Marketing and Promoting Electrification Using Behavioral Science: Results from a National Survey

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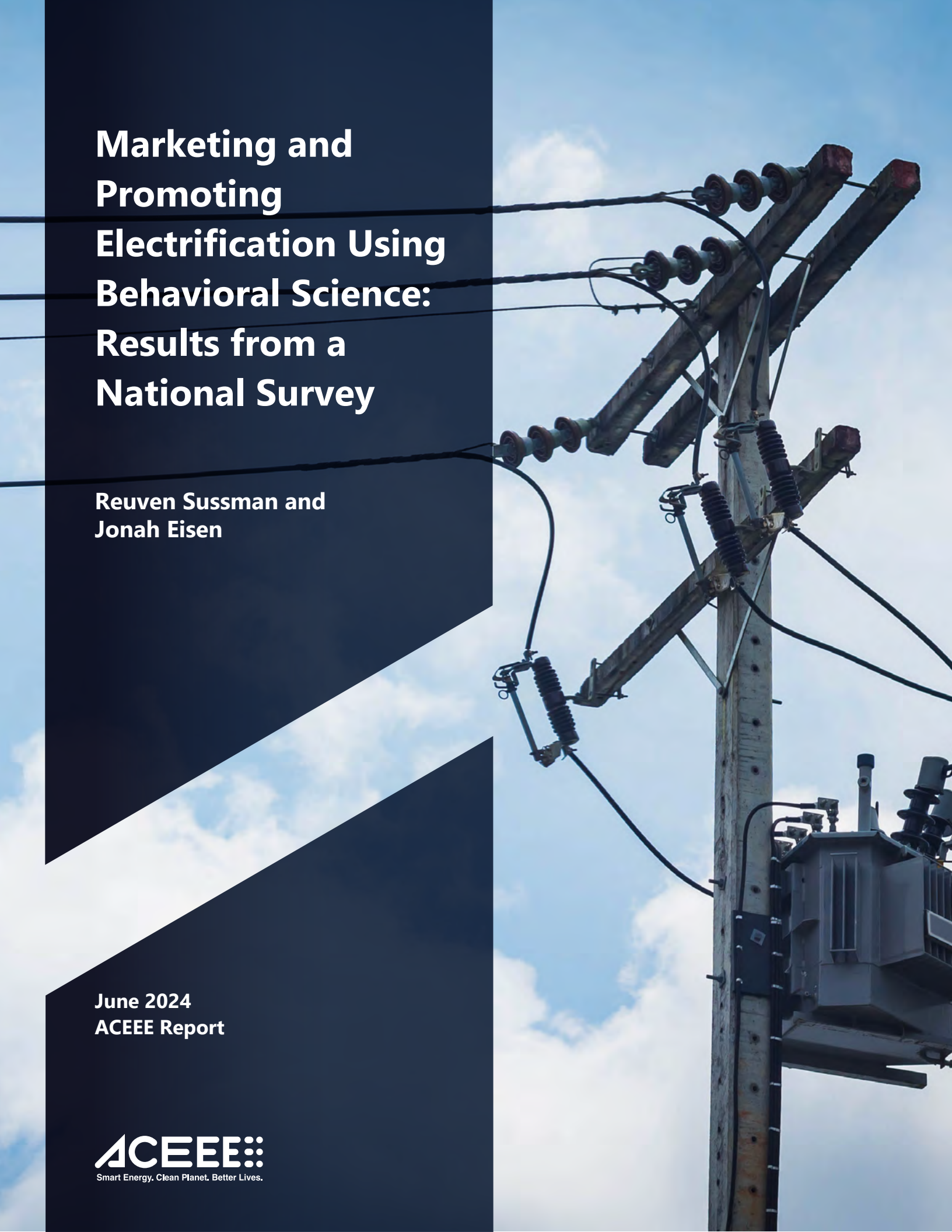
ACEEE Report



ACEEE
Smart Energy. Clean Planet. Better Lives.

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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.

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Data and licensing information

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Executive Summary

KEY FINDINGS

- Consumers who choose to switch home appliances to electric options when their system breaks cite their main reasons for doing so as the environment, health, safety, reliability, and perceptions of energy efficiency. For cooking, a key reason is that electric stovetops are easier to clean.
- Childhood experience with the electric appliance or heating/cooling system and belief in climate change are significant predictors of an individual's desire to switch from nonelectric to electric heat, hot water, and cooking.
- The three most commonly perceived barriers to home electrification are high costs of electricity, perceived inefficiency of electric technologies (relative to nonelectric equivalents), and inferior cooking experience (for stovetops). These are partly based on myths and outdated information.
- Owning electric lawn equipment is a potential gateway technology for electrification, especially for cooking. Further research is needed to explain this finding, but we believe this is because a positive experience with electrification leads to greater acceptance of future electrification measures.
- Utilities, program administrators, and implementers should leverage behavioral science techniques and insights into consumer preferences to optimize their program design, marketing, and uptake (e.g., by offering lawn equipment electrification programs).
- Findings are based on a nationally representative survey of 1,801 U.S. homeowners and renters distributed representatively among all four major census regions.

Residential building energy use (not including residential transportation) contributes to approximately 20% of total U.S. greenhouse gas (GHG) emissions (Goldstein, Gounaridis, and Newell 2020), making it a key sector to decarbonize. When electricity is generated from carbon-free sources, electrification—that is, the process of replacing technologies or systems that use fossil fuels with electricity-powered equivalents—is a critical step in reducing GHG emissions and mitigating climate change (Cleary 2022). Electrifying most U.S. residential and commercial buildings by 2050 could abate 306 million metric tons (MMT) of CO_2 emissions (Mai et al. 2018). This would be the equivalent of cutting emissions in these sectors by approximately 50%. To achieve these major emissions reductions, it is essential to first identify current perceptions, interests, and potential barriers for adopting electrification technologies. Structural barriers should be addressed with large-scale policies and programs, while psychological or social barriers should be addressed with behavioral science-based approaches.

We surveyed a nationally representative sample of 1,801 American adults, including renters and homeowners, to understand household behaviors and preferences related to home energy use.[1] This report shares our survey results and demonstrates how utilities, program administrators, and implementers can use behavioral science to more effectively market and promote residential electrification.

TARGET CONSUMERS WHO ARE LIKELY TO SWITCH

The most significant driving factors for wanting to switch from nonelectric to electric end uses (heat, hot water, and cooking) were childhood experience with the electric appliance or heating/cooling system and belief in climate change. Consumers with these beliefs and experiences tend to vote Democratic, live in apartment buildings or duplexes,[2] be in younger age groups, and have lived in their homes for less than 10 years. For replacing central air-conditioning with a heat pump, belief in climate change and living in a newer home were also important influences. Consumers in these demographics could be good targets for electrification marketing campaigns.

Notably, belief in climate change may be associated with choosing to electrify, but this is not necessarily because electrification is perceived as a climate solution. Indeed, follow-up questions suggest that the connection between electrification and climate change mitigation is tenuous for many Americans. In contrast, nonbelief in climate change is a proxy for a set of underlying values, beliefs, and worldviews that likely affect both perceptions of electrification and of climate change. Therefore, for consumers motivated by climate change—such as those along the coasts or in urban regions—messages emphasizing electrification as a climate solution could be effective for promoting electrification. For other consumers (including the average American in our survey), environmental messages might not be the most effective.

FOCUS MESSAGING ON ELECTRIFICATION'S PERCEIVED BENEFITS

Many consumers who were not currently using electricity for each of the three end uses (heat, hot water, or cooking) said that they would choose to switch to electric if their systems broke. These participants cited the environment, health, safety, reliability, and perceptions of energy efficiency as the main reasons for doing so. Cooking was unique in that the second most common reason for choosing to switch to electricity was that electric stovetops are

[1] As Appendix A describes, a third-party panel research company recruited the participants for our survey.

[2] Respondents in apartment buildings and duplexes may be renters or owners. Homeowners have a greater degree of control over their residences, but renters are also an important group to consider as some rebate and incentive programs (e.g., some IRA provisions) are open to renters, and many renters eventually go on to own homes.

easier to clean (behind environmental reasons). Focusing marketing efforts on these benefits could be helpful for encouraging electrification decisions.

ADDRESS PERCEIVED AND ACTUAL BARRIERS

Electricity cost—including the perception that a new electric system is more expensive to operate than a nonelectric version—was the most frequently cited barrier to electrifying home and hot-water heating (and second most cited barrier for cooking). Interestingly, despite efficiency often being perceived as a major benefit of electrification, electricity's perceived inefficiency (relative to other fuels such as natural gas) was often cited as a barrier as well.[3] For cooking, respondents preferred gas over electric predominantly because they perceived gas stoves as offering a better cooking experience than electric options. However, most respondents were probably thinking of electric resistance rather than induction stovetops, which they may not have previously used. The induction cooking experience is different, and arguably better, than traditional radiant electric cooking in terms of precision, speed, reduced heat loss, and ease of cleaning.[4]

These three perceptions (high cost, inefficiency, and inferior cooking experience) are often based on outdated information. For example, today's electric heat pumps are more efficient than traditional electric resistance heaters, and electric induction stovetops often provide a better cooking experience than older radiant electric versions. Although large-scale structural, policy, and programmatic solutions are needed to reduce the costs of electricity and high-end efficient electrification measures, attempts to correct misperceptions about electrification could benefit from the use of behavior-based strategies. For example, creating stronger marketing campaigns that highlight the cooking and health benefits of induction stovetops (alongside other energy-saving benefits) and promoting gateway electrification technologies, such as electric lawn equipment, could help increase interest and adoption rates.

ENCOURAGE ELECTRIFICATION THROUGH GATEWAY TECHNOLOGIES

Behavior-based strategies could include direct-experience activities. Our survey found that residents who own gateway electrification technologies are more likely to choose to switch to electricity than those who do not. In this report, we focus on electric lawn equipment and

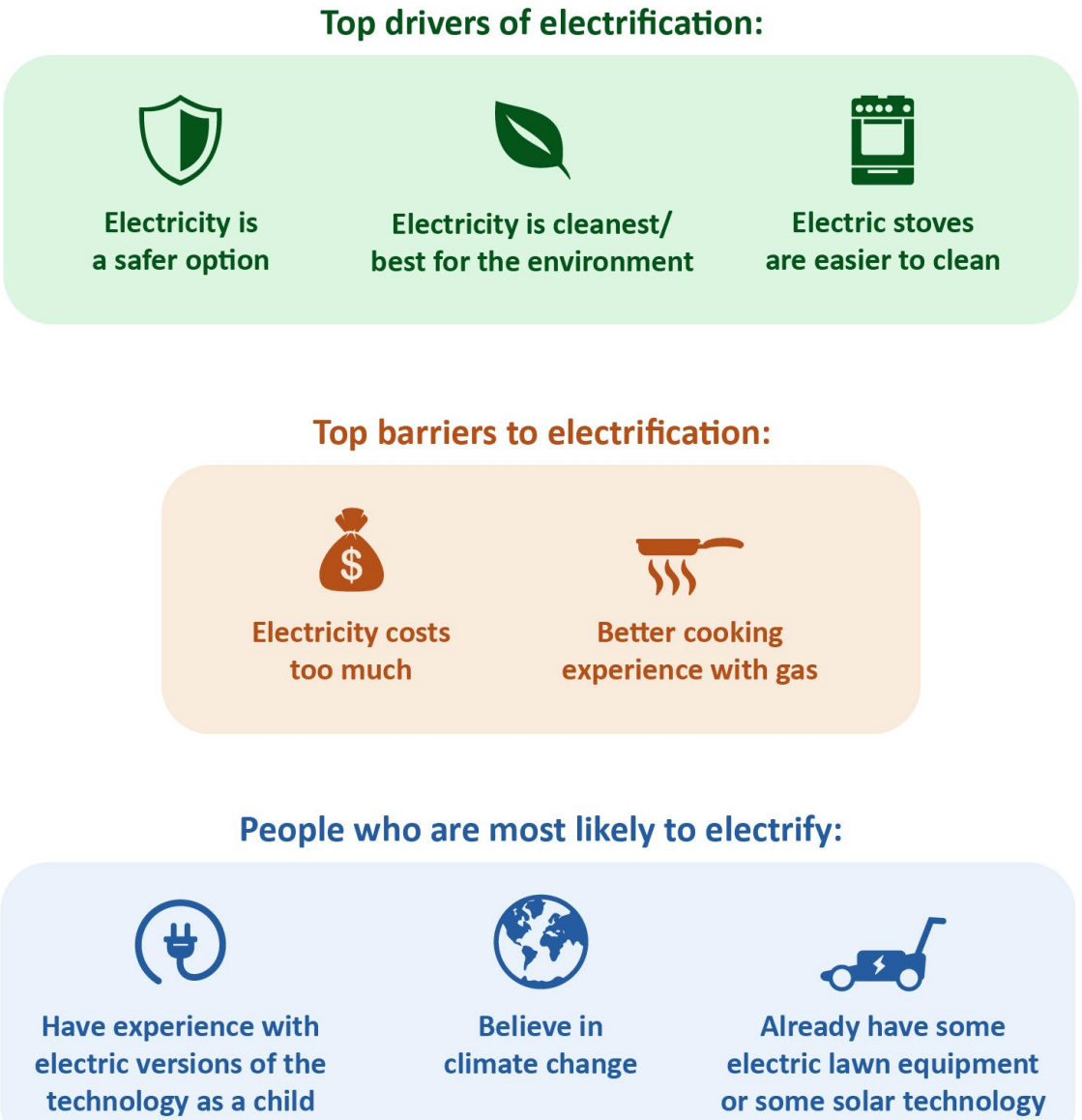
[3] More research is needed to understand the reason for this apparent contradiction. We suspect it was because respondents considered different types of electric and nonelectric technologies when providing these answers.

[4] More research is needed on perceptions of induction versus radiant electric stovetops and whether these perceptions change after experience with each. Perceptions of the cooking experience with induction can be more positive than with radiant electric stovetops, but barriers (such as not being able to use certain cookware) persist (Lynch 2019).

solar technology as possible gateway technologies, but electric vehicle ownership may also be effective. Current programs that provide direct experience include induction-cooktop lending programs and hands-on heat pump training for contractors. Future research should investigate the potential of these and other types of gateway and experience-based (free trial) programs.

IMPLEMENT POLICIES THAT INCREASE ADOPTION: INCENTIVES WHEN SOMETHING BREAKS CAN HELP

In terms of policy support, respondents preferred tax credits and rebates ("carrot" policies) over mandates and requirements ("stick" policies). Our data also show that offering appliance rebates when an appliance breaks is significantly more effective than doing so when the existing appliance is still working. Democratic voters were significantly more supportive of electrification policies than Independents and Republicans. Low-income respondents showed significantly more support than non-low-income respondents for all polices, except for those based on tax credits.


Top drivers of electrification:
Electricity is a safer option
Electricity is cleanest/ best for the environment
Electric stoves are easier to clean
Top barriers to electrification:
Electricity costs too much
Better cooking experience with gas
People who are most likely to electrify:
Have experience with electric versions of the technology as a child
Believe in climate change
Already have some electric lawn equipment or some solar technology

Introduction

Today, approximately 40% of electricity is generated from zero-carbon sources (EIA 2024a). Renewable portfolio standards are helping to increase this percentage, as is the lower cost of wind and solar generation compared to other sources of electricity. As the power sector decarbonizes, electrification—that is, the process of replacing technologies or systems that use fossil fuels with electricity-powered equivalents— is now a critical step in reducing greenhouse gas (GHG) emissions and mitigating climate change (Cleary 2022).[5] Electrification is also a growing part of the energy economy, which provides jobs and revenue for U.S. companies. Structural barriers to electrification (such as technologies, incentives, policies, and workforce) must be removed wherever possible, but support and demand from individual consumers will also be critical for expanding electrification efforts. Individuals' support creates interest in small- and large-scale electrification initiatives—such as for installing heat pumps, purchasing electric vehicles (EVs), or switching gas ranges for electric ones—while also increasing the likelihood of energy policies being enacted and having lasting impact.

In recent years, the federal government has unlocked hundreds of billions of dollars' worth of clean energy investments for consumers to use to decarbonize their homes and the energy grid. Despite monumental success in getting these clean energy bills passed, a July 2023 poll found that less than 3 in 10 Americans knew either a good deal or great deal about the Inflation Reduction Act (IRA) (Washington Post 2023). To ensure that this IRA money is put to good use and helps the United States achieve its ambitious climate goals on time, consumers must be aware of these opportunities—and interested in taking advantage of them—especially in relation to residential electrification opportunities.

This report shares the results of our nationally representative survey[6] on U.S. consumers' attitudes toward electrification; it also offers recommendations to help utilities, program administrators, implementers, and marketing professionals in their efforts to create and market electrification programs. We provide strategies that these stakeholders can immediately act on to help improve consumer buy-in and participation in electrification projects and promote their support for electrification policies.

Our research explores five main questions:

[5] ACEEE defines beneficial electrification strategies as those that provide three forms of societal benefits: reduced energy consumption (total source Btus), lower consumer costs, and reduced greenhouse gas emissions (GHG) (https://www.aceee.org/sites/default/files/electrification-dc.pdf).

[6] The survey included representative numbers of Americans from all four major census regions (Northeast, Midwest, South, and West). Appendix A has a complete breakdown of respondent characteristics as compared to the general U.S. population.

1. Which market segments of U.S. homeowners are most (and least) interested in various types of electrification measures (electric space heating, electric ranges, electric hot-water heaters) and why?
2. What stated barriers are most (and least) important for preventing U.S. homeowners from implementing specific electrification measures?
3. What types of electrification policies are most (and least) palatable?
4. What behavior-based strategies encourage consumers to electrify?
5. How can utilities, technical experts, and policymakers effectively work with behavior scientists and communication experts to help consumers overcome the identified psychological barriers?

Background

Of the approximately 129 million housing units in the United States, the majority are single-family homes (Statista 2023). Currently, only about 25% of those homes are all-electric (Diamon, Sanders, and Hronis 2022). Because residential building energy use accounts for about 20% of U.S. GHG emissions, upgrading new and existing homes to become more energy and carbon efficient will be an essential step in helping the United States reach net-zero emissions (EIA 2023). Effectively decarbonizing homes begins with electrifying major end-use technologies (e.g., heating and water heating) that currently run on emission-intensive fossil fuels. Figure 1 illustrates U.S. residential energy consumption by end use in 2022. Space heating accounts for more than one-third of residential energy consumption. Figure 2 depicts the percentage of housing units that used different fuels for different end uses. As the figure shows, around 51% of homes used fossil fuels for space heating, 53% used fossil fuels for water heating, 39% used fossil fuels for cooking, and 20% used fossil fuels for clothes drying.

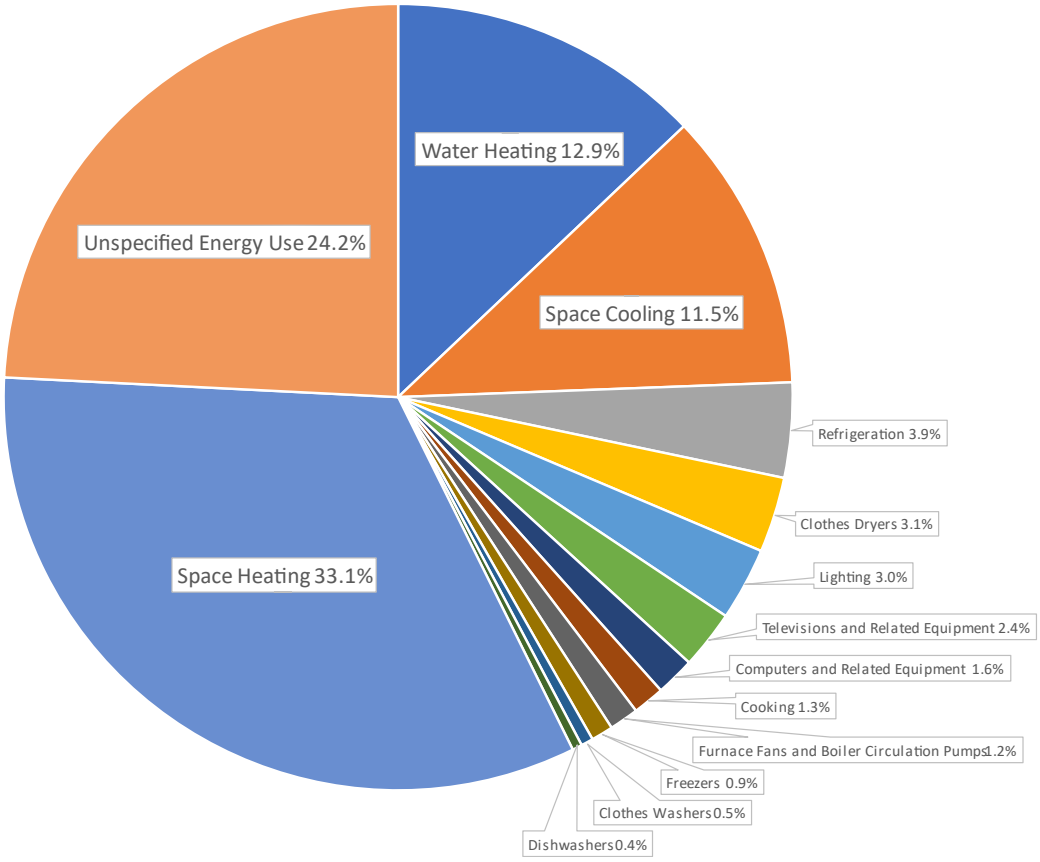
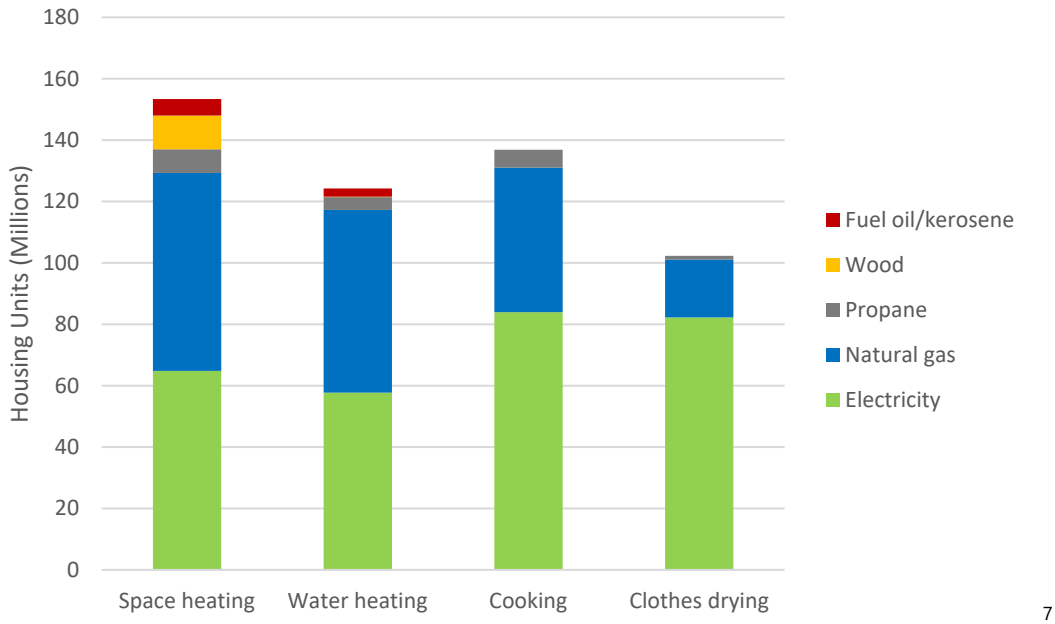


Figure 1. U.S. residential energy consumption by end use in 2022. Source: EIA 2023b.



[7]

Figure 2. Fuels used in U.S. homes by end use. Source: EIA 2024b.

In 2020, 75% of U.S. households used fossil fuels for at least one end use (RECS 2020). Natural gas was used to fuel more than 50% of residential space heating systems, and electricity powered 36% of those systems (Diamond and Sanders 2023). Homes that switch from gas furnaces to efficient electric heat pumps reduce their carbon dioxide emissions by an average of 38–53% (Pistochini et al. 2022). Moreover, switching to heat pumps and heat pump water heaters can reduce a U.S. home's heating emissions by 35–93%, depending on the state (Tan and Teener 2023).[8] Thus, there is a major opportunity to dramatically reduce energy consumption and GHG emissions in residential homes by transitioning away from fossil fuels in heating and other end uses.

Encouraging consumers to electrify their homes and support efficient electrification policies will require sophisticated marketing and outreach strategies, alongside clear economic benefits for homeowners. To be successful, these strategies must make use of information about energy consumers' current attitudes; understanding these attitudes toward electrification is critical to facilitating a move toward electrification and away from fossil fuels. We need to know who is interested (or uninterested) in implementing electrification

[7] Clothes drying percentages include only those homes that have clothes dryers.

[8] The fuel mix in each state determines the possible GHG emissions reductions in that state. States with more electricity produced from fossil fuels will see greater emission reductions from the switch to heat pumps and heat pump hot-water heaters.

measures and what the perceived barriers are that might be stopping them. This will inform program administrators and implementers on how to best target and message programs, products, and policies. To date, this information is generally unavailable to many of the people and organizations that need it.

Currently Available Information on Electrification Attitudes

A preliminary scan of the literature on attitudes toward electrification reveals relatively few peer-reviewed studies and only a handful of publicly available reports and poll results. Peer-reviewed research in North America tends to focus on support for electrification policies and a willingness to invest in electric technologies. Public reports on electrification preferences (such as preferences for heating fuels) are well documented in Australia and Europe, but this research is only starting to emerge in North America.

Generally, Americans are unaware of the emissions impacts of their homes but supportive overall of electrification policies and incentives. One survey (*N* = 1,264) by advocates for electrification shows that voters across the U.S. political spectrum sufficiently underestimate the impact of their household decisions on emissions but are concerned about household energy costs and support federal measures to make zero-emission electric appliances more affordable (Deiseroth 2021). Most of these survey respondents would also consider using a federal rebate program for zero-emission appliances, and 65% would prefer government investments go to electric appliances rather than gas-powered appliances. Another study (*N* = 4,255) finds that 53% of U.S. adults over 18 years old were supportive of offering tax incentives for electrification, while 28% were opposed to it (Climate Nexus 2023). That study included hypothetical policy questions and found that using mandates—such as requiring homes and buildings to be 100% electric—performed better than language that included bans on gas.

Homeowners and renters across the United States also seem willing to invest in electric technologies (such as heat pump water heaters, heat pump HVAC, induction stoves, and electric dryers) assuming they are affordable. While cost tends to be the most important decision-making factor for renters when purchasing new appliances and home technologies, for homeowners, health, safety, and durability of products are more important factors than costs (Antonopoulos 2023). In Georgia, policies to lower the upfront investment cost of electrification technologies and financial assistance programs—such as the Pay as You Save (PAYS®) model [9]—helped to increase interest and potential adoption rates of electrification technologies (Brown et al. 2023).

[9] PAYS® is a voluntary on-bill tariff program that ties the payback of an energy efficiency improvement to the meter.

Although only 11–13% of Americans have installed heat pumps to date (Antonopoulos 2023; RECS 2020), 40% of homeowners indicate they would install one, according to a survey of 10,000 respondents (Antonopoulos 2023). Typical indicators of willingness to pay for EVs, rooftop solar, and heat pumps include having knowledge about energy systems, perceiving climate urgency, being a Democrat, and focusing on a sustainable lifestyle (Brown et al. 2023). Given this, it is clear that understanding how various attitudes, beliefs, and demographics influence decision making is key to designing effective electrification policies and programs.

Preferences for electric or gas appliances and systems vary based on both demographic and geographic conditions. About 60% of Americans prefer a home in which all or most major appliances are powered by electricity, according to the most recent Climate Change in the American Mind Survey (Leiserowitz et al. 2023); this percentage is similar to other countries, such as Australia (Stolper, Diseris, and Di Benedet 2023). Large majorities (more than 6 in 10) of survey respondents see both gas and electric appliances for home heating, water heating, and cooking as reasonably affordable and easy to maintain, with a slight edge toward electric appliances (Climate Nexus 2023). When thinking about purchasing or renting a new home, 42% of respondents prefer electricity for heating and 34% prefer gas (Climate Nexus 2023). All or mostly electric homes are preferred by Democrats more than Republicans; Black respondents more than Hispanic/Latino and white respondents; and urban more than rural or suburban respondents (Leiserowitz et al. 2023). That said, the Residential Energy Consumption Survey (RECS) suggests that only 26% of existing homes are all-electric (as of 2020), so there is more desire for electric homes than availability.

Switching from gas to electricity for cooking tends to be more difficult than for other end uses. When asked about preferences for cooking (regardless of what they were currently using) American respondents were split down the middle for gas or electric stoves (Leiserowitz et al. 2023); this is similar to the EU and Australia, where opinions are also divided (Sovacool et al. 2021; Stolper, Diseris, and Di Benedet 2023). In part, this is due to the effective marketing of gas cooking—that is, decades-long campaigns run by natural gas companies—which has created a cultural norm around gas being a superior cooking method (Regunberg 2022).

One reason that electrification in general is not more popular could be a lack of connection between it and climate change. For example, in both Europe and Australia, climate action is considered important, but studies show that home heating systems are often perceived as environmentally benign and home electrification is not always strongly associated with climate change mitigation (Sovacool et al. 2021; Stolper, Diseris, and Di Benedet 2023).

Understanding the psychological underpinnings that shape attitudes and choices about electrification in the United States is pivotal for crafting effective, targeted interventions. Our primary purpose with this report is to identify strategies for shifting these attitudes and encouraging residents to electrify their homes. In the following sections, we describe our

method for measuring general electrification interest to inform marketing campaigns aimed at encouraging adoption of electrification technologies and programs.

Survey Data and Methodology

Using a nationally representative sample of 1,801 U.S. citizens over the age of 18, we surveyed homeowners and renters on their views about various electrification practices and policies.[10] We designed the survey to understand current home energy sources and behaviors, as well as respondents' preferences for fossil fuels or electricity for various end-use appliances and systems. We asked questions about personal and household demographics; home energy sources for heating, cooling, cooking, water heating, clothes drying, and lawn equipment; and interest in/attitudes toward electrification policies and programs. The full survey is available online on the open-access online data repository, OSF.[11]

Our sample of participants was representative of the U.S. population in terms of age, income, gender, political affiliation, and major U.S. census region. The sample was slightly more educated than the general U.S. population (i.e., more participants with associates or college degrees) and slightly less racially diverse (i.e., more white participants). The sample, recruited by an independent panel research company, was distributed among the four main U.S. census regions in a nationally representative manner (Northeast, Midwest, South, and West). Respondents lived in homes built in the same years as the national average that are the same size as the national average. Similar to the general U.S. population, 71% of our sample owned their homes (only 6% more than the national average) and 28% rented. Based on their household income and household size, we estimate that 33% of our sample qualifies as low-income (under 200% of the Federal Poverty Level), which is similar to other available U.S. statistics (Census Bureau 2023). Appendix A offers complete details about respondent demographics and how they compare to the general U.S. population.

The sample was also representative of the U.S. population in terms of home energy use. Twenty-nine percent of the survey respondents said that electricity is the only source of energy used in their homes, and 58% also use natural gas (a smaller percentage use other fuels). RECS reports similar numbers in its 2020 survey, with 26% of homes being all-electric and 55% using natural gas (EIA 2022). In our sample, 10% of homes have solar panels and 8% have other solar technologies (hot-water heater, solar battery storage, lighting, pool equipment, etc.), some of whom may have both. This is higher than average for the U.S. (3.7%), but the U.S. data include only single-family homes (EIA 2022b). More than 50% of

[10] The sample was recruited by ROI Rocket, a third-party panel research firm.

[11] https://osf.io/9qc4j.

homes in our sample currently have central heating, and 18% have central heat pumps (other heating technologies are also used in smaller numbers); these percentages are very similar to the U.S. average (60% and 13%; EIA 2024b). Nearly half of participants in our survey (46%) use a natural gas water heater and 18% have a gas-powered clothes dryer (nearly identical to the national averages of 48% and 20%; EIA 2024b). Our sample included a much lower number of homes that use electric resistance storage hot-water heating than the national average (24% versus 48%; EIA 2024b), but we also had both renters and owners in our survey, and 13% of respondents said they were unsure what type of hot-water heater they had.

In the following sections of this report, we dive deeper into respondents' attitudes and choices regarding electrifying their homes (or not), focusing specifically on residents who currently do not use electricity for various end uses. We examine self-reported barriers to residential electrification, and how these barriers vary by market segment. We also examine perceptions of electrification policies and programs, alongside behavioral science-based strategies for encouraging adoption.

Which Market Segments of U.S. Homeowners Are Interested in Electrification Measures and Why?

People Already Using Electricity Want to Keep Using It

For each of the three target systems (home heating, hot water, and cooking), we asked participants whether they would replace a broken system with an all-electric version of that system (as opposed to one powered by some other fuel source), assuming the cost and ease of installation was the same for all options.[12] Across all three of our targeted end uses, respondents who were already using electric versions were likely to choose to replace them with electric versions.

Those who already had all-electric homes were statistically significantly more likely to choose electric replacement options than those who also had natural gas or some other fuel hookup at home (61% versus 41% for heat, 69% versus 42% for hot water, and 68% versus 41% for cooking). Similarly, those who were already using electricity for the targeted end use were statistically significantly more likely to choose an electric replacement than those who were not already using electricity for that end use (69% versus 38% for heat, 66% versus 43% for hot water). The difference was greatest for cooking, in which 69% of those cooking with electricity would choose to stay, while only 28% of those currently cooking with gas would

[12] For example, "If your home's current heating system broke down and you had the choice to replace it with a new appliance/system powered by one of the following fuels, which would you choose? (Assume all system types have the same cost and ease of installation)." The full survey is available at: https://osf.io/9qc4j.

switch. Overall, the percentage of participants willing to switch from gas to electric cooking was lower than the percentage willing to switch for the other two end uses (20–30% versus 40% or more).

Self-Reported Reasons for Switching

When offered a list of potential reasons[13] for choosing electric over nonelectric replacements (excluding participants who were already using electricity for each end use) the most common reasons were related to safety, environmental sustainability, energy efficiency, and reliability. However, cooking was a little different. The second most common reason for choosing electricity for cooking (behind environmental reasons) was that the stovetop would be easier to clean. These perceived benefits should be the subject of marketing messages created by program administrators promoting these technologies. Table 1 shows the complete list of responses, and their popularity.

Table 1. Frequency of each reason for choosing to electrify; the shading represents the higher (lighter blue) and highest (darker blue) percentages

Reason	Heat % (*n*)	Hot water % (*n*)	Cooking % (*n*)
Electricity is a safer option for my home	34.9% (188)	32.2% (177)	29.3% (65)
Electric stoves are easier to clean	--	--	32.4% (72)
Electricity is cleanest/best for environment	32.1% (173)	28.9% (159)	44.1% (98)
Electricity/electric appliances are more energy efficient	26.9% (145)	25.6% (141)	32% (71)
Electricity is a more reliable option for my home	24.1% (130)	25.6% (141)	18.0% (40)
I can use renewable energy sources to power it	22.6% (122)	22.2% (122)	18.5% (41)
Electricity is a healthier option for my home	25.0% (135)	20.5% (113)	19.8% (44)
Electricity is [cheapest option or cheaper than gas]	15.4% (83)	19.1% (105)	25.7% (57)
Electric appliances are more modern	20.0% (108)	16.7% (92)	13.5% (30)
My home is not connected/set up for [gas or other fuel sources]	14.5% (78)	14.4% (79)	1.8% (4)
Other fuel sources are too expensive	—	—	3.6% (8)

[13] The list was derived from a similar Australian study in which researchers coded open-ended responses to this question. Table 1 shows the full list.

Reason	Heat % (*n*)	Hot water % (*n*)	Cooking % (*n*)
Other	1.1% (6)	1.1% (6)	1.4% (3)

Characteristics of Respondents Who Would Switch

Utilities and program administrators working with marketing agencies should direct their electrification marketing efforts toward consumers who are most willing to electrify. For residents not currently using electricity for any of the three end uses, several characteristics often define those who chose to switch from non-electricity to electricity—and those who did not. Across all three end uses, those interested in switching when a system broke were statistically significantly more likely to

- Have had childhood experience with the electric version of the technology
- Believe in climate change
- Vote Democratic
- Live in an apartment building or duplex
- Be under 55 years old
- Have lived in their home for less than 10 years

Also more likely to switch were renters,[14] low-income participants (below 200% FPL), non-white participants, participants with lower household incomes, and those living in smaller (<750 square foot) homes or homes built from 1970 to 2009. However, these factors were not consistently important for all three end uses.

Many of the above characteristics overlapped; for example, renters tend to be more likely to live in apartment buildings, and those living in their homes for fewer years tend to be younger. Across all three end uses, the most important driving factors were childhood experience with electric versions of the system and belief in climate change. Depending on the end use in question, those with childhood experience were 1.5–2.3 times more likely than those without it to choose to switch to electricity, and those who believe climate

[14] Renters are an important group to consider because some rebate and incentive programs are open to them, pending landlord consent, and because many renters go on to eventual home ownership. It is notable that this group, and those in multifamily buildings in general, tend to be slightly more interested in electrification than other groups.

change is happening[15] were 1.6–1.8 times more likely to switch than those who did not or were unsure.

For heating and cooking, being a Democrat was a key driving factor (associated with choosing to switch 1.5–1.8 times more often than Republicans), while home type was important for heat and hot-water decisions (those in apartments and duplexes chose to switch 1.6–4.4 times more often than those in single-family detached homes). Age was a driving factor for space heating decisions (18- to 24-year-olds were 2.3–2.7 times more likely to switch than various older age groups). Regional differences in these statistics would be interesting to examine in more detail in future research.

For each end use, table 2 shows the significant differences in respondent characteristics. The statistically significant differences ($p < .05$) are highlighted in bold; they are unique predictors (primary factors) of switching (as opposed to just being associated with switching). Appendix B has more details about our statistical analyses and results.

Table 2. Characteristics of respondents that predict interest in electrification

Characteristic	Description	Heat	Hot water	Cooking
Childhood experience	Participants with experience with the electric version of the technology in childhood home are more interested	Primary factor	Primary factor	Primary factor
Climate change belief	Participants that believe climate change is happening are more interested	Primary factor	Primary factor	Primary factor
Political affiliation	Democrats are more interested than Independents, who are more interested than Republicans	Primary factor	Related factor	Primary factor
Home type	Single-family home, row house, and mobile home are uninterested, and duplex and apartment buildings are interested	Primary factor	Primary factor	Related factor
Age	Generally, respondents under 55 are more interested	Primary factor	Related factor	Related factor
Time living in current home	Respondents who lived in their homes less than 10 years are more interested	Related factor	Related factor	Related factor

[15] We asked participants, "Do you believe climate change is happening?" They could answer "yes," "no," or "not sure."

Characteristic	Description	Heat	Hot water	Cooking
Ownership status	Renters are more interested than owners	Related factor		Related factor
Low-income	Respondents qualified as low-income are most likely to switch	Related factor	Related factor	
Race	Non-white respondents are more interested than white respondents	Related factor		
Age of home	Those in the oldest and newest homes are more likely to switch	Related factor		
Home size	Participants in homes under 750 sq. ft. are most interested	Related factor		
Household income	As income decreases, interest increases		Related factor	

Note: "Primary Factors" are variables that are unique independent predictors of choosing to replace broken nonelectric technologies with electric versions (found through logistic regression). "Related Factors" are variables that are significantly associated with the decision to switch (found through zero-order chi-square tests), but they influence decisions through their influence on the Primary Factors; that is, they do not drive the decisions independently, but they are related to the outcomes.

Replacing Central Air-Conditioning with A Heat Pump System

A decision to change an (electric) central air-conditioning (AC) system to an (electric) central heat pump system is not strictly an electrification decision since the AC is already electric; however, if the heat pump system is able to also replace a (nonelectric) central heating system then it is a potentially important opportunity to change the heating system from fossil fuels to electricity. We asked a subsample of participants who have central air-conditioning (but not a heat pump) a slightly different question about switching than we asked for our three primary end uses: "Imagine you had a central air conditioner in your home that needed to be replaced within the next 5 years. What is the likelihood that you would replace that system with an all-season heat pump (which works for both cooling in the summer and heating in the winter)?" On a scale of 1–5 (1 = very unlikely, 5 = very likely), the average response was 3.21 (slightly above "neutral").

Among participants who were asked this question, two driving factors uniquely predicted the decision to switch to a heat pump: (1) belief that climate change is happening (2.64 for nonbelievers; 3.21 for believers); and (2) living in a newer home (likelihood increasing steadily from 3.04 for oldest homes to 3.45 for newest homes).

It makes sense that participants in older homes would be reluctant to switch to a heat pump, as doing so might be more complicated or costly for them. Although other factors are also associated with switching—that is, renting, childhood experience, age, voting Democrat, being non-white, living in newer homes, and living in the home for fewer years—their

influence works through the two driving factors above (belief in climate change and living in a newer home).

Belief in Climate Change and Electrification Decisions

For our survey question, "Do you believe climate change is happening?" 74% answered yes, 14% answered no, and 12% answered not sure. Belief that climate change is happening is a strong unique predictor of choosing to electrify heat, hot water, and cooking (when current systems break). However, this finding is correlational and a belief in climate change may not necessarily cause a decision to electrify. Indeed, of those that believe climate change is happening, only 46% agree or strongly agree with the statement "Disconnecting from gas and electrifying more homes is critical to mitigating climate change" (the average rating 3.34, which was closest to "neither agree nor disagree").

Typically, climate change denial is not an isolated idea, but rather a proxy for a more general way of thinking. It is a strong indicator of values, ideologies, worldviews, and political orientation (Lewandowsky, Oberauer, and Gignac 2013; Hornsey et al. 2016). As such, these underlying elements may be the reason for climate change nonbelievers' decisions not to electrify, with a lack of belief in climate change being one among a constellation of beliefs contributing to the decision. Therefore, electrification messages should not necessarily center on climate change mitigation. They should instead target residents that do not deny climate change (which is most Americans), but for the average American, the message should not be primarily about the environment.

The environment is a critically important issue for Americans in coastal states and urban areas (Howe et al. 2015), and therefore an environmental message could be a potent one for this subgroup. When an electrification promotion message is about the environment for this or any group, it should clearly draw the connection between electrification and emissions reductions, and not assume that homeowners understand this connection. That is, some education should be embedded.

What Stated Barriers Prevent U.S. Homeowners from Electrifying?

"Electricity Costs Too Much"

Program administrators and utilities promoting electrification should be aware of the perceived barriers to electrification so that they can craft programs and marketing efforts to overcome them. When survey respondents indicated that they would replace a broken system (heat, hot water, or cooking) with a nonelectric version, we asked for an explanation (in an open-ended question, not selecting from a list). We then coded their responses into

themes. Across all three end uses, when participants currently using gas opted to continue doing so, the most common reason was some version of "electricity costs too much."[16]

This perception—that a new electric version of a system would be more expensive to operate than a nonelectric version—was pervasive. The cost of electricity was the top reason respondents with nonelectric heated homes mentioned for choosing not to electrify (36% of answers) and for respondents with nonelectric hot-water heaters choosing not to electrify (34% of answers). This differed by region, as we discuss later. For cooking, the perception that electricity would be more expensive was second (10% of answers) only to the perception that gas offers a better cooking experience with better heat distribution (38% of answers).[17] We examined the top reasons for choosing not to switch to electric end uses for several subgroups (55 years or older, living in single-family detached homes/mobile homes/row houses, Republicans, homeowners, white, living in their homes for 10 or more years, and living in homes built before 1980), but results were nearly identical for each subgroup (i.e., perceived high cost being important). Answers differed somewhat by census region, as described below. Table 3 shows the top reasons for each subgroup to choose not to electrify each end use.

"Electricity Is Not the Most Efficient"

Although far less common than cost, many respondents not currently using electricity for each end use mentioned the perception that electricity was less efficient (or gas was more efficient) as a reason not to switch. For home heating and water heating, this was the second most common answer (mentioned in 9% and 17% of answers, respectively), and the eighth most common for cooking (3% of answers).

Notably, however, efficiency was also often cited by those who chose to switch as a reason for doing so. Thus, perceptions of efficiency could shift decisions either toward or away from electrification depending on the types of devices consumers are considering. Program administrators and utilities could potentially overcome the barrier of perceived inefficiency among consumers by educating them on higher-efficiency, newer technologies and offering incentives reducing the costs of these high-end options.

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[16] Primarily, respondents discussing this theme mentioned the ongoing cost of electricity (i.e., operational cost), but their answers occasionally also included "total cost of ownership," which could include upfront costs of replacing nonelectric systems with electricity. However, including these costs was rare, particularly because we instructed participants to assume that the cost and ease of installation would be equivalent across all options.

[17] Notably, respondents considering which type of stove top to replace could choose "electric (such as a resistance or induction)" or "natural gas." We believe that when considering electric stove tops, most respondents were likely thinking of electric resistance rather than induction because induction is less common and thus less familiar. Currently, induction cooktops are present in only 5% of U.S. homes (AHAM 2023). More research into this topic is needed as the market share for, and popularity of, induction stoves begins to increase (AHAM 2023).

A few subgroups were particularly likely to perceive that electric options were less efficient than their nonelectric alternatives. Program administrators working with these subgroups should tailor their messages with this in mind. Respondents in older age categories (55+) cited a belief that electricity was a less-efficient option for water heating 18–27% of the time, and for home heating 5–15% of the time. Republicans, white respondents, those in older homes, and those living in their homes for 10 or more years all cited inefficiency as a reason not to switch water heating (17–19% of the time).

Table 3. Top stated barriers to electrification

Space heating

	Overall	Over 55-year-olds	Single-family detached home	Republican	Homeowners	White	Lived in home for 10+ years	Home built before 1980
Electricity costs too much	36%	40%	37%	39%	38%	38%	36%	37%
Electricity is not the most efficient heating source	9%	11%	9%	7%	9%	9%	8%	8%
Heat from nonelectric sources is warmer/better	8%	7%	8%	9%	8%	8%	9%	8%
Used to using gas	7%	7%	6%	6%	6%	6%	7%	8%
Power grid reliability concerns	7%	5%	6%	7%	7%	7%	7%	6%

Water heating

	Overall	Over 55-year-olds	Single-family detached home	Republican	Homeowners	White	Lived in home for 10+ years	Home built before 1980
Electricity costs too much	34%	40%	35%	24%	35%	35%	35%	36%
Gas is more efficient	17%	20%	19%	19%	18%	18%	19%	18%
Used to using gas	9%	7%	8%	11%	6%	8%	7%	6%
Power grid reliability concerns	8%	5%	8%	9%	8%	8%	8%	10%
Natural gas is cleaner than other fossil fuels	5%	7%	5%	5%	8%	6%	7%	6%

Cooking

	Overall	Over 55-year-olds	Single-family detached home	Republican	Homeowners	White	Lived in home for 10+ years	Home built before 1980
Better cooking with gas/even heat distribution	38%	37%	40%	35%	40%	41%	37%	42%
Electricity costs too much	10%	13%	10%	14%	10%	9%	11%	10%
Easier cooking with gas	7%	9%	7%	6%	7%	8%	8%	6%
Used to cooking with gas	7%	6%	6%	6%	6%	6%	6%	8%
Faster cooking with gas	6%	4%	6%	6%	6%	5%	4%	7%

Note: Percentages refer to the proportion of respondents who chose not to switch and mentioned the target barrier.

Reality or Misperceptions?

When respondents indicate that they would not switch to electricity because electricity costs too much or electricity is not the most efficient option, are their perceptions accurate? If so, then large-scale policy, programmatic, and technology changes would be required to remove barriers to electrification. If perceptions are inaccurate, then marketing, education, and behavioral science-based strategies would be useful for utilities and program administrators to employ. To try to discern the accuracy of respondent perceptions, we examined the frequency of these answers by geographic region.[18]

In the Northeast and Midwest, cost was by far the most often mentioned barrier for not switching to electricity (38–41%). In the South and West regions, cost was still important (29–37%), but these respondents also commonly perceived that electric heat was not the most efficient option (11–12%). This could reflect the fact that the Northeast and Midwest regions have colder climates (and therefore spend more energy on home heating) and have higher electricity costs (relative to gas; Nadel and Fadali 2022). Likely, a mix of reality and misperceptions are guiding their decisions, suggesting that both larger-scale structural solutions and behavior-based strategies are required in these colder regions. For example, electrification might be coupled with deep envelope retrofits or with improved rate change structures so that gas and electric rates are more comparable.

For cooking, most of the barriers cited for not switching from gas to electricity could be considered misperceptions; this is mainly because newer induction cooktops provide advantages over gas ranges that respondents may not be aware of. Currently, less than 5% of U.S. homes have induction ranges (AHAM 2023). Our survey respondents were thus unlikely to have direct experience with them and were likely thinking only of the less-advantageous electric resistance stovetops when answering questions about electric cooking.[19]

For cooking, the top answer for not switching to electricity (a theme we extracted from our open-ended question) was "better cooking experience with gas and more even heat distribution." This is something that experience with new induction ranges could change. Newer induction ranges cook food evenly and quickly, and they provide much more control over the precise heat level of pots and pans than electric resistance stovetops (Efficiency

[18] Examining responses by census region provides only preliminary answers to these questions. A more in-depth analysis of energy costs, technology adoption levels, and energy usage by various technologies in each region is needed.

[19] More research is needed on perceptions of induction versus radiant electric stovetops and whether this perception changes after experience with each. Perceptions of cooking experience with induction can be more positive than with radiant electric stovetops, but barriers persist, including not being able to use certain cookware (https://www.nytimes.com/wirecutter/blog/why-dont-people-use-induction-cooktops).

Vermont 2024). Other common responses from this group that might also change with this experience are "cooking with electric is not as good" (6%), "cooking with gas is easier (7%), "cooking with gas is faster" (6%), "food cooked on gas stoves tastes better" (1%), "I'm used to cooking with gas" (7%), and "I just prefer cooking with gas/flames" (6%). Thus, unlike heat and hot water, our data suggest that gas ranges likely have entrenched cultural and emotional connections to consumers that go beyond structural and financial barriers. Therefore, electrifying cooktops could be an end use that is well positioned to benefit from a behavioral science-based approach (in conjunction with programs and policies that bring prices to parity with gas).

Perceived Lack of Climate Impact

Only 70% of respondents believe that climate change is happening, and only 40% of those respondents indicate that home electrification is an important climate solution. Additionally, many respondents had misperceptions about which residential climate actions are truly the most impactful. We asked participants to rank, in order, the top five actions they could take at home to reduce carbon emissions, using a list of 10 possible actions derived from previous literature reviews (Gardner and Stern 2008; Dietz et al. 2009; Subramanyam et al. 2017). We asked this question because we realized that responses to it could help program administrators and utilities design educational campaigns around energy literacy, which could, in turn, promote electrification.

The two most common household actions to mitigate climate change that respondents mentioned among their top five were "using renewable sources of energy (e.g., solar panels, geothermal, wind)," which appeared in the top five of 55% of respondents, 28% of whom ranked it first; and "adding insulation and sealing air leaks," which was in the top five for 64% of respondents, but only 10% ranked it in first. Arguably, these two actions are correctly ranked in the top five.

The three next most popular actions were "turning off the lights when not in use," "changing thermostat settings to conserve energy," and "switching to more energy-efficient windows." More than 50% of respondents placed these actions in their top five, yet the impact of two—lights and thermostat—are overestimated (Gardner and Stern 2008). Moreover, "switching to electric efficient water heating systems," was among the lowest-rated actions (in the top five of only 32% of respondents), while other electrification measures ("switching to electric efficient heating and cooling systems" and "switching to electric efficient appliances") were popular, but ranked by less than half of respondents (43–48%) among their top five. These rankings are generally aligned with previous literature on what people think are impactful actions (Attari et al. 2010).

Participants' rank-ordering of impactful actions further supports the hypothesis that one reason for the lukewarm interest in residential electrification is that it is not perceived as a top action for mitigating climate change. Program administrators can target this misperception with marketing, education, and behavior change campaigns among consumers that may be concerned about sustainability and the environment.

Extra Challenge for Renters

In our sample, 28% of respondents were renters (as compared to 35% nationally). On average, renters were more interested than homeowners in switching to electricity for all three end uses. Some government incentive programs are open to renters (e.g., some IRA provisions), but participation nevertheless requires landlord consent.

We asked renters: "How likely are you to talk to your property manager about energy efficiency rebates if you were aware of a program to save energy?" On average, renters answered "neither likely nor unlikely" (2.99 out of 5) but those who said they would switch from nonelectric to electric end uses indicated a higher likelihood of talking to their property management company about rebates. This was statistically significant for heat, borderline significant for cooking, and nonsignificant (but in the correct direction) for hot water.

Encouraging renters to talk to their landlords or property management companies about electrification rebates could be a viable path for increasing electrification uptake. Program administrator and utility marketing and outreach activities could focus on this subgroup; they could also talk directly to the owners or property managers themselves. Finally, as renters move into homeownership, builders and home sellers should be prepared to offer electrification as a benefit of their new homes, given that this is something renters appear to be interested in.

Lack of Program Awareness

A final barrier to electrification could be a lack of program awareness. Only 18% of survey respondents thought they knew of a program to help electrify their homes. This lack of awareness could be a barrier to electrification. It partly stems from a genuine lack of available programs in the respondents' geographic regions, but it also comes from a lack of awareness of programs that are available. Recent research suggests that residents are frequently unaware of available energy efficiency programs in their regions, causing those programs to be undersubscribed (Burak 2023).

Program administrators and utilities can improve program uptake by adding elements that consumers want. Of the small percentage of respondents who had heard of an electrification program, 59% had either participated or planned to participate. To increase participation, more than half of respondents suggested—by choosing from a list of possible suggestions—that programs provide "good financial incentives" (57%) and make sure "that the energy savings are worth it long term" (50%). Roughly 25% of respondents also indicated that providing trusted contractors (27%), easy availability of electric appliances (26%), and fast timelines for installation (24%) are also important.

What Types of Electrification Policies Are Most (and Least) Palatable?

Survey respondents rated their support for five hypothetical energy efficiency and electrification policies from "very unsupportive" (1) to "very supportive" (5). On average, respondents' support landed between "neither supportive nor unsupportive" and

"supportive" (2.95–3.66 out of 5). That is, they were neutral to somewhat positive about these policies being enacted.

Homeowners Prefer Carrot Policies to Stick Policies

Comparing "carrot" and "stick" policies, support was higher for the three carrot policies, including two electrification policies and one efficiency policy: "a rebate for low-income homeowners that completely covers the cost of a new electric appliance" (*M* = 3.66); "giving homeowners a 30% tax credit on efficient gas burning furnaces and hot water heaters" (*M* = 3.64); and "rebates for home energy upgrades that would differ based on income" (*M* = 3.43). Support was lower for two electrification stick policies: "requiring envelope upgrades alongside making electric systems upgrades" (*M* = 3.09) and "any time you replace a heating or cooling system it would have to be electric" (*M* = 2.95).[20] These findings align with previous research on preferred environmental policies (Attari et al. 2009; Swim and Geiger 2021). Although stick policies may be most effective, carrot policies are most politically feasible.

Electrification Preference Varied with Political Affiliation and Income Level

In all cases, Democrats were significantly more supportive of the five policies than Independents, who were significantly more supportive than Republicans. And, for all policies except the one based on tax credits, there was significantly more support from low-income respondents (under 200% FPL) than among non-low-income respondents. This is likely because low-income households need financial incentives more than other households, but have a lower tax burden and are therefore generally less likely to participate in programs that provide tax credits (Dickert-Conlin, Fitzpatrick, and Hanson 2006).

Residents Were More Supportive of Electrification Policies in Western and Southern Regions

Among policies related to furnaces and hot water, we examined one for efficient nonelectric technologies and one for electric-only technologies to compare preferences. We found statistically significant differences in support for these policies between colder and warmer census regions (where the frequency of using gas also differed, as figure 3 shows). For the mandate that new heating systems be electric, there was significantly less support in the Northeast and Midwest than in the South and West. For the policy providing a tax credit for efficient gas furnaces and hot-water heaters, there was more support in the Northeast and West than in the South. Thus, resistance to policies eliminating gas may be strongest in colder climate regions in which natural gas is pervasive. Policy-change efforts to reduce or

[20] Some research suggests that providing larger rebates for envelope efficiency upgrades can make electrification (particularly air source heat pumps) more economical (Wilson et al. 2024).

eliminate gas might be most successful in warmer, less gas-dependent regions that are populated with Democratic and Independent voters. Paradoxically, however, these regions of the United States typically have fewer of these voters. Thus, electrification legislation faces a challenging political map.

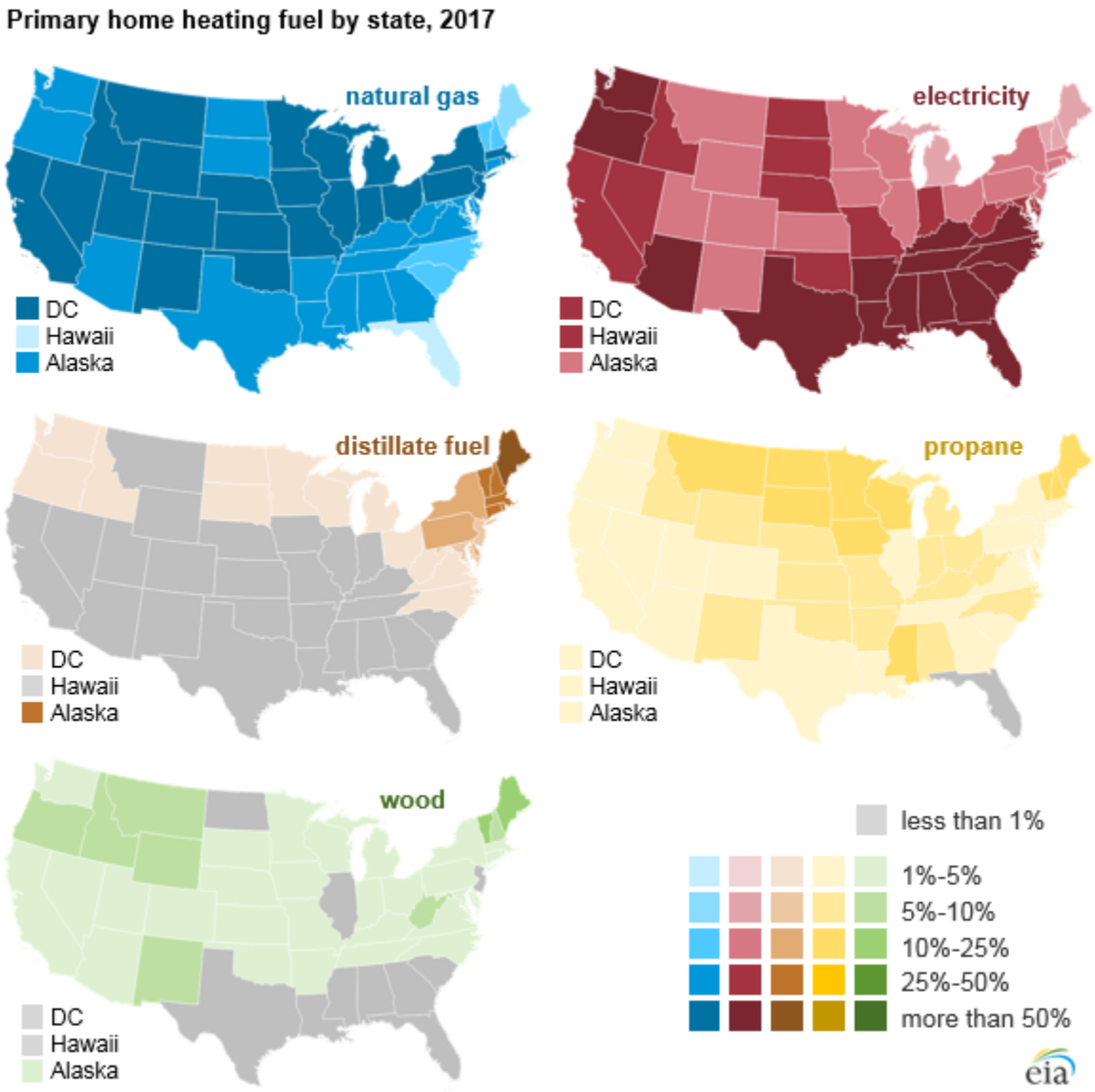

Figure 3. Home heating fuel by region. Regions in the Northeast and Midwest have high frequency of natural gas for home heating, which may partially explain regional differences in electrification policy preferences. Source: U.S. Energy Information Administration, based on Census Bureau American Community Survey 2017.

Behavior-Based Strategies for Encouraging Consumers to Electrify

Aside from policies and programs to remove structural barriers and reduce costs, proponents of electrification should consider behavioral strategies for maximizing the

uptake of electrification measures. In addition to targeting consumers who are most likely to respond to electrification efforts and crafting messages that both highlight reasons for switching and overcome barriers for not switching (as described earlier), program administrators and others should consider out-of-the-box strategies. Among those strategies are encouraging gateway electrification measures (electrifying one end use, which leads to electrifying other things); and providing hands-on experience with all-electric appliances and systems (e.g., free loaner programs). Ensuring that residents receive rebates and incentives at the optimal moment—such as when something needs replacing—can help to promote residential electrification.

GATEWAY ELECTRIFICATION MEASURES

Adoption of electrification or efficiency measures can sometimes lead to adoption of additional measures. The initial technology adopted (e.g., electric lawn equipment) could be considered a "gateway" technology if it leads to future adoption. Gateway measures might increase uptake of additional measures for various reasons. These reasons are important to consider because they dictate the types of measures to consider and how those measures are promoted.

First, gateway technologies could facilitate adoption through positive spillover. This is a phenomenon in which individuals act consistently and are therefore likely to repeat similar behaviors when presented the opportunity (Lanzini and Thørgeson 2014). Second, gateway technologies could be effective because of deep education—learning about the benefits of electrification through hands-on experience. Such an experience leads to an appreciation for electrification that is deeper and more effective than learning about the technology through reading or hearing about it. It might therefore help to overcome perceived barriers to switching. In Germany's EV extended trials, for example, people permitted to lease new BMW EVs for three months showed signs of reduced range anxiety over time, as well as increases in EV acceptance, perceptions of their usefulness, intentions to recommend them, and intentions to purchase (Franke et al. 2017). Third, some home energy measures, such as installing rooftop solar panels, provide an increased benefit when more home systems run on electricity, thereby creating a financial incentive for switching.

In our survey, we examined solar technology and electric lawn equipment as potential gateway technologies that could be the first steps toward whole-home electrification. However, based on co-adoption trends of EVs with solar photovoltaics and other technologies (Cousse and Wüstenhagen 2019; Chakraborty et al. 2023), we believe EV purchase and other efficiency measures could also be effective gateways. We embarked on this research after hearing anecdotes from a program manager at an American electric utility, but it is preliminary and would benefit from more in-depth survey and analysis.

The Lawn Equipment Gateway

The subsample of respondents to our survey who had a lawn and owned at least some electric (rather than gas-powered) lawn equipment were statistically significantly more likely to switch from gas to electricity for cooking (p = .003, 1.84 times more likely) and borderline

significantly more likely to switch to electric for home heating (p = .056, 1.33 times more likely) and for water heating (p = .062, 1.32 times more likely). Thus, encouraging the adoption of electric lawn equipment could be a good first step toward encouraging electrification of home cooking and possibly heat and hot water. Program administrators and utilities promoting home electrification should, therefore, consider providing lawn equipment electrification incentive and education programs as well. The DC Sustainable Energy Utility, for example, already offers residential lawn equipment rebates to qualified DC residents (DCSEU 2024).

We asked participants the following: "If your current lawn equipment broke down and you had the choice to replace it with new gas/diesel or electric equipment, which would you choose?" The best predictor of choosing to replace with electric lawn equipment is already owning at least some electric lawn equipment (p < .001). Unlike other electrification measures, having an all-electric home is not significantly associated with choosing electric lawn equipment (p = .577). Thus, this could be a good "first electrification" measure for many homes.

When participants who did not already own some electric lawn equipment (n = 665) chose to buy replacement lawn equipment that was electric (n = 174 of those), the top reasons they chose for doing so were that it is cleaner or better for the environment (38%), requires less maintenance (34%), makes less noise (32%), is more energy efficient (26%), and is cheaper to operate (27%). Participants who believed in climate change, voted Democratic, were not low-income qualified (i.e., above 200% of the Federal Poverty Level), and had higher household incomes were most likely to choose to switch to electric lawn equipment. Of these factors, belief in climate change was the only unique driving predictor of this decision, but this analysis was based on a small sample and should be confirmed with a larger study.

Using the information above to decide which groups to focus on in lawn equipment electrification campaigns—and what messages to use in those campaigns—can help utilities and program administrators craft effective marketing strategies to encourage adoption of this gateway technology.

The Solar Gateway

Bundling rooftop solar with EVs can lead to increased co-adoption (Chakraborty et al. 2023), and positive feelings about solar energy can lead to higher co-adoption of electrification measures (Cousse and Wüstenhagen 2019). Whatever the mechanism, it seems that solar adoption can encourage uptake of additional measures. For program administrators, focusing electrification campaigns on customers who have already adopted solar technologies is low-hanging fruit.

In our survey, respondents who owned some sort of residential solar technology (rooftop PV, solar PV with storage, solar hot-water heater, or other solar technology) were statistically significantly more likely than nonsolar owners to switch from gas to electricity for cooking

and water heating (all *p*s < .001, 1.8–2.11 times more likely) and borderline significantly more likely to switch to electricity for space heating ($p = .077$, 1.34 times more likely).

Hands-On Experience

Given the potential importance of hands-on experience with electrification measures through gateway technologies, other programs that provide this type of experience may also hold promise. For example, some municipalities (e.g., Ava Community Energy 2024) have induction cooktop lending programs that allow homeowners to try out induction cooktops and experience the benefits directly without the financial risks of purchasing a whole new range. Other programs provide contractors with direct experience using and installing electric heat pump technology. One such program, Philadelphia's Heat Pump Lab, brings installers on site for hands-on training at all levels—from high school students to seasoned contractors—with a special focus on low-income local residents (Takemura 2023). These programs are critical because contractors are an influential segment of the electrification ecosystem. Further research on the effectiveness of hands-on electrification programs is needed.

Working with Behavior Scientists and Communication Experts to Help Consumers Overcome Barriers

This report demonstrates that the barriers to electrification go beyond structural, physical, and financial barriers. Even in hypothetical scenarios in which electrification measures have the same cost and ease of installation as nonelectric alternatives, residents still choose to electrify less than half the time. Both the drivers and barriers to electrification measures are often behavioral and, as such, may be best addressed with psychological, behavioral, or communication-based strategies.

Behavioral science looks at residential electrification from a human-centered perspective, asking who the target audience is, why they are using or not using the service, what levers might encourage uptake, and how success can be measured. Behavioral scientists use their general understanding of human motivation and behavior to drive participation in these programs. Importantly, behavioral science also espouses an evidence-based systematic approach that builds in evaluation and analysis plans.

For example, behavioral scientists have demonstrated that enrollment in an electricity demand-side management program could be increased significantly by making program

sign-up a public act (Yoeli et al. 2013).[21] This new approach, which grew out of theories of human behavior, was four times more effective than the utility's previous strategy of offering a $25 incentive. A wide variety of similar behavioral intervention strategies have been applied for encouraging sustainable transportation choices (Sussman, Tan, and Kormos 2019) and use of public transit (Kormos, Sussman, and Rosenberg 2021). Such programs have varying levels of success, but with good testing and evaluation, they can be effective in many contexts.

Social and environmental psychologists, behavioral scientists, and other relevant academics can be easily reached through universities or nonprofit research groups such as ACEEE. For-profit behavioral science consulting companies can also offer these types of services.[22] It is important to engage behavioral scientists early in the program design process to not only help inform program design, but also to build in evaluation from the start. Ideally, these third-party experts are neutral and can conduct their work without bias or influence from interested parties.

Discussion

Program administrators and utilities working with marketing agencies can use information in this report to effectively target and tailor their outreach efforts. As shown in figure 4, this nationally representative survey revealed several important patterns about how U.S. citizens perceive electrification and their willingness (or unwillingness) to electrify their homes. In general, respondent feelings about fully converting their homes to all-electric ranged from neutral to slightly positive. However, fewer than half of respondents who were not already using electricity for heat, hot-water, or cooking systems/appliances chose to replace those systems (when broken) with electric versions. That said, those who already had all-electric homes or electric versions of the target end use preferred to stick with electricity when doing replacements.

[21] The program publicly posted sign-up sheets that required residents to print their name and unit number rather than an anonymous code.

[22] These types of organizations and companies can be found by searching online for "behavioral science research companies" or attending conferences such as Behavior, Energy & Climate Change (BECC). The BECC conference website, which includes an archive of agendas from prior years, can also be a useful resource: https://beccconference.org.

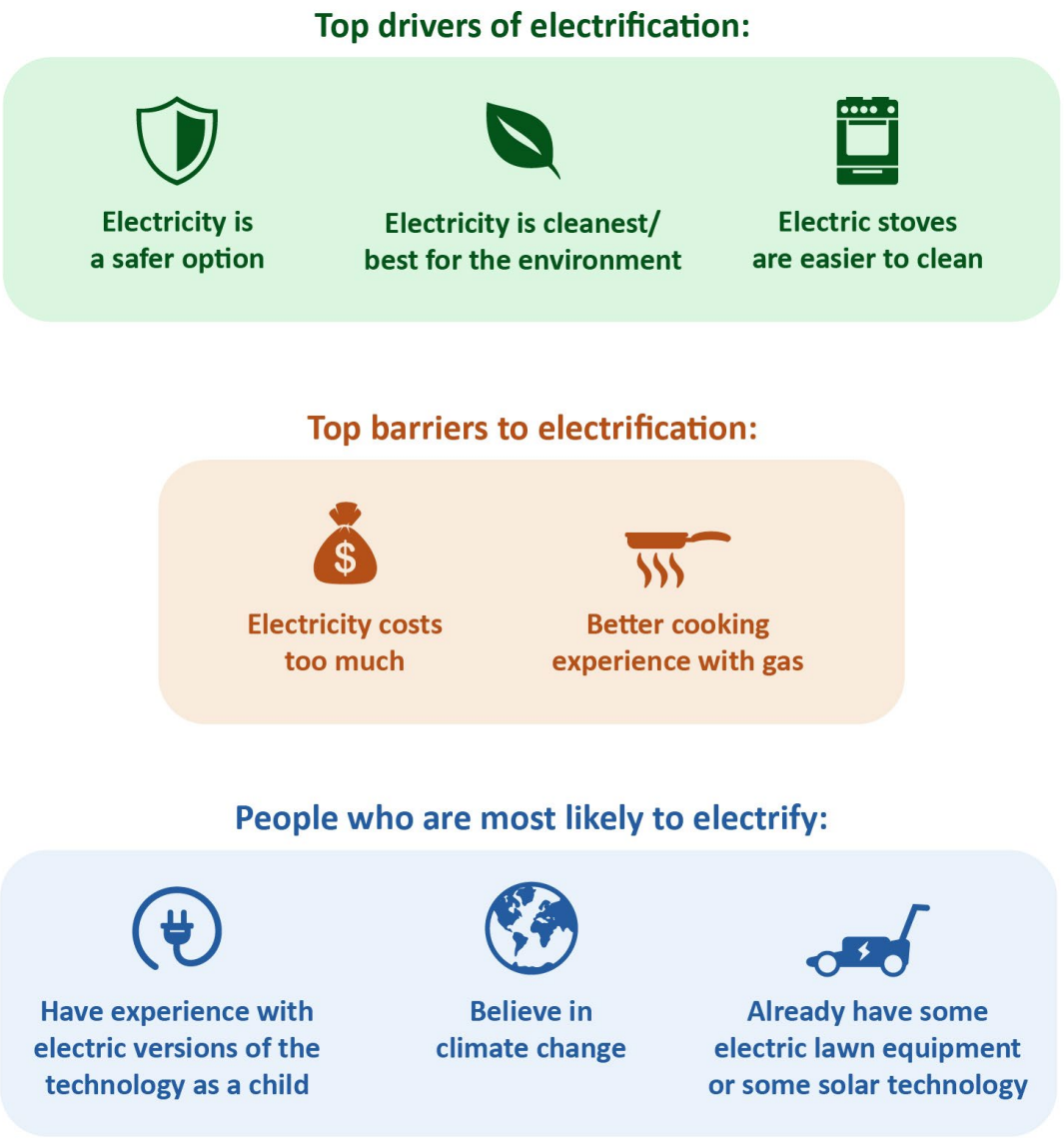

Figure 4. Summary of who is most likely to electrify and why (or why not)

FOCUS MESSAGING ON SAFETY, ENVIRONMENTAL SUSTAINABILITY, ENERGY EFFICIENCY, OR RELIABILITY

When respondents did choose to electrify heat, hot-water, or cooking systems, they usually cited safety, environmental sustainability, energy efficiency, or reliability as the reason. Cooking was unique in that a major motivator for switching was that electric stovetops are easier to clean. Focusing marketing efforts on these benefits could help to encourage electrification decisions. And, while all switches to electrification are pro-environmental actions, we found that focusing on the environment is a winning message for only a subsample of Americans. Tailoring messages for the target audience is key.

CHILDHOOD EXPERIENCE AND A BELIEF IN CLIMATE CHANGE

Respondents who wanted to switch from nonelectric to electric end uses tended to have childhood experiences with electric versions of that end use and a belief that climate change is definitely happening. These respondents live in an apartment building or duplex, vote Democratic, are in younger age groups, and have lived in their home for less than 10 years. For replacing central air-conditioning with a heat pump, belief in climate change and living in a newer home were also important influences. Therefore, consumers in these demographics could be good targets for electrification marketing campaigns by program administrators and their marketing partners.

Notably, belief in climate change may be associated with choosing to electrify, but this is not necessarily because electrification is perceived as a climate solution. Indeed, follow-up questions suggest that the connection between electrification and climate change mitigation is tenuous for many Americans. Further, not believing in climate change is a proxy for a set of underlying values, beliefs, and worldviews that likely affect perceptions of electrification and climate change. Given this, for consumers concerned about climate change, messages helping them see that electrification is a climate solution could be effective for promoting electrification.

OVERCOME PERCEIVED AND ACTUAL BARRIERS: COST, INEFFICIENCY, AND COOKING EXPERIENCE

Program administrators should also design programs and marketing efforts to address the most commonly cited barriers to electrification. Electricity cost (and perceived electricity cost) is the most cited barrier to electrifying home and hot-water heating. Sometimes this perception is accurate (in which case, rate design options should be considered; Yim and Subramanian 2023). When it is not, however, a behavioral science-based strategy and educational campaign showing the relative costs of electric and nonelectric options could be effective. For cooking, respondents preferred gas over electric predominantly because they think gas stoves offer a better cooking experience than electric options. This too could be overcome with behavior-based strategies that include gateway technologies (described below) or hands-on trial experience (e.g., extended EV use or induction cooktop lending programs).

These three perceptions (high cost, inefficiency, and inferior cooking experience) are in many cases based on outdated information (e.g., electric heat pumps are more efficient than traditional electric resistance heaters, and electric induction stovetops often provide a better cooking experience than old-style radiant electric versions). Although large-scale structural, policy, and programmatic solutions are needed to reduce the costs of electricity and high-end efficient electrification measures, misperceptions about electrification could benefit from behavior-based strategies. For example, creating stronger marketing campaigns highlighting some of the cooking and health benefits of induction stovetops (alongside other energy-saving benefits), or promoting gateway electrification technologies, such as electric lawn equipment, could help to increase interest and adoption rates.

PROMOTE GATEWAY ELECTRIFICATION TECHNOLOGIES: LAWN EQUIPMENT, SOLAR, AND MORE

Behavior-based strategies could also include direct-experience activities. Our data suggest that residents who gain hands-on experience through owning electric lawn equipment or solar technology are more likely to electrify their hot-water systems, heating systems, and (especially) stoves. Thus, targeting consumers who own these gateway technologies and offering programs that encourage their uptake could effectively shift consumers toward additional electrification measures.

PROVIDE INCENTIVES WHEN TECHNOLOGIES NEED REPLACING

In terms of policy support, respondents expressed greater support for homeowner tax credits and rebates (carrot policies) than policies that required replacing systems with electric options or required envelope upgrades alongside electrification upgrades (stick policies). Offering appliance rebates when an appliance breaks (or when the owner plans to replace it) is significantly more effective than doing so when the existing appliances are still working (and owners have no plans to buy new ones). Democratic voters were significantly more supportive than Independents and Republicans. Low-income respondents showed significantly more support than respondents with higher incomes for all polices except those based on tax credits.

RECOMMENDATIONS:

1. **Target electrification campaigns to those who are most open to switching.** Customers who have childhood experience with electric versions of the end use in question and those who believe climate change is happening were more likely to be open to electrification than other customers. These customers tended to vote Democratic, live in multifamily buildings or duplexes, be in younger age groups, and have lived in their homes for less than 10 years.
2. **Recommend electric options to customers with aging or broken appliances.** Program administrators should educate contractors on available tax credits so they can share them with customers when appliances need replacing. Financial incentives, such as the IRA's 30% tax credit for electric appliances, prove most effective when directed to consumers looking to replace a broken appliance than to those whose appliances are working properly.
3. **Use messages that highlight the right benefits**. For all three end uses, the most commonly mentioned benefits were the environment, health, safety, reliability, and perceptions of energy efficiency. For cooking, an important benefit is that electric stovetops are easier to clean. Although consumers who are willing to electrify are likely to believe in climate change, they may not perceive electrification as a climate solution. Messages that focus on environmental sustainability should therefore educate consumers on the connection between electrification and emissions reductions.

4. **Address perceived barriers through policies, programs, and behavioral strategies.** For heat and hot water, the perceived high cost of electricity was the most important barrier (and perceived inefficiency was second). For cooking, it was that the cooking experience was inferior (and that the costs of electricity are higher than gas). These perceived barriers reflect a mix of reality and misperceptions; as such, overcoming them requires a mix of both policies/programs and behavioral science-based approaches.
5. **Provide direct experience to help increase acceptance and adoption.** Encouraging the adoption of gateway electrification measures, such as electric lawn equipment or solar technology, may be an effective method to increase acceptance of additional electrification measures. Similarly, other programs that provide direct experience, such as hands-on induction cooktop lending programs, may also be effective.

Conclusion

Electrification is a critical step toward reducing energy use and mitigating climate change. Although current attitudes toward switching from fossil fuels to electricity are typically somewhat positive, they are not strong enough to move most Americans at the pace needed. Targeting the right audiences with the right messaging around benefits, and enacting programs and policies that help overcome perceived barriers will go a long way toward propelling electrification initiatives forward in a timely manner.

Behavioral science can help increase the rate of electrification with effective marketing and programming that is evidence based and backed by robust evaluation. It is especially important for promoting electrification measures such as electric cooking, which often has greater psychological barriers than structural or financial ones. When behavioral scientists work in concert with advocates, policymakers, and state energy offices, electrification can happen more quickly and effectively, leading to a brighter future for all.

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Appendix A: Survey

As we noted in the main text, our survey design was largely modeled on the Australia Institute's 2023 survey. To ensure that we achieved as close to a nationally representative sample of U.S. citizens 18 years or older as possible, we implemented participant quotas based on age, income, and region. Using the U.S. Census Bureau's American Community Survey (ACS) estimate data for 2022 and other U.S. Census Bureau datasets, we calculated national percentages of these demographic indicators (age, income, and region) and applied them to our sample size to determine our survey quotas.[23]

Using either a computer or mobile device, the respondents completed our web-based survey, which had a median completion time of 9.85 minutes. Individuals were recruited for our survey via ROI Rocket, a panel research company. Depending on how far respondents advanced throughout the survey, they were labeled as either "complete" or as "disqualified." The latter meant that they had missed both attention check questions and/or a particular quota that they met was already filled. The research team further sifted through the dataset of "complete" respondents to identify and remove poor quality responses characterized by straight lining answers, incoherent open-ended responses, a missed attention check, and other factors.

Survey Respondents

Category	Study sample (*n*)	U.S. average
Age		
18–24	10.5% (189)	9.4%
25–29	4.8% (86)	6.6%
30–34	11.5% (206)	7.0%
35–39	7.8% (140)	6.7%
40–44	8.0% (143)	6.5%
45–49	7.1% (127)	5.9%
50–54	9.8% (175)	6.3%
55–59	6.8% (122)	6.2%
60–64	9.9% (178)	6.5%
65–70	8.6% (155)	5.6%
70–74	6.2% (111)	4.6%
75 years or older	8.9% (160)	7.2%
Income		
Less than $10,000	5.1% (92)	5.5%
$10,000–24,999	10.6% (191)	10.5%
$25,000–49,999	18.7% (337)	18%

[23] Dataset S0101 was used for age, S1901 was used for income, and SCPRC-EST2022-18+POP was used for regions.

$50,000–99,999	29.5% (531)	29%
$100,000–199,999	25.3% (455)	25.6%
$200,000 or more	10.8% (194)	11.5%
Geographic region		
Northeast	19.4% (350)	17.5%
Midwest	21% (378)	20.5%
South	37.1% (669)	38.4%
West	22.4% (404)	23.6%
Home type		
Single-family detached home	69.9% (1259)	63.6%
Single-family attached home (e.g., duplex with exactly two units)	4.3% (77)	6.3%
Row house/townhouse with more than two units	4.1% (74)	24.7%
Condominium/apartment structure with up to six units	5.9% (106)	
Condominium/apartment structure with more than six units	10.4% (188)	
Manufactured/mobile home	3.6% (6)	5.2%
Home vintage		
Built 1939 or earlier	7.3% (131)	11.6%
Built 1940–1949	2.7% (49)	4.4%
Built 1950–1959	6.9% (124)	9.5%
Built 1960–1969	8.1% (146)	9.8%
Built 1970–1979	11.9% (215)	14%
Built 1980–1989	12.7% (228)	12.9%
Built 1990–1999	12.8 (230)	12%
Built 2000–2009	13.5% (244)	13.9%
Built 2010–2019	8.8% (159)	10%
Built 2020 or later	3.9% (71)	1.9%
Don't know	11.3% (204)	—
Ownership status		
Rent	28.3 (502)	34.8%
Own	71.6% (1269)	65.2%
Low-income		
Below 200% of federal poverty level	33% (392)	27.5%
Race		
American Indian or Alaska Native only	0.4% (9)	1.0%
Asian only	4.9% (89)	5.9%
Black or African-American only	6.9% (125)	12.2%
Hispanic, Latinx, or Spanish origin only	3.3% (60)	--
Native Hawaiian or other Pacific Islander	0.05% (1)	0.2%
Middle Eastern or Arab American	0.16% (3)	--
White only	77.1% (1390)	60.9%
Multiple races	5.8% (105)	12.5%
Prefer not to say	0.4% (8)	—

Other	0.7% (13)	—

Appendix B: Statistical Analyses

Here, we provide a basic summary of our statistical analyses. For more detailed results of specific tests, please contact the authors directly.

Demographic Predictors of Switching to Electricity for Each End Use

For each end use (heat, hot water, and cooking), we started by conducting a series of zero-order chi-square tests to learn which predictors, if any, were associated with choosing to replace a broken system or appliance with an electric version (i.e., choosing electric as opposed to nonelectric, a categorical choice). For each end use, we first used a chi-square test to examine whether currently having an all-electric home, or already using the electric version of that item, led to significantly more frequent choice electric replacements.

We then examined only the subset of participants that, for each end use, were not already using an electric version of the technology. With this subgroup, we conducted chi-square tests to learn which categorical variables had zero-order associations with decisions to switch to an electric version of the technology (i.e., to electrify that end use).

Finally, we constructed logistic regression models for each end use. Each model included only the significant zero-order predictors from the previous step. This allowed us to determine which variables were independent and unique predictors of electrification for each end use.

We used the same procedure as above for determining which variables predicted the decision to switch from central AC to heat pump, except that we used a linear regression rather than a logistic regression because the choice was continuous ("On a five-point scale, how likely would you be to switch from a central air-conditioning system to a heat pump capable of cooling and heating?").

Perceived Barriers to Electrification of Each End Use

For each end use (heat, hot water, and cooking), we hand-coded responses to the open-ended question that asked participants why they would not replace their broken system with an electric version. Next, we sorted the coded themes by frequency and reported them without further analysis. We then created frequency tables across all participants and across subgroups, identifying them by the above analyses as least likely to switch (i.e., 55 years or older, living in single-family detached homes/mobile homes/row houses, Republicans, homeowners, white, living in their homes for 10 or more years, and living in homes built before 1980).

Electrification Policy Preferences

We asked participants their degree of support for each one of five policy types on a Likert scale from (1) "very unsupportive" to (5) "very supportive." After calculating overall mean support for each policy across all participants, we examined three demographic variables to

determine if there were statistically significant differences between subgroups. For each policy, we conducted one-way ANOVAs comparing policy support levels among (1) Democrats, Republicans, and Independents; and (2) participants in four major census regions (Northeast Midwest, South, and West). We also conducted t-tests comparing low-income to non-low-income participants on policy support levels for each policy.

In addition to the policy support questions, the survey also included two questions about participants' likelihood (1= very unlikely to 5= very likely) of purchasing new efficient electric appliances given a 30% tax credit. One question asked for the likelihood of purchase to replace a working appliance, while the other was identical, but asked for the likelihood of purchase to replace a broken appliance. We conducted a paired samples t-test to determine if the difference in answers to the two questions was significantly greater than 0 (i.e., that the answers to the two questions were significantly different from one another).