# RAF061/2223 Impact of Heat Pump Costs on Uptake: A Discrete Choice Experiment

Main Report

Prepared by ICF Consulting Services Limited in association with The Behaviouralist and Moonlight Research for the Department for Energy Security and Net Zero

Department for Energy Security and Net Zero (2024)

Completed by ICF Consulting Services Limited in association with The Behaviouralist and Moonlight Research for the Department for Energy Security and Net Zero prior to the general election in the United Kingdom in July 2024.

As such, any references to government policies, commitments, or initiatives may reflect the stance of the previous administration and were accurate at the time of fieldwork and writing.

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# Executive Summary

## Background

The decarbonisation of heating will be a key element in achieving net zero greenhouse gas emissions by 2050. This is underlined by the government's commitment to accelerating the deployment of low-carbon heating as part of its Warm Homes Plan.[1] Heat pumps have been identified as a scalable option for green home heating. To achieve mass deployment, it is essential to increase the uptake of heat pumps in homes that have already been built, replacing their existing heating systems. There are several barriers to the uptake of heat pumps in existing properties, including their actual and perceived costs. However, there is presently limited evidence on how upfront costs (the costs of system installation etc.) and running costs (energy bills) affect demand for heat pumps across different consumer groups. This information is key to understanding how to develop targeted policies that will effectively and efficiently stimulate heat pump uptake.

This study was commissioned to gather evidence on willingness to pay for air source heat pumps (ASHPs) amongst owner-occupiers in Great Britain at different price scenarios (covering both upfront and running costs). The key research questions were: how do upfront and running costs individually affect the willingness to pay for an ASHP, and what is the relative importance of each cost type? Secondary research topics included testing the extent to which financing options, population characteristics and the provision of information relating to future home heating policy would affect heat pump demand.

## Methods

This study gathered evidence using a discrete choice experiment. This method aims to elicit preferences from participants by asking them to make choices between options. We asked participants to make a choice between renewing their current, fossil-fuel-based heating system or installing a heat pump at different upfront and running cost levels. We framed this choice as a hypothetical situation where participants would replace their current heating system in the next two years. We tailored the costs that were presented to participants to their household and energy demand characteristics to the extent possible.

To conduct the experiment, we surveyed a representative sample of owner-occupied households. The survey sample consisted of homeowners with oil or mains-gas based heating systems, living in Great Britain. We also asked about the potential impact of different financing options (e.g., loans) on participants' interest in heat pumps. We then conducted a randomised controlled trial (RCT) to assess the impact of different communication-based interventions on heat pump demand. We randomly selected some participants to which we gave additional

[1] UK Government (2024), Help to save households money and deliver cleaner heat to homes.

information or prompts on home heating planning and a potential phase-out of fossil-fuel based heating systems. We then compared the difference in demand for heat pumps amongst these participant groups with participants who receive no additional information. Note that this research was conducted in 2023 and is reflective of the previous government's policy direction, which announced plans to phase-out the installation of fossil-fuel boilers off the gas grid from 2035.

## Headline findings

We find a statistically significant negative, non-linear relationship between upfront costs and demand for ASHPs across on and off gas grid households. This means that the demand for ASHPs increases as upfront costs decrease. Additionally, we observe that a given reduction in ASHP upfront costs has a greater impact on ASHP demand when upfront costs are lower (e.g., upfront costs have a stronger effect on demand when they decrease from £4,000 to £3,000 as opposed to £6,000 to £5,000).

We also find a statistically significant negative, non-linear relationship between running costs and demand for ASHPs for off and on gas grid households. This indicates that the impact of reducing ASHP running costs on ASHP demand is greater when ASHP running costs exceed those of fossil fuel heating systems, compared to when ASHP running costs are already equal to or lower than those of fossil fuel heating systems.

Although running costs are important, upfront costs appear to be more important in influencing ASHP demand. For example, for those living on the gas grid and estimated to have low energy consumption, a £1,000 reduction in the upfront cost of a heat pump is estimated to increase demand by 10 percentage points, while the equivalent increase in lifetime running costs (i.e., a £4.20 increase in monthly running costs) would reduce demand by 1.1-1.4 percentage points. This result suggests that households assign more importance to costs incurred in the present compared to those in the future (i.e., present bias). This result could also be influenced by how costs were presented in the experiment, i.e. as monthly running costs rather than yearly or total lifetime running costs. This framing may have led some participants to underestimate the relative importance of running costs.

We find that there are statistically significant positive interaction effects between upfront and running costs for participants living on the gas grid. This means that, for example, running costs tend to matter more when upfront costs are lower. We also found that higher status quo running costs have a positive effect on heat pump demand (i.e., having higher monthly bills for your current fossil fuel-based heating system increases your likelihood of wanting an ASHP).

We identified several significant relationships between household or respondent characteristics and the likelihood of wanting to install a heat pump. Those who are more likely to choose a heat pump tend to be: under 65 years old, wealthier (have higher income and savings), more concerned about climate change and their environmental impacts, more concerned about the cost of their monthly bills, and already be planning some energy efficiency improvements. The types of households that are more likely to choose heat pumps live in off-gas grid homes, have smart meters already installed, and have an electric vehicle. However, the impact of changing costs did not differ by types of consumers, i.e. all types of consumers were more willing to pay for heat pumps at lower costs, relative to higher costs.

Findings from the RCT suggested that giving participants information about a potential future phase-out of fossil fuel boilers increases demand for heat pumps. However, there was no incremental positive effect of adding planning prompts (i.e., a prompt to plan ahead for the replacement of participants' heating systems) found on heat pump demand.

The financing option that participants claimed would have the greatest effect on their interest in heat pumps was accessing a reduced mortgage interest rate (54% of participants with a mortgage said this would make them more likely to choose a heat pump). The second-most popular option was providing discounted energy tariff rates during off peak hours (33% of participants said this option would make them more likely to choose a heat pump).

# Conclusions

The findings from this study show that the demand for heat pumps increases as upfront costs decrease. Moreover, the lower the upfront costs the greater the effect of a £1 reduction in upfront costs. Additionally, heat pump demand increases as running costs decrease, with this effect being more pronounced when ASHP running costs initially exceed those of fossil fuel heating systems. Although running costs are important, we find that upfront costs matter more to households when choosing to install a heat pump.

We identified several household and respondent characteristics which mean people are more likely to take up a heat pump. In terms of further increasing uptake, we find that disseminating information on a potential fossil fuel phase out and providing financing options, such as reduced mortgage interest rates, would be beneficial.

Going forward, the findings can be used to model heat pump adoption in the UK as prices change, and as the characteristics of the homeowning population shift. This could serve to develop targeted policies that effectively support these households to adopt heat pumps.

# Introduction

*The Department for Energy Security and Net Zero (DESNZ) commissioned this study to gather evidence on willingness to pay for air source heat pumps (ASHPs) amongst British owner-occupiers at different price scenarios (covering both upfront and running costs), exploring potential financing options.*

## Study background, purpose and key research questions

In 2019, the UK government set a legally binding target to achieve net zero greenhouse gas emissions across the UK economy by 2050. The transition from fossil fuel heating systems to low-carbon alternatives will play an important part in the decarbonisation of buildings, and this is underlined by the government's commitment to accelerating the deployment of low-carbon heating as part of its Warm Homes Plan.[2] Air source heat pumps (ASHPs) are a scalable option for decarbonising heat in certain types of household and are therefore expected to form a substantial portion of retrofit low-carbon heating installations in existing homes.

There are several challenges regarding the uptake of ASHPs, including: higher upfront financial costs of ASHPs compared to fossil-fuel heating systems, (in some cases) higher or similar running costs for ASHPs relative to fossil-fuel heating systems, the greater degree of hassle associated with installing an ASHP, people's unfamiliarity with the technology and the novelty of the market. Research has shown that the perceived costs of a domestic heat pump is a critical barrier to uptake for households.[3] Costs for consumers to consider when installing a heat pump are multifaceted, including the capital costs of the unit and ancillary equipment, labour costs, and the costs of any supporting works needed (e.g., insulation improvements, new radiators, post-installation redecoration). Households may also be uncertain about running costs, since estimating the cost of heat from ASHPs, relative to other heating systems, is complex and dependent on several factors (including the relative price of energy sources and home energy efficiency). For the average home using gas central heating, installing an ASHP could be around £9,000 more expensive than a conventional boiler without Government support (the Boiler Upgrade Scheme grant currently provides £7,500 to help reduce these costs).

VAT relief and subsidy mechanisms are used to reduce upfront costs and stimulate the uptake of heat pumps within existing households. Between 2014 and 2022, the domestic Renewable Heat Incentive (RHI) awarded regular cash payments to households that installed a heat pump. Its successor, the Boiler Upgrade Scheme (BUS) awards grants (worth £7,500 for an ASHP) to reduce upfront costs. Even then, there are often cost gaps between a new gas boiler

[2] UK Government (2024), Help to save households money and deliver cleaner heat to homes.
[3] UK Government (2021), Heat Pump Ready: Supporting Information; UK Government (2013), The Future of Heating: Meeting the Challenge

and a heat pump. It is expected that the cost of heat pumps will continue to fall over time[4], as the market develops and innovates.

Given the novelty of the market, there is limited evidence on how upfront and running costs affect demand for heat pumps across different consumer groups. This is a growing area of research; studies have been conducted regarding households' opinions towards, and willingness to pay for heat pumps, alongside evaluations of current policies aimed at stimulating their uptake. For example, Nesta examined homeowners' willingness to pay for a heat pump at various prices through a discrete choice experiment,[5] and Public First researched household opinion on ASHPs and which policies would be most effective at encouraging their take-up.[6] This study uses a discrete choice experiment (DCE) to investigate the willingness of owner-occupiers in Great Britain to adopt ASHPs under different price scenarios, which enables the construction of a demand curve for ASHPs. It builds upon previous research by: gathering data from a representative sample of owner-occupied households in Great Britain that are both on, and off the mains gas grid, and answering the following research questions:

- For a representative sample of owner-occupiers in Great Britain how do relative upfront and running costs of ASHPs individually affect willingness to pay for them?
- What is the relative importance of each cost type (upfront, running) in affecting decisions to take up ASHPs?

The following secondary research questions were also explored:

- To what extent do different financing options affect decisions to take up ASHPs?
- How do decisions to take up ASHPs vary by subpopulations of interest (e.g., on/off-gas grid households)?
- How do decisions to take up ASHPs vary with select characteristics of interest (e.g., environmental attitudes, knowledge of ASHPs)?
- To what extent would presenting participants with information and prompts relating to future home heating policies (e.g., highlighting the timelines for phasing-out fossil-fuel based heating systems) affect intentions to install an ASHP?

The results of this study will enable DESNZ to better understand the incentives needed to encourage homeowners to switch to heat pumps, therefore supporting future policy design aimed at overcoming barriers to ASHP uptake.

[4] Eunomia, Department for Energy Security and Net Zero (2023), The Cost Of Heating Appliances: A Comprehensive UK Database (available here)
[5] Nesta, The Behavioural Insights Team (2022), Estimating the willingness to pay for a heat pump
[6] Public First (2021), Research on Air Source Heat Pumps (available here).

# Overarching findings

The findings from this study indicate that reducing heat pump upfront costs increases heat pump demand. Notably, the effect of a £1 reduction in upfront costs on demand is greater when the upfront costs are lower. Furthermore, we find that reducing heat pump running costs increases demand and that the effect is greater when heat pump running costs initially exceed that of fossil fuel heating systems. Overall, however, upfront costs matter more to households compared to running costs when choosing to install a heat pump.[7]

We identified several household and respondent characteristics mean people are more likely to take up a heat pump. In terms of further increasing uptake, we find that disseminating information on the planned fossil fuel phase out and providing financing options, such as reduced mortgage interest rates, would be beneficial.

Interestingly, consumer characteristics (e.g., income, property type) do not appear to alter the way in which costs affect demand. Nonetheless, there are several characteristics that make consumers more likely to take up a heat pump generally.

Going forward, the findings can be used to model heat pump adoption in the UK as prices change, and as the characteristics of the homeowning population shift. This could serve to develop targeted policies that effectively support these households to adopt heat pumps.

The following subsections, alongside the Technical Annex to this report, explain these findings in greater detail.

[7] It is important to note that this result could be influenced by how costs were presented in the experiment: as monthly running costs rather than total lifetime running costs. This framing may have led some participants to underestimate the relative importance of running costs due to difficulty in projecting the total amount within the experimental context. This framing was chosen, however, as it represents how information is typically presented to people in real-life situations.

# Methodology

*This chapter summarises the methodology employed in this study. A detailed description of the methodology is set out in the Technical Annex.*

## Data collection

### Pilot

The study team tested the questionnaire and the discrete choice experiment through the delivery of a pilot study with a small sample of property owners. The pilot also involved cognitive testing of the questionnaire. We used the findings from the pilot and cognitive tests to refine the methodology for the main experiment.

#### Sampling

We sampled homeowners with mains-gas and oil-based heating systems, living in Great Britain, which represent around 86% and 6% of owner-occupied homes respectively.[8] We excluded owner-occupiers living in high rise buildings, since heat networks are likely to be a more technically feasible option for such households.

We identified the sample using postcode data, to ensure representativeness. The basic sampling frame used the Postcode Address File (PAF) and we matched this with EPC data where possible. We divided the sample into on-grid and off-grid homes, and stratified by region and Index of Multiple Deprivation (IMD) to ensure national income and geographic coverage. We screened all participants prior to taking part in the discrete choice experiment, to remove ineligible participants.

We set sample size targets for the main experiment [9](2,500 from participants on the gas grid, and 1,500 off-grid[10]) to meet the minimum sample size required to robustly conduct planned analyses with each group, estimated through power calculations (described in detail in the Technical Annex).

Participants were recruited by letter in a ‘push-to-web’ approach. We offered participants a £5 voucher for completing the survey, and entered all those who took part in the survey (even if they did not complete it) into a prize draw for a £250 voucher. Overall, 6,086 responses were received for the main experiment. Annex 1 in the Technical Annex contains details of the number and share of households contacted and responses received.

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[8] Shares from DESNZ analysis which combines the English Housing Survey with Scottish and Welsh surveys.
[9] For clarity, we designate the primary experiment conducted as part of this study as the "main experiment" to differentiate it from the pilot experiment and the subsequent supplementary experiment, which served to validate results found in the main experiment.
[10] We purposefully oversampled off-grid homes, to ensure the analysis would have sufficient statistical power.

## Survey design

This section outlines the discrete choice experiment and the RCT, more depth on these and the rest of the survey can be found in Annex 1 and 6 of the Technical Annex.

### The discrete choice experiment

Discrete choice experiments are a common method used to estimate consumer preferences. Research suggests that hypothetical decision making can be a valid proxy for real financial decisions made by consumers.[11]

In this study, we presented all participants with the same hypothetical scenario: that they are considering replacing their current heating system within the next two years. We then presented them with two options: to renew their current heating system (i.e., the status quo option), or to install a heat pump.

We asked participants in the main experiment to choose between a heat pump or renewing their current heating system under 13 cost scenarios (choice sets). In each, we presented participants with information about the upfront costs and running costs of the heat pump option and their status quo heating system, alongside detail on the benefits and drawbacks of each system. The cost of their status quo heating system remained the same each time, but the costs of the heat pump varied. It’s important to note that monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs. For further details on how cost levels were estimated, please refer to the Technical Annex.

We tailored the costs we presented to participants based upon their current heating system and heat demand. These groups can be seen in Table 1 below.

**Table 1: Discrete choice experiment attribute levels**

| Criteria | High energy demand (on gas grid) | High energy demand (off gas grid) | Low energy demand (on gas grid) | Low energy demand (off gas grid) |
|---|---|---|---|---|
| Participant assigned to group if they have # number of bedrooms | 4+ | 3+ | 1-3 | 1-2 |
| Status quo monthly running cost | £240 | £240 | £200 | £200 |
| Status quo upfront cost | £3,600 | £6,900 | £3,000 | £6,000 |

[11] Johnson & Bickel, 2002

| Criteria | High energy demand (on gas grid) | High energy demand (off gas grid) | Low energy demand (on gas grid) | Low energy demand (off gas grid) |
|---|---|---|---|---|
| ASHP monthly running cost range | £195-£240 | £195-£240 | £165-£200 | £165-£200 |
| ASHP upfront cost range | £3,600-£15,000 | £3,600-£15,000 | £3,000-£10,000 | £3,000-£10,000 |

Notes: Monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs. For further details on how cost levels were estimated, please refer to the Technical Annex.

### Randomised controlled trial

We included a randomised control trial (RCT) towards the end of the survey to assess the impact of different interventions on household intentions to install an ASHP. In the RCT, participants were randomly assigned to one of three experimental conditions:

- **Control:** We told participants how much a heat pump was likely to cost to install and run for their home, with links to government websites to 1) check if a heat pump is suitable for their home, 2) find a heat pump installer, or 3) apply to the Boiler Upgrade Scheme.
- **Treatment 1:** In addition to the information given to control group, we showed this group messaging about a possible fossil fuel-based boilers phase out.
- **Treatment 2:** In addition to the information given to the treatment 1 group, we gave this group a prompt to plan ahead for the replacement of their heating system (e.g. before this became necessary due to malfunction or in advance of a possible fossil fuel boiler phase out).

As the RCT outcome measure, we asked participants to state the likelihood that they would install a heat pump in the next two years.

### Supplementary experiment

Following the main experiment[12], the study team conducted a supplementary experiment aimed to test the validity the results of the main experiment and estimate demand for air source heat pumps (ASHPs) in scenarios where ASHP running costs are equal to or greater than those of fossil fuel heating systems (i.e., the status quo option). Its purpose was to complement the findings of the main experiment discussed in this report by presenting a wider range of cost scenarios.

This supplementary experiment used the same sampling methodology and survey design as the main experiment. However, it differed in the cost scenarios presented to participants in the

[12] For clarity, we designate the primary experiment conducted as part of this study as the "main experiment" to differentiate it from the pilot experiment and the subsequent supplementary experiment.

discrete choice experiment. Specifically, the supplementary experiment included scenarios where ASHP running costs exceeded those of fossil fuel heating systems (refer to the Technical Annex for a more detailed description of the methodology used in the supplementary experiment).

**Table 2: Discrete choice experiment attribute levels (supplementary experiment)**

| Criteria | On-gas grid | Off-gas grid |
|---|---|---|
| Status quo monthly running cost | £195 | £200 |
| Status quo upfront cost | £3,150 | £6,200 |
| ASHP monthly running cost range | £165-£225 | £170-£230 |
| ASHP upfront cost range | £3,150-£6,200 | £6,000-£10,000 |

Notes: Monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs. For further details on how cost levels were estimated, please refer to the Technical Annex.

# Analysis

An explanation of the data cleaning, descriptive statistics, regression analyses, analysis of the RCT and financing option results, as well as the robustness checks conducted is within Technical Annexes. This section presents a high-level summary of the discrete choice experiment analysis conducted for both the main experiment and the supplementary experiment.

## Discrete choice experiment analysis

### Regression specification

We analysed the discrete choice experiment data by running several multivariate regression models. We conducted the main analysis using Linear Probability Models, as these models produce the most easily accessible and interpretable coefficients for the average effects of different variables. The model estimates the effects of upfront and running costs of heat pumps on demand for heat pumps. More specifically, it presents the change in the probability that a participant chooses a heat pump at different upfront and running cost levels. We confirmed the robustness of this by also running mixed logit model. These analyses were conducted both for the main experiment and the supplementary experiment and can be found in the Technical Annex.

We ran the regressions for the four energy demand groups separately, as these groups faced different status quo and heat pump costs.

### Sample representativeness and reweighting

The main specification reported on in this section does not include weights on region, property size and gas grid status. This is because, in running separate regressions on each of the four energy demand groups, discrepancies in grid status distribution are already accounted for.

To verify their robustness, we also re-ran all our other key multivariate regression specifications with weights to account for discrepancies in regional distribution, property size, and grid status. We conducted these checks to mitigate the risk of response bias where those who responded to the survey were different from the universe from which they were selected. These additional analyses found similar results to those found in the main model, thus supporting its robustness. The results of this analyses are presented in Tables 41-47 in Annex 2 of the Technical Annex for the main experiment and Tables 74-75 in Annex 3 of the Technical Annex for the supplementary experiment and discussed in the Results section below.

The descriptive analysis section in Annex 2 and Annex 3 of the Technical Annex provides more information about the precise distribution of respondent characteristics and analyses of how these differ to the overall population for both the main experiment and the supplementary experiment, respectively.

## Limitations

There are several limitations to the design of the research methodology that are important to consider when interpreting the results. These can be read in full in the Technical Annex, and a summary of the limitations that readers should consider when interpreting the main results is laid out below.

The study took place during a cost-of-living and energy cost crisis, which may affect how participants made decisions in the discrete choice experiment and could affect the long-term validity of the results of this study. To mitigate these potential issues, we:

- Verified the robustness of the main results by examining how the costs of ASHPs depend on participant income and savings.
- Asked participants to consider a hypothetical scenario where the upfront costs and running costs of installing a heat pump did not vary over time (setting up a decision environment that did not include price volatility).

While hypothetical decision-making is commonly used as a proxy for real life decisions in similar studies, the fact that it is not a real-life decision is an inherent limitation of the methodology. In real life, people would spend more time deciding between a heat pump and their existing heating system (it is, however, unclear whether this would make participants more or less price sensitive). Importantly, real-life financial costs associated with purchasing a heat pump cannot be fully captured in hypothetical scenarios. Other barriers to heat pump adoption may also be amplified, meaning uptake in real life is likely to be lower than in this experiment. Participants may have also suffered from decision fatigue as they went through the experiment.

To mitigate risks associated with the hypothetical nature of the experiment, we:

- Piloted the survey to assess how reflective the choices people made were of real-life decisions choices. Overall, participants felt they were making realistic choices.[13]
- Asked participants in both the main and the supplementary experiment how confident they were when choosing a heat pump. Using this data, we conducted additional analyses re-coding participants who claimed that they were uncertain about choosing a heat pump as not choosing one in that particular choice set (i.e., each instance in which participants were asked to make a choice between a heat pump and their status quo heating system). These analyses were used as robustness checks and confirmed the reliability of the main multivariate regression results.
- Gave as much information as was feasible regarding non-cost related considerations of ASHP uptake that people would face in real-life when making this type of decision.
- Tailored costs presented to respondents in the main experiment depending on the number of bedrooms in their household so that participants faced realistic costs when making decisions.
- Asked households participating in the supplementary experiment whether they had previously changed their heating system and, if so, the reasons behind their decision. These questions aimed to gauge the proportion of individuals who engage in proactive planning when considering the renewal of their heating systems. Such insights are crucial for households considering shifting to heat pumps rather than renewing their current heating systems out of necessity.

Additionally, the survey was distributed through an online-only platform, which means that some households that were eligible to participate may have been excluded. Relatedly, several participants reported difficulties in accessing the survey link. It is unclear whether these less digitally able groups would have responded differently, and therefore if and how this may affect the findings.

Furthermore, due to the higher than anticipated response rates, a second reminder was not distributed to the final subsample of survey respondents. Any potential bias introduced by this was checked for and corrected (see the Technical Annex – Annex 2).

Finally, the supplementary experiment, conducted a few months after the main one and during a different season (winter versus spring), could raise concerns about potential seasonal bias affecting respondents' awareness of their heating systems and costs. To address this, we used the same sampling method and collected data on participants' knowledge and attitudes toward

[13] The pilot was, however, conducted with a smaller, and non-representative sample.

their heating systems. Results indicate comparability between samples in terms of knowledge and attitudes toward heating systems and in terms of absolute preferences, suggesting that seasonal differences may not have significantly impacted the survey.

# Results

*This chapter discusses the results from the survey and accompanying experiments. More detailed analyses and results can be found in the Technical Annex.*

## Results from the Discrete Choice Experiment

This section presents findings from our analysis of the data from the discrete choice experiment.

### The effects of upfront costs on demand for ASHPs

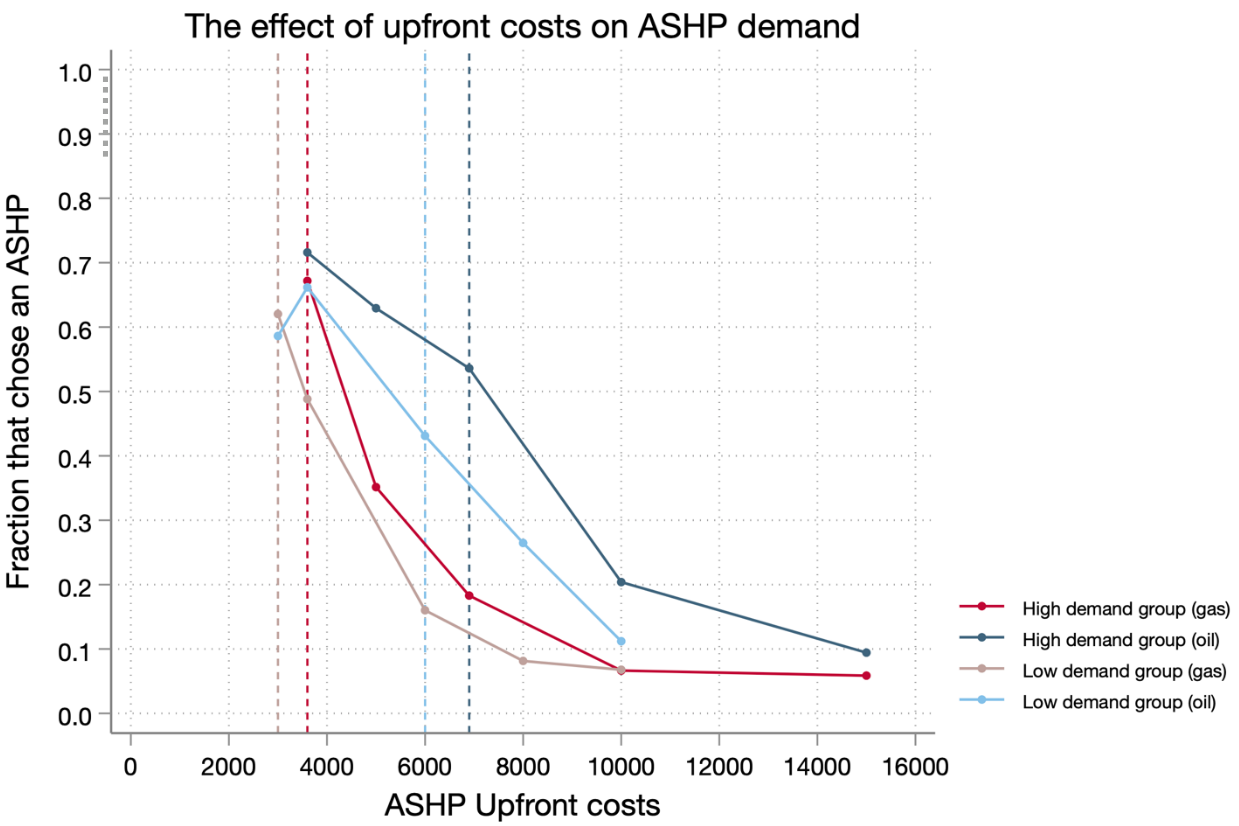
There is a clear non-linear negative relationship between upfront costs and demand for heat pumps for all four demand groups (i.e., high demand on-gas grid, low demand on-gas grid, high demand off-gas grid, low demand off-gas grid). This means that the demand for heat pumps increases as upfront costs decrease. Moreover, the lower the upfront cost, the greater the effect of a £1 reduction in upfront costs.

This relationship is shown in Figure 1 below, which illustrates how participants' demand for heat pumps changes as a function of the upfront costs they were presented with (while running costs are held fixed[14]). The four lines on the graph represent the upfront cost demand curve for each of the four demand groups at fixed levels of running costs. This figure shows that, for example, 65% of participants in the low energy demand on gas grid group chose the heat pump option when the upfront cost was £3,000, aligning with the cost of renewing their current gas boiler. However only 7% of participants in the same group chose a heat pump when the upfront cost was £10,000[15] [16].

The results derived from the main multivariate regression specification indicate that there is a statistically significant negative non-linear relationship between upfront costs and heat pump demand across all four energy demand groups costs (see Table 39 in the Technical Annex),. This means that, on average (i.e., not taking non-linearity or interactions into account), a £1,000 decrease in upfront costs increases the demand for heat pumps by approximately 10 percentage points.

[14] The negative non-linear relationship between upfront costs and demand holds when keeping different levels of running costs fixed, suggesting that it is generalisable beyond the specific running cost levels used in Figure 1 (i.e., £200 per month for low demand groups and £240 for high demand groups).
15 The main experiment incorporated status quo running costs that were 10% higher than our initial best estimates at the time the experiment was conducted. Consequently, the absolute demand derived from the main experiment is slightly overestimated. Findings from the supplementary experiment suggest that, on average, demand estimates should be revised downward by 3.8 and 2.6 percentage points for respondents on and off the gas grid, respectively.
16 While we observe in Figure 2 a positive relationship between upfront costs and demand in the low demand off-gas grid group in the segment between £3,000 and £3,600, the difference in demand is not statistically significant. The sample size for the low demand off gas grid group is small compared to that of other groups (n = 218), which means that the estimates are less reliable (and noisier) for this group.

**Figure 1**: The relationship between ASHP upfront costs and demand for heat pumps for different energy demand groups




Notes: This figure presents four demand curves (one per energy demand group). The demand curves are plotted using choice data from the discrete choice experiment, and the costs that participants were shown are represented by dots in the chart. Running costs are held constant at the status quo running cost level; that is, at £200 for those in the low energy demand groups (n=2,328 for the low on-gas grid group and n=218 for the low off-gas grid group), and at £240 for those in the high energy demand groups (n=1,453 for the low on-gas grid group and n=2,087 for the low off-gas grid group). The curves are estimated by using the share of participants who said that they would buy a heat pump at a given upfront costs, while the running cost is held fixed at a given level. The curves for the four groups differ in coverage because the four groups were shown different ranges of upfront costs in the discrete choice experiment. The vertical dotted lines indicate the upfront costs of the status quo heating system for the four respective groups. It is important to note that the main experiment incorporated status quo running costs that were 10% higher than our initial best estimates at the time the experiment was conducted. Consequently, the absolute demand derived from the main experiment is slightly overestimated. Findings from the supplementary experiment suggest that, on average, demand estimates should be revised downward by 3.8 and 2.6 percentage points for respondents on and off the gas grid, respectively. Moreover, monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs.

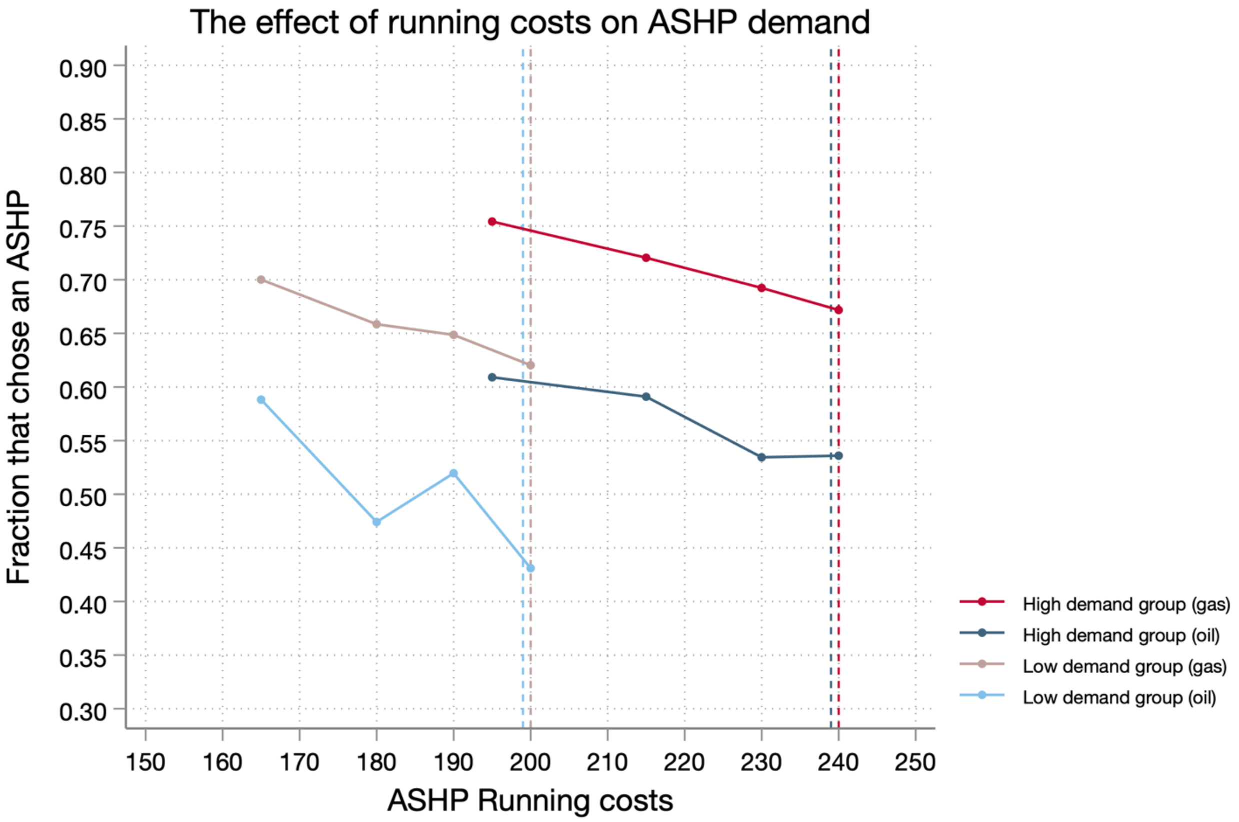
## The effects of running costs on demand for ASHPs

Findings indicate that as running costs decrease, the demand for heat pumps increases. Figure 2 and Figure 3 below illustrate how the demand for heat pumps changes as a function of the ASHP running costs, while ASHP upfront costs remain constant at the status quo levels. Figure 2 displays demand curves derived from data in the main experiment, covering scenarios where ASHP running costs are equal to or lower than the status quo running costs. In contrast, Figure 3 depicts demand curves computed from data in the supplementary experiment, representing scenarios where ASHP running costs exceed or are equal to the status quo running costs.

The results from the linear multivariate regression analyses reveal a statistically significant negative relationship between running costs and heat pump demand (see Tables 22 and 23 in the Technical Annex). While findings from the main experiment do not decisively confirm the presence of a non-linear relationship when ASHP running costs are equal to or lower than the status quo running costs (see Table 39 in the Technical Annex), results from the supplementary experiment indicate a statistically significant non-linear negative effect for both on and off gas-grid respondents (see Tables 74 in the Technical Annex).

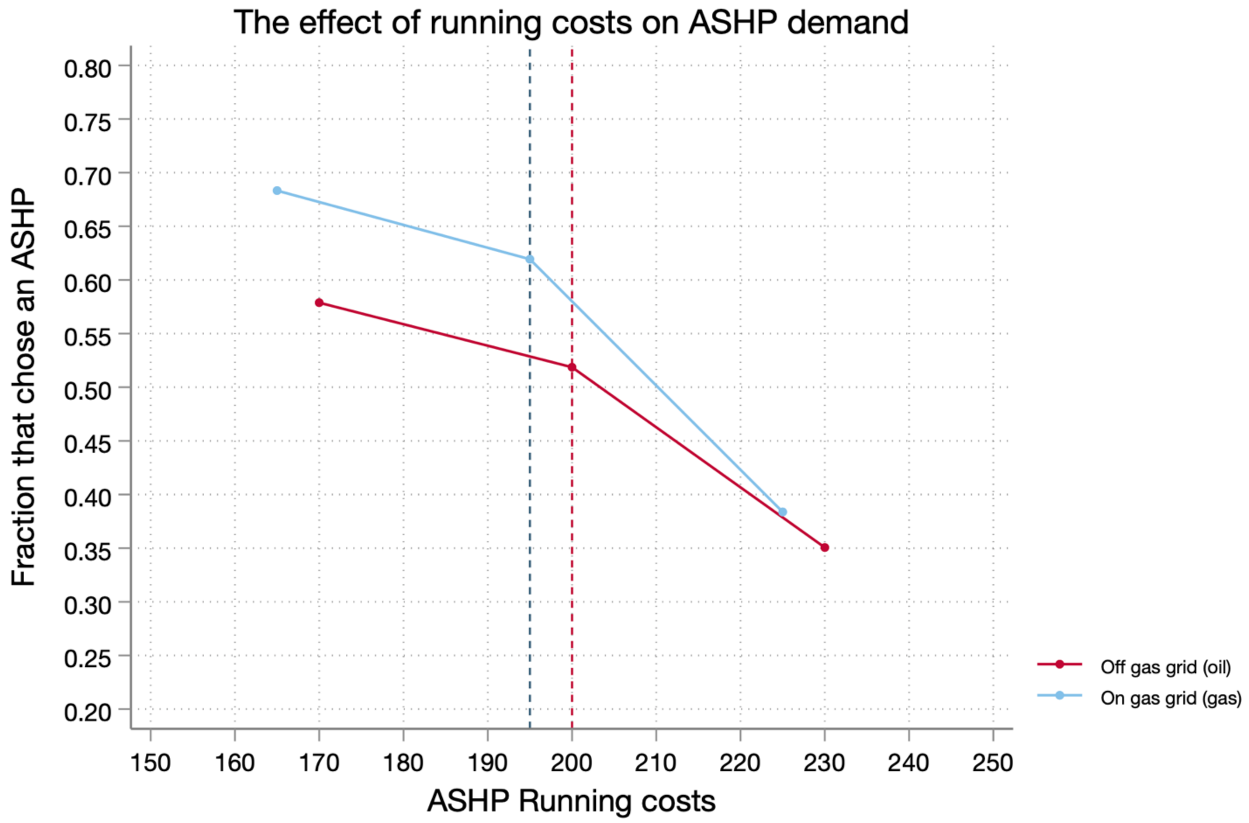
Taken together, these findings suggest there is an inflection point when running costs fall below those of the status quo. In other words, a £1 reduction in ASHP running costs has a greater impact on ASHP demand when ASHP running costs are higher than those of the status quo, compared to a £1 reduction in ASHP running costs when they are already equal to or lower than those of the status quo. This suggests that participants' preferences for ASHP running costs are influenced by their relative difference compared to the status quo running costs.

**Figure 2: The relationship between ASHP running costs and demand for heat pumps for different energy demand groups**




Notes: This figure presents four demand curves (one per energy demand group). The demand curves are plotted using choice data from the discrete choice experiment, and the costs that participants were shown are represented by dots in the chart. The upfront costs are maintained at the current status quo levels, specifically £3,000 and £3,600 for the low (n=2,328) and high (n=1,453) energy demand gas groups, and £6,000 and £6,900 for the low (n=218) and high (n=2,087) energy demand oil groups, respectively. The curves are estimated by using the share of participants who said that they would buy a heat pump at a given running costs, while the upfront cost is held fixed at a given level. The curves for the four groups differ in coverage because they were shown different ranges of upfront costs in the experiment. The vertical dotted lines indicate the running costs of the status quo heating system. The main experiment incorporated status quo running costs that were 10% higher than our initial best estimates at the time the experiment was conducted. Consequently, the absolute demand derived from the main experiment is slightly overestimated. Findings from the supplementary experiment suggest that, on average, demand estimates should be revised downward by 3.8 and 2.6 percentage points for respondents on and off the gas grid, respectively. Moreover, monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs.

**Figure 3: The relationship between ASHP running costs and demand for heat pumps for on and off gas grid groups (supplementary experiment)**




Notes: This figure presents two demand curves (one for off gas grid and one for on gas grid groups). The demand curves are plotted using choice data from the supplementary experiment, and the costs that participants were shown are represented by dots in the chart. The upfront costs are maintained at the current status quo levels, specifically £3,150 and £6,200 for the on-gas grid group (n=641) and the off-gas grid group (n=482), respectively. The curves are estimated by using the share of participants who said that they would buy a heat pump at a given running cost, while the upfront cost is held fixed at a given level. The curves for the two groups differ in coverage because they were shown different ranges of upfront costs in the experiment. The vertical dotted lines indicate the running costs of the status quo heating system. It's important to note that, monthly running costs were presented to participants as total energy bills (i.e., combining gas and electricity costs), calculated based on average prices from 2022-2023, representing peak billing costs

## Demand for ASHPs when upfront and running costs are at parity with the status quo heating system

When analysing the share of participants that chose heat pumps over renewing their current heating systems when upfront and running costs of the two options are the same, we found that more than half of most groups would choose a heat pump when costs are on par (see tables 51-54 in the Annex 2 of the Technical Annex). Around 67% of participants in the high energy demand on gas grid group chose the heat pump when upfront and running costs were on par, while 62% did so in the low energy demand on gas grid group. Moreover, 54% of participants in the high energy demand off gas grid group chose a heat pump when the costs were the same, and 43% chose the heat pump in the low energy demand off gas grid group.

In scenarios where ASHP upfront and running costs align with those of fossil fuel boilers, households' motivations for selecting ASHPs shift, with greater emphasis placed on environmental impact over installation-related concerns. This suggest that on average, the positive aspects associated with heat pumps (e.g., lower environmental impact and potentially enabling hedging against future fossil fuel prices) could outweigh the potential negative aspects associated with heat pumps (e.g., the hassle associated with installations, heat pumps being an unknown technology) when prices are on par.[17] Indeed, participants that chose a heat pump when costs were on par with their current heating system were more likely to state that they did so to minimise their environmental impact, and running costs compared to all participants. They were also less likely to care about the indoor and outdoor space that a heat pump would require, and the hassle associated with installing a new heating system). These findings highlight a shift in people's motivations for ASHP adoption under cost parity scenarios, suggesting potential policy avenues to further incentivise ASHP uptake.

## The relative importance of upfront and running costs

The multivariate regression results and the slopes of the curves in Figure 2 and Figure 3 suggest that demand for heat pumps is more sensitive to reductions in upfront costs than reductions in running costs, other things being equal. This sub-section presents an in-depth discussion of the relative importance of the upfront and running costs of heat pumps in terms of how they influence demand for heat pumps. This involved comparing the regression coefficients for the average effects of upfront and running costs (see Table 22 of Annex 2 of the Technical Annex).

Overall, considering the results from both the main and supplementary experiments, upfront costs are seven to sixteen times more important than running costs, depending on households' energy demand and grid status. Findings also suggest that upfront costs are relatively more important to off-gas grid participants compared to on-gas grid participants and for low energy demand groups compared to high energy demand groups. Taking figures from the main experiment, upfront costs are eight and nine times more important than running costs for high and low demand on-gas grid participants, respectively. In contrast, upfront costs are fifteen and sixteen times more important than running costs for high and low demand off-gas grid participants, respectively. This means that, for example, a £1,000 decrease in the upfront cost of a heat pump was estimated to increase demand by 10 percentage points while the equivalent decrease in undiscounted lifetime running costs (i.e., a £4.20 increase in monthly running costs) would reduce demand by 1 percentage point for the on-gas grid low energy

[17] It is important to note that participants in the DCE may not be fully aware of what is required to install a heat pumps, relative to changing their status quo heating system, so these estimates may not generalise to those who are more knowledgeable about what it takes to install a heat pump. In other words, some participants who state that they would prefer a heat pump when costs are on par might, in reality, decide that they prefer to keep their boiler when they learn what is required in order to switch system.

demand group (when ASHP running costs are equal to or lower than those of the status quo) [18].

The findings suggest that respondents' decision-making is likely influenced by three potential factors:

- Present bias: A preference for avoiding immediate costs over considering future costs.
- Liquidity constraints: Difficulty accessing funds immediately for upfront costs, which could be due to financial limitations such as the inability to afford a heat pump, investments tying up resources, or challenges in obtaining loans or affordable financing.
- Computational limitations: Difficulty in comprehending the long-term implications of small increases in monthly running costs, such as a £1 increase over the lifespan of a heat pump.

There are two important points to note when interpreting the above results:

- Firstly, we obtained these by comparing the *average* marginal effects of upfront and running costs (for all four demand groups). As Table 39 in the Technical Annex shows, the marginal effect of a £1 increase in upfront costs is, for example, lower when upfront costs are at a higher level. This means that one may obtain different estimates of the relative importance of upfront and running costs at different points in the cost distributions (e.g., running costs may be more important relative to upfront costs when upfront costs are lower). In addition, the relative importance of upfront and running costs may vary by household characteristics (e.g., property type, income, age).
- Secondly, the estimated relative importance of costs may also depend on how costs were presented to participants. For example, running costs may have potentially had a larger effect on demand if they had been presented as yearly or total lifetime running costs as opposed to monthly running costs. In this study, running costs were presented as monthly costs as this is how information is typically presented to people in a real-world context. However, this framing may have led some participants to underestimate the relative importance of running costs due to difficulty in projecting the total amount.

Assuming that participants have a constant annual discount rate, that they value £1 in 20 years as much as £7-£16 now, depending on whether they are on the gas grid or off gas grid and their energy demand, it is possible to derive an implied discount rate between 10%-15% for participants of the DCE[19]. This discount rate should be interpreted with caution, in part due to

[18] To get to this estimate, we assumed that a heat pump lasts for around 20 years and households pay 12 bills a year. We then computed (by dividing the coefficient for the average effects of running costs for each demand group by 240, i.e., 12 times 20) the relative importance of £1 in upfront costs and £1 in overall running costs. Without taking into account temporal discounting (i.e., the notion that money in the future is worth less than money in the present), this calculation shows that a £1 increase in the total running costs of a heat pump over the course of 20 years reduces demand by (0.26/240) 0.001 percentage points.

[19] The discount rate was derived using the following formula: discount rate = (FV/PV)^(1/n) – 1 , where FV=future value, the PV=present value and n=20 (the number of years a heat pump is likely to last. In the main experiment, we observed discount rates of 11%, 12%, 14%, and 15% among participants in the high demand on-gas grid, low demand on-gas grid, high demand off-gas grid, and low demand off-gas grid groups, respectively. In contrast,

the strong assumptions that are required when computing it, and to it capturing a range of factors (from present bias to liquidity constraints).

## Interaction effects between upfront costs and running costs

In this section we assess the interaction effects between running costs and upfront costs. Figures 1-8 (Annex 2 of the Technical Annex) present the demand for heat pumps whilst holding upfront and running costs fixed at different levels for different energy demand groups. These analyses suggest, particularly for those living on the gas grid, that the effects of upfront costs vary as the running cost changes (i.e., running costs and upfront costs interact). These also suggest that the effects of running costs are sensitive to the precise level of upfront costs.

Findings from the main multivariate regression specification (see Table 39 in the Technical Annex) show that there is indeed a statistically significant positive interaction effect between upfront costs and running costs for the high and low demand on gas grid groups. This means that one cost (i.e., upfront costs or running costs) has a greater effect on the demand of heat pumps when the other cost (i.e., running costs or upfront costs) is low. For example, a £1 reduction in upfront costs has a lower effect on demand if running costs are set at £200 as opposed to £165 per month. Similarly, a £1 reduction in running costs has a lower effect on demand if upfront costs are £6000 as opposed to £3000. This finding suggests that participants think about costs relatively. A high upfront or running cost may ‘anchor’ participants to a higher price and make them perceive the other cost as less important (i.e., anchoring effect). Additionally, when ASHP upfront costs are high, reducing running costs may not significantly affect the lifetime net present value of a heat pump. However, as upfront costs decrease, running costs become more important. By reducing running costs to match those of alternative fossil fuel heating systems, a tipping point could be reached, facilitating the adoption of ASHPs.

We do not find statistically significant interaction effects between upfront and running costs for the high demand off gas grid group. This lack of significance might be attributed to the potential effect size being too subtle to detect reliably. Additionally, we find a statistically significant negative interaction effect between upfront costs and running costs for the low demand off gas grid group. As discussed in the preceding paragraph, this means that, for example, a £1 increase in one cost (i.e., upfront cost or running cost) has a higher effect on demand if the other cost type is high. Whilst this result is statistically significant, the sample size of the low demand off-gas grid group is far smaller than that of other demand groups, which means that estimates for this group are less reliable and that we have a lower probability of detecting the true effect for this group.

Further analyses that reweight the main multivariate regression model to account for discrepancies in the geographical distribution (i.e., natural representation of regions) and

despite presenting participants in the supplementary experiment with varied upfront and running cost values and using narrower cost ranges, we found discount rates of 10% and 12% for the on and off gas grid groups, respectively property size (see Tables 41 and 42 in the Technical Annex) confirm the robustness of these results.

## Other predictors of heat pump adoption

To understand relationships between the characteristics of respondents and the likelihood of wanting to install a heat pump, we performed a multivariate regression analysis using the discrete choice experiment choice-level data.[20] The multivariate regression controls for all variables discussed in this section and includes weights to address discrepancies in grid status distribution. The results are based on the pooled sample of respondents, rather than segregating them into the individual four energy demand groups. Overall, those who are more likely to choose a heat pump tend to be: younger (under 64), wealthier (have higher income and savings), be more concerned about climate change and their environmental impacts, more concerned about the cost of their monthly bills, and already be planning some energy efficiency improvements. The types of households that are more likely to demand heat pumps are those that live in off-gas grid detached houses built after 1900 that have smart meters installed, and have an electric vehicle.

### Heating system characteristics and energy efficiency improvements

Table 60 in the Technical Annex shows that, even when controlling for heating system characteristics and existing energy efficiency improvements, **off-gas grid households are far more likely to want to install a heat pump**. On-gas grid households were 14 percentage points less likely to want a heat pump than off-gas grid households. This result may, in part, be due to households on the gas grid facing lower costs associated with replacing their currently fossil-fuel heating system than those off the gas grid. However, as the main specification model shows (Table 39 in the Technical Annex) , off-grid households are more likely to choose a heat pump even when controlling for status quo costs and heat pump costs. This reinforces the observation in Figure 2 that demand is, generally speaking, higher in the two off-gas grid groups.

Controlling for heating system characteristics and energy efficiency improvements, the analysis shows that **those who own a smart meter or an electric vehicle** are significantly (2 percentage points and 6 percentage points, respectively) more likely to want to install a heat pump. Those **planning home energy efficiency improvements** are 4 percentage points **more likely to choose a heat pump** than those who are not. We do not find a statistically

[20] Associations were estimated using OLS regressions, and clustered standard errors at the individual level. Detailed regression results are presented in Table 60 in the Annex 2 of the Technical Annex. More specifically, the multivariate regression controls for all variables discussed in each sub-section of this section of the report. The regression results were also weighted to account for discrepancies in grid status distribution (these discrepancies are due to a conscious decision to over-sample the off-gas grid group). It is important note that since this regression analysis includes a many covariates, the magnitude of the coefficients are likely to be underestimate due to cofounding factors.

significant association between the age of one's heating system that the intention to install a heat pump.

## Income, savings, age, and gender

Table 60 in the Technical Annex shows that there is **no significant relationship between gender and heat pump demand**. Among homeowners, those **aged between 25-64** exhibit the highest likelihood of choose a heat pump, with the age group between 25 and 34 being the most inclined toward this choice. **Higher income** is also associated with heat pump demand: those with an income between £60,000 to £100,000 are, for example, around 3 percentage points more likely to choose a heat pump than those with an income between £20,000 and £40,000. In line with this, those who have **more than £10,000 in savings** (even when controlling for income) are 2 percentage points more likely to choose a heat pump. Struggling to pay bills is not significantly associated with heat pump demand.

## Attitudes toward, and knowledge about, heat pumps

Table 60 in the Technical Annex shows that those say they are **concerned about climate change** - all else equal - are 5 percentage points more likely to choose a heat pump. Those who **believe that their energy prices are likely to rise** in the next 2 years are 4 percentage points more likely to choose a heat pump. Being **interested in saving money on their monthly bills** (6 percentage point increase in demand) and wanting to **minimise their environmental impact** (17 percentage point increase in demand) are **positively** associated with wanting a heat pump.

Wanting to **save money on upfront costs** (3 percentage point decrease in demand), wanting to be **familiar with their heating system** (a 3 percentage point reduction in demand), wanting to **minimise occupied space** (a 6 percentage point reduction in demand), and wanting to **minimise time and inconvenience** associated with their heating system (a 10 percentage point reduction in demand) is associated with **being less likely** to want a heat pump.

Participants who **passed the knowledge question were 5 percentage points more likely** to choose a heat pump. However, those **who claimed to know a lot about heat pumps were actually 7 percentage points less likely** to opt for one (relative to those who had not heard of heat pumps, holding the level of actual knowledge constant). Furthermore, the effect of claiming to know a lot about heat pumps on the likelihood of choosing a heat pump remained consistent regardless of whether participants passed the knowledge question or not. This suggests that some participants may exhibit overconfidence in their understanding of heat pumps or could be exposed to other types of information (It's worth noting that the knowledge question in this survey primarily focused on practical and operational aspects of heat pumps), potentially including negative information or falsehoods about ASHP, not directly captured in this survey.

### Property type, property age, property size, mortgage status, and tenure

Table 60 also shows that people living **detached houses are most likely** to want a heat pump by 2 percentage points. Additionally, having **a mortgage** is also **positively associated** with a 7 percentage point increase in heat pump demand. However, we don't find statistically significant results for both of these findings when controlling for other variables, such as including income and savings. We do find that households that have owned a property for 10 or more years and those that expect to own the property for 10 years or more are less likely to install a heat pump by 2 and 1 percentage points respectively (controlling for other variables, including age). We also find that households that live in properties that were built before 1900 are less likely to install heat pumps.

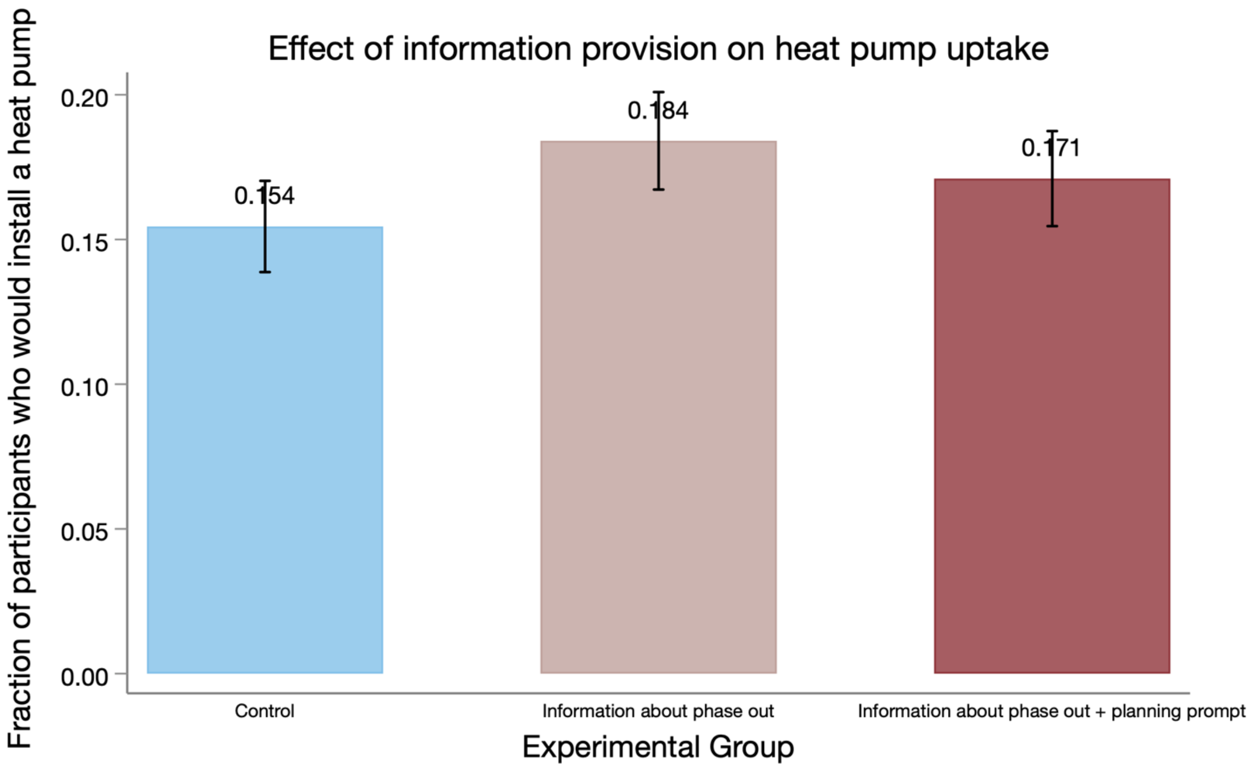
## The effects of information provision on heat pump demand

This sub-section examines whether presenting participants with information about a possible phase-out of fossil fuel boilers and/or prompts to start planning for the future replacement of their heating system influences demand for heat pumps. We used data from the randomised controlled trial (RCT), which was administered after the discrete choice experiment. The results suggest that **adding information about a possible phase-out of fossil fuel boilers increases demand for heat pumps**. However, the analysis does not find any incremental positive effect of adding planning prompts on heat pump demand.

Participants were allocated to a control condition, or to one of two treatment conditions. Figure **4** presents the share of respondents who said that they were somewhat or extremely likely to buy a heat pump in the different experimental conditions. The figure shows that those in treatment 1 were significantly more likely to choose a heat pump than those in the control group. However, those allocated to treatment 2 were not significantly more or less likely to choose a heat pump than those in the control group or in treatment group 1. The analysis is unable establish whether these prompts are counterproductive.[21] These results did not vary significantly by participant group (i.e., on/off gas grid groups).

**Figure** 4**: The effects of information provision and prompts on heat pump demand**

[21] The planning prompts may have other secondary effects on participants' intentions or behaviours that were not recorded within the scope of this study but which could affect the likelihood of installing a heat pump. For instance, planning prompts could help close the intention-action gap (i.e., help people follow through with their intentions).




Note: This table presents the share of participants who said they would choose an ASHP in each of the RCT condition groups. The error bars present 95% confidence intervals for the three groups. For more detailed results, please see Table 62-63 in the Technical Annex.

## Financing options and heat pump demand

Table 3 presents the share of participants that believe that a given financing option would increase their likelihood to install a heat pump by a lot or a great deal, both across all participants and by energy source. Here, we asked participants how likely they were to install a heat pump based on the predicted costs of installing a heat pump for their property type, and how this would change considering each option presented.

**The financing option that participants claim would have the greatest effect on their interest in heat pumps is gaining access to a reduced mortgage interest rate** (54% of participants who have a mortgage say that this would increase their probability of buying a heat pump by a lot or a great deal). The second-most popular option was discounted energy tariff rates during off peak hours, with 33% of all participants stating that this would increase their likelihood of buying a heat pump. The third-most popular option - with 31% stating it would increase their chances of buying a heat pump - was a 0% interest loan over 7 years. In contrast, 16% said that the 0% interest loan over 2 years would increase the probability that they would buy a heat pump. Similarly, 19% and 15% stated that stamp duty relief and being able to add the upfront cost of a heat pump to their mortgage, respectively, would make them more likely to buy a heat pump.

Results were relatively consistent across on- and off-grid households. Reduced mortgage interest rates were, for example, most popular in both groups. Further, adding the upfront cost of the heat pump to their mortgage and having access to a 0% interest loan over 2 years was the least popular for all segments.

**Results were relatively consistent across on- and off-grid households, and for households with high or low energy demand**. Reduced mortgage interest rates were, for example, most popular in all segments. Further, adding the upfront cost of the heat pump to their mortgage and having access to a 0% interest loan over 2 years were the least popular for all segments.

**Table 3: Effect of Financing Options on the Increased Likelihood to Install a Heat Pump**

| Financing option | All | On gas | Off gas |
|---|---|---|---|
| 0% interest loan over 2 years | 16% | 18% | 14% |
| 0% interest loan over 7 years | 31% | 33% | 28% |
| Reduced mortgage interest rates if heat pump installed | 54% | 57% | 48% |
| Adding the upfront cost of the heat pump to their mortgage | 15% | 16% | 12% |
| Stamp duty relief for buyers | 19% | 19% | 19% |
| Discounted electricity rates during off-peak hours | 33% | 33% | 32% |
| Sample size (n) | 6086 | 3781 | 2305 |

Notes: This table presents responses to a question about the extent to which each financing option would increase their likelihood to install a heat pump on a 5-point Likert scale from “Not at all” to “A great deal”. This table presents the share of respondents that report that a given financing option would increase their likelihood to install a heat pump by “a lot” or “a great deal”. Averages are presented for the study sample as well as those on and off the gas grid. The two financing options related to mortgages are asked only to participants who report having a mortgage on their current property.

# Conclusions

*This chapter summarises the key findings from the study, in consideration with the main research questions.*

## Headline findings from the study

**How do upfront and running costs of ASHPs individually affect homeowners' willingness to take up ASHPs, and what is the relative importance of upfront and running costs in affecting decisions to take up ASHPs?**

The lower the upfront costs, the higher the ASHP demand for off and on gas grid groups with high and low energy demand. Additionally, the effect of additional upfront costs depends on the existing level of upfront costs. An extra pound of upfront cost matters more when upfront costs are lower. On average, disregarding the non-linear and interaction effects between upfront costs and demand, a reduction of £1,000 in the upfront cost of a heat pump is estimated to raise demand by 10 percentage points across off and on gas grid groups with high and low energy demand.

Similarly, the lower the running costs, the higher the demand for heat pumps. However, the reduction in running costs has a more pronounced effect on demand when they exceed the status quo running costs, compared to when ASHP running costs are equal to or lower than the status quo. In scenarios where ASHP running costs surpass those of the status quo, a £1,000 decrease in undiscounted total lifetime running costs of the heat pump (equivalent to a £4.20 decrease in monthly running costs) leads to a demand increase of 1.4 percentage points for the on-gas grid group and 1.1 percentage points for the off-gas grid group, on average (without considering non-linearity and interactions). In contrast, in scenarios where ASHP running costs are equal to or lower than those of the status quo, a similar reduction in undiscounted total lifetime running costs of the heat pump results in a demand increase of 1.3 to 1.1 percentage points for the high and low on-gas grid groups, and 0.8 to 0.6 percentage points for the high and low off-gas grid energy demand groups, respectively[22].

Upfront costs are between seven to sixteen times more important to participants compared to running costs when choosing to install a heat pump depending on their energy demand and grid status. This means that, for example, a £1,000 increase in the upfront cost of a heat pump was estimated to reduce demand by 10 percentage points, while the equivalent increase in lifetime running costs (i.e., a £4.20 increase in monthly running costs) would reduce demand by 0.6-1.4 percentage points across all energy demand groups. These calculations, however,

[22] Note that if we are operating in a scenario akin to the original experiment and wish to manipulate running costs (i.e., scenarios where ASHP running costs are lower or comparable to those of the status quo), it is advisable to use the estimates from the main experiment. In contrast, if we are in or considering a scenario resembling the supplementary experiment (i.e., a scenario where ASHP running costs are greater than those of the status quo and are reduced to levels comparable to or lower than those of the status quo), the estimates from that setting should be employed.

do not take into account factors like temporal discounting (i.e., that future costs matter less than current costs) or inflation. It should be noted that this result could also be influenced by how running costs were presented in the experiment, i.e. as monthly running costs rather than total lifetime costs. This framing means that participants may have found it difficult to estimate total savings from running costs.

There are statistically significant positive interaction effects between upfront and running costs for participants living on the gas grid. This means that running costs tend to matter more when upfront costs are lower (i.e., a £1 reduction in running costs has a bigger effect on demand if upfront costs are £3000 as opposed to £6000). This finding may provide a useful insight for further policy development. If upfront costs come down or grant funding is in place to reduce the upfront cost of ASHPs, interventions to reduce running costs may more effectively encourage greater ASHP adoption.

**How do decisions to take up ASHPs vary by subpopulations of interest and characteristics of interest?**

The analysis identified several variables that predict interest in ASHPs. For example, off-grid households were (even when controlling for a range of factors) far more likely to choose a heat pump than those on the gas grid. Those who are planning energy efficiency improvements in the near future are also more likely to choose a heat pump. Moreover, higher income is associated with greater interest in heat pumps, as are savings. Other factors that are positively associated with ASHP demand include concern about climate change, being interested in saving money on their monthly bills, and understanding what a heat pump is (based on knowledge tests). Participants living in detached houses are more likely to choose heat pumps than those living in other property types.

Factors that are negatively associated with demand for heat pumps include having lived in a property for 10 years or more or expect to live in it for 10 or more years, being concerned about the upfront costs associated with replacing their heating system and wanting to minimise the hassle and space required for such replacements. Claiming to be knowledgeable about heat pumps (controlling for actual knowledge about heat pumps) is also negatively associated with choosing a heat pump.

**Does presenting participants with information on a possible fossil-fuel boiler phase-out and planning prompts influence intentions to install an ASHP?**

The randomised controlled trial shows that it would be beneficial to share information about the planned phase-out of fossil fuel boilers, as this significantly increased demand for heat pumps, regardless of whether households are on or off the gas grid. More specifically, the phase-out information increased the share who wanted a heat pump by 2.9 percentage points, which is equivalent to a 15.4% increase in demand relative to those who were not shown this information.

The analysis did not find any significant positive effect associated with presenting participants with prompts encouraging them to plan ahead for the next time they need to replace their heating system.

**To what extent do different financing options affect decisions to take up ASHPs?**

A significant share of respondents stated that the availability of financing options would influence their likelihood of adopting a heat pump. The most popular financing options were reduced mortgage rates, with 54% of participants with a mortgage stating this would make them more likely to choose a heat pump, and discounted electricity rates during off peak hours, with 33% of all participants suggested this would make them more likely to do so. These findings suggests that it might be possible to improve heat pump demand by marketing Time of Use tariffs to homeowners.

Participants also thought that 0% interest loans would increase their demand for heat pumps. However, the duration of the loan had a big effect on its attractiveness; 31% said that a 7-year loan would increase their chances of buying a heat pump, while only 16% said the same for a 2-year loan.

Overall, this study shows that both reducing ASHP upfront costs and running costs can significantly increase demand for heat pumps, although the effect of reducing upfront costs is larger. To further increase adoption, providing information on possible fossil fuel phase-outs and offering financing options like reduced mortgage rates could be beneficial. Looking ahead, these findings can serve to develop targeted policies that effectively support these households to adopt heat pumps.

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