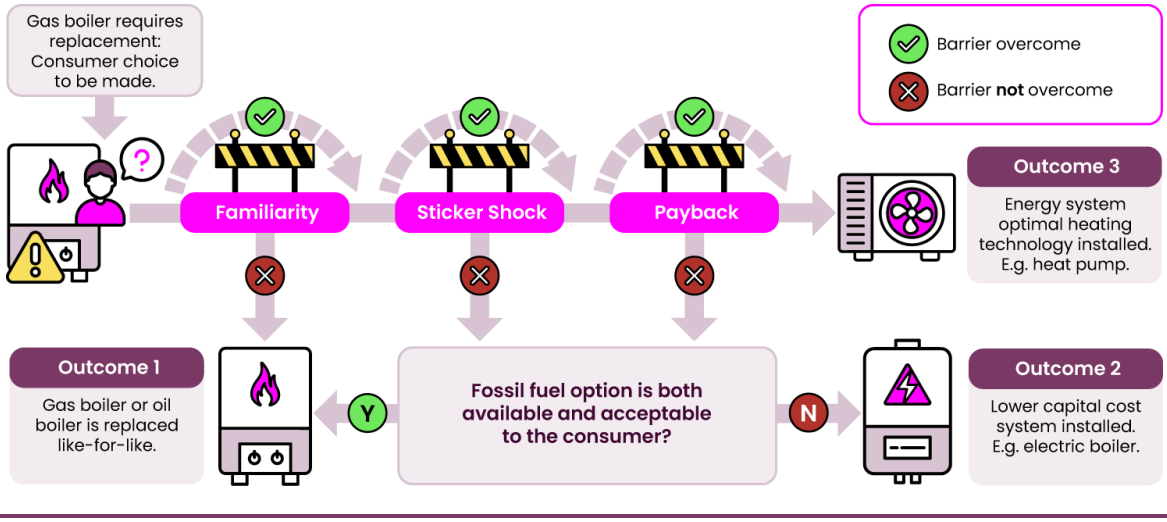


Figure 4 demonstrates the impact of the barriers on consumer choice, and three potential outcomes which may arise. These outcomes have different implications for the energy system and energy trilemma.

Outcome 1: None of the barriers are overcome, the preferred solution is to install fossil fuel boilers like-for-like. This represents a less optimal[3] solution for heat decarbonisation.

Consumers under outcome 1 choose to re-install a gas or oil boiler as their preferred heating solution. Under this scenario, carbon budgets are missed: given the average gas and oil boiler lifetime is around 15 years, mass uptake of low carbon heating could only happen into the 2040s and 2050s (assuming consumers replace systems at the end of their product lifetime). Under this outcome, consumers remain exposed to international gas prices for longer. Furthermore, repurposing or decommissioning of the gas grid would occur later and likely result in higher expenditure for the energy system and consumers.

Outcome 2: Once consumers are familiar with their choices, limited ability to deal with up-front costs and concerns about payback periods mean the lowest-carbon, most energy efficient, solutions remain unattractive.

Under outcome 2, an increased number of low carbon solutions that are less optimal for the energy system overall are installed. This could include electric boilers or electric panel heaters due to their high electricity use. Based on efficiency, annual electricity use for heating is higher than outcome 1 or 3, and, in the worst case, could be 2-3 times higher than in outcome 3. These options will directly impact consumers via higher energy bills and indirectly from increased energy system costs. Additional generating capacity will be needed, including dispatchable power, and substantially more network investment, particularly in distribution systems.

Outcome 3: Consumers are familiar with the options available, willing and able to afford them, and see a payback period that works for them. The preferred solution is optimal for the energy system, heat decarbonisation and long-term affordability.

Under outcome 3, consumers choose to install heating solutions that are cheaper to run, can operate flexibly or reduce peak demand on the electricity system. This could include technologies like heat pumps, storage heaters or connection to a low-carbon district heat network. Overall, electricity demand is high but lower than outcome 2 and peak demand is lower. Natural gas demand for heating reduces in line with carbon budgets. Under this outcome, there would be a flatter heat demand profile, reducing the capacity of generation, storage and network reinforcement needed for the transition compared to outcome 2.

Provided the barriers can be addressed, there are positive signs that consumers prefer technologies that are beneficial to the energy system.

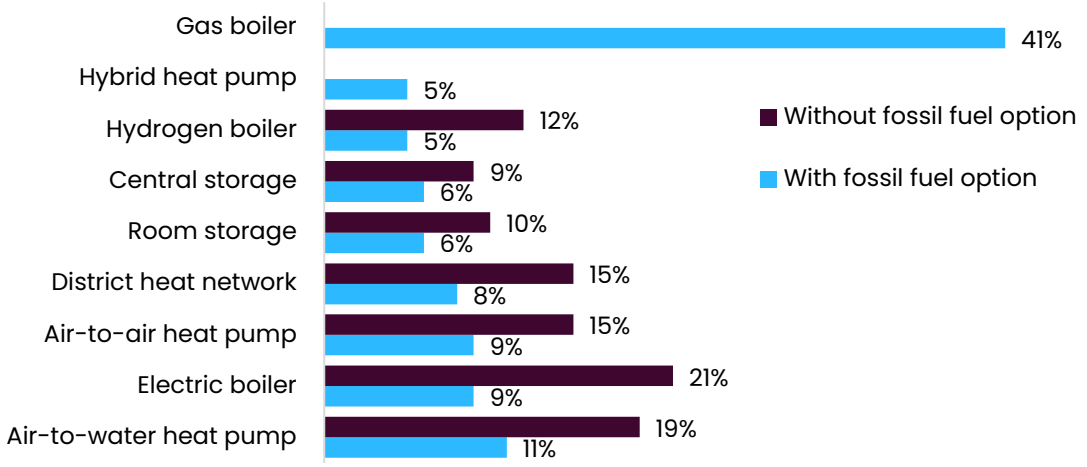
When shown alongside a single alternative low carbon technology or hybrid option, in a paired comparison, gas boilers were chosen 74% of the time. This result suggests that there is significant change required to the status quo to prevent low-carbon choices from being

[3] In this section we use "optimal" to refer to balancing the energy trilemma. For example, a low carbon heating solution that's affordable for consumers and highly efficient or can operate flexibly.

perceived as high-risk, unfamiliar, or unaffordable, especially when households may make decisions under stress, time pressure or limited budgets.

When gas boilers were not chosen, the top three options selected were district heating, air-to-water heat pumps and air-to-air heat pumps. However, when respondents were asked to select a future heating system from a wide range of options, instead of a paired comparison (Figure 5), where no fossil fuel option or grant for heat pumps was available, 21% of respondents selected an electric boiler as their preferred option. This preference for electric boilers may be due to a combination of familiarity and low upfront cost.

Figure 5: Heating technology choice with and without fossil fuel heating options.



Survey question: Which heating system would you choose if your heating system reached the end of its life today? Note: Total may not equal 100% due to rounding.

This situation may change as familiarity with other low carbon technologies increases. Understanding the extent to which electric boilers may be the most suitable option and the impact of adoption more widely on the electricity system is key. Consumer support can help ensure that lower system impact choices are made where appropriate with 27% choosing air to water heat pumps when grants were available compared to 19% otherwise.

Our survey asked separately about centralised and room electric storage heaters. Individually these options proved less popular, but as a combined category, storage heaters comprised 19% of selections when no fossil option was available. These solutions are better for the energy system compared to direct electric heating but could still have significant local network impacts if uptake within a specific area was particularly high. Although hybrid heat pumps (for example systems combining an air-to-water heat pump and gas boiler) have been mooted as a possible interim solution, they were consistently placed last in our consumer choice experiments, chosen by 5% of respondents when available, likely due to high upfront price and complexity. We also tested hydrogen boilers, which are often put forward as a means to reduce electricity system costs. However, these were lower in popularity. When no fossil options were available only 12% of respondents chose hydrogen boilers, likely due to a lack of familiarity and potential high running costs. This order of preference for heating technologies was broadly consistent across other survey questions.

3 Opportunities for a cost effective and equitable heat transition

To support the transition away from fossil fuel heating, government has deployed a number of policies such as the Boiler Upgrade Scheme, Warm Homes Plan and Clean Heat Market Mechanism. However, a rapid increase in the pace and scale of low carbon heat deployment is needed to meet carbon budgets.

This section summarises some of the opportunities for action to overcome the three barriers identified by our survey results.

Barrier	Opportunity
Familiarity	1. Awareness campaigns, targeted at potential early adopters, alongside upskilling trusted intermediaries, like installers. 2. Provide stronger signals on the phase out of gas boilers needed to meet carbon budgets. 3. Encouraging landlords with higher willingness to invest more and be 'early adopters' will promote familiarity via the rental market.
Sticker shock	4. Aligning consumer technology choice with optimal energy system solutions should drive the lowest costs for all. 5. Enable trusted finance options alongside continued grant support and seek innovation to reduce upfront costs.
Payback	6. Drive through the delivery of full half-hourly settlement to enable more market-based flexibility offerings. 7. Driving down the cost of electricity relative to fossil gas will improve payback for low carbon heating.

3.1 Tackling the familiarity barrier

Opportunity 1: Awareness campaigns, targeted at potential early adopters, alongside upskilling trusted intermediaries, like installers.

The low familiarity of low carbon technologies seen in the survey demonstrates the scale of the challenge to decarbonise heat. Today, only around 1% of homes have a heat pump and therefore GB is in the very earliest stage of technology adoption. Our survey found that climate conscious individuals were more likely to consider a low carbon heating system yet may be unaware of the options. Targeting awareness campaigns at those most interested in decarbonising, and providing support for social landlords, could help accelerate early adoption.

Through the focus groups we saw that heating installers and gas engineers were often a trusted source of advice on heating systems. More clarity for these skilled workers on the future direction for home heating and a focus on retraining for heat pump installation would help ensure that consumers receive the best information. This should include not just upskilling on the benefits of heat pumps, but also on flexible tariffs and controls that

can deliver savings on energy bills, to make the transition to low carbon heating as simple and beneficial as possible.

"They're my people on the ground and they do everything... They organise it, and then [they] get in touch with me... [to say], just to let you know, we have to replace the boiler. It's going to cost this much. Is this okay? And I normally okay it... You've got no choice when you're not there."

Female, 45
Landlord, larger portfolio

Opportunity 2: Provide stronger signals on the phase out of gas boilers needed to meet carbon budgets.

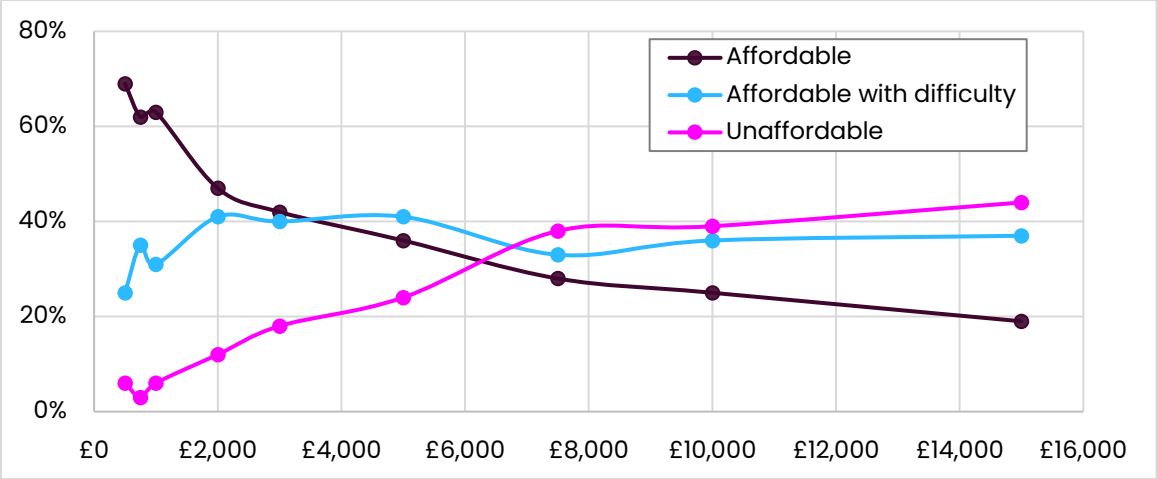
Whilst familiarity with and attitudes towards low carbon heating will change over time as more people share their experiences and deployment grows, in any technology transition, there will always be later adopters. Our survey showed that gas boilers had a 74% selection rate when shown alongside another technology and therefore are likely to remain a favoured option. Modelling from our Future Energy Scenarios (FES) 2025 suggests that heat pump installation rates require a 31% year-on-year average increase until a full phase out of new gas boiler installations from 2035. Signalling the intent to phase out new gas boiler installations early will help raise awareness and support acceleration of the adoption of low carbon heating.

Opportunity 3: Encouraging landlords with higher willingness to invest more and be 'early adopters' will promote familiarity via the rental market.

Throughout the survey, we were interested in exploring the impact of tenure and income on familiarity and consumer choice. We wanted to understand how landlords would respond when considering their own home and how that might differ for their rental property. The survey found that landlords were 18% more likely than the general population to plan changing a heating system in their own home and more likely to accept longer payback periods for both their own and their rental property. When reporting on their rental property, 56% of landlords find high upfront expenditure (£15,000) "affordable" or "affordable with difficulty".

Evidence from the survey demonstrates that landlords are more engaged in the transition than the general population. Around 19% of the housing stock in GB is privately rented. Supporting those landlords with higher willingness or capacity to switch their rented homes to low carbon heating would decarbonise a significant proportion of GB housing stock. This may result in increased familiarity among other demographics via the experience of low carbon heating in the rental market. Increased uptake in the rental sector could also promote unit cost reduction and greater innovation over the long term, paving the way for a more inclusive and equitable pathway to adoption across all income levels. However, focus groups demonstrated the complexity of this issue for landlords. Working closely with this group will be key to unlocking the opportunity.

Figure 6: Landlord affordability for the upfront cost of a heating system installation.



Survey Question: see Figure 2. Note: Landlords responded based on their most recently let out property.

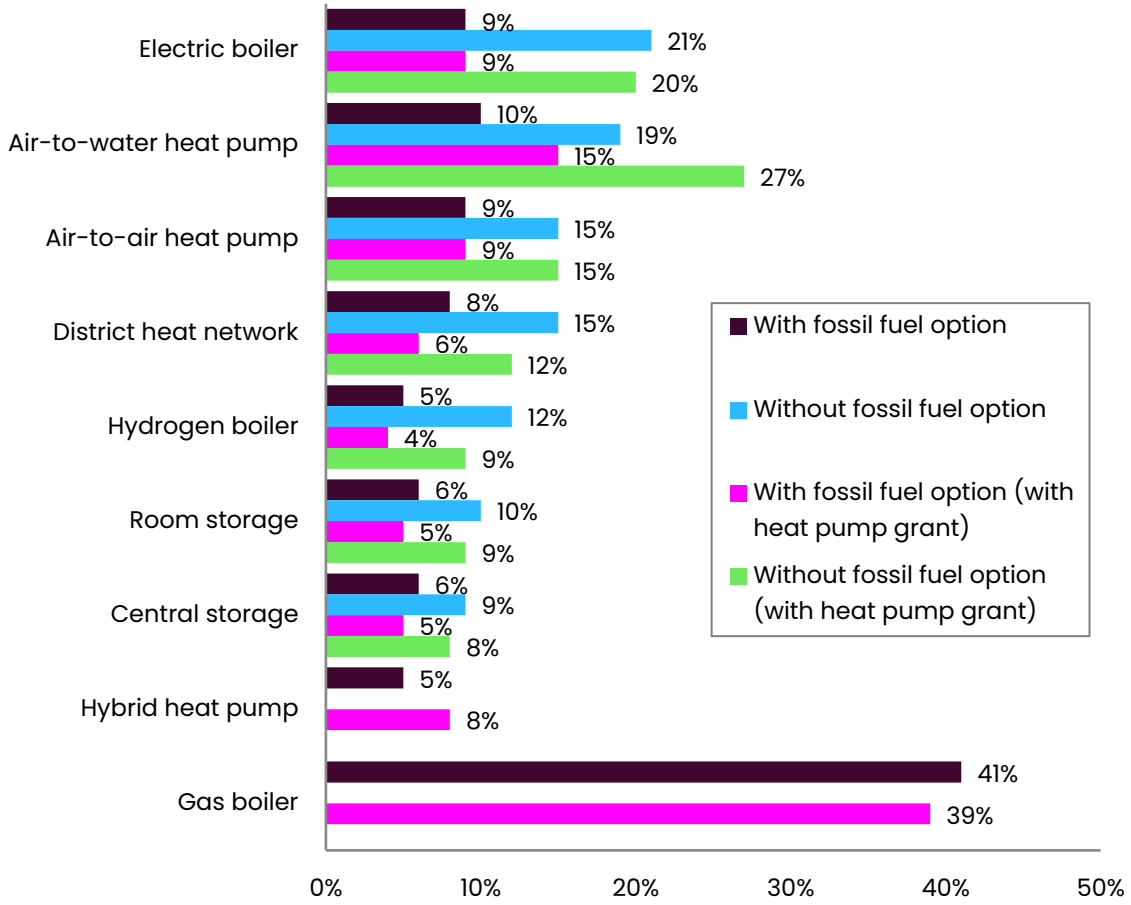
3.2 Overcoming sticker shock

Opportunity 4: Aligning consumer technology choice with optimal energy system solutions should drive the lowest costs for all.

Our survey explored how the uptake of different heating systems could be influenced by levers such as grants or legislation. We found that when fossil fuel options are not available to consumers, electric boilers and air-to-water heat pumps were the most popular choices at 21% and 19% respectively. However, introducing grant support for heat pumps reverses this picture, with 20% opting for electric boilers and 27% for an air-to-water heat pump. As a combined category heat pumps (including air-to-air) were selected by 42% of respondents when fossil fuel options were not available and grants were provided.

Heat pumps, as a result of higher efficiency, offer a direct operating cost benefit on energy bills, and a lower whole system cost compared to electric boilers. Understanding the magnitude of the system cost savings could unlock funding to support the adoption of technologies that deliver the lowest cost outcome for the system and consumers alike. Government grants should seek to align consumer preference with those energy system optimal solutions and ensure that all households are able to install solutions that will serve them best in the long term.

Figure 7: The impact of grants and removing fossil fuel options on heating technology choice.



Survey Question: Which heating system would you choose if your heating system reached the end of its life today? Note: Percentage figures are percentage of respondents selecting the option and may not total to 100% due to rounding.

Opportunity 5: Enable trusted finance options alongside continued grant support and seek innovation to reduce upfront costs.

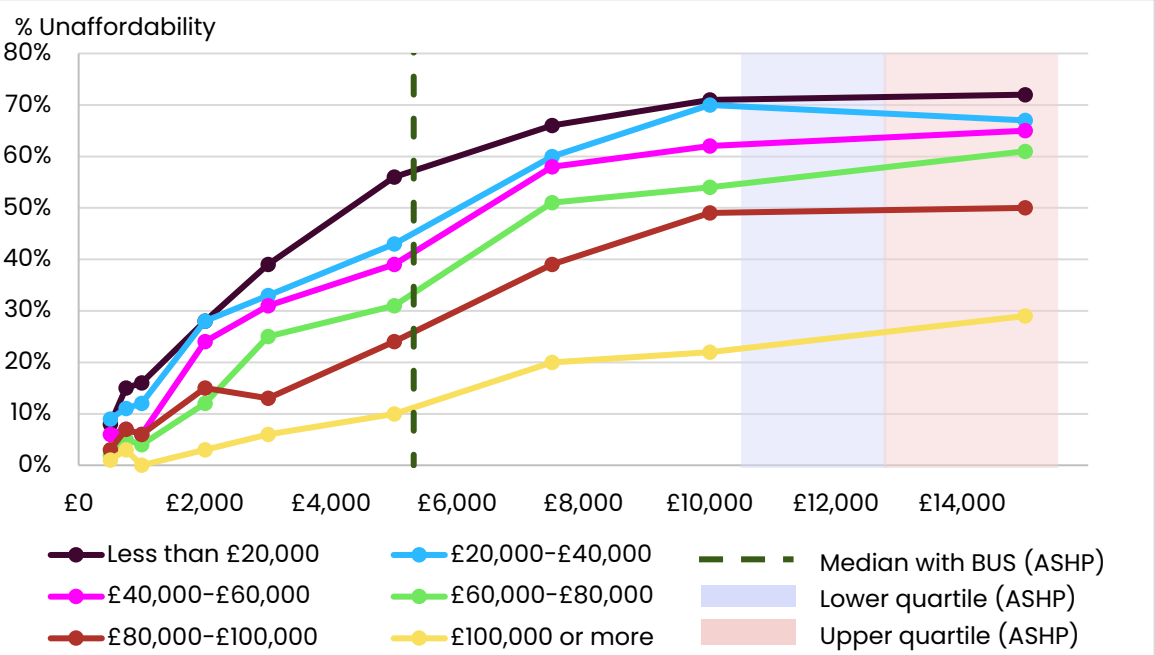
In Section 1.3, we saw that whilst many households are able to afford heat pumps (with the BUS grant) and other low carbon options, some continue to find this unaffordable.

For a heating system costing £5,000, households earning £20,000 or less experience much higher levels of unaffordability (56%) compared to other income bands. With an average heat pump installation at around £12,500 today, compared to a combi boiler at £3,000 it is clear that reducing heat pump installation costs through innovation and flexible financing will enable more households to make the transition. Alongside this, given their low upfront cost, low-income homeowners may be more likely to install electric boilers. This finding raises concerns given the higher running costs long-term. Therefore, targeted long-term grant support may be required for some demographics.

Heat pumps will not be suitable for all homes. Heat networks represent one option for those in urban areas and may be more suitable for households who are less financially resilient due to the lack of installation charges. Storage heaters could also provide an alternative for some homes. These systems would lower bills relative to electric boilers, but the price

for central electric storage heaters are still too high for many at around £6,000 plus installation costs.

Figure 8: Homeowner perceived unaffordability for upfront cost of a heating system by income band.



Survey Question: See Figure 2. Note: Dashed line represents median air source heat pump (ASHP) installation cost after the BUS grant is applied. Blue and red shaded areas represent lower and upper quartiles for ASHP installation costs before the BUS grant is applied.

3.3 Improving payback

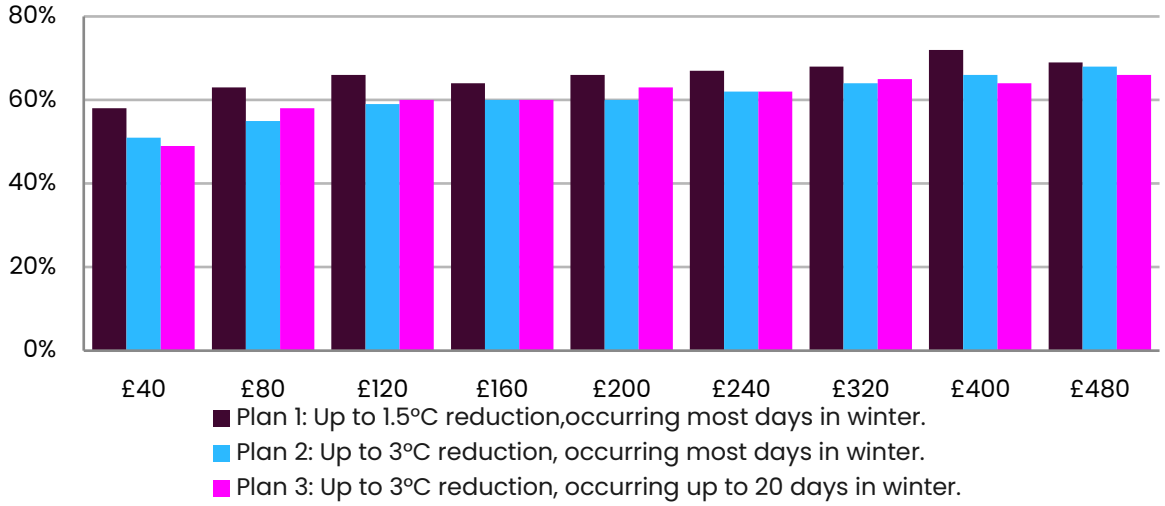
Opportunity 6: Drive through the delivery of full half-hourly settlement to enable more market-based flexibility offerings.

Operating a home heating system flexibly can deliver savings on electricity bills, reducing payback periods and also help lower energy infrastructure costs. In our Clean Power 2030 advice to government we outlined that heating and hot water could provide up to 6 GW of consumer flexibility at peak times by 2030. Some energy suppliers already provide tariffs to encourage flexible heat pump operation and third-party heat pump control apps are available to automate flexibility, making the most of times when electricity is cheaper. Flexible operation of heating alongside other electrified technologies could have a big impact on how we plan and operate the energy system of the future.

Our survey tested respondents' willingness to participate in three different flexibility plans. We found all three were widely accepted at even relatively low incentive levels, with around 50% reporting willingness to accept only £40 of annual saving. Flexible tariff offerings today

can deliver savings in excess of £300 per year for an average house,[4] suggesting 60% of consumers may be willing to adopt such schemes. Delivery of market-wide half hourly settlements will facilitate more competition amongst suppliers and enable households to make full use of their potential to flex.

Figure 9: Willingness to accept different automated heating temperature adjustment plans for varying annual savings levels.



Survey question: Would you accept this plan if it saved you £X annually? Yes, I would accept this plan. Note: Some variation may be observed between savings levels and plans as each respondent answered for three savings levels (randomised across high, medium and low).

Opportunity 7: Driving down the cost of electricity relative to fossil gas will improve payback for low carbon heating.

The long payback period of low-carbon electrified heating today is driven by the ratio of electricity to gas price.[5] Decreasing this ratio will reduce running costs relative to gas boilers and help in reducing the payback barrier for low-carbon heating.

At present, electricity and gas prices in GB include levies which fund a range of policies including energy efficiency programmes and renewable energy incentives. Levies are highest on electricity, increasing the price of electricity relative to gas (for a typical household, levies make up 16% of the final electricity price on a household bill, compared to 6% for gas).

To reduce the impact of the payback barrier, heat pumps would need to have favourable headline operating costs relative to gas boilers.

[4] NESO calculation based on OVO heat pump tariff and winter 24/25 price cap.

[5] Between January to March 2025, this ratio was around 4.0 (24.86p/kWh for electricity and 6.34p/kWh for gas). Allowing for boiler efficiency, a heat pump would need to operate with a seasonal coefficient of performance of 3.6 to be at cost parity with a gas boiler at this ratio (assuming standing charges remain). Whilst this is achievable for heat pumps, many do not deliver this level of performance in practice. The Energy Systems Catapult electrification of heat project indicated an average of only 2.9, implying higher costs for running a heat pump than running a gas boiler.

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