



High-impact decisions that reduce household emissions

Findings from BETA's *Towards Net Zero* survey

August 2025

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Who?

Who are we?

We are the Behavioural Economics Team of the Australian Government, or BETA. We are the Australian Government's first central unit applying behavioural economics to improve public policy, programs and processes.

We use behavioural economics, science and psychology to improve policy outcomes. Our mission is to advance the wellbeing of Australians through the application and rigorous evaluation of behavioural insights to public policy and administration.

What is behavioural economics?

Economics has traditionally assumed people always make decisions in their best interests. Behavioural economics challenges this view by providing a more realistic model of human behaviour. It recognises we are systematically biased (for example, we tend to satisfy our present self rather than planning for the future) and can make decisions that conflict with our own interests.

What are behavioural insights and how are they useful for policy design?

Behavioural insights apply behavioural economics concepts to the real world by drawing on empirically-tested results. These new tools can inform the design of government interventions to improve the welfare of citizens.

Rather than expect citizens to be optimal decision makers, drawing on behavioural insights ensures policy makers will design policies that go with the grain of human behaviour. For example, citizens may struggle to make choices in their own best interests, such as saving more money. Policy makers can apply behavioural insights that preserve freedom, but encourage a different choice – by helping citizens to set a plan to save regularly.

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Executive summary

Home energy upgrades are a high-impact way for people to reduce their greenhouse gas emissions and energy bills, and increase comfort. Individuals and households will play a key role in progressing towards the Australian government's target of Net Zero emissions by 2050, in addition to major legislative, regulatory and infrastructure changes. Despite their benefits to households, the decisions around making home energy upgrades are not easy. They can be expensive, complex, inconvenient and time-consuming.

Understanding the capabilities, opportunities and motivations driving home energy upgrade decisions is the first step in identifying ways to increase uptake. In 2023, BETA ran an online survey with a sample of 4,891 Australians, which provides valuable insights to inform this discussion.

Key findings

Many Australians want to reduce their emissions. For some people, environmental sustainability motivates home upgrades. 47% who installed solar reported that *one* of their reasons to do so was to be environmentally sustainable.

However, **financial motivations and barriers often overpower other considerations.** Those who can afford to make upgrades are primarily motivated by long-term cost savings. 67% of people with solar panels said their *main* reason for doing so was to save on energy costs. Meanwhile, those with financial constraints are locked out of the decision to make upgrades. When asked what made the choice to get solar difficult, close to half cited cost. Apart from climate values and financial incentives, a range of other benefits are emerging, showing that **the value proposition for home energy upgrades is growing.**

Knowledge and confidence drive upgrade decisions, but are low. 18% of respondents did not know if their home had any insulation. Only 11% were confident that their home had ever had an energy assessment, and 38% of this group could not recall the rating. Only 8% of respondents were *very confident* that they knew which individual or household actions most limit greenhouse gas emissions; a further 34% were *fairly confident*.

Complicated information is difficult to absorb and complex decision-making environments can harm confidence. Behind cost, the second most common friction to installing solar was the complexity of choice. However, **clear information from helpful salespeople, installers and websites reduces complexity and enables action.**

Factors such as home ownership status, the physical characteristics of a home and available funds determine whether an upgrade is possible. 28% of our survey sample did not face any such 'hard' barriers. These **'hard' barriers for over 70% of respondents obstruct the home upgrade decision completely.** Meanwhile, factors such as low confidence and high complexity present 'softer' frictions, which are surmountable under the right conditions.

Summary of Behavioural Insights

People often weigh present costs more highly than future benefits

1. Make cost savings and payback periods on home energy upgrades salient to households.
2. Conduct research to understand which financial supports are most effective for different home upgrades, and for households with different income and asset levels.

Bundled benefits offer greater perceived value

3. Promote both financial and non-financial benefits of upgrades. Identify new benefits as they emerge and communicate them to the public.

Awareness is a critical pre-condition for action

4. Boost uptake of home energy assessments to increase knowledge of current home efficiency and tailored opportunities for improvement. To maximise impact and reach, ensure advice is timely, for example by bundling home upgrade advice with home renovations or sales.

Uncertainty and indecision often lead to inaction

5. Test what works to boost knowledge and confidence, and reduce uncertainty about making the wrong decision (e.g. choosing the wrong upgrade or paying too much). Consider tailoring advice, regulating the way choices are presented (e.g. through standardised quotes or rating scales), and correcting misinformation.
6. Test which types of advice and messages best translate into action. Consider the timing of messages (e.g. provide information when appliances need to be replaced), personal relevance (e.g. provide information relevant to individuals' current housing), and social encouragement (e.g. encourage people to share information with family and friends).

People are overwhelmed by complex, difficult tasks

7. Consider what parts of the decision and installation process can be simplified into easy steps. Provide information about home upgrades that breaks down technical jargon into digestible information. Offer rules of thumb that make the decision easier.
8. Conduct research to examine the specific antecedents and circumstances associated with different types of upgrades. Consider the unique motivations for each, and what 'timely' decision aids could look like for each.

Some hard barriers reduce the feasibility of home upgrades

9. Consider well-designed incentives for landlords that help renters, and incentives for community-based projects that benefit residents of multi-dwelling buildings.
10. Conduct research to identify ways to support households to optimise their solar energy generation and use. Consider ways to leverage technological advancements and automation to rely less on household habits, and more on set-and-forget decisions.

Why?

Policy context: Towards Net Zero

The Australian Government has legislated a target to reach greenhouse gas emission levels of 43% below 2005 levels by 2030, and Net Zero emissions by 2050 (Australian Government 2022). Major legislative, regulatory and infrastructure changes are underway in Australia to support the achievement of these Net Zero targets. Behaviour change at the individual and household level will further accelerate our progress towards Net Zero.

In Australia, residential buildings account for 11% of greenhouse gas emissions (DCCEEW 2023a). Among the actions individuals can take to limit their own greenhouse gas emissions, home upgrades are some of the most impactful.

Much of the Australian housing stock was built before energy standards were introduced, and therefore has substantial scope for energy efficiency improvements. On average, existing Australian homes rate 2.2 stars out of 10 in the Nationwide House Energy Rating Scheme (NatHERS), compared to 6.2 stars for new homes (Rajagopalan et al. 2023). The majority of home energy use is associated with heating and cooling (40% of household energy use) and appliances (25% of energy use) (DCCEEW 2023b).

High-impact household decisions are decisions that target significant sources of non-renewable energy consumption, and once made lead to a sustained reduction in greenhouse gas emissions, as shown in Table 1. Other decisions that relate to frequent, habitual behaviours, like switching off lights when not in use or having shorter showers, will be less impactful in reducing emissions.

Table 1. Emissions reduction potential of home energy upgrades

Home upgrade	Average emissions reduction potential (Ivanova et al. 2020)	% of average household emissions ¹
Replace old heating, cooling and hot water appliances with heat pump technology	Opting for heat pump technology (e.g. reverse cycle air conditioning for cooling and heating) could save an average of 0.8 tonnes of carbon dioxide equivalent per person per year (tCO ₂ eq/cap)	5%
Install roof, ceiling, and/or wall insulation	Improving thermal insulation and windows could save an average of 1.1 tCO ₂ eq/cap	7%
Apply double or triple glazing on windows		
Install rooftop solar panels	A household producing their own renewable energy could save an average of 1.3 tCO ₂ eq/cap	9%
Install rooftop solar panels with battery connected		
Replace an internal combustion engine (ICE) vehicle with an electric vehicle (EV)	Shifting from an ICE vehicle to a battery EV can save an average of 2 tCO ₂ eq/cap	13%
Total	5 tCO₂eq/cap	34%

In addition to reducing emissions, these upgrades have the co-benefits of reducing bills and making homes more comfortable to live in. The Energy Efficiency Council found increasing household ratings from one to 3 stars can reduce energy bills by around 30% and increasing from 3 to 5 stars can reduce bills by around 18% (DCCEEWc 2023).

Improving home energy efficiency, and supporting household decisions about energy use and appliance purchases, are priorities for governments across Australia. The Australian Government has invested \$1.6 billion to support home upgrades that improve energy efficiency. In addition, state, territory and local governments across the country have introduced policies to improve home energy efficiency. To boost uptake of high-impact emissions reductions actions by households, and to optimise government investment in this sector, we need to better understand the behavioural barriers and enablers of home upgrade decisions.

¹Assuming average Australian household of 2.6 people with annual emission of 15 CO₂eq (Ritchie et al. 2023)

Behavioural insights: what we know about home energy upgrade decisions

Australians want to reduce their greenhouse gas emissions

Previous survey work in Australia has shown that the overwhelming majority of Australians believe climate change is occurring (Richardson et al. 2022; The Sunrise Project 2022). There is evidence that environmental motivations are associated with home upgrades like rooftop solar, reducing carbon pollution is a frequently-cited reason for installing solar (Stolper et al. 2021).

Financial motivations appear to be even stronger. Reducing energy bills and saving money are the top reasons for buying or considering rooftop solar (Stolper et al. 2021). Rates of solar uptake are also sensitive to financial subsidies: postcodes in Australia that receive a higher subsidy under the Small-scale Renewable Energy Scheme also have higher levels of solar installations (Best et al. 2019a). We now want to understand how financial motivations are playing out in the current context of rising cost-of-living, lower feed-in tariffs and fluctuating rebates and incentives.

It is not always easy to know the best action to take

Research by Richardson et al. (2022) suggests that a majority of Australians are engaging widely in simple, cost-free behaviours such as switching off lights (around 86%). More complex, costly decisions such as the purchase of rooftop solar have been made by fewer Australian households (around 30% (ARENA 2024)). A Canadian survey found the more effective respondents perceive an action to be at reducing emissions, the more willing or likely they are to engage in it (Impact Canada n.d.). This suggests increasing knowledge of what behaviours are most effective could lift rates of those behaviours.

The information environment can be overwhelming for home energy upgrade decisions. Research from the Behavioural Insights Team (BIT) in the UK found that a decision like the purchase of a heat pump is a complex and long process, with multiple opportunities for confusion, cognitive overload and dissuasion by retailers or tradespeople (Park et al. 2023).

The decision is often influenced by factors outside people's control

High upfront costs can pose a high barrier for people to make upgrades, especially in low-income households (Park et al. 2023; ACTCOSS 2023). Beyond this, physical characteristics of a home can also mediate the uptake of upgrades. When it comes to solar, homeowners and those living in separate or semi-detached houses are much more likely to have solar panels than renters and those living in apartments (Best et al. 2019b). In a survey of the general population, the most common reason for *not* considering solar panels was 'I rent, so it's not my decision' (36%) (Stolper et al. 2021). Similarly, in the UK, a common reason for not considering making energy efficiency improvements is not owning their own home (Park et al. 2023).

Houses with more rooms and larger roof areas are also more likely to have solar panels (Best et al. 2019b). Older houses (those over 20 years) are less likely to install solar panels, perhaps because their roof or electrical wiring is not suitable for rooftop solar (Best et al. 2019b).

Upgrade decisions made by family, friends and neighbours could also affect the likelihood that a household makes upgrades in their own home (Palm 2017; Graziano and Gillingham 2014). This could be because seeing upgrades, such as solar panels, up and running on a neighbour's roof confirms that they can work free of hassle, particularly when it is hard to trial or observe the personal benefits of certain upgrades without the homeowner installing them (Palm 2017).

More research is needed to understand high-impact decisions

Through our scan of existing Australian and international literature described above, we also identified gaps in the research. While much of the literature focusses on habitual behaviours (such as recycling, switching off lights and reducing single-use plastic use), there was less information on high-impact decisions that offer *sustained* reductions in emissions. We were also interested in behaviours and the attitudes that underlie those behaviours, as many existing surveys focus only on attitudes and beliefs, rather than actions. Finally, as technology and policy landscape evolves, so too does the choice environment in which people make home upgrade decisions. We wanted a contemporary snapshot of how Australians are making the decision about home energy upgrades to better inform policy decisions.

We hypothesised that although upgrades offer environmental, financial and lifestyle benefits, the decision to upgrade is not easy, because upgrades can be expensive, the process of deciding which upgrades to prioritise can be complex, and installation can be inconvenient and time-consuming. We conducted research to test this hypothesis, and to generate evidence about how to support households to make home energy upgrades.

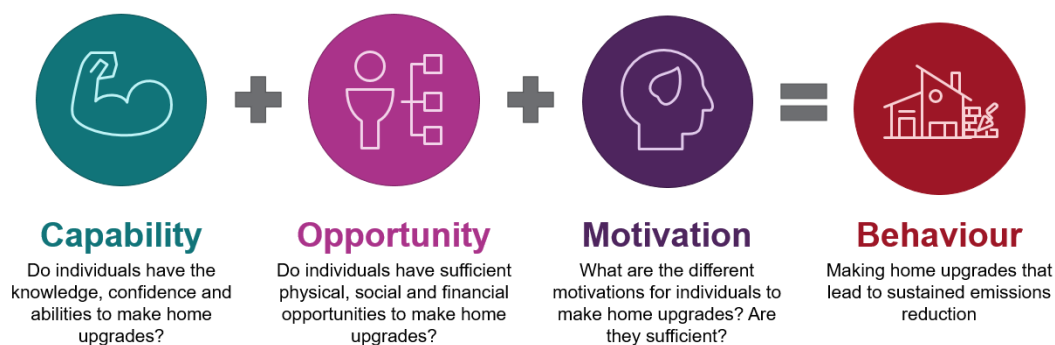
What we did

We addressed a gap in understanding motivations, capabilities and opportunities underlying a range of home energy upgrades in Australia. We designed a survey in consultation with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and the Australian Energy Regulator. The survey captures a snapshot of how Australians are currently making decisions about high-impact upgrades. The survey also captured experience of and response to cost of living pressures and these findings are the focus of another BETA report (forthcoming).

We used the COM-B framework (Michie et al. 2011) to examine the home upgrade decision, and to design and analyse the survey. COM-B considers whether a decision-maker has the capability, opportunity, and motivation to perform a certain behaviour. This framework allowed us to understand the unique decision-making context experienced by different cohorts of the population. The age and features of a home, available finances and local climate can make the most effective decision different for different households: for some, the best decision might be to seal gaps around windows and upgrade to a more efficient fridge, while for others it would be to invest in an EV or solar panels. Understanding these factors allows us to design effective interventions.

Figure 1 describes our key research questions (adapted from The Decision Lab, n.d.).

Figure 1. The decision to make home upgrades requires sufficient capability, opportunity, and motivation



Survey design

We ran an online survey of 4,891 Australians. Our sample was broadly representative of the Australian population on gender, age, and location (capital city or outside capital city). We oversampled the smaller States and Territories (Australian Capital Territory, Northern Territory and Tasmania) to allow analysis of cohorts within these regions. Full details about the demographic characteristics of our sample are available in the Technical Appendix.

Respondents were recruited through a panel provider (The Online Research Unit) and completed the survey on Qualtrics from 18 July to 28 August 2023. The survey took an average of 15 minutes to complete.

Survey questions

The survey questions fell into categories of capability, opportunity, motivations and home upgrade behaviours. We also included a spotlight on rooftop solar, cost of living and typical demographics questions. The survey contained 5 main modules:

- **Climate motivations** – we asked about attitudes, values and behaviours relevant to climate change to understand motivations for emissions reduction behaviours.
- **Home upgrades²** – we asked about existing energy infrastructure in respondents' homes, home upgrades they already have, and how much they know about the impact of upgrades on household emissions.
 - We were interested in respondents' **home energy efficiency 'literacy'**. We presented various hypothetical scenarios that involve realistic choices a householder might need to make when considering home upgrades. There was an objectively correct answer to each question in the context of greenhouse gas emission reduction goals.
- **Residential rooftop solar** – as uptake and awareness of solar is high compared to other home upgrades, we asked households with solar panels about their motivations for installing solar and how easy or difficult they found the process. For households without solar, we sought to understand their motivations and barriers.
- **Cost-of-living** – we asked about perceptions and experiences of the cost of living, particularly energy prices, to understand how rising costs impact respondents' values, priorities and behaviour.
- **Demographics** – we asked about personal characteristics including age, location, employment status and housing status, to facilitate a more nuanced understanding of enablers and barriers across different cohorts.

Analysis

We took an exploratory approach to the analysis of the survey results. We generated descriptive statistics and cross-tabulations and used the COM-B framework to guide our analysis. This provided a comprehensive overview of the range of influences on home upgrade behaviour.

Hierarchical regression

Some of our survey questions allowed us to compare the relative frequency with which respondents reported barriers and enablers to making upgrades, in order to estimate their relative importance. But with such a large number of factors associated with motivation,

² A note on terminology: in this report we use the term 'upgrades' to describe features and appliances that respondents currently have in their homes, or could consider purchasing or installing in the future. These include: double or triple window glazing; wall, ceiling or roof insulation; rooftop solar panels, and batteries connected to panels; gas or electric heating/cooking (including switching from gas to electric); and electric vehicles.

capability, and opportunity, it can be difficult to get an overall sense of which factors are the most critical in shaping behaviour.

We quantified the relative impact of a select group of barriers and enablers on solar uptake by using hierarchical regression models. Selection of predictors included in the models was based on existing literature. See the Technical Appendix for detailed regression results.

Qualitative analysis

For survey questions that prompted a free-text response, we analysed responses using a grounded theory approach. We used the TextIQ function within Qualtrics to iteratively code free-text responses into common categories. The coding, manually completed by a researcher, was compared to the topic recommendations generated through Qualtrics' machine learning topic generator to check for missing categories. We then manually analysed categories of responses for sentiment and common experiences to complement quantitative findings from the survey.

Opportunities for additional analysis

Our survey was designed to explore multiple research topics, and there is extensive scope for further analysis beyond what is detailed in this report. In this report, we focus on factors associated with uptake of home upgrades. Additional analysis will be used to inform future BETA research and publications. De-identified unit-level data from this survey will also be made accessible on the Australian Data Archive.

Limitations

As with any research, our survey has limitations which should be considered when interpreting our results. For example, in our survey we ask people to recall a past behaviour, and think about future intentions. While these self-reports are useful, they do not always reflect how people actually have behaved or will behave. Another consideration is that while our sample is large and broadly representative of the Australian population on many measures, we did not use probability-based sampling.

In light of these limitations, we have taken care in interpreting the results of our survey. We do not make any causal claims, nor do we claim that our findings can be extrapolated to the general population.

Results

A snapshot of Australian homes

Table 2 shows the home upgrades reported by our survey respondents. 71% reported having roof, ceiling, and/or wall insulation. Rooftop solar panels was the next most common home upgrade. The newer technologies of batteries and EVs were reported by fewer than 10% of our respondents.

Table 2. Prevalence of home upgrades among our sample^{3 4}

Home upgrades	% of respondents with the home upgrade
Insulation (roof, ceiling, and/or wall)	71%
Rooftop solar panels	39%
Double or triple glazing on windows	21%
Have ever replaced gas with electric appliances	12%
Battery connected to rooftop solar	7%
EV	3%
None of the above (including 'don't know')	21%

Environmental sustainability motivations are part of the equation

Key insight: Many Australians want to reduce emissions. For some people, environmental sustainability drives the choice to make home upgrades.

People care about limiting their own emissions

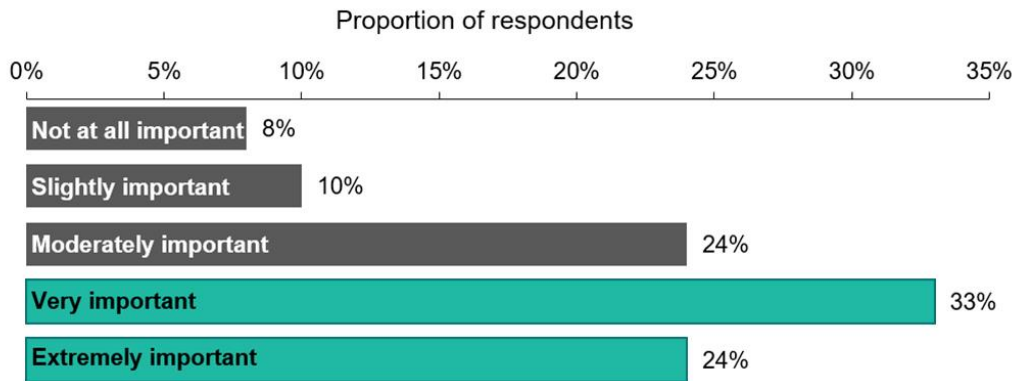
Our survey respondents showed strong support for collective action to mitigate climate change. Four out of five respondents agreed that climate change is real. Most (75%) agreed that if we act collectively, we can limit climate change. Two thirds of respondents believed that their actions can have a positive effect on climate change. Figure 2 shows that a majority

³ 'Have replaced gas with electric' includes respondents who have replaced gas appliances with electric ones, and those who have disconnected a gas connection.

⁴ Percentages in this table add up to more than 100% because respondents could select more than one type of upgrade.

of respondents thought it was *extremely important* (24%) or *very important* (33%) that they limit their own greenhouse gas emissions.

Figure 2. Most survey respondents thought it was very or extremely important that they limit their own greenhouse gas emissions.

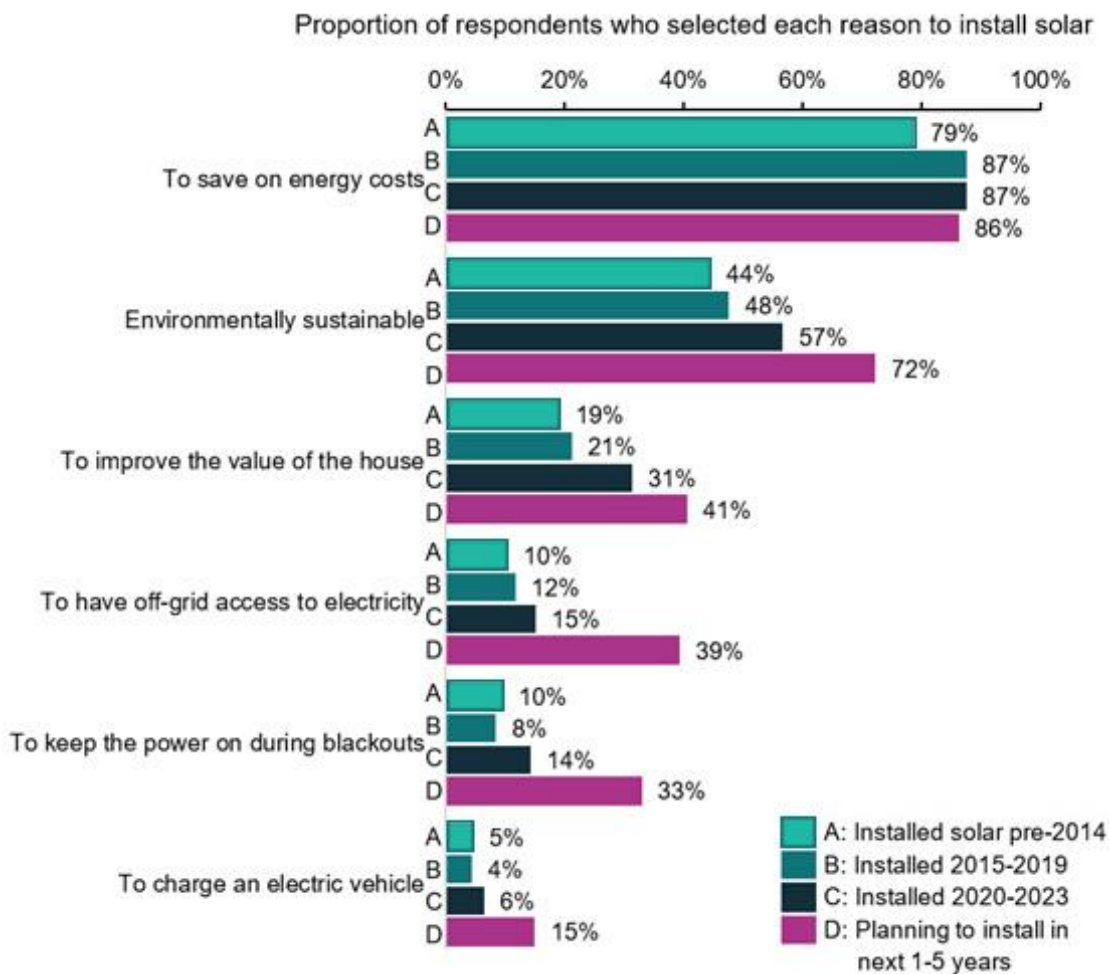


Question text: 'How important is it to you that you limit your greenhouse gas emissions?' $n=4,880$

Environmental sustainability motivations

Of the respondents who had installed solar panels, 47% said one reason was to be environmentally sustainable. This appears to be an increasingly popular motivation: compared to those who installed solar some time ago, respondents who have installed solar since 2020, or who plan to install it soon, were much more likely to value environmental sustainability (see Figure 3).

Figure 3. The new generation of households planning to install solar are interested in a broader range of benefits than cost savings.



Note. 480 respondents (represented by the purple bars) said they were planning to install solar panels in the next 5 years. 1,884 respondents said they had already installed solar panels. Each of these groups were asked their main reason for installing [or wanting to install] rooftop solar.⁵

⁵ Respondents could select multiple reasons for installing, or wanting to install, solar panels.

Financial factors dominate the home upgrade decision

Key insight: Financial motivations and barriers often overpower other motivations. Those who can afford to make upgrades are primarily motivated by long-term energy cost savings, while those with financial constraints are locked out of the decision to make upgrades.

Financial motivations

Of the respondents with solar panels, the most common *main* reason for installing solar was financial; 67% said their main reason for installing solar was *to save on energy costs* (compared to 14% who selected *to be environmentally sustainable*).

"I earn money [from solar feed-in tariffs]. I couldn't give a damn about climate change."

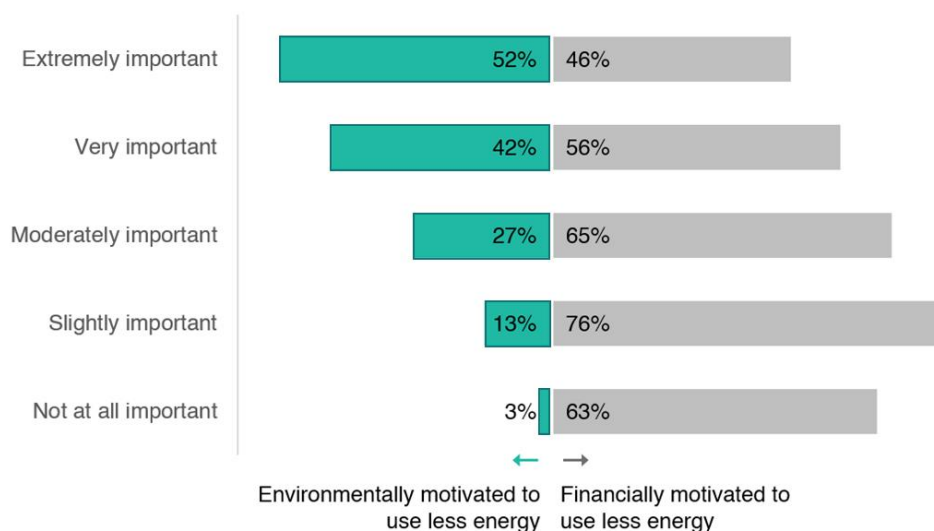
Respondent with solar, man aged 75+, QLD

This trend, in which the potential for financial savings overpowers the desire to be environmentally sustainable, was consistent throughout our survey. Cost savings drive desire to reduce energy use and grid reliance

An overwhelming 93% of respondents reported wanting to use less energy. A majority (58%) said they wanted to use less energy in order to *lower the cost of their energy bill*, while the remaining 35% said it is *better for the environment*. As Figure 4 shows, for respondents who think it is very or extremely important to limit their emissions, environmental and cost motivations were roughly on par (42/56%). However, for those who are not as driven to limit their emissions, energy bill cost savings were a much bigger driver of using less energy (63-76%) than environmental concerns (3-13%).

Figure 4. Nearly half of people who believe it is important to reduce their greenhouse gas emissions choose lowering energy bills as their main reason for wanting to use less energy.

Importance of greenhouse gas emission reduction by proportion of respondents who were **environmentally** or **financially** motivated to use less energy



Question text: 'How important is it to you that you limit your greenhouse gas emissions?' cross-tabulated with 'Do you want to use less energy?' | n=4,880

Respondents who installed batteries were asked why they chose to do so. Of the 333 text responses, most were seeking some level of grid independence, primarily to save money or to have more control over their bills.

“So I could sell power back to grid when the wholesale price peaks.”

Respondent with solar and battery, man aged 45-54, SA

Cost-of-living pressures are not driving home upgrade decisions

Cost-of-living pressures were highly salient at the time respondents were completing the survey, with rising energy prices, interest rates, and inflation. Making an upgrade to reduce energy costs in the future can therefore be an effective response to rising costs.

In our survey, we found evidence that only a small number of respondents are behaving like this. When we asked people without solar panels if anything was making the choice to get solar panels easier, some respondents said rising energy prices and bills meant the decision to get solar panels had become easier.

“The cost of purchasing will offset the cost of increasing energy bills.”

Respondent without solar, man aged 55 – 64, SA

However, rising cost-of-living more commonly led to other behaviours that were unrelated to home upgrades. We asked respondents who reported experiencing cost-of-living pressures how they were managing those pressures. Common responses included *cut back on optional spending* (58%), *used savings (or saved less)* (46%), and *turning appliances off or down* (39%). Only a small number of respondents reported making home upgrades: 6% reported *upgrading to more efficient appliances* and 4% reported *renovating to increase home energy efficiency*.

Upfront costs pose high friction in the upgrade decision

The significant upfront cost of home upgrades is one important reason home upgrades are not more common. When we asked people with solar what made installing solar more difficult, the most commonly-reported barrier was financial. Respondents cited the upfront cost of purchasing and installing the panels, along with reduced tariffs. Cost was also the most common reason people with solar panels had not purchased batteries. Among people who do not have solar, the barrier of cost was even more common. Nearly half of free-text responses cited cost as the main reason the choice to get rooftop solar was difficult. Respondents also referred to competing financial priorities:

“Cost. We have budgeted our money for other things at the moment and solar is not a priority.”

Respondent without solar, woman aged 35 – 44, QLD

The amount of savings available to a household influences upgrade decisions. A majority of respondents (64%) planning to install solar intended to finance it with savings (as opposed to credit cards or loans). When we asked respondents who had solar if anything made the process of installing solar easier, around a third of responses mentioned financial incentives such as government subsidies or interest free loans.

“A good discount from the Government for installing solar panels.”

Respondent with solar, woman aged 55 – 64, SA

We also asked respondents with solar if they had been exposed to certain cues in their environment that might have encouraged the purchase of solar panels. Of respondents who had panels installed recently⁶, 46% reported hearing about *government subsidies or rebates for solar*. This was the most commonly reported cue (more common than *noticing friends or family install solar*, or coming across a *helpful website*). *Loans or finance options* were also less common, with 14% of respondents who had installed solar recently reporting noticing these.

The value proposition for home upgrades is growing

Key insight: Apart from climate values and financial incentives, a range of other factors are increasingly influencing decisions about home upgrades.

New motivations to install rooftop solar are emerging

Financial and environmental factors were dominant motivations for home upgrades, but a minority of respondents selected other reasons. For example, respondents with solar panels reported that reasons for installing solar included *to improve the value of the house* (23%), *to have off-grid electricity* (12%), *to keep the power on during blackouts* (10%) and *to charge an electric vehicle* (5%). Figure 3 shows these reasons are increasing in popularity, with more people who have installed solar since 2020, or who plan to install it soon, selecting these reasons, compared to people who installed solar some time ago.

The behaviours, opinions, and recommendations of others can influence decisions about certain upgrades. For example, some respondents who had installed solar panels recently reported noticing friends, family, or a neighbour installing solar, before they themselves got solar installed. More than a third (37%) noticed that friends or family had solar or a battery installed, while one in 5 noticed a neighbour had solar or a battery installed.

Knowledge and confidence play a role

Key insight: Knowledge and confidence drive upgrade decisions. Complicated information is difficult to absorb and complex decision-making environments can harm confidence.

People understand the role of home upgrades in emissions reduction

Early in the survey, we asked respondents an open-ended question: *What do you think is the most important action an individual or household can take to limit greenhouse gas emissions?* The following were the 6 most common themes from free-text responses, suggesting people understand the fundamentals of climate change and the actions they can take to limit emissions:

1. Use less energy from fossil fuels and/or switch to renewable energy

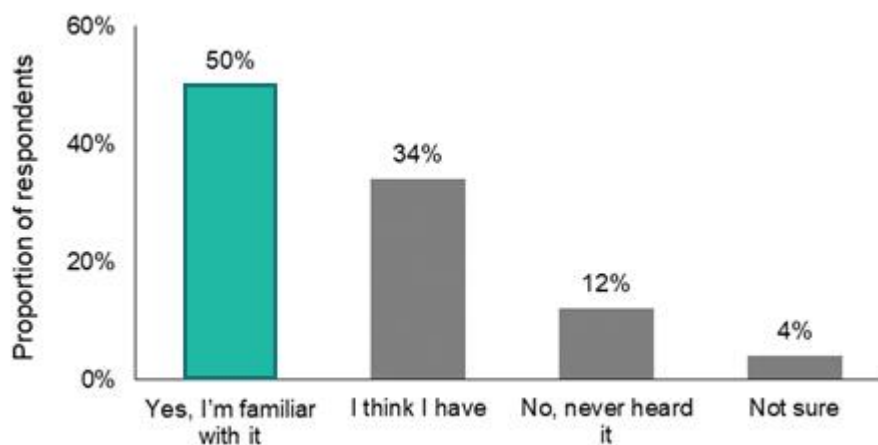
⁶ Here, we report results for people who reported installing solar since 2020. We are more interested in people who installed solar recently, because the policy landscape and retail environment has shifted significantly since solar first became available to households.

2. Generally consume less
3. Reduce private vehicle use
4. Recycle
5. Install solar panels on private homes
6. Reduce waste.

Solar panels and EVs were more commonly named as ways to reduce a household's emissions, compared to other forms of home upgrades (such as heat pump technology, insulation and window glazing). This finding suggests there may be limited awareness of these other home upgrades and how they can reduce household emissions.

While our survey respondents generally had good awareness about the fundamentals of climate change, awareness for newer terms like 'Net Zero' is lower. As Figure 5 shows, half of respondents were familiar with the term.

Figure 5. Half of our survey respondents were familiar with the term 'net zero'.



Question text: 'Have you heard the term net zero before when talking about climate change?' | n=4,888

Knowledge of current home features is low

Some respondents in our survey did not know important details about their home infrastructure. For example, 18% did not know if their home had any insulation, while 14% did not know if their home had double or triple-glazed windows. Knowledge was even lower for renters than owners. Of renters, 35% did not know if their home had any insulation, compared to 10% of owners. Of renters, 26% did not know if they had double- or triple-glazed windows, compared to 8% of owners.

Home energy assessments can be powerful sources of information about greenhouse gas emissions – assessments provide an objective overall rating, customised recommendations, and can quantify the emissions-reducing impact of home upgrades. However, we found people had very low levels of knowledge about home energy assessments. Only 11% of respondents were confident that their home had ever had an energy assessment. Of this small group, 52% did not know which rating scheme was used in the assessment and more than a third (38%) could not recall how many stars it had rated.

Awareness varied substantially by jurisdiction. Nearly 40% of respondents living in the ACT were confident that their home had at some stage had an energy assessment, and most

knew the star rating. This awareness far exceeds that of other jurisdictions: the proportion of respondents reporting a known energy assessment ranged from 8% in Queensland to 14% in the Northern Territory

Room for improvement in knowledge about reducing emissions

We presented respondents with several scenarios, and asked which action was best for limiting greenhouse gas emissions to gauge their energy efficiency 'literacy'. The scenarios were short but presented enough context so that each had an objectively correct answer. The average accuracy rate across the whole sample was 63% (between 2 and 3 correct answers out of 4). The Technical Appendix describes all 8 scenarios in full, along with the percentage of respondents who responded to each scenario correctly.

Of the 8 scenarios, the scenario which elicited the highest proportion of correct answers asked whether a hypothetical person living in Cairns and working from home should replace her large, 25 year old air-conditioning unit with a new, more energy efficient one, or keep her current unit until it breaks down. Of the respondents, 79% of people correctly identified that the air-conditioning unit should be replaced straight away, while 13% recommended keeping it and 8% didn't know.

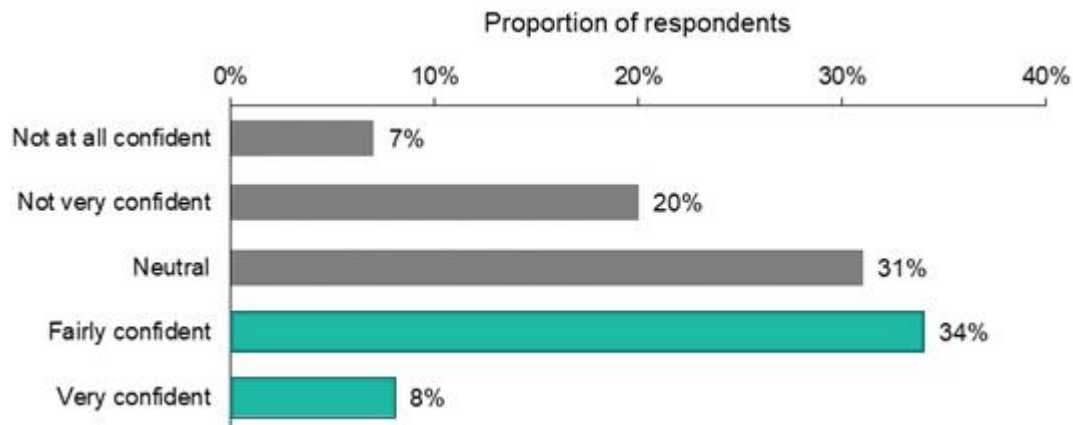
Survey respondents' self-reported confidence that they knew which actions most limit greenhouse gas emissions did not predict accuracy on these scenario questions. People who reported they were *very confident* had an average accuracy rate of 63%, which was much the same as those who were *fairly confident* (68%) and those who were *not very confident* (65%).

However, people who believed it was important to limit their emissions did score higher. People who felt it was *extremely important* or *very important* had an average accuracy rate of 67-69%, which was higher than those who felt it was *moderately important* (61%), *slightly important* (59%) or *not at all important* (45%). It is not clear from our survey data whether environmental motivations drive accurate knowledge, or knowledge drives motivations.

Most people unsure which home upgrades most reduce their emissions

In our survey, we found that only a minority of survey respondents felt confident that they know what actions best reduce greenhouse gas emissions. As Figure 6 shows, only 8% of respondents were *very confident* that they knew which individual or household actions most limit greenhouse gas emissions; a further 34% were *fairly confident*.

Figure 6. Only 8% of our survey respondents were very confident about which actions most limit greenhouse gas emissions.

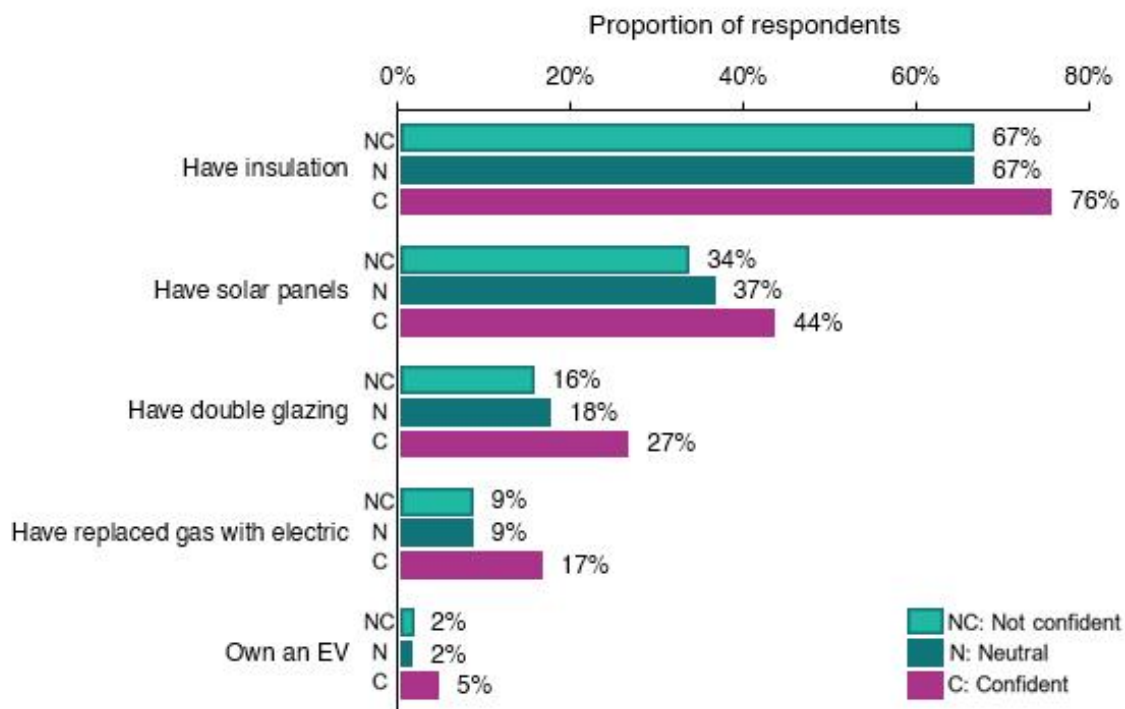


Question text: 'How confident are you that you know which individual or household actions most limit greenhouse gas emissions?' | n=4,880

Respondents' confidence about actions suitable for their particular household was also low. Over 60% of our sample thought that a renovation or upgrade would likely reduce their energy bills⁷. But of this group, only 20% were *very confident* that they could choose the right renovation or upgrade. Figure 7 shows that individuals who were *confident* had higher rates of uptake of *all* home upgrades compared to individuals who were *not confident*.

⁷ Energy bill reduction is a suitable proxy for emissions reductions because of the proportional relationship between energy bills and energy consumption.

Figure 7. Respondents who were confident about which actions most limit greenhouse gas emissions were more likely to have upgrades than those who were not confident.



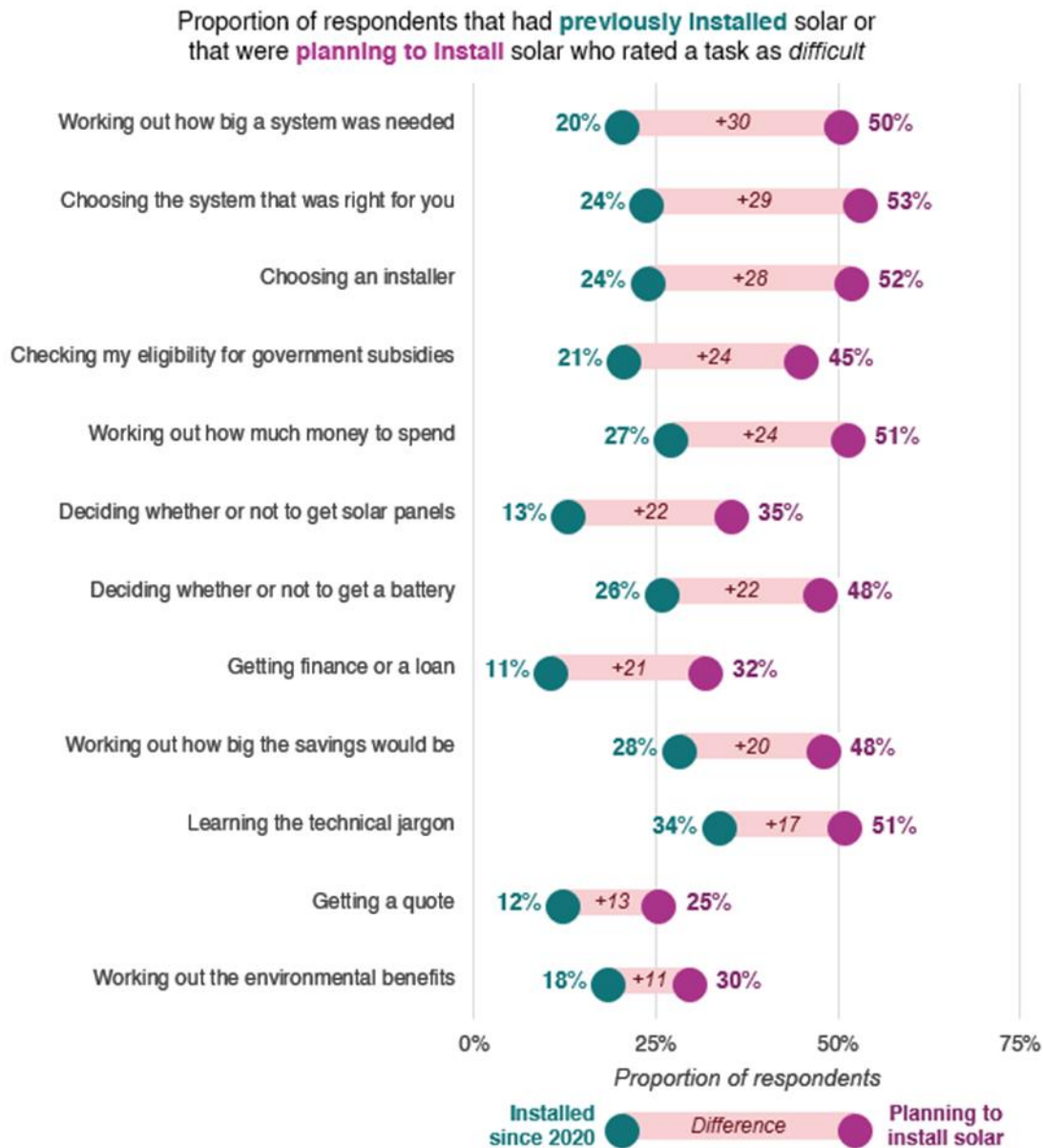
Question text: 'Does your current home have insulation/solar panels/double or triple glazing' | $n=4,880/4,863/4,881$ and 'Have you ever replaced gas with electric appliances?'⁸ | $n=3,060$ cross-tabulated with 'How confident are you that you know which individual or household actions most limit greenhouse gas emissions?'

Multiple pain points slow down research into solar installation

Complex decision-making environments can reduce people's confidence in their ability to make the right decision, or even one that is good enough. Respondents in our survey who were planning to install solar within the next 5 years perceived many associated tasks to be difficult. Figure 8 shows that more than 50% of this group found it *difficult* to choose the system that was right for them, choose an installer, work out how much money to spend, learn the technical jargon and work out how big the system would be. Among respondents who had installed solar, we found that the task they most frequently rated as difficult was learning the technical jargon. Unsurprisingly, those people find the steps to install solar harder while investigating it, compared to those who have completed the steps.

⁸ 'Have replaced gas with electric' includes respondents who have replaced gas appliances with electric ones, and those who have disconnected a gas connection.

Figure 8. Households planning to install solar panels find many of the tasks more difficult than those who have completed solar installation.



Question text: 'These are some of the tasks that people might do when making the choice to get solar panels. Did you find [are you finding] these tasks easy or hard?' | n=1,690-1,697 [385-388] cross-tabulated with a derived variable indicating whether respondents have installed solar panels since 2020, or indicated that they plan to install within the next 5 years

Helpful information eases complexity of upgrade decisions

When we asked an open-ended question about what makes the process of considering and installing solar difficult, both respondents with and without solar said complexity was a source of difficulty. Behind cost, the second most common friction mentioned was the complexity of choice, including the sheer number of options available to consumers.

"Yes there are so many companies with different prices, made it difficult to trust anyone and made it difficult to choose."

Respondent with solar, woman aged 35 – 44, VIC

“Trying to figure out the options – so many and difficult to differentiate.”

Respondent without solar, woman aged 55 – 64, TAS

On the other hand, having assistance in sifting through this information can make installing solar panels easier.

“A comprehensive series of quotes offering different solutions and a detailed explanation of the different scenarios/expected outcomes. Good customer service.”

Respondent with solar, woman aged 55 – 64, ACT

“Family members who already had solar broke down the basics for me and ‘demystified’ solar so that I could ask more targeted questions with salespeople.”

Respondent with solar, woman aged 45 – 54, SA

When asked what they had noticed before installing solar panels, of respondents who had installed solar recently, 31% said they were provided with helpful information from a salesperson or installer, while 23% came across a website containing helpful information.

Overcoming the odds: ‘hard’ barriers and ‘soft’ frictions

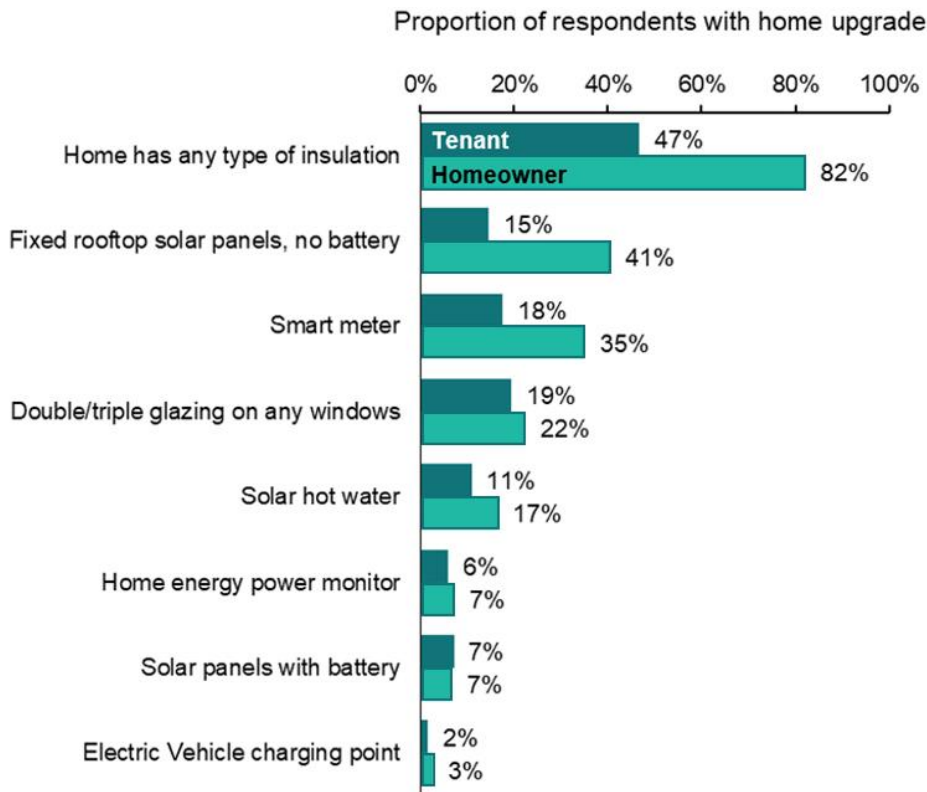
Key insight: Factors such as home ownership status, the physical characteristics of a home and available funds determine whether an upgrade is possible. These ‘hard’ barriers obstruct the home upgrade decision altogether, whereas ‘softer’ frictions such as low confidence and high complexity are surmountable under the right conditions.

Home ownership and physical features of the home can pose a barrier

“I don’t own the house I live in and am prevented from making such additions.”

Respondent without solar, man aged 45 – 54, NT

In our survey, homeowners were more likely than tenants to report having almost all of the home upgrades we asked about. As Figure 9 shows, 82% of homeowners reported having insulation, compared to only 47% of tenants (although this likely to be an underestimation of actual insulation rates in rental properties, because tenants may lack knowledge).

Figure 9. Homeowners are more likely to have home upgrades than tenants

Question text: 'Is your home ... [rented from a private landlord or real estate, rented from government or community housing, being paid off, owned outright, other arrangement]', cross-tabulated with 'Does your home have any of the following features' | $n=4,863$ and 'Does your current home have insulation/double or triple glazing' | $n=4,880$

Regardless of home ownership status, living in a freestanding house increases the likelihood of having solar panels. In a regression analysis, we found that living in a house had the largest effect on solar uptake of all predictors tested (see Technical Appendix 3 for full details about the regression). In our sample, 48% of respondents in freestanding houses had solar panels, compared to 24% of those in semi-detached houses or townhouses and 11% of those in flats or apartments.

There are other barriers which make solar panels less compelling

Some respondents with a freestanding house did not want rooftop solar (10% *No*, 16% *Not really*), but many of these respondents had already investigated solar and determined that it was not feasible. Sometimes it was not feasible for financial reasons, other times because of the physical structure or location of their home (e.g. too much shading on the roof).

"I had an energy audit and I use so little electricity it wasn't deemed viable."

Respondent without solar, woman aged 45 – 54, NT

"We tried, due to orientation and design it is not cost effective at present."

Respondent without solar, man aged 45 – 54, WA

In a regression analysis, we found that people living in solar zone 4 (areas of the country that receive the least sunlight) were significantly less likely to have solar panels than people living in solar zones 1, 2, or 3.

Some respondents reported wanting solar panels, but having no plans to purchase and install. Some of this group said they were anticipating, or in the process of making, a housing transition. It was not the right time to install solar panels because they were building a larger family home or downsizing for retirement.

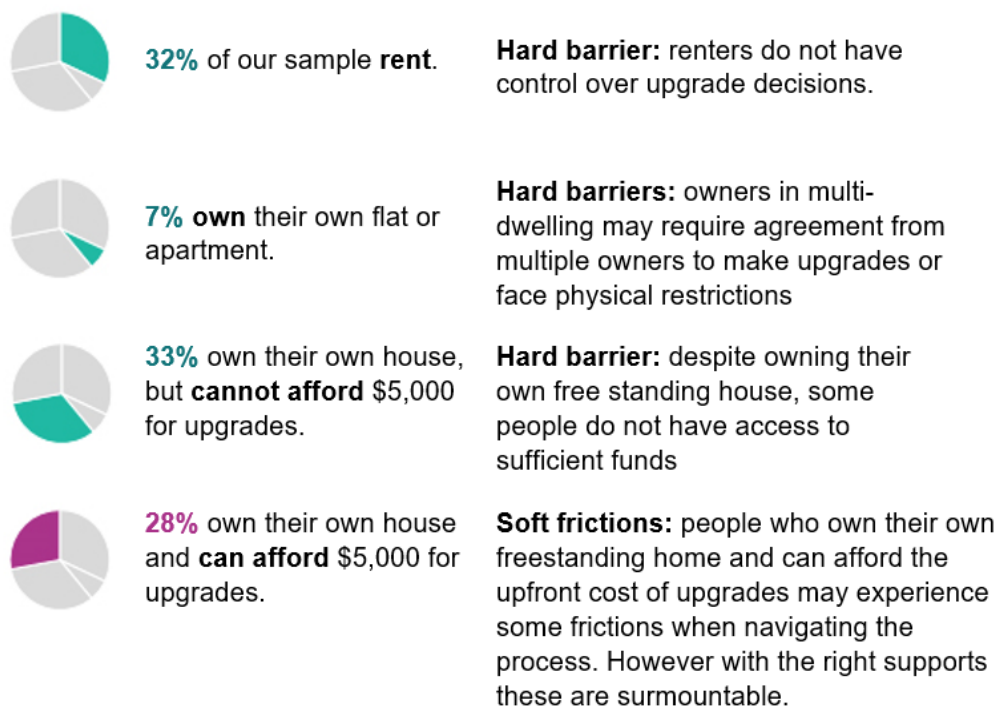
“I do not intend to be in my current house for much longer, I will be upgrading in a few years when I have kids. I do not see the point in forking out a few grand, when it is unlikely I would see a return on my energy savings in that time.”

Respondent without solar, woman aged 18 – 24, WA

A large majority face at least one hard barrier to home upgrades

We examined what proportion of our sample are facing some of the hard barriers described above. **Error! Reference source not found.** shows that of our total survey sample, 32% rent or are in other housing situations where they do not have control over upgrade decisions. Others live in apartments or flats, requiring agreement from multiple owners to make upgrades possible, and would face physical restrictions (like sharing walls, roofs or heating systems). Insufficient savings to fund upgrades also pose a barrier for some. In our sample, this leaves 28% of respondents who do not face any of these barriers.

Figure 10. Proportion of household facing barriers to home upgrades⁹



Question text: 'Is your home ... [rented from a private landlord or real estate, rented from government or community housing, being paid off, owned outright, other arrangement]', cross-tabulated with 'Imagine

⁹ These barriers were selected as they impede all home energy upgrades listed in Table 1 (except replacing an ICE vehicle with EV).

*you wanted to make your home more energy efficient (such as by adding insulation, solar panels or by replacing a major appliance) and you were confident it would save you a lot of money on future energy bills. How much could you **afford** to pay upfront? (without needing a loan or credit)?*

Many of these respondents, who can afford \$5,000 or more for a home upgrade and own a house, already have some types of upgrades in place. Table 3 shows that insulation and rooftop solar are the most common types of upgrade completed by people who have the opportunity and means.

Table 3. Prevalence of home upgrades amongst those with the opportunity and means¹⁰

Home upgrades	% of respondents with the home upgrade
Insulation (roof, ceiling, and/or wall)	89%
Rooftop solar panels	57%
Double or triple glazing on windows	23%
Have ever replaced gas with electric appliances	14%
Battery connected to rooftop solar	8%
None of the above (including 'don't know')	6%

Our survey revealed untapped potential of high 'flexibility capital'

Optimising the emissions-reducing potential of solar energy is aided by having greater 'flexibility capital' (Powells and Fell 2019), whereby more energy consumption can be shifted to the daylight hours when solar panels are producing energy. Some households will be more flexible than others, for example because they have someone at home during the day who can adjust when they use appliances like dishwashers and washing machines.

In our sample, 53% of households currently have someone at home during the day *all or most of the time* and a further 19% have someone home *half of the time*. Households with solar panels have someone at home slightly more often than households without solar panels: 59% of households with solar panels have someone at home *all or most of the time* compared to 50% of households *without* solar panels.

Surprisingly, having someone at home during the day did not impact satisfaction with solar panels: 64% of respondents with someone at home *all or most of the time* were satisfied compared to 61% of respondents with someone at home *hardly ever* or *never*. We explore why this might be the case further in the Discussion and conclusion.

¹⁰ 'Have replaced gas with electric' includes respondents who have replaced gas appliances with electric ones, and those who have disconnected a gas connection.

Bringing it all together with COM-B

The behaviour: Home upgrades

Rates of some upgrades are high, including world-leading rates of rooftop solar uptake. However, there is room for improvement, especially in thermal and appliance upgrades.

Capability

Do individuals have the knowledge, confidence and abilities to make home upgrades?

Our survey respondents showed knowledge of fundamentals of climate change, and the role of home upgrades in emissions reduction. However, knowledge about their own home features, and confidence about which upgrades would most reduce their emissions were low. Assistance in sifting through options helped reduce complexity for respondents exploring solar installation.

Opportunity

Do individuals have sufficient physical, social and financial opportunities to make home upgrades?

The physical characteristics of a person's home is one of the main constraints in upgrade decisions, and dictates whether upgrades are possible at all. The behaviours, opinions, and recommendations of others can influence decisions about certain upgrades. But ultimately, the hard barriers posed by upfront costs, climate zone and permissions needed to install upgrades each obstruct a person on their journey from considering an upgrade to making it. Just over 25% of our survey respondents faced none of these hard barriers to installation.

Motivation

What are the different motivations for individuals to make home upgrades? Are they sufficient?

The primary motivation for survey respondents who had made upgrades was cost-saving – even among those who value limiting their own emissions. For many, environmental motivations were neither necessary nor sufficient to drive the decision to make home upgrades. Ultimately, households are not necessarily making a choice between the environment and cost savings; a good home upgrade can do both, and more. For people contemplating an upgrade, the benefits are often bundled with comfort and/or convenience, and this is what creates the most compelling value proposition.

Discussion and conclusion

Australia has embarked on its journey towards Net Zero. We are now at a critical juncture where we can harness opportunities to support households' decisions about their home, finances and wellbeing.

Government intervention during residential solar's infancy helped propel a little-known technology into a widely accepted one that many Australians already have, or aspire to have. While our research shows that there are still barriers of entry to this technology (e.g. upfront cost and complexity of choice), the market is already addressing these through greater availability of information, comparison websites and services. There is an opportunity now to replicate the success and ubiquity of solar with other home upgrades that will help households lower their emissions and bills, and increase the comfort of their home.

Finding effective ways to address low knowledge, confidence, and decision-making power about the right kinds of home upgrades will help households when it comes time to make those big, costly decisions. BETA's research will assist government to prioritise and focus efforts on changes that will make the biggest difference to everyday Australians and the nation's collective effort to reduce emissions. Below we outline the key insights from the behavioural sciences and relevant recommendations emerging from our research.

People often weigh present costs more highly than future benefits

Across a range of home upgrades, we found that financial motivations dominated decisions. But our survey also revealed 2 distinct cohorts: those who can afford home upgrades, and those who do not have the financial means to cover upfront costs. For people who have the means to make home upgrades – through savings, access to financial assistance, or both – messages and incentives regarding the cost savings resulting from upgrades will be more persuasive than those relating to environmental benefits. Cost savings can be difficult to calculate, as they are a complex result of many factors (e.g. a household's energy consumption, climate, appliance costs). Apart from rooftop solar, payback periods do not seem to be readily communicated for many home energy upgrades. Better communicating these cost savings may therefore encourage home energy upgrade behaviour among those who can afford the upfront costs.

For those who do not have access to funds, upfront costs pose a hard barrier in the decision to proceed with upgrades. While we found financial considerations to be an important factor in the decision to make home upgrades, counterintuitively, a very small proportion of households (fewer than 7%) are responding to rising cost-of-living by upgrading to more efficient appliances or renovating to increase energy efficiency.

Rebates, subsidies and loans that reduce the upfront cost of upgrades are all likely to have *some* effect. The extent to which these supports *overcome* the cost barrier is not always easy

to estimate. For example, low-income households may be unwilling to take on the financial risk of a loan, or unable to meet repayments on a zero-interest loan (ACTCOSS 2023). Increasing awareness and opportunities for people to access these supports will engender an equitable pathway to Net Zero, on which the perks of home upgrades are not only reserved for those who can afford it.

Bundled benefits offer greater perceived value

We found that most people are concerned about climate change and believe that their actions can make a difference – meaning secondary arguments about environmental sustainability will sweeten the deal for many. But environmental sustainability on its own, without any communication of financial benefits, will only motivate a minority of people. We found environmental motivations are neither necessary nor sufficient to activate home upgrade decisions.

Outside of financial and environmental motivations, other benefits of home upgrades are emerging. For example, having off-grid electricity, and therefore gaining energy independence and minimising exposure to power outages, is an increasingly popular reason to get solar panels and batteries. While this benefit will not apply to all households, it will be highly beneficial to residents of regions that are frequently exposed to outages. Understanding and communicating these non-financial benefits of rooftop solar will become increasingly important as feed-in tariffs drop and limits on exports to the grid become normalised.

This principle applies to other types of home upgrades as well. Rapid advancements in technology may mean that people are not aware of all the potential benefits. Each of the benefits of home upgrades – reducing emissions, improving comfort, reducing bills, increasing the resale value of the home – can have a cumulative effect that ultimately drives a householder contemplating an upgrade to action.

Awareness is a critical pre-condition for action

Our findings reveal substantial room for improvement in knowledge of current home features, especially those that are not immediately visible, like insulation, double-glazed windows and appliance efficiency. Knowledge about these features was even lower for renters than owners. Awareness about a home's current energy efficiency, and what upgrades offer the biggest bang for buck, are critical inputs in the decision to make upgrades.

Home energy assessments provide exactly this knowledge, but our survey found few are seeking them, and many do not even know if their home has had an assessment. Only about 5% of our survey sample knew the results of a home energy assessment conducted on their current home. The exception to this was in ACT, the only jurisdiction in Australia where energy assessment ratings must be disclosed to buyers and tenants.

Uncertainty and indecision often leads to inaction

Imperfect knowledge about the emissions reduction potential of different actions may lead to too much effort being spent on lower-impact behaviours. We cannot say, based on our survey, that engaging in lower-impact behaviours 'crowds out' (or stops people from) participating in higher-impact behaviours (see Park et al. 2023). However, we did see

substantial room for improvement in knowledge about high-impact behaviours. The average accuracy rate across our 4 scenario questions was 63%. We need to help people who are motivated to reduce emissions, and who have the resources to make a change, to make the *right* change. Our survey found that respondents who felt emissions reduction was very important had higher levels of accurate knowledge – information provision may benefit people with lower levels of climate concern most.

Confidence may be the key ingredient to help people follow through on their intention to make home upgrades. We found consistent links between confidence and actual behaviour. People who reported higher levels of confidence about choosing the right upgrade or appliance were also more likely to have insulation, double glazing, solar panels and EVs, compared to people who reported lower levels of confidence.

It is likely that the process of successfully completing a home upgrade itself boosts confidence. Nevertheless, we think that boosting confidence in order to encourage home upgrades is worthwhile. Throughout our survey, we found that confidence about decision-making in this space was generally low. We expect that a combination of easy-to-access and easy-to-understand general advice, paired with customised recommendations from trustworthy retailers or tradespeople, will put most households in a strong position to make effective decisions.

People are overwhelmed by complex, difficult tasks

Once a household has decided to make an upgrade, they are faced with a series of tasks to make this happen. Half of respondents who were planning to install solar reported finding it difficult to choose the right type and size of system, choose an installer, work out how much to spend, and learn the technical jargon. For some, such complexity may induce enough friction to grind the process to halt. Offering the right supports can help overcome the frictions introduced by the complexity or difficulty of tasks.

For others, complexity may lead to satisficing¹¹ rather than optimising their choice of home upgrades. Future research can examine how complexity and motivation interact with other logistical factors, and how this varies across different types of home upgrades. For example, the decision-making environment for installing rooftop solar is different to those for replacing old appliances with new efficient ones. A household might notice high energy bills, consider their finances and over a period of months or years determine installing solar is right for them. Meanwhile a household's broken hot water system might warrant urgent action, and replacing like for like is often the simplest route. The reasons for making an upgrade, the steps required, available time and urgency, and complexity of the decision will vary substantially in each scenario.

Some hard barriers reduce the feasibility of home upgrades

Owning your own home and living in a house were clear drivers of uptake of most home upgrades, especially rooftop solar. People who do not own their own freestanding home have weakened decision-making power. Tenants have very little agency, with almost all home features and fixed appliances being the responsibility of their landlords. A tight rental market

¹¹ Making an adequate or satisfactory decision, rather than an optimal one.

can also encourage tenants to *not* ask for upgrades, for fear of being asked to leave or having to wear an increase in rent as a result (Chisholm et al. 2020). Interventions or supports that address landlords' motivations and needs will be more effective than trying to encourage or educate tenants who are in a less powerful position.

A majority of Australians face at least one hard barrier. However, 28% of respondents reported being able to afford \$5,000 or more for a home upgrade, and own a house. This means they are well placed to make upgrades and warrant policy interventions that support them to turn this capacity into action.

There is also an opportunity to tap into flexibility capital to optimise solar-generated energy and reduce the risk of grid instability. Of the households with solar panels, 59% have someone at home *all or most of the time*. These households have greater flexibility capital, but this arrangement did not impact satisfaction with solar panels. This could be because households without people home during the day do not know that using energy during the day is optimal (that is, they do not know what they are missing). Alternatively, households without people home during the day may have found other ways to use energy during the day (e.g. by running appliances on timers), meaning the benefit they gain from solar is equivalent to the benefit households *with* people at home gain. Our survey data does not tell us which possibility is more likely.

Nonetheless, interventions which help householders manage their energy use in a way that maximises solar generation will help reduce emissions and costs. This approach will also be crucial in supporting the increase in renewable electricity generation, because increased rooftop solar uptake risks grid instability. Further research to understand current energy behaviours and awareness of demand flexibility principles will help inform policy settings that encourage adaptive energy use in the future.

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