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ARTICLE

Defining sustainable home renovators in Australia

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Abstract
Home renovation is a global phenomenon, where households seek to remodel, reconfigure, and retrofit their home. While often a response to the material conditions of a dwelling, such as decay and damage, renovation also as emerges as a practice central to identity creation, sense of home, and leisure. Importantly, improving household sustainability is increasingly driving renovation activities, as governments and households seek to reduce the environmental impact of residential dwellings. Drawing on data collected from a national survey developed by the authors, this paper explores sustainable renovation practices in Australia. The paper provides a three-level analysis of home renovators. First, the paper profiles recent renovators. Second, the extent to which sustainability was considered by recent renovators during the renovation process is investigated. Third, the relationship between personal values placed on household sustainability and the sustainable renovation practices are explored. The analysis reveals that sustainability is an important renovation driver. However, sustainable renovation practices differ between groups of homeowners, with educated and wealthy homeowners most likely to undertake sustainable renovation. Further, those with a stronger commitment to household sustainability are the most likely to include expensive sustainability technologies as part of their renovations. However, it is younger households, who are less committed to the principles of household sustainability, that are most likely to access government subsidies to support the inclusion of these technologies as part of their renovation. The different profiles and actions of these renovator groups reveal a series of challenges and opportunities for governments seeking to promote household sustainability.

Keywords Renovation · Sustainability · Australia

1 Introduction

Home renovation is a global phenomenon, emerging as central to social, cultural, and economic practices of home making across western, market liberal, countries (Judson & Maller, 2014; Mackay & Perkins, 2017a). Yet, the exact practices, objectives, and regulatory frameworks shaping renovation activity differ between national contexts. In this paper

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we focus on Australia, which, given the level of renovation undertaken by households across the country, has been characterised as the "*Renovation Nation"* (Allon, 2008). We focus on the ways sustainability considerations have influenced recent renovation activity of homeowners, thereby filling a gap in existing literature by linking sustainable renovation practice and sustainability beliefs at the national level, whilst contributing to wider international debates around the role of the home in improving sustainability (Altmann, 2014; Baumhof et al., 2018; Jowkar et al., 2022; Saffari & Beagon, 2022). While drawing on data from Australia, our findings provide framework for considering renovation in other countries, specifically how sustainable renovation activities and wider beliefs around sustainability work to create distinct renovator types, characterised by divergent socioeconomic and demographic profiles. Further, by revealing differences in uptake of government subsidy programs between renovator types, our analysis provides insights for policy makers seeking to influence household practices to improve sustainability and limit resource use.

Renovation is a process where housing stock is "remodelled and remade to suit homeowners' aspirations and to comply with changing expectations about home, its appearance and function" (Maller & Horne, 2011: 59). The term renovation is often used to describe an "element of upgrading to improve performance to meet new conditions or standards" (Judson et al., 2014: 63), which might include significant structural work, such as demolition or new construction. Retrofitting, modification, maintenance, repair, home improvement, and decorating, have also been used to describe forms of renovation.

Renovation has already been the topic of much research in Australia (Judson et al., 2014; Maller & Horne, 2011; Maller et al., 2012). For Allon (2008), home renovation is an outcome of the all-encompassing obsession of Australian households with property, connecting renovation to status seeking amongst some households. It is estimated that the total expenditure on renovation in Australia is similar to that on new housing (Judson & Maller, 2014). In 2017 it was estimated that AU$33.2 billion (US$21.5 billion[1]) was spent on home renovation (HIA, 2018, in Hulse & Milne, 2019), a figure which is expected to have grown to AU$41.2 billion (US$26.7 billion) by 2021 (Williams, 2021). The majority of home renovations cost less than $70,000 (US$45,400) and managing/minimising a renovation budget is a key consideration for homeowners (Podkalicka & Milne, 2017). Thus, renovation can require significant investments of time and money, potentially requiring homeowners to access savings or debt finance (Tjørring & Gausset, 2019).

Renovation can contribute to dwelling up-keep and physical appearance, impart a sense of identity and feelings of homliness for residents, and enable leisure activities (Allon, 2008; Mackay & Perkins, 2017b). Improved design and functionality, and increased property value are key motivations for renovation (Cook et al., 2013; Dominika et al., 2022; Podkalicka & Milne, 2017; Rosenberg, 2011). Other renovation motivations include lifestyle pursuits, such as a desire to become more sustainable (Maller et al., 2012). For some, displaying a commitment to environmental concerns through the renovation process is vital to maintaining and presenting their identity (Judson et al., 2014).

Everyday household activities can have significant environmental burdens (Evans, 2018), with reducing energy use and greenhouse gas emissions from buildings central policy objectives for governments (Judson et al., 2014). The house/household is viewed as a site of (unsustainable) consumption. It is estimated that approximately 12% of Australia's greenhouse gas emissions come from households (Hulse & Milne, 2019), with the bulk of these emission originating from existing properties, rather than new build housing

[1] Based on exchange rate on 27/10/2022 (AU$1 = US$0.65). All US$ rounded to nearest $100.

(Podkalicka & Milne, 2017). The housing sector has also been identified as a major contributor to greenhouse gas emissions internationally (Bagaini et al., 2022; Saffari & Beagon, 2022). The home and household have, therefore, been identified as key sites in the response to environmental challenges, such as resource use, carbon emissions and climate change (Bagaini et al., 2022; Carr & Gibson, 2015). In Europe, for example, home renovation has been identified as vital in meeting the Sustainable Development Goals (Jowkar et al., 2022; Saffari & Beagon, 2022). While, in the Australia context, few households identify sustainably concerns as the main catalyst for renovation (Hulse et al., 2015; Tapsuwan et al., 2018), the past two decades has seen an increase in the number of dwellings undertaking renovations to improve sustainability, with increases in dwellings with insulation, water saving devices, and solar technologies (Horne & Dalton, 2014).

Following a review of literature on renovation, we use a series of survey questions as heuristic devices to characterise renovator types, thereby providing a three-level analysis of home renovators (Table 1). First, we profile *recent renovators*, revealing how they differ from *non-recent renovator* homeowners (Level 1) (using recent renovation activity [i.e., past 5 years] to define renovator types). Second, we investigate the extent to which sustainability was considered by *recent renovators* during the renovation process, thereby identifying *sustainable recent renovators* and *non-sustainable recent renovators* (Level 2) (using sustainable renovation activity to define renovator types). Third, we explore the degree to which recent renovators agreed that being sustainable in the home was important for them, thereby defining four types of recent renovators based on their underlying beliefs about the importance of household sustainability and recent sustainable renovations: *concerned sustainable renovators, unconcerned sustainable renovators*, *concerned non-sustainable renovators*, and *unconcerned non-sustainable renovators* (Level 3) (using beliefs around household sustainability to define renovator types). The four groups were identified though the cross tabulation of two questions in the survey: "Was sustainability a consideration when you renovated?" and "To what extent do you agree with the statement—Being sustainable in the home is important to you".

2 Methodology

To date, much of the research exploring sustainable renovation practices in Australia has been qualitative, focussing on the activities and experiences of small, in-depth case studies. In this paper we take a different approach, providing a national snapshot of sustainable renovation. To do so, we developed a survey that was administered, both online and via telephone, by a market research company in February 2020. The survey included a wide-ranging set of questions exploring sustainable household practices, such as attitudes about sustainability, recycling, food and clothes purchasing practices, and engagement with environmental groups. In total, 3013 surveys were completed, providing a statistically valid sample for all Australian households (99% level of confidence, 0.025 confidence interval).[2] Households were recruited until a statistically valid sample was achieved. This paper explores a subset of questions on renovation and focuses on renovation practices of owner occupiers (i.e., homeowners both with and without mortgages) between 2015 and 2019. In total, 1788 homeowners completed the survey, providing a statistically valid sample for all

[2] Based on 8,289,084 households in Australia (ABS, 2016).

Table 1 Levels of analysis used to identify sustainable renovator types (Figures in the table do not add up as renovator groups exclude survey responses that failed to answer question or answered "Don't know")

Total responses:	Homeowners: 1788				Other tenures: 1225
Level 1: Renovation undertaken in the past 5 years	Recent Renovators: 655				Non-Recent Renovators: 1133
Level 2: Sustainability considered as part of renovation	Sustainable Renovators: 429		Non-Sustainable Renovators: 195		
Level 3: Importance of being sustainable in the home	Concerned Sustainable Renovators: 337	Unconcerned Sustainable Renovators: 52	Concerned Non- Sustainable Renovators: 145	Unconcerned Non-Sustainable Renovators: 50	

Source: National household survey 2020. Authors' calculations

homeowner households in Australia (95% level of confidence, 0.025 confidence interval),[3] 655 of which had undertaken a recent renovation (Table 1).

We provide an inductive analysis. By cross tabulating questions related to recent renovation activity, the influence of sustainability on renovation activity, and underlying beliefs around the need for households to be sustainable, we provide a fine grain analysis of different renovator typologies. In doing so, we draw together and expand literature on sustainable renovation activity and household sustainability beliefs, revealing how these groups differ in terms of key demographics and socio-economic status. We acknowledge that other factors, such as age of dwelling or the efficiency of existing appliances, also play a role in promoting renovation activity. Further, Australia is characterised by diverse climate zones that potentially influence renovation activity. These issues were not covered in the survey, and this might be viewed as a limitation of this research.

3 Renovation: a cultural and economic practice

Renovation is a product of the relationships between occupants (humans) and dwellings (non-humans) (Gabriel & Watson, 2013), and a wider set of associations, such as finance and housing markets, regulations and government subsidies, and new technologies and building techniques. Renovation is mediated by a series of institutional, economic, behavioural (social/cultural/educational), and market considerations (Bagaini et al., 2022). Housing, and its renovation, is a socio-material assemblage, and is the site of complex socio-cultural dynamics (Carr & Gibson, 2015), where technical and non-technical aspects come together (Jowkar et al., 2022). Materials are implicated in everyday practices, including consumption and renovation (Lane & Gorman-Murry, 2011; Shove et al., 2007). Dwelling age is a driver of renovation (Baum & Hassan, 1999), where the material components may have failed via damage and decay (Carr & Gibson, 2015; Cox, 2016) or where the style and appearance may have dated and now be considered out of fashion (Allon, 2008; Rosenberg, 2011; Shove & Hand, 2005).

In the Australian context, the capacity to renovate is a privilege largely reserved for homeowners (the dominant housing tenure, with 66% of household owning their property either outright or with a mortgage[4]), with renters severely restricted in their ability to reconfigure their dwelling (Bate, 2021). However, important differences are observed between homeowners, where there is an established correlation between household income, employment security, and renovation activity (Baum & Hassan, 1999; Gibson et al., 2013), with high income households more likely to undertake renovation. Life course is also an important influence on renovation, with key stages of life, such as home purchase, children leaving home or retirement, initiating change to the dwelling (Tapsuwan et al., 2018; Tjørring & Gausset, 2019).

Much of the existing research has focused on renovation as a cultural phenomenon, where the reconfiguration of home emerges as an expression of socioeconomic status, lifestyle, and cultural preferences (Allon, 2008). Homes emerge as "material structures that provide the scaffolding for emotional investments, social relations and meanings of everyday life" (Dowling & Mee, 2007, 161). Renovation emerges as a practice which enhances

[3] Based on 5,420,917 households in Australia who own or are purchasing their dwelling (ABS, 2016).

[4] According to the 2021 Australian Bureau of Statistics Census (https://www.abs.gov.au/census/find-census-data/quickstats/2021/AUS) [accessed: 28/10/2022].

comfort, cleanliness, and convenience (Blunt & Dowling, 2006). Renovation represents a form of expression and identify creation, which can contribute to a sense of "homeliness", comfort, and security (Blunt & Dowling, 2006; Hulse & Milne, 2019). Dowling and Mee (2007) identify the movement toward open-plan domestic spaces as central to shifting ideals of domesticity and family life in Australia. For Shove and Hand (2005), kitchen renovation emerges as the product of past experiences and perception of future use, often aligning with cultural norms of entertaining, identity, and domesticity. However, open plan designs can increase use of energy and water intensive technologies (Maller et al., 2012).

Renovation is a heterogenous activity. Renovators range from those who engage professionals to design/undertake renovation to those who renovate themselves. Thus, a central theme of the renovation literature is the growth of DIY (Do-It-Yourself) projects, both to reduce cost and as a form of cultural identity (Cox, 2016; Mackay & Perkins, 2017b). DIY renovation has been linked to expressions of masculinity and the negotiation of gendered domestic relationships (Cox, 2016). DIY is also identified as a leisure activity, which requires dedication to self-education (Mackay & Perkins, 2017b; Podkalicka & Milne, 2017), and can draw on the advice, support and labour of friends and family (Maller et al., 2012). Mackay and Perkins (2017a) outline how renovation, particularly DIY, has expanded as a product of globalised commercial processes, such as product manufacturing, big-box retailing, advertising, and popular media.

Renovation is also a financial strategy, where homeowners seek to increase the value/equity of their property, sometimes realising this increased value in the short-term through sales (Cook et al., 2013). For Allon and Redden (2012, 375), homeowners are "financial subjects for whom the pursuit of life security and private wealth accumulation" and where renovation emerges as a lever for achieving these outcomes. This renovation (particularly DIY) and sales process has been popularised through property lifestyle/renovation programs (Mackay & Perkins, 2017a). Even for households who do not intend to sell, increasing the value of the home is often a key renovation driver. Renovation has emerged as a form of urban entrepreneurialism and (re)investment where homeowners create wealth through transforming their dwelling (Cook et al., 2013; Mackay & Perkins, 2017a). Renovation is, therefore, one expression of the financialisation and commodification of housing, where a dwelling is considered a financial asset, with financial considerations (such as capital/wealth accumulation) driving activity, rather than housing being solely a place to live (Aalbers, 2016; Dominika et al., 2022).

4 Renovation and sustainability

Australian households are increasingly concerned about the impact of household consumption practices on the environment (Gabriel & Watson, 2013; Maller & Horne, 2011). Renovation has emerged as a sustainability practice, where households modify their dwelling to reduce environmental impact, such as water and energy use, while also saving on utility costs. Through adopting sustainable renovation practices, households respond to wider discourses of sustainability, where households and their actions are positioned as important sites for addressing global environmental challenges (Moloney & Strengers, 2014). Gabriel and Watson (2013: 221) differentiate sustainable renovation from other forms of renovation due to the specific objective of "reducing the household's energy, water and resource use", achieved by retrofitting the house with new technologies. Households adopting such practices are positioned as an emerging group of "green renovators" (Horne et al., 2014).

For these renovators, installing sustainability technologies emerges as a form of personal expression, a representation of who they are and what they believe in Altmann (2014). However, existing research also reveals a disjuncture between concerns about sustainability and changes in household practices (Moloney & Strengers, 2014; Shove et al., 2007). Thus, being concerned about sustainability does not necessarily mean sustainably renovation practices will be adopted, as is explored below.

Despite a concern for the environmental impact of housing, Maller and Horne (2011) note that most households are likely to make relatively minor alterations to their dwellings and daily routines to improve sustainability (e.g., energy efficient light bulbs, water efficient shower heads or adding blinds). There has been a tendency for campaigns from governments and non-government organisations to promote the uptake of these every day, low cost, technologies (Carr & Gibson, 2015). Examples of government efforts to improve household sustainability include programs that have provided free water saving technologies, such as shower heads (Maller et al., 2012). Thus, the bulk of sustainable renovation activity might be characterised as low impact (Bagaini et al., 2022) or shallow (Saffari & Beagon, 2022) renovation, which include the instillation of one or two new technologies rather than whole house renovations. These interventions seek to improve household sustainability through the introduction of new, more efficient, technologies, rather than shifting consumption practices. Reflecting on renovation activities in Australia, Moloney and Strengers (2014) argue that these "small" and "easy" interventions, that fail to alter consumption practices, are unlikely to lead to significant and sustained reductions in environmental impact.

However, some sustainable renovation practices can be large and expensive. The most commonly cited example is that of installing solar panels, though installing water tanks, battery systems, and property wide window glazing are also examples (Baumhof et al., 2018; Chapman et al., 2016; Gibson et al., 2013). In addition, contemporary sustainable renovation efforts are likely to include new smart home technologies, such as smart meters, to monitor energy use and smart appliances or fixtures to minimise use (Pears & Moore, 2019). Three important influences on large-scale sustainable renovation practices emerge.

Firstly, undertaking large-scale sustainable renovations can be a technical process involving installing solar panels, wires, batteries, control panels, switchboards, pipes, and pumps. As such, these renovation projects tend to be undertaken by professionals, as required by planning and construction regulations (Judson & Maller, 2014; Mackay & Perkins, 2017b). The technical nature of sustainable renovation practices often emerges as a barrier for owners (Altmann, 2014), with experts required to "translate" the benefits of and, subsequently, install the technology. Many sustainable renovation technologies cannot be installed in DIY fashion, drawing a wider network of experts, licencing bodies, technologies, regulations, and financial considerations into the renovation process (Horne & Dalton, 2014). These types of sustainable renovations can challenge the underlying financial objectives of renovators who wish to avoid over capitalising, by spending too much on renovations (Hulse & Milne, 2019).

Secondly, renovation cost and the availability of government programs, grants, and subsidies are key influences on large-scale renovations decisions. Where cost of new technologies is high, government support is often necessary to reduce upfront costs (Lan et al., 2020; Saffari & Beagon, 2022). Government subsidies for environmental retrofits have increased awareness of the environmental impact of Australian housing and promoted renovation (Altmann, 2014; Horne et al., 2014), with similar processes observed internationally (Baumhof et al., 2018; Schaffer & Brun, 2015). Reducing household energy and water consumption has been the focus of government interventions, with schemes centred on

ceiling insulation, solar hot water and electricity, and water tanks (Maller & Horne, 2011). Thus, the home has emerged as a site of government intervention, with policies and programs seeking to reduce resource use, most frequently through the uptake of eco-efficient technical interventions (Judson et al., 2014). These government schemes also work to support market niches, where, in the absence of the subsidy, there would be limited demand for the technology (Horne & Dalton, 2014). A dedicated industry has emerged around providing specialised water and energy efficient renovation services to homeowners (Horne et al., 2014). Yet, the type and level of government support has been sporadic, the site of political contestation, and complicated by the three-tiered system of government (Local, State and Federal) (Chapman et al., 2016). Inconsistent regulation, pricing (e.g., rebates or tariffs), and communication have been identified as barriers for government efforts to improve household sustainability (Crabtree & Hes, 2009).

For example, subsidies in the form of Feed-in-Tariffs (FiTs) and tax benefits have been used to encourage the uptake of residential rooftop solar PV, with a view to increase the production of renewable energy and reduce greenhouse emissions (Chapman et al., 2016; Lan et al., 2020). There have been more than 2.86 million total solar system installations in Australia, predominantly by households, with just over 333,000 installed in 2020 (Australian Energy Council, 2020). Solar PV is often included in major renovation projects (Judson et al., 2014; Lan et al., 2021). There is a correlation between government subsidies (e.g., FiTs) and household take-up, with falls in the installation of rooftop solar coinciding with decreases in financial support (Lan et al., 2020). Battery installation rates are lower, with over 8300 batteries installed in 2020 (Australian Energy Council, 2020). Nevertheless, this rate is higher than previous years, supported by state government schemes for battery installation, such as the Empowering Homes Program in NSW, the Solar Homes Program in Victoria, and the Home Battery Scheme in South Australia. Through renovation practices which introduce "resource enabling technologies", households transform the home from the site of consumption to a site of production where energy is produced via solar panel (Gibson et al., 2011). While variables such as solar insolation availability (amount of solar radiation received), cost of electricity, and financial incentives influence the instillation solar PV as part of a renovation (Poruschi & Ambrey, 2019), socioeconomic variables, such as being middle-aged, more educated, and high-income, are also influential (Lan et al., 2021; Sardianou & Genoudi, 2013). Gibson et al. (2013) found that wealthy households were twice as likely to install solar power, compared to the poorer households. However, they also found that wealthy householders were most likely to have higher energy consumption.

Thus, while government interventions have encouraged renovators to adopt efficient products, this might result in limited improvements in water and energy usage (Hulse & Milne, 2019). In short, any benefits which result from the introduction of more efficient technologies, might be offset by changes in household behaviour that increase consumption (Podkalicka & Milne, 2017). There is often a significant gap between the estimated savings pre-renovation compared to actual saving, largely due to a result of household practices (Tjørring & Gausset, 2019). For example, it is claimed smart meters have limited impacts on household practices (Pears & Moore, 2019), while water tanks might save less water than predicted (Moy, 2012), or the introduction of water and energy saving technologies might increase use (Randolph & Troy, 2012). A critique of direct government intervention is that these schemes rarely influence household behaviours (Tjørring & Gausset, 2019; Vlasova & Gram-Hanssen, 2014).

Thirdly, aesthetics, convenience and comfort emerge as barriers to large-scale sustainable renovation. Sustainable renovation practices that focus on technical solutions and

downplay liveability considerations are unlike to receive widespread uptake (Jowkar et al., 2022; Kapedani et al., 2022). Households looking at engaging in sustainability programs have raised concerns that activities and technologies are inconvenient, time consuming, or are a barrier to household behaviours (Jowkar et al., 2022; Moloney & Strengers, 2014). The aesthetics of sustainably technology, such as solar PV or water tanks, is a barrier, with some households unwilling to include them as part of a renovation, as they negatively impact on property appearance (Tjørring & Gausset, 2019). While renovators can express environment concerns, sustainability considerations are often less important than other considerations, such as adding space, bathrooms, or reconfiguring living/kitchen spaces, which are seen to enable new home making practices, contribute to identity creation, and, potentially, increase property value (Judson et al., 2014; Kapedani et al., 2022). Even projects that do consider environmental sustainability often also included adding space for entertaining and leisure purposes, potentially increasing resource consumption (Horne & Dalton, 2014). The remainder of the paper draws on these themes emergent in literature on sustainable renovation, as well as insights into renovation practice more broadly, to reveal the differences between renovator and non-renovator households, the extent to which sustainability was considered during renovation, and how underlying sustainability beliefs influenced renovation.

5 Defining sustainable renovator types in Australia

5.1 Level 1: Recent renovator households

In this section we draw out the differences between *recent renovators* (renovations in the past 5 years) and *non-recent renovators* (no renovations in the past 5 years). *Recent renovators* accounted for just over a third (36.6%, 655 responses) of homeowners who completed the survey. This is not to suggest that *non-recent renovators* had not undertaken renovations in the past, just that none had been undertaken between 2015 and 2019. The focus on the past 5 years is important, as this period has seen significant government programs targeted at improving household sustainability and increased availability of more efficient and affordable sustainable technologies for the home. We acknowledge that numerous policy interventions/incentives were implemented by state and Commonwealth governments prior to this period, with households potentially accessing government subsidies to undertake renovation more than 5 years ago. Further, each state has its own policy framework and set of sustainability incentives. It is beyond the scope to this paper to explore the impact of each of these frameworks on renovation behaviour.

A series of important differences are observed between *recent renovators* and *non-recent renovators* (Table 2). *Recent renovators* were younger than *non-recent renovators*, with 40.6% of recent renovators aged 39 years or younger and only 23.6% aged over 60 years. The inverse is observed for *non-recent renovators*, with just 23.7% aged under 39 years and 39.2% aged over 60 years. *Recent renovators* were more likely to be in full-time or part-time employment (71.5%) compared to *non-recent renovators* (53.8%) who were more likely to be retired (32.7%, compared to 18.2% for *recent renovators*). Further, and reflecting the different age profiles, *recent renovators* had higher levels of university level qualifications (47.1%) compared to *non-recent renovators* (40.5%). Finally, *recent renovator* households had higher household incomes (with 19.8% earning over

Table 2 Prolife of recent and non-recent renovators (Level 1 analysis)

	Recent renovators	Non-recent renovators	Statistical significance
Number of responses	655	1133	
Average residents per household	3.03	2.66	$p < 0.001$
Age group			
18 to 29 years	19.8%	10.3%	$p < 0.001$
30 to 39 years	20.7%	13.4%	
60 to 69 years	13.5%	17.3%	
70 years or older	10.1%	21.9%	
Tenure			
Own outright	48.7%	52.3%	
Own with mortgage	51.3%	47.7%	
Employment			
Employed—working full-time	54.4%	36.9%	$p < 0.001$
Employed—working part-time	17.1%	16.9%	
Unemployed	1.8%	4.0%	
Not in the labour force	4.9%	5.6%	
Retired	18.2%	32.7%	
Education			
Year 12 or below	23.2%	32.5%	$P < 0.01$
Certificate III or IV[a]	12.7%	12.4%	
Diploma or Advanced Diploma[b]	15.6%	13.2%	
Bachelor Degree	24.9%	23.2%	
Graduate Certificate or Graduate Diploma	4.6%	4.7%	
Postgraduate Degree	17.6%	12.6%	
Household Income			
Under $100,000 (US$64,800)	50.1%	55.3%	$p < 0.001$
$100,001 to $150,000 (US$64,800 to US$97,300)	24.1%	20.6%	
$150,001 to $200,000 (US$97,300 to US$129,800)	11.6%	8.6%	
Over $200,001 (US$129,800)	8.2%	5.9%	
Prefer not to say	6.0%	9.5%	

Source: National household survey 2020. Authors' calculations

[a]Vocational training completed in technical college (equivalent to certificates undertaken at US community colleges)

[b]Vocational training completed in technical college (equivalent to associate degrees undertaken at US community colleges)

AU$150,000 [US$97,300] per annum) compared to *non-recent renovators* (with 14.5% earning over AU$150,000 [US$97,300] per annum).

Recent renovators were more likely to be young, employed, have higher levels of formal education and household income compared to *non-recent renovators*. These demographic differences are statistically significant (ranging form $p < 0.01$ to $p < 0.001$). While these differences are important, questions remain about the extent to which *recent renovators* engaged in sustainable renovation practices. It is this issue to which we now turn.

Table 3 Profile of sustainable and non-sustainable renovators (Level 2 analysis)

	Sustainable renovators	Non-sustainable renovators	Statistical significance
Number of responses	429	195	
Average residents per household	3.1	2.9	
Age group			
18 to 29 years	21.1%	16.5%	$p < 0.01$
30 to 39 years	23.7%	15.5%	
40 to 49 years	18.0%	15.5%	
50 to 59 years	15.9%	26.3%	
60 to 69 years	12.2%	15.5%	
70 years or older	9.1%	10.8%	
Tenure			
Own outright	48.3%	47.7%	
Own with mortgage	51.7%	52.3%	
Employment			
Employed—working full-time	60.8%	42.6%	$p < 0.001$
Employed—working part-time	16.3%	17.9%	
Unemployed	1.4%	2.6%	
Not in the labour force	2.8%	8.7%	
Retired	15.9%	22.6%	
Education			
Year 12 or below	17.7%	33.3%	$p < 0.001$
Certificate III or IV	10.5%	14.9%	
Diploma or Advanced Diploma	15.6%	15.9%	
Bachelor Degree	28.9%	18.5%	
Graduate Certificate or Graduate Diploma	5.4%	3.6%	
Postgraduate Degree	20.3%	12.3%	
Household Income			
Under $100,000 (US$64,800)	46.9%	55.4%	
$100,001 to $150,000 (US$64,800 to US$97,300)	25.6%	22.6%	
$150,001 to $200,000 (US$97,300 to US$129,800)	12.8%	8.2%	
Over $200,001 (US$129,800)	8.9%	7.7%	

Source: National household survey 2020. Authors' calculations

5.2 Level 2: Sustainable renovators and non-sustainable renovators

In this section we explore the profile and actions of *recent renovators*, drawing out differences between those who considered sustainability as part of their renovation activities and those that did not.[5] A strict definition of sustainability was not provided in the survey, allowing participants to use their own perceptions of sustainability when nominating

[5] Questionnaire question: "Was sustainability a consideration when you renovated?".

Table 4 Sustainable technologies adopted by sustainable and non-sustainable renovators (Level 2 analysis)

	Sustainable renovators	Non-sustainable renovators	Ratio
Lower cost/less technically advanced			
Energy efficient appliances	90.9%	74.8%	1.2
Ceiling fans	73.0%	64.6%	1.1
Wall insulation	71.6%	52.2%	1.4
Ceiling insulation	53.1%	56.2%	0.9
Double glazed windows	42.7%	19.5%	2.2
Higher cost / more technically advanced			
Solar panels	66.9%	43.8%	1.5
Smart energy meter	58.3%	36.7%	1.6
Solar hot water system	47.6%	19.9%	2.4
Battery storage	35.7%	14.2%	2.5
Household heat pump	32.2%	12.4%	2.6
Smart thermostat	31.9%	11.9%	2.7
Green walls/roof	28.4%	8.0%	3.6
Geothermal heat pump	22.6%	7.1%	3.2

Source: National household survey 2020. Authors' calculations

whether they considered sustainability during the renovation. Most *recent renovators* (65.5%,[6] 429 responses) did consider sustainability,[7] with important differences observed between the profile of *sustainable* (those who considered sustainability as part of their renovation) and *non-sustainable renovators* (those who did not consider sustainability as part of their renovation) (Table 3).

Sustainable renovators were younger than *non-sustainable renovators*, with 44.8% aged between 18 and 39 years, compared to 32.0% of *non-sustainable renovators*. Alternatively, 21.3% of *sustainable renovators* were aged over 60 years, compared to 26.3% of *non-sustainable renovators*. Further, *sustainable renovators* were more likely to be employed full- or part-time (77.1%) and less likely to be retired (15.9%), compared to *non-sustainable renovators* (60.5% and 22.6% respectively). *Sustainable renovators* also had higher levels of formal qualification (54.6% with university qualifications) and higher household incomes (21.7% with annual incomes over AU$150,000 [US$97,300]), compared to *non-sustainable renovators* (34.4% with university qualifications and 15.9% with household incomes above AU$150,000 [US$97,300] per annum), although household income difference does not reach statistical significance.

We asked all renovators what technologies they included in their recent renovations (Table 4). While we did not collect data on technologies which may have already been present prior to renovations (and, thus, not required to be included as part of the renovation), this dataset reveals important difference between the technologies adopted by *sustainable* and *non-sustainable renovators*. Unsurprisingly, *sustainable renovators* were more likely than *non-sustainable renovators* to include technologies that could contribute to reductions in energy and water consumption (such as solar panels and smart energy meters). The only

[6] Percentage of total sustainable renovators (n 655).

[7] Analysis excludes those who answered "Don't know" (31 renovator households).

exception being ceiling insulation, where *non-sustainable renovators* were slightly more likely than *sustainable renovators* to have included this technology (56.2% compared to 53.1%). When comparing the adoption of sustainability technologies between these groups, three important differences are observed.

First, relatively simple, and lower cost sustainable technologies were most likely to be adopted by *sustainable* and *non-sustainable renovators* alike, such as energy efficient appliances, ceiling fans, and insulation (wall and ceiling). Installing energy efficient appliances was the most common sustainable technology included in renovation, with 90.9% of *sustainable renovators* and 74.8% of *non-sustainable renovators* including them as part of their renovation. These types of technologies are less likely to require professional tradespeople for installation or the costs are relatively cheap (Moloney & Strengers, 2014). Further, these interventions can have immediate benefits in terms of reduced energy or water usage, potentially lower household energy and water expenses (Maller & Horne, 2011), although, as noted above, might also lead to increased consumption (Podkalicka & Milne, 2017). For these technologies, the difference between *sustainable* and *non-sustainable* renovators was relatively small, with a ratio of *sustainable renovators* to *non-sustainable renovators* ranging from 0.9 to around 1.4.

Second, there was a series of more technical and costly technologies which have relatively high uptake by both *sustainable* and *non-sustainable renovators*, such as solar panels and smart energy meters. For these technologies, the ratio between *sustainable* and *non-sustainable* renovators ranged between 1.5 and 1.6. While *sustainable renovators* were approximately 50% more likely to include these technologies than *non-sustainable renovators*, uptake is high for this latter group. For example, 43.8% of *non-sustainable renovators* included solar panels and 66.9% of *sustainable renovators*. The high uptake of solar panels (and smart energy meters which are often installed with solar panels), especially by *non-sustainable renovators*, rests on the availability of government support, in the form of household grants and rebates (Poruschi & Ambrey, 2019). Like some of the simple and lower cost technologies discussed previously, these more expensive/technical sustainability technologies (especially solar panels) emerge as more financially appealing in the short- to mid-term via lowering power costs and the possibility of income/rebates from energy sold to the electricity grid (via FiTs). However, rebate levels have been declining in recent years, reducing the immediate financial benefit of installation (Chapman et al., 2016; Lan et al., 2020).

Third, there were more expensive and technical technologies where uptake is lower for both *sustainable* and *non-sustainable renovations*. It is in this area that the difference between these groups is also the greatest, with *sustainable renovators* much more likely to include technologies, such as battery storage, heat pumps and green walls, than *non-sustainable renovators* (ratios range between 2.2 and 3.7). For these technologies, the cost appears to emerge as a barrier to adoption, especially for *non-sustainable renovators*, and where financial payoff only occurs in the long-term (Moloney & Strengers, 2014). An illustrative example of these technologies is battery storage. While the cost of solar panel technology has declined over the past decade, accompanied by an increase in efficiency, and household uptake (Lan et al., 2020), household battery technology remains expensive, with fewer households investing in battery storage as part of a PV solar insulation (Australian Solar Council, 2020). Over a third (35.7%) of *sustainable renovators* included battery storage as part of their recent renovations, compared to 14.2% of *non-sustainable renovators*, suggesting that more expensive and technical sustainability technologies are more likely to be incorporated by those explicitly seeking to improve household sustainability. The higher uptake of these technologies also reflects the profile of *sustainable renovators* outlined

Table 5 Renovator groups defined by sustainability beliefs and practices (Level 3 analysis)

	Was sustainability a consideration when you renovated?	
	Yes	No
Being sustainable in the home is important to you		
Strongly agree or agree	Concerned sustainable renovators 377 responses 57.5% of renovators	Concerned non-sustainable renovators 145 responses 22.1% of renovators
Other response	Unconcerned sustainable renovators 52 responses 7.9% of renovators	Unconcerned non-sustainable renovators 50 responses 7.6% of renovators

Percentage of total sustainable renovators (n 655)

Source: National household survey 2020. Authors' calculations

above, as they are more likely to have the financial resources to pay for these technologies (high incomes and employment) and are likely to recuperate significant installation costs over the long-term (as they are younger households). However, there is a need to explore the underlying intentions and beliefs around household sustainability and its influence on renovation activity, which is where we now turn.

5.3 Level 3: Renovation activity and household sustainability beliefs

In this section we expand the analysis, drawing together renovation practices (i.e., whether sustainability was considered as part of renovation) and underlying beliefs around the importance of being sustainable in the home. While it might be expected that households who consider sustainability as part of their renovation also feel that household sustainability is important and, alternatively, that those who did not consider sustainability when renovating do not consider household sustainability as important, our data reveal a more complex picture, highlighting important differences within renovator groups. To draw out the tensions between sustainable renovation practices and household beliefs around the importance of sustainability in the home, we cross-tabulated two survey questions (Table 5), revealing four distinct renovator groups:

- *Concerned sustainable renovators* are those who considered sustainability when undertaking their renovations and agreed that household sustainability is important to them. It is likely underlying beliefs about the need to be more sustainability influenced decisions related to the type of renovation initiated.
- *Unconcerned sustainable renovators* are those who considered sustainability when undertaking their renovations but did not agree that household sustainability is important to them. For this group it is likely that the decision to incorporate sustainable measures in their renovation was not driven by a commitment to wider sustainability beliefs, with other considerations (such as increasing value, reducing utility costs, lifestyle) potentially being more important.
- *Concerned non-sustainable renovators* are those who did not consider sustainability when undertaking their renovations but agreed that household sustainability is impor-

Table 6 Profile of renovator groups defined by sustainability beliefs and practices (Level 3 analysis)

	Concerned sustainable renovators	Unconcerned sustainable renovators	Concerned non-sustainable renovators	Unconcerned non-sustainable renovators	Statistical significance
Number of responses	377	52	145	50	
Average residents per household	3.1	3.0	2.9	3.1	
Age group					
18 to 29 years	17.3%	49.0%	17.1%	16.3%	$p < 0.001$
30 to 39 years	24.2%	19.6%	16.5%	10.2%	
40 to 49 years	18.6%	13.7%	11.2%	30.6%	
50 to 59 years	17.0%	7.8%	25.3%	22.4%	
60 to 69 years	12.5%	9.8%	16.5%	12.2%	
70 years or older	10.4%	0.0%	13.5%	8.2%	
Tenure					
Own outright	47.7%	51.9%	51.2%	44.0%	
Own with mortgage	52.3%	48.1%	48.8%	56.0%	
Employment					
Employed—working full-time	58.9%	75.0%	40.6%	44.0%	$p < 0.001$
Employed—working part-time	16.4%	15.4%	20.6%	14.0%	
Unemployed	1.4%	1.9%	3.0%	0.0%	
Not in the labour force	3.2%	0.0%	8.8%	10.0%	
Retired	17.2%	5.7%	23.0%	22.0%	
Education					
Year 12 or below	17.7%	17.3%	30.0%	42.0%	$p < 0.001$
Certificate III or IV	11.1%	5.8%	18.8%	10.0%	
Diploma or Advanced Diploma	15.4%	17.3%	16.5%	12.0%	
Bachelor Degree	28.6%	30.8%	17.1%	20.0%	
Graduate Certificate or Graduate Diploma	5.3%	5.8%	4.1%	0.0%	
Postgraduate Degree	20.7%	17.3%	11.8%	16.0%	

Table 6 (continued)

	Concerned sustainable renovators	Unconcerned sustainable renovators	Concerned non-sustainable renovators	Unconcerned non-sustainable renovators	Statistical significance
Household Income					
Under $100,000 (US$64,800)	46.4%	50.1%	55.9%	56.0%	
$100,001 to $150,000 (US$64,800 to US$97,300)	25.8%	25.0%	20.6%	26.0%	
$150,001 to $200,000 (US$97,300 to US$129,800)	12.2%	17.3%	10.0%	8.0%	
Over $200,001 (US$129,800)	9.8%	1.9%	7.1%	6.0%	

Source: National household survey 2020. Authors' calculations

tant to them. For these renovators there was an underlying commitment to improving household sustainability, however it was not a driver of renovation activity.

- *Unconcerned non-sustainable renovators* are those who did not consider sustainability when undertaking their renovations and did not agree that household sustainability is important to them. For this group improving household sustainability was not a priority and did not inform renovation decisions.

Each of these renovator groups display distinct demographic and economic profiles presented in Table 6.

Concerned sustainable renovators were the largest group that responded to the survey. The age structure of this group was more dispersed compared to the other renovator groups, with both young households (41.5% aged 39 years or younger) and older households (22.9% aged 60 years or older) falling within this category. Reflecting this age structure, *concerned sustainable renovators* were made up of a mix of employed participants (75.3% employed either full- or part-time) and retirees (17.2% retired). This group of renovators were the most educated, with 54.6% of participants having a university qualification, and had the highest incomes, with 22.0% earning more than AU$150,000 [US$97,300] per annum. Based on our data, renovators who were concerned about household sustainability and considered sustainability as part of their recent renovation were more likely to have higher levels of education and income compared to other renovator groups. However, this renovator group is made of two distinct groups: a younger employed set of renovators and an older, potentially retired, group. This group might be characterised as "green renovators" (Horne et al., 2014) where sustainability beliefs and desires informed renovation decisions.

There were fewer *unconcerned sustainable renovators*. This group of renovators were the youngest, with 68.6% aged 39 years of age or less and just 9.8% aged over 60 years. Despite a younger age profile, these renovators were relatively advantaged compared to other groups. *Unconcerned sustainable renovators* had the highest rate of outright owners (51.9%, well above the typical outright ownership rates for this age category), the highest proportion in employment (90.4% in either full- or part-time employment), lowest proportion of retirees (5.7%), high levels of formal education (53.9% with university qualifications) and relatively high incomes (19.2% earning over AU$150,000 [US$97,300] per annum).

Concerned non-sustainable renovators were the second largest renovator group. This group displays a 'value-action' gap between beliefs around sustainability and renovation behaviours (Moloney & Strengers, 2014), where sustainability beliefs have little impact on practices (Shove et al., 2007). This group were the oldest renovator category, with 30.0% of participants aged over 60 years of age, and a further 25.3% aged 50 to 59 years. Subsequently, *concerned non-sustainable renovators* had the highest proportion of participants who were retired (23.0%) and a lower proportion who were employed (61.2%). They were the least likely to hold university qualifications (33.0%) and had lower incomes compared to other renovator groups (17.1% with incomes over AU$150,000 [US$97,300], and 36.5% with incomes AU$75,000 [US$48,700] or less per annum). These renovators were likely to want to include sustainable renovation technologies, however they potentially lacked the financial resources to do so.

Unconcerned non-sustainable renovators were the smallest group. While this group had a relatively high proportion of participants aged over 60 years of age (20.4%), it recorded the largest proportion of middle-aged participants, with 53.0% aged between 40 and

Table 7 Sustainable technologies adopted renovator groups defined by sustainability beliefs and practices (Level 3 analysis)

	Concerned sustainable renovators	Unconcerned sustainable renovators		Concerned non-sustainable renovators		Unconcerned non-sustainable renovators	
	Percent of renovator type (%)	Percent of renovator type (%)	Ratio	Percent of renovator type	Ratio	Percent of renovator type (%)	Ratio
Lower cost/less technically advanced							
Energy efficient appliances	82.1	58.0	1.42	61.9	1.33	37.8	2.17
Ceiling fans	63.3	48.0	1.32	50.0%	1.27	40.0	1.58
Wall insulation	65.9	48.0	1.37	41.5	1.59	24.4	2.70
Ceiling insulation	69.4	54.0	1.29	54.2	1.28	44.4	1.56
Double glazed windows	43.2	44.0	0.98	16.9	2.55	13.3	3.24
Higher cost / more technically advanced							
Solar panels	61.6	40.0	1.54	33.9	1.82	35.6	1.73
Solar hot water system	50.7	46.0	1.10	18.6	2.72	8.9	5.70
Smart energy meter	50.2	46.0	1.09	23.7	2.12	11.1	4.52
Battery storage	37.6	40.0	0.94	11.9	3.17	8.9	4.22
Household heat pump	27.5	48.0	0.57	9.3	2.95	6.7	4.13
Smart thermostat	31.4	36.0	0.87	12.7	2.47	0.0	–
Green walls/roof	30.6	32.0	0.96	6.8	4.51	8.9	3.44
Geothermal heat pump	23.1	30.0	0.77	3.4	6.83	8.9	2.60

Source: National household survey 2020. Authors' calculations

59 years of age, and the smallest proportion aged under 39 years of age (26.5%). Despite this age profile, *unconcerned non-sustainable renovators* had the lowest proportion of participants in employment (58%) and the second highest proportion in retirement (22.0%). A further 10.0% indicated that they were not in the labour force, while 8.0% indicated that they engaged in "other" forms of employment. This group recorded the lowest levels of formal education, with 42.0% indicating that high school was their highest level of education, while 36% had university qualifications. Further, *unconcerned non-sustainable renovators* recorded the lowest proportion of high-income households, with just 14.0% with an income above AU$150,000 (US$97,300) per annum, and the second highest proportion of lower income participants, with 36.0% earning AU$75,000 (US$48,700) or less per annum.

Differences between renovator types are also observed when exploring the technologies included as part of their recent renovation (Table 7). Three key differences become apparent. First, and unsurprisingly, *unconcerned non-sustainable renovators* were the least likely to have included sustainable technologies, compared to the other renovation groups. The most common sustainable renovations undertaken by this group were ceiling insulation (44.4%), ceiling fans (40.0%) and energy efficient appliances (37.8%), however, these

levels were well below those of *concerned sustainable renovators* (the other end of the sustainable renovation spectrum), who were, respectively, 1.56, 1.58 and 2.17 times more likely to make these changes as part of their renovation. *Concerned non-sustainable renovators* were more likely to include sustainability technologies compared to *unconcerned non-sustainable renovators*. The exceptions being solar panels, green roofs/walls and geothermal heat pumps, although the adoption of the latter two technologies was very low for both groups. These findings suggest that even when issues of improving sustainability were not considered as part of a renovation, those who had an underlying commitment to improving household sustainability were more likely to include sustainability technologies compared to those who were not concerned with household sustainability. It is likely that the limited financial resources available to *concerned non-sustainable renovators* meant that other aspects of home renovation were prioritised over sustainability concerns.

Second, for several technologies, such as energy efficient appliances, ceiling insulation, and ceiling fans, the uptake rates for *unconcerned sustainable renovators* and *concerned non-sustainable renovators* were similar. As noted above, these are relatively simple and lower cost sustainable technologies (Moloney & Strengers, 2014). For *concerned non-sustainable renovators*, including these technologies potentially allows them to pursue their goal of being more sustainable in the home. This also reveals the fluid definition and interpretation of sustainable renovation, as participants who included these technologies (ranging from 50.0% for ceiling fans to 61.9% for energy efficient appliances) did not perceive these to be part of a sustainable renovation. That is, these were part of a renovation where they did not consider sustainability. The same is true for the smaller proportion of *unconcerned non-sustainable renovators* who also included these technologies. The technologies can promote household sustainability, but sustainability was not considered during the renovation.

Third, while *sustainable renovators* are the most likely to include sustainability technologies (Table 4), important differences are observed between *concerned* and *unconcerned sustainable renovators*. For those relatively simple and low-cost technologies, there is a high level of uptake from *concerned sustainable renovators*, with rates higher than *unconcerned sustainable renovators*. For example, 82.1% of *concerned sustainable renovators* included energy efficient appliances, 1.42 times more than *unconcerned sustainable renovators*. Similar differences are observed for ceiling fans, and ceiling and wall insulation. These findings reveal that *concerned sustainable renovators* are more likely to incorporate simple and lower cost technologies.

A different picture emerges when exploring large, more expensive technologies, where *unconcerned sustainable renovators* were more likely to include these technologies as part of a renovation. These more extensive or complex technologies include double glazed windows, battery storage, smart thermostats, green walls/roof, and heat pumps. The difference between these *unconcerned sustainable renovators* and *concerned sustainable renovators* ranges from quite small (e.g., for glazed windows) to large (e.g., heat pumps or smart thermostats). These findings suggest that the propensity to incorporate more expensive and technical technologies as part of a renovation rests, not on underlying sustainability concerns (i.e., the assumption that those that are more concerned about sustainability will incorporate these technologies), but on socioeconomic variables. Thus, *unconcerned sustainable renovators*, who tended to be young, in full-time employment, and with high incomes, were the most likely to incorporate these technologies. It is possible that the willingness to invest in larger, more expensive technology by this group reflects a belief that that they might be able to recuperate their high costs over the long-term, leading to future savings, or increase in property value (Moloney & Strengers, 2014).

Table 8 Access to government support schemes by renovator groups defined by sustainability beliefs and practices (Level 3 analysis)

Did you access government schemes to support your renovations?					
	Concerned sustainable renovators (%)	Unconcerned sustainable renovators (%)	Concerned non-sustainable renovators (%)	Unconcerned non-sustainable renovators (%)	Total
Yes, Federal government schemes	22.3	46.2	12.4	18.0	21.3
Yes, State government scheme	35.3	42.3	14.7	14.0	28.8
Yes, Local government schemes	23.9	44.2	7.1	4.0	19.6
Accessed schemes from at least one level of government	46.4	65.4	25.3	26.0	40.8
Accessed schemes from all three levels of government	12.5	25.0	2.9	2.0	10.2

Source: National household survey 2020. Authors' calculations

The higher uptake of more expensive technologies by *unconcerned sustainable renovators*, might also be explained by the higher propensity for this group to access government support schemes (Table 8). *Unconcerned sustainable renovators* were the most likely to access support schemes offered by each level of government, ranging from 42.3% accessing State government schemes to 46.2% who had accessed Federal government schemes, with 65.4% accessing support from at least one level of government, while 25.0% had accessed support from all three levels. This high uptake of government support schemes helps explain why *unconcerned sustainable renovators* incorporate technologies, while not having an underlying commitment to improving household sustainability. For this group, the availability of government support appears to be a major driver of the uptake of technologies.

Uptake of government support schemes by *concerned sustainable renovators* was lower, ranging from 22.3% for Federal government schemes to 35.3% for State government schemes, with 46.4% accessing support from at least one level of governments, while 12.5% had accessed support from all three levels. Given their underlying commitment to improving household sustainability, the lower uptake of government support schemes is somewhat surprising, suggesting that they may not have been aware of these schemes or that the remaining cost of incorporating sustainability remained significant.

Concerned non-sustainable renovators were much less likely to access government support schemes, ranging from 7.1% for Local government schemes to 14.7% for State government schemes, with 25.3% accessing support from at least one level of government, while 2.9% had accessed support from all three levels. The low uptake of government support schemes by this group of renovators is also somewhat unexpected. While this group did not consider sustainability when undertaking their renovation, their underlying desire to improve household sustainability suggests that they might be more inclined to access government support schemes which promote household sustainability than observed. For this group, which is the oldest, with a high proportion of retirees, and lower household incomes, it is likely that the initial cost of expensive sustainability technology and the long period before they were paid off, even after including government subsidies, was a significant barrier to adoption.

Together these finding reveal that is not just an underlying commitment to improving household sustainability (i.e., *concerned sustainable* and *non-sustainable renovators*) that increased the propensity of a household to access government support, but underlying socioeconomic and demographic characteristics. On one hand this is a positive, with households which might not otherwise incorporate sustainability technologies into their renovations being enticed to do so. On the other hand, there remains a significant proportion of renovators who are concerned about household sustainability and/or actively considered sustainability as part of their renovation who are not accessing government schemes.

6 Conclusion

In this paper we have explored sustainable renovation practices in Australia by presenting a national snapshot of renovation activity and the extent to which sustainability concerns influenced renovation. While existing research suggest that sustainability concerns are likely to be less important that social, cultural, and economic drivers (Hulse & Milne, 2019), our data reveal that sustainability was considered by many homeowners undertaking recent renovations. Better understanding household renovation practices offers insights for

government policies and programs to improve household sustainability, where, internationally, the potential of renovation as a means for reducing greenhouse gas emissions is yet to be fully realised (Bagaini et al., 2022). In mobilising a three-level analytical framework, important differences in terms of demographics, socioeconomic status, and underlying sustainability beliefs are identified as key influences on sustainable renovation practices.

As an analytical starting point, we compared *recent renovators* with *non-recent renovators* (i.e., those households who had not undertaken a renovation in the past 5 years). *Recent renovators* are more likely to be young, employed, have higher levels of formal education and household income compared to *non-recent renovators*. These findings echo previous work on renovation practices, where financial resources and life stage have been identified as renovation drivers (Allon, 2008; Cook et al., 2013).

Our findings also support existing research on renovation and the uptake of new sustainable technologies, which argue that there are correlations between socioeconomic variables, such as being middle-aged, more educated, and high-income, and the propensity to undertake sustainable renovation (Horne & Dalton, 2014; Lan et al., 2021; Sardianou & Genoudi, 2013). This is most evident when comparing *sustainable renovators* and *non-sustainable renovators* (Level 2), with the former more likely to be young, employed, educated, and have higher household incomes. Our analysis reveals how *sustainable renovators* are also more likely to include more expensive or complex sustainability technologies as part of their renovations.

While our analysis (Levels 1 and 2) support existing research on sustainable renovation practices, we have advanced discussion around sustainable renovation practices by drawing renovation activity and underlying socioeconomic characteristics into conversation with underlying concerns around household sustainability practices (Level 3). In doing so, we reveal important differences within the *sustainable renovators* and *non-sustainable renovator* groups. A series of important new insights emerge from this analysis.

First, *concerned sustainable renovators*, who are like "green renovators" identified previously (Horne et al., 2014), while having high income and education levels, were less likely to undertake sustainable renovations compared to *unconcerned sustainable renovators*. This was especially true for renovations that included expensive or complex sustainability technologies. This is an important insight, as it reveals that an underlying commitment to improving household sustainability does not, necessarily, increase the propensity to undertake complex and expensive sustainability renovations.

Second, and relatedly, the propensity for *unconcerned sustainable renovators*, who were younger and more likely to be employed, to include expensive or complex sustainability technologies as part of their renovation rests upon their willingness to access government schemes. *Unconcerned sustainable renovators* were far more likely to access these schemes compared to other renovator groups. This suggests that the inclusion of these technologies is not a response to an underlying concern about household sustainability, but response to government subsidies, which potentially reduces utility costs or increase property value in the long-term (Moloney & Strengers, 2014). From a policy perspective this could be viewed as a success as households who might otherwise not adopt these technologies have been enticed to through these schemes. Alternatively, there remains households that are concerned about improving their household sustainability which are not accessing these schemes, likely due fact that initial cost remains high and saving only accrue in the long-term. There is scope for innovative policy and program approaches, such as the One-Stop-Shop model, as adopted in Europe (Bagaini et al., 2022), to simplify sustainable renovation in the Australian context, potential improving environment outcomes. Coordination

between the diverse set of actors involved in sustainable renovation remains a concern in Australia and internationally (Jowkar et al., 2022).

Third, *concerned non-sustainable renovators* were more likely than *unconcerned non-sustainable renovators* to implement sustainability technologies (although at much lower levels compared to *sustainable renovators*). This finding reveals that even when improving sustainability was not considered as part of a renovation, an underlying commitment to improving sustainability is likely to result in at least some sustainable elements being included.

We acknowledge that we do not include an analysis of household practices following the introduction of sustainability technologies, which have been shown to negate much of the benefits of new technologies via increased consumption (Podkalicka & Milne, 2017). Nevertheless, this paper fills an important gap in existing knowledge of sustainability renovation practices in Australia by providing a national analysis of sustainable renovation activity and the influence of socioeconomic status and underlying sustainability concerns.

Declarations

Compliance with ethical standards This research was approved by the Macquarie University Human Research Ethics Committee. All participants provided informed consent. There are no conflicts of interest.

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