

# **Housing and sustainability: bridging the gap between technical solutions and householder behaviour**

## **Abstract**

There are many technical innovations for reducing water and energy use in residential housing, predominantly for use in new homes, but also for existing housing stock (administered through renovations). Additionally, householders can reduce energy and water use by changing their behaviour. However, although Australian Bureau of Statistics data shows Australians are becoming more aware of water and energy use, overall demand is not decreasing. This is partly due to an increase in the number and size of homes and the growing number of single-person households. In light of this, and combined with the fact that Australia's population will continue to grow, the environmental performance of housing is becoming critical.

Technological solutions do not automatically or generally lead to reductions in energy use, nor is behaviour change inevitable – even with growing awareness. Despite the existence of government subsidies, and readily available technologies, uptake and usage of energy and water saving technologies is not widespread. With the prominence of climate change in the collective consciousness and the growing awareness of the potential financial impact on households and communities (e.g. food and fuel costs), there is an expectation that people will change their behaviour.

With a focus on technological solutions to address efficiency, social practices around consumption are taken for granted or overlooked. There is a need to go beyond commonly cited reasons for the lack of uptake of new technologies (e.g. cost) and the individual-based explanations of behaviour (e.g. no motivation, incentive) and carry out in-depth analyses into the social practices of householders in their daily routines. Analysing the 'dynamics of demand' highlights the two-way relationship between behaviour and the socio-technical systems which shape it.

Providing insight into this dynamic will identify a wider range of solutions for improving the environmental sustainability practices of householders. This paper briefly describes two research projects which adopt this approach.

## Introduction

With current estimates at more than 7.7 million homes (ABS, 2007), the Australian residential building sector makes a significant contribution to greenhouse gas emissions and places considerable demand on water supplies. Domestic energy consumption makes up a significant part of that contribution. Behaviour change is driven through information and media campaigns, labelling or demand management strategies. For example, the Victorian Government 'black balloon' television campaign encouraging Victorians to reduce energy waste by switching off home appliances, lighting etc when not in use and lowering heating and air conditioning demand with revised temperature settings. Mitigation strategies for reducing energy consumption in the home and improving the environmental performance of houses more broadly, are generally technological, from installing more energy efficient lighting, heating and cooling systems to adopting energy efficiency standards.

The growth in awareness of climate change and its implications has generated a wealth of information about the reality of the phenomenon and the impacts of energy and water consuming activities. Individuals are being urged to take responsibility for their own consumption and reduce their environmental impact - whether it is by buying green power, driving less or using 'grey' water. However, despite the increase in the availability of information, the use of fossil-fuelled electricity and the demand for water continues to rise in the residential sector (DEWHA, 2008; ABS, 2007). The uptake of many measures to improve the environmental performance of homes does not appear to be occurring to the extent necessary to reduce green-house gas (GHG) emissions in the timescales apparently required.

To date, improving the environmental performance of houses has focused on technological solutions and innovations with less emphasis on understanding the complex socio-technical factors shaping and influencing the choices and practices of householders (Shipworth, 2005; Shove, 2003; Chappells and Shove, 2003; Chappells et al., 2000). Shove and others argue there is a need to go beyond commonly cited reasons for the lack of uptake of new technologies (e.g. cost) and the resistance to change daily practices (e.g. no motivation, incentive) and carry out in-depth analyses into the social practices of householders in their daily routines. Furthermore, there is very little research on home renovations or the experience of household members involved in actively trying to improve the environmental sustainability of their homes (Dalton et al., 2007). This to some extent reflects a lack of research more broadly around the formation of social practices within the home, particularly around energy demand and consumption.

This paper outlines two research projects at Melbourne's RMIT University, titled respectively, *Carbon Neutral Communities: Making the Transition (CNC project)* and *The Practice of Going Green: the Experience of Home Owners in Improving the Environmental Performance of Housing (PGG project)*. These projects aim to bridge the gap between understanding and applying technological solutions to improve the sustainability of houses and the role of non-technical factors in influencing householder behaviour. The following outlines the context for the research. First, we briefly describe the current trends in energy and water use in the residential sector. This is followed by a discussion about theoretical concepts framing both projects and then each project is

outlined including the aims, approaches and outputs before the paper concludes with summary remarks.

## **Energy Use and the Residential Sector**

About 29 billion tonnes of greenhouse-causing gases are released into the atmosphere annually by human activities, including 23 billion from fossil-fuel burning and industry (IPCC, 2007a). Between 2000 and 2006 global emissions grew by 3.1 per cent per annum compared to a 1.1 per cent growth rate in the 1990s (Garnaut, 2008). Climate scientists invariably accept that human activity, especially those activities related to the production and use of carbon-based energy sources, have caused or are exacerbating global warming, and predict serious consequences for the planet (IPCC, 2007a). This position reflects the overwhelming evidence linking human-induced climate change and recent extreme weather events, sea level rise and climate trends, and consequent severe damage to human life and supporting ecosystems (IPCC, 2007a; G8 Presidency, 2005; Lowe, 2005; Flannery, 2005).

While it is recognised that GHG emissions arise from various sources, the main concern is emissions from the combustion of fossil fuels for energy. Most such energy is consumed in cities, particularly in buildings and transport (Fien, 2004; Hamnett and Perkins, 2005a/b; Gleeson et al., 2000). There is an extensive body of research on the technologies and design of GHG reduction options for cities and buildings (e.g. Hamnett, 2005a/b; Goldie et al., 2005; Jenks and Dempsey, 2005; Roaf et al., 2004a/b).

A review of literature on energy demand and GHG abatement in the building sector shows that residential and commercial buildings account for almost one quarter of Australia's total GHG emissions (CIE 2007). This is largely driven by the end use of, or demand for, electricity. A report prepared for the Australian Government showed that the residential sector is responsible for 13 per cent of total energy use, nine per cent of total water consumption and 12 per cent of total GHG emissions (Akmal and Riwoe, 2005). The report also projected that there would be an increase in energy use per dwelling of 1.7 per cent per year despite gains in energy efficiency. The growth in residential energy use has been attributed to smaller household sizes, an increasing number of houses as well as dwelling size and growth in sales of energy consuming appliances. Energy use within the home is driven largely by space conditioning with heating accounting for 45 per cent of energy use. Other significant energy uses are for water heating (25 per cent), electrical appliances and lighting (27 per cent) and cooking (4 per cent) (Pears, 2007). Electricity, largely coal-fired, provides 45 per cent of total residential energy and generates 83 per cent of GHG emissions (Pears, 2007).

The Intergovernmental Panel on Climate Change (IPCC) identifies a wide range of mitigation technologies and practices available to reduce energy consumption in the home, some of which include: efficient lighting and natural lighting; improved insulation and passive and active solar design for heating and cooling (IPCC, 2007b). These are in addition to a whole range of policies and measures such as: appliance standards and labelling; building codes and certification; public sector leadership programs and procurement and incentives for energy service companies (IPCC, 2007b). While to date the focus has been on improving the environmental performance of new residential

building stock, it is argued that while this is important, it should not be done at the expense of improvements to existing housing—98 per cent of stock (Dalton et al., 2007). A recent study from the IPCC Working Group III has found that over the whole building stock, the largest portion of carbon savings by 2030 can be achieved by retrofitting existing buildings and replacing energy using equipment (Levine et al., 2007). The same report also states that while technological solutions play a key role in determining carbon emissions, the potential reduction through non-technological options has been rarely assessed and the potential leverage of policies over these is poorly understood (Levine et al., 2007).

### **Water Use and the Residential Sector**

Australia is a dry continent with high rainfall variability making water supplies particularly vulnerable to climate change. Somewhat paradoxically, Australian residential water use is among the highest in the world with water shortages becoming increasingly common and expected to worsen with climate change (Walker, 2008).

In 2004, 98 per cent of households in capital cities were connected to mains or town water supplies (ABS, 2007). Statistics from 2000-01 show that households in Australia used nine per cent (2181GL) of the total water consumed (ABS, 2007). In Victoria, the Melbourne region consumes 10 per cent of the State's water, the remaining nine per cent is for regional use, four per cent for rural and domestic stock use and 77 per cent is used in agriculture (Victorian Government, 2006). Despite the majority of water being used for agriculture, households are indirect users of this water through the purchase of agricultural products. To avoid underestimation, measures of household water use should include embodied water (i.e. water used in the provision of goods and services) as well as direct consumption. The Australian Conservation Foundation (ACF) reports that water used to produce food and other goods and services is more than six times greater than direct household water use (ACF, 2007). According to ACF figures, 23 per cent of residential water consumption is due to direct household use, 28 per cent is consumed in goods and services, and 46 per cent is due to food consumption (including eating at restaurants) (ACF, 2007). In terms of direct consumption, Melbourne households consume approximately 60 per cent of the available water (Victorian Government, 2007). Overall, domestic water use increased by 28 per cent from 1993 to 1994, while per capita use increased from 95kL per year in 1993-94 to 115kL per year in 2000-01 (an increase of around 18 per cent) (ABS, 2007). Hence, the increasing demand for residential water is due to a growing population as well as increasingly water-intensive lifestyles. Although estimates vary, approximately one-third of residential water use can be attributed to bathrooms and toilets (ABS 2007). Water for the garden and exterior of the home has also been a significant component of residential water consumption, contributing 44 per cent to household water use in 2000-01 (ABS, 2007).

Some previous research has measured Australian attitudes to the environment and consumption behaviour, for example, the longitudinal study, *'Who cares about the Environment?'* (Department of Environment and Climate Change NSW, 2007) which has been conducted triennially since 1994. It measures the environmental knowledge, attitudes and behaviours of people in New South Wales over time. The most recent survey was undertaken in mid-2006. To assess whether there had been a shift in

community views and behaviours specifically in relation to water conservation and climate, a supplementary survey was undertaken in mid-2007. More than half of the respondents (52 per cent) nominated the category 'water conservation/ management /supply/drought' as the single most important environmental issue, with a further 17 per cent nominating this as the second most important issue (Department of Environment and Climate Change NSW, 2007).

The study also found that in 2007 more people (79 per cent) reported they often made an effort to reduce water consumption compared to their behaviours in 2006 (75 per cent). Of these, nearly half reported they reduced their water consumption because of water shortages (46 per cent) while 14 per cent cited water restrictions. This suggests that people are more motivated to change their behaviour for value based reasons than because of legal requirements (Department of Environment and Climate Change NSW, 2007).

The ABS predicts that Australia's population will increase from 22.8 to 25.7 million by 2026 (ABS, 2007). If the 2000-01 average per capita use of water (115kL) remains constant, Australians will consume around 28 per cent more water in 2026 than in 2000-01 (ABS, 2007). The fact that Australia's population is increasing in combination with increasing per capita use means that insights into encouraging household behaviour change around water usage are critical.

### **From Technological Solutions to Householder Behaviour**

Technological solutions to improve energy and water efficiency in households is essential, but if they are unable to produce the intrinsic motivation and action required for broadly-based industry and community understanding, commitment and action (Horne et al., 2007). The pervasive nature of carbon-based, water-intensive lifestyles and work practices in Australia demands additional strategies based on education, capacity-building and encouragement of voluntary measures, which a report of the United States National Research Council calls "new tools for environmental protection" (Dietz and Stern, 2002). Using such tools requires "an understanding of the behaviours and the individuals and organisations whose behaviour is to be changed" (Dietz and Stern, 2002 p. 11).

A useful body of work seeks to deconstruct behaviour at a number of levels, from global agencies down to the individual consumer (Reddy, 1991; Rolls, 2001; Shove, 2003). A review of the literature which explores what motivates people to reduce energy use in the home was carried out for the Australian Greenhouse Office in 2000. It argued that "energy efficient technologies and regulations are unlikely to significantly reduce home energy use" and that "understanding the householder is a key to successful home energy action programs" (Shipworth, 2000 p.88). Classification of consumer types, analysis of motivational factors in inducing behaviour change and design strategies which can script or enforce less carbon and water intensive behaviour are all addressed in this literature and are directly relevant to the research outlined in this paper.

There is limited research into non-technical barriers to GHG reduction, and as a result they are poorly understood (Kellett, 2003; Stevenson et al., 2002; Clemitshaw et al., 2002). One US study, however, identified a range of barriers to communities becoming

more sustainable including: a lack of prescriptive goals for community action; strong external forces, especially economic, working against sustainability; the short-term nature and complexity of decision making, behavioural change and capacity building processes (Tonn and MacGregor, 1998).

Both the *CNC* and *PGG* projects have emerged to bridge the gap between our knowledge about appropriate technical solutions and the practice of reducing energy and water use and improving the environmental performance of the home.

The *CNC* project explores the nexus between the social practices around household energy use and the infrastructures and institutions of energy provision. This will investigate the barriers to reducing household energy use and identify strategies to assist communities' transition to carbon neutrality.

The *PGG* project has emerged to explore the important, and overlooked, process of renovating existing dwellings and in particular homeowners' experiences of improving environmental performance. Both studies begin with the proposition that despite the existence of a wide range of technologies, information and knowledge available to assist the process of 'going green' in the home, very few households are taking the necessary steps to improve environmental performance - or if they do they are confronted with a range of barriers that are difficult to overcome (Dalton et al., 2007). Before outlining how both research projects contribute to new knowledge, some conceptual issues framing both projects are discussed.

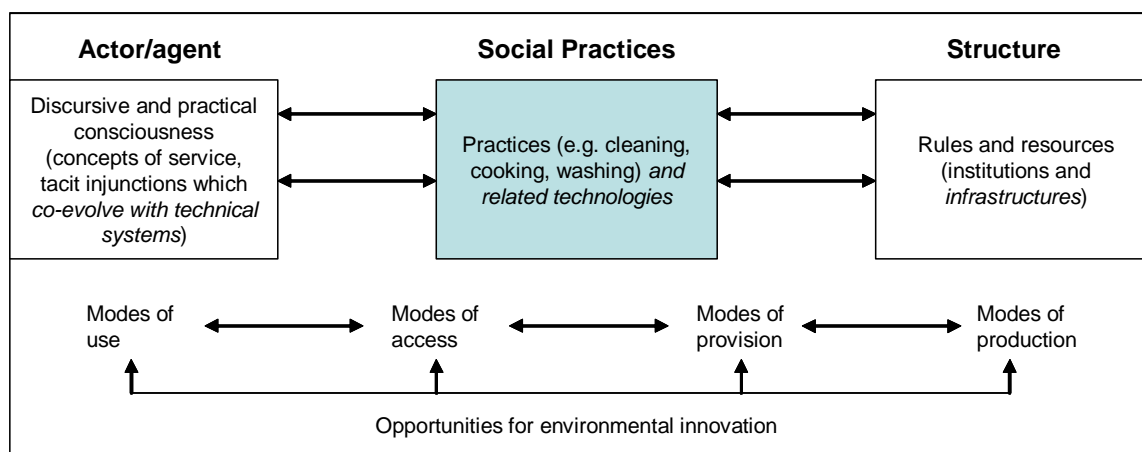
### **Social Practices, Consumption and Socio-technical Systems**

Householder behaviour is constructed and reproduced within the context of socio-technical systems which comprise institutions, regulations, infrastructure and technologies. The behaviour of individuals is also framed and shaped by the norms and values of the communities in which they live. The focus on technological solutions to improve energy and water efficiency and reduce the impact of our increasingly carbon-intensive lifestyles, while important, tends to sidestep the importance of the individual and structural determinants of consumption (Shove 2006; Chappells and Shove, 2003; Chappells et al., 2000).

While sustainable technologies are one part of the solution to improve efficiencies, further examination of the 'dynamics of demand' for electricity and water is required (Shove, 2006). In addressing demand, governments generally go as far as providing information and advice, for example, regarding the use of low-energy light globes or recommending the purchase of more efficient washing machines and refrigerators. They generally stop short of regulating, advising or instructing people how they should conduct themselves in their homes. Shove contends that "the result is a somewhat technocratic approach that fails to engage with the big questions of what our needs are and how they are constructed and reproduced" (Shove, 2006 p. 294).

In reconceptualising the relationship between consumption, technology and practice, Giddens' theory of structuration (1984) has been applied to situate social practices, as "being defined, maintained and reproduced by and through the interaction of structure and agency" (Shove, 2006 p. 295) (Figure 1).

Figure 1 Interaction of structure and agency



In this framework there is a dialectical relationship between individual behaviour, values, habits and routines and the structures, institutions and infrastructures with which they take place. In this context, the “relations between technology and practice and between practice and consumption are of real consequence for energy demand” (Shove 2006, p.295) and a number of opportunities for environmental intervention and innovation can be identified. Through further analysis of the ‘dynamics of demand’, the relationship between consumption and efficiency can be explored and ‘maladaptive’ processes, where efficiency leads to increased consumption (i.e. the rebound effect), can be elucidated.

This framework provides an understanding of the relationships between social, institutional and infrastructure factors. It demonstrates that there is a ‘ratcheting up’ effect where changes in or across either of these dimensions lead to changes in social norms and to an increase in energy or water use. Logically then, we can envisage interventions leading to a ‘ratcheting down’ effect. But what interventions are needed to achieve a reduction in energy and water demand? The following sections outline how both the CNC and PGG projects will address these questions.

## PROJECT 1: CARBON NEUTRAL COMMUNITIES - MAKING THE TRANSITION

*Carbon Neutral Communities – Making the Transition (CNC project)* is an Australian Research Council funded project. The CNC project explores the relationship between social practices around household energy use and the infrastructures and institutions of energy provision. It will investigate the barriers to reducing household energy use and identify strategies to assist communities’ transition to carbon neutrality. There is a particular focus on social practices and analysing behaviour change initiatives and other non-technical interventions. By evaluating selected initiatives and undertaking action based research at the local government and household level, the project will identify the necessary transition mechanisms required to make the shift to carbon neutrality.

The project has four key aims:

1. To identify carbon neutral potential, and social, economic, cultural and capacity barriers to achieving this potential.
2. To assess the application of established techniques to address such barriers and provide practical solutions to carbon transition.
3. To develop and test strategies for building the capacity needed to facilitate the breakthrough required in achieving carbon neutral communities by 2020 (the

key date in The National Greenhouse Strategy [Commonwealth of Australia 1998]).

4. To disseminate this knowledge to our project stakeholders and the wider community.

While there is a range of possible definitions of a carbon neutral community, the one being used in this research links the concept to the climate change agenda and refers to the contribution of a 'community' to reducing GHG emissions (Horne et al., 2007).

A carbon neutral community is defined as one that produces zero net human-induced GHG emissions (the term carbon being a short-form common term for greenhouse gas). There is a distinction made between 'greenhouse neutral' and 'zero emission' in this project. A carbon neutral community is likely to still produce GHG emissions although, almost inevitably, to a lesser extent than is currently the case. However, the community will be greenhouse neutral in that it offsets these emissions by a variety of means, such as the production and export of electricity from non-GHG emitting sources.

The project has a number of industry, local government and community based partner organisations in Victoria and South Australia. These include Manningham City Council (Victoria), City of Playford (South Australia), Northern Alliance for Greenhouse Action, International Council for Local Environmental Initiatives, Moreland Energy Foundation, Community Power and Consumer Affairs Victoria. The project team includes researchers from the University of South Australia and the RMIT University Centre for Design and Global Cities Institute.

The team takes an empirical approach which incorporates both quantitative and qualitative methods to address the technical assessment and social and economic factors in transition. This research approach, which is divided into a number of phases, represents a socio-technical analysis that incorporates an analysis of the policy, regulatory and institutional factors shaping household energy demand and the non-technical factors including the production and reproduction of social practices, routines and norms as well as behaviour change, capacity building and social learning processes.

The first phase is the preliminary research, which involves a review of background and underpinning literature concerning the carbon economy, climate change and local government, technical and non-technical approaches to reducing GHG emissions, as well as approaches to community change. Detailed studies of socio-demographic structures, economic activities and trends and environmental issues and priorities are also important for case study areas. In the second phase, a quantitative analysis of resources and technical opportunities is being undertaken for the whole of the City of Playford and City of Manningham, the project partner local authorities. This includes establishment of a methodology and data gathering to establish the baseline conditions, followed by identification of energy efficiency opportunities and renewable resource assessment. Carbon dioxide abatement options can then be ranked according to cost effectiveness and payback time. Target reductions in carbon dioxide output for each of the case study areas will be identified, and action research project plans established, including local government, household and community levels.

The third and fourth phases involve the development of a database of relevant initiatives, particularly household behaviour change initiatives, in Victoria, South Australia,

nationally and internationally followed by a qualitative analysis of a selected range of initiatives designed to examine the discourses, concepts and assumptions embedded within a selected range of 'carbon neutral' and behaviour change initiatives. A synthesis of Phases 1-4 is then required in order to develop an evaluation framework for CNC related initiatives (Phase 5).

This empirically based approach requires trial evaluation processes to be carried out to assist in validation and calibration of evaluation guidelines for communities transitioning to carbon neutrality. The project also includes planned action research with householders and communities (Phase 6). An in-depth analysis of a range of household social practices, routines, norms and concerns around energy and water use will be carried out and a program of actions and interventions will be developed in conjunction with the households which will then be implemented. A method for monitoring and evaluating the outcomes of those interventions will be established to assess the impact of those actions on reducing energy and water usage and the implications on householders understanding and commitment to ongoing action. This action based research will provide a deeper insight into the relationship between the socio-technical systems in which social practices are formed and what is required if those practices are to be transformed.

The final phase, and one that runs throughout the project, is about the communication and dissemination of information and results that emerge from the project. Regarding the latter, an active, linked, and regularly updated website has been developed ([www.rmit.edu.au/cnc](http://www.rmit.edu.au/cnc)) to facilitate dissemination and enabling resources, such as best practice examples. The site will host all the publications generated through the research as well as links to a range of initiatives in this area. The site is both a communication tool for the project team and to more widely disseminate the work of the project.

While the project is driven by a strong research agenda, its purpose is to generate useful material for communities and groups actively engaging in the transition towards carbon neutrality. The review of programs and initiatives will provide a useful source of information for communities. The evaluation framework will provide advice about methods of designing and carrying out program evaluation.

Finally, the project aims to develop a set of guidelines to assist communities in the process of becoming carbon neutral. It will signpost potential barriers and identify the strategies and techniques necessary for engaging communities and developing the capacities to create sustained behaviour change.

## **PROJECT 2: THE PRACTICE OF GOING GREEN: THE EXPERIENCE OF HOME OWNERS IN IMPROVING THE ENVIRONMENTAL PERFORMANCE OF HOUSING**

This project, *The Practice of Going Green: The Experience of Home Owners in Improving the Environmental Performance of Housing* (PGG), is a joint initiative of the Portfolio of Design and Social Context, The Global Cities Institute and the Centre for Design at RMIT University. The central proposition of the 'practice of going green' project is that regulatory approaches are likely to be useful and may even be essential; however, they will never be enough to generate a sustainable existing housing stock. One reason for this is that households include complex sets of interrelated practices,

which can confound and circumvent well-meaning technical approaches to improved environmental performance.

Given that there is very little research on household experiences of renovations, this project addresses the question:

*‘What practices do household members engage in when they plan and undertake housing renovations aimed at improving the environmental performance of their dwellings and what is the nature and extent of their accomplishments and difficulties?’*

The project incorporates consideration of the nature of household dynamics, the use of information about greening residential housing, and interactions with regulators, agents and the residential building services and product supply industries, in other words: the interrelationships between households, institutions and the building industry.

The broader context is the study of social practices within the production-consumption dynamic. Specifically, the research explores mechanisms shaping homeowners’ practices relating to housing renovations, and the extent to which these mechanisms support or impede the achievement of sustainable housing. Rather than psycho-social approaches focussing on individual motivations, values and behaviour, we adopt the view that householders are actors in a social system, and explore how they engage with that system, or particular components of it, when they renovate.

The research adopts an ethnographic approach to record the experiences of homeowners who have sought to improve the environmental performance of their houses. We examine ‘going green’ in the broader context of socio-cultural factors (including consumption patterns, housing trends, lifestyle choices and behavioural norms), as well as the culture of home owners who choose to renovate their home to be more sustainable.

An interview approach, borrowing from ethnographic methods, caters to such complex, ‘real-world’ settings and by collecting various types of data, an ethnographic approach is ideal for providing insights into the culture of home owners ‘going green’ in housing renovations. A sample of homeowners, household members and their dwellings is being studied over a 12 month period. Data is being collected on the beliefs, behaviours and attitudes of all members of each household, as well as the housing stock and the renovation/s taking place.

As the research is exploratory, a purposive sample is used to obtain a diverse range of households in the study. Diversity rather than representation is sought in demographics (e.g. cultural background, family structure, age), housing stock (e.g. age, type) and stage in the renovation process. Interviews are the primary source of data. The following criteria are being used in recruiting potential participants - they must:

- own and occupy their home;
- have consent from all members of the household over 18 years of age;
- intend to renovate to become more sustainable in some capacity (from modifying the existing building infrastructure to extensions), either ‘do-it-yourself’ or professional; and
- be willing and able to participate in the research for 12 months.

The first part of the project is a pilot study, to test the approach and methods, in particular the interview and data collection approach and analysis. Using key informants

and existing research partners (e.g. local councils), and advertising at seminars and workshops on housing environmental performance, seven Melbourne households who expressed their original intent to undertake a 'green' renovation were invited to participate in the research. A principal reference person in the household was interviewed once, in their home following recent renovation activity. The interviews were in-depth using a semi-structured format, and conducted by pairs of researchers. Discussion centred on the motivations and outcomes of the renovation, where information was sourced on renovating sustainably, how key relationships are negotiated, and any barriers they have encountered. With participants' consent, interviews were recorded and photographic records made of the dwellings.

While the results of the pilot study are not the focus of this paper, it is pertinent to note that it revealed a wide range of expectations, intentions, difficulties and outcomes. The renovators interviewed are all clearly focussed on 'green' outcomes – yet this means many different things and is also modified through the renovation process by a range of factors, including: attitudes and advice of designers, architects, builders; regulators; availability of products and materials; budgets and negotiation between family members. While the desired outcome is envisaged either as the achievement of more comfort, 'normality', or to meet new 'requirements' (e.g. an area to house a new barbeque for entertaining) – or typically it appears, for a complex mixture of these things – it is clear that renovating is often a frustrating and highly emotional endeavour for homeowners. Moreover, the negotiated actual outcome is a product of a wide range of social interactions. Fitting this into a policy frame of technologies, paybacks and 'behaviour change' is not straightforward, and suggests strongly that a wider social context is not only a backdrop to individual behaviour and technology uptake, but is often centre stage.

The experience and outcomes of the pilot have informed the 'main' study, which is currently planned. In this study, 50 to 150 households in several Australian states and/or territories will be recruited, using broadly similar recruitment techniques to the pilot in addition to snowball sampling. Multiple types of data will be collected. Each homeowner and the members of their household will be interviewed in their homes using the semi-structured interview schedule used in the pilot. However, household members will be interviewed twice, once at the commencement of the study and again 12 months later, and additional data about the house and renovation will be collected at each point. Apart from a brief description and photographs of the housing stock and grounds, data on gas, water, electricity use, and the general performance of dwellings will be collected. Details of the renovation will also be collected. Copies of plans and other documentation will be obtained with participants' consent.

During the 12 months, participants will have access to a 'blog' site on the internet which will enable them to record their experiences of renovating, as well as engage in a dialogue (or 'story') with participants from other households. Data from the blog will be collected and incorporated into the analysis and interpretation of findings.

Analysis will be inductive to explore the underlying relationships and practices of individuals within the household and those they encounter during the renovations process. The focus will be on household narratives on housing renovations, the broader contextual accounts of participants' lives and their motivations for seeking to improve the environmental performance of their housing. Data from the interviews will be

analysed in conjunction with data from the blog. This will strengthen the results and enable deeper layers of meaning to emerge. The physical data collected on the housing stock will provide a context to the data gained from interviews and the blog data. Data on utilities use for each household will be matched with participants' practices stated during interviews as a means of validation.

Synthesis and analysis will be undertaken drawing on social practices and sustainable consumption theory and literature, in addition to interpretation using theory from the sociology of households and their networks and the meaning of housing and the home. Throughout the project, new insights into Australian homeowners' experiences of renovating to be more sustainable will be developed. Potential changes to existing structures and processes will be identified and recommendations made regarding the implications of homeowners' experiences for the design of future policy aimed at improving energy and water efficiency in private housing.

## **Conclusion**

There is an opportunity to make a substantial contribution to the reduction of the environmental impacts of housing stock in Australia, in particular green house gases and water use, through understanding the daily practices and home improvement activities of households. However, this requires moving beyond linear technological and regulatory approaches to those that focus on the dynamic between behaviours and the socio-technical systems that shape them. The two studies outlined are designed to specifically address this gap.

The *Carbon Neutral Communities* and the *Practice of Going Green* projects explore this dynamic in the context of households and their renovation practices. They will provide much-needed data on the lived experiences of Australians attempting to reduce their environmental impact. The findings so far provide a consistent, emerging theme for the research. As a result we suggest the 'gap' between technical solutions and householder behaviour is in fact a relationship rather than a void, and that this relationship is a result of social practice. People's concern for whether they have got their renovation 'green enough', whether they are doing the 'right' thing, or what standard of environmental outcome (or comfort) is appropriate, all strongly reference the role of social standards and norms. Unless we develop a wider understanding of the shaping and continual reshaping of these norms and practices, our attempts to relate 'behaviour' with 'technical solutions' will be flawed.

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