MESSAGING COMPREHENSIVE RETROFITS

Reuven Sussman
Grace Lewallen
Steven Conrad

April 2024
ACEEE Report

Smart Energy. Clean Planet. Better Lives.

Contents

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

About the Authors

Reuven Sussman directs ACEEE's Behavior, Health, and Human Dimensions Program, conducting energy efficiency research on behavior change and health. Reuven earned a doctor of science in social and environmental psychology from the University of Victoria (Canada), where he is an adjunct professor and member of the Faculty of Graduate Studies. He won the 2019 Early Career Award from the American Psychological Association's Environmental, Population and Conservation Psychology Division and is on the editorial boards of the *Journal of Environmental Psychology* and *Journal of Social Psychology*.

Grace Lewallen is a research analyst in ACEEE's Behavior, Health, and Human Dimensions Program, where she researches the human behavior aspects of energy efficiency to encourage more pro-environmental behaviors. Grace earned a master of behavioral and decision sciences from the University of Pennsylvania and a bachelor of arts in German language and international trade from Clemson University.

Steven Conrad is an associate professor of systems engineering at Colorado State University. For more than 25 years, he has conducted research and consulted with the water and energy industry on the feedbacks between human–environmental systems. His research couples social and engineering sciences to inform decision making and visualization, the quantification and modeling of system function, and system optimization and resilience. Steven earned a Ph.D. in environmental resource management from Simon Fraser University, Canada.

Acknowledgments

This report was made possible through the generous support of the U.S. Department of Energy (DOE), National Grid, CenterPoint Gas, the Tilia Fund, and internal ACEEE funds. The authors gratefully acknowledge external reviewers, internal reviewers, colleagues, and sponsors who supported this report. External expert reviewers included Sean Williamson, Lindsay Asmussen, and Amy Royden-Bloom from DOE; Robert Gifford from the University of Victoria; Iain Walker from Lawrence Berkeley National Laboratory; Jeff Flaherty from Wise Energy; and Gary Boyer from Edge Energy. Internal reviewers included Jen Amann, Lyla Fadali, and Steve Nadel. The authors also gratefully acknowledge the assistance of Dan Howard, Dan Farrell, Jonah Eisen, and Kevin Yang. External review and support do not imply affiliation or endorsement. Last, we would like to thank the following members of ACEEE's editorial and communications team: Mary Robert Carter, Kate Doughty, Mark Rodeffer, Nick Roper, Keri Schreiner, Ethan Taylor, Roxanna Usher, and Mariel Wolfson.

Suggested Citation

Sussman, Reuven, Grace Lewallen, and Steven Conrad. 2024. *Messaging Comprehensive Retrofits*. Washington, DC: ACEEE. www.aceee.org/research-report/b2403.

Executive Summary

KEY FINDINGS

- In an online choice experiment, homeowners tended to prefer comprehensive retrofit packages including heating/cooling system upgrades (7% increased preference), water heater upgrades (22% increased preference), and appliance upgrades (5% increased preference). Preferences varied by demographic segment; we identified six package types that were most preferred by the five demographic groups we identified. Primarily, packages included only efficiency upgrades, but one group (17% of interested homeowners) liked packages with rooftop solar and Level 2 electric vehicle (EV) charging.
- In our nationally representative sample of U.S. homeowners (N = 1,500), we found that 65% are willing and able to invest at least $1,000 in comprehensive energy upgrades. To maximize current programs, we recommend focusing marketing efforts on these homeowners. Typically, homeowners in this group are moderate-to-high income (household income >$50,000/year), college educated (undergraduate or higher), live in large homes (2,001–2,500 square feet), have lived in their homes for 6–10 years with no children at home, and own—or are considering buying—an EV. The Inflation Reduction Act (IRA) provides lower-income homeowners expanded incentives to help them receive home energy retrofits; these should be expanded to further assist homeowners who need it.
- Homeowners across all demographic segments rated upfront costs, bill savings, and home comfort as the factors most driving their home energy upgrade decisions. These three elements are the most important to target with marketing messages (with health being the fourth). However, other factors, such as the ability to install new smart technologies and/or to increase property values varied significantly by demographic segment and could therefore help further tailor marketing campaigns to make them more effective.
- Randomized experiments testing realistic scenarios showed that certain trigger points can increase the likelihood of upgrading, and that sometimes a step-by-step foot-in-the-door technique might help move a customer from a single upgrade to a more comprehensive package.
- Though nearly two-thirds of homeowners were willing spend at least $1,000, comprehensive retrofits are generally more expensive. Among the financial incentives that we tested in one scenario, a zero-interest loan with no upfront costs was the only mechanism that significantly shifted behavior toward upgrading.
- We recommend tailoring comprehensive retrofit packages and marketing approaches based on the consumer segments we identify in this report, as well as offering comprehensive upgrades to those segments specifically after trigger points such as HVAC replacement or new home purchase. Moreover, incentives should be increased and creative financing solutions provided to maximize uptake of retrofit packages.

Comprehensive energy retrofits—that is, renovations designed to achieve at least a 20% reduction in household energy consumption[1]—deliver substantially higher energy savings compared to smaller energy efficiency improvements. Hence, encouraging homeowners to go beyond minor upgrades to comprehensive-level retrofits is now an important goal of state energy offices, energy efficiency program administrators, and the federal government. However, stepping up energy retrofits has always been a challenge for energy programs, and promoting comprehensive upgrades is even more difficult.

Financial incentives, such as those provided through the Inflation Reduction Act (IRA), reduce costs and are a critical tool for increasing residential energy upgrades. However, they may fall short if not complemented by behavioral-informed messaging strategies and program design elements that maximize the impact of these incentives. This report offers actionable recommendations for how good programs can be made great with a few small tweaks in how they are put together and presented. We draw on existing research, expert interviews, and our own online survey to answer key research questions posed by state energy offices and program administrators.

Taken together, our results suggest that comprehensive retrofits are a tough sell, but recommending the right package to the right people at the right time can help significantly. Even after existing rebates and credits are included, the costs of upgrading are out of reach for many homeowners. Although nearly two-thirds of our sample (65%) reported a willingness to spend at least $1,000 on upgrades, that still left a large minority unable to do comprehensive retrofits. IRA provisions offer augmented rebates for low-income homeowners, but non-low-income homeowners (especially those close to the low-income threshold) receive fewer incentives and often remain unable to upgrade. Our experiment on perceptions of financial incentives showed that solutions such as no-interest loans with no money upfront significantly increased willingness to invest in comprehensive upgrades.

Moreover, our experiment on using the foot-in-the-door technique to upsell clients who may not initially request comprehensive upgrades showed that customers who agreed to one type of efficiency upgrade were often interested in additional efficiency upgrades. However, to do this type of upselling, contractors must be able to offer a variety of upgrades of different types (heating and cooling, insulation, hot water, windows, etc.) through one point of contact and at one point of sale. This type of general contractor business model for efficiency improvements is relatively rare. It also requires that contractors be intimately familiar with available rebates, tax credits, and financing options in their regions (which is uncommon) and have the ability to maximize those options through creative solutions. For

[1] For details on our use of this term, see the "Defining 'Comprehensive'" section, which begins on page 2.

example, in one of our experimental scenarios, the contractor suggested staggering projects to reduce costs and take advantage of credits and incentives year over year.

Creating upgrade packages that appeal to specific demographics may also help. In general, our discrete choice experiment demonstrated that comprehensive packages that included efficient water heating, heating/cooling, and appliance upgrades were selected significantly more frequently than those without. Packages featuring windows upgrades, rooftop solar installation, or Level 2 electric vehicle (EV) charger installation were selected significantly less frequently. Nevertheless, windows and solar may be attractive as individual upgrades, and some homeowners in our sample (about 17% of interested homeowners) were moved by EV charging and rooftop solar being included in upgrade packages. Window upgrades, in particular, are less applicable to most homes and, therefore, will be important to a select group but may not be chosen by most homeowners. This shows why listening to customers and being able to address their particular home energy interests and concerns (even when they might involve non-efficiency improvements) can lead to more upgrades.

Marketing and outreach efforts should also respond to homeowner barriers and drivers of upgrading. As identified in previous research (e.g., Sussman and Chikumbo 2017), total costs, projected savings, and comfort were of primary importance to nearly everyone in our sample (with health being the fourth-most important). That said, our segmentation study showed that other factors, such as interest in new smart technology, can differentiate some groups from others in subtle ways that can be used to better tailor campaigns.

Our experiment on energy upgrade trigger points showed that approaching customers after key events, such as the need to replace an HVAC system, or after buying a new house, significantly improved the chances that they would agree to install a heat pump heating and cooling system. Approaching after an HVAC-related trigger that was small (annual maintenance) or after a large home remodeling project that was unrelated to HVAC (e.g., kitchen remodeling) did not significantly increase the likelihood of upgrading.

Our report provides several proofs-of-concept of what could work to improve comprehensive upgrade efforts using behavioral science. The time to test these in the field is now. Unprecedented financial incentives offered through IRA provisions, with tax incentives starting in 2023 and rebates in 2024, can enable U.S. state energy offices and energy efficiency program administrators to make giant leaps in improving existing buildings. We hope this report will help them make the most of these opportunities.

Introduction and Background

Reducing the energy consumption of existing buildings is a key strategy for averting catastrophic climate change. Residential energy retrofits can meet this challenge while improving the lives of residents, as energy upgrades can make homes more comfortable, healthy, valuable, and generally more pleasant (Kamal, Al-Ghamdi, and Muammer 2019). Retrofit initiatives have existed for decades, but the mounting urgency of climate change and housing quality now requires that we increase our attention on moving from any home energy upgrades to comprehensive upgrades. Programs such as Home Performance with ENERGY STAR have been espousing this move since 2002, but it remains a tough nut to crack.

Comprehensive energy retrofits deliver substantially higher energy savings compared to smaller energy efficiency improvements.[2] Hence, encouraging homeowners to go beyond minor upgrades to comprehensive-level retrofits is now an important goal of state energy offices, energy efficiency program administrators, and the federal government. However, stepping up energy retrofits has always been a challenge for energy programs, and promoting comprehensive upgrades is even more difficult. Indeed, a survey of nearly 500 assessors revealed that while an estimated 71% of homeowners purchased at least one recommended upgrade, only 1% adopted all the suggested upgrades (Palmer et al. 2013).

We recognize the current low uptake of comprehensive residential retrofits as a high-impact opportunity. If state energy offices and other efficiency program administrators can improve the attractiveness of comprehensive energy upgrades, the percentage of homeowners who complete comprehensive residential retrofits would likely increase. Financial incentives, such as those provided through the Inflation Reduction Act (IRA), reduce costs and are an important piece of the puzzle (perhaps the most important), but behavioral-informed messaging strategies and program design elements can maximize these incentives without requiring substantially more investment.

In this report, we offer actionable recommendations rooted in behavioral science and psychology research as well as on-the-ground experience from assessment professionals and contractors. We suggest how good programs and program offerings can be made great with a few small tweaks in how they are put together and presented. We draw on existing research, expert interviews, and our own online survey to answer key research questions posed by state energy offices and program administrators.

[2] For more detail on our use of this term, see the "Defining Comprehensive" section on page 2.

The report begins by defining comprehensive retrofits, the current policy/program landscape, and how behavioral science can address outstanding program design questions. We then describe our online survey and the results of experiments and segmentation studies embedded within it that answer six important research questions. We end with a summary of program recommendations and future directions for research and implementation.

DEFINING COMPREHENSIVE

In line with the minimum energy savings requirements in the 2022 IRA Home Efficiency Rebate program, we use the term comprehensive energy retrofit here to refer to residential energy upgrades that exceed a 20% modeled reduction in energy consumption[3] (H. R. 812 Inflation Reduction Act of 2022; Ungar and Nadel 2022). Comprehensive retrofits are not the same as deep retrofits, which have been defined as whole-home retrofits achieving 40% or greater modeled energy savings (Cluett and Amann 2014). Our definition of comprehensive aligns our research directly with IRA provisions to provide insights that will inform the effective implementation of these financial incentives.

DIVERSE PATHS TO COMPREHENSIVE ENERGY RETROFITS

Achieving 20% modeled energy savings can be accomplished by combining multiple energy upgrades into one residential energy retrofit project. This bundling strategy can provide distinct advantages over individual one-off upgrades. For instance, when homeowners install attic insulation, upgrade their HVAC systems, and replace windows in a single comprehensive retrofit project, the upgrades complement each other effectively. The attic insulation and windows reduce winter heat loss and summer heat gain, and the upgraded HVAC system can be optimally sized and will operate more efficiently in a better-insulated home. Collectively, these upgrades generate a synergistic effect, resulting in greater energy savings and comfort improvements than would be likely when upgrading the elements separately.

However, there are many pathways to achieving comprehensive-level energy savings. Comprehensive energy retrofits can encompass a wide range of upgrades, including HVAC system upgrades, insulation improvements, air sealing, window and door replacements, and energy-efficient appliance installations. Depending on the climate region and the home's initial condition, it is also possible to achieve this level of energy savings by upgrading the

[3] In some contexts, there is a distinction between "measured" and "modeled" savings. Measured savings must meet a 15% energy reduction requirement across an aggregator's portfolio of projects, while project savings must achieve 20% to qualify for the rebate. For simplicity and consistency, we have adopted the 20% savings threshold here.

home's heating and cooling systems to a heat pump, which can result in approximately 20% energy savings on its own.[4]

The diversity of options for comprehensive retrofits prompts an important question: Which, if any, set of upgrades would be the most appealing to homeowners? As program administrators, contractors, and other stakeholders prepare to implement the Home Efficiency Rebate program along with other IRA incentives, gaining a deeper understanding of the most compelling comprehensive retrofit pathways and upgrades becomes increasingly essential.

IRA POLICIES AND PROGRAMS

The IRA allocates billions of dollars to improve the energy efficiency of existing homes and to reduce greenhouse gas emissions. Among the IRA's various programs, the Home Efficiency Rebate program—which was allocated $4.3 billion in funding—specifically incentivizes the adoption of whole-home retrofit projects for households across all income levels and home types.

The IRA also includes a provision, the Home Electrification and Appliance Rebates, for specific home energy upgrades. Depending on the project and the household income level, this program may provide higher total incentives for comprehensive upgrades. For low-income households, some energy upgrades may be covered by a 100% rebate up to a total of $14,000, and for middle-income households, a 50% rebate may be available. Moreover, additional state and local incentives may be available in various jurisdictions across the country.

Additionally, the IRA increases the value of the long-standing 25C Energy Efficient Home Improvement tax credit for various individual upgrades. As of 2023, it raises the credit to 30% of the cost and amends the original $500 lifetime cap to an annual cap of $1,200, with lower limits for specific upgrade items (Ungar and Nadel 2022). Although it offers financial benefits, this credit is claimed on tax returns, which may be somewhat exclusively advantageous for households that both pay taxes and can pay the upfront costs of improvements until they can claim the tax credit.

The smaller, but also impactful, Energy Efficiency Revolving Loan Fund Capitalization Grant Program (EERLF) in the Bipartisan Infrastructure Law (BIL) provides an additional $250 million to states to promote residential and commercial energy efficiency measures. Unlike IRA provisions, EERLF does not include prescribed rebates and tax credits to homeowners.

---

[4] This refers to overall energy use (i.e., joules), regardless of fuel type. Some homes may switch their heating and cooling systems from gas to electric, while others may already have electric systems that are upgraded to a heat pump.

Instead, the program provides capital that can be leveraged by states to create financing solutions for homeowners (e.g., low-interest loans, green banks, or on-bill financing initiatives) or to provide grants to low-income homeowners for energy upgrades or weatherization readiness projects (Cosgrove 2023). Here, we focused primarily on IRA provisions, which provide the bulk of savings on most non-low-income comprehensive retrofit projects, but recognize that financing solutions, such as those supported by EERLF, also help get comprehensive energy upgrade programs into homes.

For contractors to be most effective, they should learn the programs and incentives available for the work they are doing. The complexity and variety of incentives can be truly challenging to navigate, but maximizing their ability to sell comprehensive retrofits will depend on their ability to learn, discuss, and creatively use these incentives. Although our focus in this report is on how to encourage non-low-income households to invest in comprehensive upgrades using IRA incentives as a backdrop, many of the lessons can be carried over to other demographics and projects.

USING BEHAVIORAL SCIENCE TO IMPROVE ADOPTION

Behavioral science research can provide valuable insights into the underlying factors that influence consumer preferences and home energy upgrade decisions. Behavioral insights can also help program administrators fine-tune the messaging, framing, and delivery of incentives to align with homeowners’ motivations and needs.

RESEARCH QUESTIONS

Our goal with this report is to leverage behavioral science insights to offer actionable guidance that empowers state energy offices and program administrators to effectively implement IRA incentives and promote increased adoption of comprehensive retrofits. To this end, we focused on six specific research questions:

1. What are the most appealing comprehensive retrofit packages for homeowners (i.e., upgrade packages that achieve 20% modeled savings)?
2. Does adding nonenergy-saving or energy-production measures make packages more appealing?
3. Which U.S. homeowner demographics are best to target with comprehensive retrofit marketing to achieve the highest response rate?
4. What trigger points are best for encouraging comprehensive upgrades (home fixes, planned maintenance, planned remodeling, etc.)?
5. Can using foot-in-the-door (a behavioral science strategy) encourage homeowners to conduct comprehensive retrofits?
6. When financial incentives are available, how should they be presented to homeowners to maximize uptake?

Survey Method

To answer our six research questions, we examined existing literature and conducted interviews with experts; we then administered our own online survey with original experiments and segmentation studies. Our answers below reflect a synthesis of these data sources, with a focus on the new information provided by the survey.

Our survey was completed by a large national sample of U.S. homeowners (*N* = 1,500). It included a discrete choice experiment (DCE),[5] three randomized control trials to test behavioral-science-based solutions, and a suite of demographic questions about homeowners and their homes to allow for segmentation analyses. The complete survey is available on OSF (Sussman 2024).

Our survey was completed by U.S. homeowners from across the country. All were over 18, spoke fluent English, owned single-family homes (i.e., a single-family detached home, duplex, rowhouse, townhouse, manufactured/mobile home, or condominium/apartment structure with no more than six units). Further, our respondents were not employed in the fields of marketing, advertising, or public relations, or by environmental organizations or utility providers. Participant recruitment was facilitated by a third-party panel provider, ROI Rocket. Apart from an overall higher level of education, and a slightly lower number of Black and Hispanic individuals, our sample closely mirrors national demographics of U.S. homeowners. The surveyed homeowners were roughly evenly split among the four major U.S. census regions (Northeast, Midwest, South, and West), and the age of respondents' homes closely mirrored that of U.S. homes overall. Appendix A offers a full demographic profile of participants and home characteristics as compared to the overall U.S. homeowner population and housing stock.

Online (lab-based) experiments may not perfectly reflect real-life decision making, but they do a reasonably good job of simulating actual behavior (Kormos and Gifford 2014), and they have the distinct advantage of rigorously testing a range of possible reactions to real-world situations. Options that are not yet available in the real world can be tested, and their potential value can be assessed in the absence of other confounding variables. That is, we can test hypothetical possibilities in a way that allows us to learn not only if they are associated with change, but also if they actually cause changes in decision making.

---

[5] A discrete choice experiment is a research methodology that simulates real-life decisions by presenting individuals with a series of choice scenarios where they have to select one option from several, each with varying attributes. By analyzing the choices, the individuals make, we gain insights into the factors that influence decision making.

What are the most appealing comprehensive retrofit packages? Does adding nonenergy-saving or energy-production measures make packages more appealing?

We compared the results of an open-ended question that asked homeowners for a single energy upgrade they were most interested in to a DCE in which those homeowners made choices between realistically priced comprehensive upgrade packages. This approach allows us to uncover the most important features that drive people's preferences for home energy upgrades.

WHAT HOMEOWNERS SAY THEY ARE INTERESTED IN

The most frequent answers to an open-ended question about preferences at the end of the survey ("Which energy upgrade are you most interested in for your home?") showed that homeowners want windows and door upgrades (354 mentions), solar photovoltaic panel installation (331 mentions), and HVAC upgrades (269 mentions) as their single most preferred upgrades.[6] However, as our DCE demonstrated, windows and solar were not appealing as parts of comprehensive retrofit packages. Overall, we recommend creating packages based on our DCE findings (which follow below). Later, in our "Recommendations" section, we discuss the disconnect between upgrades that homeowners say they want and the realistic decisions that homeowners make on upgrade packages.

ASSESSING PACKAGES WITH A DCE

Previous studies using DCEs to understand decision making related to energy efficiency have primarily focused on determining how much money individuals are willing to invest in general energy efficiency or in specific items (that are not always directly related to efficiency; see Bakaloglou and Belaïd 2022). For example, researchers have used DCE to determine homeowner willingness to pay for carbon emission reductions from home energy improvements (Achtnicht 2011; Achtnicht and Madlener 2014) and their willingness to pay for specific home upgrades (windows, façade, ventilation, insulation, etc.) in isolation or a few combinations (Banfi et al. 2008; Fernandez-Luzuriaga et al. 2022).

Limited research exists into consumer preferences for comprehensive retrofits, and most of these studies were conducted outside the United States. One notable German study explored the roles of environmental concern and comfort expectations in comprehensive energy-saving retrofit decisions (Galassi and Madlener 2017). The experiment assessed what

[6] These results include all homeowners in the survey. However, when limiting the results to just homeowners willing to invest at least $1,000 in comprehensive upgrades, the results and top three most-cited answers are nearly identical. More details about this open-ended question are available in the complete survey, which is available on OSF (Sussman 2024).

German homeowners and renters valued most in terms of expected benefits from the retrofits. It found that the most significant factors were air quality improvements, energy bill savings, and monthly costs incurred (payments for implementing the retrofit). However, that study and others like it looked at these factors in the context of abstract retrofits without evaluating their impact on specific retrofit measures or more concrete retrofit scenarios. As such, they help us learn that homeowners care about these energy benefits, but the studies do not tell us how homeowners would prefer to obtain them. That is, we still do not know which upgrade packages homeowners find most appealing.

While our DCE employs hypothetical scenarios, most participants (73%) indicated that they approached the experiment by drawing from their own real-life circumstances. Consequently, the results displayed variations depending on participants' characteristics, further reinforcing the assumption that they evaluated the costs and benefits of each upgrade in a manner consistent with real-life decision making.

DCEs have three key design features: attributes, levels, and choice sets. Attributes are the core elements of the product or service of interest. In this study, the attributes are the various home energy upgrades that might be included in a comprehensive energy retrofit package (insulation, windows, heating/cooling systems, etc.). In our DCE, we also went beyond energy efficiency measures to include rooftop solar and electric vehicle (EV) chargers as potential attributes. Through prior research and expert interviews, we learned that these non-efficiency elements are appealing to homeowners and, although not yet commonly included in comprehensive packages, we hypothesized that they could make traditional packages more appealing. Table 1 shows the full list of attributes.

Table 1. Choice experiment attributes and levels

Attributes	Levels	Cost by level	Monthly savings
Insulation and air sealing	1. —	$0	$0
	2. Insulate and air seal attic	$4,400[R]	$17.54
	3. Insulate and air seal attic and rim joist	$5,900[R]	$22.96
Windows and doors	1. —	$0	$0
	2. Upgrade windows	$14,700	$22.96
	3. Upgrade windows + one door	$16,660	$25.05
Heating and cooling systems	1. —	$0	$0
	2. Upgrade either heating OR cooling system to a higher efficiency model	$7,370	$11.67
	3. Upgrade heating AND cooling system to a heat pump	$8,230[R]	$46.41
	4. Upgrade heating AND cooling system to a heat pump and install a smart thermostat	$8,530[R]	$50.58

Attributes	Levels	Cost by level	Monthly savings
Water heater	1. —	$0	$0
	2. Upgrade to heat pump water heater	$1,750[R]	$20.77
Major appliances	1. —	$0	$0
	2. Upgrade one appliance to an ENERGY STAR appliance	$1,540	$1.36
	3. Upgrade two appliances to ENERGY STAR appliances	$3,090	$2.71
	4. Upgrade three appliances to ENERGY STAR appliances	$4,630	$4.07
Solar panels	1. —	$0	$0
	2. Install solar panel system	$23,300[TC]	$137
EV charger[7]	1. —	$0	$0
	2. Install EV charger[#]	$1,316[TC]	$0

Costs and savings calculated primarily using base values from RS Means and research by Lawrence Berkeley National Laboratory (Less et al. 2021). For full details, see Appendix B.

[#]We assigned a savings of $0 to installing an EV charger because we assumed homeowner EV charging behavior would remain unchanged from before to after installation. That is, we assumed the homeowner would otherwise charge at home using a Level 1 charger.
*TC denotes a value that was adjusted to reflect IRA tax credits.
*R denotes a value that was adjusted to reflect IRA rebates.

Respondents learned about each attribute through a brief explanation and a quiz. Only after correctly answering quiz questions indicating that they understood attributes and their associated benefits (financial and nonfinancial) were respondents able to complete the rest of the experiment. Attribute information was also shown during the experiment when respondents hovered over an attribute. Thus, respondents could use descriptions of each attribute to help make informed decisions. Choosing the attributes, pricing them, calculating their energy and financial savings, and deciding how to describe them was a critical task that we considered carefully (see Appendix B for more details).

[7] For the EV charger calculations, we assumed that homeowners already owned an EV and were using a Level 1 charger for at-home charging. The addition of an EV charger in this context does not imply the acquisition of a new EV, just the installation of the new charging infrastructure for an existing EV. This assumption is made to isolate the impact of the specific retrofit measures on energy costs from a change in charging behavior; it does not consider the scenario in which homeowners are transitioning from off-site charging to on-site charging.

Each attribute (energy upgrade) has multiple levels, each with increasing benefits. For example, the Heating System attribute can be left as-is (Level 0 = no upgrade); upgraded to a high-efficiency standard furnace (Level 1); or upgraded to an efficient combination two-in-one electric heat pump heating and cooling system (Level 2). Figure 1 shows an example of the Water Heater attribute. We systematically mixed and combined attribute levels into 144 possible upgrade packages, which were presented to homeowners in pairs, alongside costs and financial savings. Homeowners were asked to look at each pair and select their favorite package in each. This was done six times for each participant.[8]

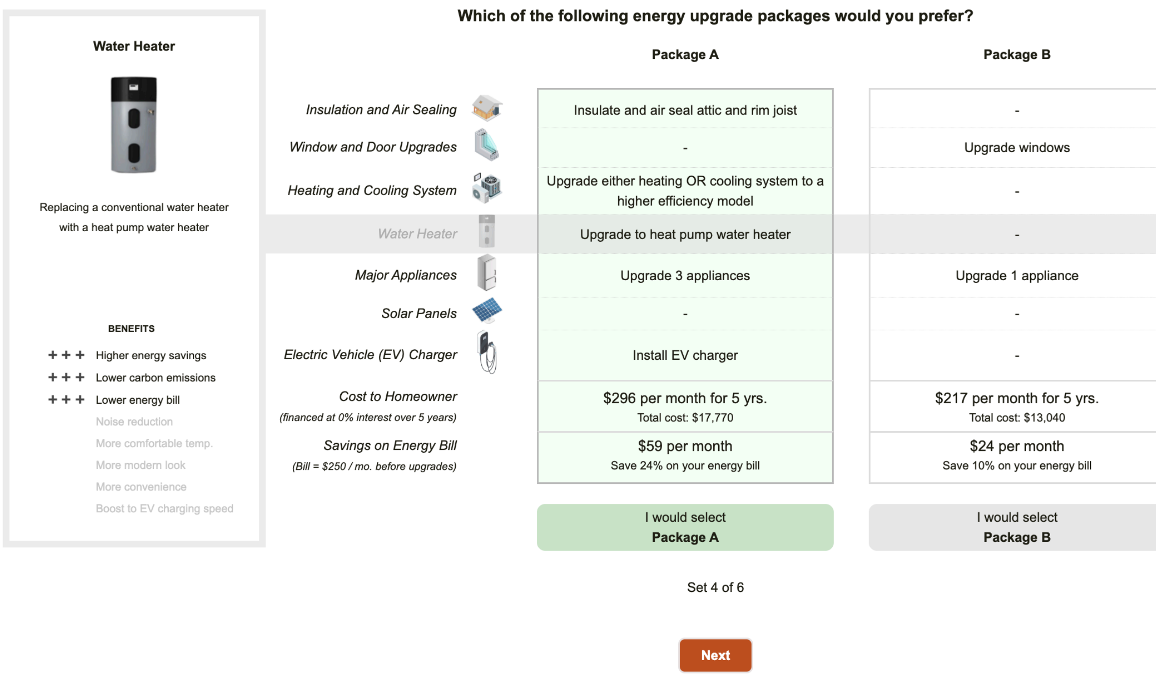

Figure 1. A DCE screenshot. This task required homeowners to select a preferred package from each of six pairs. Here, the respondent is deciding between Package A and Package B. Homeowners could hover over an upgrade to see a reminder about its benefits. In this example, the homeowner is hovering over "Water Heater" to learn more before making a decision.

Willingness to Invest in Home Energy Upgrades

Prior to starting the experiment the first question we asked homeowners was simply "How much would you be willing to spend today to do comprehensive retrofits on your home?"[9]

---

[8] This methodology did not require every homeowner to see every package or pair of packages.

[9] This question was presented alongside the definition of comprehensive retrofits used in this report.

Although this question was not a component of the experiment itself, responses to this question offered early indications of how homeowners might react to the experiment.

The median amount respondents were willing to spend was $2,000, but 35% of homeowners indicated a willingness to spend less than $1,000. This significantly affected their behavior in the experiment in a way that made their data unusable. Despite reducing package costs using rebates from the IRA High-Efficiency Electric Home Rebate Program, and despite this being a hypothetical scenario, this group still chose only the cheapest options in all cases and preferred not to do any upgrades.[10]

Nevertheless, this in itself is an interesting outcome: It suggests that roughly 65% of homeowners (excluding low-income homeowners) would entertain the idea of home energy upgrades.[11] For low-income populations, additional incentives are available through the IRA to bring the costs of some upgrades down to $0. Other existing energy efficiency programs, including the federal Weatherization Assistance Program, also provide a way for low-income homeowners to receive no-cost comprehensive upgrades. However, this report does not focus on low-income programs.

To learn which comprehensive retrofit package elements were most attractive, we chose to focus only on the 65% of homeowners (N = 975) in our sample who were willing/able to invest at least $1,000 in comprehensive retrofits.[12] We elaborate on the characteristics of this group later in the "Which Homeowner Demographics Are Best to Target?" section.

The Most Attractive Retrofit Package Elements

Package Elements

Of the comprehensive energy retrofit packages presented to participants, the most attractive elements (those that homeowners were most likely to select) were energy efficiency measures. In particular, upgrading heating and cooling systems (Z = 5.88), upgrading water heater (Z = 9.53), and upgrading appliances (Z = 4.18) significantly increased the frequency

[10] We also asked survey respondents how they approached the DCE task. Most homeowners (73%) stated that they considered their real-life financial circumstances when making their selections, despite being able to select any upgrades they wanted in our hypothetical scenario.

[11] Homeowners in higher-income households tended to be more willing to invest in comprehensive upgrades, but income is only one factor predicting willingness to invest. Understanding which homeowners prioritize investing in at least $1,000 in upgrades is covered later in the "Who Is Willing and Able to Invest at Least $1,000?" section.

[12] Although smaller than our initial sample size, power calculations revealed that this would be sufficient for constructing our planned latent class and known class models.

with which homeowners chose packages with those items (by 7%, 22%, and 5%, respectively).

Including a nonenergy measure (Level 2 EV charging, $Z = -9.58$) and an energy-production measure (rooftop solar, $Z = -6.44$) generally reduced how often homeowners selected the packages (by 23% and 20%, respectively). This is likely because they were expensive and, in the case of EV charging, did not provide financial savings.[13] We included rooftop solar and a Level 2 EV charger as potential non-efficiency additions, based on evidence that they might make efficiency packages more attractive to homeowners.

Notably, homeowners avoided packages with efficient windows ($Z = -10.93$, 19% reduction in preference) and did not significantly move toward or away from packages with insulation ($Z = 0.45$, a nonsignificant 4% reduction in preference). This could be partly because our experiment may have focused homeowners slightly more on financial aspects of the decision than on nonfinancial benefits (e.g., windows are often purchased for aesthetic appeal and insulation provides important comfort and health benefits). But it could also signal that contractors must pay extra attention to homeowners' specific concerns with their homes (suggesting insulation and windows when appropriate) and possibly also educate homeowners on nonfinancial benefits of upgrades.

Across nearly all demographic groups, packages were selected more frequently when they included the following elements:

- Heating and cooling systems (7% increased preference)
- Heat pump hot-water heaters (22% increased preference)
- Appliances (5% increased preference)

[13] Purchasing an EV or a plug-in hybrid EV can save money, as can switching from a fast-charging public charger (direct current fast charging) to home charging. For the purpose of this scenario, we assumed homeowners already owned an EV and were charging it at home using a Level 1 charger (i.e., the same behavior as before purchasing the charger).

And packages were avoided when they included the following elements (possibly because they were expensive or offered lower financial savings):

- Solar (20% reduced preference)
- Triple-pane ENERGY STAR windows (19% reduced preference)
- Level 2 EV charger (22% reduced preference)

Differences In Preferences Between Homeowner Segments

Income and Education

We analyze income and education together as they are typically closely related (individuals with more education tend to have higher incomes). Across the lowest income households (under $20,000/year) and the homeowners with fewest years of education (high school or less), homeowners were motivated to choose packages that include upgraded heating/cooling systems (9–12% increased preference) and heat pump hot-water heaters (20–22% increased preference), but they were also motivated not to choose packages with EV chargers (19–26% reduction in preference) or efficient windows (16–25% reduction in preference). This is likely because of high costs, relatively less (or no) bill savings, and the fact that households at this income level are less likely to own EVs.

For middle-to-upper-middle income households ($50,000–199,999) and homeowners with more than a high school education, this pattern of preferences remains similar, except that appliance upgrades also slightly increase preferences for packages (with borderline significant 2–8% increases for non-low income and 3–9% increases for middle incomes). Curiously, homeowners with a bachelor's degree and those earning $100,000–130,999 actively avoided packages with insulation (7% and 10% reductions in preference, respectively), as opposed to not being moved either way by insulation.

However, for the highest income group ($200,000 and above), solar, EV chargers, and appliance upgrades go from being actively demotivating to neither positive nor negative influences (i.e., perhaps slightly more appealing). For this high-income group, only heating/cooling upgrades and heat pump hot-water heaters are reliable positive drivers of preference for comprehensive packages (10% and 51% increased preference, respectively).

Number of Years in the Home

Our sample had a large minority of homeowners who had lived in their home for at least 20 years (41%) and who planned to stay in their home indefinitely or for at least 20 more years (47%). Homeowners in these two groups who were willing to invest at least $1,000 in comprehensive retrofits saw the most value in energy efficiency upgrades (with significant Z scores of 2.13–6.07 for various efficiency upgrades). They tended to like packages with heating/cooling upgrades (4% increased preference), hot-water heater upgrades (18% increased preference), and appliance upgrades (4% increased preference), and actively avoid packages with insulation (5% reduction), windows (17% reduction), solar (29% reduction), and EV chargers (23% reduction). New homeowners (less than one year in their home) chose packages with solar options (Z = 2.00) more than homeowners living in their homes for more than one year (Z = –7.8 to –0.09) although this group of new homeowners willing to invest at least $1,000 was rather small ($N$ = 15). Notably, age is usually related to number of years in the home (older adults being more likely to have stayed in the home longer). So, these tendencies may also be age related—that is, older adults may have similar preferences to those who lived in the home for 20+ years.

EV Purchasers

Not surprisingly, the small number of EV owners (N = 57) in our sample were the only group of homeowners that were significantly motivated to choose packages that included EV chargers (24% increased preference). The inverse is also true, however. The far larger number of homeowners (N = 518) who did not own EVs and had no plans to purchase one much more strongly avoided choosing packages that included an EV charger (29% reduced preference). Perhaps more surprisingly, the somewhat sizable number of homeowners who do not currently own an EV but plan to purchase one soon (N = 310), still did not significantly value an EV charger in retrofit packages (5% increased preference, nonsignificant).

Political Party

In our sample, republicans, democrats, and independent/unaffiliated homeowners differed somewhat in their likes and dislikes. As in the general sample, all three groups significantly preferred packages with heating/cooling (7–9% increased preference), and hot-water heater (13–30% increased preference), and democrats and independents also preferred packages with appliance upgrades (5–8% increased preference). Democrats were 2.3 times more likely to choose options with heating and cooling upgrades than republicans. All three groups avoided packages with windows (18–19% reduction in preference), rooftop solar (12–26% reduction in preference), and EV chargers (18–27% reduction in preference). However, among the three groups, republicans tended to have the strongest negative responses to packages with solar (26% reduced preference and two times more likely to dislike options with solar than democrats), EV chargers (27% reduced preference), and insulation (4% reduced preference, borderline significant).

TYPES OF HOMEOWNERS AND THE PACKAGES THEY LIKE

After removing the group of homeowners who were unwilling to spend at least $1,000, as well as a class of homeowners that did not show a clear pattern of decision making, we determined that there were most likely five different types of homeowner upgraders as follows.

1. *Not Interested in Comprehensive Retrofits; Only Appliance Upgrades and Definitely Not Solar (28% of Interested Homeowners)*

This group of homeowners selected packages that included appliance upgrades and very strongly stayed away from packages with rooftop solar. In fact, the dislike of solar accounts for 61% of their preferences for or against packages. Both these tendencies may be related to the cost of upgrading (appliances being low cost and solar being high cost). Given that appliances do not comprehensively reduce energy bills (i.e., modeled savings of at least 20%) and that solar would greatly reduce energy bills, we might also conclude that reducing energy bills is of lower importance to this group than spending as little as possible. People in this group are older, have a lower- to middle-income bracket (but not the lowest income brackets <$20,000), live in attached housing (duplex or row house), and have lived in their home for 5–15 years.

People in this group are more likely to be:

Living in a duplex or row house	Older	Moderately low income	In their current home for 5–15 years

2. *Upgrade My Mechanical Systems … and Maybe Some Other Things Too (26% of Interested Homeowners)*

This group is the cautiously interested group of upgraders and tends to select packages that include upgrades to their hot-water heater and heating/cooling systems. Sometimes, they also would not mind other upgrades, such as solar and EV charging, but they are not strongly moved (positively or negatively) by windows, insulation, or appliance upgrades. Fortunately, for many homes, a package with just heating/cooling systems and hot-water heater upgrades can reduce energy consumption by 20% (modeled savings) or more, especially if heating and cooling is upgraded to an efficient electric heat pump that both heats and cools (Mayernik 2023). Based on their decisions, it would seem that this group is interested in bill savings but may want to localize their upgrades to just one area of the home—an area that does not require the type of disruptive work involved in other upgrades, such as insulation and windows. This group may also be thinking more about bill savings than ancillary benefits of energy efficiency, such as comfort and improved indoor health. People in this group tended to be female, more likely to have small family sizes (fewer children at home), and less likely to be in low-income brackets.

People in this group are more likely to be:

Female

In smaller families

Not in lower-income brackets

3. *Give Me Energy Independence; Solar, EV Charger, and Energy Efficiency (17% of Interested Homeowners)*

This group is strongly motivated to buy packages that include solar. Adding an EV charger, upgraded appliances, insulation, heating/cooling upgrades, and more efficient hot-water heater allows the homeowners to reduce their energy bill close to zero and somewhat increase their resilience when energy prices fluctuate or there is a power outage. This group is interested in all energy upgrades, other than windows (possibly because they are expensive relative to their energy savings). People in this group are likely to be female and have plans to purchase an EV. They are in both low-income brackets (below $50,000) and the highest income bracket (above $200,000), and live in both the smallest homes (under 1,000 square feet) and the largest homes (over 3,500 square feet).

People in this group are more likely to be:

Female

Planning to purchase an EV

4. *Reduce My Energy Consumption to the Max; Traditional Comprehensive Energy Efficiency (17% of Interested Homeowners)*

This group of homeowners is interested in energy efficiency upgrades of all types, including insulation and windows (items which are not important to, or even actively avoided by, most other groups). However, this group is not particularly interested in additional nonenergy conserving measures, such as EV chargers and rooftop solar. Possibly, this group recognizes the significant nonfinancial benefits of energy efficiency (e.g., improved comfort, indoor health, noise levels, convenience, or aesthetics) and/or the environmental benefits. This group wants to get the most-efficient home possible. The people in this group are more likely to be male, older, have incomes less than $200,000, live in larger single-family detached homes (mostly over 1,500 square feet, with many over 2,500 square feet), and to have larger families than other groups.

People in this group are more likely to be:

Male | Older | Living in larger single-family homes | In larger families | In income brackets under $200,000

5. *Upgrade My Mechanical Systems … and That Is All; Especially Not Solar, EV Charging, or Windows (12% of Interested Homeowners)*

This group of homeowners is actively opposed to solar and EV charging and is best characterized by its extreme dismissiveness of packages that include these elements. The homeowners in this group also avoid packages with windows upgrades. The only package elements that they are drawn to are efficient heating/cooling and hot-water heater upgrades. As in the other group interested in mechanical systems, homeowners in this group are motivated to reduce their energy bills through mechanical systems upgrades. They are also much more strongly opposed to spending money on expensive items with relatively low savings returns; these items include windows, solar, and EV charging. Again, the nonfinancial benefits of energy efficiency may be less important to this group. People in this group are likely female, have incomes of $150,000–200,000, and do not live in single-family detached homes (and thus may have more difficulty installing rooftop solar or EV charging).

People in this group are more likely to:

Female | Not living in single-family detached homes | Have moderately high incomes ($150,000–200,000)

LIMITATIONS OF DCE

DCEs are well suited to exploring homeowners' preferences for home energy upgrades for several reasons. First and foremost, this methodology allows us to explore hypothetical situations that are not common in the real world (e.g., comprehensive retrofit packages that include rooftop solar and EV charging). By giving respondents defined choice options instead of relying on self-reports or open-ended answers, DCEs allow us to better understand the tradeoffs that people were willing to make among various attributes provided in the choice context.

Unavoidably, however, this DCE is a simplification of real-life home energy upgrade decisions, as the package options provided do not encompass the full range of possible energy upgrades homeowners can make to their homes (only the most common). Indeed, the manner in which upgrades were framed (with cost and savings prominently displayed) may have slightly pushed homeowners to prefer measures that save money rather than those that also provide other benefits, such as comfort and improved air quality.

Our design was also unable to accommodate the additional energy efficiency possible from combining multiple upgrades. That is, for situations in which two or more efficiency upgrades complement each other and combine to provide extra energy savings, these extra savings were not shown.[14] Additionally, participants in DCEs display a hypothetical bias (Loomis 2011). That is, they typically commit to spending more money and tolerating greater risk than they would in real life. Even though most homeowners in our study stated that they used their actual personal financial situations to inform their decisions, we nevertheless expect that preference for some home energy upgrades may have been overstated. Despite these limitations, DCE studies are generally reflective of reality and are often used to inform policy decisions (e.g., Greene 2010).

Which U.S. homeowner demographics are best to target with comprehensive retrofit marketing?

Given that marketing and advertising campaigns are most effective when tailored to the target audience, we conducted several subanalyses on key demographic variables to learn which messages could work best with each audience segment.

[14] Because of the restrictions on DCE design, we could not increase savings or reduce costs more than the sum of individual upgrades. However, contractors rarely conduct these sorts of cost comparisons (modifying HVAC or solar sizing when insulation is increased, for example). As a result, the presentation is generally realistic.

DIFFERENT PACKAGES FOR DIFFERENT GROUPS

As described earlier, 35% of homeowners in our survey indicated that they currently would not (or could not) invest even $1,000 to receive comprehensive energy upgrades on their homes.[15] We considered this group "unable to invest" and found that they tended to select energy upgrades based only on price, always choosing the cheapest option, and not being moved by any of the benefits these upgrades could confer. Low-income customers in this group could be well served by low-income energy efficiency programs or specific IRA provisions for income-qualified customers. Given that this was not a focus of our work, we conducted our analyses of preferred upgrade packages (the DCE analyses) after excluding this group of homeowners. Of the remaining 65% of homeowners that were able to invest at least $1,000, the preferred packages differed somewhat by various demographic variables (as we note earlier in the "What are the most appealing comprehensive retrofit packages for?" section).

WHO IS WILLING AND ABLE TO INVEST AT LEAST $1,000?

Several factors identified homeowners who were currently more likely to be willing to invest at least $1,000 in comprehensive residential retrofits. As expected, homeowners with more money are more likely to be willing to invest. Those with moderate or higher incomes, more years of education (closely associated with income), and those not below 200% of the Federal Poverty Level (a common criterion for being designated low-income that combines income, state, and household size) are more likely to be willing to invest at least $1,000 in comprehensive home upgrades.[16] Similarly, those who have EVs or are planning to purchase them, as well as those living in moderate to larger homes, are more likely to fall into this group.

Perhaps less obviously, males are more likely than females to be willing to invest at least $1,000, as are slightly younger homeowners and homeowners without children currently living in the home. Those who had completed at least one home energy upgrade (and therefore may have better understood the value of upgrading) are more likely to be willing to invest than those who had not.

---

[15] Of the total sample, 19% were willing to spend $0. The median willingness to spend for comprehensive retrofits was $2,000 and the most frequently mentioned amount was $5,000.

[16] Homeowners provided their income as a range, rather than a specific number. Thus, we estimated low-income status by using the midpoint of income ranges (or $200,000 for highest income group) and combining that information with household size and U.S. state. We looked at whether each participant was below 200% of Federal Poverty Level (FPL) for their state using FPL tables for 2022 income (Ungar and Nadel 2022). In total, 19.3% of our sample was estimated to qualify as low income.

Homeowners in the West census region are more likely to be willing to invest $1,000 than those in any of the other three regions (Northeast, Midwest, or South). Democrats are more likely to invest than independent/unaffiliated homeowners, who are, in turn, more likely to invest than republicans. Tables 2 and 3 summarize the characteristics of homeowners in our sample that are most and least associated with being willing and able to spend at least $1,000 on comprehensive retrofits.

Table 2. Top factors statistically significantly associated with being currently willing to spend at least $1,000 on comprehensive home energy upgrades

	Demographic factor	Homeowners willing and able to invest $1,000 or more (%)
1	Own, owned, or may buy an EV soon	79%
2	Undergraduate degree or higher level of education	70–78%
3	Lived in the home 6–10 years	75%
4	More than $200,000 in household income	74%
5	2,001–2,500 sq. ft. home	71%
6	No children at home	71%

Note: We include only factors for which 70% of homeowners (or more) indicated a willingness to invest at least $1,000.

Table 3. Factors associated with currently being unwilling to spend at least $1,000 on comprehensive home energy upgrades

	Demographic factor	Homeowners willing and able
1	Earning under $50,000	47–54%
2	Low-income qualified	52%
3	Have not previously done any upgrades	54%
4	High school education or less	59%
5	Not owning and not considering an EV	59%

Note: We include only those factors in which 60% of homeowners (or fewer) indicated a willingness to invest at least $1,000. Homeowners who indicated that they were willing to invest might plan to pay for the investment on credit or by some other means. There could also be a hypothetical bias (overstatement of actual willingness to pay), which is often the case with online surveys of this type.

DECISION FACTORS DIFFER BY CONSUMER SEGMENT

In addition to the various message framing experiments described earlier in this report, we also asked homeowners to self-rate the factors that influence their decisions to upgrade (or not upgrade) their homes. We developed a list of possible factors based on previous research (e.g., Achtnicht and Madlener 2014; Wilson, Crane, and Chryssochoidis 2015; Klöckner and Nayum 2016) and on discussions with energy experts. Homeowners rated the importance of each factor along a five-point scale from "very unimportant" (1) to "very important" (5). Table 4 shows the complete list of possible factors.

Table 4. List of factors that influence the decision to upgrade

Factor	Mean rating of importance
Total cost	4.54
Increased home comfort	4.04
Reductions on energy bill	4.4
Healthier living environment	3.77
Impact on property value	3.68
More convenience	3.43
Environmental impact	3.17
Noise reduction	3.12
New smart technologies	2.87

Note: Homeowners rated the importance of each factor contributing to energy upgrade decisions from 1 ("very unimportant") to 5 ("very important").

Two financial factors (the total cost of upgrading and the potential energy bill reductions) were self-rated as most important (M = 4.54 and M = 4.40 out of 5, respectively), and home comfort was rated as third-most important (M = 4.04 out of 5). These three factors were the most highly rated for every demographic subsegment, so messages focusing on them are likely to be effective with any target market in the United States. Health was further down the list at fourth (M = 3.77 out of 5). Although previous research finds that other factors are also important (especially health; e.g., Sussman and Chikumbo 2017; Galassi and Madlener 2017), the cost of upgrading, potential bill reductions, and home comfort emerged as most important in the sample.

Messages addressing these factors may describe methods for reducing costs (e.g., through rebates, tax credits, or no-interest loans), or they may espouse the benefits of energy efficiency for reducing energy bills and increasing home comfort. Interest in new smart technologies was least important to decisions regarding residential energy upgrades (M = 2.87 out of 5), but this factor varied significantly among many subgroups.

As our online supplementary material shows, the relative importance of all the factors varied by demographic segment (Sussman 2024). So, while cost, savings, and comfort are always safe messaging approaches, other messages may also resonate with some groups. Calling out these differences in advertising and marketing could help those target groups resonate more strongly with the campaign. Based on our analysis, following are some customizations to consider:

- For low-income customers, focus on messages that describe (and create program measures that reduce) the total costs of upgrading.
- For the highest-income households ($200,000 or more) total cost is important, but still less important than it is for other income groups. Therefore, messages about reducing this cost may be less impactful. Instead, for this and other high-income households ($100,000 or more), as well as homeowners in large new homes and those with high education levels (graduate degrees), focus on improved property value and the chance to install new smart technologies (which may be a sort of proxy for luxury home improvements).
- Homeowners who own, have owned, or are planning to own an EV are a particularly important market segment as they represent the low-hanging fruit for wanting home energy upgrades. For this group, installation costs are a highly important factor, but are relatively less important than for those who do not own an EV and are not planning to purchase one. Compared with non-EV purchasers, the EV group is more motivated by all the positive benefits of energy efficiency (noise reduction, environmental impact, property value, convenience, comfort, new smart technology). This group is especially interested in creating a healthier indoor environment and bill savings. Thus, messages espousing any of these benefits may be effective. As with all groups, comfort continues to be important here as well.
- Like homeowners who own, have owned, or are planning to own an EV, those with children living at home are also more motivated than others by the positive benefits of energy efficiency (noise reduction, environmental impact, property value, convenience, healthier indoor environment, new smart technology, comfort, and bill savings). However, unlike EV purchasers, they are just as concerned about upfront costs as everyone else. This group would likely be most responsive to messages about any of energy efficiency's positive benefits, alongside a message about how total costs can be reduced.
- For homeowners who have lived in their homes for a long time (20 years or more) or are likely to continue to live in their homes for a long time (indefinitely, or at least 20 years), messages should avoid focusing on how energy efficiency increases property value or

how it provides an opportunity to install new smart technologies. As with other groups, messages about bill savings, increased home comfort, and mitigating total costs will likely be most effective.

- Republicans and homeowners in the South are less likely to respond to messages about the positive impact of energy efficiency on the environment. Instead, consider focusing on comfort, energy bill reductions, and mitigating total costs.

What trigger points are best to target for encouraging comprehensive upgrades?

Events such as moving to a new home or major home renovations often lead to changes in people's personal, psychological, and material circumstances. These identifiable moments, or trigger points, represent windows of opportunity when barriers to change, such as inconvenience or cost, may be lower than at other times. By recognizing and understanding these trigger points, stakeholders can make the most of key opportunities to successfully increase adoption of energy-saving measures.

According to previous research on trigger points, evidence suggests that specific upgrades may be more closely linked to specific moments of change (Wilson, Crane, and Chryssochoidis 2015; EST 2011). Major home renovations can function as a trigger point for energy-efficient upgrades. According to a survey conducted by the Energy Saving Trust in the United Kingdom, 85% of homeowners who planned to undertake significant home improvements within the next three years expressed that they were willing to allocate additional funds for energy efficiency improvements. In our conversations with experts and stakeholders, the potential for timing energy upgrades with other improvements or repairs came up frequently. Some experts we spoke with suggested that homeowners often express interest in additional home energy upgrades at the time of equipment replacement.

However, recent research indicates that the urgency of the equipment replacement may play a significant role in the decision of whether or not to upgrade. Recent work by Environment and Climate Change Canada and Impact Canada found that urgency suppressed heat pump upgrades: When people urgently needed to replace their heating systems, they were less likely to choose heat pumps, regardless of their previous heating source, compared to those who did not have an urgent need for replacement (Deleniv 2023).

SCENARIO TESTING

To test which (if any) trigger points might boost the effectiveness of a pitch for comprehensive retrofits, we conducted an experiment in which homeowners were randomly assigned to different scenarios and asked if they would complete a recommended comprehensive energy upgrade. These scenarios were vetted by energy efficiency experts and a handful of contractors across the United States who install these types of upgrades to ensure that the scenario and associated costs were realistic.

For this experiment, we presented a comprehensive upgrade that was simple, straightforward, and often recommended for homes across the country: upgrading inefficient heating and cooling systems to a single energy-efficient air-source heat pump capable of both heating and cooling. Average national energy models estimate that this upgrade alone can reduce site energy consumption by 20% (Mayernik 2023), making it potentially an IRA-qualifying comprehensive retrofit (Ungar and Nadel 2022). Although we chose this particular upgrade to test whether timing matters, we chose it because we believe the results and conclusions can be generalized to similar residential upgrade situations of similar costs.

We tested seven scenarios in which heat pump upgrades (with the exact same costs) were recommended following different trigger points. We compared the scenarios to each other and to a scenario with no triggering event other than receiving a home energy assessment (control).

Two triggering event scenarios were reactive: "Imagine your basement has water damage and needs to be repaired and, although your HVAC was spared, it is nearing the end of its usable life" and "Your heating system broke and needs to be repaired." Three events were proactive: "Imagine you are planning to retire your heating system in a year or two, after its useful life," "You are doing your annual heating system tune-up," and "You are doing a kitchen remodeling project." Finally, one event was about moving into a new home: "Imagine you bought a new house."[17] We paired trigger points with a short rationale statement linking the trigger with the suggested heat pump. The exact text of each scenario is in the complete survey, available on OSF (Sussman 2024).

BEST TRIGGERS: RELEVANT REPLACEMENTS AND MOVING TO A NEW HOUSE

Homeowners in the control, who were recommended a heat pump upgrade costing $10,000 after receiving a home energy assessment, responded with the lowest likelihood of upgrading. As figure 2 shows, when homeowners were randomly assigned to first imagine a triggering event involving a needed heating system replacement (broken or planned system retirement) they had a higher likelihood of upgrading. This was not only higher than the no-trigger control scenario, but also higher than all other triggers.

[17] We derived the seven triggering events from expert interviews and behavioral insights. For example, basement flooding is a significant predictor of willingness to upgrade (Sussman and Chikumbo 2017), kitchen remodeling is a potential entry point for energy upgrade conversations (Antonopoulos 2023), and moving to a new home capitalizes on the Habit Discontinuity Theory (Verplanken et al. 2008), otherwise known as "Fresh Start" (Petersen et al. 2017).

When homeowners were asked to imagine a scenario in which they needed to repair their basement and their HVAC was close to the end of its life, or a scenario in which they recently bought a new house, they were also statistically significantly more likely to upgrade than when no triggering event occurred.

However, when homeowners were randomly assigned to imagine a scenario in which they experienced only a minor heating-system-related situation (getting an annual tune-up) or a planned renovation of an area unrelated to the heating system (kitchen), the trigger did not significantly increase the likelihood of upgrading to a heat pump.

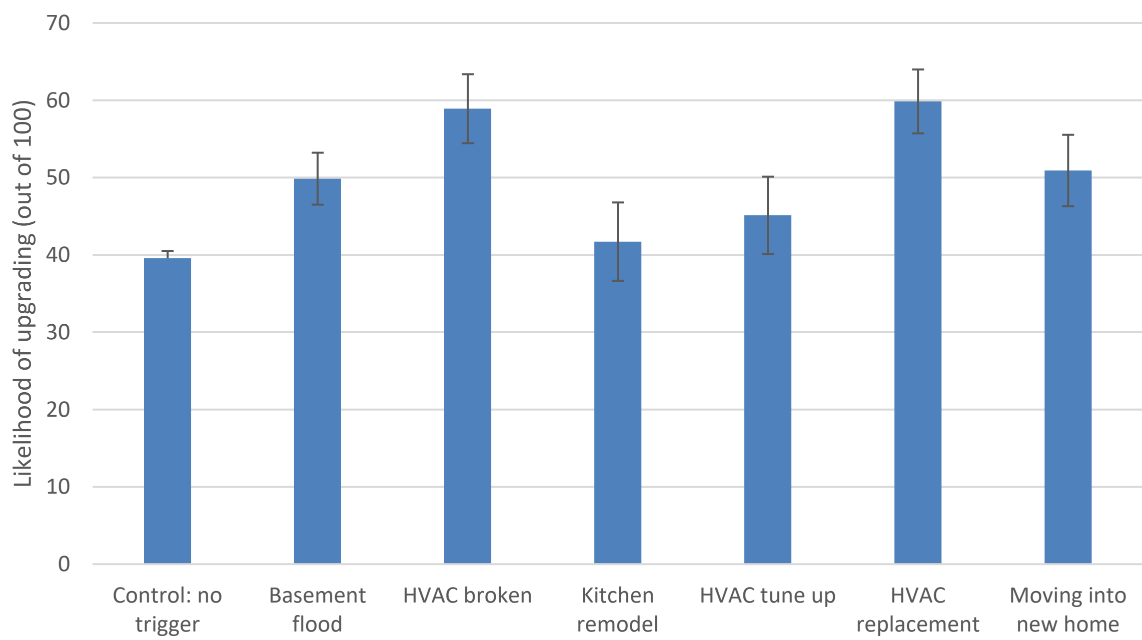

Figure 2. Trigger points leading to an increased willingness to upgrade existing HVAC to an efficient two-in-one heat pump. Of the seven tested triggers, only kitchen remodeling and an annual HVAC tune-up did not significantly increase the likelihood of upgrading. Error bars indicate 95% confidence intervals.

These findings suggest that the precursor events that make upgrading to a heat pump most likely are those related to replacing the heating system (proactively or reactively) or possibly repairing an area of the home that may house the HVAC system (i.e., the basement).[18]

[18] In our discussion with contractors, we learned that reactive HVAC replacement (i.e., an emergency fix) is not a great time to encourage upgrading. However, this experiment suggests that this would be just as good a time as during a proactive replacement. To square these findings, we suggest recommending an upgrade during both reactive and proactive replacement events. Reactive replacement events may be less important than proactive replacements, but they are likely still much better than other non-replacement events.

Interestingly, however, moving into a new house, which does not necessarily require heating system replacement, could also be an effective triggering event for promoting heat pump upgrades or similar comprehensive upgrades. Minor heating system maintenance (i.e., an annual tune-up) and major remodeling projects unrelated to the heating system (i.e., kitchen remodeling) did not increase the likelihood of investing in a heat pump.

Comprehensive upgrades are best recommended after a trigger point related to replacing at least one component of the package, or after moving into a new house. As we discuss later, constructing packages by adding items step-by-step (the foot-in-the-door strategy) may be effectively combined with trigger points to encourage upgrading.

Importantly, because participants were assigned to scenarios at random (which is impossible in the real world), we can say that some trigger points caused the differences in likelihood of upgrading to a heat pump. A strength of our research methodology is that we can effectively rule out other explanations for differences between reactions. We cannot say for sure that homeowners would act the same way in real life as they do in this hypothetical scenario (and a trigger's effect accounts only for a medium to small amount of variation in behavior anyway[19]), but the fact that we found differences across scenarios in this national sample of real homeowners is promising.

Can using foot-in-the-door (a behavioral science strategy) encourage homeowners to conduct comprehensive retrofits?

Behavioral-science-informed strategies leverage behavioral insights or "nudges" to encourage behavior change, without restricting customers' freedom to choose. For example, showing homeowners that neighbors are investing in energy efficiency may encourage similar investment, given that these technologies can spread through geographic regions via social networks (Noonan, Hsieh, and Matisoff 2013). Although social-norms approaches such as this one show promise for encouraging energy retrofits in general, we chose to focus on a strategy that could be particularly helpful for encouraging comprehensive retrofits.

The foot-in-the-door approach is one such strategy that has proven effective in other energy-related decisions (DOE 2012). Foot-in-the-door leverages the behavioral insight that when individuals first agree to an initial request, they are later more likely to agree to a second, related request. In terms of comprehensive upgrades, this would mean building a

[19] The effect of triggers could have been even higher if we were comparing them to homeowners in the control group with no reason to upgrade. Our control group scenario involved getting a home energy assessment.

package of upgrades one item at a time by suggesting upgrades after previous upgrades have been agreed to.

Previous research confirms that the practice of upselling (which is similar to foot-in-the-door) is quite common in residential energy retrofitting (DOE 2012). Findings from New York State Energy Research and Development Authority (NYSERDA 2015) suggest that upselling may indeed move customers receiving energy to consider larger, more-comprehensive energy retrofit projects when additional measures are in the same improvement category (e.g., insulation and air sealing). They are not usually moved to combine measures from different categories (e.g., insulation and heating systems).

However, some program administrators expressed skepticism about homeowners' willingness to accept additional measures, citing a common response from homeowners: "maybe another time." Moreover, there are concerns, supported by empirical evidence, that upselling could have negative impacts on the satisfaction, loyalty, or trust between homeowners and contractors (NCLC 2017). Given that very few homeowners actively seek comprehensive-level home energy upgrades, it becomes especially important to understand the effectiveness of upselling additional improvements.

FOOT-IN-THE-DOOR

In this scenario, we test a situation in which a contractor was called for a whole-home window replacement (not a home energy assessment), but the home may nevertheless be a good candidate for comprehensive upgrades. To test whether a foot-in-the-door strategy could work, we crafted a hypothetical situation in which the contractor offers a like-for-like replacement of the windows, but then also offers a series of escalating offers to construct a comprehensive retrofits package if the homeowner agrees at each step along the way. At each step, the contractor also includes all the potential incentives available through IRA provisions (providing both the total and incremental costs) and suggests doing the last step the following year to receive additional rebates. The exact text for each scenario is in our full survey in the OSF database (Sussman 2024). Table 5 shows the order of recommended upgrades, and Appendix C offers a more detailed description of each recommendation.

Table 5. Order of upgrades recommended to homeowners using the foot-in-the-door approach

Step	Description of recommendation	Cost
0	Like-for-like window replacement for the full home. Newer windows that are marginally better. This is what the homeowner asked for.	$11,000
1	EnergyStar window upgrade.[20] Leads to fewer cold drafts in winter and fewer hot spots in summer, as well as providing some level of insulation that saves money and reduces energy used for heating and cooling.	+$4,000
2	Air sealing and attic insulation. Ensures consistent indoor temperature and energy efficiency. Normally costs $8,000, but if you also upgrade your windows then you qualify for a $2,000 rebate.[21]	+$6,000
3	Heat pump for heating and cooling. New and highly efficient two-in-one heating and cooling system that uses about one-third of the energy. Your current heating and cooling systems are around 11 years old and might need replacement soon. Heat pumps work best in homes with tight sealing and good insulation, just like the improvements you're already making. I suggest installing the heat pump next year (i.e., doing the work over two years) to take advantage of a federal rebate that saves 50% (about $5,000).[22]	+$5,000

[20] This upgrade refers to ENERGY STAR triple-pane windows. Respondents were informed that these were "more efficient," but to keep the task simple, they were not explicitly told how the windows achieved this efficiency (i.e., by being triple-pane)

[21] The IRA Home Efficiency Rebate provides homeowners who earn over 80% of their area median income (AMI) with a rebate of $2,000/home if the whole-home retrofit meets the minimum requirement of 20% modeled energy savings (Ungar and Nadel 2022). Homeowners that meet the same energy savings level requirement who fall under 80% of the AMI qualify for a $4,000/home rebate (Ungar and Nadel 2022). According to calculations from the National Renewable Energy Laboratory and the DOE, combining attic insulation, air sealing, and ENERGY STAR window upgrades could reduce energy consumption for the typical U.S. home by approximately 20%, thereby making this combination of upgrades eligible for the Home Efficiency Rebate program incentives (Harris 2022; ENERGY STAR n.d.). Given that we were unable to differentiate participants by their AMI qualifications, we opted to present all respondents with rebate information that reflects the $2,000/home rebate (for homeowners above 80% AMI) as this is what would be most applicable to market-rate homeowners.

[22] The IRA Home Electrification and Appliance Rebates includes multiple rebate offerings for various specific home energy upgrades. This program has an annual maximum total across all rebates received. By separating the

Findings

In our scenario, the likelihood of a homeowner saying yes to each consecutive request is high if they said yes to the preceding request. Of the homeowners who were offered a windows upgrade to ENERGY STAR windows, 72% said yes (the odds are 2.52 times higher of a yes than a no). Of those who said yes to the window upgrade, 62% said yes to the insulation upgrade (odds are 1.62 times higher of a yes than a no). Of those who said yes to ENERGY STAR windows and then to insulation, 82% said yes to a heat pump (odds were 4.46 times higher of a yes than a no). Thus, at each stage, it would appear logical to offer the next addition.

However, another way to look at the result is to compare the total number of yesses to the complete package to the total number of potential yesses if the package were simply offered right away to everyone at the outset without using a stepwise approach (i.e., right after providing the quote for the like-for-like window replacement). In our study, the total number of people who said yes to the comprehensive retrofits when they were asked straight away was not significantly different than when it was offered using the stepwise foot-in-the-door approach (39–44% either way).

BUILD A PACKAGE STEP-BY-STEP

For customers who may not initially be looking for comprehensive retrofits, using the foot-in-the-door approach to build a package step-by-step may be an effective approach. At each stage, customers who said yes to a previous proposal have a good likelihood of saying yes to the next one. Although the foot-in-the-door strategy may not lead to significantly higher numbers of comprehensive retrofit package than offering them straight away to

---

work into two years, the homeowner can receive this maximum in each year. Regarding rebates specifically for heat pumps, homeowners below 80% of their AMI would receive a rebate for 100% of the cost (up to $8,000), and homeowners above 80% of their AMI would receive a rebate valued at 50% of the heat pump cost up to $8,000. Again, we opted to present all respondents with rebate information that reflects the rebate amounts for homeowners above 80% AMI (50% of the heat pump cost) as this is what would be most applicable to market-rate homeowners; therefore, the value of this rebate would be approximately $5,000.

A homeowner wishing to maximize his or her savings for all three upgrades would benefit from splitting the upgrades into two phases and taking advantage of both the Home Efficiency Rebate and High-Efficiency Home Rebate programs. The value of the Home Efficiency Rebate ($4,000/home in total) for what would effectively be a deep retrofit (above 35% modeled energy savings) would be far less than the $7,000 a homeowner could receive in rebates by opting for one Home Efficiency Rebate for the combination of insulation and air sealing ($2,000/home for reaching 20% modeled energy savings) and one High-Efficiency Electric Home Rebate for the heat pump (Ungar and Nadel 2022; H.R. 812, 118th Congress).

customers, it might increase some contracts by one or two items, even if they do not choose to invest in a completely comprehensive package.

Our scenario was specific to planned window replacement, which will not apply to every home or homeowner. Nevertheless, the experiment shows proof of concept for a foot-in-the-door strategy in a realistic scenario with realistic pricing. Hopefully, this is enough to encourage contractors to attempt the strategy with customers in the field. We are interested in hearing about experiences contractors have with this approach. Offering energy retrofits to customers who have not initially requested an energy audit is challenging, and it often fails. This strategy may slightly increase the likelihood of success, but it is unlikely to lead to comprehensive energy upgrades every time.

Our scenario also requires contractors to form networks of expertise and offer a variety of upgrades in a package, even if their expertise is traditionally narrow (e.g., window replacement). Additionally, contractors must understand IRA incentives (and hopefully other local incentives) and how they can be stacked and maximized by, for example, doing work in stages across multiple years. We discuss this in greater detail in the "Recommendations" section below.

When financial incentives are available, how should they be presented to homeowners to maximize uptake?

Although more beneficial than individual upgrades, comprehensive energy retrofits can be prohibitively expensive for many homeowners (Cluett and Amann 2014; Stern 2011). To pay for upgrades, homeowners may choose to apply for financing through in-store options or through the U.S. Department of Housing and Urban Development (HUD). They may also choose to pay for some upgrades using their credit card. Fortunately, financial incentives such as rebates and tax credits are also available to help defer these costs for most homeowners. Indeed, IRA provisions offer unprecedented rebates and incentives for homeowners to complete comprehensive upgrades. Nevertheless, the universe of potential incentives can be difficult for contractors to navigate and for homeowners to understand. Moreover, it is unclear which type of incentive (rebate, tax credit, deferred payment, etc.) is most helpful for shifting homeowner decisions on these high-priced home improvements. By identifying the most attractive mix of financing solutions, we can potentially make substantial strides in reducing financial barriers.

FINANCE OPTIONS AND FRAMING

We randomly assigned homeowners to scenarios in which different financial incentives were offered for comprehensive upgrades, and then asked if they would complete a suite of recommended improvements. The improvement package (attic insulation, a heat pump replacing current heating and cooling systems, and a heat pump hot-water heater) was very similar to the package preferred by 17% of homeowners in the DCE we presented earlier.[23] We estimated the costs of upgrading using data from Lawrence Berkeley National Laboratory (LBNL), RS Means, and EnergySage, and the scenarios were vetted by energy efficiency experts and a handful of contractors across the United States to ensure realism. Although we tested this particular suite of upgrades only for this experiment, the findings may translate to other comprehensive energy upgrade packages at the same price or higher.

We tested six typical scenarios; in each, a home energy assessor recommended the suite of upgrades to the homeowner. For each scenario, the total cost of upgrades known to the homeowner at time of sale were the same ($16,310). We consulted several experts to verify that this price was realistic for a slightly above-average-sized package.[24] We compared scenarios to each other and to a scenario in which no potential financial incentives are mentioned (control).

Homeowners randomly assigned to the first scenario (with no financial incentive mentioned) saw only that their hypothetical home was assessed and that these three upgrades were recommended by the assessor. Those randomly assigned to any of three other scenarios additionally learned that rebates may be (or are definitely) available (and in one case they could be used to reduce immediate upfront costs). Those assigned to a fifth scenario learned that a tax credit would reduce the price. And those assigned to the final scenario were offered a zero-interest loan, with no upfront costs, that would spread out payments over five years.[25] Table 6 describes these scenarios.

[23] For the average American home, this suite of upgrades would reduce energy consumption by over 20% and would, therefore, qualify as comprehensive. These upgrades are also incentivized by recent federal government legislation. Of interested homeowners, 17% (those identified as "Reduce My Energy Consumption to the Max") were drawn to this package, as indicated in our DCE described earlier in this report.

[24] The average comprehensive package sold through the Home Performance with ENERGY STAR program was approximately $7,500 in 2013, which is roughly $9,905 in 2023 dollars (before rebates; Jacobsohn, Moriarta, and Khowailed 2013).

[25] In economic terms, spreading out these costs over five years is equivalent to reducing the cost because of inflation. The average person generally perceives immediate costs as less desirable than future costs but are unlikely to do this type of mental arithmetic *per se.*

Table 6. Finance framing scenarios

	Scenario	Text
1	Control	[No financial incentives mentioned.] **Total cost would be $16,310.**
2	Potential rebates	The assessor informs you that these upgrades would cost **$16,310**, but he also **offers to look into whether you might qualify for rebates** that could reduce the cost of these upgrades.
3	Specific customer rebate	The assessor informs you that these upgrades would cost **$19,500 upfront**, but he is **aware of a rebate you can apply for** after the work is done to **get back $3,250**. That means these upgrades would in **total cost $16,310**.
4	Specific rebate to reduce upfront cost	The assessor informs you that these upgrades would **normally cost $19,500 upfront**, but he is **aware of a rebate** people can apply for after the work is done to **get back $3,250**. He **offers to cover the $3,250 upfront and claim the rebate for you**, so you **don't have to pay as much at the beginning**. That means these upgrades would in **total cost $16,310**.
5	Specific tax credit	The assessor informs you that these upgrades would cost

	Scenario	Text
		$19,500 upfront, but he is **aware of a tax credit you can apply for** after the work is done to get **a $3,250 reduction in the amount of tax you owe next year**. That means these upgrades would in **total cost $16,310**.
6	Zero-interest loan	The assessor informs you that these upgrades would cost **$16,310**, but he is aware of a **zero-interest loan you can apply for** and that you **don't have to pay for anything upfront**. The upgrades would in **total cost $16,310**, but you could **pay for the upgrades over the next five years**.

Each of the financial incentive scenarios was realistic (modeled off the maximum IRA tax credit value for the upgrades) and theoretically useful for encouraging comprehensive upgrades. For example, research on plug-in EV incentives suggests that although all incentives can encourage adoption, those that reduce costs earlier in the purchase process (e.g., reducing sticker price) are most effective, and those that reduce costs later (e.g., tax credits) are least effective (Hardman et al. 2017). This is possibly because of hyperbolic discounting, which is the idea that people perceive things as more valuable when they are received right away. Zero-interest loans may also be appealing because of a sort of reverse hyperbolic discounting—that is, costs seem lower when they can be paid off in the future. They also allow for smaller payments, which may reduce the psychological pain of payments (i.e., they may make the price seem more manageable).

Findings

As expected, when no incentives were presented to homeowners (control condition), they expressed the lowest interest in doing the full suite of upgrades. Interestingly, however, for our specific suite of upgrades, suggesting that rebates might be available (scenario 2), describing the specific IRA rebates (scenario 3), and even offering to claim the rebate to reduce upfront costs (scenario 4) did not lead to statistically significant increases in homeowner willingness to purchase the full suite of upgrades. Indeed, describing the specific rebate amounts (scenario 2) and offering to claim the rebate (scenario 3) produced nearly the exact same willingness to upgrade as presenting no incentives at all. The tax credit (scenario 5) also performed no better.

As figure 3 shows, only the no-upfront cost/no-interest loan increased homeowner willingness to purchase the suite of recommended upgrades (scenario 6). Willingness to upgrade in this scenario was not only higher than the control condition, but also higher than all other conditions except for the scenario in which the contractor promises to "look into potential rebates" (this condition is lower but not statistically significantly lower than the no-upfront costs/no-interest loan). Possibly, combining the no-upfront cost/no-interest loan with additional rebates could further increase uptake, but we did not test this condition.[26]

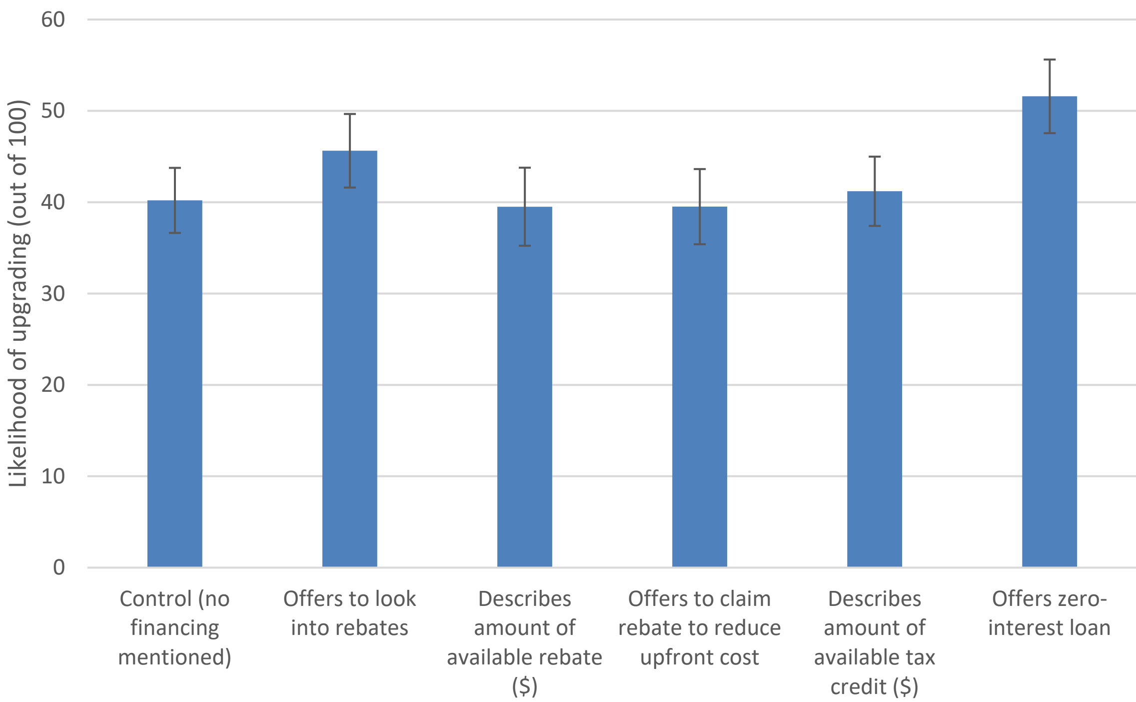

Figure 3. The likelihood of investing in a suite of upgrades (attic insulation, heat pump heating/cooling, and heat pump hot-water heater) after hearing about options for reducing costs. After applying any of the incentives, the costs were the same in each scenario ($16,310). Only the zero-interest loans option significantly increased the likelihood of upgrading. Error bars indicate 95% confidence intervals.

[26] On their own, rebates did not significantly change decision making in our experiment, but it is possible that in combination with this type of loan, rebates could further shift behavior.

An alternative interpretation of our results is that consumers are acting rationally by choosing the options that reduce the inflation-adjusted price below $16,310. In scenario 2, consumers are told that the contractor will "look into" potential rebates beyond the $16,310 price tag, meaning that the price *may* be reduced to being lower than the other conditions. In scenario 6, economic analysis would show that the actual total cost, after inflation, would be lower if the costs are paid over five years without interest. Although consumers tend not to engage in these types of mental calculations when making purchase decisions, their decision making could suggest that they are acting rationally by responding to scenarios with the lowest price. Regardless, the experiment demonstrates that in this particular expensive-but-realistic scenario with realistic financing/incentives, homeowners find a no-upfront cost/no-interest loan most appealing.

COMPREHENSIVE RETROFITS ARE EXPENSIVE: OFFER NO-INTEREST LOANS WITH NO UPFRONT COSTS

In our research and in expert interviews, we were able to confirm that getting commitment to comprehensive upgrades (as opposed to individual upgrades) is challenging primarily because the price is high. Upfront costs for comprehensive upgrades are expensive for most homeowners, even after substantial IRA rebates (except for low-income provisions that cover 100% of costs for select customers, which was not tested here). These types of rebates will make an impact on lower-cost upgrade packages, but we recommend pairing them with financing options for higher-cost comprehensive retrofits.

Providing a no-interest loan with no upfront costs (or a similar financial option) may therefore be the only option that is particularly attractive. PG&E's Energy Efficiency Financing Program and the Mass Save® HEAT Loan are two examples that offer no-interest loans (PG&E 2024; Mass Save 2022). Despite customers generally preferring any financial incentives over loans (Zhao et al. 2012), loans were attractive in this case because they came with no interest and overcame the even greater barrier of upfront costs.

Notably, we found no significant difference between contractors offering to claim the rebate on behalf of customers and contractors directing customers to apply for the rebate themselves. This may have an effect for one-off or less expensive upgrades, but it did not for above-average comprehensive upgrades, such as those in our scenario, which tend to be pricier.

This suggests that the standard incentives provided by the IRA legislation tax credits may be insufficient on their own to reduce comprehensive retrofit prices to manageable levels for the average homeowner. The High-Efficiency Electric Home Rebate Program can, in some cases, provide higher rebates, but unless the price is dramatically reduced, these types of above-average upgrades will be challenging for most homeowners to afford. Additional incentives and/or financing options that eliminate upfront costs will help. IRA incentives (and similar initiatives) are critically important for encouraging upgrades, but they should be paired with affordable loans or expanded to provide more assistance to moderate-income households.

CURRENTLY AVAILABLE SPECIALIZED FINANCING OPTIONS

Although in our experiment, zero-interest loans with no upfront costs were most effective, these types of programs are currently scarce in the United States. More commonly, states leverage their limited capital—and attract private capital—to provide low-interest loans (below market rate). These loans may be less preferred by homeowners than interest-free loans, but they can be provided to a larger number of households and thus have a potentially larger impact. For example, Michigan Saves and Maryland's BeSMART Energy Efficiency Loan programs offer loans at much less than the market rate (Michigan Saves 2023; Maryland Department of Housing and Community Development 2024). Tennessee Valley Authority's low-interest energy efficiency loan program requires no upfront cost from homeowners for energy upgrades (TVA EnergyRight 2024).

Beyond conventional banks and lending practices, there are specialized financing options made available by utilities, specialized lenders, and energy efficiency programs to help homeowners pay for more costly energy efficiency home improvements. Utility providers may offer efficiency as a service, a financing model where homeowners pay for energy efficiency upgrades through a subscription-like service (Gillham et al. 2023; Henner and Howard 2022; De Tommasi et al. 2022; Cleary and Palmer 2019).

In addition to utilities, an increasing number of green banks are emerging (U.S. EPA 2022). These specialized financing organizations, which are often public or nonprofit, leverage both public and private funds to promote clean energy projects. Green banks provide various financial services, including credit enhancements and co-investments, often offering loans with interest rates lower than the market average (U.S. EPA 2022). Thanks to recent funding opportunities offered by the Environmental Protection Agency's National Clean Investment Fund, national green lenders are set to receive extra financial support in the near future. This support has the potential to broaden access to capital for a wider range of individuals, businesses, and communities looking to invest in cost-saving and pollution-reducing clean technology projects.

Recommendations

A major increase in comprehensive retrofits of existing homes is necessary to avoid catastrophic climate change and to improve living conditions for millions of Americans. Recently implemented government incentives for residential energy upgrades (e.g., IRA provisions) are a critical step for meeting this goal, but these incentives will fall short without deliberate and systematic strategies for maximizing uptake. Behavioral science can help identify these strategies by tailoring messaging to distinct segments of homeowners.

City and state energy offices, contractors, and program administrators looking to encourage comprehensive upgrades can use the findings from this research to market their energy upgrade programs and teach contractors a few tips for going beyond a single upgrade to more comprehensive upgrades.

Who to Engage

Unsurprisingly, given the high cost of comprehensive upgrades, higher income homeowners—who are likely to have more formal education and live in larger homes than lower-income segments—were the most likely to be willing to invest a nontrivial amount of money (>$1,000) in energy retrofits. Similarly, those considering an EV purchase (or who already own an EV) and those who have already done at least one home energy upgrade are more likely to want comprehensive retrofits.

What Matters to Different People

Nearly all homeowners cite total costs of upgrading, bill savings, and home comfort as the most important reasons to upgrade (or not upgrade) their homes. However, some homeowners differ in the relative importance they assign to these and other factors. For example, cost and savings are particularly important to low-income homeowners, while high-income, high-education households may also value an improvement in property value and a chance to install new smart technologies (which they may view as luxury home improvements). Also, EV purchasers (or intended purchasers) often assign higher value than other segments to energy upgrade benefits such as noise reduction, environmental impact, property value, convenience, healthier indoor environment, and the opportunity to install new smart technology.

For homeowners who have lived in their homes for a long time (20 years or more) or are likely to continue to live in their homes for a long time (indefinitely, or at least 20 years), messages should avoid focusing on how energy efficiency increases property value or how it provides an opportunity to install new smart technologies. As with other groups, messages about bill savings, increased home comfort, and mitigating total costs will likely be most effective.

Republicans and homeowners in the South are less likely to respond to messages about the positive impact of energy efficiency on the environment. Instead, consider focusing on comfort, energy bill reductions, and mitigating total costs.

What to Offer

When nothing is known about the homeowner, three items generally make comprehensive retrofit packages particularly appealing: heating and cooling systems upgrades, heat pump hot-water heaters, and appliance upgrades. Insulation is also sometimes appealing, while windows are rarely selected. We tried adding some nontraditional items to packages (rooftop solar and EV charger), but these were not appealing to most homeowners considering comprehensive energy upgrades.

After removing the group of homeowners who were unwilling to spend at least $1,000, as well as a class of homeowners that did not show a clear pattern of decision making, we determined five likely homeowner archetypes:

1. Not Interested in Comprehensive Retrofits; Just Appliance Upgrades and Definitely Not Solar (28% of interested homeowners)
2. Upgrade My Mechanical Systems … and Maybe Some Other Things, Too (26% of interested homeowners)
3. Give Me Energy Independence; Solar, EV Charger, and Energy Efficiency (17% of interested homeowners)
4. Reduce My Energy Consumption to the Max; Traditional Comprehensive Energy Efficiency (17% of interested homeowners)
5. Upgrade My Mechanical Systems … and That's All; Especially Not Solar, EV Charging, or Windows (12% of interested homeowners)

Homeowners also differed in their preferred packages based on income and education, number of years in the home, EV ownership, and political party identification. Generally, they all preferred HVAC upgrades, hot-water heater upgrades, and appliance upgrades, but some also preferred other options (see the "What Are the Most Appealing Comprehensive Retrofit Packages?" section).

How to Offer Comprehensive Upgrades

We conducted three experiments to test hypothetical scenarios in which contractors recommended comprehensive energy upgrade packages to homeowners. Each experiment suggested one or more ways to improve the odds of homeowners saying yes to comprehensive upgrades.

Capitalize on trigger points directly related to retrofit opportunities or to moving into a new house

In a scenario for encouraging heat pump upgrades, trigger points related to replacing an existing HVAC (either because it broke or because of a planned retirement) caused the biggest increase in willingness to upgrade. Fixing the space that might house the homeowner's aging HVAC system (the basement, in our scenario) was also an effective trigger point, as was moving into a new house. However, smaller HVAC-related events, such as annual tune-ups, and unrelated home improvements, such as kitchen remodeling, did not significantly influence homeowners' willingness to upgrade. These findings align with previous research that suggests homeowners may prefer to address energy efficiency room-by-room rather than embracing whole-house retrofits (ESF 2011).

Present financial incentives such as no-interest loans with no upfront costs

In a scenario testing financial incentives for slightly above average (but still common) comprehensive retrofits (combining hot-water heater, HVAC, and insulation upgrades), we learned that no-interest loans with no upfront costs made upgrading more likely. Rebates, such as those provided by IRA, are helpful for encouraging home upgrades, especially for average or lower-cost upgrade packages. However, more expensive comprehensive packages (such as those in our scenario) should be paired with a financing option. In our scenario, rebates and tax credits on their own did not significantly move homeowners to invest in upgrade packages.

In terms of market-rate homeowners, IRA provisions are likely to be particularly effective for those with the monetary means to invest in some upgrades but who need a financial boost to do them immediately, as well as to increase the scope to make the improvements comprehensive. Although not tested in our experiments, combining IRA provisions with zero-interest loans could enhance the provisions' effectiveness and maximize their impact. These IRA provisions could also be well suited for income-qualified homeowners who are able to get the maximum rebates from the provisions (sometimes reducing costs to $0; these customers were not a focus of this report, however).

BUILD PACKAGES STEP-BY-STEP

A stepwise foot-in-the-door approach (i.e., suggesting "one more thing" to homeowners), could be an effective way to encourage homeowners to move from single upgrades to comprehensive measures. In our scenario, a homeowner planned for whole-home window replacement and was encouraged to move to additional energy upgrades, through step-by-step additions. Offering full packages at the outset is also effective, but it risks missing homeowners who would be willing to consider one more upgrade but not comprehensive packages. The step-by-step strategy should be tested in the field, as it could be a promising method for homeowners who did not initially reach out to get a home energy assessment.

LIMITATIONS OF USING AN ONLINE SURVEY

The goal of our survey was to demonstrate what is possible in a way that complements on-the-ground action to improve uptake of comprehensive retrofits. Using a few realistic scenarios allowed us to create this proof of concept, but the work must now be taken out of the lab and into the field to learn how well these findings map onto real-world situations.

POLICY RECOMMENDATIONS

Incentives can be used to push consumers to purchase items they might not otherwise be inclined to buy. Indeed, every upgrade—and especially comprehensive packages of upgrades—could benefit from additional incentives. Our DCE findings, combined with our open-ended question about homeowner preferences, our interviews with experts, and our examination of previous literature, suggest that insulation would particularly benefit from additional incentives, as it is preferred in isolation but not as part of a package. Customers would strongly respond to incentives for this upgrade.

Windows and solar are similarly preferred by customers in isolation but not in packages (likely because they greatly increase package costs). However, the cost per carbon avoided for these technologies is low and, as such, they generally should not be further incentivized. Although our experiment suggests that additional incentives would likely have a strong effect on uptake for these upgrades, incentive dollars would not stretch as far or have as great an impact from an energy, carbon, or bill-savings perspective.

Policymakers should consider modifying incentive eligibility requirements to provide more help to moderate-income households. The IRA legislation (and similar efforts) provide low-income homeowners with substantial incentives for energy upgrades that are significantly higher than incentives would be for non-low-income households. The benefit to low-income homeowners is greatly needed and an important contribution of the legislation. However, the rigid income cutoffs mean that homeowners who only barely miss that cutoff receive substantially lower rebates. As we note from this research, this lower rebate is insufficient to encourage many homeowners to upgrade. We suggest instead using a sliding income scale for eligibility that provides most assistance to lower-income homeowners, but still offers a large amount of assistance to moderate-income homeowners as well. In such a system, the rebate amount would decline as income increases.

Alternatively, modifying building energy codes, building performance standards, and other mandates required for home renovations could be another way to drive comprehensive upgrades (although this approach is more difficult to implement than offering incentives).

As we discussed earlier, no-interest loans with no upfront costs (and similar mechanisms) may also effectively push homeowners toward investing in comprehensive upgrades. Such mechanisms can have the side benefit of enabling other strategies as well, including foot-in-the-door and upselling. According to research from 2014, the French government's 0% interest rate for energy upgrades at the time was perceived by contractors as a strategic tool for upselling additional energy upgrades. Through interviews with French contractor firms, the researchers determined that the loan essentially functioned as a facilitator for the contractors to employ the foot-in-the-door approach to encourage customers who had initiated home improvement projects to incorporate additional low-carbon measures once the initial home improvement project had begun (Killip, Fawcett and Janda 2014).

CHANGING THE BUSINESS MODEL

Comprehensive retrofits face considerable structural challenges in the prevailing atomized business model (Brown et al. 2018). To implement the effective practices we have identified, contractors may need to substantially adjust their business models. Most notably, having the capability to provide a comprehensive range of upgrades will become increasingly essential for expediting the adoption of comprehensive-level energy retrofits (Bertoldi et al. 2021). The following programs have successfully implemented strategies aligned with our recommendations.

Fort Collins Utilities

Fort Collins Utilities' Epic Homes is an innovative program that seamlessly integrates financing options, a one-stop-shop business model, a contractor network, and utility services to accelerate clean energy projects and improve health in the community. The program provides low-interest financing not just for whole-home energy efficiency retrofits but also for rooftop solar and water conservation projects. Through its partnerships with Fort Collins Efficiency Works and CARE, Epic Homes provides free energy audits to low-income households and provides access to a shared contractor network used by other Fort Collins' energy efficiency programs (City of Fort Collins 2023). Epic Homes' Loan Program offers customers an on-bill loan option, granting them access to no-money-down financing at 0% or low-interest rates for energy efficiency improvements and solar projects up to $50,000. This program, with its convenient access to contractors, complimentary energy audits, and comprehensive financing options, closely aligns with our research findings (EESI 2023).

Mass Save

Mass Save is an energy efficiency program in Massachusetts that provides a range of resources, including rebates, incentives, training, and support, to facilitate energy efficiency upgrades for residents and businesses. Mass Save offers no-cost virtual or in-home energy assessments, a critical step in qualifying for incentives and equipment rebates (Mass Save 2023a). Following the assessment, individuals receive a personalized energy savings plan outlining recommended upgrades based on their specific needs and results. One of the most attractive aspects of the program is the Mass Save HEAT Loan, which offers homeowners zero-interest financing opportunities for energy efficiency improvements such as insulation, heat pumps, heat pump water heaters, window replacements, and battery storage.

The Mass Save program stands out as a bright spot in its alignment with our research findings. Homeowners are most inclined to consider comprehensive retrofits when they have access to zero-interest loans and incur no upfront costs. These features allow the program to significantly enhance the appeal of energy-efficient upgrades while making them accessible to a wider audience.

Efficiency Vermont

Efficiency Vermont stands out in the field of energy efficiency and retrofit programs due to its multifaceted approach, effectively addressing behavioral barriers and enabling Vermonters to invest in energy efficiency. The program offers an array of loan options, some with 0% interest, allowing homeowners to easily finance various energy-related projects. Its Home Energy Loan program provides flexible financing for weatherization and heating improvements, encompassing a wide range of enhancements from heat pumps to insulation and solar water heaters. Efficiency Vermont also excels in providing comprehensive energy assessments, objective third-party advice and support, and committed education and outreach to foster a deeper understanding of energy efficiency throughout Vermont. Moreover, the program’s income-based assistance initiatives ensure that even low-income individuals and families get the level of financial assistance they need to upgrade their homes. This helps energy efficiency benefit everyone, regardless of financial situation.

Discussion and Conclusion

Taken together, our results suggest that comprehensive retrofits are a tough sell, but recommending the right package to the right people at the right time can help significantly. Even after existing rebates and credits are included, the costs of upgrading are out of reach for many homeowners. Indeed, although 65% of our sample reported a willingness to spend at least $1,000 on upgrades, for the other 35%, comprehensive retrofits remain out of reach. IRA provisions help address low-income homeowners who are unable to invest, but a large and important segment of other homeowners nevertheless remains unable to upgrade. Future policies and programs should address this issue by decreasing rebates proportionally by income, rather than employing strict low-income cutoffs for the biggest rebates. However, given current constraints on IRA provisions, creative solutions are needed now. Such solutions might include no-interest loans with $0 upfront, staggering projects to take advantage of tax and other credits year over year, and offering homeowners a variety of upgrade options easily through a sort of general contractor approach.

Creating upgrade packages that appeal to specific demographics may also help. Comprehensive packages that included efficient water heating, heating/cooling, and appliance upgrades were selected most often in our study. Those with windows, rooftop solar, and EV charging were selected significantly less frequently (likely because they are less applicable to many homeowners). Nevertheless, windows and solar may be attractive on their own, and some homeowners (about 17% of interested homeowners in our study) were moved by having EV charging and rooftop solar included in upgrade packages. This shows why listening to customers and being able to address their home energy interests and concerns (even when they might involve non-efficiency improvements) can lead to more upgrades.

Marketing and outreach efforts should also respond to homeowner barriers and drivers of upgrading. As identified in previous research (e.g., Sussman and Chikumbo 2017), total costs, projected savings, and comfort are of primary importance to nearly everyone in our sample. That said, other factors, such as interest in new smart technology, can differentiate some groups from others in subtle ways that can be used to better tailor campaigns. Approaching customers after key trigger points, such as the need to replace an HVAC system or household windows, can also improve the chances of doing comprehensive upgrades, especially when paired with a stepwise foot-in-the-door strategy for building comprehensive packages.

Overall, this paper provides several proofs-of-concept of what could work to improve comprehensive upgrade efforts using behavioral science. The time to test these out in the field is now. Unprecedented financial incentives are being offered now and into the future through IRA provisions, and U.S. state energy offices and energy efficiency program administrators are therefore poised to make giant leaps in improving existing buildings. We hope that this report will help make the most of these opportunities.

References

Achtnicht, Martin. 2011. "Do environmental benefits matter? Evidence from a choice experiment among house owners in Germany." *Ecological Economics*, *70*(11), pp.2191-2200. https://doi.org/10.1016/j.ecolecon.2011.06.026

Achtnicht, Martin, and Reinhard Madlener. 2014. "Factors Influencing German House Owners' Preferences on Energy Retrofits." *Energy Policy* 68 (May): 254–63. doi.org/10.1016/j.enpol.2014.01.006.

Bakaloglou, Salomé, and Fateh Belaïd. 2022. "The Role of Uncertainty in Shaping Individual Preferences for Residential Energy Renovation Decisions." *The Energy Journal* 43 (4). dx.doi.org/10.5547/01956574.43.4.sbak.

Banfi, Silvia, Mehdi Farsi, Massimo Filippini, and Martin Jakob. 2008. "Willingness to pay for energy-saving measures in residential buildings." *Energy economics* 30 (2): 503-516. https://doi.org/10.1016/j.eneco.2006.06.001

Bertoldi, Paolo, Benigna Boza-Kiss, Nives Della Valle, and Marina Economidou. 2021. "The Role of One-Stop Shops in Energy Renovation - a Comparative Analysis of OSSs Cases in Europe." *Energy and Buildings* 250 (November): 111273. doi.org/10.1016/j.enbuild.2021.111273.

Brown, Donal, Paula Kivimaa, Jan Rosenow, and Mari Martiskainen. 2018. "Overcoming the Systemic Challenges of Retrofitting Residential Buildings in the United Kingdom: A Herculean Task?" *Transitions in Energy Efficiency and Demand*. Milton Park, UK: Routledge. www.taylorfrancis.com/chapters/oa-edit/10.4324/9781351127264-7/overcoming-systemic-challenges-retrofitting-residential-buildings-united-kingdom-donal-brown-paula-kivimaa-jan-rosenow-mari-martiskainen.

D'Alpaos, Chiara, and Paolo Bragolusi. 2018. "Buildings Energy Retrofit Valuation Approaches: State of the Art and Future Perspectives." *Valori e Valutazioni* 20: 79–92. www.proquest.com/openview/c1a2969577664a2c4c8035cd47839d08/1?pq-origsite=gscholar&cbl=5051204.

Census Bureau. 2022. "American Housing Survey." www.census.gov/AHS..

City of Fort Collins. 2023. "Utilities: Epic Homes." Accessed October. www.fcgov.com/utilities/epichomes.

Cleary, Kathryne, and Karen Palmer. 2019. "Energy-as-a-Service: A Business Model for Expanding Deployment of Low-Carbon Technologies." Resources for the Future. www.rff.org/publications/issue-briefs/energy-service-business-model-expanding-deployment-low-carbon-technologies/.

Cluett, Rachel, and Jennifer Amann. 2014. *Residential Deep Energy Retrofits*. Washington, DC: ACEEE. www.aceee.org/research-report/a1401.

Cosgrove, Erin. 2023. "How States Can Grow Equitable Efficiency Programs with the Revolving Loan Fund." *Northeast Energy Efficiency Partnerships Blog*, March 27, 2023, neep.org/blog/how-states-can-grow-equitable-efficiency-programs-revolving-loan-fund.

Deleniv, Sofia. 2023. "Identifying Key Drivers and Barriers of Heat Pump Adoption in Canada." Presentation to Behavioral Science and Policy Association, May 5.

de Vries, Ger, Mariëlle Rietkerk, and Renee Kooger. 2020. "The Hassle Factor as a Psychological Barrier to a Green Home." *Journal of Consumer Policy* 43 (2): 345–52. doi.org/10.1007/s10603-019-09410-7.

DOE (Department of Energy). 2012. "Home Performance Contractor Business Model." *Better Buildings Neighborhood Program Business Models Guide*. Washington, DC: DOE. www1.eere.energy.gov/buildings/betterbuildings/neighborhoods/pdfs/bbnp_business_models_guide.pdf.

EESI (Environmental and Energy Study Institute). 2023. "Colorado: Fort Collins Utilities Epic Homes Program." Accessed October. www.eesi.org/obf/case-study/FortCollins.

EPA (Environmental Protection Agency). 2023greenb. "Green Banks." www.epa.gov/statelocalenergy/green-banks.

EST (Energy Saving Trust). 2011, "Trigger points: a convenient truth Promoting energy efficiency in the home." UK Department of Energy and Climate Change. Accessed March 28, 2024. http://btckstorage.blob.core.windows.net/site621/EST%20GD%20Trigger%20Points%20report%202011%5B1%5D.pdf.

Fawcett, Tina. 2014. "Exploring the Time Dimension of Low Carbon Retrofit: Owner-Occupied Housing." *Building Research & Information* 42 (4): 477–88. doi.org/10.1080/09613218.2013.804769.

Fernandez-Luzuriaga, Jon, Iván Flores-Abascal, Luis del Portillo-Valdes, Petr Mariel, and David Hoyos. 2022. "Accounting for Homeowners' Decisions to Insulate: A Discrete Choice Model Approach in Spain." *Energy and Buildings* 273 (October): 112417. doi.org/10.1016/j.enbuild.2022.112417.

Galassi, Veronica, and Reinhard Madlener. 2017. "The Role of Environmental Concern and Comfort Expectations in Energy Retrofit Decisions." *Ecological Economics* 141 (November): 53–65. doi.org/10.1016/j.ecolecon.2017.05.021.

Greene, David L. 2010. *How Consumers Value Fuel Economy: A Literature Review*. EPA-420-R-10-008. Prepared by Oak Ridge National Laboratory. Washington, DC: EPA. nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1006V0O.txt.

Henner, Nick, and Bryan Howard. 2022. Utilities and Energy Efficiency as a Service: The Potential for Win-Win Partnerships. Washington, DC: American Council for an Energy-Efficient Economy. https://www.aceee.org/research-report/u2203.

Jacobsohn, Eli, Courtney Moriarta, and Gannate Khowailed. 2013. "Overview of Home Performance with ENERGY STAR Results." Department of Energy, Office of Energy Efficiency and Renewable Energy. Accessed on March 19, 2024, https://www.energystar.gov/ia/home_improvement/downloads/HPwES_Results_ACI2014_for_ACI.pdf.

Judson, Ellis P., and Cecily Maller. 2014. "Housing Renovations and Energy Efficiency: Insights from Homeowners' Practices." *Building Research & Information* 42 (4): 501–11. doi.org/10.1080/09613218.2014.894808.

Killip, Gavin, Tina Fawcett, and Kathryn B. Janda. 2014. "Innovation in Low-Energy Residential Renovation: UK and France." *Proceedings of the Institution of Civil Engineers - Energy* 167 (3): 117–24. doi.org/10.1680/ener.14.00011.

Klöckner, Christian A., and Alim Nayum. 2016. "Specific Barriers and Drivers in Different Stages of Decision-Making about Energy Efficiency Upgrades in Private Homes." *Frontiers in Psychology* 7: 1382. www.frontiersin.org/articles/10.3389/fpsyg.2016.01362.

Kormos, Christine, and Robert Gifford. 2014. "The Validity of Self-Report Measures of Proenvironmental Behavior: A Meta-Analytic Review." *Journal of Environmental Psychology* 40 (December): 359–71. www.sciencedirect.com/science/article/abs/pii/S0272494414000851

Less, Brandon, Ian Walker, Nuria Casquero-Modrego, and Leo Rainer. 2021. "The cost of decarbonization and energy upgrade retrofits for US homes." Lawrence Berkeley National Lab.(LBNL), Berkeley, CA (United States). https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf

Loomis, John. 2011. "What's to Know About Hypothetical Bias in Stated Preference Valuation Studies?" *Journal of Economic Surveys*, 25 (2): 363–70. doi.org/10.1111/j.1467-6419.2010.00675.x.

Maryland Department of Housing and Community Development. 2024. "BeSMART Energy Efficiency Loan for Homeowners," Accessed February. dhcd.maryland.gov/Residents/Pages/besmart/default.aspx.

Mass Save. 2023a. "Residential Programs & Services." www.masssave.com/en/residential/programs-and-services.

———. 2023b. "Residential Services: 0% Interest Financing." www.masssave.com/en/residential/rebates-and-incentives/heat-loan-program.

Michigan Saves. 2023. "Home Improvement Loans for an Energy-Modern Home." Accessed September. michigansaves.org/residential-homes/ - how-it-works.

Noonan, Douglas S., Lin-Han Chiang Hsieh, and Daniel Matisoff. 2013. "Spatial Effects in Energy-Efficient Residential HVAC Technology Adoption." *Environment and Behavior* 45 (4): 476–503. doi.org/10.1177/0013916511421664.

Palmer, Karen, Margaret Walls, Hal Gordon, and Todd Gerarden. 2013. "Assessing the Energy-Efficiency Information Gap: Results from a Survey of Home Energy Auditors." *Energy Efficiency* 6 (2): 271–92. link.springer.com/article/10.1007/s12053-012-9178-2.

Petersen, Sebastian, Géraldine Henningsen, and Arne Henningsen. 2017. "Encouraging Residential Energy Efficiency Improvements." Technical University of Denmark. orbit.dtu.dk/files/158815427/1_Thesis.pdf#page=112.

PG&E (Pacific Gas and Electric Company). 2024. "Energy Efficiency Financing (EEF)." www.pge.com/en/save-energy-and-money/energy-saving-programs/energy-efficiency-programs-for-businesses/energy-efficiency-financing.html - accordion-ead1344b8b-item-96517b690d.

Rao, John. 2017. "Residential Property Assessed Clean Energy (PACE) Loans: The Perils of Easy Money for Clean Energy Improvements." NCLC (National Consumer Law Center). www.nclc.org/resources/residential-pace-loans-the-perils-of-easy-money-for-clean-energy-improvements/.

Research Into Action. 2015. *2012–2013 Home Performance with ENERGY STAR® Process Evaluation/Market Characterization Assessment.* Albany: NYSERDA (New York State Energy Research and Development Authority). www.nyserda.ny.gov/-/media/Project/Nyserda/Files/Publications/PPSER/Program-Evaluation/2015ContractorReports/2012-2013-HPwES-Process-Evaluation-Market-Characterization-Assessment-FinalReport.pdf.

Sussman, Reuven, and Maxine Chikumbo. 2017. *How to Talk about Home Energy Upgrades*. Washington, DC: ACEEE. www.aceee.org/research-report/b1701.

Sussman, Reuven, Maxine Chikumbo, and Natalia Miller. 2019. *After the Audit: Improving Residential Energy Efficiency Assessment Reports*. Washington, DC: ACEEE. www.aceee.org/research-report/b1901.

Sussman, Reuven, Hannah Bastian, Steven Conrad, Emma Cooper, Elizabeth Tong, Ang Sherpa, and Shiva Pourfalatoun. 2022. *Energy Labels Affect Behavior on Rental Listing Websites: A Controlled Experiment*. Washington, DC: ACEEE. https://www.aceee.org/research-report/b2204.

TVA (Tennessee Valley Authority) EnergyRight. 2024. "Residential: Financing." Accessed February. energyright.com/residential/financing/.

Ungar, Lowell, and Steven Nadel. 2022. "Home Energy Upgrade Incentives: Programs in the Inflation Reduction Act and Other Recent Federal Laws." ACEEE. aceee.org/policy-brief/2022/09/home-energy-upgrade-incentives-programs-inflation-reduction-act-and-other.

Verplanken, Bas, Ian Walker, Adrian Davis, and Michaela Jurasek. 2008. "Context Change and Travel Mode Choice: Combining the Habit Discontinuity and Self-Activation Hypotheses." *Journal of Environmental Psychology* 28 (2): 121–27. doi.org/10.1016/j.jenvp.2007.10.005.

Wilson, Charlie, Leah Crane, and George Chryssochoidis. 2015. "Why Do Homeowners Renovate Energy Efficiently? Contrasting Perspectives and Implications for Policy." *Energy Research & Social Science* 7 (May): 12–22. doi.org/10.1016/j.erss.2015.03.002.

Zaunbrecher, Barbara S., Katrin Arning, Julian Halbey, and Martina Ziefle. 2021. "Intermediaries as Gatekeepers and Their Role in Retrofit Decisions of House Owners." *Energy Research & Social Science* 74 (April): 101939. doi.org/10.1016/j.erss.2021.101939.

Zhao, Tingting, Lindsey Bell, Mark W. Horner, John Sulik, and Jinfeng Zhang. 2012. "Consumer Responses towards Home Energy Financial Incentives: A Survey-Based Study." *Energy Policy* 47 (August): 291–97. doi.org/10.1016/j.enpol.2012.04.070.

Appendix A. Participants

RECRUITMENT

We collaborated with ROI Rocket, a panel research company, to assemble a nationally representative sample of 1,500 homeowners. During the data collection phase, we received survey responses from a total of 5,754 participants. However, 4,254 of these responses were excluded from our analyses for various reasons. Specifically, 1,273 respondents did not meet our predetermined inclusion criteria;[27] 2,517 were disqualified due to quota restrictions for achieving a nationally representative sample; 353 responses were incomplete; and we manually disqualified an additional 111 responses due to data quality issues or exceptionally rapid survey completion times.[28] Consequently, our final dataset for analysis comprised 1,500 homeowners, which we determined a-priori would provide sufficient power to run our planned statistical analyses.

When we compared our sample to the broader U.S. homeowner population, we observed a slight underrepresentation of homeowners with high school education or less (13% in our sample, 27% in U.S. population) and who were of Hispanic, Latinx, or Spanish origin (3% in our sample versus 11% in the United States). The sample was roughly equally distributed among the four major U.S. census regions (Midwest 25%, Northeast 25%, South 27%, and West 21%). As the tables below show, our study sample's characteristics are representative of the larger population of U.S. homeowners.

[27] Participants had to be homeowners residing in the continental United States, proficient in English, and age 18 or older. We excluded individuals employed in marketing, advertising, public relations, or those working for environmental organizations or utility providers. Additionally, participants had to own a single-family detached home, duplex, rowhouse, townhouse, manufactured/mobile home, or a condominium/apartment structure with no more than six units.

[28] We excluded certain responses from our analysis using the following criteria: a) completion times less than 7.5 minutes (half the expected completion time); b) nonsensical answers, such as random letters and numbers or assuming the cost of comprehensive retrofits is zero dollars; c) write-in responses that did not address the question; and d) responses that followed a straight-line pattern.

DEMOGRAPHICS

Table A1. Gender distribution

Gender	No. in sample	% of sample	% of U.S. population
Female	751	50.1%	50.9%
Male	747	49.8%	49.1%
Nonbinary/other	1	0.1%	---

The gender distribution in our study was nearly balanced, comprising 751 females (50.1%) and 747 males (49.8%). A very small percentage identified as nonbinary/other or preferred not to answer, each representing less than 0.1% of the total sample.

Table A2. Home type distribution

Demographic factor	No. in sample	% of sample	% of U.S. population
Condominium/apartment structure with up to six units	32	2.1%	6.3%
Manufactured/mobile home	56	3.7%	6.0%
Row house/townhouse with more than two units	43	2.9%	—
Single-family attached home (e.g., duplex with exactly two units)	34	2.3%	—
Single-family detached home	1,335	89.0%	89.7%

The participants in our study were primarily homeowners of single-family detached homes, accounting for 89% of the sample. These percentages generally align with the housing distribution in the U.S. population, except for manufactured/mobile homes, which were slightly underrepresented in our sample compared to the national population.

Table A3. Education attainment distribution

Highest level of education	No. in sample	% of sample	% of U.S. population
Some high school	9	0.6%	5%
High school graduate	185	12.3%	22%
Two years of college or less	176	11.7%	14%
More than two years of college (without degree completion)	59	3.9%	—
Trade/vocational school	86	5.7%	4%
Two-year college degree (associate degree, etc.)	157	10.5%	10%
Undergraduate degree	408	27.2%	25%
Some graduate school (without degree completion)	92	6.1%	—
Master's degree	268	17.9%	17%
Advanced professional or academic degree (MD, PhD, JD, etc.)	58	3.9%	—

Most participants in our sample held an undergraduate degree, accounting for 27% of the group. This was followed by a significant number of individuals with a master's degree, making up 18% of the sample. Notably, our participant group appears to be more highly educated than the general population, with a larger percentage of master's degree holders than expected. High school graduates were underrepresented, making up just 12.3% of the sample compared to 22% in the national population.

Table A4. Race and ethnicity distribution

Race	No. in sample	% of sample	% of U.S. population
American Indian or Alaska Native	2	0.1%	1%
Asian	68	4.5%	5.1%
Black or African-American	65	4.3%	9.5%
Middle Eastern or Arab American	7	0.5%	—
Mixed race	75	5.0%	1.2%
Native Hawaiian or other Pacific Islander	2	0.1%	0.2%
Other race, ethnicity, or origin	6	0.4%	—
White	1,229	81.9%	82.8%

The racial composition of our sample was predominantly White, representing 82% of the respondents. Comparing our sample to the broader U.S. population, we observed minor differences in the distribution of racial groups. Our sample closely resembled the U.S. population in terms of White and Asian participants but had a lower percentage of Black or African American participants (4.3%) compared to the percentage in the U.S. homeowner population (9.5%).

Table A5. Sample distribution in relation to Hispanic origin

Origin	No. in sample	% of sample	% of U.S. population
Hispanic, Latinx, or Spanish origin	43	2.9%	10.9%
Not of Hispanic, Latinx, or Spanish origin	1,457	97.1%	89.1%

Our sample had a smaller percentage of Hispanic and Latinx participants (2.9%) compared to the percentage in the U.S. homeowner population (10.9%).

Table A6. Census region distribution

Region	No. in sample	% of sample	% of U.S. population
Midwest	373	24.9%	23.0%
Northeast	412	27.5%	16.7%
South	400	26.7%	39.3%
West	315	21.0%	21.0%

Our sample had a roughly equal representation of respondents across all four major census regions (21–28% from each). The states with the highest number of respondents were New York (N = 131) and California (N = 137). Population calculations are based on data from [2022 ACS 1-Year Estimates Data Profiles.]

Table A7. Household income level distribution

Household income level	No. in sample	% of sample	% of U.S. population
Less than $20,000	108	7.2%	11.1%
$20,000–49,999	289	19.3%	20.5%
$50,000–99,999	500	33.3%	29.4%
$100,000–139,999	252	16.8%	16%
$140,000–199,999	187	12.5%	12.1%
$200,000 or more	164	10.9%	10.9%

The most represented income group was $50,000–99,000, which included 33% of respondents. Using the midpoint of income ranges (and $200,000 for highest income group), we estimated the number of

participants that might be considered low income. To do this, we looked at whether each participant was below 200% of Federal Poverty Level by combining income information with household size and state; we then looked up the appropriate level for each combination.

Table A8. Low income distribution

Income group (estimates)	No. in sample	% of sample	% of U.S. population
Low-income	289	19.3%	22%
Not low income	1,210	80.7%	78%

Table A9. Home size distribution

Size of respondent's home	No. in sample	% of sample	% of U.S. population
Up to 1,000 sq. ft.	73	4.9%	9%
1,001–1,500 sq. ft.	329	21.9%	22%
1,501–2,000 sq. ft.	392	26.1%	24%
2,001–2,500 sq. ft.	291	19.4%	17%
2,501–3,000 sq. ft.	190	12.7%	10%
More than 3,000 sq. ft.	226	10.9%	10.5%

After excluding 62 "don't know" responses, the sample data closely resemble the distribution of home sizes in the U.S. population, with most respondents having homes that range from 1,001 to 2,500 sq. ft.

Table A10. Home construction year distribution

Year built	No. in sample	% of sample	% of U.S. population
1940 or earlier	155	10.6%	10.975%
1941–1950	67	4.6%	4.39%
1951–1960	149	10.2%	10%
1961–1970	130	8.9%	10%
1971–1980	189	12.9%	13.943%
1981–1990	198	13.6%	12.81%
1991–2000	219	15.0%	13.628%
2001–2010	194	13.3%	14.999%
2011–2020	132	9.0%	9.077%
2021–present	28	1.9%	---

Overall, our sample was highly representative of the U.S. population in terms of home construction year. The majority of our participants' homes were constructed between 1971 and 2010, meaning that most of our respondents' homes were 13–52 years old at the time of the survey.

Table A11. Age distribution

	Sample mean	U.S. pop. mean
Age (Sample)	57.19	56

The average age of homeowners in our sample was 57 (SD = 14.2), which closely mirrors the U.S. population mean of 56.

Table A12. Household size

	Sample mean	U.S. pop. mean
Number of adults	2.08	—
Number of children	0.42	—
Total household size	2.5	2.57

The average total household size of our sample was about 2.5 people, with approximately 2.1 adults and 0.4 children per household. Approximately 24% of the people who took part in our survey had at least one child living with them, which is close to the U.S. average of 29%.

Table A13. Fuel source

Fuel source	% of sample	% of U.S. population
Electricity	87%	94%
Natural gas	64%	63%
Heating oil	7%	6%

In our survey, 87% of respondents reported using electricity at home and 64% reported using natural gas. The natural gas percentage aligns closely with the 63% of homeowners nationwide. However, 87% for electricity usage was slightly below what might be expected; this could be because respondents interpreted the question as related to specific end uses (e.g., heating) rather than all electricity usage. Propane was used by 9% of participants, while 7% relied on heating oil, and 8% utilized solar energy.

Table A14. EV ownership

EV ownership status	No. in sample	% of sample
"Yes, I own an electric vehicle."	73	4.9%
"I used to own an electric vehicle but no longer do."	6	0.4%
"I'm not sure."	31	2.1%
"No, but I'm considering purchasing one in the near future."	393	26.3%
"No, I have no plans to purchase an electric vehicle."	992	66.4%

Most respondents do not have an EV and do not have plans to purchase one (66%), while 26% do not have one and may purchase one in the near future. Only 5% currently (or used to) own an EV.

Table A15. Political identity

Political affiliation	No. in sample	% of sample
Democratic Party	487	33.6%
Republican Party	484	33.4%
Independent/unaffiliated	427	29.5%
Other	14	1.0%
I don't know /I don't vote in U.S. elections	36	2.5%

After excluding those who preferred not to answer, there was an even split among democrat (33%), republican (33%), and independent/unaffiliated (29%) participants.

Table A16. Number of years in home

Number of years in home	No. in sample	% of sample
Less than 1 year	32	2.1%
1–5 years	262	17.5%
6–10 years	240	16.0%
11–15 years	191	12.7%
16–20 years	165	11.0%
More than 20 years	610	40.7%

A large subset of respondents (41%) indicated they had lived in their current homes for more than 20 years.

Table A17. Number of additional years respondents plan to live in current home

Number of years intending to live in current home	No. in sample	% of sample
Less than 1 more year	27	1.8%
1–5 more years	217	14.5%
6–10 more years	225	15.0%
11–20 more years	186	12.4%

Number of years intending to live in current home	No. in sample	% of sample
At least 20 more years, but I'll probably move eventually	71	4.7%
Indefinitely, I don't plan to move out	628	41.9%
Not sure/undecided	146	9.7%

Most respondents indicated that they plan to live in their home indefinitely (42%), and a substantial minority indicated some uncertainty about how long they would live in their current home. No information on continued residence intentions is available for the general U.S. population in the American Housing Survey or American Consumer Survey.

Table A18. Willingness to spend for efficiency

	No. in sample	Mean	Median	Mode	Std. D	Min.	Max.
All respondents	**1,500**	$5,186.93	$2,000	$5,000	$12,565.81	$0	$300,000

Before we asked questions about energy upgrades, we asked participants how much they would be willing to spend (within a five-year timeframe) for a comprehensive home energy upgrade that could save them 20% on their energy bills. The responses varied significantly, with a notable minority (35%) expressing unwillingness to spend $1,000 or more (including 13% who responded with $0). We categorized this group as "unable or unwilling to invest in energy upgrades."

Table A19. Factors statistically significantly associated with being currently willing to spend at least $1,000 on comprehensive home energy upgrades

Factor	Subgroup	Percentage of homeowners willing and able to invest $1,000 or more	Odds ratio for homeowners willing and able to invest $1,000 or more (odds of yes)
Annual household income	Less than $20,000	47%	0.89
	$20,000–49,000	54%	1.17
	$50,000–99,000	67%	1.95
	$100,000–139,000	73%	2.65
	$140,000–199,000	70%	2.28
	More than $200,000	74%	2.81
Low income (estimated)	Low income	52%	1.09
	Non-low income	68%	2.13
Education	High school or less	59%	1.45
	Trade/vocational/2-yr degree	64%	1.76
	Undergraduate	78%	2.11
	Graduate degree	70%	2.29
Children at home?	Yes	63%	1.71

Factor	Subgroup	Percentage of homeowners willing and able to invest $1,000 or more	Odds ratio for homeowners willing and able to invest $1,000 or more (odds of yes)
	No	71%	2.42
EV ownership/ consideration	Not owning, not considering	59%	1.41
	Own, owned, or considering buying soon	79%	3.72
Home size	up to 1,500 sq. ft.	61%	1.54
	1,501–2,000 sq. ft.	65%	1.84
	2,001–2,500 sq. ft.	71%,	2.42
	2,501 sq. ft. or more	70%	2.3
Previously done home upgrades?	Have done at least one in the past	66%	1.96
	Have not done any in the past	54%	1.19
Remaining number of years living in home	Up to 5 years	68%	2.09
	6–10 years	75%	2.95
	11–20 years	68%	2.15

Factor	Subgroup	Percentage of homeowners willing and able to invest $1,000 or more	Odds ratio for homeowners willing and able to invest $1,000 or more (odds of yes)
	20 years or indefinitely	60%	1.51
Major U.S. census region	Northeast	63%	1.71
	Midwest	60%	1.52
	Southwest	67%	2.03
	West	71%	2.39
Political party	Democratic	70%	2.38
	Republican	58%	1.38
	Independent/unaffiliated	68%	2.16

Prior experience with energy assessments and energy upgrades

Only 21% of survey respondents indicated that they had already received a home energy assessment. Of the remainder, 74% had not received an assessment and the rest said they "don't know" or "prefer not to answer."

Most respondents had already completed three to five upgrades (21% completed three, 19% completed four, and 16% completed five). Only 10% had not completed any upgrades (N = 149), and only 0.6% (N = 6) said they had completed upgrades from all eight categories of possible upgrades.

The home energy upgrades and replacements most frequently mentioned by respondents were appliances (72%), water heaters (62%), heating and/or cooling systems (53%), and windows (48%). Notably, respondents may have interpreted the question as referring to general replacements, not neessarily improvements related to efficiency. We interpret these responses as experience in being in the market for these upgrades, not specifically that they were shopping for energy efficiency upgrades.

Appendix B. Discrete Choice Experiment Method Details

SELECTING ATTRIBUTES AND THE DCE DESIGN

In aiming to design an experiment around retrofits reaching 20% modeled energy savings, our study was unable to explore all possible retrofit measures available in the real choice context. We navigated several critical constraints inherent to discrete choice experiments (DCEs) to ensure the reliability and validity of our study. One key concern was cognitive fatigue. Complex choice sets can make it challenging for respondents to make decisions, and presenting too many choice sets may also overwhelm participants and lead to rushed or inconsistent choices. To address this, we carefully selected attributes and levels for each choice set, aiming for a comprehensive yet manageable representation of potential energy upgrades.

We selected the key attributes for this experiment by consulting a diverse group of experts and examining existing research (Sussman and Chikumbo 2017) to identify the upgrades commonly included in comprehensive home energy retrofits. We consulted 14 experts with diverse backgrounds to gather a range of opinions and ensure that we took a well-rounded approach to determining our focus. These experts spanned various stakeholder groups, including "bright spot" service providers, trade associations, contractors and assessors, program implementers, and green financiers.

Initially, our curiosity about the relationship of energy efficiency measures and other home improvements led us to consider including a variety of nonenergy-efficiency upgrades in the energy package choices. We were particularly interested in exploring whether the inclusion of solar panel installation, solar storage, EV chargers, and induction cooktops would enhance package attractiveness. Additionally, we contemplated adding nonenergy upgrades such as roofing or kitchen renovations to our list of attributes alongside the energy-efficiency measures.

After consulting again with our panel of experts and considering the limitations of designing a DCE, we identified priority questions aligned with our research goals to finalize a set of upgrades exclusively focused on energy-related attributes, prioritizing energy efficiency, renewable energy, and electrification upgrades over architectural and aesthetic improvements.

Once we had determined the shortlist of attributes and levels to include in the experiment, we calculated the optimal number of exposures required for each choice set and the optimal number of choice sets each respondent should be shown to determine the final attribute selection. To streamline the number of choice tasks for respondents, we employed a fractional factorial design, reducing the total number of unique decisions to just 72 pairs of packages to choose from. We then employed a strategic blocking randomization approach, setting up the experiment so that participants were randomized to see one of 12 blocks (or choice sets) of six package decisions.

The final version represents a refined set of energy upgrades and upgrade categories most commonly considered as part of comprehensive home retrofits alongside two electrification energy upgrades: solar panels and EV chargers.

CALCULATING AND DISPLAYING COSTS AND SAVINGS INFORMATION FOR ENERGY UPGRADES

For both the DCE and the other survey experiments, we calculated two types of cost information estimates for all upgrade measures: 1) installation costs, and 2) monetary reductions in monthly energy bills.

We calculated the base costs of energy efficiency upgrades by comparing a variety of data sources, initially deriving these upgrade costs using data from RS Means, reports from Lawrence Berkeley National Laboratory, and technical support documents from the U.S. Department of Energy. Subsequently, we adjusted these median costs for inflation and applied cost reductions based on the expected reduction from the High-Efficiency Electric Home Rebates Program (Ungar and Nadel 2022). We adjusted the costs based on upgrade-specific incentives rather than on the rebates obtained from surpassing the 20% modeled energy savings threshold in order to maintain complete independence among the upgrade attributes, as required by the constraints of this experimental design.

Another constraint of DCEs required that each additional level be more expensive than the lower level(s) of the attribute. For example, when considering the heating and cooling system attribute, the heat pump upgrade had to be priced higher than the cost of replacing either the heating or cooling system alone. Given that the rebate for heat pumps is so substantial (50% off, with a maximum reduction of $8,000 for market-rate consumers), the base price of the heat pump had to be higher than the cost of the average heat pump system; otherwise, after adjusting for the rebate, the heat pump would be cheaper than the first-level option of an individual heating or cooling system upgrade. To address this, we chose to inflate the base heat pump cost to $16,230 in line with a high-end multi-zonal model, with a reduced cost of $8,230 after applying the rebates.

We had to make two other specific cost adjustments for both the appliances and HVAC attributes. First, we had to ask about major appliances as one attribute rather than asking about multiple different types of appliances separately. To obtain singular estimates of base cost and cost savings for the major appliances attribute, we calculated composite numbers that averaged the values across the key major appliances with ENERGY STAR certifications: refrigerators, dishwashers, and clothes washers and dryers. Additionally, because respondents approached the choice context from different experiences with various heating fuels, we calculated our HVAC cost equipment savings using a weighted average of both electric and gas systems.

We obtained a cost estimate from EnergySage for a 7.9-kW solar PV system (assuming an average size home of 1,500–2,000 sq. ft.) from EnergySage. To estimate the potential cost savings for adopting solar in the DCE context, we first established the cost per kilowatt-hour (kWh) at $0.1582, derived from a four-month average of residential electricity costs reported by the U.S. Energy Information Administration (EIA) in its July 2023 monthly energy review.

We then calculated the power typically generated by a 7.9-kW solar PV system, considering a derate factor of 0.8 and an average of 4.5 hours of sunlight per day in the United States. This calculation resulted in annual electricity output of 10,380 kWh from the solar PV system. To determine the savings that the solar system would bring to the home, we multiplied this projected annual electricity output value by the estimated cost in cents per kWh that the homeowner would regularly pay to the electricity provider. This resulted in savings of $137 per month on the electricity bill.

In some packages that included solar panel installation, the monthly energy bill cost reductions matched or exceeded the total monthly energy bill ($250) of the inefficient home; this occurred when solar panels, in combination with additional efficiency upgrades, would be able to generate enough electricity to cover the home's consumption in full. This also resulted in some package options with which homeowners could expect (hypothetically) to receive money back on their energy bills, via solar credits, for producing extra energy beyond the home's needs. However, it is important to note that this calculation's validity rests on the assumption that the home is solely powered by electricity; additional electricity production would not offset the costs incurred from using gas.

Regarding EV chargers, our calculations estimated that there might be an increase of 38.41% on the monthly electric bill if the homeowner switched from not charging the EV at home to charging it at home. For the purposes of this experiment, however, we just assumed that there would be no additional energy efficiency benefit from switching from Level 1 charging to Level 2.

To verify the real-world accuracy of the calculated values, we spoke with energy efficiency experts and contractors across all census regions. They provided guidance to further adjust our attributes and levels, as well as to verify the cost estimates we obtained for installing various upgrades and upgrade levels.

DISPLAYING COST INFORMATION

Before launching the survey, we conducted pilot testing to uncover any unexpected issues, collect feedback from participants, and refine the experiment for optimal clarity and engagement. We explored two different DCE designs featuring different cost information: one displaying the total percentage of energy savings, and the other displaying the expected savings on a monthly energy bill. We calculated the average monthly energy bill of combined electricity and gas using the EIA data from July 2023 and inflated this value by 20% to represent an above-average energy consuming home (rounding the number to $250).

Recognizing that respondents' preferences could be heavily influenced by cost information, we also considered the possibility of excluding cost information entirely from the DCE. Ultimately, we decided to include cost information to maintain realism. Most people consider cost when making decisions about home upgrades, and excluding this information would not align as closely with the practical considerations central to this research. After these considerations and pilot testing, we chose to incorporate both pieces of additional cost information (monthly energy bill savings and percentage of energy savings) to allow respondents to easily compare the packages along cost and efficiency dimensions. Table B1 shows the level and total cost savings for each attribute in the DCE.

Table B1. Attribute levels and cost savings

Attributes	Levels	% cost savings	Monthly bill reduction	Total install cost
Insulation and air sealing	No insulation/air sealing upgrade	0%	$0	$0
	Insulate and air seal attic	8.4%	$17.54	$4,400[R]
	Insulate and air seal attic and rim joist	11%	$22.96	$5,900[R]
Windows and doors	No windows/doors upgrade	0%	$0	$0
	Upgrade to Low-E double-paned windows	11%	$22.96	$14,700
	Upgrade to Low-E double-paned windows; upgrade an exterior door to an ENERGY STAR door	12%	$25.05	$16,660
Heating and cooling systems	No HVAC upgrade	0%	$0	$0
	Upgrade (1) heating or cooling system to a higher efficiency model	5.59%	$11.67	$7,370

Attributes	Levels	% cost savings	Monthly bill reduction	Total install cost
	Upgrade heating and cooling systems to a heat pump	22.23%	$46.41	$8,230 [R]
	Upgrade heating and cooling systems to a heat pump and install a smart thermostat	24.23%	$50.58	$8,530
Water heater	No water heater upgrade	0%	$0	$0
	Upgrade to an EE heat pump water heater	9.95%	$20.77	$1,750[R]
Major appliances	No appliance upgrades	0%	$0	$0
	Upgrade one appliance to an ENERGY STAR appliance	0.65%	$1.36	$1,540
	Upgrade two appliances to ENERGY STAR appliances	1.3%	$2.71	$3,090
	Upgrade three appliances to ENERGY STAR appliances	1.95%`	$4.07	$4,630
Solar panels	No solar upgrade	0%	$0	$0
	Install solar panel system	31.5%	$137	$23,300[TC]
EV charger	No EV charger upgrade	0%	$0	$0
	Install EV charger	0%	$0	$1,316[TC]

These savings numbers can be interpreted as 10% savings = 90% of original cost, based on a $2,213.16 annual energy bill.

HOVER FEATURE

To present nonmonetary benefits information without crowding the choice screen, we introduced a hover feature. This allowed respondents to hover their cursors over energy upgrade attributes to display the level of benefits associated with carbon emissions, noise reduction, comfort, aesthetics, and convenience compared to other upgrade categories. Respondents received instructions on accessing this hover feature prior to viewing the choice sets.

EXCLUDING AND OPT-OUT / STATUS QUO OPTION

We made a conscious decision to exclude an opt-out option from the package choices in the DCE. Our research questions were strategically focused on capturing nuanced preferences among varying energy retrofit options rather than simply gauging homeowners' general interest in energy upgrades overall. Realistically speaking, we assumed and anticipated that a substantial proportion of participants would prefer an opt-out choice if given the option to do so given the high costs associated with home energy upgrades. The absence of an opt-out option forces a choice between options, allowing us to better understand the relative preferences for different retrofit packages. Additionally, by omitting the opt-out option, we mitigated the need for an even larger respondent pool, as including such an option would have required a larger sample to detect statistically significant differences in preferences between the retrofit alternatives given the likelihood of many opt-out responses.