

Experimental evidence on heat pump and retrofit subsidies

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Abstract

Heat pumps often require complementary building-fabric upgrades to work most efficiently, a requirement that may explain persistent gaps between policy targets and household uptake. Using a nationally representative survey experiment of over 1,000 homeowners with oil or gas heating systems, this paper examines homeowner willingness to switch to a heat pump when faced with building fabric upgrades under different levels of financial support. Retrofit requirements were tailored to dwelling characteristics, while heat pump and retrofit grant levels were independently randomised. Learning about heat pump benefits increased willingness to switch, from 39 points to 50 points out of 100, but this increase was largely eliminated once respondents learned of retrofit requirements of their home. Enhanced grants for both heat pumps and complementary upgrades partially offset this decline. Results further show that grant support influences willingness more strongly than equivalent decreases in private costs. A €1,000 increase in grant support raised willingness by 1.50 points, versus a 0.90-point reduction from an equivalent rise in private retrofit costs, suggesting subsidies carry value beyond their direct financial effect. Resistance to upgrades appears to operate mainly through cost, although homeowners in older dwellings and lower-income households remain less willing to adopt even when costs and grant support are held constant. Meeting heat pump targets under fabric-adequacy policies will likely require substantially greater and better-targeted subsidies, although financial support alone may be insufficient to overcome barriers faced by some households, particularly those living in older homes and with lower incomes.

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1 Introduction

Residential heating is one of the largest sources of emissions in high-income countries (International Energy Agency, 2025). The most effective way of decarbonising the sector is widely considered to be replacing fossil fuel heating systems – mostly oil and gas boilers – with electric ones, such as air- and ground-source heat pumps, alongside powering national grids via renewables (Huckebrink & Bertsch, 2022). In recognition of this, governments across North America and Europe have committed substantial public resources to heat pump subsidy programmes, including capital grants and tax incentives (Kerr & Winskel, 2021). Despite this policy effort, adoption rates in multiple countries lag far behind targets. The gap between policy ambition and heat pump adoption among households motivates this paper.

Some barriers to heat pump uptake have received much attention. Heat pumps have relatively high capital costs and homeowners tend to know little about them, whereas fossil fuel boilers benefit from lower replacement costs and familiarity (de Jager et al., 2025). The policy solution has thus been to lower costs and increase homeowner awareness. While such interventions are sensible, they treat the decision to purchase a heat pump as a self-contained choice, comparable to replacing one boiler with another. In reality, the efficiency and comfort gains of heat pumps depend on the thermal performance of the building, meaning dwellings with poor insulation and airtightness will experience less of these benefits without improvements to the building fabric (Lingard, 2021).

This physical constraint has resulted in a policy challenge (Eyre et al., 2023). If homeowners are encouraged to switch to a heat pump with a promise of lower heating bills, and these efficiency gains are not realised, there will be understandable backlash and limited diffusion. However, mandating full retrofits prior to installation would be too costly for most households and would substantially delay diffusion. Most countries have opted for policies that fall somewhere between these extremes, such as by recommending insulation upgrades alongside heat pumps (Kerr & Winskel, 2021). Ireland adopted a threshold-based approach, whereby eligibility for heat pump grants is assessed against the dwelling's heat-loss indicator (HLI). Dwellings that meet the threshold can qualify for heat pump support without further works, whereas ones that do not must undertake some combination of upgrades, such as improved insulation or window and door upgrades. These airtightness improvements often require contemporary upgrades to ventilation systems.

This policy context means many homeowners do not simply face a decision between replacing a boiler or switching to a heat pump, but between replacing a boiler or

undergoing building fabric upgrades and switching to a heat pump. While much of the existing literature has focused on the cost associated with the heat pump itself or the disruption associated with its installation, these are likely to be just part of the homeowner's investment decision. Understanding how households respond to the bundled investment problem, and whether targeted support for the complementary retrofit component shifts adoption independently of support for the heat pump itself, is the central aim of this paper.

To do so, the paper uses evidence from a nationally representative experimental survey of over 1,000 homeowners in Ireland currently heating their homes with fossil fuels. In the survey, respondents reported their stated willingness to switch to a heat pump at multiple time-points linked to how they would encounter information on heat pumps in reality: before learning about their benefits, after learning about their benefits, after learning about installation costs, after learning about retrofit requirements and at the end of the survey considering all prior information. Although this willingness-to-switch measure does not constitute an actual investment decision, intentions are useful in technology adoption research where real-world investments are infrequent, expensive and difficult to observe experimentally (Alberini, 2019). Moreover, the paper does not claim to identify those who will switch to a heat pump, but to instead analyse trajectories towards switching, under the assumption that individuals with higher stated willingness are more likely to switch than individuals who state they would stick to their existing heating system. In the experiment, gross costs and retrofit requirements were personalised to the respondent's dwelling type, while heat pump and retrofit grants were randomly assigned to either market levels or enhanced levels, in a 2x2 factorial design. This sequential design and variation in costs permits analysis of how homeowners form the decision to switch to a heat pump and the role of private costs and capital grants in this decision.

The results make three core contributions to the literature on residential energy technology adoption. First, they show that the fabric-adequacy requirement is sufficiently large to erase most of the willingness to adopt a heat pump gained from learning about their benefits. Under market-level grants, learning about heat pump benefits increased willingness to switch from 40 on a 100-point scale at baseline to 50, but learning about required works drove predicted willingness down to 25 points. Enhancing capital grants for the heat pump or associated retrofit works attenuated this decline, but only the combined effect of both enhanced grants left final willingness above baseline (42 points).

Second, the results show that subsidy support appears to operate through more than a straightforward reduction in net project cost. Once fully informed of costs and retrofit

requirements, a €1,000 increase in grant support raised willingness by 1.50 points on average, compared to a 0.90 reduction associated with an equivalent €1,000 increase in total retrofit cost. This asymmetry suggests that grant support carries additional weight in the adoption decision, beyond its financial value. Policymakers evaluating the cost-effectiveness of grants on a pure net-cost basis may understate the value relative to unsupported price increases.

Third, in a model of willingness once fully informed of all retrofit requirements and costs, cost and grant coefficients are essentially unchanged when indicators for which specific upgrades (e.g., insulation, windows) are included. This provides tentative evidence that resistance to retrofitting operates mainly – at least initially – through its price tag, rather than through the particular measures involved. At the same time, dwelling age remained a significant predictor of lower willingness even after costs, grants and homeowner age were held constant, while willingness also remained lower among lower-income households. These findings point to cost-independent concerns, such as anticipated complexity or disruption specific to older housing stock or liquidity constraints, that standard financial support alone may not resolve. Together these results suggest the dominant channel is financial, though further work on the role of dwelling age would be useful.

The remainder of this paper is structured as follows. The next section presents a brief review of relevant literature on barriers to heat pump adoption, the effects of financial incentives and emerging evidence on decisions to retrofit. Section 2 describes the study sample, experimental design and analytic strategy. Section 3 details the results. Section 4 summarises the findings and discusses their implications.

1.1 Relevant Literature

1.1.1 Barriers to Heat Pump Adoption

When faced with a choice, consumers are highly sensitive to the financial attributes of heating systems, particularly upfront installation costs and expected operating savings (Alberini & Bigano, 2015; Meles, Ryan & Mukherjee, 2022; Rouvinen & Matero, 2013; Scarpa & Willis, 2010; Schleich, Guetlein, Tu & Faure, 2022). Stated preference methods also show that consumers are responsive to the inconvenience associated with installing a new heating system, with several studies identifying negative effects of installation-related disruption and hassle costs (Curtis, Grilli & Lynch, 2024; Pardy, Rhodes, Axsen & Jaccard, 2026; Scarpa & Willis, 2010), though findings are not entirely consistent (Schleich et al., 2022).

Despite apparent price-sensitivity, households frequently underinvest in energy-efficient technologies relative to predictions from conventional economic models (i.e., the energy efficiency gap or energy paradox; Allcott & Greenstone, 2012; Jaffe & Stavins, 1994). To explain this gap, research increasingly emphasises the role of information deficits, uncertainty, liquidity constraints and social influences (de Jager et al., 2025).

Regarding heat pumps, many households report limited familiarity with the technology and uncertainty regarding installation, operating costs and suitability of their home (Chitchyan, 2025; Karytsas, 2018; Morland & Fylan, 2025; Pardy, Rhodes & Jaccard, 2022; Timmons, Shier & Ó Ceallaigh, 2026). Consistent with this evidence, informing consumers on technology performance and costs increases willingness to pay for one (Collins & Curtis, 2017; Eßer et al., 2024). Social learning also appears important. Households who have observed installations in neighbours' homes or who have visited dwellings that use a heat pump report greater willingness to adopt one (Timmons, Ó Ceallaigh, Carthy & Rogan, 2026), while social norm interventions increase stated adoption intentions (Hafner et al., 2019).

1.1.2 Financial Incentives

Given the importance of upfront capital costs, governments have widely adopted grants, tax credits and other forms of financial support to encourage investment in low-carbon heating technologies (He & Qian, 2026). Consistent with this, higher subsidy levels generally increase uptake of energy-efficiency and low-carbon technologies and are more effective than general information campaigns (Alberini, Banfi & Ramseier, 2013; Hlavinka, Mjelde, Dharmasena & Holland, 2016).

However, effectiveness of such policies is determined not only by absolute uptake but whether subsidised households would have undertaken the investment in the absence of publicly-funded support (i.e., free-ridership; Alberini & Bigano, 2015; Train, 1994). Evaluation of tax-credit programmes frequently find that they are disproportionately adopted by households already predisposed towards investing in energy improvements, such as those who are wealthier and more attentive to energy costs (Alberini, Bigano & Boeri, 2014; Oltshoorn, Schleich, Gassmann & Faure, 2017; Risch, 2020). These findings raise questions about whether subsidies effectively target the market failures they are intended to address (Allcott, Knittel & Taubinsky, 2015; Collins & Curtis, 2018).

A recent finding from stated preference research suggests, however, that subsidies may carry additional value beyond their monetary amount. In a discrete choice experiment, Schleich et al. (2022) observed positive value on subsidies even after

accounting for the reduction in net cost of a new heating system (consistent with earlier findings by Train and Atherton, 1995). Subsidies may thus operate not only by reducing financial barriers but through non-financial channels. Candidate mechanisms include reducing perceived risk, increasing confidence in the investment, signalling government endorsement or activating loss aversion from the prospect of forgoing the financial benefit. If households value grants for reasons beyond their monetary value, then an increase in grant support may not have the same effect on adoption as an equivalent reduction in private costs. Similarly, withdrawing grant support may have larger effects than the resulting increase in net private costs.

1.1.3 Heat Pump Adoption as a Bundled and Sequential Decision

Together, this literature suggests that heat pump adoption reflects evaluation of direct costs and benefits, as well as uncertainty surrounding investment outcomes. However, the decision is often analysed as a choice between alternative heating systems. Since heat pump performance depends on the thermal characteristics of the dwelling, adoption may require complementary investments in insulation, airtightness or other building-fabric improvements. Relatedly, household energy investments are often made gradually as information is acquired and evaluated over time (Fawcett & Killip, 2014; Wilson, Crane & Chrysoschoidis, 2013). This suggests that households may initially respond to information regarding technology benefits and subsequently revise their preferences when confronted with installation costs, retrofit requirements or available financial supports.

Recent work has applied this perspective to heat pump adoption. Using a sequential information experiment, Timmons, Shier and Ó Ceallaigh (2026) show that homeowners become substantially more willing to install a heat pump after learning about its benefits, but that much of this increase is eroded when information regarding installation costs and retrofit requirements is revealed. The economics of the decision to install a heat pump may therefore differ from those implied by studies examining heating-system choice or retrofit investment in isolation. Similarly, households may respond differently to financial support for installing the heat pump and support for complementary retrofit measures (Akhatova & Kranzl, 2025). Building on this literature, the present paper examines how financial support influences decisions involving both elements of the investment package.

1.2 Research Questions

From the above, this paper set out to answer the following research questions:

RQ1. How does homeowner willingness to install a heat pump evolve as information is revealed under different heat-pump and retrofit grant levels?

RQ2. What complementary upgrades are associated with greater willingness to install a heat pump?

RQ3. (a) Do households respond symmetrically to changes in private costs and grant support? (b) Do subsidies influence adoption beyond their direct impact on net project costs?

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.

2.1 Sample

Participants were recruited in February 2026 through the Ipsos Knowledge Panel, a probability-based online panel designed to be representative of the adult population in Ireland. Stratified quota sampling was used to obtain a sample broadly representative of homeowners in Ireland by mortgage status, age and region. Eligibility criteria required respondents to be homeowners living in a house (rather than apartment or other dwelling type), to have a gas or oil boiler and to report at least some responsibility for household heating system decisions. They were paid €3 for completing the 15-minute study, which included a separate experiment on biofuels (Timmons, Shier & Lynch, 2026) and other measures to be reported separately.

A total of 1,175 respondents met the eligibility criteria and started the survey. Data from 93 respondents who did not complete the survey were excluded. A further 64 respondents were automatically excluded for failing quality-control checks, which required participants to correctly identify true statements about heat pumps after being presented with a definition and to complete a CAPTHCA verification task. The final analytic sample therefore comprised of 1,018 respondents. Sample characteristics are reported in Table 1.

Respondents were randomly assigned in a 2 x 2 factorial design that independently varied the level of heat pump subsidy (market-level versus enhanced grant) and the level of building fabric subsidy (market-level versus enhanced grant). Balance tests indicated no statistically significant difference across the four experimental groups on any of the characteristics reported in Table 1, suggesting that randomisation was successful (see the Supplemental Material (SM)).

Table 1. Sample Characteristics

Characteristic		%
Ownership	With mortgage	49.6
	Owns outright	50.4

Age	18-39 years	14.0
	40-59 years	51.1
	60+ years	35.0
Region	Dublin	28.7
	Rest of Leinster	27.9
	Munster	27.5
	Connacht-Ulster	15.9
House Type	Detached	45.0
	Semi-detached / End-of-Terrace	41.0
	Terrace	14.0
Building Energy Rating	AB	26.2
	CD	32.4
	EFG	3.1
	Exempt / Don't know	38.3
House Age	2010+	5.9
	2000-2010	29.7
	1978-2000	31.4
	1950-1977	21.3
	Pre-1950	11.7
Boiler Type	Gas	45.8
	Oil	54.2

2.2 Experimental Framework

The experiment builds on the stated preference design developed by Timmons et al. (2026) and extends it by introducing variation in subsidies for required building fabric upgrades. Respondents were asked to imagine that their existing heating system was about to reach the end of its useful life and required replacement, matching the trigger point for most homeowners to consider adopting a heat pump (Weiss, Dunkelberg, & Vogelpohl, 2012). They were then presented with a series of information blocks in the order they would be expected to learn about heat pumps from a contractor: (1) the benefits of heat pumps, (2) the cost of a heat pump system and any relevant subsidies; (3) the cost of necessary upgrades to (i) ventilation, (ii) windows and doors and (iii) wall insulation, if any and including relevant subsidies. At the end, participants saw information on low-cost finance (reported separately in the SM). The outcome of interest was respondents' stated willingness to switch to a heat pump following each information block. All measures and content are available in the SM which is available on the project's ResearchBox (https://researchbox.org/8989?PEER_REVIEW_passcode=RVRNKQ).

Cost and retrofit requirement information was tailored to the participant's home characteristics and costs were further independently varied across two dimensions.

2.2.1 Tailored Retrofit Requirements

Unlike the below subsidy treatments, the building fabric upgrades required under the contemporaneous 'fabric adequate' heat pump policy were not randomly assigned. Instead, the upgrades presented to each respondent were based on their dwelling characteristics, as reported at the beginning of the survey experiment. Respondents had answered a series of questions regarding the energy efficiency characteristics of their home, including the age and condition of windows and doors, the presence of wall insulation and whether the dwelling had mechanical ventilation. Responses were used to determine which upgrades were necessary for eligibility to government heat pump grants. Branching was designed in consultation with engineers at a retrofit company.

For example, respondents who reported that their windows or external doors had not been upgraded within the previous 20 years were informed that replacement windows and doors would likely be required ($n = 372$; 36.5%). Respondents reporting that their home lacked wall insulation, or who were uncertain about the presence of insulation, were informed that wall insulation would be required ($n = 284$; 27.9%). In addition, respondents whose homes did not have mechanical ventilation were informed that the installation of a mechanical ventilation system would be recommended as part of the retrofit package ($n = 973$; 95.6%). While ventilation upgrades do not contribute directly to meeting the HLI threshold, they are commonly recommended to maintain indoor air quality, particularly where airtightness measures, such as improved insulation and replacement windows and doors, reduce natural ventilation.

Tailoring the retrofit package in this way increases ecological validity by aligning the experimental scenario with the constraints and requirements homeowners are likely to encounter when considering a heat pump in practice. Rather than evaluating a generic retrofit package, respondents assessed a set of upgrades linked to the characteristics of their own dwelling, making the decision context more representative of real-world heat-pump adoption. This approach also permits analysis of whether willingness to adopt varies according to the composition of required upgrades as they occur across the current Irish housing stock. Such analyses are necessarily descriptive, however, because retrofit requirements are endogenous to dwelling characteristics and previous investment decisions.

2.2.2 Heat Pump Subsidy Treatment

Turning to the between-subjects treatments, respondents were randomly assigned to one of two heat pump subsidy conditions. In the market grant condition, respondents saw the level of financial support currently available for heat pump installation under existing policy arrangements. For example, a heat pump for an average semi-detached home costs approximately €18,000, with a maximum One Stop Shop grant in February 2026 of €12,500, leaving €5,500 in private capital cost to the homeowner. For comparison, replacing a gas boiler would cost approximately €2,500. This represents the baseline policy environment faced by households considering a heat pump investment.

In the enhanced heat pump grant condition, respondents saw an increased grant designed to equalise heat pump installation with a conventional boiler replacement. For example, the grant for a semi-detached home was increased to €15,500, leaving €2,500 in private capital cost to the homeowner.

2.2.3 Retrofit Subsidy Treatment

The second randomised treatment varied the level of financial support available for required building fabric upgrades. In all scenarios, respondents were informed that certain energy efficiency improvements would be required to qualify for the heat pump grant, reflecting the HLI threshold for support.

Respondents assigned to the market grant condition saw existing levels of financial support for these upgrades. For example, for a semi-detached home under market conditions in February 2026, window and door upgrades would cost approximately €10,400; mechanical ventilation upgrades would cost approximately €4,500; and external wall insulation would cost approximately €19,000, net of grants. Respondents assigned to the enhanced retrofit subsidy condition saw increased support designed to reduce the private cost burden associated with completing the required works by approximately €10,000 for a full retrofit. Upgrades to a semi-detached home under this treatment would cost €7,500 for windows and door upgrades; €3,500 for mechanical ventilation; and €15,000 for external wall insulation.

2.2.4 Outcome Measure

The primary outcome is respondents' stated willingness to replace their existing boiler with another boiler of the same type or with a heat pump. Following Timmons et al. (2026), willingness was measured on a continuous scale ranging from 0 ("definitely stick with a boiler") to 100 ("definitely switch to a heat pump"), capturing both the

direction and intensity of respondents' preferences and permitting observation of how willingness evolves as additional information is provided.

Respondents evaluated switching to a heat pump at least five times during the survey. First, they provided a baseline assessment of their willingness to install a heat pump after reading a basic description but before receiving any information about benefits, costs, grants or retrofit requirements. This baseline measure captures initial preferences and serves as a reference point for subsequent changes in willingness.

Second, respondents read about the benefits of a heat pump, including potentially lower heating bills. Respondents then re-evaluated their willingness to adopt one. Third, they read information on the cost of installing a heat pump together with the applicable grant level, corresponding to the size of their home and their randomly assigned heat pump subsidy treatment, and re-evaluated their willingness to adopt one.

Fourth, respondents read information on each building fabric upgrade required for their dwelling. The required measures were shown sequentially, in randomised order, and reflected the respondent's reported dwelling characteristics, as described above. Where applicable, respondents received information on (i) the installation of mechanical ventilation, (ii) wall insulation, and (iii) replacement windows and doors. For each required upgrade, respondents read the associated costs, based on the size of their home, and the relevant level of retrofit grant support determined by their randomly assigned subsidy treatment. The information also contained details on the level of disruption involved with the upgrade. After each upgrade, participants again indicating their willingness to install a heat pump. These repeated evaluations allow the marginal effect of each additional retrofit requirement on adoption intentions to be observed. Those who needed no upgrades ($n = 34$; 3.3%) were informed of such and responded on the same scale.

After all required upgrades had been presented, respondents provided a final overall assessment of their willingness to install a heat pump, given the complete package of investments and available financial support. Respondents also read about low-cost finance to support the remaining private investment required after grants; results from this stage were used to inform the design of a follow-up study and are reported in the SM.

The information sequence was fixed in this order, reflecting the order in which consumers learn about the heat pump installation process in the real world, as confirmed through consultations with employees at a retrofit company. This sequential

design was intentional to maximise policy relevance. The design means the estimated stage effects should be interpreted as changes associated with successive information exposure rather than the isolated causal effect of any individual information component, which would require order randomisation.

2.3 Empirical Strategy

The experimental design generates repeated measures of stated willingness to switch for each respondent, observed at between five and seven points corresponding to successive information stages (baseline, benefits, installation cost, the tailored sequence of required upgrades and the full-package assessment). To first assess the effects of information and subsidy levels on willingness (RQ1), the primary analysis involved regressing the 0-100 willingness score onto a set of information stage indicators, with baseline assessment as the reference category. The model uses respondent fixed effects to absorb all time-invariant characteristics, including dwelling characteristics, underlying environmental preferences, attitudes towards energy efficiency and other stable respondent characteristics, and standard errors clustered at the participant level. This is particularly important because households living in dwellings that are already more suitable for heat pump installation may also be systematically more willing to adopt the technology for reasons unrelated to the experimental information provided.

Because the tailored retrofit requirements mean that not all respondents view all three upgrade stages (vents, insulation, windows), the coefficients on these stages are estimated only among the subset of respondents for whom the relevant upgrade was required. The 34 respondents whose homes required no upgrades are excluded from these models, since they have no observations at the upgrade stages. Separate models within each of the four treatment cells defined by the 2x2 combination of the heat pump subsidy treatment (market vs. enhanced) and the retrofit subsidy treatment (market vs. enhanced) are presented to allow the full trajectory of responses to vary freely across treatment arms. The interaction term model is reported in the SM. Where relevant, changes in willingness following preceding information are tested using Wald (χ^2) tests of coefficients.

Second, to assess the association between different combinations of upgrade requirements and willingness to switch (RQ2), a complementary, second model splits respondents into groups defined by their required upgrade bundle (e.g., ventilation only; ventilation and insulation; all three upgrades; no upgrades required), pooling across subsidy treatments. Because bundle membership is determined by respondents' reported dwelling characteristics rather than random assignment, these

comparisons are descriptive rather than causal: households requiring more extensive upgrades may differ systematically from those requiring fewer, including in their underlying propensity toward energy-efficiency investment. This analysis is presented to be informative for policy targeting, though it cannot be interpreted as the causal effect of upgrade requirements themselves.

Then, to assess responsiveness to costs and subsidies (RQ3), a third analysis exploits variation in the costs shown to participants. The combinations of dwelling characteristics and randomised grant treatments generated total retrofit costs that ranged between €15,000 and €88,000 ($M = €41.2k$, $SD = €17.4k$) and total grants that ranged between €12,500 and €50,000 ($M = €22.4k$, $SD = €7.3k$). A cross-sectional OLS model estimates the contribution of these retrofit costs and grant support to respondents' final, fully-informed willingness to switch:

$$\text{Switch}_i = \beta_0 + \beta_1 \text{TotalCost}_i + \beta_2 \text{TotalCost}_i^2 + \beta_3 \text{TotalGrant}_i + \beta_4 \text{TotalGrant}_i^2 + \text{Xi}'\gamma + \varepsilon$$

where Switch_i is respondent i 's final stated willingness to switch (0-100) and TotalCost_i and TotalGrant_i are measured in thousands of euros. Xi is the vector of dwelling and respondent covariates: dwelling type, tenure, dwelling age, boiler type, presence of an open fire, respondent age and sex, region, urban/rural location, educational attainment and employment status. Unlike the panel models above, this specification uses a single cross-sectional outcome per respondent and therefore does not include respondent fixed effects or clustering.

Because grant levels are inherently linked to retrofit requirements and cannot exceed retrofit costs, total costs and grant amounts were strongly correlated ($r = 0.83$). Nevertheless, VIFs in linear models remain below conventional thresholds (<5) and coefficient estimates are stable across alternative specifications, implying that the experimental design generated sufficient independent variation to permit separate estimation of both effects. Costs and grants are entered as quadratic terms to allow for non-linear responses across their range. As such, average marginal effects, evaluated across the observed range of each variable, are used to compare the effects of both total cost and grants on willingness per €1,000. An additional model complements this by adding dummy variables for each upgrade requirement, to estimate any effect of upgrades not captured by the financial cost.

Results from this cost sensitivity analysis are robust to splitting costs and grants by heat pump and specific upgrades; using quartile indicators in place of the continuous cost and grant terms; exclusion of the most common cost/grant values and exclusion of the top 5% of the cost distribution (reported in the SM).

3 Results

Figure 1 shows the distribution of baseline willingness to switch to a heat pump. The distribution is bimodal, with the largest cluster around 50 and the next largest close to 0 (i.e., stick with a boiler), and is somewhat right skewed. The mean rating is 39.1 ($SD = 27.8$). The distribution implies that, at baseline, many homeowners are open to switching to a heat pump but may be somewhat uncertain, while a large group are reluctant to do so and few are very willing.

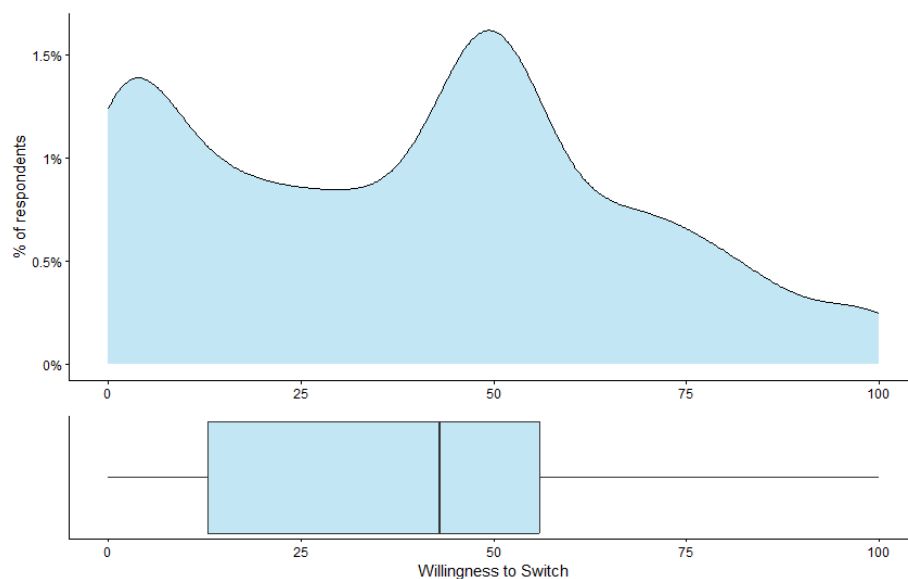


Figure 1. Baseline willingness to switch to a heat pump, where 0 indicates "definitely stick with a boiler" and 100 indicates "definitely switch to a heat pump."

3.1 Fixed Effects Regression

Figure 2 shows predicted mean switch ratings at each stage from the regression models (reported in Enhanced grants for either the heat pump or the retrofit upgrades attenuated these negative responses, with willingness at around 30 points. Respondents who saw enhanced supports for both the heat pump and upgrades retained the greatest willingness to switch, particularly for ventilation and window improvements (42-43 points, marginally but statistically significantly above their baseline willingness). The attenuation of these declines suggests that a significant portion of resistance to retrofit requirements reflects concern about their financial burden.

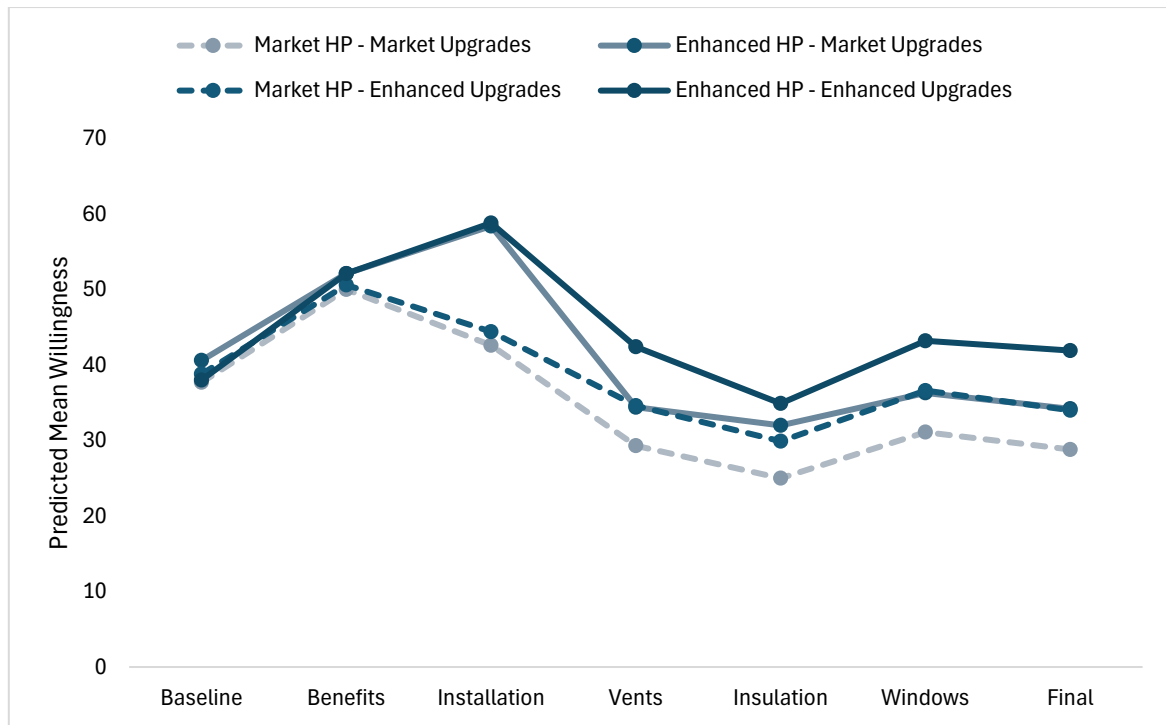


Figure 2. Predicted willingness-to-switch across information stages. Note that enhanced heat pump grant was shown on the Installation page, while the enhanced upgrade grants were shown across Vents, Insulation and Windows pages.

Because upgrade requirements were tailored to respondents' homes, not all participants observed all upgrade stages. Means for ventilation, insulation and window stages therefore represent within-respondent changes among the subset of households exposed to each requirement and should not be interpreted as responses from a common sample across stages. Results are consistent in a balanced sample model, which restricts the analysis to only those who saw all three upgrades (SM).

The final assessment, after respondents had considered the complete package of required investments, highlights the cumulative effect of the subsidy treatments. Predicted willingness was lowest under market conditions and highest when enhanced grants were available for both the heat pump and the upgrades. The gap between these scenarios at the final stage is substantial (29 points vs. 42 points), indicating that support for both the heat pump itself and complementary retrofit measures may substantially improve adoption willingness, even among households with full understanding of the requirements involved.

Overall, the figure suggests that while information about heat pump benefits increases willingness to adopt in all circumstances, learning about costs and retrofit requirements can substantially reduce support under current subsidy levels. Enhanced heat pump grants help maintain willingness following installation cost information,

while enhanced retrofit grants reduce resistance to the complementary investments required under fabric first policies. The combination of both policies appears most effective in sustaining willingness throughout the decision-making process.

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

	Model 1: Market HP Market Upgrades	Model 2: Enhanced HP Market Upgrades	Model 3: Market HP Enhanced Upgrades	Model 4: Enhanced HP Enhanced Upgrades
Information (Ref: Baseline)				
Benefits	12.29*** (1.33)	11.53*** (1.23)	11.72*** (1.20)	14.13*** (1.50)
Installation	4.87** (1.56)	17.84*** (1.60)	5.53*** (1.43)	20.81*** (1.61)
Vents	-8.47*** (1.48)	-6.19** (1.78)	-4.21** (3.12)	4.40* (1.76)
Insulation	-12.71*** (2.50)	-8.59** (2.45)	-8.91*** (2.20)	-3.11 (2.64)
Windows	-6.65** (2.03)	-4.25 [†] (2.32)	-2.23 (1.72)	5.24* (2.21)
Final	-8.96*** (1.46)	-6.37*** (1.76)	-4.85** (1.39)	3.92* (1.73)
Constant	37.74*** (1.04)	40.59*** (1.11)	38.84*** (1.01)	38.00*** (1.19)
Obs.	1,525	1,713	1,761	1,550
N	228	257	265	234

[†] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$. *Note.* Vents, Insulation and Windows coefficients correspond only to those who saw these upgrades. Models exclude participants whose homes required no upgrades ($n = 34$).

Figure 3 presents the analysis for different upgrade bundles (combining the subsidy treatments; regression models are reported in the SM.). There is unavoidable endogeneity within these bundles, as respondents who live in houses with different retrofit requirements may differ from each other in ways correlated with their retrofit requirements, such as their propensity to undertake energy efficiency investments in general. Nonetheless, the results are of interest to policy from a descriptive perspective. The trajectories show that all groups responded favourably to the heat pump benefits, moving from approximately 40 points to 50 points. The exception is the small heat pump ready group, who require no upgrades; their willingness increases to only 44 points. Given the very small cell size, this effect is tenuous, but the finding may reflect that they likely live in homes that are already energy efficient and so stand to benefit less from marginal efficiency improvements.

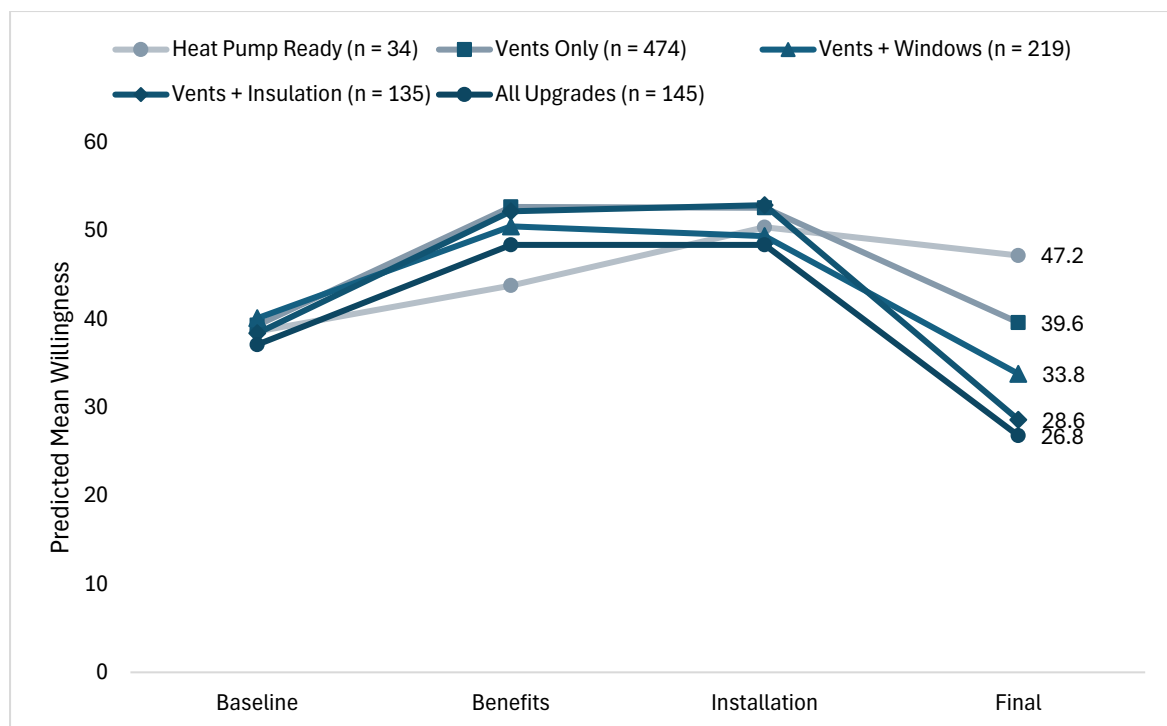


Figure 3. Predicted margins from regressions models split by required upgrade bundles. Note, the windows + insulation bundle is excluded due to low cell sizes.

The heat pump installation costs do not appear to affect any group, except for the positive effect of the small heat pump ready group, noting that this trajectory contained the combined heat pump subsidy treatments, where the negative effect of the market grant is netted out by the positive effect of the enhanced grant.

Of most interest is the final evaluation, made once all information on upgrade requirements was known. The heat pump ready group were most willing, at 47 points. In comparison, the ventilation-only group returned to baseline at 40 points. Those who also need windows were the next most favourable, though below baseline at 34 points. The least favourable were those who needed ventilation and insulation upgrades or all three. Interestingly, there is little difference between these groups (29 points vs. 27 points), implying that, once ventilation and insulation are required, there is little further negative influence of window upgrades. , with the full interaction model reported in the SM). The results show that willingness to switch significantly increased from 38-40 points out of 100 at baseline to around 50 points after reading information on heat pump benefits. This pattern is consistent across subsidy treatments, implying successful randomisation in pre-treatment openness to heat pump adoption.

The trajectories diverged once respondents were informed about heat pump installation costs and grant support. Under the two enhanced heat pump grant

treatments, willingness increased further following information on installation, reaching almost 60 points on average (Wald tests against the benefits stage: $\chi^2 = 28.35$, $p < .001$; $\chi^2 = 26.03$, $p < .001$). By contrast, willingness declined in both market heat pump grant conditions (Wald tests against the benefits stage: $\chi^2 = 26.07$, $p < .001$; $\chi^2 = 25.60$, $p < .001$), though it remained approximately 5 points above baseline. These results indicate that reducing the private cost of heat pump installation strongly mitigates concerns arising from the upfront investment required.

Willingness reduced following building fabric upgrade information across all treatments. Lowest willingness was observed among respondents facing market levels of support for both heat pumps and retrofit measures, with willingness reaching 25 points following information on insulation, significantly below baseline. Enhanced grants for either the heat pump or the retrofit upgrades attenuated these negative responses, with willingness at around 30 points. Respondents who saw enhanced supports for both the heat pump and upgrades retained the greatest willingness to switch, particularly for ventilation and window improvements (42-43 points, marginally but statistically significantly above their baseline willingness). The attenuation of these declines suggests that a significant portion of resistance to retrofit requirements reflects concern about their financial burden.

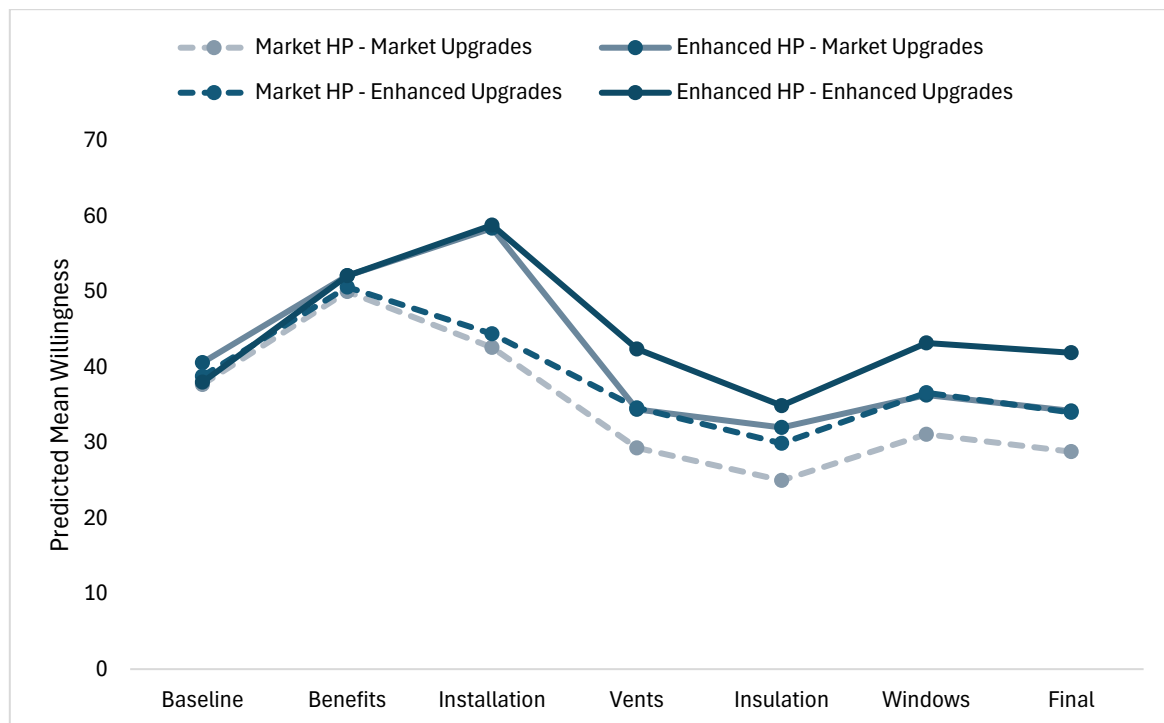


Figure 2. Predicted willingness-to-switch across information stages. Note that enhanced heat pump grant was shown on the Installation page, while the enhanced upgrade grants were shown across Vents, Insulation and Windows pages.

Because upgrade requirements were tailored to respondents' homes, not all participants observed all upgrade stages. Means for ventilation, insulation and window stages therefore represent within-respondent changes among the subset of households exposed to each requirement and should not be interpreted as responses from a common sample across stages. Results are consistent in a balanced sample model, which restricts the analysis to only those who saw all three upgrades (SM).

The final assessment, after respondents had considered the complete package of required investments, highlights the cumulative effect of the subsidy treatments. Predicted willingness was lowest under market conditions and highest when enhanced grants were available for both the heat pump and the upgrades. The gap between these scenarios at the final stage is substantial (29 points vs. 42 points), indicating that support for both the heat pump itself and complementary retrofit measures may substantially improve adoption willingness, even among households with full understanding of the requirements involved.

Overall, the figure suggests that while information about heat pump benefits increases willingness to adopt in all circumstances, learning about costs and retrofit requirements can substantially reduce support under current subsidy levels. Enhanced heat pump grants help maintain willingness following installation cost information, while enhanced retrofit grants reduce resistance to the complementary investments required under fabric first policies. The combination of both policies appears most effective in sustaining willingness throughout the decision-making process.

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

	Model 1: Market HP Market Upgrades	Model 2: Enhanced HP Market Upgrades	Model 3: Market HP Enhanced Upgrades	Model 4: Enhanced HP Enhanced Upgrades
Information (Ref: Baseline)				
Benefits	12.29*** (1.33)	11.53*** (1.23)	11.72*** (1.20)	14.13*** (1.50)
Installation	4.87** (1.56)	17.84*** (1.60)	5.53*** (1.43)	20.81*** (1.61)
Vents	-8.47*** (1.48)	-6.19** (1.78)	-4.21** (3.12)	4.40* (1.76)
Insulation	-12.71*** (2.50)	-8.59** (2.45)	-8.91*** (2.20)	-3.11 (2.64)
Windows	-6.65** (2.03)	-4.25† (2.32)	-2.23 (1.72)	5.24* (2.21)
Final	-8.96*** (1.46)	-6.37*** (1.76)	-4.85** (1.39)	3.92* (1.73)
Constant	37.74*** (1.04)	40.59*** (1.11)	38.84*** (1.01)	38.00*** (1.19)
Obs.	1,525	1,713	1,761	1,550
N	228	257	265	234

[†] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$. *Note.* Vents, Insulation and Windows coefficients correspond only to those who saw these upgrades. Models exclude participants whose homes required no upgrades ($n = 34$).

Figure 3 presents the analysis for different upgrade bundles (combining the subsidy treatments; regression models are reported in the SM.). There is unavoidable endogeneity within these bundles, as respondents who live in houses with different retrofit requirements may differ from each other in ways correlated with their retrofit requirements, such as their propensity to undertake energy efficiency investments in general. Nonetheless, the results are of interest to policy from a descriptive perspective. The trajectories show that all groups responded favourably to the heat pump benefits, moving from approximately 40 points to 50 points. The exception is the small heat pump ready group, who require no upgrades; their willingness increases to only 44 points. Given the very small cell size, this effect is tenuous, but the finding may reflect that they likely live in homes that are already energy efficient and so stand to benefit less from marginal efficiency improvements.

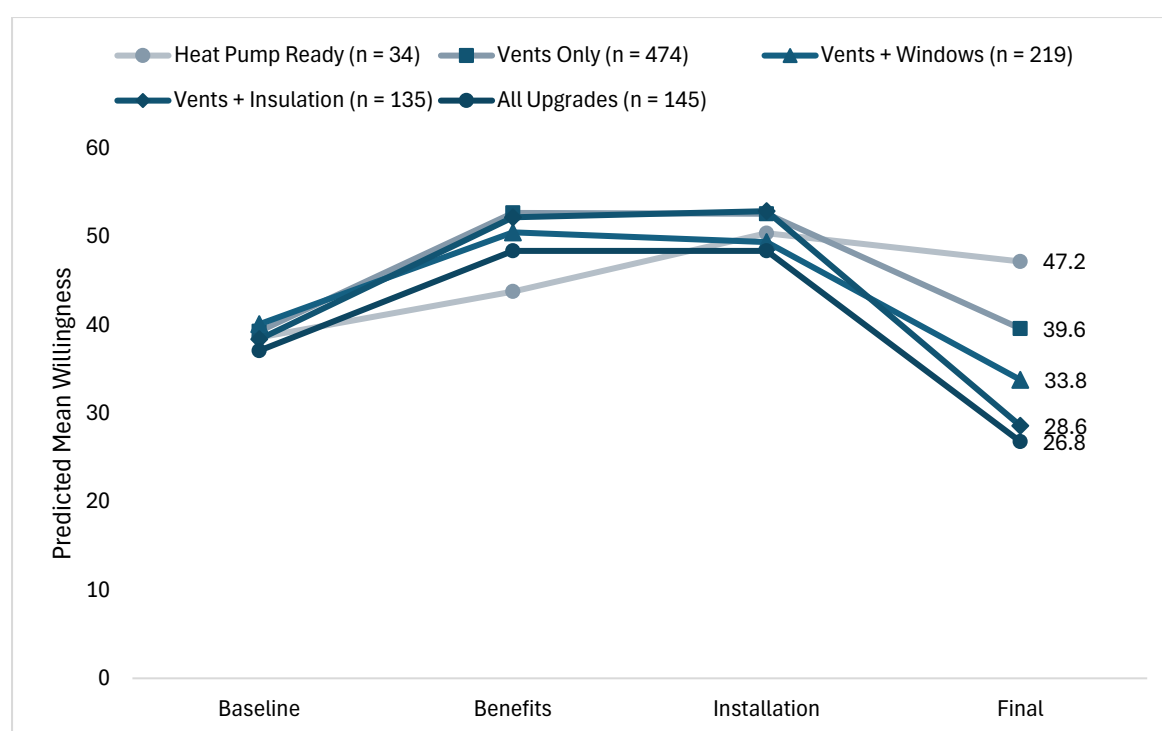


Figure 3. Predicted margins from regressions models split by required upgrade bundles. *Note, the windows + insulation bundle is excluded due to low cell sizes.*

The heat pump installation costs do not appear to affect any group, except for the positive effect of the small heat pump ready group, noting that this trajectory contained

the combined heat pump subsidy treatments, where the negative effect of the market grant is netted out by the positive effect of the enhanced grant.

Of most interest is the final evaluation, made once all information on upgrade requirements was known. The heat pump ready group were most willing, at 47 points. In comparison, the ventilation-only group returned to baseline at 40 points. Those who also need windows were the next most favourable, though below baseline at 34 points. The least favourable were those who needed ventilation and insulation upgrades or all three. Interestingly, there is little difference between these groups (29 points vs. 27 points), implying that, once ventilation and insulation are required, there is little further negative influence of window upgrades.

3.2 Intentions with Full Information

Results from the cost sensitivity analysis indicate significant and non-linear relationships between willingness and both total costs and grant support (Table 3; Figure 4). Higher retrofit costs were associated with lower willingness to switch to a heat pump ($b = -1.43, p < .001$), while the small positive quadratic ($b = 0.01, p = .016$) suggests that this negative relationship attenuates at higher cost levels. However, the turning point is estimated outside of the range of observed costs, at approximately €96,000.

Higher grant support was associated with greater willingness ($b = 3.11, p < .001$), though again the negative quadratic term ($b = -0.04, p = .017$) indicates diminishing marginal returns to additional subsidy. In this case, openness appears to plateau above grants of €40,000, though caution is warranted as the observed data are scarce above this level ($n = 30$).

Given that the estimated turning points lie beyond the observed range of retrofit costs and in the tail of grant amounts, the practical interpretation is that willingness declines across most of the observed retrofit cost range and increases across observed grant amounts, albeit at a decreasing rates for both.

Given non-linear effects, average marginal effects are used to compare the effects of retrofit and grant effects. The average marginal effect of retrofit costs was -0.90 ($p < 0.001$), indicating that a €1,000 increase in total retrofit costs reduced willingness by 0.90 points on average. By contrast, the average marginal effect of grant support was 1.50 ($p < 0.001$), implying a 1.5-point increase in willingness for each additional €1,000 of grant funding. The larger grant effect suggests that households may respond more strongly to increases in subsidy support than to equivalent increases in retrofit costs,

indicating that grants may influence adoption decisions through channels beyond a simple reduction in net expenditure.

Turning to other variables, dwelling age is also associated with openness to switching. Relative to homes built since 2011, households living in homes built pre-2011 report significantly lower willingness to adopting a heat pump. The largest effect is observed for pre-1950 dwellings, whose occupants score approximately 13 points lower in willingness. This pattern is consistent with the possibility that owners of older homes anticipate greater retrofit complexity or uncertainty. Most other dwelling and respondent characteristics are not significantly associated with willingness once retrofit costs and grants are taken into account, though urban households are marginally more willing to switch than rural households, replicating Timmons et al. (2026).

To distinguish the financial burden of retrofit requirements from any independent effect of the measures themselves, Model 2 adds indicators for whether ventilation, insulation and window upgrades were required. The cost and grant coefficients are substantively similar, giving tentative evidence that the negative response to retrofit requirements appears to operate primarily through their associated financial burden.

Results are robust to an alternative specification using the net private cost instead of the total retrofit cost, which shows similar non-linearity at high levels (see SM). In this model, there is also a positive, linear grant effect, further supporting that subsidies influence adoption through channels beyond a simple reduction in net costs. Results are also robust to several alternate specifications, including quartile indicators for both total retrofit costs and grant amounts, exclusion of the most common total cost and grant amounts and exclusion of the highest 5% of costs (see SM).

Table 3. OLS regression predicting final willingness to switch to a heat pump.

	Model 1	Model 2
Total Cost (€000)	-1.43*** (0.33)	-1.53* (0.75)
Total Cost ² (€000)	0.01* (0.00)	0.01† (0.00)
Total Grant (€000)	3.11*** (0.83)	3.08*** (0.83)
Total Grant ² (€000)	-0.04* (0.01)	-0.04* (0.01)
Ventilation		-4.24 (6.16)
Windows		2.90 (7.28)
Insulation		1.12 (10.99)

Owns Home Outright (Ref: Has Mortgage)	-2.40 (2.27)	-2.59 (2.28)
House Built (Ref: 2011+)		
2000-2010	-9.40* (4.06)	-9.15* (4.09)
1978-2000	-8.65* (4.19)	-8.43* (4.21)
1950-1977	-7.32 [†] (4.37)	-6.94 (4.39)
Pre-1950	-13.29** (4.67)	-13.17** (4.68)
House Type (Ref: Terrace)		
Semi-Detached	-3.97 (2.87)	-3.47 (4.54)
Detached	-1.47 (3.43)	-0.33 (8.91)
Oil Boiler (Ref: Gas)	3.70 (2.40)	3.59 (2.40)
Open Fireplace	-0.65 (1.77)	-0.53 (1.78)
Homeowner Age (Ref: 18-39 years)		
40-59 years	1.00 (2.73)	1.12 (2.75)
60+ years	4.86 (3.60)	5.04 (3.62)
Man (Ref: Woman)	-1.05 (1.85)	-1.16 (1.86)
Region (Ref: Dublin)		
Rest of Leinster	-3.54 (2.75)	-3.76 (2.76)
Munster	0.01 (2.74)	-0.21 (2.77)
Connacht-Ulster	-1.82 (3.39)	-2.21 (3.41)
Urban (Ref: Rural)	4.35 [†] (2.52)	4.18 [†] (2.53)
Employment Status (Ref: Full-Time)		
Retired	-5.39 [†] (3.17)	-5.09 (3.18)
Other	-3.92 [†] (2.30)	-3.71 (2.31)
Socio-Economic Status (Ref: AB)		
C1	-3.69 [†] (2.11)	-3.54 [†] (2.11)
C2DEF	-0.61 (2.26)	-0.42 (2.27)
Constant	40.65*** (8.79)	46.33*** (11.61)
Obs.	1,018	1,018

[†] $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

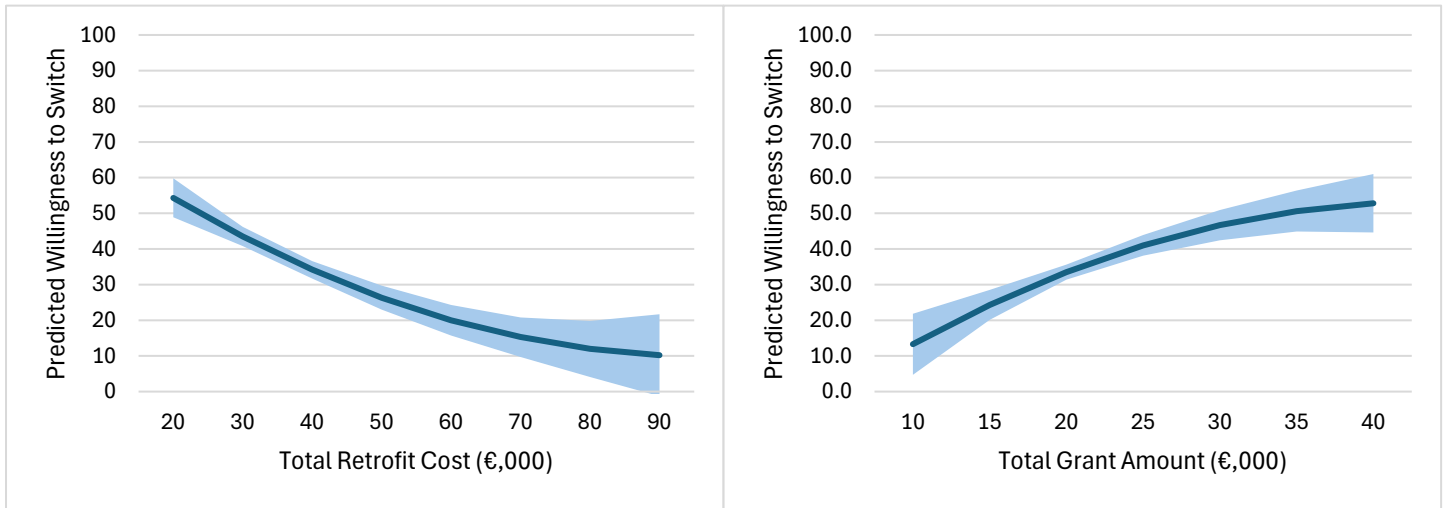


Figure 4. Predicted mean willingness to switch by total retrofit cost (left) and total grant amount (right). Mean willingness averages over other variables at each value of the x-axis. Shaded areas indicate the 95% confidence interval.

4 Discussion

This paper set out to examine whether enhanced financial support for required fabric adequacy investments boosts willingness to switch to a heat pump. Results show that the decline in willingness to switch under fabric investment requirements is partially offset by enhanced capital grants that target both the heat pump and the complementary upgrades. Results also suggest that homeowners respond more strongly to increases in grant support than to equivalent increases in private cost, implying that grants carry value above their monetary amount. This section discusses these findings before considering the broader policy implications.

4.1 Enhanced Subsidies

Results replicate the increase in willingness observed once homeowners learn of heat pump benefits, consistent with prior evidence on information deficits as a barrier to uptake (Eßer et al., 2024). However, this increase is eroded once homeowners learn of the fabric adequacy requirements required to satisfy a HLI threshold policy (Timmons, Shier & Ó Ceallaigh, 2026). Enhanced financial supports mitigate this decline, but need to be targeted at both the heat pump and the complementary measures.

Average willingness to switch remained below the midpoint of the scale, even under the most generous subsidy scenario, suggesting that subsidies alone are unlikely to close the adoption gap motivating this paper. Notably, grants in the most generous scenario covered almost two-thirds of total costs, amounting to €27,000 against average retrofit costs of €41,200. Even at this level of subsidy, willingness remained in favour of traditional boilers. Market grants were much lower (c. €17,500). This suggests that where fabric upgrades are required, increasing heat pump adoption to meet targets will demand substantially greater public investment to offset the financial costs and disruption imposed on households.

4.2 Upgrade Requirements

All complementary upgrades were associated with lower willingness to install a heat pump. Ventilation upgrades, despite being comparatively inexpensive, produced a large negative effect, plausibly indicating the disutility associated with the disruption of additional works (Curtis et al., 2024). However, in the model accounting for upgrade costs, the coefficients for insulation and window upgrades are positive though non-significant. This pattern suggests that resistance to these measures may be driven primarily by their cost rather than the upgrades themselves. By contrast, ventilation upgrades remain negative after controlling for costs. Moreover, adding windows on top

of insulation and ventilation was associated with little further change in willingness, possibly reflecting a floor effect once respondents already face a substantial package of works. A limitation is that a windows-plus-insulation bundle could not be estimated because of a very small cell size, although this likely reflects market conditions, as improvements in airtightness of this kind would typically require ventilation works.

Of further interest is that the small group of respondents who needed no upgrades were not substantially more willing to adopt a heat pump than those requiring a single or even multiple upgrades. One possible explanation is that households in more energy-efficient dwellings expect smaller gains from switching technology and therefore lower savings on energy bills. Any benefit from avoiding retrofit expenditure may thus be offset by weaker perceived returns from heat pump adoption. However, as with all comparisons across upgrade bundles, these results should be interpreted descriptively rather than causally. Upgrade requirements were determined by dwelling characteristics rather than random assignment, meaning that households requiring more extensive works may differ systematically in their underlying propensity to undertake energy-efficiency investments.

4.3 Price Sensitivity

Consistent with Schleich et al. (2022), results suggest that subsidies carry psychological value beyond their direct financial benefit. A €1,000 increase in grant support increased willingness by around two thirds more than a €1,000 increase in retrofit cost reduced it (1.50 vs. 0.90). This asymmetry implies that households value a euro received through a grant more highly than a euro of avoided expenditure. The mechanisms underlying this asymmetry require further research, though plausible candidates include reduced perceived risk, reduced uncertainty or loss aversion associated with forgoing available support. Regardless of the mechanism, the finding has implications for subsidy programme appraisal. Evaluations that assume grants affect behaviour solely through their financial value may underestimate their effectiveness.

However, these results do not speak to the efficiency of subsidy expenditure. As noted in the Introduction, energy upgrade subsidies are often claimed by households who would have invested anyway, raising concerns about free-ridership (e.g. Alberini et al., 2014; Collins & Curtis, 2018). Consistent with this concern, willingness to switch remained significantly lower among homeowners in the C1 social grade and among those not in full-time employment, even accounting for costs and grant support. This suggests that barriers not fully addressed by subsidies, potentially including liquidity constraints, may continue to deter adoption among some households. Many grant

schemes require households to fund works upfront and claim reimbursement afterwards. For households with limited savings or access to credit, the need to carry substantial costs and uncertainty around repayment timelines may represent a significant barrier to adoption. Upfront payments or financing mechanisms may help to reduce inequalities in access to retrofit investment.

Results also show evidence of non-financial resistance. Those with older homes were more reluctant to switch. Holding costs, grants and other factors constant, owners of pre-1950 dwellings are substantially less willing to adopt a heat pump. The estimated magnitude is equivalent to increasing retrofit costs by approximately €12,000 relative to an otherwise identical post-2010 dwelling (based on a 13-point difference in willingness with a marginal reduction of 0.90 points per €1000). This effect may reflect concerns about project complexity, disruption, technical uncertainty or the risk of unforeseen costs when retrofitting older properties. Households in older housing stock face barriers that are not fully captured by financial costs alone, suggesting that increasing subsidy levels may be insufficient to overcome resistance in some segments of the housing stock.

4.4 Broader Policy Implications

The findings imply that achieving ambitious heat pump deployment targets under fabric-adequacy requirements is likely to require substantial support for complementary retrofit measures in addition to support for the heat pump itself. Policymakers therefore face a three-way trade-off between maximising uptake, achieving lower heating bills for consumers and limiting public expenditure.

One option would be to relax or remove fabric-adequacy requirements, allowing households to access heat pump grants without undertaking complementary upgrades. Such an approach would likely increase adoption by reducing upfront costs and disruption, but could lower operating-cost savings and system efficiency, particularly in less efficient dwellings. Since expected bill savings are a primary motivator for heating system choice (Meles et al., 2022), any reduction in operational performance would likely weaken the longer-term attractiveness of heat pumps.

Alternatively, greater emphasis could be placed technologies that reduce the need for deep fabric upgrades, such as hybrid or high-temperature heat pumps (Saffari, Keogh, De Rosa & Finn, 2023). These systems operate effectively at higher HLI and may therefore face less homeowner resistance. Evaluating these alternatives would benefit from evidence on homeowner willingness to adopt heat pumps where expected running-cost savings are smaller than those typically associated with deep retrofit

pathways. Policies that improve the relative operating-cost advantage of heat pumps, including carbon pricing and electricity pricing reforms, may also strengthen adoption incentives where fabric upgrades are limited (Huckebrink & Bertsch, 2022).

More broadly, biofuels may represent a lower-carbon transitional option for households facing the largest fabric-upgrade burden. Previous evidence suggests that homeowners place considerable value on the relative simplicity of switching to biofuel-based heating systems, which do not require building-fabric upgrades (Timmons, Shier & Lynch, 2026). However, this pathway faces its own challenges, including uncertainty regarding the environmental credentials of available fuel supplies and tax structures that limit operating-cost incentives (Vollmer, Reaños & Lynch, 2025).

4.5 Limitations and Future Research

Several limitations qualify these implications and point to useful extensions for future work.

The willingness measure captures stated preferences rather than observed adoption behaviour. Stated-preference measures are valuable when studying infrequent and high-cost investments that are difficult to observe experimentally (Alberini, 2019), but are not direct predictions of market uptake. Indeed, stated willingness is likely to exceed adoption, implying that the effects estimated here may represent an upper bound on responses to enhanced financial support. Consequently, the impact of grants on actual installation decisions may be smaller still.

Future research linking survey responses to administrative records on grant applications, retrofit assessments and installations would help establish the extent to which expressed willingness translates into observed behaviour. However, while installation data can identify completed investments, it offers limited insight into households that seriously investigate heat pump adoption before deciding not to proceed. Data on where households disengage during the decision-making process would be particularly informative.

The analysis is restricted to owner-occupiers using oil or gas heating systems in Ireland. The study is therefore particularly well suited to examining responses under Ireland's threshold-based fabric adequacy framework, but the extent to which the estimated effect sizes generalise to other institutional settings remains uncertain (Eyre et al., 2023; Kerr & Winskel, 2021). That said, several findings, including the sensitivity to financial incentives and the non-monetary value of subsidies, are consistent with evidence from other countries (e.g., Schleich et al., 2022). The underlying mechanisms

identified here are therefore likely to have broader relevance even where the precise magnitudes differ.

4.6 Conclusion

This paper finds that meeting ambitious heat pump deployment targets under fabric-adequacy requirements is likely to require substantially greater public support than is currently available. Although grant support increased willingness to adopt, average willingness remained in favour of fossil fuel boilers even under the most generous subsidy scenario. At the same time, grants appeared to exert an influence beyond their direct monetary value, with increases in subsidy support having a larger effect on willingness than equivalent decreases in retrofit costs. Together, these results suggest that financial support remains a powerful policy lever, but one that may need to operate at considerable scale where complementary fabric upgrades are required.

However, the benefits of expanding subsidy provision may not be evenly distributed across households. Willingness to adopt is lower among owners of older homes and among some less advantaged groups, even after accounting for costs and grant support. This suggests that barriers associated with affordability, uncertainty and disruption are unlikely to be fully resolved through financial incentives alone. Consequently, increasingly generous subsidies may continue to disproportionately benefit households that are already relatively well positioned to invest.

The findings therefore point to the limits of a strategy centred on capital subsidies. While financial support will remain critical, meeting decarbonisation targets will likely also require complementary pathways that reduce the retrofit burden faced by households, whether through alternative heat pump subsidy models, reforms to eligibility requirements or other low-carbon heating options. Determining behavioural responses and relative cost-effectiveness of these approaches compared with continued expansion of subsidy programmes represents an important priority for future research.

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