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Effects of building fabric requirements on willingness to adopt a heat pump

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Abstract

Decarbonising residential heating requires widespread adoption of heat pumps, yet uptake remains below policy targets. Low uptake may be partly explained by building fabric upgrades that current policy assumes heat pumps require to work efficiently, but the effect of these upgrades on heat pump adoption remains underexplored. This study examines how such requirements influence homeowners' willingness to adopt heat pumps using a pre-registered survey experiment with a nationally representative sample of homeowners in Ireland (n = 574). Participants reported their intentions to adopt a heat pump as they received sequential information on its benefits, installation costs, and personalised upgrade requirements for their own home. Information on benefits significantly increased willingness to adopt, but this effect was fully reversed once participants learned about required building fabric upgrades. Wall insulation in particular had a large deterrent effect, with a marginal reduction in adoption intention of approximately 40% compared to only ventilation upgrades (19.7% vs. 11.6%). An embedded survey experiment testing an enhanced heat pump installation grant substantially increased willingness at the point of cost information, but this effect was largely eroded after upgrade requirements were introduced. Additional interventions, including cost comparisons and information on low-cost financing, had no meaningful impact. The results demonstrate that adoption decisions depend on the full set of costs and requirements associated with heat pump installation. Forecasts that fail to recognise the deterrent effects of these requirements are likely to overestimate heat pump uptake. Policies that subsidise heat pumps alone are unlikely to achieve target uptake where significant preparatory works are required.

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1 Introduction

Decarbonising residential heating is one of the most significant challenges for energy policy. The residential sector accounts for over a fifth of global energy demand and, in advanced economies, approximately 70% of this energy is used for space and water heating, mostly from fossil fuel boilers (Eurostat, 2025; International Energy Agency, 2025). Heat pumps, which transfer heat from outdoor air or ground sources using electricity, offer a low-emission alternative that can, when powered by an increasingly decarbonised grid, deliver substantial reductions in household carbon emissions. Their widespread adoption is a central feature of national decarbonisation strategies (Department for Energy Security & Net Zero, 2026; Department of the Environment, Climate and Communications, 2021; Ministerie van Klimaat en Groene Groei, 2025).

Despite policy support and subsidies for adoption, uptake remains below projections (Lynch, Reaños & Farrell, 2026). Heat pump sales in Europe declined in 2023 and 2024 and retrofit adoption has been particularly slow (European Heat Pump Association, 2025). This divergence between policy intent and household behaviour highlights the need to understand barriers to adoption under existing financial incentives (Zhu, Curtis & Clancy, 2023).

While an existing literature has examined homeowner preferences for heating system attributes, the role of building fabric prerequisites for heat pump installation has received comparatively little attention. Unlike boiler replacement, which is generally a straightforward swap of one appliance for another, heat pump installation under current grant designs in Ireland typically requires preparatory upgrades, such as wall insulation and ventilation and air tightness improvements to ensure efficient operation (Collins & Dempsey, 2019; Lingard, 2021). In many dwellings, there are fears that failing to undertake such upgrades can result not only in high running costs, but in poor system performance, potentially rendering the installation ineffective or entirely unsuitable. These upgrades are often expensive, with total costs that can exceed €40,000 (e.g., Electric Ireland Superhomes, 2026). Although such investments can yield long-term savings and comfort benefits (Caird, Roy & Potter, 2012; Carroll et al., 2025; Saffari, Keogh, De Rosa & Finn, 2023), the immediate cost, complexity and disruption likely constitute substantial deterrents, particularly given present-biased preferences (Lades, Clinch & Kelly, 2021). The effect of these requirements on adoption intentions remains underexplored.

This study addresses this gap using a survey experiment with a nationally representative sample of homeowners in Ireland. Participants learned about heat pumps before receiving personalised information about the building fabric upgrades their specific home would require before one could be installed. Some were randomised to see enhanced installation grants and information on low-cost financing options. By employing methods from Information Integration Theory (Anderson, 1981) to measure changes in adoption intentions, our design allows us to (i) estimate the sequential effect of relevant heat pump information, including the benefits and upgrade requirements, (ii) to test whether a more generous grant can offset the negative impact of this information and (iii) to identify which household and dwelling characteristics predict high willingness when fully informed.

1.1 Literature Review

1.1.1 Heating System Attributes

Financial factors are consistently identified as primary determinants of heating system choice (e.g., Schleich, Guetlein, Tu & Faure, 2022). Upfront cost and expected bill savings explain a substantial share of variation in preferences (Meles, Ryan & Mukherjee, 2022; Rouvinen & Matero, 2013; Scarpa & Willis, 2010). Homeowners show strong preferences for policies that reduce up-front installation costs, for example through interest-free loans (Behavioural Insights Team, 2022). However, financial incentives do not appear to be strong drivers of comprehensive retrofit measures (Collins & Curtis, 2016) and may be taken advantage of by those who would invest in retrofitting in the absence of financial support (Collins & Curtis, 2018).

Non-financial factors remain underexplored (de Jager et al., 2025). One such is familiarity with alternatives to traditional boilers (Chitchyan, 2025; Michelsen & Madlener, 2016). Surveys in multiple countries show that while many homeowners report having heard of a heat pump, understanding of them is low (Morland & Fylan, 2025; Pardy, Rhodes & Jaccard, 2022) and awareness of installation details even lower (Chitchyan, 2025; Karytsas, 2018). Accordingly, even households who consider themselves informed about heat pumps may hold incomplete or inaccurate beliefs about what adoption would actually entail for their specific home.

“Hassle costs” (i.e., the time, effort, stress and disruption associated with adopting a new product or behaviour) are often raised as barriers (Gillingham & Palmer, 2014; Lades et al., 2021; Snape, Boait & Rylatt, 2015), though empirical evidence is mixed. For example, though some studies find negative effects of the inconvenience associated with heating system change (Pardy, Rhodes, Axsen & Jaccard, 2026; Scarpa & Willis, 2010), others report null effects (Behavioural Insights Team, 2022; Schleich et al., 2022). These null findings may reflect the simplified representations of disruption in typical discrete choice experiments, for example as abstract “minor works” vs. “major works” or time in days, rather than as the concrete, multi-stage process of building fabric upgrades that many households would actually face. More detailed depictions of retrofit works, in which home and room habitability during installation are clearly described, show that the negative value homeowners place on disruption can offset much of the expected cost savings from retrofitting (Curtis, Grilli & Lynch, 2024). However, administrative evidence on whether more complicated retrofit projects have higher abandonment rates show mixed results (Collins & Curtis, 2017a; Pillai, Reaños & Curtis, 2021).

1.1.2 Information Provision

A smaller literature has examined how information provision affects heat pump adoption intentions. Presenting cost information about fossil fuel systems and heat pumps has been shown to increase willingness to pay for heat pumps by around 25% compared to a no-information control (Eßer et al., 2024; see also Collins & Curtis, 2017b), while informing participants that a majority of neighbours had installed heat pumps has shown positive effects on adoption intentions, with financial information providing a smaller additional boost (Hafner, Elmes, Read & White, 2019).

These studies suggest that information can shift adoption intentions meaningfully, but they have focused primarily on benefits and nudges rather than on adoption requirements. This is a significant gap. The relevant question for many households considering a heat pump is not simply whether they would want one in the abstract, but whether they would want one given the specific preparatory work their home requires. A household that is positively disposed toward heat pumps in principle may have a very different reaction upon learning that adoption would require, for example, full external wall insulation and window replacement.

1.1.3 Information Integration Theory

We draw on Information Integration Theory as our theoretical framework (Anderson, 1981). Information Integration Theory proposes that individuals form judgements by combining multiple weighted inputs. Each input has a valence (how positive or negative it is in itself) and a weight (how much attention is paid to it relative to other information) and overall judgements are updated as new information is encountered. Information Integration Theory has been applied to understand decision-making in multiple domains, including health (Kattan, 2009), law (Estrada-Reynolds, Gray & Nuñez, 2015) and politics (Chung et al., 2012).

Applied to heat pumps, adoption intentions represent an integration initially of beliefs about benefits and financial costs, followed by the installation requirements homeowners learn about following a technical evaluation of their home and consultations with engineers. Information about building fabric prerequisites is likely to carry negative valence (increased cost and disruption) for most households (Curtis et al., 2024) and should therefore reduce adoption intentions. The theory predicts that differential effects across information types can be tested by presenting information sequentially in the order homeowners are likely to encounter it in the market. Despite its relevance, we could locate no applications of Information Integration Theory to the study of low-carbon technology adoption.

1.2 The present study

This study examines how heat pump adoption intentions evolve as homeowners receive information about them. Ireland provides a particularly relevant context. Heat pumps are central to the state's Climate Action Plan targets (Department of the Environment, Climate and Communications, 2021) and substantial grant support is available through the Sustainable Energy Authority of Ireland, both for heat pumps and other retrofit works, but adoption remains well below the trajectory required to meet national targets (SEAI, 2025). The Irish housing stock is dominated by semi-detached and detached properties built before modern insulation standards, meaning that a large proportion of households require significant building fabric upgrades prior to heat pump installation.

We employed a within-subjects survey experiment. Participants were asked to consider a heating system replacement scenario in which their existing boiler is nearing the end of its life, reflecting the decision point at which households are most likely to consider alternatives (SEAI, 2020). We sequentially revealed information on the benefits of heat pump adoption, the costs of installation and personalised information about the specific upgrades their home would require. The study content was developed in consultation with industry professionals to ensure that upgrade requirements and cost estimates reflect realistic retrofit conditions. Grant information for heat pump installation and building fabric upgrades were accurate at the time of data collection. This design allows us to measure how intentions to adopt change at each stage of the information sequence and to estimate the marginal deterrent effect of each upgrade category. We also embedded between-subjects experiments to assess, given previous literature, whether (i) enhanced grant support can offset the negative impact of upgrade requirement information, (ii) explicit comparisons against boiler replacement costs influence intentions and (iii) information on low-interest loans matters to homeowners. The study thus provides novel evidence on behavioural barriers to heat pump adoption, identifies policy-relevant intervention points and introduces Information Integration Theory as a useful framework for analysing low-carbon technology decisions.

2 Method

The study was implemented using Gorilla Experiment Builder and was compatible with laptop, tablet and mobile devices (Anwyl-Irvine et al., 2020). It was conducted in line with the ESRI's Research Ethics Committee policy and was pre-registered at https://osf.io/bp6st.

2.1 Participants

Participants were recruited by a market research and polling agency[a] using stratified quota sampling to be representative of homeowners in Ireland by ownership status (with or without a mortgage), age and region in December 2025. Further inclusion criteria were to live in a house (rather than apartment or other dwelling), to have a gas or oil boiler and to have at least some responsibility over heating system decisions in their home. A total of 776 participants met the inclusion criteria, though data were not stored for 85 who did not complete the study in full and a further 37 who failed a quality control question, in which they needed to select true statements about heat pumps from a list after being presented with a definition. A further 80 reported already owning a heat pump and were branched to complete a separate survey. Characteristics of the final 574 analytic sample are presented in Table 1.

Table 1. Sample Characteristics

Characteristic		%
Ownership	With mortgage	48.4
	Owns outright	51.6
Age	18-39 years	12.7
	40-59 years	48.8
	60+ years	38.5
Region	Dublin	29.3
	Rest of Leinster	24.4
	Munster	28.8
	Connacht-Ulster	17.6
House Type	Detached	44.1
	Semi-detached / End-of-Terrace	40.9
	Terrace	15.0
Building Energy Rating	AB	24.0

[a] https://www.redclive.ie/

	CD	33.3
	EFG	4.6
	Exempt / Don't know	38.2
House Age	2010+	8.4
	2000-2010	26.5
	1978-2000	31.5
	1950-1977	20.7
	Pre-1950	12.9
Boiler Type	Gas	46.3
	Oil	53.8
Ventilation	Natural + Mechanical Extract Ventilation (MEV)	1.2
	Demand Controlled Ventilation (DCV) / Mechanical Ventilation with Heat Recovery (MVHR)	4.2
	Other	94.6
Insultation	External	10.8
	Internal	31.4
	Cavity Wall	36.6
	None / Don't know	51.5
Window Glazing	Triple	15.9
	Double	83.7
	Single / Don't know	4.5

Note. Participants could select multiple options for some characteristics, meaning percentages can sum to more than 100 (e.g., if the house has windows of different glazing).

2.2 Measures and Design

Following screening and quota questions, participants were informed that the study was about home energy use. They then completed a home characteristic questionnaire covering building type, age, energy rating, wall insulation, window glazing and ventilation systems. Responses to these questions were used to tailored subsequent information and questions to each participant's circumstances, as described below.

The main survey then began with an open-text question asking participants what they know about heat pumps, followed by a definition and picture of an air-to-water heat pump to establish a common baseline level of familiarity. Measures related to perceived social norms and expectations of hassle were collected at this stage and will be analysed and reported separately. All measures and content are available in the

Supplemental Material (SM) which is available on the project's Open Science Framework page (https://osf.io/bp6st).

2.2.1 Adoption Intentions Measure

Throughout the task, participants rated their intention to switch from their current boiler to a heat pump on a slider scale anchored at 0 (*would definitely choose another* boiler) and 100 (*would definitely choose a heat pump*). Participant saw endlabels but numerical values were not displayed to encourage intuitive responding and reduce anchoring on round numbers (e.g., Liu & Conrad, 2016). This scale was administered at between 5 and 8 points during the task, depending on the homeowner's upgrade requirements, yielding a within-person response trajectory for each participant.

2.2.2 Information Presentation

For the main task, participants read a scenario in which their boiler engineer, during a routine service visit, advised that their boiler would likely need replacing within the next year. This framing reflects evidence that heating system replacement decisions are typically made at 'breakdown' or replacement moments, when households are most likely to consider alternatives (SEAI, 2020). Outside this decision point, the high upfront cost and disruption of switching technologies make adoption substantially less likely while a functioning boiler remains in use. Participants provided their initial intention-to-switch rating at this point, before receiving any further information about heat pumps. This served as the baseline measure.

Participants then received four sequential information chunks, rating their willingness to switch after each one. The overall order of chunks was fixed to reflect the real-world sequence in which homeowners learn about heat pumps: benefits, installation (with enhanced grants shown to a random subsample and regular grants otherwise), home upgrade requirements (if any) and, financing options (shown to a random subsample). Upgrade requirements consisted of up to three further chunks depending on the building fabric of the participant: ventilation, shown if the house had no form of mechanical ventilation; wall insulation, shown if the house was built before 2005 and did not have existing wall insulation; windows and doors, shown if the house had any single glazed windows. The order of specific upgrade types was randomised across participants. Homeowners who met no criteria for building fabric upgrades were informed their house was probably well enough insulated without further works. While wholly accurate fabric upgrade requirements would require a technical building assessment by an engineer, the survey was designed to use the homeowner's knowledge to approximate requirements. The survey contents and branching were designed in consultation with industry experts.

2.2.2.1 Benefits
Participants read about the advantages of heat pumps relative to gas or oil boilers, covering running costs, reduced carbon emissions, comfort, lower maintenance requirements, increased property value and eligibility for government grants.

2.2.2.2 Installation
Participants read information on the cost of installing a heat pump, installation duration and expected disruption. This information was tailored to the participant's dwelling type. For example, participants living in terraced houses were shown cheaper and less disruptive installation information than those living in detached homes, in line with real market information. Within this chunk, participants were randomly assigned to one of four conditions in a 2x2 design: (a) real market grant amount vs. enhanced grant amount that would equivalise the cost of a heat pump and boiler and (b) cost presented alone vs. alongside the cost for a replacement boiler. Participants rated their willingness to switch after viewing this information.

2.2.2.3 Home Upgrade Requirements
Participants read about any energy efficiency upgrades their home would require to be eligible for heat pump installation grants. The specific upgrades shown depended on the home characteristics reported at the outset. Participants were informed about mechanical ventilation (n = 549; 95.6%), wall insulation (n = 181; 31.5%) and/or window and door replacement (n = 20; 3.5%) only where their home did not already meet the relevant standard. Participants whose homes already met all requirements were informed that no further upgrades were needed (n = 24; 4.2%). For each applicable upgrade, participants were shown the estimated cost, any available grant support, expected duration of works and level of disruption for their home type. This content was based on consultation with industry professionals. For participants whose home required more than one upgrade (n = 145; 25.3%), the order in which upgrade types were presented was randomised. Participants provided a willingness-to-switch rating after each individual upgrade chunk, permitting assessment of the incremental effect of each upgrade type.

2.2.2.4 Financing
A randomly selected subsample (n = 287) received information about low-cost financing options available for heat pump installation. The remaining participants proceeded directly to the final rating without this information. All participants then gave a final willingness-to-switch rating.

The survey concluded with standard socio-demographic questions.

2.3 Analytic Approach

To examine how willingness to switch changed across the information sequence, we estimated ordinary least squares (OLS) regressions with participant fixed effects. Although we had pre-registered a mixed effects specification, we used fixed effects to account for unobserved participant characteristics that could be correlated with information conditions. For example, a concern here is that participants who had already upgraded elements of their home may differ from those who had not. A Hausman test confirmed that the fixed and random effects estimates differ significantly (χ^2 (8) = 28.02, $p < .001$), implying fixed effects was the appropriate specification. Moreover, the primary research question concerns within-person change in willingness across the information sequence rather than between-person differences in overall willingness and the fixed effects estimator eliminates all stable individual heterogeneity from the comparison.

The dependent variable was the willingness-to-switch rating (0-100) recorded at each measurement point. Information chunk was entered as a categorical predictor with baseline willingness as the reference category, yielding coefficients that represent the average within-person change in willingness relative to the pre-information rating. Standard errors were clustered at the participant level to account for the non-independence of repeated observations within individuals. To assess whether willingness changed between successive information chunks, rather than relative to baseline, we used Wald tests on the relevant pairs of coefficients. To test for effects of grant level, boiler comparison and upgrade order, we updated the main model with interaction terms between information chunk and the relevant between-groups treatment. We present effect sizes as model coefficients and chart the predicted means.

Finally, we conclude with an exploratory test of predictors of high willingness following full information. We estimated a logistic regression on a binary indicator of final willingness (rating ≥ 70), including experimental condition variables and sociodemographic and dwelling covariates. The results presented here are not sensitive to the cut-off for high willingness.[b]

[b] An exception is that the effect of educational attainment becomes significant if lower thresholds are used, with individuals educated to degree level or above being more likely to report high willingness.

3 Results

Baseline knowledge of heat pumps was mixed. More than half of homeowners (55.8%) reported they know nothing or very little about them. The next largest group (23.2%) gave an approximate definition of how they work (e.g. “they extract heat from the air and this is used to heat water…”) or reported knowing a lot about them. Others were split between those who responded with a negative statement (e.g., “they cost a fortune on your esb [electricity] bill”; 7.5%), a positive statement (e.g., “they are an energy efficient way of heating your home”; 7.0%) or a neutral statement (e.g. “they are used in all new builds now”; 6.5%).

In the remainder of this section, we first report unadjusted distributions of willingness to adopt a heat pump before presenting the main results from regression models.

3.1 Intention Trajectories

Figure 1 shows the distribution of intentions-to-switch at (i) baseline, (ii) following information on the advantages of a heat pump, (iii) following information on the installation costs and disruption and (iv) after all information on energy upgrade requirements was read. The chart shows a slightly negative skew at baseline, with 37.0% responding between 0 and 30 (in favour of a boiler), 42.5% between 31 and 70 and 20.5% above 70 (in favour of a heat pump M = 41.4, SD = 28.5). Intentions were improved by information on heat pump benefits with little change following information on installation costs (M = 52.5, SD = 27.2 and M = 51.0, SD = 30.3, respectively). Final intentions, following all information on upgrade requirements, were more negative (M = 36.8, SD = 29.2).

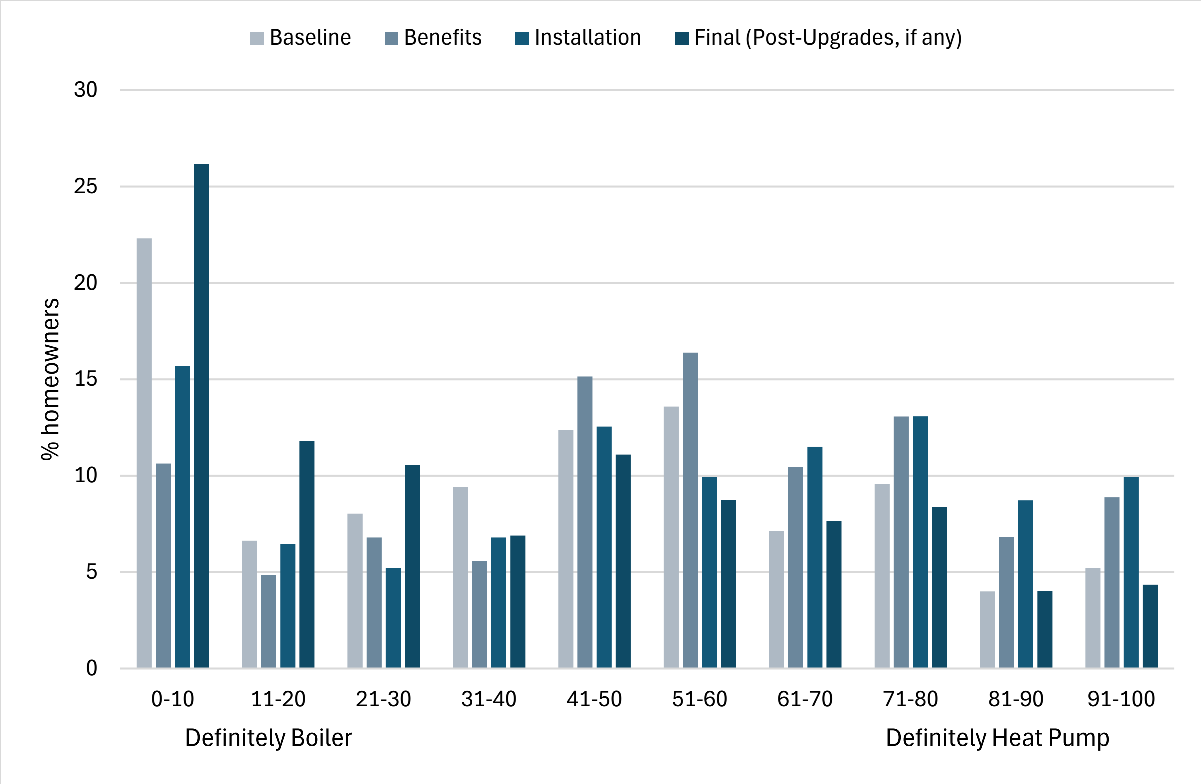

Figure 1. Distribution of willingness-to-switch at baseline and following information on heat pump benefits, installation costs and after all upgrades information.

3.2 Fixed Effects Regression

3.2.1 Information Chunk

Model 1 in

Table 2 presents the regression model predicting intentions following each information chunk, with participant fixed effects to account for individual differences. Coefficients show the difference in ratings following each information chunk compared to baseline willingness.

The results show that intentions significantly increased from baseline after reading information on heat pump benefits (b = 11.17, SE = 0.83, p < .001). There was no further change following information on the cost and disruption associated with heat pump installation (χ^2 = 2.30, p = .130), though this null effect masks an effect of the grant level (returned to below). Compared to after reading about installation, intentions dropped significantly for each upgrade requirement (ventilation: χ^2 = 236.16, p < .001; insulation: (χ^2 (= 124.60, p < .001; windows: (χ^2 = 27.96, p < .001)), whereas there was no significant change among those who learned their home needed no other energy upgrades (χ^2 = 1.56, p = .212). Intentions increased among those who read about financing options, compared to intentions after ventilation upgrade information (χ^2 = 4.23, p = .040), insulation upgrade information (χ^2 = 12.01, p < .001) and no upgrades (χ^2 = 15.82, p < .001), though remained significantly below baseline. The comparison against window upgrade information was non-significant but based on a small sample (n = 20; χ^2 = 0.04, p = .834). Compared to before any upgrade information was read, final intentions were significantly lower (χ^2 = 216.59, p < .001).

Table 2. Fixed effects regressions on intentions-to-switch to a heat pump

	Model 1	Model 2	Model 3
Information (Ref: Baseline)			
Benefits	11.17*** (0.83)	10.28*** (1.44)	8.19*** (1.78)
Installation	9.67*** (1.09)	2.76 (1.75)	7.28* (3.20)
Vents	-5.54*** (1.10)	-8.94*** (1.84)	-13.68*** (3.12)
Insulation	-8.83*** (1.64)	-6.05* (2.52)	-14.04*** (3.22)
Windows	-4.21 (2.65)	-9.79* (3.98)	-6.42* (2.62)
No Upgrades	6.56* (2.66)	0.41 (3.97)	-
Finance	-3.66** (1.20)	-6.28** (2.15)	-12.60*** (3.31)
Final	-4.61*** (1.03)	-6.79*** (1.76)	-13.85*** (2.94)
Info. x ...		... Enhanced Grant	... Vents First
Benefits x ...		-0.58 (1.67)	2.58 (2.79)
Installation x ...		15.34*** (2.09)	2.77 (3.94)
Vents x ...		4.82* (2.20)	11.58** (3.82)
Insulation x ...		-1.85 (3.26)	5.17 (4.12)
Windows x ...		15.98*** (3.92)	-1.24 (4.36)
No Upgrades x ...		12.90* (5.55)	-
Finance x ...		5.40* (2.39)	6.58 (4.33)
Final x ...		5.09* (2.05)	5.43 (3.70)
Constant	40.95*** (0.69)	40.97*** (0.69)	38.57 (1.18)
Obs.	3,290	3,290	907
N	574	574	138

**p* < .05; ***p* < .01; ****p* < .001.

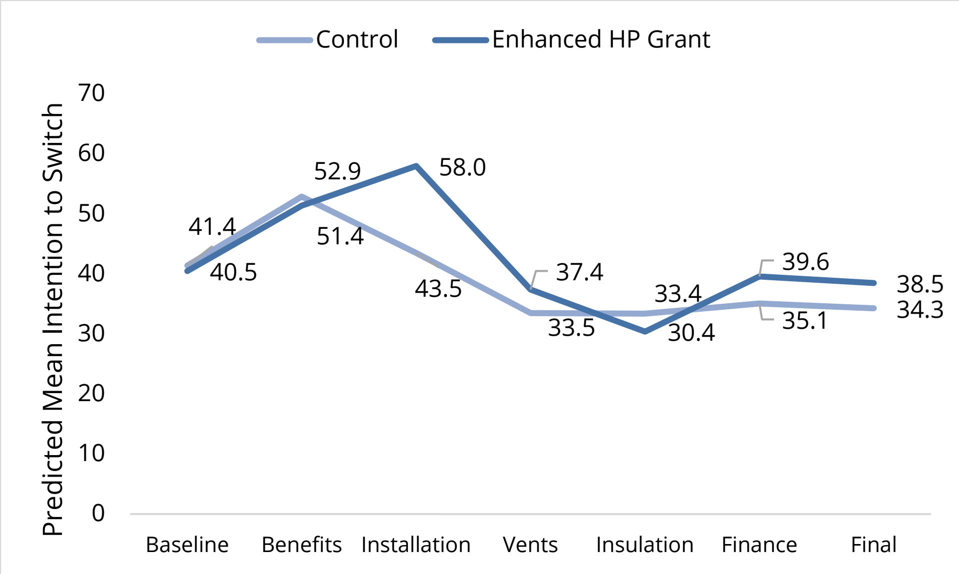

Figure 2. Predicted intentions-to-switch from Model 2. Note that enhanced grant information was shown with the Installation information.

3.2.2 Grant Level

Model 2 in Table 2 presents an interaction between information chunk and the level of the heat pump grant, with predicted margins presented in Figure 2. Note that, because the model uses participant fixed-effects, the grant effect is only detected through its interaction with the within-participant trajectory. The results show that, while there was no difference between the treatment and control group at baseline and benefits stages (i.e., prior to treatment; 40.5 vs. 41.4 and 51.4 vs. 52.9, respectively), a large difference emerged following the installation information, with those who read about an enhanced grant that equivalised the cost of a heat pump with the cost of a boiler becoming much more willing to adopt a heat pump than those who read about market grants (58.0 vs. 43.5). The control (market-level) grant amount appears to have negated the positive effects of benefits, returning the control group to baseline intention levels. However, the positive effect of the enhanced grant diminished following information on necessary upgrades and is non-significant following information on insulation (30.4 vs. 33.4). The positive effect is significant at the final stage, though much smaller in magnitude than immediately upon treatment (38.5 vs. 34.5).

3.2.3 Boiler Comparison

A similar interaction with whether an explicit cost comparison against a traditional boiler was included on the installation page had non-significant effects. For brevity, we report these in the SM.

3.2.4 Order Effects

As few participants required window and door replacements (*n* = 20; 3.5%), we restricted our test of order effects to those who required both wall insulation and ventilation upgrades (*n* = 138; 24.0%) and tested for effects of seeing ventilation upgrade information first (Model 3 in Table 2). The model shows that ventilation upgrade information had a significantly less negative impact on intention to switch when it was shown before insulation upgrades compared to after, however there was no significant difference by the final evaluation stage. The was also no insulation interaction, implying it had a similar negative effect regardless of whether it was presented before or after information on ventilation.

3.3 Intentions with Full Information

To identify predictors of willingness following full information, we transformed final intentions into a binary variable whereby those who gave a final rating of 70 or above (18.0% of the sample) are classified as 'willing' to switch to a heat pump. Using logistic regression, we regressed this variable onto information treatments: the upgrade information shown (excluding windows due to the low cell size), grant size, boiler comparison and finance. Results are broadly similar using alternative cut-offs for willingness and an OLS on final intentions (SM). To test for upgrade information, we compared those who saw they needed only ventilation upgrades (*n* = 412, 71.8%) to those who saw both ventilation and insulation (*n* = 137, 23.9%). We retained an indicator for those who saw no upgrade information in the model but refrain from inference due to very low cell size (*n* = 20). The model includes controls for house age and boiler type and homeowner age, gender, region, urbanicity, educational attainment and employment status.

Model 1 in Table 3 shows a negative effect of needing insulation upgrades in addition to ventilation upgrades. The table presents log odds and we convert the model outputs to predicted probabilities to present effect sizes more intuitively. These predicted probabilities from the model show a 44% reduction in willingness attributed to insulation upgrades (19.8% vs. 11.1%; the equivalent figure is 27.8% among those with no upgrades, but the cell size is too small for strong inferences). The model further shows a positive effect of equivalising the cost of a heat pump and boiler through an enhanced grant compared to market grants at the time of the study (predicted probabilities: 20.8% vs. 15.3%, a 36% increase). This effect is a cleaner test of the effect of the enhanced grant.

Other house-level and individual-level characteristics also predict high intentions. Those living in terraced homes, who saw cheaper and less disruptive upgrades due to smaller house size, were more likely to report high intentions than those in larger homes (24.4% for terraced vs. 20.6% for semi-detached, test of coefficients: $\chi^2(1, 571) = 3.00$, $p = .083$; and 13.4% for detached). Oil boiler owners were also over 50% more likely to report high intentions compared to gas boiler owners (22.5% vs. 14.6%). Controlling for these house-level differences, those living in an urban area were also over 50% more likely to report high intentions than those living in a rural area (20.2% vs. 12.8%).

Table 3. Logistic regression predicting high intentions to switch to a heat pump.

	Model 1
Upgrades (Ref: Ventilation Only)	
Ventilation and Insulation	-0.73* (0.32)
None	0.48 (0.50)
Enhanced Grant (Ref: Market Grant)	0.41† (0.23)
Boiler Comparison (Ref: No Comparison)	-0.01 (0.23)
Finance Information (Ref: No Information)	-0.34 (0.23)
Owns Home Outright (Ref: Has Mortgage)	-0.06 (0.31)
House Built (Ref: 2011+)	
2000-2010	0.44 (0.46)
1978-2000	0.04 (0.48)
1950-1977	0.41 (0.49)
Pre-1950	-0.11 (0.56)
House Type (Ref: Terrace)	
Semi-Detached	-0.24 (0.32)
Detached	-0.78* (0.38)
Oil Boiler (Ref: Gas)	0.58* (0.29)
Open Fireplace	-0.35 (0.24)
Homeowner Age (Ref: 18-39 years)	
40-59 years	0.06 (0.36)

60+ years	-0.16 (0.50)
Man (Ref: Woman)	0.13 (0.25)
Region (Ref: Dublin)	
Rest of Leinster	-0.28 (0.35)
Munster	0.17 (0.32)
Connacht-Ulster	-0.45 (0.42)
Urban (Ref: Rural)	0.58† (0.35)
Degree or Above (Ref: Below Degree)	0.37 (0.24)
Employment Status (Ref: Full-Time)	
Retired	0.21 (0.44)
Other	0.50 (0.32)
Constant	-2.10*** (0.72)
Obs.	571

†p < .10; *p < .05; **p < .01; ***p < .001.

4 Discussion

This study provides novel experimental evidence on how building fabric upgrade requirements affect homeowners' willingness to adopt heat pumps. Using a within-subjects design with a representative sample of homeowners, we tracked intentions as participants learned about the benefits of heat pumps, their installation costs and personalised upgrade requirements. Results show that upgrade requirements, particularly wall insulation, substantially reduce willingness to adopt, more than offsetting the gains from learning about heat pump benefits. An enhanced grant that equates heat pump costs with boiler replacement significantly but only partially mitigates this effect. Once fully informed, socio-demographic predictors of willingness appear strongly linked to building-level rather than individual-level characteristics. These findings have direct implications for retrofit policy design.

4.1 Building Fabric Upgrade Requirements

The scale of the deterrent effect of building fabric upgrade requirements is perhaps the most striking finding. While intentions increased sharply after information on benefits, they dropped below baseline once participants learned about the upgrades their home would require to qualify for existing heat pump installation grants. That this deterrent effect was significant and large even after accounting for stable individual differences in the model highlights how consequential such requirements are for adoption decisions. These findings extend previous work on the negative effect of disruption and hassle associated with retrofit works (Curtis et al., 2024; Scarpa & Willis, 2010). Crucially, however, our design captures responses to concrete, personalised descriptions of what adoption would actually require for a specific home. This large effect of personalised information may indicate that previous null results of disruption information (e.g., Behavioural Insights Team, 2022; Schleich et al., 2022) were due to abstract representations of disruption. Another possibility is that, where disruption associated with heat pump installation was not clearly distinguished from disruption arising from building fabric upgrades, this may have attenuated the estimated effect by masking the particularly strong deterrent associated with fabric upgrades. Our results suggest that these are not equivalent. Participants showed relatively little aversion to the installation process itself, but reacted strongly to the additional, often extensive, fabric upgrade requirements.

The prevalence of upgrade requirements in our sample also warrants emphasis. Though our method necessarily relied on homeowner knowledge rather than an engineer's inspection of the home, our instrumentation was designed in consultation with industry experts and thus represents a reasonable approximation. In our sample, nearly 1-in-4 required both mechanical ventilation and wall insulation. The implication is that, for a substantial share of households, replacing a gas or oil boiler is not simply a choice of "heat pump or boiler" but "heat pump plus substantial preparatory investment or boiler." Policy that fails to account for this reality risks overestimating adoption rates.

4.2 Financial Incentives

The grant level experiment showed that equivalising the net cost of heat pump installation with boiler replacement substantially increased adoption intentions when homeowners learned about these costs, supporting previous evidence that reducing upfront cost differentials is likely to be an effective lever (Behavioural Insights Team, 2022; Meles et al., 2022). However, the positive effect of the enhanced grant was substantially eroded once upgrade requirement information became clear. Immediately after learning about upgrades, the difference between the two grant groups was no longer statistically significant. The enhanced grant retained a marginal positive effect at the final evaluation stage, but the magnitude was considerably smaller than the initial boost. This pattern suggests that even generous financial incentives for heat pumps cannot fully compensate for the additional cost and disruption associated with building fabric upgrades. The results imply that policies that address only the cost of the heat pump itself, without also substantially addressing other upgrade costs, are unlikely to be sufficient to bring adoption intentions to the levels required for decarbonisation targets. The potential for increased fabric upgrade grants may be worth exploring.

The null effect of providing explicit cost comparisons against boiler replacement is also noteworthy. Prior evidence suggests that comparative cost framing can increase willingness to pay for heat pumps (Eßer et al., 2024) and perceptions of how heat pumps compare to traditional heating systems are a strong driver of adoption intentions (Timmons, Ó Ceallaigh, Carthy & Rogan, 2026), yet we find no incremental effect here. One possibility is that participants in the control group had effectively made an implicit comparison themselves, making the explicit comparison redundant. Another is that homeowners care about more than the purchase price when comparing heating systems.

The weak effect of financing information is similarly notable and contrasts with evidence that interest-free loans can materially shift willingness (Behavioural Insights Team, 2022). It is possible that, by the time financing information was provided (i.e., after the negative impact of upgrade requirements had already been absorbed), the marginal effect of an additional financial product was insufficient to reverse declining intentions (see also Morland & Fylan, 2025). This finding also highlights the importance of testing the drivers of adoption intentions among homeowners that are better informed of the total financial implications of heat pump adoption.

4.3 Socio-Demographic Differences

The logistic regression of predictors of high willingness following full information showed that other household characteristics matter for switching intentions. Perhaps unsurprisingly, those living in smaller terraced homes that require less extensive and costly upgrades were more willing than those in larger detached homes. Participants with existing oil boilers were also more likely to report high willingness than those with gas boilers, perhaps reflecting the cheaper and more stable running costs for gas boilers. Finally, urban homeowners were more than 50% more likely than their rural counterparts to report high adoption intentions after receiving complete information. This disparity is one of the few urban-rural differences observed in Ireland regarding climate action (e.g., Martin, Timmons & Lunn, 2026), but is consistent with administrative data that urban dwellers undergo more comprehensive retrofit projects (Collins & Curtis, 2016). Though differences in housing stock or heating systems (e.g., greater reliance on gas-fuelled heating) appear plausible, these factors are controlled for in the statistical model.[c] Notably, exploratory analyses show no urban-rural differences in heat pump intentions prior to information on building fabric upgrades, suggesting that the gap reflects differences in attitudes to upgrade requirements rather than underlying attitudes to heat pumps. One possibility is that urban dwellers may be more likely to have noticed other homes in their area as having undergone retrofits, including external wall insulation (Timmons et al., 2026; Wolske, Gillingham & Schultz, 2020).

The absence of other socio-demographic predictors of intentions in the final logistic regression is also informative. Much of the earlier literature on heating system preferences identifies sociodemographic gradients, particularly for income and education (Schleich et al., 2022; Meles et al., 2022). Education emerged as a significant predictor in our models when the threshold for high willingness was reduced (SM), which suggests that these differences occur only between low and moderate levels of openness, particularly when homeowners are fully informed about the specific requirements of their own home. The policy implication is that broad demographic targeting of heat pump promotion may be less efficient than approaches that identify households on the basis of building fabric characteristics and the magnitude of the upgrade burden they face.

[c] Adding an estimate of household income to the model does not change the effect (Supp. Mat.).

4.4 Policy Implications

The findings imply that policy schemes that subsidise heat pump installation but leave a significant residual cost burden for the required preparatory works are unlikely to achieve the behavioural response needed to meet national targets (see also Mac Uidhir et al., 2020). The substantial deterrent effect of insulation requirements in particular, which drove a 40% reduction in the probability of high willingness, suggests that expanding subsidies for insulation and ventilation upgrades, possibly as a bundled package with heat pump installation, may be needed to increase adoption rates. Delivery models that simplify the process of managing multiple fabric upgrades with heat pump installation and grant applications, for example through one-stop-shop services, are likely to further lower practical barriers to adoption. Additional measures recorded in the survey, reported in the SM, showed strong homeowner preferences for the one-stop-shop service with 67.3% favouring it over a self-managed process.

The findings also lend support to policy that lower building fabric requirements, such as tests of heat pump performance under conditions of greater heat loss (e.g., SEAI, 2026a) and high temperature heat pumps (HTHPs) that are designed to produce hotter water than standard heat pumps, meaning they can be used in buildings with older radiators and poorer insulation and thus reduce the fabric upgrade requirements for homeowners (SEAI, 2026b). Targeting HTHPs to homes with higher upgrade burdens could enable early electrification of heating while insulation upgrades are completed over time. This staged approach may achieve higher near-term uptake than a policy that conditions subsidy support on comprehensive upfront fabric improvement, though how willing homeowners are to adopt HTHPs, which consume more energy than low-temperature systems, is unknown. The findings also lend support to exploring the use of alternative fuels, such as hydrogenated vegetable oil or biomethane, that have substantially lower switching costs albeit with attenuated emissions reductions (Lynch, et al., 2026).

Further implications are notable from the baseline knowledge data. Over half of homeowners report little or no knowledge of heat pumps. This finding is reinforced by the strong effects of subsequent information provision, which implies that homeowners did not have this information when making their initial judgement. Information on benefits produce substantial increases in intentions to adopt a heat pump, comparable to findings in other experimental studies (Eßer et al., 2024; Hafner et al., 2019), that are maintained if grant levels equivalise the cost with a traditional boiler. On a positive note, very few homeowners reported negative misconceptions, for example that heat pumps do not work in Ireland’s climate. The degree of uncertainty, however, means there is considerable scope for misconceptions to take hold (e.g., Lewandowsky, 2021).

Proactive communication strategies that clearly articulate the benefits of heat pumps, while also being transparent about what installation involves for typical Irish homes, could help households form more accurate prior beliefs.

4.5 Limitations and Future Research

These implications should be considered alongside the study's limitations. Our survey measured stated intentions rather than actual behaviour. Intention-behaviour gaps are well-documented in the energy efficiency literature (Collins & Curtis, 2016). The share of households who would actually proceed with heat pump adoption following full information is likely lower still than the 18% who reported high intentions in our final measure.

Second, while the survey content was developed in consultation with industry professionals and reflects realistic upgrade requirements and cost estimates for Irish homes, upgrade requirements in practice are determined by detailed technical assessments that our self-reported home characteristics can only approximate. The accuracy of the personalisation is therefore bounded by the quality of self-reported data on building type, age, insulation and glazing. Participants who incorrectly self-reported their home characteristics may have received inaccurate upgrade information. Relatedly, inferences about the effect of window and door replacement requirements are constrained by the small number of participants assigned to this information (3.5%). The low cell size reflects the survey branching, which directed participants to that information only if they reported having at least some single-glazed windows. While single glazing is rare, a technical inspection may result in window replacement recommendations on grounds that our survey could not capture, for example the frame condition, air leakage around seals or the thermal performance of older double-glazed windows.

Third, the study focused exclusively on homeowners with existing gas or oil boilers in Ireland. Tests of the generalisability of the findings to renters, landlords, apartment dwellers or homeowners in different national contexts present opportunities for future research. However, many of the challenges examined here are not unique to Ireland. Several Western European countries, including the United Kingdom, Germany, France and the Netherlands, are also seeking to decarbonise large stocks of existing homes that were originally designed for fossil-fuel heating and may require building fabric upgrades to accommodate heat pumps. Nevertheless, differences in housing stock characteristics, policy incentives and energy prices may affect the magnitude of the observed effects. Replication studies in contexts with different baseline building fabric standards, different fuel mixes or different institutional arrangements for retrofit support would help establish the external validity of the core findings.

Fourth, the study was not designed to examine the role of social norms or the influence of peer networks on heat pump adoption. The deterrent effect of building fabric requirements may change as heat pumps diffuse through neighbourhoods (e.g., Arvanitopoulos, Wilson & Morton, 2025).

4.6 Conclusion

This study provides experimental evidence that building fabric upgrade requirements represent a substantial barrier to heat pump adoption. Using a within-subjects design grounded in Information Integration Theory, we show that personalised information about the specific upgrades a household's home requires significantly reduces adoption intentions. Heat pump benefits information provides a meaningful initial boost to intentions, but the negative impact of learning about ventilation and insulation requirements is larger and more persistent. Enhanced financial incentives that reduce the net cost of installation help, but are insufficient on their own to counteract the deterrent effect of upgrade requirements, particularly for insulation. Together, these findings highlight the need for residential decarbonisation policy that better facilitates building fabric upgrades.

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