

**Dwelling adaptation for sustainability:
Improving interventions for energy efficiency,
comfort and equity in Tasmania**

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Declaration of Originality

To the best of my knowledge and belief this thesis is my own original work. I have not previously submitted any part of this work for a degree or diploma at any institution. Any use I have made of others' work is acknowledged in the text and the thesis does not contain any material that infringes copyright.

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Statement of Ethical Conduct

The research investigation conducted for this thesis abides by the ethical requirements of the University of Tasmania Human Research Ethics Committee. Ethics approval was gained through applications H9709 and H9880.

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Related papers

I have co-authored one conference paper and one journal paper that draw on data gathered for this thesis. Analysis for the papers was conducted separate from the analysis conducted for this thesis. The findings and discussions in the papers are not critical to the findings of this thesis but do support points of discussion in this thesis.

Stratford, E., A. Davison, P. Watson and C. Elliot (2008). Barriers to renovation for housing sustainability in Tasmania. Sustainable Buildings 2008 (SB08). 21-25 Sept Melbourne.

Gabriel, M. and P. Watson (2013). "From Modernist Housing to Sustainable Suburbia: how occupants and their dwellings are adapting to reduce home energy consumption." Housing and Theory. 19 March: 1-19.

Abstract

In Tasmania it is common for householders in disadvantaged circumstances to live in uncomfortable and energy inefficient housing, which creates sustainability and affordability challenges. Adapting dwellings and dwelling practices to improve comfort and energy efficiency can help to create healthier, more affordable and more equitable living conditions. Yet, householders dwelling in disadvantaged circumstances who would benefit most from adaptations tend to be the people with the least adaptive capacity. Interventions encouraging dwelling adaptation for energy efficiency and comfort have had limited impact in Tasmania. I argue that limited effectiveness of interventions is in part due to their generalised designs. This investigation seeks to contribute to the creation of more effective interventions to support households with low adaptive capacity in Tasmania. To this end the study asks *in Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?*

Influences shaping dwelling adaptation outcomes come from complex ecologies of social and environmental relationships that are multi-faceted, multi-scaled, and interconnected. To engage with such complex considerations, an incremental, emergent, mixed method research approach was used. To respond to the research question and simultaneously acknowledge the complexity of the research problem, understanding was sought of: contextual influences on dwelling comfort and energy efficiency outcomes; current dwelling conditions and dwelling practices of households in relation to comfort and energy efficiency; and, householder experiences of adapting for comfort and energy efficiency. Contextual issues were explored through a literature review, context observation and focus groups of housing stakeholders. Householder experiences were explored through longitudinal, semi-structured interviews and dwelling observations conducted with 17 households. All householders had applied for an energy efficiency rebate and lived in Glenorchy (part of Greater Hobart) in Tasmania. Contextual reviews found that while housing stakeholders recognise the need to improve the energy efficiency and comfort of existing dwellings, business-as-usual practices and historical legacies affect

adaptation opportunities. Reviews of existing intervention approaches found that they required better integration of intervention methods and better understanding of householders' lived experiences.

The lived experiences of householders provided detailed information on dwelling conditions, practices and adaptations related to comfort and energy efficiency. Analysis used mixed methods but with an emphasis on qualitative, thematic analysis. Examination of household dwelling conditions and practices revealed that dwellings were energy inefficient and supplemental heating was required in cold weather, but that householders were resourceful and regularly considered possible adaptations to improve comfort and energy efficiency. Examination of adaptations showed that householders progressed incrementally through identifiable stages of problem solving. Adaptation processes and outcomes were affected by numerous influences related to adaptation goals and strategies; adaptive capacities; background experiences and knowledge; values sets; information flows; householder connections, networks and relationships; occupants; and the general adaptive methods of change households used. The influences identified provided indications of ways that interventions could interact with households and their adaptive processes. Therefore this thesis suggests measures that emphasise understanding contextual variables, key influences, and key relationships, and tailoring to the householder groups being supported.

Overall, the findings confirm that there is a need to understand the detail of householder experiences and local contexts before designing interventions encouraging energy efficiency and comfort adaptation. The findings present new knowledge in regards to contextual influences; dwelling conditions and dwelling practices around energy efficiency and comfort in Tasmania; the key influences shaping dwelling adaptations for householders; and the considerations and types of variance that need to be accommodated in the design of interventions. Such understanding will help to design and tailor adaptation interventions, leading to the possibility of interventions that more effectively progress dwelling sustainability for more households in Tasmania.

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Dedication

This is dedicated to my children Samuel, Ashley and Louis. You inspire me to strive.

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Preface

This research has come about because a mother gave voice to a challenge: ‘Do I pay for heating or medication?’ With little money and a son who experienced severe asthma, this mother faced a dilemma about whether to heat the house or medicate her son’s condition; she often could not afford both. She was not even sure heating the house helped prevent her son’s asthma because, with her limited income, she couldn’t afford to heat their ‘leaky’ house much anyway.

This mother articulated her dilemma to a geographer, Elaine Stratford, who was working in her community. Despite having heard of similar situations before, Stratford left the conversation vexed that situations such as this existed at all. In Tasmania, an island State of Australia where the pair lived, principles of equity and sustainability were included in legislation, and policy goals to address unsustainable housing situations were well established. Simple home improvements could be supported which would improve the comfort of mother and child and reduce their heating costs at the same time. Yet this woman and many others experiencing the same difficulties had never received home improvement assistance. Stratford resolved to better understand the barriers that stood in the way of low income householders being able to make simple home improvements for energy efficiency.

The mother’s and child’s predicament was shared by Stratford with me when I first began this research investigation (pers. com. July 2006). This thesis has been produced as part of the response to this predicament and looks to discover the key reasons why householders, especially those living in disadvantage, are unable to adapt their dwellings in Tasmania.

The thesis has been supported by the Office of Energy, Planning and Conservation (OEPC) in the Tasmanian Department of Infrastructure, Energy and Resources and the University of Tasmania through funding 50 per cent of the research scholarship each. When the research scholarship was funded, the Tasmanian Government did not have an explicit policy direction or mandate to pursue this topic. Despite this gap the OEPC saw the benefit of a study that would explore the effects of housing quality on social and economic outcomes.

Chapter 1. The challenge of unsustainable housing in Tasmania

1.1 Thesis aims and research question

This thesis presents findings from an inquiry that aimed to identify key design considerations for interventions encouraging dwelling adaptation to improve comfort and energy efficiency in households with low adaptive capacity in Tasmania.

Underlying this aim was an intention to support more effective intervention activity by providing a more sophisticated understanding of dwelling adaptation processes in context. In a practical sense, the inquiry aspires to inform and guide housing stakeholders in government, commerce and social support sectors. The inquiry therefore sought to understand the nature of dwelling adaptation; current intervention approaches; and how this understanding could be applied by relevant stakeholders.

The inquiry worked towards its aim by asking *in Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?*

1.2 The challenge

Housing and its associated dwelling space is a key medium through which people experience and act in the world. Despite being minimal consumers of resources when compared with their well-off counterparts, low income, disadvantaged householders are often critically affected by poorly performing housing through discomfort and inefficient energy consumption. Providing assistance to improve dwelling comfort and energy efficiency can alleviate housing disadvantage by improving occupant health and housing affordability and can also reduce environmental impacts (Dayaratne et al. 2008; Office of the United Nations High Commissioner for Human Rights 2009), assisting a move towards more sustainable residential dwelling (Vale et al. 1996).

Relatively minor and inexpensive changes to dwelling features and dwelling behaviours can generate significant energy and comfort improvements for disadvantaged occupants and the environment. However, social disadvantage and low adaptive capacity are recognised throughout the world to cause *inertia* in dwelling adaptation (for example: Bhatti et al. 1994; Horne et al. 2009; Howden-Chapman et al. 2007; Maloney 2008; Rosa et al. 1988; Stratford et al. 2008; Wilson et al. 2007). This inquiry therefore starts from the premise that in situations where households lack important adaptive capacity (especially in situations of recognised disadvantage) *supporting* householders to make dwelling adaptations to improve energy efficiency and comfort is an important part of advancing sustainability. This premise is backed by scholars, the Australian government and the social support sector (Dalton et al. 2008; Elliott et al. 2009; Harland 1993; Maller et al. 2010; Sustainable Development Commission 2006).

In Tasmania, the site of the case studies for this research, it is common for householders to live in cold, uncomfortable and energy inefficient housing. Due to significant and entrenched socio-economic disadvantage in the state, it is also common for householders inhabiting the most uncomfortable, energy hungry houses to have limited capacity to enact adaptations: even making minor adaptations can prove difficult.

Attempts to design interventions for householders with low adaptive capacities in Tasmania have been relatively ineffective because the interventions have been small in scale, applied inconsistently or designed without understanding of housing and householder contexts. Further afield in Australia¹ and internationally interventions have been applied at larger scales, but despite this have not always been that successful. Local, Australian and International intervention experiences have shown that more insight is required to ensure interventions are truly effective for householders who most need them.

¹ Australia is a federation comprising a national government – hereafter referred to as the Australian Government; six state governments – Western Australia, South Australia, Victoria, Tasmania, New South Wales and Queensland; two territory governments – Northern Territory and the Australian Capital Territory (seat of the national capital of Canberra); and various external territories and dependencies.

1.3 The research response

In response to the challenges for dwelling adaptation in Tasmania and for intervention design more generally, this research inquiry sought to understand in detail the nature of dwelling adaptation in situations where adaptive capacity is low or key adaptive capacities are missing; and how this detailed understanding could be applied in interventions by stakeholders in Tasmania. The study worked towards these aims by asking *in Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?*

To answer the research question an emergent, incremental, mixed method approach was used, that emphasised qualitative methods. This approach allowed the inquiry to engage with a sustainable ontology, sustainability goals, multiple perspectives and relational influences; to develop an evidence base in context from real life experiences; and to embrace the complexity that these explorations generated.

An underlying sustainable ontology and sustainability goals meant recognising social mechanisms and relationships that influence dwelling contexts and adaptive opportunities. Working from a (uncommonly used) social-ecological and contextual perspective allowed the inquiry to engage with these considerations and to move away from limited rational and reductive-ist (technical and economic) notions of sustainability. Taking this approach also facilitated exploration of new ways to approach similar sustainability and adaptation problems (Crabtree 2009).

Engaging with the Tasmanian dwelling adaptation context supported the socio-ecological perspective taken in the research; and, critically, helped to develop contextual understanding where, previously, little information had existed. Context reviews provided (otherwise unavailable) information on assorted organisations and stakeholders involved in dwelling adaption activity, and helped to highlight the ways stakeholders related to and affected intervention outcomes.

Detailed examination was made of householders' lived experiences to ensure that this inquiry's findings were relevant to real household situations, as well as to fill gaps in knowledge that exist relating to the effects of real life needs, priorities and adaptive experiences on intervention approaches. Much research about adaption and intervention design work to date has been based on generalised problems, statistics and theories and has given little consideration to real lived experiences of householders and stakeholders (Crosbie et al. 2010). Unless particular attention is paid to tailoring intervention approaches, disadvantage could easily be amplified by generic intervention approaches. More detailed understanding, especially in low-income situations that are more difficult for governments to support, can provide opportunities for more nuanced support lead to greater success rates for interventions.

Studying the sustainability of dwellings in the built environment; examining people's dwelling and adaptive practices; and approaching the study from a relational ecological and contextual perspective are inherently complex tasks. Too much complexity can cause problems in research. I² designed the research approach as best I could to deal with this high level of complexity, but with no guarantee that I would be successful in the end. Therefore, alongside the practical research aims of this inquiry, I also assessed the suitability of the research processes and methods themselves, in particular: the ability of qualitative research processes to accommodate investigation of complex issues of dwelling and sustainability; and, the capacity of the fieldwork and analysis techniques used to relate legitimate participant stories and to engage with social-ecologies.

The research response as presented is, of course, challenged with tensions. As Low et al. (2005: 167) state there is 'no single perfect political mechanism', or in this case, research approach, 'that will simultaneously deliver ecological sustainability, social

² Throughout the thesis I present discussion and descriptions in first person. I do this because I take responsibility for my own thoughts and discussions and I because want to remind readers of my personal (subjective) influence on this piece of research. The use of I in academic explorations is increasingly used as people 'realize that the knowledge and evidence we need for our practice is not located only in experimental research but in the experiences of ourselves' (Fulbrook 2003) and reflects 'the intimate relationship between the research and the researcher' (Hes 2005).

justice and economic success while protecting the rights of the individual. We simply have to try to find the best possible combination'. I therefore designed the research response and conducted this inquiry aware that the end result was likely to be a balance between various benefits and sacrifices; and cognisant of the possibility that truly sustainable performance will likely never be fully attained.

1.4 Situating the research

To broadly situate the research problem and exploration, this chapter explains key concepts and describes broad characteristics of the Tasmanian setting.

1.4.1 Key concepts

This research inquiry used established concepts from the discourses of housing, dwelling, adaptation, capacity, disadvantage, and sustainability and so introduces and defines them here. The key concepts of energy efficiency, comfort and equity that come from these discourses are introduced here, and are expanded upon further in chapter three.

Housing takes many and varied forms in many places. In its literal sense housing simply describes a physical case or cover (Little et al. 1992) and, while useful as a concept, the term does not encompass all physical (material) and behavioural aspects of living in a residence needed for this study. Concepts of dwelling more broadly describe the material and behavioural aspects of living in a residence that are attended to in this research. 'To dwell' broadly means to 'abide for a time, in a state, place, or condition' (Little et al. 1992: 620). As both a noun and a verb 'dwelling' creates a space in which material and lived aspects of dwelling and the relationships between them can be recognised. Dwelling can refer to any scale of living or habitation, but in this research it mainly refers to the scale of individual residences. The terms 'house' and 'housing' are used in the text to refer to the main building enclosure of individual dwelling spaces. In addition, the term 'home' is used when participants have identified their dwelling space as their 'proper abode' where they

habitually live, and where they can seek nurture, rest and refuge (Little et al. 1992: 976).

Adaptation is used in this thesis to describe the process of change householders make and is therefore important to define. 'Adaptation' is here defined as a process of change that occurs in response to a pressure or an aspiration. To adapt is to 'undergo modification so as to fit new circumstances' (Harper 2001-2012) and adaptation is the 'action of adapting'. Adaptation can describe individual to societal scales of change that lead to more resilient dwelling and 'allow societies to survive (and, beyond that, flourish)' (Smit et al. 2006: 283). Building on the concepts of dwelling and adaptation, dwelling adaptation in this study refers to change made to the physical features and to the practices of dwelling as a response to an aspiration, or as a resilient response to a critical pressure. The adaptations focussed on here are those that lead to improved energy efficiency and comfort in dwelling.

Individuals, households, communities and systems that can generate change and 'cope with change quickly and easily are considered to have high 'adaptability' ... or ... 'capacity to adapt'' (Smit et al. 2006: 283). Dwelling adaptation therefore requires adaptive capacity. In this study 'adaptive capacity' means the 'power, ability, or faculty' a person or household has to make change (Little et al. 1992: 280). Adaptive capacity varies household to household, resulting in different adaptive opportunities being available in different households. Compared to middle and higher income householders, those living with low-incomes, classically described as disadvantaged, are less likely to have the types of capacity needed to adapt their dwelling spaces and practices (Brotherhood of St Laurence 2008; Flanagan, J. 2007). Adaptive capacity can be low for reasons other than income or housing disadvantage and may be caused primarily because one or two key capacities are missing. People may be held back from adapting due to, for example, a low income, a lack of understanding of key technologies, inaccessibility of key supplies, a lack of skills, unsupportive legislation, or prohibitive social norms. Ensuring that the *right* sorts of adaptive capacity are available to people missing critical adaptive capacities, particularly those recognised to be living in disadvantaged circumstances, is recognised to be

critical in moves to adapt for sustainability and climate change (Commonwealth of Australia et al. 2008; Engle 2011; Gallopin 2006; Jerneck et al. 2008).

Householders who participated in this study ranged from those with significant adaptive disadvantage through to (a couple of) households who had reasonable levels of adaptive capacity. All participants though did have some significant capacities missing that made dwelling adaptation processes challenging in various ways. It is part of the work of this thesis to identify the mix of capacities each participant household had available *and also* how householders worked around missing capacities. This understanding is used in the final chapter of the thesis to develop recommendations on how best to support sustainable adaptation in households and what measures need to be taken when designing interventions.

In Tasmania, Australia and internationally, modern sustainable dwelling adaptation activity, including activity pertaining to energy efficiency and comfort, is driven by environmental, equity and climate change concerns (Baker 2006; Parliament of the Commonwealth of Australia House of Representatives Standing Committee 2006; Partridge 2005). The term sustainability suggests that something or someone has the ability to sustain something or someone (Annandale 1908; Oxford Editorial Team 1942). The concept expresses overarching aims to support and maintain the ecosystem and people within that system; to keep from failing; and to find ways of living that are capable of being sustained indefinitely.

In extensive international discussion over a period of more than 30 years the idea of sustainability has been explored as both a stand-alone values-based concept, and as part of sustainable development discourse (Baker 2006; Basiago 1995; Becker et al. 1999; Harris 2000; Leiserowitz et al. 2006). As such, sustainability infers holistically-considered decisions and/or assessments or actions incorporating social, economic and ecological considerations and goals. 'Sustainable development' takes the values and goals of environmental, social and economic sustainability and translates them into principles, frameworks, legislation, and governance systems at scales from the international to the municipal (Baker 2006; World Commission on Environment and Development (WCED) 1987). In this sense, sustainable

development formalises and mandates action on social, economic and environmental conduct in order to advance the values implied in sustainability discourses.

Despite the recognised opportunity and the transformative effects that sustainability and sustainable development have, the ideas are contested (Connelly 2007).

Sustainability is criticised for being anthropocentric and techno-centric (Healy 2004; Stratford 2010) and sustainable development has been criticised for taking a ‘light green’, development-centred approach that perpetuates business-as-usual (Baker 2006; Redclift 2005). Nevertheless, sustainability and sustainable development are recognised and used within existing government systems, commercial entities and community support organisations; in these systems the concepts authorise and support efforts to improve human health, affordability, equity and limit environmental damage. Sustainability goals are recognised by Australian and international governments by means of declarations, legislation and commitments.³

Principles of ecological sustainable development (ESD) were established by the Australian government to consider ‘the wider economic, social and environmental implications of our [Australia’s] decisions and actions’ and to ‘take a long-term rather than short-term view’ (Australian Government’s ESD Steering Committee 1992). Commitment to creating more sustainable settlements has been provided in the National Strategy for Ecologically Sustainable Development 1992 (ibid.); the Building Code of Australia (BCA) 2004 (Ashe et al. 2003; Australian Building Codes Board 2004); the House of Representatives Standing Committee report on ‘Sustainable Cities’ (Parliament of the Commonwealth of Australia 2005); and the Sustainability Charter in 2006 (Parliament of the Commonwealth of Australia House of Representatives Standing Committee 2006). The part that dwelling plays in advancing these goals is well-recognised and has driven efforts made in the BCA, the Sustainability Charter and the report on Sustainable Cities. In this research sustainability is used as a guiding set of values to aspire to and sustainable

³ For discussion and history of the concept of sustainability and sustainable development see: Baker 2006; Lafferty and Eckerberg 1998; Basiago 1995; and, World Commission on Environment and Development 1987.

development provides the policy framework within which the findings of the research will be used.

Importantly, sustainability discourses have made particular effort to acknowledge and incorporate social goals of human rights and equity. Emma Partridge (2005: 11) sees that sustainability provides ‘currency and clout’ to engage with social issues as a ‘a tool for framing progressive social policies – policies that, in a conservative political climate, may otherwise not be easy to advance’. The social and environmental goals of sustainability support the social and environmental intent of adapting dwellings for thermal comfort and energy efficiency and align with the need to improve social equity in Tasmania. Improving energy efficiency is recognised as a key opportunity to create more equitable housing conditions in Tasmania.

Human-induced climate change⁴ is currently a focal point for policy aimed at encouraging more sustainable dwelling at a residential scale. Australia has ratified the Kyoto protocol (Australian Government Department of Climate Change and Energy Efficiency 2010) and committed to reducing greenhouse gas emissions to a specified target through emissions reductions and the development of emission sinks (Parliament of Australia 2010). The Tasmanian Government has also committed to reducing greenhouse gas emissions.⁵ In 2009, the then Tasmanian Minister for Energy admitted that the emissions reduction target ‘presents a very real and significant challenge’ for Tasmania (Llewellyn 2009: 7). Reducing climate change emissions is a priority for Tasmania and improving residential energy efficiency has been recognised to be a cost effective way of achieving emissions reductions (McLennan Magasanik Associates 2009).

⁴ Anthropogenic climate change describes ‘change to the average pattern of weather over a long period’ that are unexplained by natural fluctuations (Australian Academy of Science Working Group 2010: 4). The change to weather patterns developed because Earth’s greenhouse effect was amplified through greenhouse emissions being released into the atmosphere from human activities. Anthropogenic climate change effects include more extreme weather events, sea level rise, and subsequent changes to ecological systems (Australian Academy of Science Working Group 2010).

⁵ The Tasmanian commitment is to reduce emissions to 60 per cent below 1990 levels by 2050, which ‘represents a target of 4.6 Mt CO₂e, or around 49 per cent below Tasmania’s emissions in 2007’ (McLennan Magasanik Associates 2009: 2).

Energy efficiency is a key strategy being used by governments to achieve reductions in greenhouse gas emissions and to mitigate unsustainable impacts because processed, supplied energy ‘contributes over half the greenhouse gas emissions in Australia’ (Newton et al. 1998: 27). Processed energy also generates environmental and social impacts through particulate and toxicity pollution, resource depletion, loss of habitat and ecosystems services and resource depletion (ibid.). The residential sector is recognised by the Australian Government to contribute around a fifth of Australia’s greenhouse emissions and is seen as a sector where significant emissions reductions can be achieved via energy efficiency (Department of Climate Change and Energy Efficiency 2012). Smit et al (2001: 879) see that mitigating climate change impacts can also foster opportunities to improve social equity because ‘adaptation [for climate change] and equity goals can be jointly pursued by initiatives that promote the welfare of the poorest members of society’. Promoting the welfare of the most disadvantaged people (they suggest) will positively affect the adaptive capacity and therefore the sustainability of whole communities. Dwelling adaptation for energy efficiency then, is recognised as a way to engage with issues of climate change and generate social equity at the same time whilst also addressing more broad concerns of sustainability.

Improving the efficiency of energy use in dwellings is strongly influenced by ‘comfort’ as both a notion and a set of practices. In unsustainable housing stock with poor thermal performance, comfort is often supported with processed (often fossil fuel) energy. In Tasmania’s relatively cold climate the reliance on processed (supplied) energy to stay comfortable is problematic. Improving comfort (without increasing energy use) can reduce household contributions to greenhouse emissions, reduce the costs of dwelling and also improve occupant health. Currently, despite the influence comfort practices have on energy use and health, they are not given much attention in Australia as an avenue through which the sustainability of dwelling may be improved. Most efforts by the Australian governments focus on improving efficiency (for example of energy or water use and of waste disposal) and technology to improve sustainability, rather than practices such as comfort (Commonwealth of Australia 2005; Roaf et al. 2005). Tasmanian efforts have maintained this efficiency

focus with a particular emphasis on energy efficiency (McLennan Magasanik Associates 2009).

There is recognition in Australia (as elsewhere around the world) that the home is where impacts from climate change, climate change policies and current economic instability converge, particularly among disadvantaged householders with low adaptive capacity (Australian Conservation Foundation (ACF) et al.; Brotherhood of St Laurence 2008; Lutzenhiser 1993; McLennan Magasanik Associates 2009; Prime Minister's Task Group on Energy Efficiency 2010). There is concern that energy changes made to mitigate climate change could be conducted in a way that actually further disadvantages already troubled households and limits opportunities for adaptation, rather than creates them (Gleeson 2008). In situations where householders have low adaptive capacity, interventions encouraging dwelling adaptations for energy efficiency and comfort can circumvent these concerns by helping to reduce energy use, improve comfort, support householder health and affordability, effectively generating higher levels of resilience to policy, climate and economic impacts (Howden-Chapman et al. 2007; Weaver 2004; Wilkinson et al. 2009).

1.4.2 The Tasmanian setting

Tasmania has particular challenges in relation to housing and socio-economic wellbeing. It has the highest proportion of socio-economically disadvantaged people of any State in Australia. When compared with Australia as a whole,⁶ 16 per cent of Tasmanians live in poverty as compared to a 10 per cent Australian average (Tasmanian Council of Social Services 2007: 3).

Disadvantage is compounded by the proportion of housing stock that is old and in suboptimal condition (Elliott et al. 2009; Flanagan, J. 2007; Flanagan, K. 2007a). Of all of the states, Tasmania has the highest proportion of housing stock over 50 years

⁶ A comparison made using the Organisation for Economic Cooperation and Development (OECD) (international) measure of poverty. OECD defines the poverty line as income less than half the country's median income (Tasmanian Council of Social Services 2007: 3).

old, with over two thirds over 20 years old (Australian Bureau of Statistics 2000). Electrical and plumbing infrastructure in the older houses around the State is also aged and a cause for concern for stakeholders involved with housing and housing infrastructure (CEFG October 2007 & May 2008).

When considering issues that influence comfortable and energy efficient dwelling, ‘the prime contextual variable is climate’ (Roaf et al. 2005: 117). Tasmania is classified as having a cool-temperate climate, which is cooler than most other areas in Australia. The Island State has distinct seasons with warm summers, cool to cold autumn and spring seasons, and cold winters. Autumn, winter and spring can be wet and windy as well as cold, leading householders to regularly use supplemental indoor heating to stay comfortable.

Solar gain is recognised as a vital support to occupant comfort in homes and critically affects dwelling microclimates around the world (Butti et al. 1980; Szokolay 1987; Vale et al. 1996). In Tasmania’s cool climate, solar gain is particularly important if indoor comfort levels are to be maintained energy-efficiently. Despite the benefits of sunlight, it is not always available or easily used for indoor comfort and energy efficiency purposes. Winter’s short days and low sun angles often interact to limit solar gain opportunities.⁷ In addition, Tasmania’s cold season is wet (and therefore cloudy), which further reduces solar gain opportunities (Australian Bureau of Statistics et al. 1999) and leads to high use of heaters.

Tasmania has the lowest winter sun angles in Australia (Figures 1.1-1.3) which can lead to positive solar gain in winter, or to sun being cut off by landscape features and neighbouring buildings. The low angle also means the solar gain is direct and ‘in the eyes’, which makes it difficult to control and use in dwelling spaces through most of the year. Even during summer the angle of the sun is low enough to cause indoor overheating. To increase and better manage solar gain in existing houses in Tasmania often requires that openings and shading are retrofitted and dwelling landscape features are altered, often quite significantly.

⁷ In 2008, sunlight hours ranged from a summer maximal mean of 9.3 hours in January to minimal mean of 4.8 hours in May and 4.9 hours in June. Climate data for 2008, the year of the interviews, are included in Appendix K.

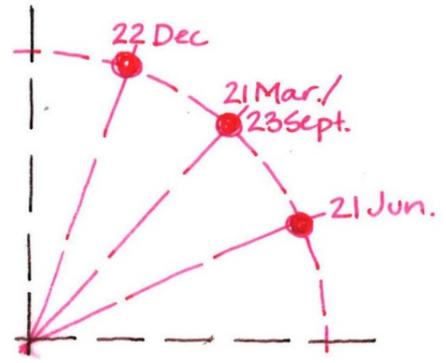


Figure 1.1: Sun angle at midday on solstices at latitude 42° south (which runs through Tasmania).

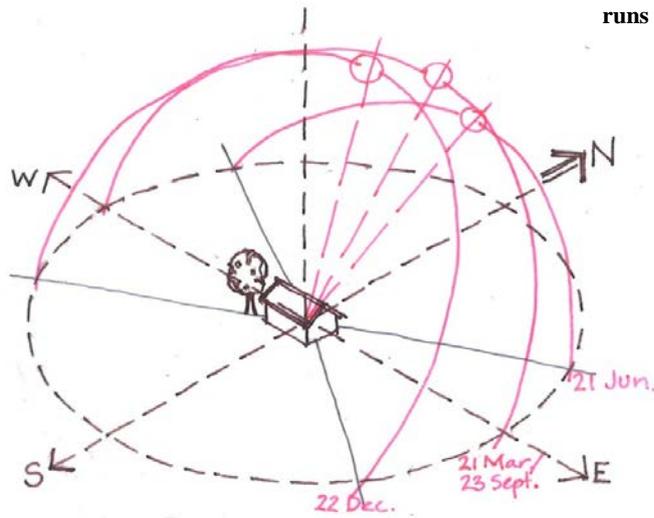


Figure 1.2: Sun path diagram at 42° south for solstices and equinoxes.

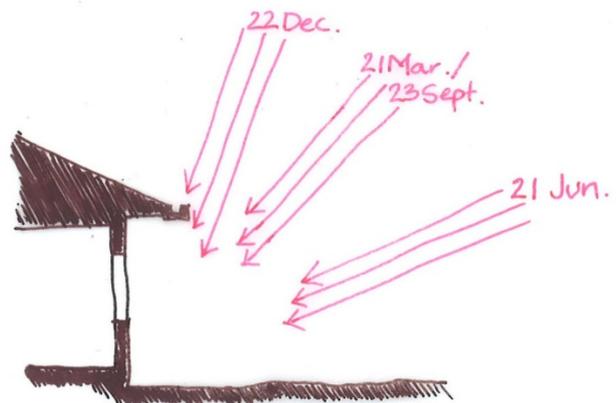


Figure 1.3: Sun angles for 42° south at midday on solstices and equinoxes in relation to window and wall positions of houses.

Aside from increasing solar gain in a controlled way, supplemental heating can be reduced by improving heat-flow resistance in building shells, incorporating other passive design strategies and using efficient dwelling practices (Ballinger et al. 1992; Bureau of Meteorology 2007; Szokolay 1987). Existing Tasmanian homes typically lack reasonable heat-flow resistance and other passive design features,⁸ in part because reasonable heat-flow resistance levels in building shells were not required by the BCA before 2003⁹ (Australian Building Codes Board 2008; Australian Building Codes Board et al. 2001).

The climate, socio-economic and housing conditions in Tasmania have prompted community and housing support organisations to call for the prioritisation of dwelling adaptation for disadvantaged householders (Brotherhood of St Laurence 2008; Consumer Utilities Advocacy Centre 2008; Flanagan, K. 2007a; Flanagan, K. 2007b; Flanagan et al. 2007; Hernandez et al. 2010). The Australian and Tasmanian governments recognise the need to assist disadvantaged households to improve energy efficiency and have attempted to provide support in various ways (Commonwealth of Australia 2008: Ch 17; Elliott et al. 2009; Prime Minister's Task Group on Energy Efficiency 2010). In the main, however, in Tasmania those advancing particular interventions have not successfully engaged on any large scale with householders with low adaptive capacity.

1.5 Summary of the thesis structure

This thesis describes the design, analysis and key findings of the research and critically evaluates the measures that can be taken in intervention design to encourage more dwelling adaptation in households with low adaptive capacity. Table 1.1 lists each chapter's research questions and content.

⁸ The focus groups from this study support this observation.

⁹ The BCA is Australia's main building standards code and is used to describe the minimal standards that buildings can be built to.

Chapter two describes the methods used in this research inquiry and outlines the underlying methodology that drove the research approach. The research was largely a qualitative study that progressed in an incremental and emergent way, emphasising contextual understanding, socio-ecological relationships and householders' accounts and experiences. The research responds to calls by scholars to incorporate sustainability and complexity, and to ground research in its socio-technical contexts (Becker et al. 1999; Crabtree 2008; Franklin 2006; Mason 2006; Patton 2002).

Chapter three and four, based on literary and contextual reviews, consider various contexts and influences in contexts on dwelling conditions and dwelling adaptation for energy efficiency, comfort and equity. Chapter three explores historical legacies; stock conditions and renovation activity related to Tasmanian housing contexts. Chapter four continues the consideration of context by describing and reviewing concepts of equity, comfort and energy efficiency as drivers of dwelling adaptations; the main interventions approaches used to encourage dwelling adaptations for energy efficiency, comfort and equity; and current understanding of the processes of adaptation.

Chapters five, six and seven report the main findings from the investigation into the dwelling conditions and adaptation experiences of 17 participant households. All households were living in the Glenorchy City Council area of Greater Hobart (the capital city of Tasmania) and had applied for an energy efficiency rebate for home improvements. The Glenorchy municipality has high proportions of low-income households, aged householders (many of whom live alone), and one parent families (Australian Bureau of Statistics et al. 2008) and therefore offered a community in which various mixes of household adaptive capacity could be explored. Household participants were consulted three times over the summer, autumn and winter of 2008 about dwelling adaptations; participant dwellings were also examined to identify dwelling energy efficiency and comfort conditions.

Chapter five reports household participants' physical dwelling conditions and dwelling practices that relate to energy efficiency and comfort, as well participant perceptions of comfort in dwellings. The exploration in this chapter is based on the description, review and assessment of content from householder narratives and from

observations I made of participant houses. This examination provides understanding of the challenges and opportunities affecting dwelling adaptations. This information provides the study with critical understanding of house performance and conditions in which interventions would be applied and, as comprehensive dwelling condition data is not available for Tasmanian houses, fills a gap in knowledge in the state.

Chapters six and seven focus on adaptation as experienced by participant households. These chapters, using the narratives householders shared in the longitudinal interviews, present stories of adaptation in detail in order to illuminate key capacities, influences and relationships affecting dwelling adaptation outcomes. Chapter six reports on adaptations participants made to their dwelling practices, while chapter seven reports on adaptations participants made to physical dwelling features. These chapters are included in order to describe, characterize and identify key influences affecting adaptations to dwelling practices and dwelling features (related to energy efficiency and comfort). These chapters explore the dynamics and variations in household experiences to identify the key issues that need to be considered in intervention designs.

Using findings from chapters three through seven, chapter eight, the final chapter, identifies measures that can be taken in intervention design to create more effective encouragements for energy efficiency and comfort adaptations in households with low adaptive capacity. As support for householders may come through various forms of intervention by various stakeholders from government, commercial or social support organisations, the findings discuss a broad range of measures that may be considered in various organisations. This chapter responds to the main research question and is intended to inform and guide stakeholders about measures that can be taken to improve intervention design and intervention implementation. The chapter also suggest paths which future research projects could follow and concludes the thesis.

Table 1.1: Chapter summary

Chapter	Research Questions	Key aims	Chapter content
1	<p>What is the problem? What are the aims and the research question that will guide the response?</p> <p>Primary research question: in Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?</p>	<p>To establish the research problem, research question, aims novel contributions, key concepts and thesis structure.</p>	<p>Describes the unsustainable housing problem in Tasmania. Argues for dwelling adaptation with a focus on energy efficiency and comfort to meet sustainability needs in households with low adaptive capacity (often due to socio-economic disadvantage). Presents the research question and key concepts: housing, dwelling, adaptation, adaptive capacity, sustainability and describes Tasmanian’s unsustainable housing situation.</p>
2	<p>What is the approach?</p> <p>What are the methodological underpinnings?</p> <p>How did I explore the research question and meet the aims?</p>	<p>To describe the research approach, including the methods used in the inquiry, and the background to selecting the approach.</p>	<p>Describes the multi method (mainly) qualitative emergent research approach by outlining relevant researcher background, the methodology, research methods, participants involved and the rationale for analysis. The approach engages with the complexity of the problem and its context to generate key findings from the lived experiences of participant households.</p>
3	<p>What colonial and contemporary legacies of dwelling adaptation are evident that may affect future interventions in Tasmania? What are the conditions of current housing stock, and the status of renovation activity?</p>	<p>To describe and review relevant Tasmanian and Australian housing and dwelling adaptation context.</p>	<p>Describes the dwelling adaptation context for energy efficiency, comfort and equity in Tasmania including historical legacies; stock condition and renovation activity.</p>

Chapter	Research Questions	Key aims	Chapter content
4	How does consideration of equity, comfort and energy efficiency motivate dwelling adaptation efforts? What intervention approaches have been used to date to encourage dwelling adaptation for energy efficiency, comfort and equity and what has been the reaction?	To describe and review context by describing: relevant motivations for dwelling adaptation; current intervention approaches; and approaches that can be used to integrate interventions.	Describes contextual views and positions taken about equity, comfort and energy efficiency to establish them as motivators for dwelling adaptation. Major types of interventions used around the world are reviewed. Current understanding of the processes of adaptation are presented in order to provides the means with which to approach the complex issues of dwelling adaptation and household lived experiences.
5	What dwelling conditions are experienced by household participants and how were they attempting to manage comfort and energy efficiency in their dwellings?	To identify, describe and review the dwelling conditions of participants and their dwelling practices related to energy use and comfort. To provide information about Tasmanian dwellings where it has previously been missing so that there is a baseline on which to envisage change.	Physical dwellings conditions and dwelling practices relating to energy efficiency and comfort are described for the 17 households participating in the study. Reviews are made of the comfort perceptions of participants, features and practices affecting the dwelling microclimates, heat flow resistance, input and extraction of heat, venting, lighting, water heating, food growing and management, occupants, power supply perceptions and appliances.
6	What happens when adaptations to practices are thought about, sought and made, and what can be learnt about how to support residents in improving the sustainability of dwelling practices and dwelling fabric?	To describe, characterize and identify key influences affecting how dwelling practices (related to energy efficiency and comfort) are changed.	Stories of adaptation to practices are shared and characterized in detail to identify what processes, relationships, stakeholders, capacities, backgrounds, information and values critically influence the adapting process.

Chapter	Research Questions	Key aims	Chapter content
7	What happens when adaptations to the physical features of a house are thought about, sought and made, and what can be learnt about how to support residents improving the sustainability of dwelling practice and dwelling fabric?	To describe, characterize and identify key influences affecting how dwelling features (related to energy efficiency and comfort) are changed.	Stories of adaptation to dwelling features are shared and characterized in detail to identify what processes, relationships, stakeholders, capacities, backgrounds, information and values critically influence the adapting process.
8	In Tasmania, what measures could be taken by housing stakeholders when designing interventions to support increased rates of dwelling adaptation for improved comfort and energy efficiency, in situations where householders have low adaptive capacity?	To respond to the main research question. To inform and guide stakeholders about measures that can be taken to improve intervention design and intervention implementation.	Using findings from chapter three to seven, suggestions are made as to measures that can be incorporated into intervention design to improve intervention outcomes. These suggestions are intended to guide improved adaptations interventions and are suggestions that target stakeholders of housing organizations and in government. Conclusions to the research are made.

Chapter 2. Methodology

2.1 Introduction

This chapter describes the approach used in this research inquiry by: providing an overview of the research methods used; relating key experiences that influenced the research design; explaining the underlying methodology that informed data collection and processing; describing the research methods in detail; introducing the participants involved in the research; and, presenting a rationale for the analysis that unfolds in later chapters.

An overview of the research methods used is presented first to provide a framework around which background experiences, methodology and detailed methods can be described. Personal research experiences are described early in the chapter to support a transparent and reflexive process and to provide background explanation of the research path taken. The methodology is described to provide explanation of the ontological, epistemological and axiological underpinnings for the inquiry and provides some explanation for the choice of mixed (primarily qualitative), incremental methods. An elaboration of methods including analytic heuristics is presented in order to explain how data was collected and used and the pathway that the research took.

2.2 Research methods overview

Engaging with a multifaceted and complex problem, I chose to conduct the research inquiry using an incremental and emergent approach which permitted ‘events to unfold’ (Patton 2002: 44), and enabled analysis to develop gradually and to be adjusted as new data (and new realisations) came to light. Mixed methods were used. I chose methods that provided the most relevant data for the research problem and that would respond to my ontological, epistemological and axiological positions. Methods were chosen step by step as new data and understanding was required to progress the research and were sourced from for previously tested methods found through reviews of scholarly literature; my past experiences; and advice from supervisors (see Appendix A). The majority of the methods used were qualitative which allowed examination of topics

using a socio-ecological lens; and consideration of dwelling adaptation as embedded, complex and interconnected with context (Crosbie et al. 2010; Franklin 2006; Guy et al. 2000; Rittel et al. 1973). Quantitative approaches were used to assess dwelling thermal performance (temperature, humidity and thermal resistance measurements) and to conduct statistical reviews (Szokolay 1987; Zeisel 2006).

To understand various influences on dwelling adaptation for energy efficiency and comfort I reviewed literature, undertook contextual observations, and engaged with housing stakeholders in focus groups. To understand the lived experience of dwelling adaptation, not least to understand what enables and impedes it, I interviewed householders who had applied for a rebate on energy efficient fixtures and fittings in the Glenorchy City municipal area. In semi-structured interviews I asked about the performance of their physical dwelling, their dwelling practices, and their adaptation activity relating to comfort and energy efficiency. I also observed their dwelling spaces and their houses to ascertain thermal performance. This mix of methods provided opportunities to elicit new insights in one particular setting, but in a way that would be relevant in similar contexts like New Zealand, the UK, USA and Canada (Elliott et al. 2009). Methods are described in more detail in a later section of this chapter and the methods used to generate content for each chapter are summarised below in Table 2.1.

Table 2.1: Methods and data used by chapter

Chapter	Research Questions	Key aims	Key methods for chapter and data used
1	What is the problem? What are the aims and the research question that will guide the response?	To establish the research problem, research question, aims, novel contributions, key concepts and thesis structure.	A problem is posed and a response is devised to respond to the problem based on literature reviews, and focus groups with stakeholders.
2	What is the approach? What are the methodological underpinnings? How did I explore the research question and meet the aims?	To describe the research approach and the background to selecting the approach.	The thesis engages with the complexity of the dwelling adaptation through a socio-ecological perspective that explores context, lived adaptation experiences of householders, and includes exploration of key influences and key relationships. Contains reflexive and descriptive explanation using literature and experience as a base for discussion. The methodology was developed in response to researcher experiences and methodological literature.
3	What colonial and contemporary legacies of dwelling adaptation are evident that may affect future interventions in Tasmania? What are the conditions of current dwelling stock, and the status of renovation activity?	To describe and review relevant Tasmanian and Australian housing and dwelling adaptation context.	Contextual review and gap analysis drawing on reviews of academic literature, government reports, context observations, media documents and focus groups (conducted for this research).
4	How do equity, comfort and energy efficiency influence dwelling adaptation? What intervention approaches exist to encourage dwelling adaptation for energy efficiency, comfort?	To describe and review context by describing: relevant motivations for dwelling adaptation; current intervention approaches; and ways of thinking about complex contexts of dwelling adaptation.	Contextual review and gap analysis drawing on reviews of academic literature, government reports, context observations, media documents and focus groups (conducted for this research).

Chapter	Research Questions	Key aims	Key methods for chapter and data used
5	What dwelling conditions are experienced by household participants and how were they attempting to manage comfort and energy efficiency in their dwellings?	To identify, describe and review the dwelling conditions of participants and their dwelling practices related to energy use and comfort. To provide information about Tasmanian dwellings where it has previously been missing so that there is a baseline on which to envisage change.	Descriptions, review and assessment of data from: on-site observation; researcher generated description (including as diagrams) of dwellings in relation to energy, comfort; temperature and humidity recorded at site; and householder accounts (of management, of energy, comfort and their home)
6	What happens when adaptations to practices are thought about, sought and made, and what can be learnt about how to support residents in improving the sustainability of dwelling practices and dwelling fabric?	To describe, characterize and identify key influences affecting how dwelling practices (related to energy efficiency and comfort) are changed.	Review and assessment of interviews with householders, on-site observation of their dwellings and analysis of narrative and description. Both content and thematic aspects of data were extracted in a layered emergent process to reveal key themes and influences.
7	What happens when adaptations to the physical features of a house are thought about, sought and made, and what can be learnt about how to support residents improving the sustainability of dwelling practice and dwelling fabric?	To describe, characterize and identify key influences affecting how dwelling features (related to energy efficiency and comfort) are changed.	Review and assessment of interviews with householders, on-site observation of their dwellings and analysis of narrative and description. Both content and thematic aspects of data were extracted in a layered emergent process to reveal key themes and influences.
8	In Tasmania, what measures could be taken by housing stakeholders when designing interventions to support increased rates of dwelling adaptation for improved comfort and energy efficiency, in situations where householders have low adaptive capacity?	To respond to the research questions. To inform and guide stakeholders about measures that can be taken to improve intervention design and intervention implementation.	Review of chapter explorations, discussions and conclusions to distil critical measures for consideration considering the multiple scales, perspectives and interrelationships studied.

2.3 Researcher background: Influential experiences

My professional experiences as a designer and sustainable building consultant, and some personal experiences, are described here because they affected the research focus, underlying methodologies, the choice of methods made (Cameron 2005; Ezzy 2002; Mason 2006; Patton 2002), and the structuring of the analysis (Beckman et al. 2007; Popper 1999). Relating these experiences ensures that the research decisions that have been made are transparent and highlights the reflexive nature of this study (Denzin et al. 2003; Schon 1983).

As a professional I have focussed on facilitating transitions to more sustainable built environments. Personal experiences as a child greatly influenced my professional focus on sustainability. Critically, I witnessed the wholesale loss of bushland ecologies to make way for large tracts of detached suburban housing. My family and I also experienced the challenging emotional impacts and effects of having limited adaptive capacity to improve our living circumstances. As a student, and then as a professional, I found later that there were challenges in trying to incorporate sustainability values and goals into building projects: methods of incorporation were underdeveloped and the available data for decisions was poor. Sustainability decisions were often generated from tick lists and according to the law of averages. Sustainability efforts were mainly directed to new-build commercial and residential developments and were arguably applied conservatively. The difficulties in incorporating sustainable considerations and the consequent constrained design and construction outcomes stemmed in part from conceptualisations of sustainability that were limited. Sustainability, as a concept and as a set of goals, often only focused on technical and efficiency issues (such as air conditioning efficiency and embodied energy) and ignored social sustainability issues (such as community consultation, equity and affordability).

My attempts to improve the application of sustainability strategies and to collate and consider missing data meant processing huge amounts of information and assessing various key priorities. In addition, in order to work out where and how sustainability changes could be incorporated into procurement, design and building processes I had to understand people's motivations, decision-making processes, influential relationships and key networks they worked within. A significant part of my professional efforts were

directed toward understanding how decisions were being made in established processes and when and how suggestions should be made so they effectively introduced sustainability principles and practices. Design theory, ecological theory, life cycle theory and decision-making theory assisted me with assessing the data, the priorities and key decision-making opportunities (Watson et al. 2004; Watson et al. 2005; Watson 2004).

Due to the challenges experienced incorporating sustainability features on professional jobs, my husband and I experimented with sustainable building ideas in our own home renovation (in Brisbane the capital of the state of Queensland). The experience showed us how challenging it is to integrate sustainability systems in a home retrofit. The renovation, conducted on a tight budget, occurred just after the birth of our third child, and was extremely stressful. Our renovation made me realise that anyone working towards sustainability goals in a renovation project needed to understand the extent of the strain and discomfort on occupants, the logistical difficulties to be faced, and the levels of complexity that made integrating change for sustainability so hard to manage.

Surprisingly, some of the most important lessons came from looking after, and living in, others' dwellings during the renovation, wherein I learned about individual styles of home-making. Each dwelling space in which we stayed was set up to meet the particular needs and requirements of its unique mix of occupants. There were significant differences in the configurations of the four houses we experienced, for example in relation to tea and coffee making, food storage, temperature modulation, leisure activities and clothes drying. All were all set up differently, partly influenced by each house's layout and facilities, and partly because of occupant preferences.

After moving to Hobart, Tasmania's capital city, to conduct this research project, I regularly engaged with people working on housing, energy efficiency, and sustainability issues. I sought advice and discussed the work with stakeholders in government, commerce and social support sectors and maintained contact with the sponsor, the Tasmanian Office of Energy, Planning and Conservation (OEPC). Each stakeholder group had a certain perspective, certain motivations and concerns about dwelling adaptation, which highlighted how varied perspectives and drivers for change could be. These engagements with the sponsor and the stakeholders ensured that the research had a practical focus, and enabled findings to be disseminated, discussed and critiqued as

they emerged and also established the importance of integrating multiple viewpoints and not oversimplifying the investigation.

These background and research-formative experiences have affected my approach to the work. I am aware that incorporating sustainable goals in renovation can be complicated and that disadvantages of capacity do limit opportunities to adapt. I can also see that while the existing housing sector has significant unrealised potential in relation to sustainability, change in the sector can be fraught. I realise that encouraging sustainable change requires understanding of decision-making processes and being alert to context, acknowledging varied perspectives and influential relationships.

2.4 Methodology

Understandings of modern western suburban housing situations are mediated knowledge coloured by various perspectives that inform what can be discovered, how and why (Mason 2006: 14; Patton 2002: 134). This section therefore explains my methodological orientations.

My methodology builds on several ideas: that sustainability intentions affect the ontological or epistemological basis for research approaches (Becker et al. 1999); that an ecological based perspective is useful when engaging with sustainability problems (Coolen 2006; Crabtree 2008; Odum 1971; Watson 2004); that an ethic of care and respect is essential to reach sustainable goals (Crabtree 2006a; Patton 2002); and that it is important to recognise the complexity of the ‘wicked’ problems that stem from the study of sustainability, dwelling and ecology (Buchanan 1992; Rittel et al. 1973).

Becker, Jahn and Steiss (1999) claim that sustainability values, goals and activity affect the ontological or epistemological basis for research approaches, and contend that sustainability’s analytical implications had been neglected up to the time of their book. They maintain that studies are needed to understand nature-society interactions; to appreciate the real and representational modes of social practices; and to foreground and better understand the social factors that affect sustainability outcomes (see, for example Healy 2004). They argue that minimal attention had been given to the social processes

involved in sustainability activity,¹⁰ despite sustainability describing ‘a field of investigation ... based on a society-oriented definition of problems’ addressing ‘how societies can shape their modes of change ... to ensure the preconditions of development for future generations’ (Becker et al. 1999: 4). Since these arguments were made, efforts to engage with social aspects and mechanisms of sustainability have advanced, and understanding of sustainability as an ontology has also progressed (Crabtree 2006b:532; Lutzenhiser 1993; Wilson et al. 2007). This study attempts to contribute to comprehension of what it means to work from a sustainable ontology that recognises social mechanisms and relationships involved in dwelling adaptation.

Ecological perspectives are helpful in viewing sustainability problems in a social and relational way and offer a sound ontological position from which to build a project focussing on sustainability as a goal. Ecology as science is ‘the economy of animals and plant’ and relationships between ‘living organisms and their surroundings’ (Oxford English Dictionary 2007). Ecological theory and approaches that expand on this scientific perspective allow consideration of the interactions and relationships between people, society and the physical environment. As a theory, and a way of seeing, ecological systems and relational understanding provides a perspective and approach that is used by a broad group of scholars (for example: Crabtree 2008; Odum 1971). The term ecology comes from the Latin root *ecos/eco/oikos*, which originally meant both house and ecology (Harper 2001-2012; Little et al. 1992: 628). The word ‘economic’ was developed from this prefix as well, and literally meant household management (Little et al. 1992: 628). The assemblages of meaning inherent in these terms, house, ecology and economy, and their connections to domestic¹¹ life suggest that interrelationships were previously understood to be an inherent part of the nature of home and therefore of dwelling (see Stratford 1994). Taking an ecological perspective allows the whole system within which dwelling sits to be recognised, and concurrently acknowledges that solutions will be interactively produced. An ecological perspective provides a way to incorporate and acknowledge the many factors that influence

¹⁰ The position that special outcomes and activity is socially produced is a common and well-argued position in the social sciences and in qualitative research (see, for example Lefebvre (2001), Shove (2003), Zeisel (2006)).

¹¹ Domestic means ‘to be of the household’ (Oxford English Dictionary 2007).

dwelling outcomes, a large proportion of which come from social activity, relations and motivations.

Beyond those meanings discussed in chapter one, the term dwelling is used throughout this work because it accommodates an ecological perspective recognising the material, behavioural and relational aspects of living in a residence. I see that a social-ecological frame is central to how we dwell and therefore also how dwelling can be investigated. Dwelling and dwelling practices manifest out of a complex ecology of social and environmental relationships that are multi-faceted, multi-scaled, and interconnected. Reducing the complexity of a given dwelling situation to its constituent parts or isolating it from its context is problematic because such manoeuvres ignore these key interconnections, influences and details on which others have written at length (for example: Crabtree 2006a; Franklin 2006; Harland 1993; McHarg 1992; Rybczynski 1986: 95-160; Watson 2004; Zeisel 2006).

From an ecological viewpoint dwelling adaption can be encouraged through various interactions and relationships, and does not just occur as an isolated act by those who dwell at the dwelling site. Supporting this ecological view of dwelling, Henny Coolen (2006: 188) refers to the domestic scale of dwelling as a 'sub-system of the environment' which binds the idea of dwelling to greater systems and processes and is useful in this research investigation. Similarly, Louise Crabtree (2008; 2009) uses an ecological lens, 'new-ecology', to engage with the complex and contextual relationships between dwellings and those who dwell. In tandem, Coolen and Crabtree's ecological approaches achieve a useful perspective, offering the opportunity, as Coolen (2006: 185) suggests, to view dwellings as 'integral parts of the environment', or as Crabtree (2009: 1) explains, to engage in a sensitive way with place and context with consideration of 'particularity, complexity and conceptuality'.

From an ecological perspective dwelling context is very important to dwelling activity and outcomes. Dwelling and its context are mutually constituted through process and activity of cultures, communities, householders, government and natural ecologies. Dwelling is therefore part of a larger socially constructed people-material ecology. In seeking to understand housing transformation, Bridget Franklin (2006: 1) argues that an understanding of context is needed, on the basis that:

the built environment does not randomly appear, but is a result of a multitude of influences and a variety of interconnecting factors: spatial contacts; ideological positions; political interventions; economic conditions; societal attitudes; historical traditions; technical knowledge; professional power; and public perceptions. Thus the shaping and re-shaping of the built environment derives from ... the structural context, the mediating role of institutions and organisations, and the actions and proclivities of individuals.

Seeking to understand real problems involving real people (and real contexts) from a sustainable value-base requires deliberate application of some important axiological principles. In particular, I see maintaining ethics of care, respect and empathy as essential when engaging with social issues, acknowledging relationships and when aiming for sustainable goals of equity, human rights, human health and environmental health.

In research, some axiological issues are dealt with via the mechanisms of ethics review processes required of higher education organisations, but most have to be monitored by researchers themselves. Patton (2002) writes about how empathy specifically allows a researcher to understand others. Crabtree (2006a: 711) writes about ‘taking an ethic of care into the public realm’ when considering sustainability in housing communities. She proceeds to ‘establish a basis for sustainability in the work on postmodern citizenship and care, rather than interrogating particular models of sustainability’ (ibid.: 713). In this inquiry care, respect and empathy *for* participants were key to engaging successfully *with* participants. Ways of approaching care, respect and empathy in research interactions, I found, were different to approaches used in daily life and were discovered gradually as the fieldwork and analysis progressed. It was also important, I found, to be clear about where and when it was appropriate to engage with empathy and where that might lead to bias (Patton 2002: 51-4).

A further axiological principle underpinning this research is that of the internationally accepted (fundamental) human right of access to a certain standard of housing and of dwelling space (General Assembly of the United Nations 1948; Office of the United Nations High Commissioner for Human Rights 1995; Office of the United Nations High Commissioner for Human Rights 2009; United Nations 1998; United Nations 2000). What constitutes sustainable housing and dwelling spaces is, however, likely to differ in diverse social and environmental contexts. In addition, as with the application of all

universal rights in practice, meeting one person's or one community's rights to acceptable housing may well lead to someone else's rights being infringed, or to the environment being damaged in some way. Questions arise about how to create dwelling environments that are environmentally sensitive and also consistent with social equity goals; this tension is not easily resolved.¹²

One final methodological challenge was how to engage with complexities inherent in the subject of this research (Harding et al. 2009; Harris 2007; Rittel et al. 1973). Indeed, Rittel and Webber (1973: 159) have suggested that complex urban problems are 'wicked' and recognising complexity has made it hard to see 'where problem centers lie, and less apparent where and how we should intervene'. They suggest though that we 'have been learning to see social processes as links tying open systems into large and interconnected networks ... such that outputs from one become inputs to others'. Other scholars have argued that solutions are difficult to find where there is no single barrier to be overcome or where there is significant complexity attending, for example, energy efficient dwelling adaptation (Elle et al. 2002). Despite the difficulties, these scholars advocate engaging with intricacy and difficulty to wicked problems, rather than recoiling from them. Consequently, I approached complex and multidimensional dwelling adaptation problems by first deeply understanding *context* and the nature of dwelling adaptation itself and then also trying to understand the nature of the phenomena in a detailed way from the perspective of the householders considering and undertaking adaptation.

2.5 Research methods

This section describes the mixed methods used to collect, process and analyse data. Methods used and the data generated with the methods have been used in various combinations to inform all the chapters of this thesis (see Table 2.1). The research was emergent, iterative and staged (Ezzy 2002; Mason 2006; Patton 2002). Grounded theory and constructivism provided some support and guidance for the emergent approach, but

¹² The discussion around the extent to which we have a right to make change to our dwellings (even when they damage the environment and other people's ability to then use the resources) is only lightly touched upon in this thesis but is an important and poorly discussed discourse in sustainability.

did not exclusively define the approach taken in the research¹³ (Charmaz 2003; Jacobs et al. 2004).

Mixed methods have been used in various housing and dwelling studies to engage with ecological complexity. For example Coolen (2006) focused on dwelling relationships with social and natural ecologies by reference to householders' focus on objects and function; Watson (2004) developed life cycle thinking strategies for design and design assessment; and Giampietro and Mayumi (2000) analysed social 'metabolism' at various scales.

Quantitative approaches were used to assess dwelling thermal performance (temperature, humidity and thermal resistance measurements) and to conduct statistical reviews (Szokolay 1987; Zeisel 2006). Such methods provided opportunities to confirm certain physical characteristics of the dwellings studied. The majority of the methods used though were qualitative because they accommodated: examination of topics using ecological and social lenses; and, consideration of dwelling adaptation as embedded, complex and interconnected with context (Crosbie et al. 2010; Franklin 2006; Guy et al. 2000; Rittel et al. 1973). Qualitative methods also enabled concurrent and in depth engagement with people, dwellings and environments (Gabriel et al.; Nansen et al. 2011; Patton 2002: 46); the consideration of detail and nuance (Ezzy 2002; Patton 2002) and of equity, empathy, power and respect (Cameron 2005; Crabtree 2006a; Smith 1997); incorporation of sustainability and social ecologies in the research approach (Becker et al. 1999; Crabtree 2008); and examination of discourse, narrative and text (Hajer 2006).

To develop an initial understanding of the research field a literature review was undertaken, starting with a review of the context in which the study would occur, leading on, in October 2007 and May 2008, to two rounds of focus group discussions with professional stakeholders in jobs related to housing—this and subsequent stages of the research are detailed below.

An opportunity arose from focus group discussions to talk with householders who had applied for rebates offered by an energy efficient home improvement project—at heart a

¹³ Adaptive theory was discovered later in the research process and its theory also supports and validates emergent research approaches (see, for example Bessant et al. 2005; Patton 2002: 40-45)

sustainability project—entitled the Glenorchy Greenhouse Action Energy Rebate (GGAER) Program. Invitations were sent out to householders who had applied for rebates through the GGAER program asking them to be involved in this research. Over three seasons in 2008 longitudinal conversations were then held with householders who agreed to participate. Those participants and their dwellings provided much of the data analysed in later chapters. A small number of interviews were also conducted with businesses and organisations involved in the GGAER program.

During transcription and early examination of the interviews, a series of key realisations emerged and cemented in place a focus on particular analytical categories. Those categories are described at the end of this chapter and provide the primary heuristics used for analysis in chapters six and seven. The progression of the research and all official communication planned and used in the fieldwork research activities is detailed in Appendices A-D.

2.5.1 Investigating background and context

Literature and contextual reviews

Literature reviews provided the starting point for understanding conceptual, empirical and relevant case study information. Various disciplines were consulted because dwelling adaptation crosses many disciplinary boundaries. The initial review chiefly focused on housing, dwelling, home improvement, equity, housing disadvantage, fuel poverty, Tasmanian housing conditions and history, Australian and Tasmanian housing policy, and sustainability and sustainable housing.¹⁴ Literature reviews continued throughout the investigation, providing theoretical, methodological and strategic guidance on context at all stages.

Context is commonly defined as ‘parts which immediately proceed or follow’ and ‘woven or knit together’ (Little et al. 1992: 412). The contextual approach allowed engagement with an ecological lens and acknowledged the complexity and interconnection of dwelling adaptation. Qualitative researchers advocate contextual

¹⁴ Initial literature reviews were included in a Preliminary Research Plan, prepared in the first few months of the PhD candidature.

analysis, encouraging consideration of multiple factors of a problem, from multiple viewpoints, so that the problem may be understood *in situ* (Ezzy 2002: 30; Guy et al. 2000: 137) and so that opportunities for change may be pinpointed. Investigating context meant not just examining text, but also people's talk and practice, characteristics of the built environment *and* the relationality of these aspects (Franklin 2006; Hajer 2006; Zeisel 2006).

Despite support for contextual analysis in theory, it is relatively rarely reported in the literature and, when presented, is often brief. The Australian Housing and Urban Research Institute (AHURI) has noted that Australian housing stakeholders reported a 'lack of a whole-of-housing-system view', and advocated for more work to be undertaken to understand the whole policy picture or context (Donald et al. 2001: 6). The lack of rich contextual reporting on housing in Australia may be due to the significant effort needed to collect and disseminate contextual information, but may also be due to a lack of consideration of context in the design of research projects.

The context review for this study had to cover a significant number of considerations because the things that drive or impede dwelling adaptation could be generated by various social processes. Among those key processes are physical supply chains, commercial markets, governance mechanisms, economic systems, the physical environment, resource supplies and collective and individual decision-making. To this end, the contextual review examined mechanisms, environments, actors and their decisions, and the ways in which they influenced dwelling adaptation opportunities. Consideration was given to social movements, housing stock quality, disadvantage and equity, sustainability and climate change at local, state, national and international scales.

Contextual information was gathered from literature and media sources, internet searches, casual engagement and conversation in the community, professional and research engagement with housing stakeholders (including the research sponsor, the OEPC), reviews of government activity and observation of housing environments in Tasmania. Conversations with stakeholders working in fields related to affecting dwelling outcomes helped to understand context not reported in the literature and only accessible as talk and practice. Staff at the OEPC, in particular, discussed the study with

me a number of times and provided feedback throughout the investigation in meetings and via email.¹⁵

During the initial period of research when the literature and context reviews were key tasks, there was a lot of interest in dwelling adaptation for energy efficiency but, from the Tasmanian Government, little ministerial focus or action on the subject. As the research progressed, however, government interest and activity developed further as a result of the development of climate change policy (Commonwealth of Australia 2008; Commonwealth of Australia and Parliament of Australia 2010; McLennan Magasanik Associates 2009). Ministerial personnel were additionally prompted to pay heed to the subject because of lobbying from social support organisations for effective minimum housing standards and qualities (Flanagan, K. 2007a; KPMG et al. 2008).

Focus groups

To consult formally with professional stakeholders in the field of housing focus groups were proposed and approval was granted by the Human Research Ethics Committee (Tasmania) network (Application No. H9709). Four groups of stakeholders from state government, local government, commercial enterprise and the social and community support sector participated in two rounds of consultation. These focus groups are referred to as follows:

- state government – SGFG
- local government – LGFG
- commercial enterprise – CEFEG
- social and community support – SCSFG.

Overall eight focus group sessions were conducted. The first round of focus groups was held in October 2007 to discuss the research problem and housing context and to garner feedback on ideas for the next stage of research, which aimed to engage householders. The second round of focus groups was conducted in May 2008 to report on and discuss early findings from analysis of household interviews. Each focus group had between three to six stakeholders present.

¹⁵ The OEPC also received eighteen reports from me during the research investigation providing updates of progress and findings as they emerged.

The aforementioned four groupings were chosen so that various perspectives of dwelling adaptation could be put forward; positions taken by stakeholder groups on the issues could be identified; and the specifics of stakeholder contexts could be understood. Focus groups also provided understanding of how decisions related to the issues discussed were being made in organisations and on what basis. The official objectives of the initial round of focus groups were to:

- identify whether stakeholders agreed there was a need to adapt dwelling for health, wellbeing and environmental impact;
- seek input regarding key context issues;
- identify stakeholder priorities (including the priorities of the institutions they represented) for dwelling adaptation and whether health, wellbeing and environmental care aims were relevant to them;
- ask for their assistance to recruit households for interviews and observation fieldwork;
- ask what they believed were the key drivers and impediments were to sustainable dwelling adaptations in Tasmania;
- develop understanding of the sorts of processes and interventions stakeholders thought would drive dwelling change for health, wellbeing and environmental reasons; and,
- generate questions for the next stage of fieldwork with householders.

The objectives of the second round of focus groups were to report back (to the same focus groups) on the initial interview discussions held with householders and to gather focus group members' feedback of the household interviews. The focus group feedback was used in the design of the second round of householder interviews.

The focus groups' discussions provided a platform upon which to begin to collectively disentangle 'the complex web of relations and processes, meaning and representation, that comprise the social world' of residential dwelling in Tasmania (Cameron 2005: 116). Through conversation we were able to interact, explore issues dialogically, and identify areas of shared understanding and difference. Collective sense was made of the research problem and possible solutions (in policy, planning, commerce and governance) were explored. In effect the conversation generated in the groups created

‘the beginnings of a body of knowledge’ (Cameron 2005:120) not accessible via other means.

Grouping participants according to the sectors within which they worked enabled the conversation to remain on aspects of the housing process that were understood and commonly shared experiences for that stakeholder group. The grouping also limited tension that may have arisen between different stakeholder groups.¹⁶

Focus group participants were selected by means of purposeful sampling (Patton 2002), which involved approaching people in organisations likely to have had experience with housing and related matters such as health, wellbeing and environmental gain or housing improvement.¹⁷ Knowledge of these organisations was achieved by means of orientation meetings conducted at the beginning of the research, by heeding advice from others in housing research, and by deriving particular insights from the contextual review. I called all potential participants before officially inviting them to ensure that they thought they were the right person to be attending and to determine whether they wanted to recommend others in their stead.

The focus groups were held at the University of Tasmania. Another researcher and formally trained architect, Prue Slatyer, who was familiar with housing research, assisted with discussions and note taking. All participants had been supplied information sheets prior to the sessions (see Appendix B). I led the conversations with semi-structured questions and prompts, allowing conversation to progress in an iterative and emergent fashion. Participants were skilled communicators and well-practised in meeting situations, so discussions generally flowed well. By attending, participants implicitly acknowledged their interest in housing and dwelling research, policy and practice. I did not pretend to be a neutral or objective facilitator and participants were not taken to be neutral stakeholders.

It is often the case that many professionals know each other in populations as small and as clearly bounded as Tasmania. There was a high likelihood, therefore, that people I

¹⁶ From the contextual review it became apparent that the different sectors had disagreements relating to priorities and that funding from state government made challenging their position financially damaging. Some organisations in the social support sector, for example, had programs funded by state government, which could cause challenges in a focus group conversation.

¹⁷ Housing was used as the key term in initiations and discussion because it is a well understood term.

invited would know each other. If I was unlucky, in my ignorance, to invite people who were hostile, the conversation may have suffered (Cameron 2005: 121; Ezzy 2002; Patton 2002). In most circumstances though, I found that people's relationships with and knowledge of each other was useful and created a comfortable conversational atmosphere.

Difficulties did arise in the local government focus group, where it was clear through pauses in conversations, hesitancy and body language that there were power differences in the room.¹⁸ This dynamic led to participants hesitating to answer some questions. In addition, the issues of housing and dwelling were challenging at Local Government level because the responsibility for supporting dwelling adaptations mostly fell outside of their governance responsibilities.¹⁹

Overall the focus groups provided contextual information from various points of views that allowed me to develop a much more detailed understanding of dwelling adaptation possibilities in Tasmania. The groups confirmed that uncomfortable, energy inefficient housing in Tasmania was seen as a relevant and important problem, especially in situations where householders lived on low incomes and experienced other capacity challenges. They verified that little action was being taken to support dwelling adaptation for energy efficiency. This understanding guided the design of the next stages of the research.

Emergence from reviews of the importance of everyday lived experience

During the period when the initial contextual and literature reviews and the focus groups discussions were being conducted, it became clear that important voices were missing from this (and other) explorations of energy efficient dwelling adaptations. The missing voices were those of householders who could recount their lived experiences in

¹⁸ There were also large age differences between participants as well with some participants new to their local government careers and some who had well established government careers.

¹⁹ Government at local level has specific responsibilities as directed by state government, which limits the opportunity for local government initiatives. Also around the time of the focus groups local government were in a significant era of change, with water facilities about to be handed over to regional water authorities as the local councils around Tasmania were having difficulty maintaining the infrastructure. It was also suggested that local government in Tasmania were simply unprepared to take on any more responsibility, due to high levels of responsibility with small teams on small councils.

adapting dwellings for energy efficiency or other sustainability dividends.²⁰ It was clear that such narratives and experiences could increase situation-specific understanding of dwelling practices and as such were a key data need for this inquiry. This realisation critically influenced the next steps of method design.

Consideration of householder experiences was also missing from most discourses on housing in Tasmania. Despite this dearth of attention locally, there were some excellent examples—not all of them oriented to housing—of engagement with lived experiences in research elsewhere (ibid.: Hand et al. 2007; Lefebvre 1991; Moran 2004; Zeisel 2006). Joe Moran notes that research on the everyday increased after World War Two ‘as a way of making sense of particular kinds of cultural change in Western societies’ (2006: 53). Nonetheless, the everyday often

remains unnoticed because it is practised thoughtlessly and dismissed as banal and boring; it is made up of intangible, transitory phenomena such as gestures, habits and routines; and it evades conventional forms of knowledge, which tend to abstract and intellectualize experience, overlooking the phenomenology of concrete experience (ibid.: 56-7).

Standpoint feminists²¹ have also made the point that everyday life is important and argued that exploring the everyday provides useful insights into tacit knowledge.

The knowledge people have by virtue of their experience is a knowledge of the local practices of our everyday/every night worlds. It is for the most part what Michael Polanyi ... called “tacit knowledge”—a knowing that is the very texture of our daily/nightly living in what we know how to do, how we go about things, and what we can get done (Smith 1997: 393).

Crosbie and Baker (2010) argue that understanding inhabitants is crucial to designing successful energy efficiency interventions in housing and note that most studies overlook this obvious need. Householders, they say, need to be participants in and not just consumers of interventions encouraging adaptations.

²⁰ I had of course had many *informal* conversations with people about their dwelling quality, and barriers and drivers for renovations, improvements and adaptations. People’s houses and concerns about their houses were obviously of high priority, but formal recordings of householder opinions are rare.

²¹ Although Dorothy Smith (Smith 1997) argues that standpoint theory feminists are not one whole group, but practitioners working in parallel.

In reality householders are the people most involved in adaptations to their own homes and can provide the best eyewitness accounts. By investigating the everyday experience of domestic life, this study seeks to deliver a rich picture of houses as sites of dwelling and dwelling adaptation activity. Combining insights from the everyday experiences of dwelling adaptation with those derived from focus groups and the literature and context reviews provided opportunities for deep understanding of dwelling ecology, comfort and energy management, and adaptation; all of which are generally overlooked in housing sustainability research and assessment.

2.5.2 Investigating dwelling adaptation with participants of the Glenorchy energy rebate program

An opportunity emerged through focus group contacts to work with householders who had applied for the Glenorchy Greenhouse Action Energy Rebate (GGAER) Program. The intention of the rebate was to encourage energy efficient home improvements and was organised and project managed by Sustainable Living Tasmania (SLT)²² in cooperation with the Glenorchy City Council (GCC).

From July 2007 to May 2008, residents of the Glenorchy municipal area were offered rebates on appliances, fixtures and fittings that, when installed, would assist householders to improve the energy efficiency of their homes. Engaging household participants involved in the GGAER program provided me with the opportunity to study the lived experiences of dwelling adaptations with a group of householders who had considered and/or undertaken energy efficient home improvements. It also provided the chance to study the outcomes of an intervention co-produced by a local government and an NGO. In addition, because the rebate program focused on supporting a disadvantaged community, the research engaged with people on low incomes who had challenges with adaptation capacity. I was therefore exploring 'good practice' examples to shed light on what influenced dwelling adaptation activities in householder groups experiencing missing or low adaptive capacity.

²² SLT is a non-government organisation based in Hobart, Tasmania that advocates for sustainable living.

The rebate program came about because SLT successfully sought funding from the Australian Government²³ and approached the GCC to be a project partner. SLT chose the Glenorchy area for the rollout of the rebate because staff at SLT were aware that the municipality has large numbers of low-income and otherwise disadvantaged households (Ancher 2007; Australian Bureau of Statistics et al. 2008). They considered GCC an innovative council open to assisting with the rebate project (SLT interview 17.11.08); in turn the GCC was supportive of the project to reduce greenhouse gases (Glenorchy City Council: 14). Consequently the rebate was rolled out as part of the GCC Greenhouse Action Plan.²⁴ SLT also organised for local businesses to be involved in the project. The businesses involved offered discounts on energy efficient appliances, fixtures, and fittings for householders involved with the program.

Recruitment for GGAER program rebates was conducted through Council publications, rates notices and contacts at community meeting places, such as the local shopping centres and libraries. The GGAER program supported 200 householders to purchase energy efficient items to help upgrade their dwellings. Following an SLT assessment of applications²⁵ rebates were supplied for solar hot water systems, curtains and heat pumps, and energy saver packs that contained water-saving showerheads, draft-proofing tape and compact fluorescent lights (Sustainable Living Tasmania 2008a: 1). The scheme enabled insulation to be installed in the ceilings of 67 houses and heat pumps to be installed in 17 houses. Eighteen householders installed solar hot water, eight added extra sets of curtains, and hundreds of people purchased discounted 'Home Energy Saver Packs'. Fifty householders who applied for heat pumps underwent a home energy

²³ The rebate project was funded through the Australian Greenhouse Office (now part of the Department of Climate Change) as part of a 'Low Emissions Technology and Abatement program' grant (Sustainable Living Tasmania 2008b).

²⁴ The GCC Greenhouse Action Plan had been released in 2003 with goals to reduce community emissions by 20% on 1996 levels by 2010 and to reduce corporate emissions by 70% on 1997 levels by 2010. The corporate goals were in line with the 'largest reduction target set by a local government authority in Australia' (Glenorchy City Council: 14). The rebate project for householders was rolled out in conjunction with a project to reduce car use in the GCC area. The car use reduction project was also rolled out by SLT and formed part of the GCC Greenhouse Action Plan, but is not part of the present investigation. The aim of the combined household energy efficiency and transport arms of the GGAER project was to reduce 'greenhouse gas emissions by 1300 tonnes per annum' (Sustainable Living Tasmania 2008a: 1).

²⁵ Some applicants were not offered a rebate. One such householder responded to my invitation to participate in the research and explained that he had not received an offer, was annoyed about it and declined to take part in the research. The reasons for rejecting certain applications varied but SLT clarified with me that if proposed adaptations were unlikely to have any effect on energy efficiency, the application was turned down.

audit to ensure that their dwellings would support energy efficient use of the new appliance (Sustainable Living Tasmania 2008b: 11). Householders were able to contact SLT for further information and assistance when considering the rebate and consequent potential purchases. As part of the program, SLT also conducted home energy and climate change workshops in the municipality to complement the rebate offer, and a number were well-attended (SLT interview 17.11.08; Mel summer interview 6.03.08).

In the initial stages of recruitment, applications for the rebates were mainly received from owner-occupiers; only two tenants applied. To rectify this imbalance, SLT then targeted landlords by advertising through real estate agents and by emphasising the ceiling insulation rebates, which supports everyday energy efficiency for tenants and improves the market value of the dwelling for the landlord. SLT consequently received 65 enquiries from landlords, with 27 going on to conduct improvements with a GGAER rebate²⁶ (Gabriel et al. 2010: 42).

Recruitment (for this research) of households and businesses supporting GGAER was conducted through SLT. After consultation with SLT about interviewing strategies and prompts for the research, an interview program was drafted and passed for approval to supervisors, SLT and the Human Research Ethics Committee (Tasmania) network (through Application No. H9880).

After the interview program was approved, the invitation and accompanying information sheet asking householders (who had applied for the GGAER rebate offer) to participate in the research was sent through SLT with a letter of introduction (Appendix C). SLT had 182 households to which research invitations could be sent. I hoped to recruit seven to ten household participants, but with no idea of possible response rates decided to send out two batches of invitations, with names selected from random positions on an alphabetical list. All those to be invited had at least applied for the GGAER project rebate, but may not have taken up the offer; this meant that all potential participant households had considered installing energy efficiency products in their houses with the help of a rebate.

²⁶ Engaging landlords to retrofit investments properties is understood to be challenging when the programs are not specifically tailored toward rental investors (Gabriel, Watson et al 2010).

The first batch of invitations was to 90 householders and was mailed out on 15 February 2008. A second batch of invitations was sent out on 19 February 2008 to seven more householders and one communal aged-care facility. The second batch was sent out because, at that stage, fewer than seven responses had been received. Ultimately, in response to the 98 invitations sent, 20 householders replied, 18 noting that they could participate in the research. Due to difficulties organising interviews with one potential household participant, 17 were confirmed for the study. Overall 48 interviews were conducted with the 17 households participating, over three seasons. In hindsight, this number of households was a large group to investigate in detail by myself. If I had better understood the workload involved and the sorts of response rates that could be expected I would have mailed out a much smaller number of invitations. At the time though, I was new to the recruitment techniques I was using and did not have a firm sense of how householders may respond to my invitation. I was asking for a significant commitment on their parts and was concerned the response rate would therefore be low. In future investigations in which I look in detail at an issue and attempt to embrace the complexity of an issue, I will set in place staged checks during recruitment so that I can better bound and manage the investigation.

Household participant recruitment was followed in March 2008 with attempts to engage businesses organisations in the study. Twelve of the 46 organisations involved with the household rebate component of the GGAER program were contacted for face-to-face or telephone interviews; they were selected on the grounds that they represented businesses that supplied common energy efficiency technologies and components for homes. Representatives from four of the twelve organisations responded and three were interviewed. Meetings and interviews were also held with the project managers from SLT and one of the household assessors who had been involved with SLT's GGAER project. Insights from these interviews have been used only modestly in this work, in particular informing context analysis in chapter three.

The intention of the fieldwork was to gain understanding of domestic energy efficiency, comfort and home improvement.²⁷ Data was gathered in semi-structured interviews with household participants and representatives of organisations involved with the

²⁷ Later I began to use dwelling adaptation instead of home improvement as the dwelling and adaptation were more encompassing and more accurate.

GGAER project, and through observations of household participants' dwellings. The combined accounts of householders and representatives from GGAER business organisations were intended to provide data on housing processes and the drivers of and barriers to domestic energy efficiency and comfort adaptation efforts. However, I began with household interviews and found that the data flowing from the accounts of their experiences held such rich and useful insights that I did not need to explore the organisational perspective to the same extent as I had planned. Household participant experiences of dwelling adaptation and of the rebate project came to be the chief focus of this research. The organisational perspective, whilst still pursued, became less important to the study. The revelations the household fieldwork provided justified the commitment to emergent practices, revealing original insights into dwelling and dwelling adaptations in rich detail that would otherwise not have been uncovered.

Participating households

Participating households included people of different ages, incomes, and levels of health and mobility (Appendix E, Table E-1). A total of 26 people participated in interviews from the 17 households studied. Of the 17 households four housed families who still had children living at home, six housed couples, and seven housed single occupants. None of the houses were share households. Of the 26 people who participated, one person was a child,²⁸ four participants were in their 30s, three were in their 40s, five were in their 50s, 11 were in their 60s, one was in their 70s and one person was in their 80s. Five householders living in the participant households did not participate. Two of the non-participants were adults, one was in their late teens and three were younger children. The householders are listed here using supplementary names to provide anonymity (with approximate age in brackets):

- Cara, Edward (30s) and Veronica (10);
- Del (70s) and Kirk (80s);
- Frank (60s);
- Frederick (60s) and Keira (50s);

²⁸ The child was interviewed with her parents present. I had signed permission for the child to participate in the research from her parents on forms passed through the Human Research Ethics Committee (Tasmania) network in Application H9880.

- Helen (30s) (husband and two children did not participate);
- Henry (60s);
- Lorraine and Robert (40s) (young adult children did not participate);
- Mark (60s);
- Mary and Martin (50s);
- Mel (40s) (children are part time residents and did not participate);
- Olive (60s);
- Steve and Gwen (50s);
- Susan (60s);
- Terry (60s);
- Trent (30s) (wife and child who did not participate);
- Troy and Nat (60s); and,
- Vanessa and Paul (60s).

Some key adaptive capacities of participant households are briefly described here in order to describe the participant group further. Despite high levels of motivation, there were various mixes of adaptive capacities available in each household creating unique situations dwelling to dwelling. For example, householders may have been highly skilled in planning, but may have had little money, or householders may have been time-poor, lacking money, but skilled in handy work (see Appendix E, Table E-1). Seven households were affected by physical disability and physical illness in a significant way, which impeded their dwelling management and adaptation opportunities; and seven households accommodated lone occupants, which also limited adaptive capacity.

At the time of the interviews most householders had to manage their money carefully and were living on relatively low incomes.²⁹ Household incomes included pensions, part-time, casual and full-time wages. Four households had a full-time wage earner. Two of the full-time incomes were in households with children living at home and with the other parent studying. None of the households had two full-time waged people and only two householders received professional level wages. Three households had an

²⁹ While householders provided some general, indicative information about their incomes and money management issues during interviews, I did not seek to fully quantify household incomes.

occupant running a business; all were sole-practitioner or small businesses: two appeared to be quite small-scale operations. Two householders were in seasonal, casual work in food production and were not always confident that there would be work available. Seven households (10 people) were retired: five people were on some form of superannuation benefit and four were on pensions; all of them reported that they had to budget carefully. Despite low incomes, most occupants were owners or owners with mortgages. Two households rented: one (Henry) rented from a formal landlord and another (Susan) rented from relatives who had purchased her home for her. Four households lived with mortgages, all were nuclear family households. Only one householder reported feeling like they had enough of an income (and other saved money) to regularly use it as extra capacity for dwelling adaptations. Due to income situations, most households saved or planned carefully for each dwelling change.

Implications of the choice of household samples

Typically, low adaptive capacity would limit opportunities to engage in significant scales of adaptation for sustainability, but the householders I engaged with did act to adapt, even if they were stopped in some cases. All the participating householders were motivated to adapt their dwellings and had been thinking about, or had, undertaken adaptations to their physical dwellings or dwelling practices in order to improve the energy efficiency, comfort and affordability of their dwelling situations. The sample effectively provided a set of 'good practice' examples of people working from limited adaptive capacity bases. To be involved in the GGAER program householders had to have some adaptive capacity (for example, some money or some planning skills). Studying households with some available capacity, not an abject lack of it, provided the opportunity for the inquiry to understand not just how people were stopped by barriers to adaptations, but also how they overcame them. This, I thought, would be more enlightening than observing situations where no or very little dwelling adaptation was likely to occur. The decision to focus on the households who had some capacity to adapt and to use a rebate, rather than those who did not, was made in consultation with supervisors.

Each household case was reviewed in relation to energy efficiency and comfort, and in relation to adaptations that had been or were being considered and executed. Variety across the selected households afforded the opportunity to learn by comparison across

situations and by reference to each household as a case study with intrinsic worth (Stake 2000:436-8). Comparison of all the cases provides understanding of what is similar among and different across the cases, and illuminates the variations possible in adaptation experiences and in the delivery of a rebate for energy efficiency and home improvement. Insight developed comparing cases was used to develop heuristics for analysis (Evans et al. 2002: 92-96; Ezzy 2002; Patton 2002). Findings of comparisons and variations in household adaptive conditions are described in detail in chapters four, five and six.

Household interviews

Semi-structured interviews formed the primary method for investigating householder experiences of dwelling adaptation and changes to dwelling practices. Interviews provided access to participant's experiences, perceptions and ideas that otherwise would have gone unexamined (Hajer 2006; Kvale 1996). Smith (1997: 394) argues that engaging with people's everyday experiences 'gives direct access to the necessarily social character of people's worlds'. Experience can be engaged with through conversation and enable explicit communication of content and speculation about implicit meanings. Content and implicit meanings are exposed by the way conversations are conducted and categorised, what is chosen to be said, what is left unsaid, what is assumed, and what is implied.³⁰

Over a period of seven months spanning summer, autumn and winter three interviews were held with each household. Interviews centred on discussing dwelling adaptations (home improvements), energy efficiency, comfort and related topics (Appendix C). Semi-structured and longitudinal methods allowed for in-depth conversations, which were important for this inquiry as they provided rich data and extremely detailed information that provided opportunities:

³⁰ Content data comes from participants' direct descriptions and therefore is easier to extract from conversations than implicit meanings. To identify the more elusive implicit meanings from interview transcripts, I reviewed transcripts multiple times and explored nuances of conversations, such as what is left unsaid, hesitations, laughter, emphasis and metaphors. With this information thematic analysis of implicit meaning can be developed in an emergent way. I have developed my techniques guided by my supervisors who are skilled in qualitative interpretation of texts and also through literature that explores meaning in conversation and text (Denzin et al. 2003; Hajer 2006).

- to access participants' positions and ideas through conversation and bring to light issues that otherwise would remain tacit (Cameron 2005; Patton 2002);
- for unhurried conversations that afforded thinking time for all parties and enabled the natural ebbs and flow of conversations, so that conversations could be continued and revisited where it was useful;
- for ideas to be 'constructed' and clarified or refined through conversation (Cameron 2005);
- to discover and construct my own lines of thought on the research problem emergently (Patton 2002: 47); and
- to explore seasonal changes in households³¹ while householders' memories about the detail of their practices were recent and clear.

Participation in three interviews was a lot to ask of people; the longitudinal engagement came with some risks and huge time requirements. Yet, many points of the conversations stretched across all three visits, with revelations and detail often emerging *because* there had been a long build-up of conversation and participants had time to consider conversation points. These benefits made the intensive and repeated format for interviews worthwhile.

In almost every case, householders seemed enthusiastic about the research and there were no participant complaints about the repeat visits. At the end of summer and autumn interviews I checked whether the householders were happy to proceed with the next interview and I was enabled every time. Householders seemed comfortable to be involved with conversations in their own dwelling space. My presence there also provided opportunities to use dwelling characteristics as prompts in conversations. Only one participant had circumstances that required two interviews to be at his office.

My motivation in interviews was to elicit from householders their experience, perspectives and ideas in relation to dwelling adaptation. However, as others have noted, research interviews are a specific form of conversation in which research data are co-constructed by researchers and participants (Cameron 2005; Kvale 1996). Without

³¹ It was common for recall of events, dwelling practices or behaviours to be more accurate if the discussion was close to the time of the event/practice/behaviour. The longer the time period before recall, the poorer the recollection.

denying my role as the researcher in initiating and directing the interviews, at all times I sought to provide opportunities for participant ideas and accounts of experiences to be recorded. The semi-structured approach meant that interview questions were not always followed. Effort was made, however, to cover all topics areas on the interview schedule using planned topics of conversations and prompts (Appendix C). I took great care to ensure that discussions were respectful and stayed within subjects that householders were willing to discuss. I was in their homes and asking them to give their time, their thoughts and their privacy over to me, so it was important that I ensured a safe and respectful conversational environment.

Participants knew the background and purpose to the research. Their contributions were treated with respect; imbalances of power were limited as much as possible. Feminist approaches provided some guidance in respect of limiting power imbalances in conversations, being respectful and recognising subjects as more than data opportunities (Crabtree 2006a; Ezzy 2002:21-3; Patton 2002; Smith 1997). I was careful to provide information about the project and my own background so that participants were somewhat empowered by knowing about me. In relating my background I set up the risk that people would stigmatise or pigeon hole me, choosing to answer questions according to their assumptions about what I wanted to know. Nevertheless, the benefits in allowing participants to sit in a more empowered position in the conversation outweighed the risk. Ultimately, householders responded confidently knowing that, despite my training, I also experienced capacity issues and did not find adaptations magically easy.

The methods used in interviews meant that the tone was often conversational, which allowed for relaxed and informal exchanges and for the subjects of conversation to be comprehended more calmly. I tried first to ask questions that would allow broad interpretation, and then, only if needed, defined questions further with prompts. Despite all these efforts in initial interviews householders still did sometimes ask 'Is that the sort of thing you wanted?' When this question was asked I made it clear to participants that I was interested in their responses, not a prescribed answer, so whatever answer they chose to provide was interesting and useful.

Furthermore, to provide a safe space in which people could discuss the research topics and in response to the research ethics requirements, householder identifiers such as

names and addresses have been removed from the research to provide anonymity. Despite these efforts, anonymity is difficult to uphold in a small state of Tasmania (with only approximately half a million people).³² Many of the details, even de-identified had to be handled carefully in the text to maintain anonymity.

Responses from householders communicated diverse points of view and provided a wealth of insights in relation to experiences of adapting and managing their homes; using comfort devices; the state of their dwelling spaces; and the influences affecting their adaptation efforts and outcomes.

Household observations

Meeting participants in their homes allowed for observational data to be collected on dwelling features that affected energy efficiency, comfort and dwelling adaptation opportunities. On-site observations and some recording of indoor climates supplemented information collected through interviews. Environment-behaviour researchers recognise the usefulness of physical evidence and indicators, or physical traces (Rapoport 1972; Zeisel 2006). Through observation, phenomena can be examined using ‘whatever means necessary’ in order to get a grasp on the meaning of phenomena (Rapoport 1972: 41). My background in architecture equipped me to engage in physical environment observations effectively. In particular I looked for physical traces that hinted at the way the dwelling was used and focused on understanding energy use and management, comfort management and adaptive management. Observations were made by diagramming, noting and photographing any relevant phenomena and measuring the dwelling layout and climate. Observational data included:

- dwelling designs, orientation and positions of dwellings on lots and in greater landscapes;
- the overall state of dwellings;
- openings such as window / doors positions and areas;
- major vegetation and neighbouring structures;
- key dwelling activities and the areas in which they were undertaken;

³² Hobart houses around 200 000 residents, so it is a small city. Most of my research was conducted in the municipal areas of Glenorchy and Hobart City, which were also the sites of my personal social and professional communities as well. Research, professional and social groups therefore quickly overlapped and intertwined, and it was common to run into participants at social and community events or just around town.

- structural features, materials and technology used in the dwelling;
- spot surface temperatures and humidity at strategic positions;
- mould and moisture inside houses;
- gaps in structures causing draughts;
- solar access and overshadowing;
- passive and active energy management systems in the home; and,
- physical traces indicating how householders dwelt and managed energy efficiency and comfort.

See observation prompts listed in Appendix C for additional information.

Business and organisation interviews

The efforts made to contact and interview members of organisations involved with the energy efficient rebate eventuated in only three business interviews and two organisational interviews with SLT. Interviews with businesses and organisations were also semi-structured, with questions and prompts, as well as opportunities for participants to bring up points that were not on the interview schedule (see Appendix D). Interviews were recorded and notes were taken concurrently. Business interviews were conducted in a café, an office or by telephone, taking about 30 minutes each. Two interviews with staff at SLT took 60 minutes each and were structured according to findings emerging from household interviews, which were underway at the time.

The limited response from businesses and the success of the household investigations meant that the business interviews were used as adjunct data that has provided guidance and fresh perspectives on an emergent topic. Recordings and notes from the business and SLT interviews were reviewed and learnings were fed into the design of later interviews with householders, and informed the work's broader analysis.

2.5.3 Analysis

Various scholars have noted that analysis begins as soon as data are collected (Ezzy 2002; Patton 2002). The emergent process I used, in fact, *required* analysis to begin when the inquiry began because each stage had to build on analysis and assessment of the phase that preceded it.

Recordings from focus groups and household interviews were transcribed to enable detailed content and thematic analysis. I began transcribing the focus groups and

household interviews myself and, having gained important research training in these tasks, was then authorised by supervisors to employ a transcriber. Recordings from the first round of focus groups were transcribed and summarised, and then presented at the second round of focus groups. Members of focus groups then responded to the data, which served both to check and augment the original findings.

As I engaged in content analysis of household transcripts I realised that they needed to be transcribed in more detail. I revisited every transcription and added further detail, such as extra conversational content, cut-offs in conversation, thinking pauses, nuances of expression and laughter. The more detailed transcription provided illumination of nuance in conversations. Rereading transcripts on several occasions then afforded the opportunity to describe broad ideas and themes emerging from interviews and provided me with initial, broad-brush findings.

I then engaged in thematic analysis of transcripts using the 'tag and file' management ability in NVIVO software. Concurrently I generated interview and observation data summaries for each household, and these were de-identified and then shared with supervisors and the research sponsor. Participants were sent these summaries and were invited to check them. Only two householders commented or corrected details on their summaries.

It became apparent that there were many pathways down which analysis could proceed. I attempted to prioritise and isolate issues emerging from the data using an approach where 'critical incidents' and problem centres were highlighted as key anchors (Patton 2002: 46-7; Rittel et al. 1973). Understanding gleaned from the contextual review and the focus groups provided additional guidance for the analysis of data.

Themes were refined progressively and alignments with existing theory emerged alongside this process. Effort was made to identify both the commonalities and differences of experiences so that the full range of adaptation experiences and the characteristics of dwelling adaptation could be grasped. Analysis identified that, despite complexity in the detail of the data, there were enough common experiences and common processes shared among householders that heuristics could be developed for further levels of analysis. These heuristics took the form of key traits or characteristics of the dwelling adaptation processes experienced by householders.

To characterise and identify traits of dwelling adaptation, it is important to identify the nature of dwelling adaptation. Significantly, dwelling adaptation is the *process* of changes made to dwelling practices and/or physical dwellings to improve dwelling situations;³³ it can describe the simple forming of a goal or a fully realised outcome. If change is attempted to meet an adaptation aim or goal, but that outcome is not achieved, a process of adaptation has still have been enacted. Characteristically, dwelling adaptation occurs over time in incremental ways; involves key actors—those who dwell in a household and other influential stakeholders; requires intent and purpose from all actors; occurs in specific and complex contexts; may end in change (for the better) or not; and requires key capacities, appropriate tools, products and supplies, a supportive regulatory environment, and more. It may appear quite random and messy and adaptive processes of each household can greatly differ.

Traits of dwelling adaptation that structured later stages of analysis are summarised in the following observations:

- the nature of the process of adaptation itself provides hints for how to structure dwelling adaptation encouragement attempts;
- dwelling situations such as physical and socio-economic influences affect how householders live and are critical to how adaptations progress;
- adaptation processes are motivated by purpose (for example, comfort);
- householder backgrounds are critical to how adaptations progress;
- capacities available to householders are critical to how adaptations progress;
- householders used a variety of specific strategies and general adaptive methods to advance change;
- various relationships, information flows and other influences change the course of the adaptations; and
- most householders had the potential to advance considered adaptations and had some capacity available to them.

³³ The process of adaptation in a household can also be linked to larger scales of adaptation such as the broad scale climate change adaptation required of communities in Australia. Types of adaptation and change are discussed further in chapter three.

Further stages of analysis became structured around this emergent understanding of the traits of dwelling adaptation, not least a growing appreciation of a range of critical influences on dwelling adaptation processes.

Finally, analysis has also been influenced by a nascent understanding that dwelling adaptation among participants in this research aligns with certain insights about problem solving and design process and adaptive theory (Buchanan 1992; Lawson 2006; Popper 1999; Watson 2004; Zeisel 2006). I discuss the relevance of these process, problem and adaptive theories further in chapter four.

Chapter 3. Tasmanian dwelling adaptation context

3.1 Introduction

Taking Franklin's (2006) position that reviewing the context reveals important influences and interconnections, this chapter (three) and the next (chapter four) describe and review contextual issues related to dwelling adaptation for energy efficiency, comfort and equity. I review aspects of context because there are significant gaps in contextual understanding related to this thesis problem that, if understood, will assist to improve the design of interventions in Tasmania. Contextual understanding also provides support for an ecological research approach as it enables consideration of multiple influences and multiple viewpoints in situ.

This chapter describes and reviews relevant aspects of the Tasmanian and Australian housing³⁴ and dwelling adaptation context. There have been few studies of Tasmanian residential dwelling or its performance in relation to comfort and energy efficiency. Commonly, information on comfort and dwelling energy efficiency in Tasmania is dispersed, not formally recorded, or inaccessible to the general public. Of the few existing studies that have looked at energy efficiency in housing in Tasmania; none used contextual, relational or ecological points of view. To address that gap for Tasmania this chapter describes and reviews historical legacies affecting current dwelling adaptation activity; and then reviews the state of current housing stock, renovation activity and other conditions influencing dwelling in Tasmania. In light of the topics I address, this chapter explores two questions: What colonial and contemporary *legacies of dwelling adaptation* are evident that may affect future interventions in Tasmania? What are the *conditions of current housing stock*, and the status of *renovation* activity?

For this chapter and the next I have drawn on reviews of academic literature, government reports, context observations (including reviews of stakeholder activity), media documents and focus groups (whose members provided insights otherwise unavailable or undocumented).

³⁴ Sections of the contextual review primarily discuss housing because most literature relating contextual information and data focuses on housing instead of dwelling spaces or dwelling practices.

3.2 Legacies of dwelling adaptation from colonial to contemporary times

When contemplating how to encourage contemporary dwelling adaptation it is useful to look to historical processes of dwelling change (Bellan 1971; Stretton 1989; Troy 2000b). This section responds to the question: what colonial and contemporary *legacies of dwelling adaptation* are evident that may affect future interventions in Tasmania? Expectations about dwelling standards and various activities that affect housing stock and dwelling spaces have evolved in response to social and individual priorities and contextual influences. Legacies of individual, collective, organisational and institutional choices are evident in housing form, construction processes, dwelling practices, expectations, attitudes and governance (Gleeson 2006; Rybczynski 1980; Stretton 1989; Troy 2000b). These legacies affect future opportunities for dwelling change; understanding them helps to identify what dwelling adaptation Tasmanians are able and willing to try.

Contemporary housing in Tasmania is built upon colonial settlements created by European immigrants from the early 1800s. Settlers had to draw on (and modify) predominantly British traditions in a strange place with few familiar resources, a climate different from northern Europe, and limited supply chains. The settlers effectively conducted an experiment in cultural transplanted and acclimatisation. As a result, colonial housing in Tasmania does not present 'optimum [vernacular] ... response to the environment and resources' (Lewis 2000: 53).

In succession, colonial and Australian governments were confronted with the most basic and pressing concerns in regards to housing (Dingle 2000). Housing policies were developed in response to what Susan Marsden (2000) has described a hierarchy of concerns, with public safety and health issues paramount (Stratford 1994). The consideration of amenity or higher standards of living were largely absent from housing legislation which was 'aimed at drawing a line below which building and health standards were not permitted to fall' (Marsden 2000: 35). Public authorities did not want buildings falling down, sewage making everyone sick or fires spreading through (largely timber) settlements.

Australian housing standards, planning laws and supply infrastructure for housing gradually improved throughout the nineteenth century. With federation in 1901 came a stable political system generating purpose and structure for legislative change in housing. The first half of the twentieth century saw more instances of direct intervention being applied to housing (and urban) policy, especially by means of political efforts from the Labor party (Marsden 2000). Efforts to improve housing and urban situations by means of policy have continued in waves from that time to the present (Gleeson 2006; Stretton 1989), greatly affecting housing form, construction industries and dwelling practices.

Early to mid-twentieth century there was a significant push to build what Gleeson called 'The Great Australian Settlement' (2006: 12) which 'aimed to guarantee for all the minimum conditions of a decent life' (ibid.: 24). Suburbia in this settlement was to provide the conditions for wellbeing by means of home ownership or the provision of social housing. The efforts were underpinned by a multilateral agreement to strive for 'security and a high standard of living for all' (ibid.: 13). Social wellbeing goals were to be met 'through orderly and inclusive suburbanisation and the protection of the most vulnerable through a modest public housing sector' (ibid.: 22). Even with two world wars and economic depression in the 1930s, Australia became a nation-state with extensive suburbs of reasonable housing stock that were mainly located in cities and characterised by high rates of home ownership.

By the mid-twentieth century this suburban housing drive delivered a significant stock of affordable housing (Freeland 1972), often on the margins of urban areas where land was inexpensive. Such 'social housing' was largely devoid of insulation or other comfort and energy fixtures. Nevertheless, it did provide working class populations with housing (Logan et al. 1981). Despite derogatory critiques,

life in the new suburbs ... [was] a vast improvement on areas traditionally occupied by the working class ... even the poorest usually had adequate, if rudimentary, housing, whilst a majority of households enjoyed the benefits of home ownership, good and improving urban services and high residential amenity (Gleeson 2006: 19).

The main political priority of the housing push was to encourage as much home ownership as possible since it was considered the best path to a higher standard of living

for Australians. Even people on low incomes were encouraged to purchase homes through rent-to-buy schemes (Stretton 1978). Areas of housing stock in Glenorchy, the site of the housing case studies of this research, moved into private possession through this government program in the 1960s (SCSFG October 2007).

Throughout the period in which this push for suburban housing and housing welfare was evident, certain practices and values originating in colonial times persisted, particularly the culture of do-it-yourself and taking care with materials. Resourcefulness and limited funds often drove construction priorities over labour considerations and defined what amenities could be expected in the house (Dingle 2000: 69).

However, by the mid-1970s, and due to a neoliberal shift in political and economic policy, the rhetoric of social housing gave way to another involving 'welfare housing'.

Welfare housing was now provided for 'undeserving poor' or an 'unfortunate underclass' for whom disadvantage was amplified in (often isolated) public housing estates. At this time widespread orthodoxies about the market's influence on housing activity led governments to adopt neoliberal agendas and policy (Stretton 1989).

Deregulation after the neo-liberal shift significantly diminished *direct* government intervention in housing markets (Davison 2006: 208; Troy 1995; Troy 2000a). In this market-led environment (that persists to the present), housing is 'rarely articulated as a social problem for policy focus that is interconnected with urban, health, transport, planning, policing, education, labour-market and sustainability portfolios' (Atkinson et al. 2006: np).

Alongside the political and value shifts, the twentieth century also gave rise to the modernisation of housing design, construction and maintenance, a process deeply imbued with the precepts of modernism (Hughes 1991).³⁵ The modernisation process was also fuelled by the post war 'long boom' of the 1950s and 1960s. As a result, until the oil shocks of the mid-1970s, and then a shift to environmentalism from the late 1970s, technological advances in production and transport were rapid and extensive, and limited consideration was given to environmental impacts. These trends meant that resources for housing and construction were produced *en masse*, an experience that

³⁵ Precepts of modernism include a strong faith in progress, technology, science, and experimentation and a rejection of historical understanding.

prevailed internationally. Yet, as Marosszeky (1995: 121) notes, ‘In Europe ... opposition to *mass housing* was gaining momentum ... [The] construction process had completely disrupted the natural relationship between dwelling occupants and their personal space, giving them no power to influence their immediate environment’ [emphasis added]. In this opposition there was awareness of the impacts of modern design construction and living processes (for example McHarg 1992; Rybczynski 1986), which occurred in Australia as it did overseas.

Over the period of the long boom and into the present time (despite growing evidence of the negative effects of high levels of resource use), householders have become accustomed to affordable and plentiful energy supplies and, often unquestioningly, have grown used to using more and more energy in increasingly larger dwellings, fitted with a growing number of energy-hungry technologies (Energy Efficient Strategies 2008, SGFG October 2007 and May 2008). Tasmania, in contrast to other parts of Australia, developed a hydro-electricity system³⁶ in the twentieth century which helped to generate ample amounts of affordable electricity (Thompson 1981). Using hydroelectricity also amplified the idea that resources were plentiful and inexpensive. Indeed, among Tasmanians and new migrants to the island these widespread perceptions of plentiful resources created wasteful energy practices that participants assured me still prevailed (in 2008) despite significant increases in residential electricity costs (SGFG, CEFG October 2007, May 2008). Wasteful energy practices are not exclusive to householders, with evidence of limited thinking in government about dwelling adaptation and housing stock quality and how it may affect resource use. In this vein, Stratford et al. (2008: 4) found that in considering strategies for the state’s affordable housing strategy,

Tasmanian Government stakeholders voiced an interest in the benefits of renovation for sustainability, yet highlighted the financial and policy difficulties they face. Economic pressures ... have produced what one asset manager described as demand for increases in the *number* of dwellings rather than for *quality* dividends: he termed this getting ‘bang for the buck’ [emphasis added].

³⁶ The hydroelectricity was provided by the Tasmanian Government’s Hydro-Electric Commission, which was not privatised until the mid-1990s.

3.3 Current housing stock, renovation activity and conditions influencing dwelling in Tasmania

The state of contemporary housing stock and dwelling conditions in Tasmania are concerning to stakeholders. In response, this section addresses the question what are the *conditions of current dwelling stock*, and the status of *renovation activity*?

Stock condition

Focus group experience confirmed that a significant proportion of householders live in old, uncomfortable (regularly cold) and energy inefficient housing (CEFG, SGFG, LGFG, SCSFG October 2007). Members of focus groups reported that housing had old (poorly maintained) structures and servicing (CEFG October 2007), and noted that older stock³⁷ and related infrastructure was in need of significant repair and maintenance (CEFG, LGFG October 2007); plumbing and electrical infrastructure were particular concerns. One focus group member reported that

... the Treasurer estimated that a billion dollars needed to be spent on [housing] to bring it up to contemporary standards and that is not even looking into the future, that is just bringing it up to standard (SCSFG May 2008).

Such observations are supported by data in one Australian Bureau of Statistics (ABS) survey, which found that in 2007–08 the proportion of Tasmanian householders reporting major structural problems was 19 per cent, higher than the Australian average (Australian Bureau of Statistics 2009: 7-8). A much higher proportion of those in rental accommodation reported major structural issues in the survey than did those in other occupant categories. It is noteworthy, too, that in the 12 months before the survey, repairs and maintenance had been carried out on just over half the dwellings; nevertheless tenants reported that repairs and maintenance had occurred in only half the cases where needed.

³⁷ Over a fifth of the stock was older than 50 years and over two thirds older than 20 years in 1999 (Australian Bureau of Statistics 1999). Despite the age of this information it is still a reasonable indicator due to Tasmania's slow rate of changes in housing stock.

Regularly, housing stock available to low-income households is cold (even with heating) and has moisture and mould issues (Flanagan, K. 2007a; Tasmanian Council of Social Services 2007: 11). Apprehension about the poor quality of housing stock available for disadvantaged householders has led to the community sector making regular, collective efforts to lobby for better quality housing (Flanagan et al. 2007).

Focus groups (SGFG & SCSFG October 2007) were especially concerned about the standard of rental housing available in Tasmania. The SCSFG group (October 2007 and May 2008) pointed out that rental properties are often of poor quality and it is legal for properties to be leased without provision of basic services such as water and electricity supply (Department of Justice Consumer Affairs and Fair Trading 2011; Tasmanian Government 1997). Others in the social and housing support sectors were also concerned about poor conditions in rental dwellings (Flanagan, K. 2007a; Flanagan, K. 2007b; Flanagan et al. 2007). Yet, rental prices were still unaffordable for many occupants.

Poor housing conditions are known to be a problem nation-wide, with the lack of monitoring of housing quality and basic service provision in affordable housing and rental stock key issues (Newton et al. 1998).³⁸ In this respect, the United Nations Special Rapporteur (Kothari 2006: 4) was

particularly troubled by the inadequate housing and living conditions he witnessed in some parts of the country, given that Australia is one of the wealthiest developed countries with a comparatively small population [and] ... he has come to believe that there is a serious hidden national housing crisis in Australia.

In Tasmania, inertia limiting improvements to poor quality housing is influenced by its relatively small population which, by 2012 was projected to be only half a million living in approximately 208 000 households (Australian Bureau of Statistics 2010b: table 1.17; Australian Bureau of Statistics 2012a). With the slowest population growth of any Australian state at 1 per cent³⁹ per annum (Australian Bureau of Statistics 2010a: 1),

³⁸ In 2010 the problem of a lack of reasonable minimum standards were discussed at a conference attended by social support groups and government with an aim to resolve the problem ((Department of Justice Consumer Affairs and Fair Trading 2011). No change to the Residential Tenancy Legislation has yet taken place.

³⁹ I round to the nearest whole number when citing percentages unless a close comparison is being made between variables and more detail is required.

Tasmania has a comparatively low level of increase of individual households (also at about 1 per cent per annum) compared to the national rates (1.8 per cent per annum) (ibid.: Table 1.1).

Renovation activity

Despite inertia improving poor conditions for disadvantaged households, home renovations and alterations⁴⁰ are commonplace in Australia (Allon 2008). Whilst dwelling renovations, alterations and adaptations are not reported anywhere as a complete group⁴¹ there is evidence they are popular activities. For instance, ABS surveys found that:

- In 1999 58 per cent of respondents had renovated in the previous decade (Australian Bureau of Statistics et al. 2002);
- In 2002–03 19 per cent of private sector construction revenue in Australia came from alterations and additions and another 6 per cent came from repairs (Australian Bureau of Statistics 2004);
- In 2011 alterations and additions subject to official building approval in Australia were worth \$6556 million⁴² which was nine per cent of all residential building activity (Australian Bureau of Statistics 2012b: 16); and,
- In 2004–05 revenue generated through alterations and addition work in Tasmania for owner-occupied dwellings amounted to \$187 million (Australian Bureau of Statistics 2006c).

In Tasmania, as one State Government focus group member explained, renovation is understood to be popular.

Of the people I know ... nine out of 10 would have done something significant to their homes within the last five years. Everybody is doing things to their houses; new kitchens quite often, but knocking walls, putting in built-ins or building

⁴⁰ Renovation and alteration are terms often used to describe more substantial physical adaptations where a dwelling has been extended or substantially altered.

⁴¹ The numbers of householders who undertake adaptation in all its forms is unknown and type of adaptations being undertaken and the types and ages of stock being renovated are also unreported in official statistical surveys.

⁴² Unless otherwise specified, all dollar amounts are in Australian currency.

garages. My point is that there is an order of magnitude more work going on in existing houses than in new houses (SGFG May 2008).

State government and commercial enterprise focus groups (October 2007) reported that substantial renovation work was more regularly undertaken on housing stock built in the 1950s and 1960s. This aligns with national findings that older aged dwellings are more likely to be renovated than younger stock (Australian Bureau of Statistics 2002: 192). In addition, renovations are more likely to occur in dwellings occupied by families than in those occupied by individuals, and such modifications are prevalent among people with higher incomes (ibid.).

At least some of current renovation activity is driven by a growing commitment to living more sustainably, with foci including energy, water and waste efficiency, and food generation (Horne et al. 2009; Waterworks Valley 2012). There appears however, still to be a challenge in generating activity to support sustainability goals of social equity.

Factors influencing dwelling conditions

In order to better contextualise housing and dwelling conditions housing typology, common construction materials and products and landscape influences are described here. Detached, suburban dwellings make up 86 per cent of Tasmanian stock, which is far higher than the national average of 75 per cent (Australian Bureau of Statistics 2006a; Australian Bureau of Statistics 2006b). The proportions of semi-detached housing (at four per cent) and flats (at nine percent) are well below national averages for these typologies (ibid.). Glenorchy, the site of the case studies, follows the Tasmanian trend of having a high proportion of suburban detached housing which is designed with two to three bedrooms and is set up for multiple occupants, but not large families.

The mainly suburban housing stock available reportedly does not fit occupancy requirements well, particularly for single occupants and large family households, the elderly, people with physical impairments and those trying to live affordably (LGFG, SCSFG, SGFG, CEFG October 2007 and May 2008). There are plans to correct this disjunct a little by constructing some more single occupant units, but no other remedial strategies are publicised. Certainly, for lone occupants more effort and focus is required on solutions as they are a growing and significant proportion of Tasmanians, currently

making up about a third of all Tasmanian households (Australian Bureau of Statistics 2010b: table 1.17).

Materials and products used in the building shell, and the rates they are used, indicates how well comfort and energy efficiency may be supported indoors. The trends described here are supported by statistics listed in Appendix F. Surveys identify that brick, concrete, timber and metal are commonly used in house building shells in Tasmania. The variety of materials in use is positive because it allows for a suite of possible adaptive solutions. The common use is also helpful for adaptations as it means that people (particularly trades) are likely to be familiar and skilled in working those materials and products.

Whilst the materials used in Tasmania are the same as those used nationally, the rates of use vary from other states (Australian Bureau of Statistics 1999). Timber stands out as a material that is more commonly used for walls and floors in Tasmania than in other states (Appendix F). This trend is due to timber resources historically being plentiful, cost effective and widely harvested in the State. Moreover, builders in Tasmania have had the skills required to install timber since settlement (Australian Bureau of Statistics 2005, CEEG October 2007). As timber is relatively easy to work, the common use of timber may mean that physical adaptations of the building shell are made easier.

Further, suspended timber floors are common in Tasmania (CEEG October 2007) because, among the many hilly dwelling sites, such floors are easy to construct. Suspended floors mean though, that houses are more exposed to the heat-sucking effects of regular winds and require alterations and additions to increase resistance to heat loss.

Whether it be a suspended floor or a brick wall, all materials used in house building shells in Tasmania require extra insulation to create comfortable and energy efficiency indoor areas. However, insulation rates in Tasmania are often suboptimal (see the physical intervention discussion later in this chapter and chapter four).

In general terms, the position of a dwelling in a landscape affects solar access, wind activity, design and function (CEEG October 2007). In relation to landscape, the biggest cities in the state, Hobart, Launceston and Devonport, were built around water catchments and therefore have large areas of housing sited on hills around rivers. In addition, Hobart and Devonport are close to the sea which effectively moderates the

temperatures but also exposes the settlements to strong sea winds. In all three cities, street and dwellings were laid out in response to the hills, views of rivers and principal transport routes. In Hobart, houses have been oriented to face east or west to maximise views of the Derwent River and Mount Wellington, but that positioning has undermined energy saving design and solar access opportunities.

Significant numbers of dwellings are built close to large hills in Tasmania, which seriously affects energy efficiency opportunities in dwellings. Slopes and their orientations can positively or negatively influence solar gain opportunities, precipitation levels, watershed, wind impact and soil quality, in turn affecting gardens, leisure opportunities and dwelling space microclimates (Figure 3.1). Homes overshadowed by hills and mountains are common in Tasmania. Overshadowed homes are not only more difficult to keep comfortable, they are also less desirable real estate (and are cheaper to purchase and rent). Overshadowed dwelling sites are therefore more likely to be home to those people living on low incomes.

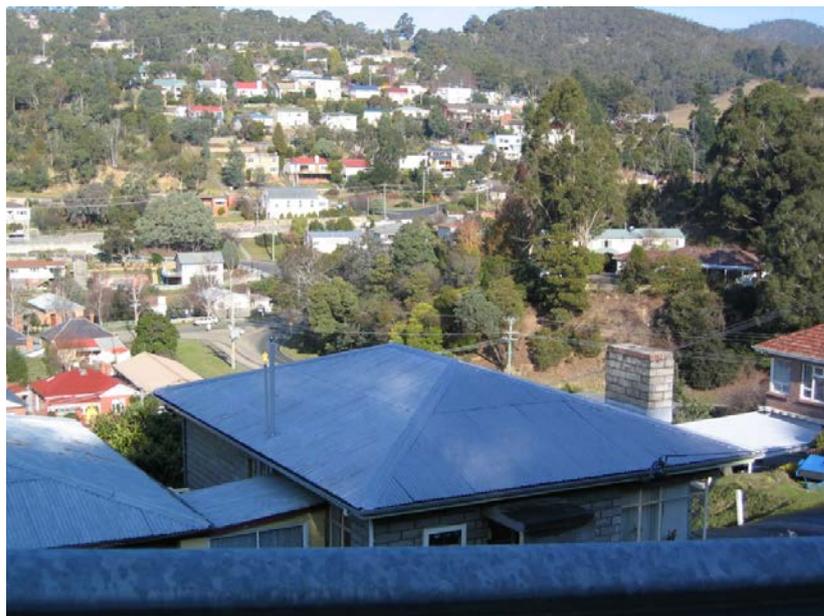


Figure 3.1: Overshadowing observed midday in winter. The photo was taken looking from a southern slope towards a northern slope in South Hobart.

3.4 Conclusions

This chapter has described and reviewed relevant aspects of Tasmanian and Australian housing and dwelling adaptation contexts. The chapter has shown that housing legacies, housing stock situations, renovation activity, construction type, materials and landscape all influence future dwelling adaptation activity and what intervention approaches are relevant for Tasmania.

Colonial and contemporary legacies have affected dwelling adaptation possibilities by creating underlying physical and attitudinal frameworks upon which adaptation and interventions will have to take place. Key legacies influencing current adaptation opportunities include: colonial base minimum standards, shelter first attitudes, and do-it-yourself resourcefulness approaches; federation and early 20th century belief in ownership of basic housing as welfare; mid-late 20th century neoliberal economic priorities and an aversion to welfare; and, modern mass production and reliance on easily accessed (relatively cheap) energy.

The conditions of current housing stock and the status of renovation activity will also affect adaptation opportunities and therefore intervention design. Overall, current housing stock in Tasmania has been shown to be uncomfortable and energy inefficient, particularly for low income households. Review of housing types, building construction, and materials show that houses do not necessarily suit the occupants that are using them and that most housing needs extra insulation to generate comfortable and energy efficiency indoor environments. Insulation rates indicate poor to moderate thermal performance only. The hilly landscape also creates particular challenges for energy efficiency and comfort with housing positions on hills affecting solar access, wind activity, design and function. All these contextual influences affect what adaptations are most critically required and the types of interventions that will be attractive to householders.

Physical adaptations for energy efficiency are possible in the existing stock and can provide existing houses with significant improvement of the comfort and energy performance of existing housing. There is hope that adaptation activity for energy efficiency and comfort can work ‘on the back of’ high levels of renovation activity in the state and a cultural fascination with renovating homes.

Chapter 4. Motivations, intervention approaches and adaptation processes

4.1 Introduction

This chapter further explores context surrounding dwelling adaptation and interventions for energy efficiency and comfort by describing and reviewing: concepts of equity, comfort and energy and their roles as motivators for dwelling adaptation activity; current intervention approaches encouraging energy and comfort improvements; critiques of intervention approaches; and theories that can help to improve intervention approaches.

Concepts and activity around equity, comfort and energy in dwellings are explored in order to establish them as legitimate motivators for dwelling adaptations. Major types of intervention approaches used around the world (and critiques of them) are reviewed in order to provide some understanding of: intervention activity over the last few decades; the types of interventions that have been applied in Tasmania and Australia; the positives and negatives of various approaches; and possible ways to improve them. Theories of adaptation are presented because they: offer some background to adaptation and to interventions approaches; can potentially guide improvements to intervention approaches; and help to overcome current implementation problems.

In light of the topics this chapter explores, the chapter is guided by two questions: How does consideration of *equity, comfort and energy efficiency motivate* dwelling adaptation efforts? What *intervention approaches* have been used to date to encourage dwelling adaptation for energy efficiency, comfort and equity and what has been the reaction?

To build a picture of and a critique around adaptation motivators and intervention approaches, this chapter drew on and reviewed academic literature, government reports, context observations (including reviews of stakeholder activity), media documents and focus groups.

4.2 Motivations of contemporary dwelling adaptation

This section responds to the questions: How does consideration of *equity, comfort and energy efficiency motivate* dwelling adaptation efforts? Design, construction and dwelling culture have shifted under the influence of sustainability discourses and practices, including those informing climate change adaptation and mitigation (Australian Building Codes Board 2004; Gleeson 2006; Low et al. 2005; Troy 2000b). In addition, the global economic crisis and the consequent slowing of economies, higher expenses, and economic and employment insecurity impinge upon the consideration of equity. The influence these economic related issues have on householder behaviour can be seen, for example, in the reduction of the value of residential building work conducted for significant renovations and new builds in Tasmania over 2010–12 (Australian Bureau of Statistics 2012c: 4).

4.2.1 Equity, social capital and disadvantage

Understandings and agreement that people have a right to an adequate dwelling standard that will support equitable living circumstances was slow to emerge and be included in Australian legislation and policy. Nevertheless, that appreciation now underpins dwelling adaptation support and advocacy activity in Tasmania (Flanagan, J. 2007; Gabriel et al. 2010; Tasmanian Council of Social Services 2007), in common with other like jurisdictions (Howden-Chapman et al. 2011; Howden-Chapman et al. 2007; Preval et al. 2010).

Equity is defined by the Shorter Oxford English Dictionary (1992) as ‘the quality of being equal or fair’. The United Nations Human Rights Declaration states that:

All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood [sic] (General Assembly of the United Nations 1948: Article 1).

Gleeson (2008: 2659) argues that housing scholars and stakeholders are looking to support fairness in urban environments as an enhanced form of equity. Fortune and advantage Gleeson says are ‘shaped by social relations’, and he asserts that no “policy direction, however, technically or economically compelling, should fail the equity test”. Australia supports the principles of intra-generational and inter-generational equity as

set out by the United Nations. This commitment can be seen in legal and welfare systems that seek to provide security and assistance to the populace, especially in cases of disadvantage. The right to an adequate standard of housing is one aspect of equity principles and declarations (Office of the United Nations High Commissioner for Human Rights 2009). At Article 25 of the United Nations Declaration of Human Rights it is stated that:

Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control (General Assembly of the United Nations 1948).

Human rights advocates see that creating 'adequate housing' is a key way to empower people and enhance equity since:

Adequate housing is essential for human survival with dignity. Without a right to housing, many other basic human rights will be compromised, including the right to family life and privacy, the right to freedom of movement, the right to assembly and association, the right to health and the right to development (Sidoti 1997: 1).

Importantly, empowerment and equity are not simply apprehended by individuals. Stretton, for example, sees dwellings as sites of the production of social capital. In them are developed and maintained a range of skills and capacities that, over time, feed back into communities to enhance this form of capital (Stretton 1974; Stretton 1999). Stretton suggests that paying attention to and measuring the social capital benefits that domestic life provides may improve social *and* environmental conditions and these, in turn, foster communities that value equitable housing and are more equitable (and fair).

Equity is thus viewed as a key value of sustainability in its broadest sense affecting economic, social and environmental outcomes (Baker 2006; World Commission on Environment and Development (WCED) 1987: 43). As Chiu (2004: 73) explains:

The sustainable development perspective reinforces a primary equity concept in housing. That is, in a fair society, the basic housing needs of every household must be met, each enjoying at least a fundamental standard of accommodation as defined by the society.

In a neoliberal climate, however, social capital and equity both are seen as the responsibilities of *active* citizens more than of governments. But active citizenship presupposes a range of capacities that disadvantage may affect. In the case of low-income or disadvantaged households, for example, a lack of capacity is generally assumed to be a key barrier to adaptive works whether for social, economic or environmental purposes (Grothmann et al. 2005; Smit et al. 2006). In short, adapting dwellings requires capacity, but opportunity to develop capacity is related to householder circumstances, including those pertaining to dwelling (Roaf et al. 2005: 117); and so the disadvantage is cyclical.

Particulars of capacity become important when considering disadvantage. Capacity is used in this thesis to mean the power, faculty or ability to achieve (Little et al. 1992: 280). Capacity tends to define the opportunities and the sort of adaptations householders can make and can be associated with an individual, a household, a social system and various other entities. Certain conditions are required to generate certain capacities and this occurs over long periods of time.

Climate change adaptation literature emphasises the importance of capacity and refers specifically to adaptive capacities that can be used to manage, cope with and respond to a given pressure resiliently. In general, the capacity to respond

is the system's ability to adjust to a disturbance, moderate potential damage, take advantage of opportunities, and cope with the consequences of a transformation that occurs. Capacity [to respond] ... is clearly an attribute of the system that exists prior to the perturbation (Gallopín 2006: 296).

Capacity limitations can occur at all levels of affluence. For instance, a person may have knowledge, but not the money or the time to act; another person may have time, but not the physical ability to act; and another person may have the time and the physical ability, but no understanding or motivation. Opportunities to make change are affected when there are numerous limitations or when the capacity needed cannot be used, traded or negotiated. A lack of capacity can be especially problematic where there are, for example physical disabilities, health issues or low incomes without adjunct support networks. Disadvantage is viewed in this study as a circumstance where various capacity limitations make adapting difficult. When compared to other states of Australia a disproportionately high percentage of the Tasmanian population are described as

disadvantaged (Tasmanian Council of Social Services 2007) and points to a need for intervention policies and strategies to support dwelling adaptation.

4.2.2 Comfort

Broadly speaking, to be comfortable is to be ‘in a state of tranquil enjoyment’. Comfortable dwellings allow people ‘to be at ease’, supported, or even to be strengthened by (and in) their environment (Harper 2001-2012).⁴³ So a comfortable home provides supports householders to be at ease and tranquil.

Rybczynski (1986) argues that the concept of comfort and practices to foster being comfortable in the home have evolved in parallel with dwelling habits and cultural change. He shows how the meaning of comfort began as the idea of being able to ‘to strengthen or console ... [and eventually broadened] to include people and things that afforded a measure of satisfaction, and ... to mean tolerable or sufficient’. Only later, in the eighteenth century, comfort ‘acquired its sense of physical well-being and enjoyment’ (ibid.:20).

In the modern context, aspirations for domestic comfort may be driven by physiological, psychological or cultural pressures, wants, expectations or actual needs. Comfort may come from various sources. For example, a comfortable bed may offer physical support, thermal comfort, and safety; a bottle of wine may offer comfort by promising access to a quenching, delicious treat; and, a heater may offer physiological comfort. No matter how it is understood, comfort has become a service that householders want and expect the home environment to provide (Shove 2003). Indeed, ‘[i]f a change occurs such as to produce discomfort, people react in ways which tend to restore their comfort’ (Roaf et al. 2005: 117). As such a widely aspired-to goal and service of the home, it is useful concept for intervention designs to respond to and aim to support.

Comfort aspirations are seen as significant drivers for energy conservation and adaptation of dwellings. An Australian Bureau of Statistics (ABS) survey conducted in three editions in 2002, 2005 and, most recently, in 2008 found that

⁴³ Comfort has even been used to directly name dwelling items, such as a blanket/rug called a ‘comforter’.

measures used to conserve energy in households, such as insulation, were adopted mostly for comfort and lifestyle reasons, rather than from a desire to save energy (2008: 7).

For Australians in general, and over 80 per cent of Tasmanians in particular, the study found the main reason to install insulation in houses was to achieve comfort (ibid.: 7, 28). In Tasmania, only 10 per cent of respondents said that cost saving was the main reason for insulating, and using less energy was the main reason for less than five per cent of those respondents (ibid.: 28).

Focus group members also saw comfort as an important incentive for dwelling adaptation. One State Government representative reasoned,

I would rather sell a comfy cushion than a hair shirt. Like telling everybody that they are going to have to tighten their belts and turn down their thermostats and live in the gloom and all the rest of it, they turn off. But maybe the driver is, 'Listen, you can have a much more comfortable house for no extra money, healthier, happier environment, get rid of those cold drafts and it won't cost you much, in fact it will save you money in the long term and your house will be worth more at the end of it (SGFG May 2008).

Due to the concept of comfort having a variety of meanings, it is not clear that everyone is aspiring to the same comfort goals. In this investigation, and because of its relationship to health and energy use, physiological comfort is the type of comfort focussed on and aspired to. Humans have fairly narrow internal thermal states that they must maintain to remain healthy and in a state of physiological ease: 'People in every society have the same physiology and core temperature of around 37.5°C, and the same adaptive mechanisms to keep their bodies at this core temperature in even the most extreme climates' (Roaf et al. 2005: 34). To maintain this thermal core temperature (and be physiologically comfortable) people have to balance heat input and outputs from the body with the minimum of effort. Lowry (1991: 113-4) explains that for people physiological

comfort accompanies minimal energy use in maintaining thermal equilibrium.

We are "uncomfortable" when feedback control is necessary and *very* uncomfortable when emergency mechanisms, such as sweating or shivering, are required [original emphasis].

Physiological *discomfort*, including in housing, can lead to ill health and, in extreme hot and cold temperatures, can lead to death (Douglas et al. 2003; Howden-Chapman et al. 2007; World Health Organization (WHO) 2007: 3). The risk of illness increases as temperatures moves away from optimum conditions (Roaf et al. 2005: 130). When people are healthy but inactive, 18-24°C is generally a safe temperature range. When the temperature drops below 16°C the body's resistance to respiratory infection begins to reduce; below 12°C there is an increase in the possibility of cardiovascular issues; and, below 5°C the risk of hypothermia increases.

Due to the significance of climatic conditions to physiological wellbeing, the World Health Organization (WHO) has set standards for thermal comfort in buildings. The temperature ranges specified are limited at 21/22°C for living areas and 18°C for other areas such as bedrooms (Ranson 1988b). These temperature ranges guide policy but are rarely met in indoor domestic environments in Australia during cold or hot weather events, unless a dwelling is passively well-designed or has heating and cooling appliances (which cause extra expense and environmental impacts).

People who are healthy and able to keep active, and who have access to variety of dwelling areas are often physiologically more comfortable. People who are elderly, disabled, or very young often have reduced thermo-regulatory responses, and are more vulnerable to physiological discomfort (Roaf et al. 2005). In addition, householders with issues of capacity, such as low incomes, are also less able to control their thermal environment and are therefore more vulnerable to physiological (and other forms of) discomfort.

Despite housing authorities understanding the impacts of discomfort on vulnerable populations, there has not yet been any significant change in housing policy. In Tasmania, members of the SCS, the LGFG and the SGFG focus groups (October 2007, May 2008) observed that the relationship between health and housing stock was not yet well-acknowledged in policy, commercial activity or other institutional activities. The SG and LG focus groups (October 2007, May 2008) also acknowledged that although the passive energy performance of dwellings was understood to affect physiological comfort and occupant health, the relationship was rarely supported through policy (LGFG October 2007). This recognition-policy action gap is not uncommon: in the United States, improvements to indoor environments have been identified that would

drive occupant health improvements and productivity gains worth billions of dollars and yet remain undone (Fisk 2000).

Physiological comfort is not just derived from housing stock performance, but is also a consequence of householder practices; both the dweller and the dwelling have agency when creating comfort in housing. In relation to the dweller, people use various methods to attain physiological comfort in their dwellings. Physiological comfort can, for example, be embodied by means of physical activity, dressing, or eating and drinking. In relation to managing thermal conditions in dwellings, after clothes, 'buildings are our third skin' (Roaf et al. 2005: 33). Various features and functions can be manipulated in the physical dwelling to create more 'comfortable' environments with the use of resources and technologies. Passive or active strategies can be used, such as enclosing and resisting heat-flow via the building shell, ventilation, solar control, and inputting or extracting heat (see chapter four for further discussion). Indeed, improving the passive performance of a building shell and improving comfort appliances are key methods of reducing vulnerability due to thermal variation whilst maintaining affordability.

In another vein, perceptions about physiological comfort needs in the home are influenced by cultural expectations and habitual practices, and collectively these also inform energy use and the environmental impacts of dwelling (Cole et al. 2008; Cooper 2009; Strengers 2008). As Shove (2003:194) suggests:

Roughly half the energy in the world is used in buildings, and much of that is devoted to keeping them 'comfortable', whether through heating or cooling. In simple energy related terms, understanding what comfort means, how it is defined and how it is realized is of immense environmental significance, especially since conventions of comfort appear to be converging around the world in ways that require the use of resource-intensive technology. If sustainability is our focus, then so are meanings of comfort and the manner of its provision.

Controlling thermal environments by using air conditioning has made people less thermally flexible, creating expectations for temperatures to be maintained in thin thermal bands (Chappells et al. 2005; Shove 2003). In Australia, the effect of these expectations can be seen in the increasing number of heating and cooling appliances being used in more rooms of more houses (Pink et al. 2010: 91); certainly, this trend is apparent in Tasmania (SGFG October 2007). Nevertheless, in her work to achieve more

sustainable dwelling outcomes, Shove (2003) has argued that people do not need to live in narrow temperature bands scripted by building and air-conditioning codes, business-as-usual solutions and cultural expectations. Shove suggests that householders can use different methods to create comfortable spaces but acknowledges with others that alternative methods may be limited by the complex technology used for indoor climate control and the scripting that comes with such specialist and dedicated equipment (Cooper 2009; Ingram et al. 2007; Strengers 2008).

At the same time, it is often hard to distinguish between what are reasonable expectations for physiological comfort and what are culturally produced expectations in excess of real needs. In this respect:

There is surprisingly little effort made in the research literature to separate wants from needs ... This [lack of distinction] reflects the problem that, beyond the physiological basics, what constitutes a necessity is relative, subjective, and reflects a person's experience, expectations, and circumstances. These needs have also tended to evolve over time so that yesterday's luxuries become tomorrow's necessities (Peattie 2010: 200).

In this light, the 'manufacture' of high consumption expectations around comfort can be re-examined. Not surprisingly in socio-technical and sustainable consumption literatures an assumption underlying much of the work on expectations, wants and needs is that—when influenced by cultural expectations—people will be led to over-consume, rather than to consume less (Chappells et al. 2005; Peattie 2010; Shove 2003). Simply referring to overconsumption is to oversimplify the issue, since, for example, maintaining basic levels of comfort in a low quality house in Tasmania may drive people to consume large amounts of energy to meet need and not cultural expectations or fashions. Maintaining basic physical comfort in Tasmania can often require the use of large amounts of supplemental heating through most of autumn, winter and spring, and sometimes even during periods in summer (Anglicare 2002; Flanagan, J. 2007). Therefore, although socio-technological critiques of dwelling comfort identify important considerations, they have not provided substantive suggestions as to how to intervene in dwelling practices to stem overconsumption of energy; nor have they fully problematized their own understandings of the relationship between consumption, comfort and disadvantage (Wilson et al. 2007).

4.2.3 Energy in dwellings

All activity needs energy. Energy is the ability to do work in a symbiotic relationship with matter and is a critical basic ingredient in the construction of dwellings⁴⁴ and dwelling activities.⁴⁵ Energy can be sourced from the sun or from the secondary sources it generates, among them wind, wave energy, food, timber or oil.

Social scientists have long recognised the importance of energy supplies and flows in human life (Cottrell 1977; Humphrey et al. 1982; Rosa et al. 1988). For example, Luis Fernandez-Galiano (2000: 7-8) outlines the various ways energy is involved in dwelling, using a parable of a tribe setting up camp in a forest.

The tribe regards the wood, just as the builder regards a natural resource (material or energetic), and considers the two basic strategies of environmental intervention: regulating natural energy flows through the creation of material structures (the hut), or exploiting the energy accumulated in combustible substances (fire): using the climate's free energy through construction, or using its accumulated energy through combustion. Construction is nourished by flows, combustion by deposits.

Forms of permanent hearths have been featured in dwellings through much of recorded history highlighting the importance of having an energy source in the domicile. In the tradition of Vitruvius,⁴⁶ fire and hearth are linked with traditional notions of domestic life and dwelling (Fernandez-Galiano 2000; Vitruvius 1960: 38-9). Fire was the traditional energy source used (and processed⁴⁷) in the home for day-to-day use. Perhaps above all else, fire could create a space of dwelling, without any assistance from walls, roofs and floors (ibid.). In the form of a fire in a hearth, energy played visual, aesthetic and functional roles in the home, supported cooking and comfort, provided a liveable and physiologically comfortable space and a focal point in the dwelling (Appendix I).

⁴⁴ Energy for dwelling is embodied in all materials, including energy consumed through processing and transporting, and construction activity.

⁴⁵ Dwelling activities include cooking, cleaning and maintaining warmth.

⁴⁶ In 'The Origin of the Dwelling House' Vitruvius (1960) argued that fire influenced initial social interaction and discourse.

⁴⁷ In this study sources of energy that need processing before they can be supplied to dwelling sites or used by householders are labelled processed energy.

Now, energy is still important but householders' relationships with it have changed. In dwellings, energy's symbolic and visual importance seems diminished. Fire has gradually been replaced by different energy sources hidden from sight and supplied by large-scale, commercial and often-distant energy systems. The hearth has been replaced by other heating and cooking technologies (Fernandez-Galiano 2000; Rybczynski 1986). The visual absence of energy has meant that traditional relationships and understanding of energy have been altered in the last hundred years of technological advancement. Visual and ideological disassociation—rendering energy invisible—means that it is harder for householders and others to know and understand energy use within the home and energy's impact on the environment. In policy circles, the legacy of 'invisible energy' is seen to be a major barrier to improving dwelling energy efficiency (Focus groups 2007; Prime Minister's Task Group on Energy Efficiency 2010; Rosa et al. 1988: 101). In response, various methods are being devised to make energy consumption visible and tangible again (Office of the Tasmanian Energy Regulator 2006; Rosa et al. 1988).

Becoming conscious of energy use and making it visible is meant to curb energy use, which had increased significantly per person over time (Odum 1971). High levels of energy use have arguably developed because, in sharp contrast to preparing a hearth (Fernandez-Galiano 2000; Rybczynski 1986), mass supply systems seem able to supply endless amounts of energy effortlessly to easy to use, effective and (relatively) affordable home technologies.

There are challenges in reducing persistently high levels of energy use in residential sectors. Estimates show that around 12 per cent of Australians' overall use of processed (and supplied) energy is in and for housing⁴⁸ (Australian Bureau of Statistics 2002: 5; Australian Bureau of Statistics 2005: 7; Australian State of Environment Committee 2011:816; Newton et al. 1998; Schultz et al. 2011). Energy use per person and overall in dwellings in Australia is increasing and is expected to keep increasing (Sandu et al. 2009: 39; Schultz et al. 2011: 5). This trend has been linked with large, and until recently, growing floor areas in new builds; the extension of the floor areas of existing dwellings; decreasing numbers of occupants per dwelling; the increase of whole-of-

⁴⁸ There is further consumption at the site of dwelling that is not measured in the 12 per cent share.

dwelling heating and cooling systems and practices; growing appliance use; and the relatively small number of dwellings affected by energy efficiency standards provided by the Building Code of Australia (BCA)⁴⁹ (Energy Efficient Strategies 2008: 22).

Despite the increase in energy used in the residential sector overall, energy use *per dwelling* is trending slightly downwards (Australian State of Environment Committee 2011). Australian State of Environment reporters attributed this reduction in part to increased rates of insulation installation; improved energy efficiency in appliances; and appliance energy efficiency becoming a more major consideration during purchases since 2008. Mirroring national trends, and due to predictions of a fairly stable population over the next decade, Tasmania is projected to have a small decrease in residential energy use, but expects no substantial reduction from efficiency gains (Energy Efficient Strategies 2008). Such small reductions will not be enough to affect climate change trajectories or to empower householders struggling with energy costs. Thus, further energy reduction and efficiency is needed in Tasmania. For climate change mitigation, around 50–75 per cent reductions on 2008 levels of energy use are needed (SGFG October 2007). The reductions needed to assist low-income families to live affordably have not been quantified.⁵⁰ Reducing energy use and improving energy efficiency by 50 per cent requires substantial investment of effort and time and also significant lifestyle change (SGFG October 2007).⁵¹ Meeting sustainability, climate change and social needs through the adjustment of dwelling energy use can be achieved by reducing the amount of energy used; by changing to a less impacting or less costly energy source; and by improving the effectiveness of energy used (that is, creating better energy efficiency).

⁴⁹ Since 2003 the BCA require has required new-build housing and major renovations to reach a reasonable standard of energy efficiency in terms of the building shell.

⁵⁰ The amount of energy use reduction or efficiency needed in low-income situations would change case by case, but from various stories of financial housing stress caused by poor quality housing a 50 per cent reduction of energy use would appear to be welcomed in many low-income households (Flanagan, J. 2007).

⁵¹ The reduction targets are just as large in other parts of the world. The Wuppertal Institute, for example, believe that Europe actually needs to ultimately reduce fossil fuel energy use by 75 per cent (a factor of four) and resource use by 90 per cent (a factor of 10) to live sustainably (Yencken et al. 2000).

The impacts from the production and use of energy vary according to source. Processed energy sources supplied to dwellings are the most important to reduce because they often cause significant environmental impacts and must be paid for by householders.

Energy consumption by households is an important contributor to greenhouse gas emissions, particularly because of Australia's heavy reliance on fossil fuels (e.g. coal, oil and gas) for electricity generation. Australia's direct greenhouse gas emissions for the residential sector (including transport) were about 9% of total emissions, an increase of 25% since 1990 (Australian Bureau of Statistics 2008: 7).

Households in Tasmania rely heavily on supplied, processed (active) sources of energy. Electricity is used by the overwhelming majority of Tasmanian residents with a 2007–08 survey extrapolating that 99.8 people use electricity as an energy source. Other energy sources were used by much smaller proportions of Tasmanian households. In 2007–08, 14 per cent of households used gas (which is low for Australia),⁵² 37 per cent of households used wood and nearly two per cent of households used solar generated power⁵³ (Australian Bureau of Statistics 2009: 41).

Between the 1960s and 2003, in large part Tasmanian electricity was generated by means of a hydroelectric system and 'back-up' gas generation plants. Since 2003, Tasmania has been part of the national energy grid, joined by a cable in the Bass Straits called 'Basslink'. Since linking to mainland-generated electricity, the hydroelectric dam levels have been low for long intervals, leading the-then Tasmanian Minister for Energy to explain that

there is no escaping the fact that, apart from last winter, the inflows to our hydro system have been generally below average for many years. This [below average water inflow] required a greater reliance on gas generation and imports over Basslink, and this has increased the emissions intensity of the electricity that Tasmanians consume (Llewellyn 2009: 7).

Using mainland electricity means that a significant proportion of electricity generation for the State is from coal-fired electricity plants. Tasmania has also become more reliant

⁵² The limited use of gas supplies may be due to cost or because they have to be transported into the state. Gas as a household energy source has been promoted over the time of this investigation and appears to be growing in popularity.

⁵³ Due to multiple intervention programs encouraging the uptake of solar technology the percentage of households that use solar grew further after 2008.

on state-based gas-powered electricity generation plants (Office of the Tasmanian Economic Regulator 2010). Members of the SGFG reiterated the significance of the limited hydroelectric supplies and explained that:

at the margin, a very fat margin, Tasmanian energy is produced by gas or imports and even if it wasn't it could be exported and replace brown coal energy in Victoria so at the margin our energy is as dirty as anyone else's (SGFG May 2008).

The amount of electricity used per household in Tasmania is high when compared with other states (Electricity Supply Industry Expert Panel 2011: 4; Muller 2010). Chief Executive Officer of TasCOSS⁵⁴, Tom Muller (2010: 1-2), reported that due to a 'cool climate and the low penetration of the recently introduced natural gas network' Tasmanian households use 'more electricity than other Australians and spend...a greater proportion of their income on household electricity'. Having to pay for processed energy through mass supply systems adds to housing disadvantage, isolating householders from easily accessed and 'affordable' flows of energy. Of approximately 225 000 residents in Tasmania using electricity in 2009, 36 per cent received concessions (ibid.: 2), which are only given to low-income householders. To this cohort, reliance on costly supplied energy and uncomfortable houses and the use of technology to support activity in their homes are very likely to cause financial duress.

In addition, through Tasmania's only residential electricity supplier (Aurora), electricity prices have been rising at considerable rates each year, exacerbating issues of energy affordability in low-income households. Over the period 2000–11, residential electricity prices increased on average around 5.5-7.5 per cent (Electricity Supply Industry Expert Panel 2011: 1). Over 2007–11, there was a total electricity price rise of 42 per cent, with the largest increment being 17 per cent made in three instalments over the first six months of 2008 (ibid.: 6).⁵⁵ The growing electricity costs have been attributed to infrastructure and maintenance costs and more recently to Australia's carbon tax, brought in July 1st 2012 (Prime Minister of Australia Hon Julia Gillard et al. 2011).⁵⁶

⁵⁴ TasCOSS is the Tasmanian Council of Social Services. The organisation represents social service organisations across Tasmania.

⁵⁵ The 2008 price rises were discussed with my participants. A similar trend is occurring around Australia (Electricity Supply Industry Expert Panel 2011: 6).

⁵⁶ The carbon tax is Australia's primary mechanism to limit greenhouse gas emissions.

Energy costs and climate change pressures that spring from energy use are two key reasons why improving residential energy efficiency (that is, more effective outcomes per kilojoule used) has become popular (Barker et al. 2007 p14; Fernandez-Galiano 2000; Odum 1971; Office of the Tasmanian Economic Regulator 2010; Rosa et al. 1988; Sustainable Development Commission 2006; Sustainable Living Tasmania 2007a; Vale et al. 1996). The Australian Government sees improving energy efficiency as a primary strategy in ameliorating a number of major ecological issues, including mitigation and adaptation for climate change (Bartlett 2010; Commonwealth of Australia 2009; Commonwealth of Australia and Senior Officials Group on Energy Efficiency 2010; Prime Minister's Task Group on Energy Efficiency 2010; Tasmanian Government 2006). Energy efficiency policy and activity is widely accepted in design, construction and sustainability industries (Australian Building Codes Board 2007b; Australian Institute of Architects 1995 - 2012) as it has been identified as having the potential to provide over half the emissions abatement Australia requires (Prime Minister's Task Group on Energy Efficiency 2010). Improving residential energy efficiency is seen to be a cost effective way to generate energy reductions and so is a major strategy for the Australian Government (ibid.).

Dwelling adaptations can reduce the use of processed energy supplies, and provide technology and environments where less energy needs to be used. In the use phase of dwelling this can be achieved by improving the physical dwelling, upgrading appliances and altering dwelling practices. An important strategy is to create passive⁵⁷ indoor environments that limit thermal swings and use available (passive) energy sources such as sun and wind.

Such efficiency strategies are necessary but insufficient to reverse the effects of excessive energy production on the environment (Watson 2004). These strategies are mainly for incremental amelioration and reduction, rather than transformative forms of adaptation. Nevertheless, there is much to be gained by pursuing energy efficiency in existing housing. Incremental change will make use of the substantial resources;

⁵⁷ Strategies to utilise passive energy, or energy in the home that does not have to be supplied from processed forms in an active manner, can significantly reduce the need for processed forms of energy to be used (for examples of passive energy use in the home see Vale and Vale 1975).

infrastructure and emotional investments embedded in existing housing and will concurrently invest in the resilience of disadvantaged households.

Despite the potential for improving energy efficiency, the gap between possible gains from technology, housing stock improvements and behaviour change and actual current energy use is large (Wilson et al. 2007). Focus groups in this study reported that there were significant cultural, economic and structural barriers in the way of improving residential energy efficiency in Tasmania (Appendix G). Investigations of barriers to energy efficient home improvement in Tasmania by Stratford and colleagues (2008) supported the concerns raised in the focus groups.

4.3 Interventions to encourage dwelling adaptation

This research inquiry assumes that interventions will be needed in order for householders with low adaptive capacity to achieve better energy efficiency and comfort. This section explores intervention approaches designed to encourage dwelling adaptation for improved energy efficiency, comfort and equity in households and responds to the question: What intervention approaches have been used to date to encourage dwelling adaptation for energy efficiency, comfort and equity and what has been the reaction?

Following Wilson et al. (2007: 170) interventions are described here as ‘any regulation, policy, program, measure, activity, or event that aims to influence behavior’ describing a form of deliberate interference with prevailing practices. Interventions have impacts which may be positive or negative (Low et al. 2005). For example: interventions may target some disadvantaged householders and not others, which could have detrimental effects socially; or a dwelling adaptation activity could rely on resource use that damages the environment. Caution is therefore needed. Despite the potential issues, if the intervention is respectful, supportive and engages with equity issues, it seems reasonable to attempt an intervention.

Social support organisations, government, housing industries, and other housing stakeholders have encouraged dwelling adaptation for energy efficiency, comfort and equity in Tasmania, Australia and internationally, providing useful lessons for the current study (Ambrose 2000; Brotherhood of St Laurence 2008; Elliott et al. 2009;

Maller et al. 2010; Sustainable Development Commission 2006). Interventions are gradually being refined as more understanding is gained of which approaches are effective at creating positive outcomes. Despite this iterative improvement, many intervention attempts to date have been assessed as having poor outcomes (Wilson et al. 2007). Not surprisingly, then, critiques of intervention approaches have emerged at the same time (See for example: Black et al. 1985; Gilbertson et al. 2006; Rosa et al. 1988; Shipworth 2000; Wilson et al. 2007). Both interventions and evaluations of them are examined here.

Australian and Tasmanian government and social support organisations have rolled out various intervention programs to encourage energy efficient adaptation⁵⁸ (Elliott et al. 2009; Gabriel et al. 2009). Tasmanians have, as yet, conducted relatively minor interventions for energy efficiency in dwellings and have done so only on relatively small scales. Consequently the interventions have not yet translated into significant improvement to the extent and levels of overall residential energy use, improvement in affordability of living, or the environmental impact of resource use.⁵⁹ The focus groups for this study indicated that a more refined understanding is required if Tasmanians are to progress and engage in large scale energy efficient interventions for adaptation. While focus group participants indicated that they and other professional housing stakeholders had a general understanding of the barriers and drivers of energy efficient adaptations in Tasmania, they felt further insight would be useful to understanding and designing more detailed, tailored and context relevant interventions (October 2007 focus groups). Ongoing discussions with the project sponsor over the intervening period suggest that this need for insight remains.

Research into barriers to improving energy efficiency of Tasmanian dwellings has been undertaken in Tasmania (as part of a suite of research of which this thesis is also a part) (Elliott 2007; Elliott et al. 2009; Stratford et al. 2008). While these barrier studies have provided useful insights, they furnished only general information and their limited contextual detail did not aid the design of targeted interventions. More detailed

⁵⁸ The Tasmanian government sponsored this research study in recognition that energy efficient intervention opportunities and barriers in Tasmania needed to be explored. Examples of intervention attempts in Australia and Tasmania are discussed in the body of this section.

⁵⁹ The high levels of residential energy use generated the key reason for this study to be conducted.

information, more investigation and analysis are required to provide ways to approach these barriers in context. Tony Weaver's case study of the retrofit of a house (2004) (also part of the same suite of research out of UTAS) indicated the opportunity that more detailed understanding of renovation may provide interventions designers.

Approaches to interventions have worked to change both physical dwelling features and dwelling practices (behaviours and decision-making) (Humphrey et al. 1982; Smit et al. 2006). Interventions approaches are categorised here as four (sometimes overlapping) approaches: societal systems and structures; the provision of missing adaptive capacity; direct involvement in making change to the physical dwelling environment; and householder decision-making and practices (Table 4.1).⁶⁰ Each intervention approach category will be reviewed in subsequent sections.

⁶⁰ The intervention approaches discussed here are also used for other dwelling adaptation goals for sustainability, such as water efficiency and waste reduction.

Table 4.1: Intervention approach categories with examples

Strategic focus of intervention with examples	Concept and main theoretical support	Scale of society at which applied and the form it is applied in	Media generally used	Notes
Societal systems and structures				
Influence through society laws and policies	Influence through adjusting societal laws and mechanisms such as economic rationalism, behavioural and environmental psychology and socio-technical and sociological approaches.	Federal, state and local government scales in the form of laws, policies, supply control and cultural/norms influence. In smaller communities through norms, covenants, community housing regulations and strata title.	People and avenues of communication. Government marketing, policy and law application.	The individual is seen as part of a society.
Manipulation of social norms.	Influence gained through manipulating norms as seen in behavioural psychology and organizational and environmental psychological approaches.	Individual, street, community and larger communities.	Community pressure to stop practices eg adverts for responsible energy use in the home. Television ads.	
Supply and market contexts	Influence by manipulating supply and markets, ie controlling availability of housing and products, pricing mechanisms and encouraging or discouraging skills markets.	Societal scale as laws, taxes, product supply laws, professional skills certifications and requirements.	Laws, taxes, product standards, professional codes of practice, skills education courses, manufacturing.	Includes pricing and prevalence of certain tenures. Strongly related to government policies and paradigms (eg liberal market based government)

Strategic focus of intervention with examples	Concept and main theoretical support	Scale of society at which applied and the form it is applied in	Media generally used	Notes
Provision of capacity				
Information provision and education	Influence through improving access to information and understanding.	National, State or local governments, other institutions, communities, or individuals.	Government web sites and publications, education programs eg TAFE, professional bodies, individual authors and community groups.	Information has been seen as a critical strategy and assumptions made that information equals adaptation activity. Theoretical and research sources can be presented through government and non-government support programs without thorough reference trails.
Cognitive/decision-making support and influence (see decision-making/practice interventions)	-	-	-	See decision-making/practice interventions below.
Assistance with physical retrofits and technical help (also see physical interventions)	Influence by providing products and/or doing retrofits to remove barriers of cost and/or limited skills in households. Assumes that theoretical support comes from engineering and architectural science. Theoretical/research sources often unidentified.	Local government programs and non-government programs mainly and some state government. To various scales of communities but generally have criteria for involvement and also limited funding, so limited participants.	Assessment and retrofit programs eg Just Change in Victoria. Hardware stores have do-it-yourself talks to educate people in skills for jobs.	Programs here focus on assisting people to achieve renovations. Actions are often suggested without thorough reference trails or explanations.

Strategic focus of intervention with examples	Concept and main theoretical support	Scale of society at which applied and the form it is applied in	Media generally used	Notes
Financial support	Influences through provision of money or reduction of cost of products for retrofit. Theoretical support from economic rationalism, social support communities, adaptation literature	Mainly National, State and local scales of intervention with funding from government. Sometimes the rebates through social support organisations or through commercial enterprises.	Governments rebates and money back agreements most common. Commercial discounts. Social support programs.	Mainly through government channels.
Changing the physical environment and improving efficiency				
Adjustments to physical dwelling	Influence sustainable housing by adjusting the physical environment. Supported by theory from Architectural sciences and building science.	Targeted at individual dwellings.	Builders, sustainability assessors.	See as a primary strategy, but renovations often expensive or time consuming. Eg insulation retrofits for improved management of heat-flow through the building shell.
Technical efficiency and design	Influence efficiency and comfort through better design and efficiency in design. Supported by theory/ approaches of engineering, architectural sciences, industrial design.	Targets the physical technology, often through mass product supply to large distribution networks, but targeted at individual homes and individual decision makers.	Various – individual products to urban master planning as the technologies may be large or small.	Improvement of the object for efficiency presumes that the object at hand is still a primary solution for the service. Often used in conjunction with point of sale decision support.

Strategic focus of intervention with examples	Concept and main theoretical support	Scale of society at which applied and the form it is applied in	Media generally used	Notes
'Smart' technology,	Influence through technology that can assist to or completely manage electricity use. In conjunctions with communication interface. Approaches and theory through engineering disciplines.	Mass supply to large distribution networks, but targeted at individual homes.	Electronic stores, hardware supplies, electrical suppliers and sales points	Part of technical efficiency idea and also about information provision eg smart meters that provide feed of information.
Decision-making / Practice change				
Decision at point of choice	Influences decision-making at point of product purchase. Theory and approaches from rational economic utility theory; and behavioural economic bounded decision theory.	Often mass marketed and mass scale supply, but focuses in on individual choice at point of sale.	Mass marketing, product supplies, and product information.	Choice at sale is often the focus of interventions. Efficiency performance of products is often supplied to assist choice.
Cognitive support and influence	Influence through supporting and influencing decisions made with theory from behavioural, organisational and environmental psychology.	Communities, small groups and individuals. Some governments may conduct large scale interventions to connect to many people concurrently.	Varies greatly: workshops, mass marketing, information sources such as internet and publications, people to people connections.	It is critical to access individuals for this approach.

Strategic focus of intervention with examples	Concept and main theoretical support	Scale of society at which applied and the form it is applied in	Media generally used	Notes
Cognitive dissonance	Influences by encouraging people to match actions to values. Theory base and approach design developed through environmental psychology and organisational change psychology.	Small groups in organisations or at workshops, local communities and nationally.	Marketing, community change programs, mass advertising.	This approach may be applied as a general program or to target a specific behaviour change eg shortening shower length and composting.
Adjusting expectations and norms associated with dwelling functions.	Influencing through adjusting expectations of how the house and householder will and should function and through the manipulation of normative behaviours as per societal systems norm change. Theory and approaches developed and explored through socio-technical scholarly observation, environmental psychology.	Various scales of application. May be targeted at a community or individual household scale.	Through interviews, mass marketing, individual conversations.	This is mainly at a discursive stage and few interventions have as yet been designed around the theory of adjusting expectations. Functions are described in Appendix I.

4.3.1 Intervention to societal systems and structures

The benefits of societal interventions to encourage change are recognised by scholars in behavioural studies, environmental psychology, socio-technical, sociological and behavioural economics (Guy et al. 2000; Rosa et al. 1988; Stretton 1989; Wilson et al. 2007). Approaches intervening in societal systems and structures are popular for encouraging both physical and practice changes in dwelling. In many cases certain social systems and structures must to be in place for individual action to take place. A CEFG member (May 2008) explained this effect: ‘Let’s provide for the pushbike at home but you can’t necessarily do that with confidence if the roads themselves aren’t suitable for pushbikes’.

Societal systems interventions work either by influencing or forcing people to comply using a broad range of techniques. Most commonly energy efficiency interventions for dwellings work indirectly by influence, by means of advertising; voluntary codes; or tax breaks for certain actions.⁶¹ Interventions may be enacted through various sectors of society but regularly through government regulation and policy; housing and residential supply markets; and the social support and community sector.

Influence through government regulation and policy

Government regulation and policy are aspects of social systems and structures regularly used to influence the activity of householders, including energy efficiency and dwelling adaptation activities. Urban and housing scholars support intervening through regulation and policy on the grounds that it will support more equitable and sustainable environments for householders (Gleeson 2006; Stretton 1989; Troy 1995). In specific terms, the Australian Government has acknowledged that energy

⁶¹ For a range of examples see McChesney et al. (2006) who discuss markets and regulatory requirements that can be used to assist home energy efficiency and Bailey et al. (2009) who write about the carbon economy.

efficiency policies are ultimately intended to support wellbeing (Australian Government Productivity Commission 2005).

Government interventions may be enacted by federal, state and local governments using such systems as taxes, policies, supply control and cultural/norms influence and planning. Laws are rarely used as interventions for energy efficiency in Australian housing despite providing opportunities to overcome key barriers, particularly for strata-title and common property dwellings (Gabriel et al. 2012b). Targets for government activity are currently undefined, but have been discussed and explored, particularly through the National Framework for Energy Efficiency (NFEE) project (Australian Government Department of Resources Energy and Tourism 2004a; Australian Government Department of Resources Energy and Tourism 2004b; Prime Minister's Task Group on Energy Efficiency 2010: 57).

Issues of design and application exist in relation to all government interventions attempted so far. Fiscal motivators have been used by the government in the form of a carbon dioxide equivalent pollution pricing and rebate provision (Australian Government 2012a; Prime Minister's Task Group on Energy Efficiency 2010: 23).⁶² The Australian Government's legislated price on CO₂e emissions (as of July 2012) is intended to help achieve emissions reductions but is likely to more heavily impact on disadvantaged households (Prime Minister of Australia Hon Julia Gillard et al. 2011). Rebates, while useful for the purpose of encouraging specific adaptations, are not effective for low-income households as they only subsidise some of the outlay for an adaptation.

In relation to building codes the Australian Government has energy efficiency standards in the Building Codes of Australia for energy efficiency performance of housing (Australian Building Codes Board 2007a). These standards are only able to affect new build and substantial renovations. Small physical adaptations on existing dwelling are not covered. In addition, Tasmania has not yet engaged the latest BCA energy efficiency standards and lags behind other states.

⁶² Economic reasons to intervene are a must as treasury (in Tasmania will not engage with energy efficiency in houses unless they think the market has failed to create efficiencies.

Improving and labelling appliance standards has been another intervention focus at the federal level through Mandatory Energy Performance Standards (MEPS) (Energy Efficient Strategies 2008). This demand side energy efficiency policy is useful (Gillingham et al. 2006) but assumes that householders are purchasing new technologies and relies on householders consuming more.

Physical upgrades and technology installation support programs have been attempted by Federal and State governments in various forms (Elliott et al. 2009). Federal programs, despite being popular were short lived due to both perceived and real problems with the programs (Commonwealth of Australia and The Auditor General 2010). The Federal Energy Efficient Homes Package (with included free ceiling insulation installation) and the Green Loans Program were closed in 2010 with safety concerns in the former and various challenges for the latter (Australian National Audit Office 2010a; Australian National Audit Office 2010b; The Senate Environment and Communications References Committee 2010). Rebates for solar technologies have also been gradually reduced because of issues about the cost effectiveness and equity of these technology subsidies (Denniss et al. 2011). Currently the government is funding a Low Income Energy Efficiency Program (LIEEP) which is the ancestor of the Green Loans Program. Having learnt from previous interventions this program is supporting various consortia to investigate novel approaches to intervening for dwelling energy efficiency (Australian Government 2012b; Australian Government 2012c). The findings from the \$100 million project will be available in 2016.

Mandatory disclosure of energy efficiency performance of a house at the point of lease or sale is proposed federal government intervention (Australian Government Department of Climate Change and Energy Efficiency 2012; Australian Government Department of Resources Energy and Tourism 2004b). There is some concern that this program will lead to low-income householders only being able to afford the cheaper and less energy efficient dwellings.

Tasmanian Government interventions to encourage energy efficiency have been limited (SCSGFG October 2007, May 2008), but there have been a number of state-led small-scale interventions over the last ten years. Much of this funding has been

fed social support groups and some community groups in relatively small amounts (at \$50 000 to a few hundred thousand at a time) for physical upgrade and influence programs, often directed to lower income households. The latest and biggest physical upgrade program initiated by the State government is the Power Savings for Tenants (PST) program which is much larger than previous interventions at \$900 000 and engages with landlord/tenant split incentives by conducting basic energy efficiency retrofits for low-income tenants (Tasmanian Government 2012b). This program is run through SLT.

Influence through residential supply markets

Societal systems and structures include markets created by the collaborative efforts of commercial entities, communities and the governments. Influence over dwelling adaptation can be effected by changing housing markets pricing systems; making certain levels of dwelling stock available; ensuring the prevalence of certain tenures; supporting affordability of rental; encouraging home ownership; and manipulating the manner or price of resources supplied to households. In relation to the Tasmanian housing market housing availability and cost (CEFG May 2008); tenure (SCSFG October 2007, May 2008); and the cost of electricity (Electricity Supply Industry Expert Panel 2011) have had a significant effect on energy efficiency and the capability people have to create a comfortable (healthy) homes.

The choice of available dwellings is restricted because the Tasmanian market is small. Lack of availability of appropriate dwelling spaces is challenging in urban rental situations. In addition, affordable and available rental stock is often energy inefficient (SCSFG October 2007). Renters in particular generally have less chance of changing their dwelling environment due to split incentives (Gabriel et al. 2009; Gabriel et al. 2010) and landlords are likely to install appliances that are cheaper up front but energy-hungry in use (CEFG May 2008).

The PST program, was designed to conduct basic energy efficiency retrofits in order to overcome some of the barriers caused by low incomes and split incentives (Tasmanian Government 2012b).

Adding to affordability and housing quality issues electricity prices have risen nationally in large increments reportedly for infrastructure upgrades and peak load needs (Llewellyn 2009). In Tasmania between 2000 and 2011 residential electricity prices basically doubled with ‘average annual increase in real electricity prices ... [of] around 5.5 per cent to 7.5 per cent’ (Electricity Supply Industry Expert Panel 2011: 1). Over 2007–08, while stakeholders and householders were consulted for this study, Tasmanian electricity tariffs rose by 20 per cent. More recently in 2011–12 period tariffs had similar rises at around eight per cent per annum (ibid: 5–6). The cost burden of these price rises in poorly performing housing is significant and has made electricity quite expensive in Tasmania compared to other states (SCDFG May 2008). Focus group members felt that the electricity price rises would impact energy use practices in homes and create affordability issues for households living on low incomes in poor quality housing stock (SCSFG May 2007, October 2008). Other focus group member felt price increases may be an opportunity to influence energy-hungry dwelling behaviours. It was recognised however that poor dwelling conditions may drive energy use and that in those circumstances price rises would detrimentally affect adaptive capacity (CEFG, SGFG October 2008). In addition to the rises in cost Tasmanian price structures were recognised to be contributing to higher energy use patterns and reviews of the electricity pricing structures have been called for (ibid).

Social support organisations working for energy efficiency and equity

Not-for-profit social support organisations who are working to bring about equitable and more generally sustainable change in society observe social structures affecting people and lobby for change to those systems. These support organisations engage with laws (including housing, economic, environmental and human rights), policies, taxes, housing standards (especially rental standards) and electricity pricing.

Currently Tasmanian social support organisations are particularly active in trying to find solutions for disadvantaged householder with the problems of poor rental standards, the electricity price structures and costs and growing water costs (Brotherhood of St Laurence 2008; Consumer Utilities Advocacy Centre 2008; Tasmanian Council of Social Services 2007).

Over the last five years social support organisations in Tasmania joined efforts to lobby for better housing quality and basic minimum standards for rental housing stock (Flanagan, J. 2007; Flanagan, K. 2007a; Flanagan, K. 2007b). Partly because of this lobbying Tasmania is currently developing minimum rental standards (Department of Justice Consumer Affairs and Fair Trading 2010). Although lobbyists tried to include water and energy efficiency as part of the basic minimum standards, they are not included. Prior to the development of the new minimum standards rented housing stock did not have to have running water or functioning services to be rented as a dwelling. Therefore, whilst the lack of energy and water efficiency standards for rental stock is regrettable, the minimum standards would be a great step forward.

Social support organisations often also provide direct capacity support for low-income and disadvantaged communities and householders. Their role in providing capacity directly is discussed in the section on provision of capacity below. Of concern, however, is that many of these organisations also have their own capacity issues because they exist on limited funding with little support (SCSFG, SGFG October 2007, May 2008). This lack of organisational capacity means that the organisations are not in a position to help with all the social systems issues and community problems they have identified as important and often rely on governments to fund energy efficiency interventions.

Detail, responsibility and priority affecting intervention design

Three key issues arise with societal level interventions that appear to critically affect the design of interventions. First, general societal level interventions are often general and broad and risk missing important detail and nuance needed to engage with dynamic and diverse householders. Present intervention, support and encouragement programs are often conducted at a broad societal scale and are applied fairly generally. In societal systems approaches individuals are seen to be able to make rational decisions and to work as part of communities in herd-like and predictable ways. These approaches are applied generally with set standards and requirements. Sometimes these approaches will suit sectors of the community and be influential. Often though, these general approaches misunderstand the real drivers for householders and can also be inequitable (SCSFG October 2007, May 2008). When

issues are considered in aggregate only, the detail of real decisions made in various and different situations can be missed. Each person has a different mix of capacity, connections and resource availability, a different situation, to negotiate. Unless particular attention is paid to tailoring interventions approaches, disadvantage is easily amplified by general social systems intervention approaches. With more detailed understanding there is the possibility of greater success rates for policy and stakeholder action, especially in the low-income situations that are more difficult for governments to support. This research therefore looks to identify the detail in the Tasmanian dwelling adaptation situations in order to learn how to design more successful sustainable dwelling adaptation encouragements, particularly in situations where householders have to engage with low adaptive capacity.

Second, it is unclear what organisations and systems should take responsibility for dwelling energy efficiency interventions when they cross so many sectors of society. When consulted housing stakeholders were unclear about which sectors and institutions were prepared to, capable of, or responsible for engaging with various energy efficiency, householder affordability and wellbeing needs.

Where responsibility to encourage, monitor and improve low quality housing stock in government systems is also unclear. State and Local government focus groups explained that there was difficulty working out who was responsible for (or had the capacity to engage with) issues such as energy efficiency and householder health problems because they ranged across so many government sectors (October 2007, May 2008). The local government focus group explained, for example, that helping individual households was a grey area for them as they would generally only intervene on private residences if a problem on the property was imposing on neighbours and the wider community (LGFG Oct 2007).

Third, acknowledging energy efficiency and householder wellbeing as clear priorities appears to be a challenge in social systems in Australia that are market led and guided by profits and budgets. In times of tight fiscal policy, energy efficiency targets are in danger of being considered a luxury for governments, commerce and social systems alike (Guy et al. 2000).

4.3.2 Interventions providing capacity

Australian governments recognise that a key problem with many intervention approaches is that they assume people already have the appropriate capacities to make adaptations.

Australian regulation impact assessments typically assume that households do not face capital constraints. An energy efficiency investment is usually deemed to be cost effective if the additional capital cost is less than the present value of the fall in future operating costs. This [assumption] implicitly assumes that householders do not face a constraint on their ability to finance a higher capital cost now in return for a stream of returns well into the future. In practice, such constraints do exist, especially for low-income households (Productivity Commission 2005: 194).

Capacity can be supplemented or the development of capacity can be supported. Provision of capacity is commonly in the form of information, education, financial support or retrofit.

Information and education

Intervention approaches for changing decision-making are often supported by information campaigns or by education programs. In 2008 when the interviews were being conducted a show called ‘carbon cops’ had just been run which showed cases of energy efficient home retrofitting, the ‘Your Home’ guide had been out for a number of years and magazines like ‘House and Garden’ were running special information pieces and competitions around reducing carbon footprints. Information provision in particular is a primary intervention strategy used to encourage dwelling adaptation in Australia and Tasmania. Information is thought to encourage adaptation by supporting decision-making and changes to practices. Although focus group participants had various ideas about what interventions were needed and how to conduct those interventions, they felt that there was a lack of understanding and some missing information that created barriers to designing successful interventions.

Energy reduction, management and efficiency strategies are often shared through sustainable information guides. Guidance is available as lists of principles to follow,

general and specific strategies, model examples and demonstration solutions (see, for example Australian Institute of Architects 1995 - 2012; Cofaigh et al. 1999; Edwards 2001; Papanek 1984; Pearson 1989; Vale et al. 1996). The Australian Government's 'Your Home' guide is a good example, providing guidance for the design and renovation of more sustainable (Commonwealth of Australia 2005).

There are guides available that explain how to renovate to improve energy efficiency, but most focus on detached or semi-detached housing stock and ignore apartment set ups, strata-title ownership and rentals. In Tasmania a large proportion of housing is detached and so generally benefits from the focus of the guides. In the last few years information that supports rental and/or apartment situations has also begun to be released.

Education programs are often required to ensure that information provision is engaged with successfully and integrated as real knowledge. Education, as opposed to simple information provision, is often argued to be an important capacity building tool that can generate further adaptive capacity for housing stakeholders and householders. Education can however be a slow approach that requires a significant amount of effort. Training to work on or think about dwelling adaptation is available in short or long term workshop and education programs. These programs tend to attract people enthused or interested in energy efficiency and sustainability and are less likely to engage disinterested people. Current self-motivated education programs are therefore not useful for whole-of-population interventions. Other education programs are needed in order to engage with people less motivated or aware. Since the Australian government interventions of 2009 onwards there have been more education programs conducted to train assessors to go into homes and assess energy efficiency and sustainability. There have also been more programs training people to conduct the sustainability and energy retrofits on houses, which are often targeted at long term unemployed people (Gabriel et al. 2010: 41). These programs could be built upon and adjusted for further use. In addition, there is a need to educate the organisations (such as government bodies, contacts at electricity suppliers and community support organisations) who are expected to impart energy efficiency, comfort and sustainability information.

Financial capacity

Adaptive capacity is affected greatly by household financial situations. Providing finance or reducing capital outlays for energy efficiency adaptations has been used as a dwelling adaptation intervention around the world and is intermittently used in interventions in Australia. Financial provision requires that the stakeholders wanting to encourage dwelling adaptation are in a position to provide funding to householders and this is rarely possible. Government is therefore the only organisation in Australia that can fund financial capacity provision and does so through rebates, sale prices on appliances and construction products, low or no interest loans, direct provision of appliance and construction products, and direct provision of retrofit / construction labour (see government discussion in the 'Interventions to societal systems and structures'). Social and community organisations often hand out the funds, rebates and other financial intervention provided by government. There is no continual funding available for residential energy efficiency programs.

There are many families who cannot afford any outlay of money for adaptations or who can only afford a small amount. For Weaver's (2004) master's case study of an energy efficiency retrofit the budget used was set at an amount that was identified as the upper limit of what people could afford in an emergency when living on a low income.

The inability to raise \$2000 in an emergency is one of the definitions of poverty⁶³ ... and provides a convenient marker of affordability for retrofitting projects aimed in particular at people who need their homes improved for health reasons (Weaver 2004: 84).

The amount of \$2000 was chosen so that the renovation study could begin to engage with issues of disadvantage related to dwelling and situations where there was a lack of capacity to make change. Weaver recognised that many households cannot afford to engage with dwelling adaptation at all, even if it is at a simple level. With \$2000 he experimented with small changes and found that the budget and the small changes were enough to have some effect on both temperature and health.

⁶³ The reference noted is (Tasmanian Government 2001).

Rebates have been a common form of encouragement for energy efficient adaptations in Australia. Besides the GGAER rebate program, there have been some other small rebate programs in Tasmania. For example, Hobart City Council has been involved with solar hot water rebates.

Retrofit and renovation assistance

Direct retrofit and renovation assistance is a technique that has been used in Australia and in Tasmania as a provision of capacity. It requires relatively large inputs of effort and money by organisations and institutions which means that programs in Tasmania have been small scale (to date). Retrofits and renovation assistance is further discussed in the section on physical interventions (below).

4.3.3 Physical interventions for improved efficiencies

Direct intervention by conducting or supporting physical dwelling adaptations overcomes some critical low-income barriers and has been found to increase the opportunity for energy efficiency gains.

During the oil supply issues of the 1970s much attention was given to solving energy use issues through improving the performance of physical housing features (Guy et al. 2000; Rosa et al. 1988: 160-1). Focussing on physical (including technological) aspects of adaption and emphasising the efficiency improvement of these elements still remains a popular focus of interventions.

The focus groups regularly centred conversation on the physical housing stock because they recognised the difference that relatively small physical adaptations could make to the energy efficiency of existing housing stock. The World Health Organisation (WHO) also recognise the importance of the physical building and specify orientation and solar access to indoor spaces as important in housing design to support health and wellbeing indoors (Ranson 1988a: 19, 48).

While physical adaptations are not the only useful adaptive strategy and in certain circumstances may fail, they do play an important role. Housing has the capacity to be a capacity in and of itself. Poorly performing housing, however, simply

undermines household capacities. Physical aspects of dwelling do influence and even ‘script’ how occupants use and adapt their houses (Ingram et al. 2007; Shove 2003). Hugh Stretton (1999) has argued, with a perspective similar to the idea of scripting, that certain physical facilities in a home could help (or hinder) an occupant’s life opportunities and as a consequence, a community’s opportunity for home-generated social capital; Stretton could see that this was particularly the case in disadvantaged living circumstances. There is widespread recognition that where adaptive capacity is low (disadvantage, low-income, missing skills) occupants do find it harder to overcome the physical ‘scripts’ they have inherited (Gabriel et al. 2012c; Hernandez et al. 2010). Physical interventions are therefore particularly helpful in situations where households have limited adaptive capacity and live in under-par housing situations. A New Zealand intervention program that conducted insulation and draught proofing upgrades to 1350 low-income households found that the households had improved indoor temperature and humidity, improved self-reported health and reduced doctor’s visits after the intervention (Howden-Chapman et al. 2007).

Information, messages and education for physical renovation

Information, influential messages and education are often shared with householders at the same time as energy efficient physical interventions are conducted in their homes. Due to the universal need for information and education they are discussed in the section on ‘Interventions Providing Capacity’ and in the ‘Decision-making / Practice Interventions’.

Messages trying to encouraging people to make physical home improvements are common (for example Tasmanian Government 2012a). In Tasmania, for example, government and commercial messages have been carried in advertising and information campaigns for many years. After growth of businesses working in energy efficiency technologies for homes there are now (2013) regular solar hot water, solar power and insulation advertisements.

Physical adaptation strategies for energy efficiency and comfort improvement

Various types of physical change can be made to bring about better energy efficiency and comfort. These physical adaptations can be made to the house building shell and structure, its fixtures and fittings,⁶⁴ technology used in the home, or to the landscape and outdoor areas. Physical energy efficiency intervention approaches regularly focus on the provision of products and labour to improve the passive thermal performance of a house or on integrating or replacing technology (through financial and installation support).

The design (including the layout and orientation) of the house is a key determinant of energy efficiency and comfort performance of a house because it effects household practices; facilitates the controls of energy flows within the house ; and supports the functionality of the dwelling and its occupants (Fernandez-Galiano 2000: 8).

Generating energy efficiency also comes from using the most appropriate energy source for any given domestic job (Watson 2004). Householders therefore also have the option of trying to change the energy source they use for certain household activities. Heating can, for example, be achieved by capturing sunlight (a passive form of energy) rather than through by using an electric heater or wood fire (an active solution). Where energy can be used without any active input of energy into the dwelling, it is called passive use of energy.⁶⁵ A house designed to passively capture the sun for heating will limit the need for extra heating inputs via fires, or fossil fuel sourced heating. Active energy inputs generally require a significant amount more resource input to achieve the function the energy is supporting. Limiting the use of active (or processed) energy is a key to creating a less impacting and more affordable dwelling situation. Passive solutions reduce the use of supplied (active) energy use and therefore are an attractive solution in situations where householders struggle to afford energy already supplied.

⁶⁴ Fittings and fixtures include lighting, heaters, garden watering systems, curtains, taps and any other aspect of the house that can be refit or refixed or newly installed in a renovation.

⁶⁵ For some examples of passive energy use in buildings see Roaf et al. (2005). For examples of how energy is used in buildings as an active input see Fernandez-Galiano (2000).

All adaptation strategies are passive or active solutions, or a mix of both. Despite the common mix of both strategies, it is useful to list passive and active strategies separately. The designs and physical changes most commonly used to optimise passive comfort and more passive energy management are:

- orienting living areas towards the sun and ensuring window and openings allow the sun to come into the building when warmth and light are needed;⁶⁶
- blocking sun from entering the house when temperatures are uncomfortably hot;
- creating a building shell that is resistant to heat-flowing from inside to out and vice-versa (including through windows);
- utilising materials and products with the lowest embodied energy; and
- zoning the house to maintain warmth in particular areas.

In existing housing engaging with these passive strategies entails, for example: installing insulation in the walls, ceiling and floor; installing doors between the house zones; the installation of draught proofing around doors and windows; retrofitting windows to be double glazed and/or to have thermal-block window coverings; and adding blinds for shading or moving window for sunlight.

Actively inputting energy into the dwelling to support dwelling functions through appliances and electrical systems is an integral part of a modern dwelling. Activities such as washing, heating and cooling, cooking, drying, cleaning and even leisure regularly use active inputs of energy. Housing that can produce its own energy (autonomous housing) still requires the active input of energy because it also has to accommodate the use of systems and appliances that require active energy supplies (Vale et al. 1996).

In Tasmania's temperate climate, in existing housing, it is common that passive strategies alone will not achieve aspired-to comfort levels. Supplemental (active)

⁶⁶ In the focus groups conversations orientation was seen as a critical strategy for new build or major renovations that they observed was regularly overlooked.

heating will also be required. In addition, passive energy collection and use will not support a range of other functions that householders require. Processed energy will be used through active systems such as appliance and the electricity supply system. Efficiency can be improved for active energy use by:

- limiting use as much as possible;
- utilising efficient and fit-for-purpose lighting and heating technology;
- utilising energy efficient appliances;
- managing heating and cooling zones so the heaters / coolers are not doing more than is necessary;
- minimising hot water use (using, for example, short runs of pipe, solar hot water and water efficient showerheads); and
- sourcing the most appropriate energy source for the job (for example, wood, gas, electricity).

Heat-flow resistance in the building shell has a critical influence on the opportunities for passive management of comfort levels and the efficiencies that may be gained in energy use in the house, especially in relation to heater use. Resistance to heat-flow in the shell differs depending on the dwelling design, construction, the material performance, its environment, solar access to the house, and the insulation status. Most building materials resist heat-flow to some degree: timber does not assist the transfer of heat and is insulative; brick and other mass materials such as concrete and stone absorb heat but it travels through them slowly,⁶⁷ creating a time delay before the heat is released on the other side; and, metals actually conduct heat.

These building materials need supplemental insulation to be added if the building shell is to maintain a level of heat-flow resistance that will support passive management in the house. Insulation can be used in ceiling/roof, wall and floor elements of the building shell and comes in either a bulk or reflective form. Bulk insulation minimises heat-flow by adding resistance to the building shell and

⁶⁷ Mass can be used in houses as a strategic store of heat, but too much mass in Tasmania generally leads to houses which stay at a colder internal average and are harder to heat up.

reflective insulation does so by reflecting heat. Adding insulation to house building shells is a useful intervention strategy due to the significant effect it can have on reducing heat-flow. The levels of insulation in houses are therefore useful indicators of the ability of a house to heat energy efficiently and to maintain reasonable levels of comfort indoors. Monitoring insulation in houses is therefore helpful when monitoring energy efficiency opportunities, comfort, or health and wellbeing in a population.

In Tasmania and Australia insulation has only been legislated a required part of newly built home construction, through energy efficiency requirements in the BCA, since 2003, and for significant sized renovations since 2010. Before this date insulation was less popular and was only used on a small percentage of newly built homes. A focus group member reported that from the 1970s through to around 1988 in Tasmania, there was a significant level of resistance from authorities and councils to the idea of legislating insulation levels required for house construction (SGFG October 2007).⁶⁸

Insulation levels have been reported by the ABS to have increased over the last two decades arguably due to growing emphasis on gaining thermal comfort indoors; growing normative pressure to ‘do your bit’ for the environment; and partly due to large interventions encouraging insulation over the last four years. In 1994 approximately 63 per cent of Tasmanian (52 per cent of Australian) households reported having had some form of insulation in some element of their building shell (that is, the floor, the walls or the ceiling). By 2005, around 75 per cent of Tasmanians (60 per cent of Australian) households reported having insulation (Australian Bureau of Statistics 2005: 10). In 2008, the figure had increased by a small amount but still sat at around 75 per cent (Australian insulation rates stood at about 61 per cent) (Australian Bureau of Statistics 2008: 7, 21). Separate dwellings were the most common building type insulated (*ibid.*: 22).

⁶⁸ Building energy efficiency and sustainability specialists, in Queensland, New South Wales and Victoria have shared similar stories with me about experiencing high levels of resistance to legislating for improved building shell energy efficiency throughout the 1980s, the 1990s and into to 2000s.

In 2009, there were two significant interventions from the Australian Government (the Green Loans Program and the Economic stimulus package) which increased insulation rates by providing free insulation installations in ceilings. Since these two packages, the proportion of households in Tasmania reporting to have insulation has increased to 79 per cent (69 per cent overall in Australia) (Australian Bureau of Statistics 2011: Table 2).

Reports simply quoting that houses are insulated in some way are deceiving. These survey figures paint a positive picture in relation to insulation in homes, but omit some important detail and misguide our assessment of the ABS figures. Firstly, the statistics available do not identify how many low-income households, as opposed to medium and high income households, have their homes insulated. Of the respondents who reported they did not have insulation, the main reason (34 per cent) given was that they were not the home owner (were renters) and were not responsible for renovations (ibid: Table 4). Renters are more likely to be living on low incomes. That renters are more likely to excuse themselves from insulating or having insulation is a good indicator that low-income renters have much less likelihood of living in an insulated house. More investigation is needed to ascertain how much less insulation low-income (including renting) households have in their building shells.

Secondly, the insulation reported is mainly laid in ceiling spaces. In the ABS series of surveys of insulation, it was found in 2011 that of the households with insulation, most (98 per cent) of the households had insulation in the ceiling, but only 36 per cent of those with insulation had it in their walls and only five per cent had it in their floors (ibid: Table 3). Heat-flow resistance is required in every plane of the building shell – and complete housing insulation in all elements of the building shell was rare. Insulation in the ceiling in a climate like Tasmania's is generally helpful, but wall and floor insulation are also extremely helpful for gaining improving comfort levels. Just having insulation in the ceiling does not necessarily mean the house will be resisting heat-flow effectively. Any extra insulation in the building shell can assist to improve heat loss.

Thirdly, the insulation reported in the surveys could be either bulk or reflective, laid in a poor way and of any age. Various types of insulation have various issues. Reflective foil insulation is particularly prone to dust as its reflective (and insulative) effects become limited. Bulk insulation is often laid incorrectly with gaps and is susceptible to moisture. Cellulose insulation is susceptible to collapse which reduces its effect.

Finally, the levels of resistance of the insulation reported are not described in the surveys. Existing houses, with insulation, most likely have insulation that performs relatively poorly when compared to new-build insulation now required through the BCA. Alongside legislative requirements insulation affordability and availability of higher performing insulation has gradually increased.

Consequently, house insulation statistics are likely to be hiding how under-insulated wall and floor elements of houses are and significant rates of underperforming insulation and poorly suited insulation. It is therefore likely that very few houses have a reasonable level of insulation that would support passive house management, comfort and energy efficiency.⁶⁹

Focus on Technology

Within the broader focus on physical adaptation, interventions for energy efficiency often focus on technological solutions. Technological solutions include introduction of technologies or adjustment and replacement of appliances, electricity supply systems, lighting, and hot water technology. It is common for technological efficiency to be the strategic focus of intervention work to bring about sustainable change.

The focus on technological solutions has been explained as having come about due to a cultural expectation that technology will be able to solve all problems; technologies being (relatively) easy aspects of the physical dwelling to install or retrofit; new

⁶⁹ This issue of resistance levels still being very low is explored in chapter four where the resistance levels of participant houses are assessed and compared with building code expectations for new houses.

technologies being fashionable and a sign of ‘success’; and significant confidence (belief) that improved technological efficiency will lead to dwelling sustainability (Brand 1994; Davison 2001; Hand et al. 2007; Nansen et al. 2011; Rybczynski 1980; Shove 2003). Gaining energy efficiency through technological means is viewed positively in sustainable development and ecological modernization discourses because technological adaptations can often occur within existing political structures and development ideals without significant change to existing market-based trade systems or consumption patterns (Davison 2011; Stratford 2010). Technology and an efficiency focus suits the pro-development (weak sustainability) approach to Sustainable development (Baker 2006).

Despite the support, technological adaptation solutions can be problematic. Technologies can break down or become obsolescent over relatively short time frames which mean they need regular replacement. Replacing technologies to improve efficiencies in housing is problematic because it actually leads to higher consumption levels and is unaffordable for many households. Due to the culturally supported popularity of technological solutions, dwelling functions are generally met through technologies (appliances) such as washing machines, heaters, dryers, and ovens that all require electricity and means that costly supplied electricity is required to cover simple daily functions. Appliance use in homes in Australia is increasing and is understood to be one of the most critical factors in the increase in energy use by the residential sector (Australian State of Environment Committee 2011; Energy Efficient Strategies 2008; Rybczynski 1980).

Criteria for selection of appliances has changed and efficiency has become a more important consideration (sometimes the main criteria) when selecting appliances and technologies (Australian State of Environment Committee 2011: 816). Cost, however, is still the most heavily weighted factor for heaters (ibid.). The cost of the technology, its upkeep and replacement can be prohibitive. In addition, technology (especially appliances) purchased for the home are influenced by cultural pressure and fashion preferences. Obsolescence can simply be an excuse rather than a real problem.

The CEEG were concerned about the emerging need to replace a wave of older heat pumps (air conditioners) which were installed around 15 years before and were underperforming and very noisy (CEEG October 2007, May 2008). Heat pump technology had become more efficient and quieter since they were installed, making replacements look attractive even if the technology was still functioning.

The emphasis on technology as adaptive solutions tends to limit the consideration of other strategies that can support efficiency, comfort and encourage sustainability. In many cases technology is not the only solution that could meet the dwelling needs or functions householders aspire to have (Fernandez-Galiano 2000; Rybczynski 1986; Shove 2003). More passive, less technical, less active adaptive solutions may actually be better solutions long-term for the householders, but are left unconsidered.

The focus on technologies as solutions is not surprising in this modern era of mass scale production. The market is flooded by technical solutions for energy and comfort adaptations. Mass produced solutions are often well marketed and become normalised solutions that are the first solution thought of or suggested to them when a householder is faced with a problem in the house. In this environment of active technologies being the most popular solutions, gaining efficiency becomes even more important.

The house as a mass-produced object, Rybczynski argues, has meant that people have to fit into strongly scripted physical environments that are very different from historical home environments. Historically houses were not as heavily scripted by mass production and were instead strongly influenced by social evolution and had developed in conjunction with the occupant needs (Rybczynski 1986). If too heavily 'scripting' then technological solutions becomes difficult for householders to 'appropriate' or adjust (Ingram et al. 2007).

Physical replacement and technical efficiency programs

Physical retrofit interventions programs have been conducted at federal and state scales over the last decade. Major government programs were discussed in the societal systems interventions.

Physical retrofit assistance supported by the Australian Government has come through a number of now concluded (prematurely closed) programs, such as the Green Loans program and the Economic Stimulus insulation installation programs (that ran 2009-10) mentioned in government interventions above. The LIEEP program, also previously mentioned in the same section, is the Australian government's latest attempt to encourage physical change in low-income housing.

In Tasmania in the last ten years interventions have come in the form of a number of disparate and isolated purchase-assistance programs for energy efficient fixtures and fittings for houses. These Tasmanian programs have generally only been small scale and were supported by various arms of government.

At a local government scale in Tasmanian interventions were relatively scarce, but some were conducted. Around the time of the 2008 interviews: Hobart City Council maintained a rebate offer for the purchase of solar hot water; Launceston City Council's had just run a wood-fire replacement program (to reduce smoke pollution in the city) for a time; and the Glenorchy City Council had taken part in the GGAER project. In contrast, local councils around Australia have run retrofit programs that provided products and assistance to make small physical feature changes for energy efficiency such as provision of efficient lighting, draught proofing and showerhead replacements.

At a State government level very little was happening in relation to energy efficiency interventions for households (see societal interventions discussion). SLT has been the project manager and facilitator of much of the government funding for retrofit programs for low-income and rental occupants. The programs SLT ran all ran for set periods of time. The Power Savings for Tenants (PST), which began in 2012, is (comparatively) a larger scale program being run by SLT and funded through the State Government that uses techniques of direct physical upgrades of rental houses in attempts to benefit low-income renters.

Just after the 2008 research interviews, the Tasmanian Climate Change Office began issuing community grants for up to \$50 000. One community group, Waterworks Valley community group, used this grant to conduct their own community level

intervention in housing. The group offered and assisted houses to make simple physical retrofits and educated them on opportunities for larger retrofits. Since 2011, an existing appliance purchase scheme for people on low incomes has been advertised as available for use for the purchase of energy efficient appliances.

In addition since 2006 there have been a number of community groups in Tasmania running bulk-buy schemes for solar hot water (SHW), photo voltaic panels and 'smart' meters (for electrical use feedback). Solar hot water bulk-buy groups came into the community around 2007, and photovoltaic and smart meter bulk-buy groups as emerged over the years after that. The initial SHW bulk buy group turned actually turned into a SHW supply business.

Interventions in Tasmania have mainly focussed on the provision and support for installation of draught proofing, insulation and showerheads; support for appliance upgrades; and in home education to support the physical upgrades. Appliance upgrades have focussed on hot water systems and heaters. Upgrades of both these systems can provide significant energy savings (Howden-Chapman et al. 2011), and heater replacements can also support improvements in health. In New Zealand a heater replacement interventions program realised health benefits for occupants with asthma. The cost of the retrofit was cancelled out by the savings made through reduction of doctor's visits due to asthma episodes (Preval et al. 2010). Another replacement study looked at health benefits gained from cook stove replacements in India and found significant health benefits sat alongside reductions in greenhouse gas emissions (Wilkinson et al. 2009).

Physical aspects work in conjunction with other aspects

Over years of attempting to create better energy efficiency through physical adaptations and technology replacement, it was realised that the physical changes alone were not enough (Shipworth 2000: 4-5). There was growing awareness that interventions that ignored the human and social aspects of dwelling had limited effects. Tracy Crosbie and Keith Baker (2010: 71) argue that

It is vital to understand energy-efficiency interventions from the participants' perspective. It does not matter how much energy hypothetically could be saved

by 'green' housing developments or energy-efficient heating and lighting systems if the energy-efficiency measures are unwanted.

The continued emphasis on technical solutions for energy efficiency interventions is they suggested 'perpetuated by the absence of accepted methodologies for socio-technical research in these areas' (ibid.: 73).

Most government intervention programs conducted in Australia privileged technological interventions and physical intervention. Whilst the community bulk buy programs in Tasmania were simply opportunistic (the community knew that other changes to the passive performance and the practices used in the house were needed as well),⁷⁰ the government programs were expecting real change in energy use from the technology replacements and simple retrofits made and did not understand the need to engage long-term with practices in the households.

Hand et al. (2007: 670) have argued that in order to create more sustainable living and consumption patterns, we need to understand 'how people organise and appropriate the hardware of contemporary life', not the hardware alone.

4.3.4 Interventions to change behaviour, dwelling practices and decision-making

Following on from the recognition of the need to understand people and their practices, the final group of interventions to be considered are those that influence behaviour, dwelling practices, and decision-making (see, for example: Barr et al. 2006; Hobson 2003; Leviston et al. 2011; Mackenzie-Mohr et al. 2011; Moloney et al. 2008; Shipworth 2000; Shove et al. 2007; Wilson et al. 2007). This group of interventions work from varied methodological positions and target interventions differently at individuals through to much larger social groups. Originally behaviour change was a popular term used in an overarching way to describe decision/practices

⁷⁰ One of the bulk buy groups went onto find funding for the retrofit of housing features so they could improve the passive performance of the houses in their community.

types of intervention approaches and was the term used by stakeholders of government and environmental psychologists (Barr et al. 2007; Maloney 2008). The term 'behaviour' means 'manner of behaving or acting' (Macquarie Dictionary 2005b) and in relation to dwelling adaptation refers to the actions of occupants.

In 1993 Loren Lutzenhiser (1993: 248) argued that more attention needed to be paid to behaviour in regards to energy use because 'it significantly amplifies and dampens the effects of technology-based efficiency improvements' but because the knowledge was 'scattered across social science disciplines' it was difficult to collate and use. Since then, a body of work has developed around behaviour change in relation to energy use including investigations into decision-making, attitudes, behaviours and practices. Disparate approaches to behaviour change do still exist however under these banners, which can limit the effectiveness of any one behaviour change intervention approach (Peattie 2010).

There have been efforts to try and better understand what behaviour itself means, which has led to growing recognition that dwelling behaviour is complex and dynamic (Wilson et al. 2007). Practice as a concept has in many instances replaced the use of the term 'behaviour' because practice means 'the action or process of performing or doing something' customarily, habitually or repeatedly (Macquarie Dictionary 2005d) and often describes dynamic and complex dwelling activity. Socio-technical approaches in particular support the practice-orientated perspective because it incorporates consideration of the doing and relating rather than just the technology or just the people alone (for example: Ingram et al. 2007; Lutzenhiser 1993; Shove et al. 2007; Wilhite 2009). They see that

the re-specification of normal practice is of greater environmental significance than the ecological design of appliances and products with which taken-for-granted needs are met (Shove 2003: 193).

Focussing on the concept of practice allows theorists and interventionists to go beyond simple actions or decisions and 'enables exploration of the dynamic interaction with the material environment, infrastructures, technology and social and cultural systems' (Maller and Strengers 2011: 496). Behaviour or action as practice can be routinized or 'widespread, replicated and evolving' and can be 'carried out by

multiple actors across time and space' and 'involves connected elements, such as bodily activities, mental activities, things, knowledge, skills, emotion and motivational knowledge' (Reckwitz, 2002). Practices may be enacted through the body, but also require knowledge, emotion and the development of strategy and aims. Along with the body and mind, objects (things) such as houses and heaters and communicative media 'are necessary components of many practices' (ibid.: 252). In 'practice theory' all parts of the practice, for example: people, their behaviour, the individual mind, objects used, words, social norms and relationships, all contribute. Concepts of practice therefore provide recognition of the interaction of occupants with dwelling things, their own knowledge, culture and their context and understood people's actions as socially and culturally situated. A practice perspective therefore recognises that interventions need to be designed considering many influences. In Australia, a handful of scholars have conducted observation of interventions and adaptations using a practice perspective, but to date no interventions have been designed using practice theory (Maller, Horne et al. 2011; Strengers et al. 2011).

Decision-making is recognised to be an important aspect of individual behaviours and practices. Decision means the act of determining, judging or the 'making up of one's mind' (Macquarie Dictionary 2005c). Interventions have tried to influence decision-making through simple information provision, attitudes and values, and social norms.

In what follows I describe commonly targeted aspects of decision-making, behaviour and practices that are used to encourage dwelling energy efficiency, comfort and sustainability. These categories described are discussed separately because they are often targeted separately by interventions.

Information provision

It is possible to influence adaptation by means of information provision to affect decision-making and practices. Information provision approaches assume that when information deficits are filled more sustainable decisions will be made and adaptive action will be taken. There is evidence that information provision does influence

people to adapt in certain circumstances, but there is also awareness that it is a poor tool when used alone (Crosbie et al. 2010).

Information provision approaches are popular in Australia and in Tasmania as fairly inexpensive yet public and obvious interventions. The Australian Government has made large amounts of information on environmentally sustainable design for new build and renovation available (for free) for householders (Commonwealth of Australia 2005). In Tasmania, information provision is mainly provided to householders in the form of sustainable retrofit and home design advice by non-government stakeholders like SLT and some community groups (Sustainable Living Tasmania 2007c; Waterworks Valley 2012). Information provision is also shared with householders in Tasmania through the physical intervention programs previously mentioned. Despite the availability of information, there is little understanding of whether or not the information provision has had any lasting or significant influence on householder decision-making. Hobart City Council (2008; 2009; 2012) engaged SLT to run a series of talks on adapting homes for improved energy efficiency and comfort in 2008 called ‘Chills and Bills’ in six different locations. At each presentation attendees (mainly in their role as householders) were able to ask specific questions they had about energy efficiency in their own homes and were able to see various retrofit ideas displayed. The talk series was reported to be a success by presenters and attendees, but there are no clear conclusions about the impacts these talks had on household practices.

Some information-sharing strategies have been well-studied. Real time energy use feedback (through a variety of interfaces⁷¹) in the home has been shown to enable householders to ‘see’ their energy use in a clear, concise and useful way that allows responsive reduction in energy use (Fischer 2008; Foster et al. 2012). Whilst energy feedback was useful, it was also found however that energy feedback had to be applied and tailored to an appropriate format for individual household situations (Fischer 2008).

⁷¹ Specifically: real-time displays in houses; internet sites; or pre-payment meters.

Providing information at the point of product purchase and the point of decision-making about the product is common information intervention strategy (Jackson 2006b; Peattie 2010). Originally based on rational decision-making theory (Wilson et al. 2007) early information provision interventions focussed on alerting people to quality and energy efficiency information and assumed that people would then make a rational choice when comparing functions and cost. The Australian Government, for example, provides assessment of the energy efficiency of appliances via a rating system which consumers can find on the internet and on stickers on appliances in shops. Understanding of decision-making at the point-of-choice is evolving. There is now recognition that customers do not always make a rational choice based on cost, function and efficiency and is influenced by much more complex considerations (Barr et al. 2006; Crosbie et al. 2010; Jackson 2006a; Wilson et al. 2007). This more sophisticated understanding is moving intervention exploration towards methodologies that recognises socio-cultural and contextual influences on decisions (Barr et al. 2006: 907-8).

Values, norms and expectations

Attitudes to housing expectations and aspirations affect housing outcomes, including energy use and comfort and may be influenced by appealing to people's values, norms and expectations. 'Attitudes' in this instance refers to the 'position, disposition, or manner' of a person, people or things (Macquarie Dictionary 2005a). Professed attitudes and the values, norms and expectations that go along with them have been researched in various countries in a disparate way (Barr et al. 2007; Fielding et al. 2009; Maller et al. 2010). In Australia, attitude surveys about sustainability are often general and rarely focus on householder actions for energy efficiency or comfort. No major attitudes, value, norm or expectation studies or surveys have been conducted in Tasmania with householders. Further afield, progress has been made to better understand how elements of attitudes affect sustainable action.

Values as factors of attitudes towards acting sustainably have been studied a great deal. Understanding gleaned from these studies have been used to design interventions for sustainable adaptation (Barr 2006; Miroso et al. 2011). The

psychological change strategy, cognitive dissonance, is an example of a strategy that uses values as a way to influence attitudes and decision-making and drive sustainable adaptation (Cotter 2012; Kantola et al. 1984). This approach tries to create dissonance in cognitive processes of individuals by showing them that their (un-environmental) behaviours don't match their intentions or values. Once people realise that their (often unconscious) values are not being met by their action, the theory is that the people will try to change their actions. Courses teaching cognitive dissonance strategies have been hosted in Tasmania in association with SLT and other environmental NGOs based on content developed by Tim Cotter and Douglas McKenzie-Mohr (Cotter 2012; McKenzie-Mohr & Associates 2006-2010).

A number of studies and surveys reported that values were not necessarily being enacted (Crompton 2008: 27; Leiserowitz et al. 2006) and an attitude-action, or value-action gap existed. When scholars delved further into value-action gaps however, they found that values did not have simple linear relationships with actions and were actually connected to actions in much more complex ways (Barr 2006; Barr et al. 2007; Fielding et al. 2009: 23; Miroso et al. 2011; Wilson et al. 2007: 181-184).

Some intervention designers and observers have argued that due to the inherent complexity of household values and motivations, intervention design needs to focus on single behaviours (Mackenzie-Mohr et al. 2011; Miroso et al. 2011). However, a single behaviour/action approach does not work very well for dwelling adaptation because dwelling, energy efficiency and comfort are all complex issues that are played out through complex practices made up of multiple behaviours or actions. In addition, dwelling adaptation may be achieved using various strategies and solutions and may require change to both practices and the physical dwelling.

Normative expectations and associated practices are also recognised to influence adaptation outcomes (Allcott 2011; Mackenzie-Mohr et al. 2011; McKenzie-Mohr et al. 1995; Peattie 2010). In Tasmania the most particular effort to affect norms by government is being conducted through the 'Earn you stars' campaign (Tasmanian Government 2012a). When the campaign and program was launched in 2008 advertisements were aired on television reminding people to do their part to reduce carbon emissions. It was targeted at individuals and implied that it was each person's

job as part of the community in Tasmania to change their practices to limit climate change and live more sustainably (Clemenger Tasmania). The campaign was opened with a media release at the home of a Tasmanian family living on a low income that had made small retrofits to their home to save energy and minimise their impact on the environment. Whether the campaign or their initial media release influenced energy use in Tasmanian households is unclear as no public reviews of the campaign are available, but it seemed that the family were meant to set a normative example for other households.

Expectations, intent and purpose are other aspects of attitudes that are developed from both values and normative influences and significantly influence adaptive pathways chosen (Peattie 2010; Reckwitz 2002; Shove 2003; Shove et al. 2007).⁷² Various scholars argue that modern dwelling expectations are driven by modern excessively consumptive norms which makes dwelling unsustainable. Discovering the part expectations, intent and purpose play in dwelling adaptation and the way they are developed and prioritised requires investigation of the detail of people's practices and the decision-making around those practices. Understanding householders' expectations was found to be useful in three intervention programs studied by Crosbie and Baker in the United Kingdom (2010). The authors concluded that interventions needed to clearly identify the direct benefits that adaptations would bring 'to participant lifestyles'. Householders, they asserted, could not connect abstract ideals to their lifestyle priorities, needs and expectations. Aspirations and expectations householders could relate to (such as comfort, aesthetics and fashion requirements) were often ignored in the communication of interventions.

It is noteworthy that comfort expectations are seen to be important in sustainable adaptation. Modern comfort expectations, scholars argue, can challenge attempts to move toward more sustainable practices because these modern comfort expectations requires energy-hungry technology and systems, such as air conditioning to be used (Cole et al. 2008; Moezzi 2009; Shove 2003; Wilhite 2009).

⁷² To begin behaviour change projects one focus group member explained her team would first identify the imperatives and desires of the target group for the program (SGFG May 2008).

It has also been found that aspired to values, expectations and intents, even when prioritised, are not always attainable because barriers can get in the way. Helen Jarvis (2003: 603) found that ‘workers’ daily lives, their working schedules and patterns and activities of social reproduction are getting more complex and fragmented’ and that the coordination of day-to-day living can simply drown out other intentions. Jarvis concludes that ‘essential connections need to be made between spheres of housing, transport, technology, work, employment and family life ... to positively influence the social-environment interface’.

Knowledge’s role in practices and altering practices

Many intervention strategies have evolved to understand that information must be mobilised as knowledge before decisions or practices may be influenced. Reckwitz (2002: 253) argues that particular practices require ‘specific forms of knowledge’: people need to not only understand, they need to know how to conduct any given practice and they also need to be motivated by the expectation and emotions to engage in the practice (ibid: 254). Knowledge and practices are also relational and affect and are affected by ways of being in and relating to the world.

Trying to engage with more factors that influence decision-making and knowledge as the driver of practices suggests that information provision interventions have to become more sophisticated. In response, investigations have been conducted into how knowledge is mobilised and used by people to change practices. Kersty Hobson (2003: 95), for example, has considered ‘how, and in what form, knowledge is mobilised when individuals rethink their personal practices’. New information, Hobson argues, is not simply added to knowledge, but instead interacts with existing knowledge and reassessment and adjustments occur according to the introduction of new knowledge (Hobson 2003). Hobson explains this process through examination of changes made to practices from an intervention program that provided a regular feed of information to participant householders through a supportive group of volunteers.

Habits as an important element of practices

The routine aspects of practices, that is habits, have been isolated by some scholars as critical aspects of practice that need to be addressed to engage with sustainability (Hobson 2003; Maréchal 2009). Society Reckwitz argues (2002: 255) is ‘structured’ by the routines of social practices’ and therefore ‘breaking’ and ‘shifting’ of structures must take place in everyday crises of routines’ and to encourage adaptation.

Hobson found, in alignment with Giddens’ (1984) structuration theory, that household habits and routines are ‘hidden’ knowledge’ which Giddens calls ‘practical consciousness’ (Hobson 2003: 104). This embedded practical consciousness guides practices without people being too aware of the cognitive processes involved. To encourage change and reassessment in habits and routines therefore, Hobson argues that cognition must be moved from an embedded (unconscious) state to a more discursive state. Hobson observed that people who are more aware of their habits and routines are better able to assess them. This strategy is similar to the ideas of cognitive dissonance. For simple habits, Hobson observed people could rethink and adjust their actions, once they are made more aware. Hobson does not think that making habits more discursive guarantees that people will always change to more sustainable ways of living however. During her study she saw that people had to deal with day-to-day personal and political struggles in their lives which could override change processes. Many habits and actions were seen by participants of her study to be influenced by outside factors and influences, particularly social, political and commercial. Occupants found changing more complicated practices hard due to the day-to-day involvement of these other aspects of society.

Everyday lived experiences as practices

In critiques of the intervention approaches related in this section there was emerging awareness of the complicated influence that day-to-day lived experiences have on adaptation opportunities. Attitudes develop, knowledge generates, decisions are made and practices are performed in relation to this rich everyday context.

Understanding of the detail of lived situations householders face and how this detail

affects dwelling adaptation is gradually encouraging better dwelling adaptation intervention design (Rosa et al. 1988).

Crosbie and Baker (2010) argue that many energy efficiency intervention attempts for housing sustainability have overlooked the need to understand householders lived situations. The lived situations, they show, provide indicators for why intervention attempts succeed or fail. An example of the import of considering the lived experience emerges from the investigation they conducted on the installation of compact fluorescents lights (CFL) in houses. The researchers heard from households that the CFLs were not to their liking (or were not a match to expectation or needed function) and were therefore regularly removed after instalment or only used in limited areas of the house. Oversights such as this have led to interventions that may seem technologically and economically sensible, but fail to attract householders and therefore have minimal impact.

The focus on lived experiences requires that research considerations and intervention designs engage in more depth and richness. Understanding the real dynamics of householder lived experiences has mainly fallen to qualitative socio-technical researchers who have attempted to better understand dwelling practices in context and look to lived experiences as a way of understanding dwelling influences and possibilities for dwelling adaptation (Chappells et al. 2005; Hand et al. 2007; Moloney et al. 2008; Rybczynski 1986; Shove 2003; Strengers et al. 2011).

4.4 Review of interventions and discussion: Calls for integration of intervention approaches

It can be seen that intervention attempts are widespread internationally but work at diversity of scales and from a diversity of perspectives. Australians have managed to conduct interventions at various scales, using some fairly set perspectives with mixed results. The Australian Government has mainly intervened using large-scale, broad-brush interventions with a focus on technology or physical solutions but has had to stop a number of their interventions due to unconsidered risk and budget outcomes.

Currently, through the LIEEP initiative, the Australian government are thoroughly assessing novel ways of engaging with low-income households to improve energy efficiency. They are running this initiative because their previous intervention experiences have taught the government the value of understanding the householder situations and responses in more detail. The two main societal level energy efficiency interventions currently being conducted through the Australian government are the carbon price (that indirectly influences households), and the BCA requirements (that directly affect new build and substantial home extensions). These two interventions, whilst useful, will not be enough by themselves to meet the energy efficiency targets required to make dwelling circumstances more equitable of to limit climate change.

Tasmanians have dabbled in interventions and have tried small scale projects with limited funding. Whilst small populations of householders have benefited from these interventions the small scale and disparate (and unpredictable nature) of funding and interventions has meant: householders are not familiar with the intervention projects and do not have confidence or familiarity with energy efficiency programs in the State (or for that matter federally); and that the interventions only have small scale effects. Australian Government interventions available for periods of time did benefit householders somewhat but failed to achieve any notable gains in relation to health and wellbeing of householders or any major reductions in climate change emissions.

The review of intervention approaches in this chapter (of systems interventions, capacity provision, physical improvements and influence in practices) has shown there is potential in each approach. However, many interventions attempted had limited effects because only one intervention approach was used and there were barriers to that particular approach's uptake; or, the target audience for the interventions were not well understood; or, the interventions were applied in a general and homogenous way and failed to recognise that people are different (one size does not fit all).

After reviewing types of interventions influencing decision-making to encourage energy efficiency, Wilson and Dowlatabadi (2007) have argued that there was value in all the approaches but that the approaches needed to be used together to have the hoped-for effects on energy efficiency. They surmise that the approaches used in

each intervention needed to ‘match the type and context of behavior in question’ (2007:191). By using a suite of approaches they felt that interventions could be tailored so the right intervention could be used at the appropriate time.

Intervention scholars have also called for integration and coordination of the various intervention approaches (Barr et al. 2006; Gilg et al. 2005; OECD 2011a; Wilson et al. 2007) tempered with understanding of lived dwelling experiences and the contexts in which people operate (Crosbie et al. 2010; Franklin 2006: 25-6). The idea of integrating approaches is not new (Rosa et al. 1988), but there has as yet only been a small amount of effort put into working out how to think about and design truly effective integrated interventions. There are examples of integrated interventions on which interventions can build, such as approaches used internationally in the Transition Towns movement (Hopkins 2008) and strategies used locally by sustainability advocates in non-government organisations and in State Government (SGFG May 2008). A State government focus group member, who worked to encourage sustainable change in business, explained that her she first identified the imperatives, desires and capacities of the group of people she was targeting and then fitted intervention approaches to match the group.

It is difficult design tailored multi-pronged intervention approaches, as the State government focus group member noted, without understanding the detail of lived experience. In a literature review of sustainable consumption literature Peattie (2010: 109) finds the clearest conclusions ‘are that green consumers are extremely heterogeneous and that their behaviour is not subject to a single explanation or a single best way to influence it’ (ibid.: 109). That there is no clear picture of a ‘green consumer’ despite the conventional attempts to identify ‘consistent and stable types of consumers for their marketing efforts’ (ibid.: 109 or 110) is likely to be a critical barrier to intervention design.

Integrating approaches also means that it is important to recognise the importance of social and material relationships in dwelling and how these play out as practices (Gabriel et al. 2012c). Recognition of how building, its occupants and society and the environment interact and work together is well recognised (Brand 1994): the physical can ‘script’ the occupant, but the occupant can also ‘appropriate’ and adjust the

physical (Ingram et al. 2007) and these are both affected by interactions with the context in which they exist. Acknowledgment of these dynamic relationships between things and people, their cultures and the social structures has been called for by housing and sustainability proponents (Crabtree 2008; Guy 2010; Moran 2006). In this regard, Guy et al. (2000: 66) argue ‘that the value of distinguishing between technical, social, economic, and political aspects of energy use is limited, even misleading, because each intersect in ... a ‘seamless web’’. Such webs are interconnected, complex, contextual, culturally specific and temporally and spatially bounded, albeit not absolutely. Social-ecological perspectives engage with the complexity and relationality of the unsustainable housing problem and also support multiple perspectives and scales and multiple approaches (Crabtree 2008; Moran 2006; Rosa et al. 1988). Interventions taking an ecological perspective will be able to target priority areas for intervention whilst still recognising the context and the interactions and relationships of that context.

4.5 Integrating intervention approaches using a processes lens

How can interventions engage with the complexity of the social-technical ecology of dwelling adaptation? Acknowledging webs of interactions, considering all actors (both technical and people) and the context leads to a need to maintaining awareness of temporality. Various scholars recognise that relationships between things (physical dwelling and dwelling technology) and people (occupants) develop over time (Hand et al. 2007; Ingram et al. 2007). Temporality engages with concepts of process, which is a concept common in studies of dwelling practice, design thinking, decision-making, learning, problem solving and social change and also in ecological fields of research. Peattie (2010: 195) researching in sustainable consumption has also recognised that the field of sustainable consumption is ‘complemented by research from fields such as industrial ecology and sociology, providing a more holistic picture of green consumption as a process’ and that recognition of process is important when considering social change in consumption. Transition theory

scholars also recognise that to design policy that will support sustainable housing (and not just the design of the housing itself) requires recognition of process and evolution as well as of context and learning processes (Voß et al. 2009).

It is possible that process awareness in these discourses can be used to structure the complex considerations of dwelling adaptation and dwelling adaptation policy. Decision-making and problem solving theory with its basic understanding of process has already been used in various areas to provide guidance when planning intervention protocols and strategies for both design and adaptation (Bessant et al. 2005; Moser et al. 2010; Watson 2004). Dwelling adaptation as a process of design has been under recent examination by scholars (Ingram et al. 2007) but requires more investigation.

Focussing on practices, relationality and context through the process of dwelling adaptation creates space for tailoring to target populations to occur and the systematic integration of multiple intervention approaches in appropriate mixes. Some examples of how a process/problem solving perspective may assist to look at dwelling adaptation intervention design are listed below (Table 4.2).

Table 4.2: Examples of the problem solving lens applied to critiquing intervention approaches.

Intervention focus	Aspects of the process focused on	Notes
Decision at point of choice.	At the point of choice, the solution possibilities have been significantly narrowed down. The decision maker has already identified a problem and limited the solutions, eg a heater rather than more jumpers, double glazing or curtains.	Influencing decision at the point of choice. Applied at a mass scale and limited to a moment in the process of problem solving through to action makes this a limited intervention strategy. Solutions are greatly limited at the point when householders have already decided to choose a technology to meet their purpose.
Influence through society laws/policies, norms, community pressure	Can be applied at various points in the process pre-resolution. These strategies are designed to intervene in the decision-making processes, but not to assist with engaging in the activity culminating from the process.	Policy and laws can be useful to prevent serious environmental and social harm arising out of adaptation processes, but these strategies can also seriously limit potential solutions. Eg alternative materials and recycled products being used in building processes have some problematic restrictions on them due to blanket policies.
Cognitive support, influence and dissonance.	These strategies also look at the problem-solution decision-making process, but not the activity culminating from the process; rather they are applied early in the problem to solution process (maybe even before problem recognition).	These programs are proving useful, but still find their success rates low.

Intervention focus	Aspects of the process focused on	Notes
Physical assistance and technical help	These strategies come in to play when the dweller has a narrowed down set of solutions and the problem solution path is already somewhat defined. They assist thinking through (a limited number of) potential solutions, choosing a solution and also may progress to assist with the activity of adaptation, with the dwellers' approval.	This process comes in after problem recognition, so people are generally already aware they have a situation which that could change.
Technical efficiency	This is related to the point of choice, but is a little different, so does need a separate category. It relies on point of choice for the final solutions.	Technical efficiency is useful and resolves issues of energy indwelling somewhat, but heading straight for the technical solution is a limited problem solving technique and reduces possible options significantly.

4.6 Adaptation types and processes

Adaptation theories, such as transition theory, recognise the importance of process and offer some useful insights for interventions designers. If interventions are to be designed successfully then understanding the type of change sought and the impact of the changes being encouraged is critical.

Various adaptations follow various processes. Numerous scales of adaptive change can be achieved in various ways, with varying time frames and consequently adaptation is often defined by how long the change takes in comparison to the complexity of the change. Adaptations may generate minor or significant changes to a system or a culture and can occur incrementally within a system, or can transform entire systems and completely erase business-as-usual practices (Park et al. 2011). Making significant change in a short timeframe is very different in nature to making smaller adjustments over longer periods of time. Various terms are used to describe the different types of change. Distinction is often made between incremental adaptation that occurs gradually and within a system and transformational change that changes entire systems in a relatively quick way (Jerneck et al. 2008; Park et al. 2011: 119). Generally theorists distinguish between minor adjustments to systems and more major adaptations that are associated with significant pressure and vulnerability in a system. Some scholars go further and argue that adaptations are only changes that cause fundamental alterations to a system, which removes incremental change from the definition (Gallopini 2006: 300). In this study the position is taken that incremental and fundamental systems change can be included as adaptation.

The type of change attempted and that which is achieved will be influenced by the:

- pressure/motivations (expectations, intents) forcing and driving change;
- capacity of the agents involved;
- level of intervention from other parties; and
- time frame for the change.

Adaptation literature pays attention to the various characteristics of adaptation processes, such as the ones described above, because they define fundamental differences in the way that adaptation occurs and therefore in the way adaptation should be approached, encouraged or intervened in.

While labelling and characterising adaptation processes is useful, caution is required as the models tend to simplify and remove the complexity of real life adaptation. Each adaptation is responsive to contexts, actions, decisions, and systems (Smit et al. 2000) and may include both incremental and transformational change processes (Park et al. 2011) and needs to engage at multiple scales with multiple models (Bailey et al. 2009; Voß et al. 2009). Transition theory and new ecology approaches engage with the need to look at adaptive change in its context, from multiple scales and in its interactive complexity (Crabtree 2009; Jerneck et al. 2008: 170).

Significant research effort is being applied to developing adaptation theory and applying it to real problems, particularly in the areas of climate change adaptation and resilience, ecological resilience and sustainability, and learning and problem solving (See, for example: Bailey et al. 2009; Crabtree 2009; Gallopin 2006; Gotts 2007; Grothmann et al. 2005; Jerneck et al. 2008; Park et al. 2011; Smit et al. 2001; Smit et al. 2006; Voß et al. 2009). So far though, adaptation theories have not been well applied at the household scale of adaptation in westernised household situations.

Guidance for understanding dwelling adaptation and adaptation processes for this study has also come from learning, design and problem solving theories (Beckman et al. 2007; Lawson 2006; Popper 1999; Zeisel 2006). These theories describe characteristics of problem solving and learning; how innovative change is generated through processes of learning and design; and reveal ways to view the detailed processes that people progress through in adaptations. Problem solving theories provide the descriptors and theories with which the stages of adaptation are characterised in this study (see Appendix S and T). Following Popper (1999) problem solving (and adaptation) can be differentiated into four basic stages: problem recognition (using prior knowledge); selecting and testing of possible solutions; enactment of solutions (choosing and acting on the most feasible solution

path); and then assessing and testing of solutions for currency and fit for future needs.

Theories pertaining to adaptation, learning, design and problem solving all recognise that change processes are brought about due to a motivation of some sort, a pressure, a stress, that encourages adaptation, or initiates problem solving (Gallopín 2006; Popper 1999; Smit et al. 2001: 879). For example, Humphrey and Buttel (1982) outline how, historically, crises have developed as particular forms of energy used by society have been, for one reason or another, in short supply and society had consequently adapted. Currently climate change impacts and legislation around climate change and their relationship with energy supplies and peak oil issues are both providing impetus to make change, as are social equity issues and sustainability issues more generally. In short:

Adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity (Smit et al. 2006: 282).

4.7 Conclusions

This chapter has examined: how considerations of equity, comfort and energy use in dwellings can motivate dwelling adaptation efforts; intervention approaches, how they have been used to date, and the positive and negatives of approaches; ways to integrate intervention approached through a process lens; and concepts of adaptation that support process-based design of interventions.

This chapter established that equity, comfort and energy use are valid motivators for dwelling adaptation at household, community and organisational scales. Despite the clear benefits of working towards these goals in situations of disadvantage and low adaptive capacity, there are significant barriers to realisation of these goals.

Tasmania is effectively in the early stages of using interventions to encourage equity, comfort and energy efficiency improvements in homes. Interventions in Tasmania

have been successful in some respects, but unsuccessful in others with major interventions having been one-offs and most interventions having been reasonably small-scale and disconnected generating little momentum for future dwelling adaption activity.

Reviewing intervention approaches from around the world showed they were less successful when they: relied on single theories and acted with singular strategies to engage householders; ignored the details of lived experience, context, and the relationships between people and things; and were not tailored to their audience. Critics suggest that multi-pronged and tailored intervention approaches are needed. They argue that in order to be successful interventions must recognise specific contextual issues; the way people process change; people's individualised and complex lives; and the social ecologies (and relationality) in which adaptations occur. Concepts of process and change are suggested as a means to engage with all these parameters. Adaptation, transition and changes theories support the validity of using a process lens to structure comprehensive and effective interventions.

Understanding various approaches that have been used for interventions; the critiques of these; and adaptation types provides a base upon which interventions can be improved. Chapters five, six and seven further explore what needs to be considered for the design of interventions in Tasmania by examining the experiences of participant householders considering and making dwelling adaptations for energy efficiency, comfort and affordability.

Chapter 5. Physical dwelling conditions and practices among participant households

5.1 Introduction

This chapter identifies, describes and reviews dwelling conditions and dwelling practices that affect the physiological comfort and energy performance of participant households. To achieve this, I respond to two questions: what *dwelling conditions* are experienced by household participants and how were they *attempting to manage* comfort and energy efficiency *in their dwellings*?

Understanding the existing dwelling conditions of, and management practices used in, Tasmanian homes is needed to design effective interventions as it helps to understand what opportunities are available for adaptations and critical priorities for adaptation. Tasmania currently does not have any detailed data on dwellings with which an understanding of prevailing dwelling conditions or common practices could be established. This chapter assists to fill this gap. I use the term dwelling conditions to describe physical dwelling features (such as house structures, walls, floors, windows, fixtures, fittings and spatial layouts) that affect the comfort and energy performance of dwelling. I use the term dwelling practices to describe habitual actions or behaviours that affect comfort and energy conditions and performance in participant households.

Explorations and discussion in this chapter were developed from data gathered at participant households using: notes from on-site dwelling observation; researcher descriptions (including as diagrams) of energy and comfort related features of dwellings; temperature and humidity recordings at site; and householder accounts of managing energy and comfort in the home.

The chapter explores conditions and management practices by relating: a summary of participant household dwelling features; the prevailing perceptions and priorities people held; participant accounts of comfort in homes; and reviews I have made of various dwelling features, dwelling practices and other key dwelling conditions.

In the main, this chapter reports on dwelling conditions, features and practices by focussing on a range of strategies that enhance comfort and energy efficiency; these strategies occur at various scales from the individual body to the dwelling. In general terms, those strategies include, but are not limited to, manipulating dwelling space and its features to moderate the microclimate of that space (indoors and outdoors); considering heat input and extraction; managing ventilation, moisture, lighting use and water use; preparing and managing food; engaging with occupant dynamics and needs; and, managing and understanding power supplied for dwelling and appliances. Each dwelling practice is affected by each dwelling condition; the whole is complex, dynamic, and determined by myriad decisions, experiences and drivers, and is generated using a mix of actions and by manipulating various dwelling features. For example, a warming comfort practice may include using certain clothing or blankets, opening and closing curtains, heating rooms, and changing garden layout and plantings to enhance microclimates.

It is important at this stage to note that to improve energy efficiency while maintaining or improving comfort levels requires that householders optimise the passive performance of dwelling features and practices;⁷³ passive strategies are therefore examined as a priority in this chapter. Physical dwelling features that contribute to passive management include: correct house orientation,⁷⁴ curtained windows, installation of solar panels and insulation. Practices that support passive comfort management include climate-responsive dressing practices, opening and closing curtains in response to day-to-day climate, and using sunlight instead of artificial light.

⁷³ Features and practices that do not require active supply of outside energy resources are described as passive. Features and practices that require outside supplies of energy are described as active.

⁷⁴ The term 'orientation' describes the way a house faces and the opportunity a house has for indoor solar gain. If a house has a living room and a number of other rooms facing north, the house may be described as having a northern orientation or a good orientation for passive thermal design.

5.2 Dwelling features overview

To provide an initial overview and a broad indicators of participant dwelling conditions and capacities, key dwelling features and socio-economic indicators are recorded in Table 5.1 below and briefly discussed here (also see Appendix E, Table E-1 and participant introductions in Chapter Two). There were both similarities and variances in dwelling features. All but one of the participants' homes are in suburban areas of Glenorchy (with mostly suburban homes as neighbours) and all homes but two are fully detached.⁷⁵ Omitting one, all homes therefore had access to reasonably sized garden spaces (but these varied in size). Ages of houses varied. Eleven of the houses were built before 1980; three were built in 1980s; two in the 1990s and one in the 2000s, which meant that over half of the houses were of a significant age and likely to need maintenance. Only four households had moved into their homes just after or near to the time the dwelling was constructed; seven had lived in their dwellings for less than 10 years;⁷⁶ and two had lived in their dwellings for more than thirty years. The longer people had lived in their dwellings, the longer they had had to conduct adaptations. Internal floor areas ranged from small to moderate when compared with Australian floor area average (Australian State of Environment Committee 2011); nevertheless, many of the houses had more bedrooms than were needed for the occupants. Most dwellings are well positioned to minimise transport energy because all dwellings but one are within walking distance of services and public transport.

Renovation activity and adaptation potential

As the final column in Table 5.1 shows, most houses had undertaken some renovation and there was potential in the physical features to accommodate various scales of future adaptations. Most householders had put time, care and attention into

⁷⁵ Only two dwellings had commercial or small scale industrial enterprises adjacent to them (Appendix L: Dwelling Plans).

⁷⁶ The relatively short lengths of time that some participants had been in their houses are not unusual for Australian households. Australians move house quite regularly especially in situations of low-income, low housing security or if they are renters (Australian Bureau of Statistics 2009).

their dwellings and a number had undertaken renovations for comfort and energy efficiency. Larger scales of renovation had been completed in four households occupied by Trent; Terry; Cara, Edward and Veronica; and Vanessa and Paul)⁷⁷. These major renovations included extensions to floor areas, new enclosed areas, and new productive gardens. Lack of large scale adaptations in other dwellings were mainly the result of physical and economic capacity constraints. Mel had not renovated because of financial constraints and because her house was relatively new and generally suited her needs. Henry's house had not been renovated because he was renting what he described as a 'cheap and basic' unit secured after separating from his wife and was 'making do' on a casual wage. Renovation and adaptations had often been completed gradually over time; some people anticipated they would conduct more adaptations gradually. Householders all had ideas for further adaptations.

Adaptations were possible because the dwellings were on suburban lots; renovation materials were accessible and familiar; and dwellings were owned outright or with a mortgage (excepting Henry's and Susan's). Dwelling age affected the adaptation activities possible, with older houses needing attention but also potentially being more easily renovated (supported by CEFG October 2007).

⁷⁷ Minor adaptations could include draught-proofing, tap washers, putting plastic over windows. Moderate renovations could include installing a new heater, adjusting doorways, or having curtains installed. Major renovations may include extensions to the floor area of the house, installing whole vegetable gardens or conducting many moderate or small adaptations at once.

Table 5.1: General dwelling features with some supporting socio-economic indicators for each participating household

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Cara, Edward (30s) & Veronica (10) all good health	C - f/t employ E - student V - child Owner with mortgage C's income	@ 560 flat, solar access	@110 Detached, 3 bed, hip roofed (tile on corrugated iron), weatherboard, short brick plinth, timber and slab floors, veg + ornamental gdns.	suburban dwellings (detached), institution, light industry	c. 1950s	c. late 2005	yes	Yes - gradually upgrading
Del (70s)and Kirk (80s) D - physical disability K - reasonable health (some issues)	Retired Owners Superannuation	@255 flat, solar access	@60 Detached, 2 bed, corrugated iron, hip roofed brick on slab, gdns.	suburban dwellings, institution	c.1994/5	c. 1998	yes	Yes -gradually upgrading

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Frank (60s) general good health (but some issues)	Retired Superannuation	@670 moderate slope	@110 Detached, 2 bed plus study, zincalume roof, brick (on weatherboard) walls, suspended timber floor and slab on ground below, veg gdns.	suburban dwellings	c.1963 Extended c. 1980s	c. mid 1970s	yes	Yes – extended for function previously
Frederick (60s) & Keira(50s) F –diabetes, physical issues K –good health	F – redundancy and pension K – casual wage Owners Wage/pension	@235 moderate slope and distributed around house	@60 Attached (party wall) unit, 2 bed, tile roof, brick walls, slab on ground, sm gdn.	suburban dwellings	c. early 1980s (?)	c. early-mid 2000s	limited	Yes, with constraints. Has renovated (internally).

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Helen (30s) (and husband and 2 children) all fair- good health	H – student scholarship Husband – f/t wage Owner with mortgage	@640 steep slop	@115 Detached house, 3 bed corrugated metal roof, weatherboard walls, suspended timber floors with one storey high brick plinth	suburban dwellings	Originally housing department c. 1960/early 70s?	c. late 1990s	yes	Yes
Henry (60s) good health	Casual wage Renting	small area shared with others	@45 Attached unit (party walls on 2 sides), 1 bed, metal roof, concrete block walls, slab on ground, gdn.	suburban dwellings, train infrastructure	Unknown but possibly c.1970s (?)	c. 2007	minimal - none	Possible but more difficult than in other types of dwelling space and with other tenures.
Lorraine and Robert (40s) good health	L – p/t wage R – f/t wage Owners	@1230 moderate slope	@130 Detached 3 bed plus study, hip corrugated iron roof, special concrete block walls, suspended timber floor and slab, animal areas, gdns.	Suburban dwellings	c. 1950s or 60s under floor extension c. early 2000s	c. 2000	yes – except late afternoon	Yes – have undertaken improvements.

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Mark (60s) good health	F/t wage Owner	@330 Moderate- steep slope	@85 Detached 2 bed, hip corrugated iron roof, brick walls, suspended chipboard and slab floor, fruit orchard.	Suburban dwellings, vacant lot	c.1995/6	c.1995	yes - but limited by neighbo urs trees and own fruit trees	Yes - body corporate regulations may limit.
Mary and Martin (50s) Mary - chronic ill health Martin - good health	Martin - own Business Owners	@650 flat to moderate slope	@150 Gable (low angle) metal roof, brick veneer walls and suspended floor and slab on ground, gdn.	Suburban dwellings	c. late 1960s	c.mid 2000s	yes	Yes - gradually undertaking improvements.

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Mel (40s) reasonable health	F/t wage Owner with mortgage	@630 Flat to minimal slope	@100 Detached 3 bed, corrugated iron, hip roof, brick veneer, slab floor.	Suburban dwelling, social facilities	c.2005	c. 2006	yes	Yes
Olive (60s) good health	Retired/pensioner Owner Superannuation	1080 flat - minimal slope	@100 Detached 3 bed, skillion (low angle) metal (clip lock), concrete feature block walls, suspended timber floors with concrete block apron, animal areas, gdns.	Suburban dwellings, light industrial	c. 1950s (?)	c. 1995	yes	Yes - has undertaken some. Special concrete blocks limit wall change.

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Steve and Gwen (50s) S – spinal problems G – ill health but still working	S – pensioner (due to health) G – owns and runs Small business Owners	@530 flat	@110 Detached 2 bed, hip 'zincalume' (corrugated) roof, weatherboard walls with low brick plinth, timber floors, veg gdns, animal areas, gdn.	Suburban dwellings	c.1930s or 40s	c. 2006	yes	Yes – gradually undertaking improvements and considering extension.
Susan (60s) poor health	Retired / Pensioner Rents from family	@270 Steep slope	@60 Detached 2 bed, corrugated metal hip roof, brick veneer walls, concrete (?) suspended floor, high brick plinth, sm gdn.	Suburban stand-alone units	c.1987	c.1996	yes	Yes – body corporate rules may limit opportunities.

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Terry (60s) good health (hip problem)	Retired Owner	@20 000 Minimal - Moderate + steep slopes	@110 Detached 3 bed, corrugated metal gable roof, weatherboard walls, stone walls under floor suspended timber floor and slab (a kit home with design adjustments), water tanks, veg gdns, animal areas.	Semi-rural dwellings	c. mid 80s (?) under-floor extension c. 2000s	c. late 1980s	yes	Yes – gradually undertaking improvements.
Trent (and wife and child) (30s) good health	F/t work Owner with mortgage	@940 Moderate – steep slope	@135 Detached 3 bed, colour bond metal hip roof, weatherboard walls, suspended timber floor (increased house floor area significantly with extension), veg gdn, tree gdn.	Suburban dwellings	c. 1950s extension c. 2007	c. late 1990s	yes	Yes – gradually undertaking improvements.

Participants + (age) + self-reported health	Participant employment status + tenure and main money source	Land size m2 + slope descriptions	House size m2 + description	Environs	When constructed	Moved in	Solar access	Opportunity for physical improvements for comfort and energy efficiency? + Upgrade status
Troy and Nat (60s) good health	T – retired / pension N – casual work Owners	@650 Moderate slope	@100 Detached 3 bed, corrugated metal roof, vinyl on weatherboard walls, suspended timber floors, fibre cement clad plinth, water tanks, fruit trees.	Suburban dwellings	c.1967	c.1967	yes	Yes – have undertaken physical improvements.
Vanessa and Paul (60s) good health	Retired Owners Superannuation	@755 Flat land	@115 Detached 3 bed, triple / double brick and weatherboard walls, suspended timber floor (increased floor area with extension), water tanks, veg gdns.	Suburban dwellings	c. 1940s extension c. 2008	c. 2003 (?)	yes	Yes – have undertaken physical improvements and extensions.

5.3 Prevailing perceptions and priorities

Perceptions of the value of energy efficiency and comfort as goals underpinned the legitimacy participants assigned to activity around (and aspirations they held) about these goals. Key perceptions about the value of these goals affected the sorts of strategies householders had implemented and the priorities they had for future adaptations (see Appendices J and U). Certainly, participants valued comfort and energy efficiency and were motivated to act and adapt for these goals. Comfort was clearly linked to physiological need by participants, as well as to cultural aspirations for ‘the good life’. Energy efficiency was often considered synonymous with resourcefulness and financial management, and was also associated with personal values of environmental and social care. Participants realised environmental, economic and social impacts came from using supplied, rather than passive, forms of energy, including climate change impacts, large carbon footprints, and environmental damage. Analysis showed that participants intended to act to enhance comfort and energy efficiency, and understood the benefits of acting for these goals—for themselves and others. However, participants thought that their use of supplied energy and electricity could be reduced, but not removed. Energy efficiency was seen to be about using the least amount of *supplied* energy possible for services, not stopping the use of it altogether.

Identifying the reasons behind householders’ choices of dwellings also helped to illuminate the sorts of expectations and criteria they prioritised in relation to dwelling function and identified key dwelling priorities for participants (Appendix H, Table H-1). Dwellings had been chosen because of location, affordability, proximity to loved ones, and for intrinsic dwelling features. Various householders were influenced in their choice of dwelling by intrinsic features, including the number of bedrooms; its maintainability and/or renovation potential; solar access; private open space for leisure, gardens and animal accommodation; aspect and slope; views; installed heating systems; heritage status; potential to support physical disability and ageing in situ; and aesthetics. The possibility of maximising comfort, ease and affordability were somewhat woven through these other considerations. Mary and Martin, for

example, chose a dwelling that could be adapted to maintain a level of comfort for Mary because she was ill; and Mel chose her house because it needed little maintenance work, was affordable, and had a heat pump heater in the living area.

Compromise was a feature of dwelling selection and was guided by key priorities. Sometimes only one or two of many selection criteria were met, and many needed or desired functions were then left unsupported. Energy efficiency features may have been considered but appeared to be less important at purchase than other features. At purchase, householders appeared to have been most concerned that houses simply met basic dwelling function and were in a reasonable location.

Income levels and tenure status significantly affected dwelling choices—affordability was an important criterion in all households. Henry’s situation provides the most extreme example of income and tenure affecting dwelling choice. With very little financial capacity Henry was looking for something affordable, small and simple. He chose a low quality unit that did not always serve his needs because he prioritised affordability above all other criteria.

Dwelling function priorities changed after dwellings were purchased and led to the need for householders to make adaptations. Trent, for example, purchased his house as a bachelor before he had a partner and a family. Subsequently he and his wife extended the house, added heating, and planted vegetable gardens and trees to ensure the house became a family home. Choice and priorities are explored further in chapters six and seven.

5.4 Accounts of the comfort performance of dwellings

Householder accounts of indoor comfort performance in their dwellings were recorded and reviewed (Appendix K, Tables K-1 to K-6). Accounts were compared against daily and seasonal climate data. The accounts provided broad indicators for householder satisfaction with indoor comfort; thermal performance of houses; and the passive thermal resistance of houses.

Summer accounts of comfort

Tasmania's summer climate is reasonably mild with low humidity and only a small number of uncomfortably hot weeks in the 30-40°C temperature range. Summer temperatures below 30°C were tolerated fairly well by most householders.

Temperatures above 30°C were felt to be 'too hot' inside and outside. While five households were able to keep comfortable indoors with little effort in summer, eight households reported indoor overheating and discomfort (mainly) in the afternoons and evenings after heat had built up over the day (Appendix K, Tables K-1 and K-2). Personal preferences for cooler weather by a number of householders exacerbated their discomfort in summer.⁷⁸ For example, despite having a cool house in summer in terms of absolute measures, Terry reported that the house felt hot and told me he had a preference for cooler weather and indoor temperatures around 17°C. Cooling was mainly achieved with fans and by closing curtains. Occasionally some air-conditioning was used. Maintaining comfort in summer required the least amount of appliance use of any season (cooling was not required in any other season).

Four households reported that there were periods where their houses felt too cool in summer. Houses that were cool to cold in summer did not easily stay warm in winter either. These cooler houses I observed either had too much (overshadowed) heavy mass in the walls and floors, were poorly orientated or had very poor thermal resistance. Houses like Trent's and Frederick and Keira's performed so badly as a result of poor thermal resistance and poor passive design that the households often found them uncomfortably hot and uncomfortably cold on the same day.

Autumn accounts of comfort

Tasmania's autumn climate is cool to cold, with periods of dry sunny days with temperatures ranging between 10 and 20°C during the day, and periods of cold, wet and windy weather when temperatures do not rise above 16°C during the day. Participants provided mixed reports about their levels of comfort in autumn

⁷⁸ Some participants had moved from the mainland to Tasmania as they prefer the colder weather in summer.

(Appendix K, Tables K-3 and K-4). On dry sunny days participants felt comfortable without any supplemental heating or cooling. However, heaters were regularly used in this season to limit discomfort in the evenings. Passive heating strategies, such as using hot water bottles, were also used alongside heaters to combat the cold. Cold, wet, windy⁷⁹ days (which were regular in autumn) seriously affected indoor comfort levels and drove householders to use supplemental heating during the day as well as the night (except for Lorraine and Robert and Vanessa and Paul)⁸⁰ (Appendix N, Table N-2).

Winter accounts of comfort

Cold winter weather led to uncomfortable indoor areas and habitual use of heaters on a daily basis (Appendix K in Tables K-5 and K-6). During the day outdoor temperatures mostly sat below 14°C and were regularly under 10°C. Wet, windy and overcast weather was common. Winter comfort expectations and practices varied greatly, and were influenced by a range of tolerances, lifestyles and different housing conditions. Most householders were able to cope with relatively cold conditions before they used their heating and their day-to-day comfort practices responded to changes in the weather.

Ten households regularly experienced indoor temperatures of around 14-16°C during winter. Indoor temperatures like this are well below what the United Nations describes as a healthy internal temperature range (Ranson 1988b; World Health Organization 2007). Householders regularly limited heater use, suggesting many were tolerant of cold weather, were physically active, were resigned to being cold, or were seeking to be resourceful. Six households (Cara, Edward and Veronica; Troy and Nat; Helen, her husband and their children; Olive; and Steve and Gwen) lived with indoor temperatures often below 18°C and sometimes as low as 13°C (recorded) using comparatively small amounts of heating. These householders reported being

⁷⁹ Strong winds are a regular feature of weather in Glenorchy, especially in exposed areas where there is clear solar access. The wind comes down off mountains to the west of Glenorchy throughout autumn.

⁸⁰ Vanessa and Paul would have liked to have been using a heater in autumn, but they were still constructing their extension and were living in the garage/granny flat area with limited heating.

comfortable at these lower temperatures. For example, Troy and Nat, often home during the day, rarely heated the house during the day in winter. The couple appeared to have large temperature ranges at which they could maintain comfort passively and coped well without heating down to about 13°C on cold days (during the daytime when they were active). Even households who used heating regularly on cold days (Del and Kirk; Mark; Frederick and Keira; Lorraine and Robert; and Mary and Martin) set their heaters fairly low at 18-20°C indicating they coped in a range of temperatures.⁸¹

Discussion: comfort performance

Householder accounts highlight that dwellings were uncomfortable at various times in summer, autumn and winter. Performance was poorest in winter; despite efforts to use passive strategies by many householders, as soon as cold weather hit, supplemental heating was required to maintain indoor comfort. Winter was therefore often uncomfortable with associated high energy use. Summer overheating was regularly uncomfortable, but very little supplemental cooling was used to counteract the discomfort and so did not present a problem for excessive energy use. The range of temperatures in which most householders were comfortable was broad but some householder had limited thermal ranges due to health issues, disability, time spent at home, or habits and cultural expectations.

Householders who managed with less heating in winter did not necessarily live in dwellings that had better passive comfort performance but instead were driven by other practices and priorities. These householders were prepared to live in cooler indoor environments and would use passive practices (such as more clothing and exercise) to extend comfort and were also driven by a strong drive to be resourceful.

⁸¹ Participants differentiated themselves from the people they knew that kept their houses at (much hotter) temperatures around 25-30 degrees suggesting that participants felt they were better able to cope in winter but also more resourceful than some others they knew.

5.5 Landscape, neighbour and dwelling features affecting the dwelling microclimate

The layout and features of a dwelling, its broader landscape characteristics and the position and nature of neighbouring features affect a dwelling space's microclimate (particularly sunlight access and winds) which, in turn, impacts comfort and energy efficiency opportunities (King et al. 1996). Dwelling features that affect microclimate conditions include the layout and position of the dwelling; trees, gardens, fences and sheds on a dwelling site; neighbouring houses and buildings; roads and footpaths; and landscape features such as land size, slope, orientation, nearby hills, mountains and bodies of water (Appendix L).

Solar gain, critical to making a dwelling's microclimate comfortable (Butti et al. 1980; Szokolay 1987; Vale et al. 1996), is affected by features of the landscape, neighbouring buildings and features on the dwelling site. Participants all reported that winter access to sun improved their comfort levels and allowed them to use passive comfort practices (for example, Trent in interview 15/03/08; Troy in interview 28/03/08; and Edward in interview 02/03/08). Access to sun varied dwelling to dwelling. Most participant households received sunlight into their houses and onto their gardens for reasonable lengths of time (Appendix L plans and solar access Table L-1). Overshadowing from low angles of sunlight hitting neighbouring houses and sheds, some small scale industrial/commercial neighbours and vegetation caused cooling of microclimates in autumn and winter. Larger land areas⁸² (listed in Table 5.1) meant more open space around houses which generally provided better solar access and more control over the site's microclimate (Lorraine and Robert maintained some boundary plants as wind breaks). Larger suburban blocks (such as Vanessa and Paul's and Troy and Nat's) had enough outdoor space for spacious gardens, leisure activities, and consistent and direct solar access. Smaller land areas, in contrast, received little direct sunlight. Frederick and Keira's and Henry's

⁸² Approximate land areas are described in square meters (m²): 400m² indicates a small suburban back yard; 500-600m² indicates a medium suburban backyard and above 800-1200 is a larger suburban backyard.

dwellings were on small land areas, with poor orientation, and were overshadowed by neighbouring buildings, which limited their access to sunlight and cooled the microclimates around their houses.

Participant houses were mostly positioned centrally on their blocks because of suburban planning requirements. While houses centrally positioned on blocks could access sun, their position reduced useable yard space, and consequently limited opportunities to manage the microclimate. Added to this, dwellings were surrounded by significant amounts of paving, concrete, bitumen and areas cleared of vegetation, which generated more extreme microclimates than there otherwise would have been (Lowry 1991).

Broader landscape features influence dwelling microclimates. The Glenorchy landscape includes flat riverside areas and hilly areas further from the river and so has both exposed and overshadowed sites. Most participants were positioned on hillsides, but none were overshadowed by the hills or mountains. The hillsides meant that dwellings had longer hours of solar access, but also meant that dwelling spaces were regularly battered by strong winds.

5.6 Dwelling features moderating the indoor thermal environment

To achieve comfort in dwellings requires householders to strictly manage their indoor thermal environments. Therefore this section reviews physical dwelling features and practices that influenced indoor thermal environments. In Tasmania, dwellings typically have limited roof overhangs, thin walls with little heat-flow (thermal) resistance, inappropriate ventilation, and windows opening to the sun. This mix of features leads to poor moderation of indoor temperatures. To moderate an indoor thermal environment a house needs to be oriented to access solar gain; resist the flow of heat; provide thermal storage opportunities; be able to be zoned for thermal control; and provide facilities for heating and cooling the indoor spaces. This

section focuses on dwelling features that provide heat-flow resistance and building skin management, thermal zoning and thermal storage to participant dwellings.

5.6.1 Heat-flow resistance of the physical dwelling enclosure

Building shells of houses that resist the flow of heat assist to control indoor thermal environments. The capacity to passively resist heat-flow provides participants with better control over indoor temperatures and less reason to use supplemental heating and cooling. Heat-flow resistance is achieved by holding heat in or out of the house for as long as possible when required through resistive building shell elements (walls, floors, roof/ceiling, doors and windows) and practices of zoning.

Most materials when used alone do not provide much resistance (Szokolay 1987).⁸³ Heat-flow resistance is cumulative and can be gained by means of overall resistance of all layers of materials in any element of a building shell. Overall resistance therefore comes from the resistance of cladding, structure, vapour barriers, air gaps and added insulation. This is why insulation is often added to house walls, ceilings and floors.

Overall thermal resistance of exterior building shells of participant houses was poor (Appendix L, Tables M-1 and M-2) with most of the building elements⁸⁴ having low resistance levels. Only three dwellings had roof or ceiling spaces which met deemed-to-comply requirements for thermal resistance in the BCA⁸⁵.

⁸³ Metal is a heat conductor and therefore is very poor at resisting heat-flow. Glass has low resistance. Wood has reasonable heat-flow resistance, but is often used as thin planks which leave gaps at joints, letting air to flow in and out of the house. Brick and stone do not have good resistance to heat-flow, but do slow the passage of heat down, often by hours, due to their high mass (Baggs et al. 2006).

⁸⁴ A building shell element is a section of the structure such as a wall, a floor, or a ceiling and could be made up of multiple layers of construction.

⁸⁵ The BCA includes standards for energy efficiency in the house building shell for new houses and for substantial house extensions (Australian Building Codes Board 2007b).

Insulation

Insulation in its various forms provides an important boost to thermal resistance in building shells.⁸⁶ All but two houses had some insulation their building shells; some householders had added that insulation themselves (Appendix M, Table M-1). Seven of the households had ceiling and roof elements with comparatively high levels of insulation,⁸⁷ but only three had enough to meet current BCA standards for new buildings.⁸⁸ Six dwellings had moderate levels of insulation in ceilings and the remaining four had low or no insulation in ceilings. Most householders thought the insulation they did have was limited in its effectiveness because it was either old, of a low resistance rating, or loose and scattered.

Insulation levels were low in floor and wall elements of all but one house. Terry, who built his own house, was the only householder who had installed insulation in all the elements of the house skin. Trent and Vanessa and Paul's houses had insulation in both walls and ceilings of extensions (as required by the BCA) and had added ceiling insulation to existing areas when they were renovating. Most participants' floors, whether timber or concrete, and whether an underfloor skirt/plinth was present or not, were susceptible to heat-sucking effects of winds and general draughts, and required significant amounts of draught proofing and insulation to be added. Floor warmth is particularly important to physiological comfort in the home which makes the lack of resistance a particular challenge to comfort. The complete absence of floor and wall insulation in most participant houses indicates poor overall thermal resistance in house shells.

Participants' reports about of the condition of insulation were not always reliable, especially if insulation had been installed by previous occupants. Participants rarely went into their roof spaces (disabled householders never went in), often relying on

⁸⁶ Insulation is achieved using either reflective, resistive, or capacitive materials (Commonwealth of Australia 2005). Foil insulation reflects heat, bulk insulation resists heat and mass materials such as brick, concrete or tiles are capacitive absorbing and re-releasing heat.

⁸⁷ When compared with the other participant houses (see Appendix M: Table M-1 and M-2).

⁸⁸ BCA energy efficiency standards have gradually been increased since their introduction in 2003. In 2003 a four star standard was required. In 2012 a five star standard energy efficiency standard is required and a six star standard is required in 2013.

trades people to inform them about the condition of insulation. The lack of knowledge meant householders were unsure about the level of insulation they had and this insecurity meant they could not assess or plan for adaptations to the insulation effectively.

Windows

Significant amounts of heat may be lost from a house building shell through windows. Heat-flow resistance of existing windows can be increased by having multiple layers of glazing (double or triple glazing), or glazing replacements, such as plastics, heat-flow resistant window frames,⁸⁹ and well-fitted heavy curtains with pelmets.

Double glazing improves heat-flow resistance while allowing windows to be kept open for daylight and views, even during uncomfortable hot or cold weather. Double glazing was uncommon in participant households; only two households had (some) windows with (a form of) double glazing. Frederick and Keira renovated two windows in their living area and one window in their bedroom with plastic glazing called 'Magicseal'; and Trent had double glazing put into windows in a living room built during his house extension. These householders noted that thermal comfort improved with the double glazing and observed that less heating was needed. Frederick noted there was less moisture built up on the retrofitted windows and traffic noise reduced.

Most single glazed windows in participant households were framed with steel or aluminium with no thermal breaks which created (weak) points in the house shell with extremely low heat-flow resistance. Most participants remedied the weak resistance in (some of) their windows by hanging indoor curtains and blinds. Del and Kirk added outdoor blinds over their windows as well. Closing curtains and blinds was an important strategy used to increase thermal resistance in both hot and cold

⁸⁹ Timber is heat-flow resistant and is a useful thermal break around windows. For metals like than aluminium and steel, thermal breaks are required in the frames to limit heat-flow.

times of the year (Appendix M, Table M-2) but, irritatingly for participants, tended to block out useful sunlight.

Householders were aware that retrofitting window coverings would help comfort levels.⁹⁰ However the standards of window coverings varied: many houses had only light to medium weight curtains, and many windows had no pelmets, which meant that there was still poor thermal resistance. Heavy drapes and pelmets, when present, were often only on main living or main bedroom windows. One reason householders kept lightweight or old window coverings was because retrofitting curtains and pelmets was costly.

Draught Proofing

Excessive air movement through gaps in building shell components can quickly suck heat out of indoor areas. Closing up gaps in the shell with draught-proofing materials enhances resistance to heat-flow. Personal experiences and friends' anecdotes meant that most participants recognised the comfort benefits of limiting draughts (for example, Steve in autumn interview 23/05/08). Draught proofing had been undertaken or was being planned by a number of the householders but had been overlooked by others. A lack of draught-proofing in many participant houses meant there was constant air leakage even when doors and windows were shut.

There were barriers to installing draught proofing, despite it appearing to be a simple task. Choosing the correct draught proofing product was one barrier to action. Participants also found it challenging to source correct draught proofing products for less common applications: products for doors and windows were accessible, but there were no products readily available for aluminium-framed sliding windows. Notably, some householders thought it was better to leave gaps (draughts) in the building shell to 'let the house breathe a bit' (Troy in summer interview 28/02/08).

When draught proofing, householders were confused about whether to close over vents built into walls, eaves and underfloor spaces in older housing. Wall vents,

⁹⁰ Some participants mentioned this understanding had some from in-home visits from SLT's Home Assessors during the GGAER program.

common in early to mid-twentieth century housing, are often built into walls and left permanently open, allowing air into the house and through the structural areas of the walls and underfloor areas, both day and night and in all seasons. A number of participant households had left these wall vents open while others had sealed them to stop draughts. By sealing the vents, moisture would be more likely to settle on and undermine the building structure and to cause mould growth inside.

5.6.2 Thermal zoning of the dwelling enclosure

Closing (or zoning) indoor areas helps to keep specific indoor spaces warm or cool. Thermal zoning is (most often) a passive practice that requires doors and curtains to be opened and closed according to comfort needs. Thermal zoning was reported to be a popular practice with participants on cold days; when heaters were being used; or, when indoor spaces needed to be kept cool. Most houses had doors and curtains that allowed them to zone areas of the house—most importantly, the kitchen and living rooms. A few households had open plan living, dining and kitchen areas which meant they were not able to zone these areas off. Henry’s house was the only one with no zoning at all (his rooms were only separated by three-quarter height partitions) making heating the living room efficiently difficult.

5.6.3 Thermal storage

Thermal storage is generally achieved through mass materials, such as brick and concrete. Building materials made of mass absorb and re-release heat slowly (Baggs et al. 2006; Szokolay 1987).⁹¹ This can be useful, but thermal mass that does not receive direct sun or other radiant heat tends to create very cool microclimates. Therefore houses constructed of lots of brick, concrete or stone that receive little sun will maintain an uncomfortably cool indoor climate. The building materials listed in Table 5.1 show that 11 houses had walls of brick or concrete and therefore had

⁹¹ A 300 mm thick brick wall, for example, can absorb incoming heat on one side, and release the heat on the other side of the wall six to eight hours later.

substantial levels of mass. Five houses also had the main area of their floor made from concrete. Very few of the houses with high levels of mass had significant levels of sun or other radiant heat sources near the thermal mass and therefore a number had consistently cool indoor climates (for example, Olive's house and Lorraine and Robert's house).

5.7 Input or extraction of heat into spaces (warming and cooling spaces)

In general terms, poor moderation of (hot or cold) external temperatures by dwelling features and dwelling practices will lead to uncomfortable indoor environments for householders. Maintaining indoor comfort in participant houses required input and extraction of heat from the sun and other supplemental energy sources. Householders used various methods to achieve input and extraction of heat, including managing solar gain, using supplemental heating and cooling appliances, and managing comfort at the level of the body.⁹²

Heat may be generated and transferred through conduction, convection and radiation.⁹³ Convective heat transfer uses a mix of conduction and convection. In the case of the sun, wood fires, or bar radiators, heat is transferred primarily as radiant heat with consequential conductive and convective heating. In the case of a heat

⁹² Brunner et al (2012) found that householders in Austria experiencing fuel poverty used a variety of strategies to try to maintain comfort.

⁹³ There are different ways to heat a body or material; the ones that are pertinent to this research are conduction, radiation and convection. Conduction is where energy is transferred from atom to atom – from a hot material energy transfer to a neighbouring atom. Radiation is electromagnetic or infrared energy that, once emitted by one material, is absorbed by the electrons of another material, causing increased vibrations in the atoms. Convection is the movement of a heated material, such as through warm air or warm water. Convection may move heated atoms around, but heat will be transferred either through conduction, or by intercepting electromagnetic radiation. If electromagnetic radiation is to be used most effectively, the material or body that is to be heated has to be in a position to receive the radiation directly. If conductive/convective heating is used, the heat is transferred through moving air and this means that the material or body that is to be warmed does not have to be in a direct position in front of the heating source. Radiation sources will also heat up other materials in the room which will conduct/convect heat around the space as well, but this occurs less directly. Convection heating then is general in nature, which can be useful, but may be less effective at warming materials and bodies.

pump, the air conditioning technology conducts heat to nearby air and then a fan transfers the heated air convectively around the space. Stand-alone heaters may be conductive, relying on the heated air to create movement in the air for convective heating, or the heater may also have a fan to assist with convection. Householders reported that they were most comfortable with the sort of heat that came from sunlight, wood fires and oil heaters, which is primarily radiation, but preferred the convenience and speed of convective forms of heating. However this preference for certain types of heat was only one of many influences that informed indoor heating practices and choices of heating systems.

Cooling spaces and bodies is achieved by extracting or moving heat out of living spaces and off of body surfaces. Cooling can be achieved by creating air movement with fans, removing extra heating with ventilation or air conditioning, and by water cooling. Cooling with an air conditioner uses the same air condensing system used in a heat pump, but in reverse.

5.7.1 Indoor solar gain - opportunities and management

Managing indoor solar gain was a common and important comfort and energy reduction strategy (Appendix K), requiring thought and effort on a day-to-day basis for all days spent at home. Participants managed solar gain indoors by routinely opening and closing doors, windows, curtains and blinds at regular times of the day and according to the weather. When heat was sought indoors, householders would first try to introduce direct solar gain. When houses were uncomfortably hot, solar gain was first eliminated from indoor areas (see Appendix N, Table N-4).

In cold weather, a lack of solar gain severely limited the ability to warm up indoor spaces passively. Solar gain helped substantially in winter 'if the sun is still shining, even if it is only a maximum 11[°C] or something, you feel warm' (Mary, winter interview 18/08/08). Sunlight was needed most in living areas (used during the day) in winter as it limited the use of heaters. Only seven households had their living areas

in a position that could access northern (midday) sunlight.⁹⁴ Some households had sun in living areas in the morning or afternoon, but solar gain at these times of the day is much harder to control.⁹⁵ Solar gain in winter was particularly limited for Frederick and Keira, Henry, and Olive (Appendix L).

Sun in summer (at its penetrating low angle) could become problematic and overheat indoor spaces. Limited roof overhangs, thin walls with little heat-flow (thermal) resistance, inappropriate ventilation, and windows opening to the sun can all lead to indoor overheating from solar gain in summer. Frank, Del and Kirk, Steve and Gwen, Cara, Edward and Veronica, and Mel and Trent all experienced uncomfortable overheating from the sun in their houses during summer. Overheating from the sun was often dealt with (passively) by closing windows, curtains and doors, leaving householders frustrated because the indoor spaces were dark. Notably, insulation in ceiling spaces appeared to exacerbate overheating in summer by catching heat in the house. Given predicted future weather dynamics, participants' dwellings will be prone to more regular overheating in the future (Roaf et al. 2005).

5.7.2 Space heating systems and practices

Supplementary heating systems and heating practices varied across the households (Appendix N). Using heaters was a common and significant part of daily comfort practices in autumn and winter and spring. Participants reported that space heating was a significant proportion of overall household electricity use and cooling was a minor proportion. Residential energy use trajectories modelled for the Federal Government support this observation showing that in 2008 Tasmanians were using around 65 per cent of their residential energy use on space heating and in 2012 were

⁹⁴ In 1999, 77 per cent of Tasmanian householder respondents to an ABS survey reported that their living areas received winter sunlight. The survey did not specify, however, how many hours of sunlight the living area received and no information was given on what other areas of dwellings had access to sunlight (Australian Bureau of Statistics 2002: 204). There is no other survey available detailing sun into living areas for Tasmanian houses.

⁹⁵ The orientation of the house is difficult to adjust without substantial change to dwellings so is less likely to be adjusted in retrofits, but may be changed in major extensions. Planning laws are therefore needed to ensure orientation is prioritised when houses are first built and when they are renovated.

predicted to be using around 62 per cent,⁹⁶ but negligible energy on cooling houses (Energy Efficient Strategies 2008). The large proportion of residential energy used for space heating makes it and related influences key concerns in dwelling adaptations.

Heater systems

Among participant households, various heaters were used in different spaces, with a consequent need for different heating practices, variations in heat outputs and comfort levels. Main heaters were commonly positioned in living or dining areas. The four main types of heaters used in living and dining areas were wood, older style oil burning, electric conductive/convective heaters, and heat pump air conditioners. Extra heating in bedrooms and bathrooms was used as needed for short lengths of time, using small radiant fan heaters, stand-alone plug-in heaters, and body-scale heaters.⁹⁷ Despite the variety of heating options available, heating could be problematic, especially where the living room heater was old or was not fit for purpose (which was common).

Heater replacements and upgrades had occurred in nine households. Terry was the only participant to regularly use a wood heater as his main heater and he found it very effective. Despite enjoying the heat that came from fire, Helen's household replaced a wood fire with a radiant / fan electric heater to limit the children's asthma. Lorraine and Robert also stopped regular use of their fire places when they installed heat pumps. Mary and Martin and Steve and Gwen had enjoyed wood fires in previous dwellings but chose not to install one in their current house because of the preparation and cleaning involved in wood fires. Others were deterred by the pollution wood smoke caused. Terry's semi-rural position meant the smoke pollution did not bother his neighbours.

⁹⁶ During the 2008 interview period Tasmania was modelled to be using 10.6petajoules of energy for space heating from a total residential energy consumption of 16.4 petajoules (pJ). In 2012 heating is still modelled as using 10.1 pJ of energy in 2012 when the total residential energy use will be around 16.2 pJ (Energy Efficient Strategies 2008: 31, 38).

⁹⁷ Body-scale supplemental heating was mainly in appliances like chair heaters and electric blankets.

Seven households used heat pumps⁹⁸ as their main space heaters because the heaters were seen to be energy efficient and convenient. Vanessa and Paul had used a GGAER rebate to purchase a heat pump. Frank and Olive had considered upgrading their main heaters to heat pumps. Participants reported that heat pumps heated rooms quickly, but said that wood fires felt better. Householders shared stories about their (and their friends') uncomfortable experiences with the convective heat and noise from heat pumps. Some households had decided not to purchase heat pumps because they did not like the convective heat they had experienced at friends' places. Mary and Martin were uncomfortable with the high levels of air movement of their heat pump, but realised that much discomfort could be overcome by using heater and air throw adjustments.

There was widespread confusion about the best way to use heat pumps. Several participants had been 'advised' by installers that the most energy efficient way to use a heat pump was to keep it running all the time at a low temperature (16°C). To participants this did not seem an energy efficient way to use a heat pump.⁹⁹ Misinformation like this widespread 'heat pump myth' made it difficult for participants to settle into well-considered and efficient heating practices.

Conductive and convective electric panel heaters and electric 'Pureheat' hybrid radiant and convective fan heaters were used as the main heaters in several houses. Those with electric panel heaters had them placed in different rooms along walls, whereas radiant/fan heaters were installed as single units and only in main living areas. Older style electric heaters, such as the one that Steve and Gwen had, could be energy-hungry. Gwen was keen to replace the heater because it was inefficient, expensive to run and did not fit with the aesthetics of their 1930s house. Electric radiant ceiling heat was used in Frederick and Keira's living room and main

⁹⁸ Heat pump describes a heater that uses air conditioner technology to extract heat from external air space and move the heat inside (or out). The heat transfer is achieved through the condensing and expanding gases, which requires a motor and compressor. Heat pumps use both outdoor heated air and electricity to create heated air inside, which can be more efficient than other electric forms of heating, which rely only on electricity by itself to do the heating.

⁹⁹ I and other people involved with energy efficiency in Tasmania investigated the heat pump myth further. That the myth was incorrect was communicated by energy efficiency professionals at public forums in Greater Hobart (from personal notes taken on 'Chills and Bills forums 2008).

bedroom. They felt the ceiling heat was very comfortable, but it appeared that it was a reasonably expensive system to run.

While Frank and Olive had investigated replacing older style oil-burning heaters in their living rooms, for various reasons they were still using them. Both had organised other space heating options but found they still returned to the oil heater in certain circumstances. For Frank it was when his granddaughter came (regularly) to stay and for Olive it was because she could prepay for the oil and found it kept her visitors comfortable.¹⁰⁰

In bedrooms, studies and craft rooms people mainly kept stand-alone plug-in heaters, and small fan heaters (Del and Kirk had a wired-in panel heater). In bathrooms participants tended to use stand-alone plug-in heaters or radiant bar heaters on walls, or, on ceilings, would use 'Ixl-tastics'—combined radiant lighting and ventilation heaters. These heaters were generally used for short bursts to keep people warm in the shower and to dry the room. One household mentioned that they considered their large television screen as a heater when they were using the television but found it overheated the room in summer!

Some households had their wired-in heating and hot water registered for a cheaper electricity tariff (42)¹⁰¹, and some did not, which created affordability challenges. Henry's rental unit hot water was not registered for tariff 42 and heating was only supplied through a plug-in heater. Plug-in heaters were not eligible for tariff 42 prices. Helen's heater was not on tariff 42 because her husband advised her there would not be enough of a cost saving to warrant calling out an electrician to install the new meter required to measure Tariff 42. In reality using Tariff 42 could reduce electricity costs from heater use by approximately 35%.¹⁰²

¹⁰⁰ Olive's heating practices and changes to practices are explored further in chapter five.

¹⁰¹ With the installation of a second meter and verification by a registered electrician, electricity used for hot water systems and wired-in heaters can be measured using this cheaper tariff. All other electricity used in residences is measured using another tariff (31).

¹⁰² In 2008 Tariff 31 cost approximately 17cents per kilowatt-hour and Tariff 42 cost approximately 11c per kilowatt-hour (Electricity Supply Industry Expert Panel 2011: 8).

Householders had either renovated their heating systems or wanted to renovate their heating systems. Renovating wired-in heating systems or wood fire places was an expensive, complicated, technical and (semi) permanent change. Householders could not test the heater before buying it, with experience of the heater's performance coming after purchase and installation.

Heating practices through seasons

Heating practices changed according to weather and householder activities and routines (Appendix N, Tables N-2 and N-3). There were two main strategies for heating main living and dining areas: either heaters were kept turned on with a thermostat and timer; or heaters were turned on and off according to need.

Heaters were not used by many households in summer, but their use at such times was instructive. Del and Kirk used their heater 'a little bit' in summer in the evenings. Being elderly, doing little exercise, and living in a house that had poor thermal resistance, meant they had trouble staying warm. Frederick and Keira used their thermostat-controlled ceiling heating on a low setting through summer. Without morning sun their house was often cold in the mornings. Frederick had health issues that limited his exercise levels and affected his ability to stay comfortable. Trent and his family, despite being active and healthy, used their heater in the kitchen in the morning because the room had little thermal resistance and received no morning sun.

As the weather cooled down through autumn, all households (but one) began to use their heaters¹⁰³, mainly in the evenings and mornings.¹⁰⁴ Del and Kirk and Frederick and Keira continued to leave their heaters on thermostat control. Martin and Mary began using their heaters during the day whenever the weather became too cold. As with Frederick and Del, Mary required extra heating to stay comfortable because of chronic illness.

¹⁰³ Lorraine and Robert were the last to begin using their heaters, but did so at the end of autumn.

¹⁰⁴ Despite cold mornings and cooling winds, overheating still occurred indoors on sunny afternoons due to low sun angles.

Winter weather somewhat increased the length of time and the temperatures at which householders heated their houses. Most people used their heaters on low or moderate levels. Heating at high temperature was only used for short spurts on very cold days. Mark and Del and Kirk were households who had less tolerance for variations in indoors temperatures and therefore more regularly used heaters when they were home (Appendix N, Table N-3). Mel started using the timer on her heat pump so that her house would be warm when she came home from work. Mark was using timers on his heaters. Lorraine and Robert only started heating their house in late winter but by winter were using all three heat pumps when they were at home.

Considering the physical dwelling features, most householders used their heating systems in what appeared a reasonable way. Heater use practices reflected strong affordability concerns and value bases of resourcefulness and environmental care. Most participants tried to reduce heater use wherever they could and at least ten households looked to use their heaters as little as they could. Major influences affecting heater use were: access to sunlight; time spent at home; occupant timetables; exercise levels; health status; thermal resistance levels in housing shells; visitors in the house; resident animals' needs; values underpinning and attitudes towards resource use; and, expectations related to thermal comfort. Ill health and disability created a clear need for more heating arguably because people were more sedentary and had poorer circulation and yet needed consistently comfortable environments. Del and Kirk's heater use, for example, was comparatively high due to ill health, disability, and lengthy periods of time spent at home.¹⁰⁵ Mark's home heater use was also comparatively high as his comfort expectations had been influenced by long periods of time spent in an air-conditioned office (heated to 22°C).¹⁰⁶

¹⁰⁵ Sixteen people in twelve of the participating households spent significant parts of their day at home. This was due to people working from home, managing chronic illness from home, parenting with young children, or being retired. The extended time at home impacted greatly on their energy bills but also may have benefited other comfort and energy efficient aspects (see chapters five and six).

¹⁰⁶ The way comfort expectations are influenced by regular use of air-conditioned environments has been examined by socio-technical scholars (Guy et al. 2000; Shove 2003; Strengers 2008).

5.7.3 Space cooling (heat extraction) systems and practices

While not as critical to participants as maintaining heat indoors in winter, cooling was important for summer indoor comfort. Cooling needs in summer generated different practices to many used in winter. Various cooling strategies were available to households and were chosen according to day-to-day weather conditions. Flexible responses were possible because of Tasmania's variable summer weather: hot conditions were generally short-lived. Strategies used were mainly space cooling (as opposed to body cooling) approaches and were generally passive. Appliances were only used during hot spells (Appendix N, Table N-4). Householders chose strategies in a sort of cascade: if one strategy did not work, another would be tried. Staying cool was achieved by encouraging air movement, ventilating indoors with fresh air, limiting heat build-up by blocking solar gain, thermal zoning, migrating through the cool areas of the house, and (if all else failed) air conditioning.

Venting was used to achieve cooler spaces by moving heat outside and providing air movement, which served to cool people physiologically and psychologically (Lowry 1991). Venting was achieved using wall vents, fans, open windows and open doors in combination to create funnelling effects indoors. Nine households regularly used venting methods when occupants were uncomfortably hot. Two people had ceiling fans in living areas which were used irregularly when it was hot. Eight households had other fans, but two had not been used for the 2007–08 summer at all, and one was used irregularly. There are regular breezes in Glenorchy which help to cool indoor areas, but a number of households reported that summer breezes often became too strong for indoor venting.

In order to maintain early morning cool and limit heat build-up indoors, householders would close houses and block out the sun using indoor blinds, curtains and, in one case, external blinds. This strategy was popular at the beginning of a hot day, and used by 14 households at various points in summer. Frank, and Del and Kirk, reported that they did not like having to use this particular cooling practice because it limited light levels for reading and other indoor activities.

Thermal zoning and room migration were used by five households to limit heat-flow and maintain comfort in houses. Martin and Mary's main bedroom overheated from the morning sun so they closed curtains and zoned the room off from the rest of the house to slow the heat transfer. Along with another two households, they also used indoor migration strategies, moving rooms at different times of day to limit the time they spent in hot spaces.

Six households had air conditioning for cooling but only used it on a handful of uncomfortably hot days over the summer. People were interested in the cooling facility air conditioners offered. Frank said that he was keen to install an air conditioner/heat pump for both its cooling and heating facilities because he was annoyed at having to close the living room curtains to keep the house cool. While using the air conditioning option on heat pumps was mostly resisted by householders, it is an easy cooling option, and that has implications for electricity use in the future in Tasmania if consumer demand increases.

5.7.4 Body-scale comfort

In general terms, body-scale comfort strategies include putting on and taking off layers of clothes, exercise, drinking warm or cool drinks, using blankets, hot water bottles, electric blankets¹⁰⁷ and heated chairs. Warming and cooling the body, rather than an entire room allows people to cater for individual body-zone comfort needs in a targeted way that can reduce the need for space heating and cooling. However, body-scale warming strategies can limit activity levels and may require more complicated dwelling practices.

Participants tended to use body-scale comfort strategies in conjunction with other microclimate management strategies in dwellings, especially when they held express intentions to be resourceful or sustainable. Body comfort strategies were predominantly passive, except where they involved electric blankets, heated chairs, and hot water. Adding clothing, a basic passive comfort strategy, was the first

¹⁰⁷ These are heaters in the form of an underlay blanket for beds.

warming strategy participants used as the weather cooled, primarily because participants understood it limited the need for space heating.

Clothing was donned for other reasons too. Cara talked about how, in cold weather, clothes and jackets were a public statement of how well parents cared for their children. Yet, Veronica, Cara's daughter, never felt the need to wear a jacket in cold weather. This amused and annoyed Cara, who said 'Part of making Vanessa wear clothes is that people will think I am a bad mother [if I don't]! You know— school with no jacket!' (summer interview 02/03/08). Cara knew her daughter was warm enough and did not really need her jacket: they had been through the 'jacket on/off stand-off' many times. Yet, Cara perceived that her ability as a mother was measured by others' assessments of whether her daughter was dressed appropriately and looked cared-for. Cara's observation about the relationships between comfort and perceived nurture shows how important the influence of community and culture are in relation to comfort action, and how important caring for children, health and comfort are to the broad community.

Exercise was noted by ten people in eight households to be an important part of maintaining comfort levels in winter and helped them reduce their use of supplementary heating. The effects of exercise sessions during the day such as gardening, walking, renovating or cutting firewood could sustain personal comfort levels through into cold evenings.

Other strategies used at the scale of the body were blankets, electric blankets and hot water bottles (Appendix N, Table N-3). Blankets were used to keep warm in living rooms at night as well as in bed. Mary and Martin related the story of a friend who could not afford much heating, so used to sit in the living room with a hot water bottle and a blanket, and would provide her guests with the same. Hot water bottles coupled with blankets were seen as an affordable, passive and energy efficient way to warm the body. Mary's friend made light of the fact that she could not afford heating, and instead saw the blanket and hot water bottle as a cosy and enjoyable way to 'beat the cold'. Olive used a hot water bottle with a blanket to limit her use of space heating in the living room, but found this strategy too constricting and was frustrated. Henry also used a hot water bottle for pain relief. Electric blankets were

used, and appreciated, by four households. In general electric blankets were used to provide initial warmth in bed, but were then turned off. Olive and Henry used hot water bottles in conjunction with electric blankets to warm their beds. Olive explained that she had only recently realised (after a warning on the radio) that the water bottle may be dangerous when used with the electric blanket. Steve used an electric heater that was part of his armchair. He tended to use this heater after Gwen had gone to bed when space heating was no longer required.

Body-scale comfort efforts were important and regular parts of comfort practices, but often required coordination to enact. Householders implied a fondness for their chosen body comfort strategies to maintain warmth. Some participants, such as Olive, preferred the freedom that space warming provided because she found warming at the scale of the body frustrating insofar as it limited her movements.

5.8 Ventilation and moisture control

Ventilation is the primary method used in housing to purge 'stale' inside air, cool indoor temperatures, and provide a feeling of air movement. Introducing 'fresh' outside air indoors often improves oxygen levels, reduces airborne toxins, and reduces humidity levels (Baggs et al. 1996). Through all these functions venting assists with physiological and psychological comfort (Ballinger et al. 1992).

Reducing and controlling moisture inside houses is important in cold weather because a high level of moisture indoors leads to the growth of mould. Mould can affect occupants' health. High levels of moisture can also undermine building materials and structures (Waters 2001).

Ventilation can be achieved by opening windows and doors, constructing mechanical or passive vent holes, or through permanent gaps in building structures. All houses in the study could be vented, but a few only had limited opportunities (Appendix O, Table O-1). Paul and Vanessa's and Olive's houses had windows that were painted shut by previous owners; reopening windows required patience, skill and time. Olive chose to leave her windows painted shut as indoors stayed cool in summer anyway; she had a number of well-placed doors for venting and felt the painted windows

repelled intruders. Paul and Vanessa chose to renovate their windows because they were keen to improve the intake of fresh air from outside.

Venting and moisture extraction were also achieved in eleven houses using mechanical extractor fans in ceilings in bathrooms and kitchens. While extractor fans were somewhat helpful, they only really moved air into roof spaces or recycled air back into the same space after filtering it. Moving moist air to unvented roof spaces can create moisture problems in roof cavities, undermining structures, claddings and insulation. Some participants had vents in their eaves to release moist air from roof spaces. Recycling air back to the same place after filtering meant that moisture and deoxygenated air stayed in the same space. Air conditioning systems used as heaters (heat pumps) in winter could also help to dry the air as they warmed it, which was helpful, but could not replace the indoor air and required the use of a significant amount of electricity.

Ventilation practices can clash with methods that reduce heat-flow or retain warmth indoors in winter. Advocates of passive design and energy efficiency often recommend venting indoors spaces as a method to cool houses during warmer weather; and advise closing and draught-proofing houses to restrict venting during cooler weather (Building Design Professionals 1995; Edwards 2001; Roaf et al. 2005). Their reasoning is that warmth and energy efficiency are more important than venting for replacement air. In Tasmania, energy efficiency advice follows this reasoning, suggesting that householders increase the heat-flow resistance of roofs, ceiling, floors and walls, and seal their houses to limit draughts (Sustainable Living Tasmania 2007c). Following this advice means that houses will be poorly vented during cold weather. When houses are closed and venting is limited moisture levels build inside. When it is cold as well, moisture will settle on surfaces and will support mould growth. Effective moisture reduction and control requires air replacement (venting) with drier air, as well as temperature control.

In winter, participant householders either closed their houses to resist heat flow all the time (12 houses in autumn and 13 in winter); or they would vent at certain times and close their houses when they were cold and wanted to use their heaters. In winter venting was mainly used to refresh air and to keep indoor spaces dry. For example,

unless it was a really cold day (below 13°C) Troy and Nat would vent during the day to keep their house ‘fresh’ and to ensure their dog could move in and out of the house. They only used heat in the evening when they had the house fully closed with the living and dining rooms zoned off from the rest of the house. They would again open windows in their bedroom for fresh air while they slept. Their practice of venting in cold weather did not follow standard energy efficiency advice but suited their needs and limited moisture levels building indoors.

In all dwellings in the study, moisture levels needed management. Most householders reported that they had to wipe windows daily during cold weather, and thought that moist windows were a normal effect of winter living. Coupled with the generally poor thermal resistance of the building shells, moisture from kitchens, showers and respiration provided large amounts of moisture in participant homes that condensed on windows and walls. Condensation reports signified that the dwellings were poorly ventilated and sub-optimally retained warmth.

Susan reported high levels of moisture on her windows in cold weather but managed to reduce condensed moisture levels on windows by regular venting year round and by installing whirly gigs in her roof.¹⁰⁸ Helen was challenged with moisture and mould¹⁰⁹ in her laundry, which she minimised by venting the house during the day all year round. Del and Kirk had moisture on windows in winter, but (in contrast to Susan, Helen and Troy and Nat) did not vent because they were trying to stay warm. They tried (often unsuccessfully) to avoid the worst effects of their moisture-laden air by maintaining warmer indoor temperatures.

¹⁰⁸ The whirly gigs are venting devices that are installed in the roof cladding and allow air to flow in and back out of the roof space. The whirly gigs most likely assisted with window moisture levels by reducing the overall moisture levels by extracting roof space moisture build-up from the kitchen and bathroom extractor fans.

¹⁰⁹ Mould was a subject participants chose not to discuss at length, perhaps because mould and moisture are associated with lack of cleanliness, which remains stigmatized, or because they viewed moisture management as a normal and obvious part of life.

5.9 Lighting

Lighting is expected to be in houses as a basic dwelling function, and its use and management has a clear relationship to comfort and energy use (Crosbie 2006). Lighting can be achieved by opening the house to sun or using artificial lighting.

The use of sunlight reduces the use of supplied energy and participants preferred sunlight because it was psychologically and physically comforting. Using sunlight was understood to be a way to make modest savings on electricity bills. Yet, sunlight is difficult to control and brings heat indoors with it. In summer householders would block out sunlight to limit heat gain and then, frustrated, found they had to use artificial lighting in the darkened spaces. Even during autumn and winter, sun angles made it hard to use direct sunlight for lighting.

Artificial lighting was regularly used by householders during the evenings, on cloudy days, and at times when the sun was direct, caused glare or felt hot. When lighting was finished with, it was immediately turned off in most houses. Dwellings constructed or renovated in the 1990s and 2000s regularly included a high number of energy-hungry recessed halogens¹¹⁰ and high wattage incandescent lights. A number of householders had inherited banks of these lights, which they found costly and frustrating:

Martin –I loathe and detest them [the recessed halogen lights in the kitchen] because of the heat loss, like punching a hole in your ceiling and creating an updraught and ... the power wastage I hate, because people think [because] they are low voltage, they think they are low wattage. There is 200 watts there [indicating the kitchen lighting] (summer interview 17/03/08).

Changing from incandescent to compact fluorescent lighting (CFLs) is currently popular as the Australian Government is phasing out inefficient incandescent lights

¹¹⁰ Standard halogen lighting for house use can use 50 to 100 watts per light bulb. Light bulbs using this amount of energy per light are now (2012) being phased out in Australia. Fluorescents and then Light emitting diodes (LEDs) have gradually gained popularity in the domestic lighting market. Halogens on the market are now more efficient, but are still comparatively high wattage compared with fluorescents and LEDs.

(Australian Government et al. 2010). Light emitting diodes (LEDs) are also becoming more widely used for domestic lighting.¹¹¹ CFLs were used in a number of households, but some participants said they did not like the light colour of the light the bulbs emitted, the aesthetics of the fittings, the awkwardness of installation, and the health risk associated with the globes. These reasons concur with other studies (Crosbie 2006; Wallace et al. 2010). In our first discussion it became apparent that Trent had not trialled the latest CFLs that emitted warmer coloured light. Between interviews Trent trialled the warmer ‘daylight’ CFLs in hallways and found them a great improvement. Gwen and Lorraine did not like the look of the CFLs because they were not in keeping with dwelling style and they would not use them anywhere visible. Del and Kirk avoided CFLs because, due to frailty from age, they used an extendable light bulb changer (they could use from the floor). The changer did not fit CFLs. Numerous households also expressed their concern about the mercury gases used in CFLs. No one knew of a safe way to dispose of the CFLS and were dubious that disposal issues had been thought through by government.

5.10 Water supply and hot water

Water supply and water heating functions were important to comfort and energy use in participants’ dwellings. Every case study dwelling was supplied with water from the Glenorchy mains water supply. Additionally, Terry, Trent, Troy and Nat, and Vanessa and Paul had water tanks in their yards.

Water supply

Despite a drought on the east coast of Tasmania in 2008, greater Hobart had adequate supplies of water, so residents were not officially *required* to restrict their water use and therefore were poorly-practised at conserving it. Nevertheless, participants were aware of the importance of conserving water and made efforts to limit their use. With a belief that water should be conserved, Troy and Nat, and Vanessa and Paul had

¹¹¹ LEDs were only just becoming available in affordable standard fittings in 2008 and were not yet in common use for household lighting applications.

planned, purchased and installed water tanks during the time they were engaged in this research. There were no rebates for the installation of the tanks however, which Vanessa found frustrating.¹¹² Despite water conservation being widely practiced in mainland Australian states, Vanessa and Paul observed that it was not a high priority in their local community or in Tasmania more broadly.¹¹³ Indeed, in 2008 responsibility and infrastructure for water supply in Hobart was being taken from councils and being given to, Southern Water, a new organisation that would manage water supply in large districts (LGFG, SGFG October 2007, May 2008). With the changeover to Southern Water infrastructure was being upgraded, infrastructure costs increased, water meters were installed¹¹⁴ and real water costs rose. Cost increases consequently began to affect the affordability of water supply in low-income households.

Water heating

Water heating has a critical influence on energy use and comfort in dwellings. Federal government modelling showed water heating was approximately 14 per cent (2.3 pj of a total of 16.4pj) of Tasmania's total residential energy use in 2008 and would be approximately the same in 2012 (2.2 pj of a total of 16.2pj in 2012) (Energy Efficient Strategies 2008: 35). In participant dwellings water was heated through electric element hot water (EEHW) systems, solar hot water (SHW) systems and heat pump hot water (HPHW) systems (Appendix P, Table P-1). No participants had gas instantaneous, or electric instantaneous systems.

Single EEHW are common in Tasmanian houses. The system heats water using an electrically heated element in the water tank. EEHW use a lot of electricity to maintain the temperature of the water so are currently being phased out in mainland Australia, but are still available in Tasmania (Australian Government Department of Climate Change and Energy Efficiency 2013). Nine householders used EEHW

¹¹² Vanessa and Paul's renovation story in Appendix T, Table T-5 relates the installation of their water tanks and the problems they faced.

¹¹³ I also made this comparison when I moved to Tasmania in 2006. Mainland Australian towns more regularly place water restrictions on their residents.

¹¹⁴ Mainland Australia, in contrast, has used water meters for decades.

systems. Four systems were positioned outside houses and five were positioned in laundries or in under-house spaces. The tank's limited insulation means that externally placed systems are exposed to more extreme temperatures and lose more heat than systems placed indoors. None of the outside or inside tanks were wrapped with any extra insulation or coverings.¹¹⁵ A number of householders had considered covering or wrapping their tanks. During the course of the interviews Troy and Nat replaced their old internally positioned EEHW system with an outside EEHW system. Troy considered wrapping his tank but was told by the plumber not to worry about adding extra insulation, as the tank was designed to be outside.

Solar hot water (SHW) systems were installed in seven households. SHW has the potential to provide a significant component of water heating in a passive way. All the SHW systems in the houses had been installed with rebates from the GGAER program. SHW systems include panels to collect solar energy, piping, a water storage tank and an electrically¹¹⁶ powered 'booster' that heats water when there is no sun. Tanks can sit beside the solar collectors on the roof, outside on the ground, or inside the house. As with the EEHW systems, externally placed tanks are susceptible to more heat loss than indoor tanks.

Of the householders who installed SHW systems: three noticed a helpful reduction in electricity use; three were unsure of the difference in electricity use (they either did not have enough data, or had not checked the data); and one found there was no difference in electricity use (meaning the system was not performing well).¹¹⁷

Both SHW installers (business organisation interview 17/10/08) and householders recognised there were problems with installation processes of SHW systems: one household's pump failed; and one household realised months after installation that the pump was wired incorrectly and was running continuously. Once identified, both

¹¹⁵ Energy efficiency guides recommend installing extra insulation on EEHW systems to minimise heat loss. SLT advisors who visited houses during the GGAER rebate program advised householders (including this study's participants) to wrap EEHW systems.

¹¹⁶ No one in this study used a gas booster.

¹¹⁷ Three contrasting solar hot water installations from this research, including the unsuccessful installation, are discussed in a paper written by Gabriel and Watson (2012a).

problems were promptly dealt with by the original suppliers. In addition, many SHW systems were installed without reminder lights or timers that meant systems ran ineffectively.¹¹⁸

Challenges with installation in part emerged because there were only a handful of plumbers and electricians experienced in installing SHW systems in Greater Hobart in 2008.¹¹⁹ Householders consequently found it difficult to engage experienced SHW installers. Since 2008 concerted efforts have been made by SHW companies and SLT to educate more trades people in SHW installation (business organisation interview October 2008).

A number of householders who had EEHW systems were interested in replacing them with SHW systems. After consideration however, most had decided against because SHW systems were costly and could be technically confusing. Olive had considered installing SHW with the GGAER rebate, but had thought that she would not be able to use Tariff 42 anymore and therefore decided against it (summer interview 25/02/08).¹²⁰

Helen installed an all-in-one heat pump hot water (HPHW) system with the GGAER rebate. A HPHW system uses air conditioning technology (run on electricity) to transfer latent outside heat into water in a tank. HPHW systems require an air conditioner and a tank, which can be placed together or separately. These systems can significantly reduce electricity needed for heating water, but can be noisy (due to the air-conditioning unit). With the HPHW Helen's household reduced electricity used to heat water by 75 per cent in winter, despite having an outside tank. Despite the efficiency, Helen was concerned about the delivery process for HPHW systems, which are very heavy. The driver delivering her system, being on a contract and not

¹¹⁸ Internal reminder lights turn on when electric boosters are in use and (in the absence of sunlight) timers control when a cooling tank will electrically reheat.

¹¹⁹ There had been a relatively recent increase in SHW systems installations due to community bulk-buys, a new SHW installation company starting up and the GGAER rebate. This increase in activity since 2008 has generated some further learning in trade groups in relation to how to install SHW systems.

¹²⁰ Olive would have actually still been able to use Tariff 42.

wanting to complain to the suppliers providing work, had attempted to move the system alone. The tank fell on him and injured him.¹²¹

Participant householders were aware of the importance of shower behaviours in limiting hot water use and had received reinforcement about the importance during GGAER Home assessment visits, and through the SLT energy savers booklet handed out during autumn interviews (Sustainable Living Tasmania 2007a). Some householders said they tried to limit their hot water use; Terry in particular spoke about his shower practices as an important part of being energy and water efficient.

5.11 Food preparation, consumption and clean up

Food preparation, consumption and clean up were related back to comfort and energy efficiency by participants. Managing food stuffs required facilities for storage (including refrigerators), preparation, cooking, eating, discarding and composting. Many of these tasks were undertaken using appliances. Participants saw they could be more energy efficient if they took care to cook food with the minimal amount of energy possible, purchased supplies from nearby shops, grew their own food, and cycled their food waste back through their gardens.

Reducing energy used for cooking was discussed in five households: Mel tried to use her microwave or a mini-oven for cooking; Olive limited the number of roasts she cooked because she thought that roasting is energy-hungry; and Frank would share the cooking with a friend living elsewhere so they only cooked once every two nights. Despite these efforts, energy used to cook is a relatively small proportion of overall energy use in Tasmanian homes—around 2.5 percent of overall energy consumption (Energy Efficient Strategies 2008: 36).¹²² In net terms, other actions can create more significant reductions in energy use; efficiency efforts in cooking are

¹²¹ The delivery man was able to get up after the incident but, to Helen's surprise and concern, refused to report the incident because of issues with work and contract structures.

¹²² This figure comes from federal government modelling predictions for cooking energy in Tasmania in 2008 (0.4 of 16.4 petajoules of overall energy used per house) and 2012 (0.4 of 16.2 petajoules) (Energy Efficient Strategies 2008: 36).

likely to have only reduced energy use slightly. Relationships between food management and energy management were not always clear to participants. For example, when Olive was trying to limit her energy use, she sought over-the-phone advice from the electricity provider and consequently removed a freezer. It eventuated that removing the freezer made no difference to her overall energy use and she lost her method for storing seasonal fruit that she would eat in winter.

Veronica, Edward and Cara and Steve and Gwen settled close to shops to limit the distance they needed to travel to buy food and had food gardens to limit their need for bought food. Food gardens were an integral part of eight households and, besides producing food, provided exercise, opportunities to save money, ways to reduce energy use and ways to limit environmental impacts. Vanessa and Paul's garden, developed slowly over five years, halved their food costs and ensured a supply of healthy food (summer interview 29/02/08). Frank found food gardening assisted him to manage his weight and to recover from the grief of losing his wife. Terry, like other gardeners, produced preserves and beverages from excess produce and shared his produce with others. Composting food waste in food gardens also assisted to minimise energy use by limiting the amount of waste that left dwellings via mechanical waste removal in trucks. Food gardens did require people to input lots of effort and to establish some significant infrastructure (such as fences, garden edging, good soil, netting and more). Nevertheless, householders enjoyed their gardens and felt they were rewarding.

5.12 Occupants

In this study, the number of occupants in a given dwelling affected the dynamics of energy use; with variation in terms of goals, priorities and practices; these affected the sorts of adaptations attempted. In comparison to households with one or two people, households with three or four people were better able to share resources such as space heating, refrigeration, cooking energy and floor areas, but also needed more

resources overall and more coordination.¹²³ Semi-permanent occupants, visitors and animals affected household dynamics, energy use and comfort (Appendix Q). The effects of animals are discussed here. The effects of semi-permanent occupants and visitors are discussed in chapter six in stories of practice adaptations.

Animal occupants significantly influenced comfort practices and energy use in both positive and negative ways. Nine households had animal residents, with dwelling features organised to support the animals' co-habitation. Animal occupants included cats, dogs, chickens, turkeys, (pet) rats, birds, fish, rabbits, guinea pigs, and on Terry's semi-rural property, resident wildlife (Appendix Q, Table Q-1, and plans in Appendix L). Animals required extra resources in households, but contributed in important ways and were seen by householders as beneficial. Animals provided psychological and physical comfort and could enhance household resourcefulness. For example, chickens produced food, processed food scraps, contributed nutrients to the gardens and assisted in managing insect populations; Veronica, Edward and Cara, and Terry, kept poultry for these reasons, and the birds were well-loved for their personalities and company.

Dogs were kept by six households, presumably mainly for company and security, but they encouraged householders to exercise, which positively affected health and thermal comfort levels. Cats were generally kept for company and psychological comfort. Cats and dogs that spent time indoors greatly affected venting, zoning and door closing practices. Participants would leave doors open for the dogs and cats in winter and cats and dogs flaps created weakened thermal resistance in doorways. However, Frederick and Keira accurately pointed out that cats 'do keep you warm at night' (autumn interview 22/05/08) as one small cat or dog can provide around 0.25-0.5kwh extra heating in an enclosed house (Vale et al. 1975).

Pet birds were kept outside, but uninvited birds also lived in Frank and Helen's roof spaces. Nesting in roofs indicated the challenge these households had with gaps in the roof or the eaves and consequent problems they had with draughts and heat-flow

¹²³ The study included households with one to four occupants.

resistance. Terry also had uninvited (but not necessarily unwelcome) frequent visits from wildlife which had led to very high fences being erected around his food gardens and domestic animal enclosures.

Overall, animals provided benefits to health, garden nourishment, waste disposal, food production, and physical and psychological comfort. It was clear that householders saw animals as positive influences and did not begrudge them the extra resources and effort their care required.

5.13 Power supply and management

For people aspiring to use energy efficiently, having a technical sense of how to manage power supplies and costs is important, but can be challenging. This section describes and analyses findings from conversations with participants about such matters.¹²⁴

The system through which power is supplied can make more difference to energy consumption than any other household feature or practice. Existing power systems are, however, hard to change so energy efficiency strategies provide ways to reduce energy when there are power supply limitations.

Participants mainly used mains electrical power in their dwellings, but there was some use of solar power for electricity, oil in heaters, petrol in gardening equipment, and wood for fire places. None of the participant households used wind, water or diesel power systems. Householders tried to limit their use of active, supplied energy by using passive strategies where possible. Only Terry used photo voltaic (PV) cells to generate electricity.¹²⁵ As is common for PV electricity production in Australia, Terry's 1KW PV system was linked to the mains electricity grid. Terry's was a relatively small PV system, but he was saving money as he wanted to increase PV

¹²⁴ For broader power and energy supply issues in Tasmania see *Energy in dwellings* in chapter four.

¹²⁵ PV cells generate electricity from the sun.

electricity production.¹²⁶ Other participants were interested in installing PVs, and had been for a number of years, but were deterred by the initial expense.

Recognising the importance of systems behind energy (power) supplies, participants regularly related large scale energy supply issues back to their domestic energy use. They recognised energy system links to affordability and functionality in the home, and environmental impacts. Troy, Martin, Frank, Cara and Edward had a reasonable level of understanding of Tasmania's residential energy and electrical supply systems. Various participants disagreed with the choices successive governments had made in relation to energy subsidies for big business, including the decision to support Bass Link, and decisions related to the development of hydro dams. Some householders were under incorrect impressions about electrical supply and erroneously assumed that renewable energy electricity should not cost as much as electricity generated by fossil fuel. Many participants commonly reported looking to mass media for information on electricity supply.

Tasmania's residential electricity supplier, Aurora, was well known to participants and was mentioned as both a *trusted* source of information and a *distrusted* business. Aurora in its trusted role provided information about energy efficiency and could source tradespeople to assist with electrical issues around the house. As a distrusted business, Aurora was seen to be profit-hungry and in collaboration with other profit hungry people in politics and energy supply.

Aurora has two supply (and billing) systems for electricity for householders. There is a quarterly billing system where electricity use is measured, and bills are sent to householders for payment; and there is an in-home pay-as-you-go meter system, where payment for electricity is made before use. Billed electricity is costed against Tariff 31 for general light and power use and the cheaper Tariff 42 for heating and hot water. At the time of the interviews residential electricity was structured so that the general tariff (31) became cheaper with the more electricity that a household used.

¹²⁶ Terry did manage to upgrade his PV system after the interviews were finished.

‘Green’¹²⁷ power was made available from Aurora to Tasmanian householders in 2008. Even though Tasmania is now linked to the mainland electrical supply (and its impacts) through Bass Link, green power has not been purchased by many residential electricity customers, possibly because, as participants explained, hydro power is already seen to be ‘green’. In addition, ‘green’ power costs more than standard electricity and so may be too expensive for many Tasmanians s.¹²⁸

Electricity use was regularly described in terms a monetary cost, rather than as a quantity of energy used. This monetary interpretation of consumption indicated the possibility that not all participants had a clear understanding of their electricity consumption. To add weight to this idea, various participants were confused about how tariffs worked and about the functions of the switches on their electrical meter boards.

Energy consumption in relation to specific appliances and systems was also poorly understood; this was not surprising as, without a feedback meter with a real time interface, computing energy consumption is reasonably complicated. Householders only had access to the aggregated energy data supplied in their electricity bills to or jargon-filled and confusing information from appliance manufacturers to guide their understanding.¹²⁹ Martin was shocked when he happened to come across information about the standby energy consumption of their newly installed heat pumps in the manufacturer’s guide. He said: “I came across a bit that said that these things always consume 35-65 watts: they are drawing that all the time” (autumn interview 26/05/08). Despite some confusion, many households had developed an understanding of the activities that critically influenced their electricity bills. Habit changes, times away from home, dwelling improvements, and new heaters made noticeable differences to electricity use and householders could connect these to changes in electricity use and bills.

¹²⁷ ‘Green’ power is electrical power generated using less environmentally damaging energy production methods that are renewable.

¹²⁸ ‘Green’ power has better success on mainland Australia where there is no hydrological power.

¹²⁹ This lack of real understanding of electricity use is why the Tasmanian government is considering installing and is trialling real-time electricity feedback display devices and smart meter for households in Australia (see discussions chapter three).

Managing domestic power use required participants to be reasonably vigilant. Overall most were careful and resourceful with their electricity use, especially when living on tight budgets. Except for one, all participants found they had to be careful and save energy where possible because of the cost of electricity supply, and as residents in Tasmania for at least two seasons, knew that electricity (and especially heating) bills would be much higher in autumn and winter. Seasonal shifts in electricity costs and increases in power costs caused many to be stressed. In response, participants like Olive, Mel, Susan, Troy and Nat reduced energy use by turning off appliances, limiting use of standby power, and turning off hot water systems while away from home. Terry would also limit the impact of electricity bills by paying in increments ahead of time. Participants were less likely to turn off appliances with important standby information that made life more convenient, for example televisions and multimedia, heater settings and remote controls; convenience seemed a priority in this regard. Householders on Tariff 42 for heating and hot water paid less for this electricity. Householders living with plug-in heaters as their main heater had to use the more expensive Tariff 31. Henry had only plug in heating. Other tenants like home are unlikely to have wired-in heaters and therefore cannot use tariff 42 to reduce costs (Appendix N, Table N-1).

Householders were asked about energy price rises experienced in 2008 (Appendix R).¹³⁰ The first rise for metered dwellings occurred just before interviews commenced. Responses varied. A number of households experienced energy price increases of \$10-\$20 per quarterly bill, which was difficult as they had little financial capacity for extra outgoings. Overall price increases created financial concern and vigilance in most houses.¹³¹ That year, extra pension payments were made to some participants by the State Government, amounting to around \$125 per quarter to assist with these increases in energy prices, and that eased the effects of the rises for some. For several, adaptations recently made to improve energy efficiency helped limit increases in electricity bills. However, additional price rises over 2009–13 would have had impact on all households.

¹³⁰ Tasmanian energy price rises were discussed in context discussion in chapter three.

¹³¹ Mark was the only one who was not vigilant because he was financially comfortable.

5.14 Appliance Use

In general terms, appliance use is projected to rise in Australia and it is modelled to be a major reasons for residential energy use increases (Energy Efficient Strategies 2008). Appliance-assisted living can increase householder capacity and enjoyment in the short term, but may also reduce resilience and the ability to be flexible and adaptable in the long term, due to a reliance on electrically powered and not well understood devices (see, for example: Chappells et al. 2005). Appliances are purchased and used by householders because they support some intent or need, and support psychological and physiological comfort. Often replaceable and non-permanent, appliances can be upgraded or introduced fairly easily to meet evolving dwelling requirements.¹³²

Each participants owned many commonly available appliances, including heaters, irons, computers, alarm clocks, bread makers, televisions, washing machines, dryers, and stoves. While most participants aimed to use passive solutions to reduce energy use, most saw appliances as necessary to everyday life: their aim was to reduce electricity (and appliance use), not to stop it. It was apparent in every home (some more so than others) that participant goals of affordability, energy reduction and reducing environmental impacts clashed with modern practices of appliance use. For example, Cara, Edward and Veronica were committed to being as sustainable as possible, but had a large, energy-hungry plasma television screen to play video games set up in a dedicated room.

5.15 Other influences on energy use

Various other factors influence comfort and energy efficiency in domestic dwellings, including personal ablutions and household cleaning, maintaining the physical structure of the dwelling, and ensuring that safety requirements are met.

¹³² I note appliance purchases contributes to energy consumption because of the embedded energy in their production, distribution, and ongoing use

Practices to achieve cleanliness in the home are driven by need and by culturally influenced aspirations and expectations (Shove 2003). Cleanliness entails clothes washing, showering, and cleaning the dwelling space. Such practices often required the use of mains supplied supplemental energy, for example to run vacuum cleaners and washing machines. Some households made a point of using passive cleaning practices, such as hanging clothes on an outside line and using cold water for washing, but everyone used some proportion of their household energy consumption for cleaning.

Maintenance of physical dwelling spaces and functions requires significant effort and energy use. Participants reported that care and maintenance of dwellings were regular activities requiring, among other things, physical ability, planning, project management skills, money, and materials. Capacity available for maintenance was a good indicator of the capability available to conduct physical home adaptations. If maintenance seemed onerous, then physical adaptations were likely to also be seen as an impost.

A need to feel safe was apparent among participants, and that need drove dwelling expectations and goals, the manner in which physical adaptations were approached, and practices when, for example, installing security systems, keeping windows closed, and keeping lights on all night. Despite the effect that these activities can have on energy use and comfort they are not explored in any depth in this thesis. These activities were omitted from discussion here because the activities were less commonly discussed by householders and (in an effort) to bound the thesis topic.

5.16 Discussion and conclusion

This chapter has reported on findings that address the question: what dwelling conditions are experienced by participants and how were they attempting to manage comfort and energy efficiency in those dwellings? The review has highlighted participant understanding of their dwelling conditions and how they attempted to secure comfort and manage energy use by maintaining certain practices and managing physical dwelling features. Participant households were, in the main,

careful about their resource use and did not use excessive levels of energy for their comfort; all sourced from the GGAER program, they were a group motivated to be energy efficient. Notwithstanding this fact, dwelling energy efficiency and comfort outcomes were affected by numerous factors, summarised below.

Dwelling features have to perform to a certain standard to affordably support comfort and limit energy use. Participant's houses were relatively thermally poor and were generally not able to achieve comfort passively. Even after some retrofitting: heat-flow resistance of the house shells was still (in the main) poor by modern standards; many houses had inefficient water heaters; much indoor lighting was inefficient; and moisture extraction was limited. Only one house and two extensions were built after energy efficiency standards were introduced in the BCA. In at least eight dwellings, the combination of poor thermal resistance in the house shell, low angled sun, and limited ventilation combined to produce hot internal living spaces on summer days and cold living spaces on winter days. The large thermal swings will likely become greater as climate changes, and will likely lead to more reliance on energy-hungry comfort solutions (for example, air conditioning for summer cooling) indoors.

All participants had some important practices they used to help manage comfort passively. Passive strategies were often used before using appliances and supplemental energy supplies. However, it was clear that appliance use and the use of supplemental energy were integral to day-to-day living. Understanding how to embed passive management as a dwelling priority more widely could assist to limit householder perceptions of electricity as essential to dwelling practices.

Solar gain helped householders to be more energy efficient and manage comfort more passively in winter. Although 15 houses received reasonable solar gain to their site for most of the year, poor orientation and poor thermal resistance limited how householders could use it. Part of the reason participants had access to sun was because their dwellings were in suburban spaces and were positioned well on slopes. The majority of Tasmanians live in suburban spaces, but a reasonably high proportion of these suburban dwellings sit on overshadowed southern hillsides. Controlling sunlight is also important in summer to minimise overheating. The importance of managing solar gain in all seasons highlights the need to ensure

legislation (in planning and design) prioritises house orientation and dwelling features for solar control in both new builds and renovations.

Poor thermal performance and having limited passive energy strategies available meant that supplemental heating was regularly used in cold weather. However, many households were determined to use heating in a minimal way. For reasonable lengths of time a number of occupants were actually able to live comfortably at temperatures far lower than the World Health Organisation recommends as healthy (Ranson 1988b); leading me to suggest that the supplemental heating was the lowest it could be. The, mostly, careful heater use highlighted the critical role of practices in managing comfort and energy efficiency. In situations where the physical dwelling offers little thermal support, practices provided the opportunity to ensure living remained affordable. Many passive and active comfort and energy efficiency practices were routine; those routines were often seasonal, malleable, and could be adjusted on a day-to-day basis according to weather. Health issues, and the comfort levels experienced in other environments, such as offices, tended to limit flexibility in practices, and to encourage more use of heating.

The management of supplemental energy involved the management of electricity use, and that was tempered by understanding and perceptions about supply, which were typified by confusion due to electricity being technically complicated and mostly intangible. Participants felt the approach to power supply in the State needed to change. In spite of looking to the government and major suppliers for guidance and information about energy efficiency in the home, participants did not trust government/supplier decision making and wanted some say in power supply decisions for the State.

Other than passive physical strategies and mains heating, householders had other ways to maintain psychological and physical comfort, including body-scale comfort, food growing and keeping animals. There was a strong positive correlation between body-scale comfort strategies, low incomes, and other capacity issues (such as poorly performing houses). Growing food was identified to be empowering for health, affordability, to limit environmental impacts, and to energy use. Animals provided company and comfort. These strategies are obviously beneficial for comfort, energy

efficiency and affordability, but are poorly researched. Further investigation into them would be helpful.

Every house and dwelling space had the potential to be physically upgraded to improve thermal performance. Householders were aware of this, and had spent time thinking through their options for change and proposing possible solutions. Consideration before making change is obviously sensible as improving comfort performance and energy efficiency regularly requires significant adjustments to physical fabric and dwelling practices.

It is apparent from this chapter's review that dwelling conditions, the way that practices are managed *and* the way adaptations are conducted does not just spring from simple need (Shove 2003; Wilson et al. 2007) but is affected by a variety of complicated influences. Understanding the influences in more detail is helpful in understanding the sorts of support that would suit householders and the ways that policy-makers can engage with householders to create regularised practice changes (Hobson 2003).

In light of these findings, chapters six and seven move on to examine change processes that householders embarked on when considering or making practice and physical dwelling adaptations in order to better understand the key factors influence adaptations.

Chapter 6. Explorations of change to dwelling practices in participant households

6.1 Introduction

This chapter focuses on adaptations that householders made to their dwelling practices. Examining these adaptations allows me to develop more detailed understanding of what influences practice adaptations, and to identify transferable insights that can be drawn from participant experiences.

Dwelling practices are a critical ingredient in any attempt to improve the sustainability of domestic life and any adaptation for comfort and energy efficiency. Evidence-based, detailed understanding of practice adaptation promises to guide the development of policies that aim to support dwelling adaptation. However, to date, this detailed type of research has been conducted by only a handful of scholars around the world, most of them engaged in socio-technical studies of housing and householder practices. This research approach is not yet well-utilised for developing intervention policy (Crosbie et al. 2010; Shove 2003; Wilson et al. 2007). In the Tasmanian context, such research is absent, and thus the present study offers a novel, in-depth investigation of how and why householders adapt their domestic practices, and identifies which practices are most commonly involved.

Dwelling practices are fundamentally groups of actions in routines or habits that help to achieve a dwelling goal; they are dynamic, complex and changeable. Making change to practice could be misunderstood to be easy and simple. As will become evident in the analysis below, many changes in everyday practices required considerable thought, coordination and effort; few were easy.

I have examined the dynamics and complexity of practices by reference to the stories of participant householders, and analysed changes made to their dwelling practices to draw out significant lessons. To this end, I have asked *what happens when adaptations to practices are thought about, sought and made, and what can be learnt about how to support residents in improving the sustainability of dwelling practices*

and dwelling fabric? To answer this question I have identified the types of changes to dwelling practice that are being thought about, made or attempted by participants; determined the reasons behind those changes, and noted the key characteristics that typify these adaptations. Physical dwelling adaptations are explored separately in chapter seven.

This chapter reports on stories and analyses in three parts. First, the selection and analysis of stories are explained and their heuristics are described. Second, nine stories of householders adapting or considering adapting practices are shared to convey diverse adaptive experiences and answer the first part of the chapter question. Third, key findings from the analysis of the stories are presented to identify the relevance of examining the stories and to answer the second part of the chapter research question.

6.2 Selection and analysis of the stories

Data used in this chapter, as in chapters five and seven, come from investigations conducted with householders living in Glenorchy. Particular stories of attempted and actual dwelling practice changes made in the households were selected because they illuminate the influences, processes and effects involved in adapting a variety of practices. Methods of data presentation and analysis used in this chapter are different from those used in chapter five. There, the exploration was structured according to categories based on key energy and comfort management strategies that could be used to attain dwelling goals. Chapter five's categorisation method was an optimal way to describe, assess and compare energy efficiency and comfort conditions and practices in Glenorchy case study households, but also led to compartmentalisation of householder experiences and de-contextualisation of conditions and practices. Sharing only elements of people's stories and doing so out of context, leads to many interconnections being overlooked and much of the complexity of lived experiences being lost from analysis. Here, by exploring the detail of stories, in context, I maintain the nuance and complexity of participants' stories. The result, although a limited co-production of real lived experience, is a series of richly layered

explanations that illuminate numerous important influences that shape dwelling practice change processes.

Particular attention is paid to a variety of adaptations that were considered and attempted by householders, and to the kinds of influences, motivations and issues of capacity that affected their dwelling practices and changes to them. Key points from each story have been tabulated in order to extract and isolate important insights pertaining to: decision making and problem solving; timing of processes of change; purposes of change/goals; strategies used to meet those goals; adaptive methods used; and, other influences that reportedly affect adaptations including stakeholders involved, capacity issues, backgrounds, values, information flows, place relationships, and interconnections (Appendix S).¹³³

The stories presented below are collated from pertinent moments that emerged from longitudinal conversations conducted over three seasons' interviews. The longitudinal approach resulted in my gradually collating bits of conversation and ideas shared by householders until I had a comprehensive 'story' of their lived experiences. The stories also comprise direct extracts from interviews; field notes about householders' characteristics or non-verbal communications; and notes of my own observations of the dwelling spaces in which our conversations were held.

Many variables affected *how* householders shared their stories, not least among them gender and our relative positions as researcher and participant. Men and women tended to emphasise different aspects of their adaptation experiences. Men would regularly refer to adapting the physical structures of their homes, focusing on technical aspects and broad political issues. Women often stressed the emotional experience of change and gave details about the decision making processes that went with making adaptations. For example, Steve explained many of the technical aspects of changes to his home and the set-up for water and energy, whereas Olive only

¹³³ Recall that in chapter two and three I provided explanation for the choice of categories used for the analysis of the stories to follow. There, I observed that the different households progressed through similar stages of decision making and problem solving and noted that various authors have effectively described this staging phenomenon in theory (Lawson 2006; Popper 1999; Zeisel 2006). I also recognised that dwelling emerged from intentions or goals (Lawrence 1987; Lawson 2006; Watson 2004).

vaguely explained the technical elements of her changes and told me about how it felt to have an arrogant advisor in her home. People who thought they were teaching me something related stories differently from people who thought I had something to offer them. For some participants helping with the research was part of being a good citizen, and for others the research was an opportunity to contribute to sustainable communities. Others were interested in efficiency as a concept specifically related to their house. *Everyone* was interested in energy efficiency in the home.

6.3 Stories of dwelling practice adaptation

This section presents rich descriptions of nine instances of dwelling practice change that were shared by participants in order to describe *what happens when adaptations to practices are thought about, sought and made*.

6.3.1 Olive's experience of aspiring to comfort and energy efficiency

This story is about a change in practice that arose while Olive tried to find the most energy efficient way to stay warm during cold nights (Appendix S, Table S-1). As Olive lived on an aged retirement pension,¹³⁴ she needed her heating to be affordable, but she also wanted to be resourceful and limit her impact on the environment.

Olive lives in a three bedroom, detached house on a suburban block. She previously had a lodger, but lived by herself during 2008 when I met with her. Her house has concrete block external walls, and receives a lot of morning sun, but is shaded by large trees to the north. This combination of concrete and overshadowing tended to create a cool indoor climate difficult to warm in winter.

Olive had the option of using two different living rooms for her evening activities (Dwelling plan, Appendix L). The larger room has three external walls, receives

¹³⁴ The maximum single rate of aged pension in 2008 was 273.50/week in March 2008 and had risen to \$281/week in September 2008 (OECD 2011b).

some eastern and western sunlight through large banks of windows at either end, and has a door to zone the room off from the rest of the house. The smaller room has two long internal walls and two shorter external walls, receives eastern sunlight through one bank of windows, has internal doors connecting it with other rooms, houses her dining table, and is adjacent to her kitchen. She preferred to be in the small room.

Olive had proceeded with a GGAER rebate, and had cellulose insulation installed in the dwelling's ceiling cavity in late 2007. Like all participants, Olive was very positive about the rebate initiative, but could not tell what difference the insulation made nor reveal whether her house was any warmer than it had been prior to the insulation being installed.¹³⁵

Olive had been concerned about the costs of a recent electricity bill. She had consequently contacted the electricity supplier who had advised her to get rid of her stand-alone freezer because it was probably the appliance that had made her energy use so high. The removal of the freezer (at some inconvenience to her) did not actually reduce her electricity bill and Olive was left wondering what to do to reduce her electricity costs.

It was apparent that Olive was proactive, having completed some difficult maintenance jobs around the dwelling space on her own, including painting the exterior of the house. She was thoughtful, and tried to find solutions to problems that were aligned with her values, which included caring for other people and the environment. Maintaining affordability was important: she was managing her finances very carefully and for years had been concerned about only using the amount of energy she could afford. As a result, Olive was careful to limit her use of heating, but found that she often felt uncomfortable on cold nights.

When I met Olive, she was trying to decide what the best night-time heating strategy would be. Olive had a few different heating options for her night-time warmth, but was not sure which one she should be using. She had the option of heating:

¹³⁵ Effects of the insulation may have been overwhelmed by the heat flow behaviours of the concrete walls; or may not have been enough to remedy the cool overall temperatures internally.

- the larger living room using a wired-in ‘pure heat’ electric heater which had a radiant heater and a fan that could be used together or separately;
- the smaller living room using an older-style ‘Vulcan’ oil-burner heater;
- the smaller room using an electric plug-in column oil heater; or
- herself using a hot water bottle and a blanket.

Olive was confused about the benefits and disadvantages of each heating choice due to the intricacies of the electricity supply system, her lack of understanding of the passive thermal performance of the dwelling, and the lack of comparative data she had for her heaters.

During 2007, Olive had thought about replacing her heating with a heat pump air conditioning system. She had sought advice from heat pump installers, and had them visit the house and provide quotes for supply and installation. Olive found the first man who came to provide a quote to be aggressive. The second man who came to provide that same service thought there would be problems with the installation because of the concrete walls and because the electrical meter box would need to be upgraded. Olive found the discussion about the electrical requirements for the heat pump had added to her confusion, so in the end she had dropped the idea.

By the time we had our second meeting at the end of autumn 2008, Olive had tried a few of the heating options mentioned above. She had been using the smaller living room and, when the weather had first cooled, had tried using a blanket and hot water bottle for warmth in the evenings. Her intention at this stage was to keep her electricity bill down and to be as resourceful as possible.

If it’s not freezing I will go get a hot water bottle and sit with it on my knee rather than put a heater on. Because it is just out of this world with all the prices and I am luckier than a lot of people because I’ve got some super [retirement funds] but for some people it must be awful. You go to the supermarket and it is all so dear (winter interview 25/08/08).

The hot water bottle/ blanket option required Olive to sit still, but sitting still frustrated her; she was not interested in watching television and could not do craft work at night because her eyesight had weakened. Because of this frustration, she

tended to go to bed early with a hot water bottle and her electric blanket turned on low. The onset of really cold nights during autumn encouraged her to use her plug-in column heater in the small living area which she assumed was the most efficient way to heat the smaller living space. When there were visitors—and she mentioned that a 90-year old friend regularly visited—she would put on the oil heater in the smaller living area but thought using this heater was an extravagance.

At the end of autumn 2008, Olive reported that she was not satisfied with her heating practices because she was still uncomfortably cold in the evenings and hated sitting still to keep warm. At Olive's request I had investigated her heating options before our meeting in autumn. Together we discussed the cost of her various heating options and compared how effective each heater was likely to be in the area it had to heat; the type of heat each heater could provide; and the differences in the effects of the heat types. The problem was complicated, and with little information available on Vulcan oil-burner heaters I found it difficult to identify which heater would be most effective and affordable. Although our discussion may have helped Olive a little, she was left with the same problem: which heating practices would be the most cost effective and comfortable?

During early winter 2008, Olive's discomfort and concerns about affordability drove her to trial a new idea. She moved all her living room furniture to the larger living area that had the wired-in electric heater, so she could see how comfortable it felt and test how affordable this solution would be. She had been motivated to try this option on a friend's recommendation. Her friend also had a pure heat radiant and fan heater, just like hers and he had assured her that it did heat effectively and that the fan-heat function could be used cost effectively.

And he went inside and said 'oh ... I've just had one of those [heaters] put into my house'. He said 'it is really cheap'. He said, 'what you want to do is just do it with the fan' and 'if you just run the fan it is very cheap, without the radiant heat, do the heat' (winter interview 25/08/08).

By the time I visited at the end of winter 2008, Olive had again moved all her furniture back into the small living area and had decided to use the oil heater as her

main heater. She related the decision she had made to me at our meeting (it is worth quoting at some length for the detail):

So I tried it [the heater in the larger living area] for a while and it didn't seem too bad so therefore I took ... everything in there. Moved everything. And then after probably about three weeks – I mean when you come out here and go back it, it did make the room warm but for some reason when I was sitting there [the large living area] I wasn't warm at all. Sitting was cold ... My legs get so cold. So about two weeks ago I thought 'I don't like this' so I put everything back here again and I have been using the oil heater. Now the logic for that is really because the oil is already paid for, but this year ... (because it has been really cold the last couple of weeks) I haven't been as careful as I usually would. But it is wonderful; it is a lovely heat, so in the evening I have been really comfortable. I wasn't comfortable with the fan-thing [electric fan heating]. And I don't like the noise of it, but that is obviously nothing to do with it, but I would much rather it was all nice and quiet. See [indicating the oil heater], you can put the fan on ... and that makes it really, really warm. In fact if you put [the temperature] up and the fan on you have to move out. But I can't tell you how much the oil is except that I could say I got it more than a year ago now but I don't use it [more than] I can help (winter interview 25/08/08).

In the end, Olive's need to be warm ultimately overcame her concern about which heater was most efficient. She was still worried about the cost of running the oil heater, but she had reasoned that the oil was prepaid and therefore was already costed and accounted for, which helped her financial management. Olive's discomfort, coupled with her test of the heater effects in the different rooms, had caused her to reassess her priorities to favour comfort.

In summary, Olive went through what can be read as a *journey* of change to reach a more affordable and comfortable dwelling situation. She recognised the need for new heating strategies, had to come up with different heating options, trialled a number of possible solutions (with the help of advice and earlier experiences) and adjusted her priorities and her goals until she found a solution that she was happy with. Olive experienced confusion and stress as a result of limited information and technical complexity, and these created challenging barriers to adaptation. Coupled with these

processes was a constant pull between financial concerns and her need to reach a fair level of comfort in a cool house. Despite assessing the viability of physical (technological) solutions, her change mainly manifested through changes to practice. Olive's comfort challenge concerned me for a number of reasons—not least because she was an older woman who spent a lot of her winter feeling uncomfortable and worrying about the costs of living. If Olive, who was a proactive and thoughtful person, was having this much trouble resolving her heating, then how were people with less decision-making capacity faring with their domestic heater management issues?

6.3.2 Del and Kirk's experience of improving comfort passively

During 2008, Del and Kirk settled on a passive change to practice that involved increasing their overnight comfort in bed and reducing their use of their electric blanket (Appendix S, Table S-2).

Del – We have changed our electric blankets for more um //-

Kirk – We have done up the doona.

Del – ... We got a piece put on the doona for winter, its lovely. Well, he kept pinching all the ... [doona] and I was left there freezing (laughs).

Kirk – Which side of the bed has the bit that trails over onto the carpet?

Del – Yours! (both laugh) (autumn interview 21/05/08).

The couple's decision to upgrade their winter bed cover was made when they had their doonas¹³⁶ cleaned at a quilt and pillow cleaning business. Del and Kirk had used the business previously and were happy with the service. The business owner advised them that their summer doona was 'lumping' and therefore would not be very effective. This issue instigated a rethink for Del and Kirk who wanted a lighter covering for summer and consequently bought a new summer doona, keeping the 'lumpy' original doona for autumn. Del and Kirk already had a heavier doona for

¹³⁶ A doona is an eiderdown quilt or duvet.

winter. They thought that using three weights of doonas was a good way to respond to the seasons and found the doona swaps reduced the layers of blankets needed and simplified blanket laundering. In winter though, the heaviest doona still did not provide enough coverage to keep them both warm and one (or the other) would get cold during the night. They decided to get the winter doona extended and engaged the quilt cleaning business they already used to complete the task.

The extended doona improved their levels of comfort and negated the need for extra overnight heating; this meant that they reduced their use of the electric blanket to an hour at the beginning of each night. Del and Kirk were pleased with their solution and therefore recommended their doona solution to me.

In summary, Del and Kirk's investment in enlarging their doona made a difference to their sleeping comfort and reduced their need for the electric blanket. The change required other people's expertise in a once-off effort of their part after which Del and Kirk were able to slip back into a familiar dwelling practice with little change.

6.3.3 Mary and Martin's experience managing seasonal changes

The effect of seasonal change on practice is obvious in both Olive's and Del and Kirk's stories. Similarly, Mary and Martin's experiences of adaptations were clearly related to seasonal climatic changes (Appendix S, Table S-3). They responded to seasonal climate change initially by migrating to Tasmania, and then responded again to the conditions in which they found themselves by adjusting their practices and adapting the physical features of their dwelling.

The couple had moved to Tasmania after losing their mainland house to bushfire. At that time, they considered either resettling elsewhere or rebuilding the place destroyed by fire. Having strong values around environmental care and advocacy they had looked into energy efficient design options, and attended workshops on the topic. Martin already had some experience with environmental building design, and therefore understood the benefits of design for climate and energy efficiency. They were confident that the Tasmanian climate would suit them because they had lived on the island before, so the decision was made to move. The dwelling they chose

needed to support dynamic daily practices. The couple purchased a house in the suburbs of Glenorchy that had a reasonably large floor area for two people and some spare rooms to accommodate a steady stream of interstate visitors; regular day visits from Mary's elderly parents; Martin working from home; and Mary's need to spend a lot of her time at home. Mary had a chronic illness and found that her practices for the day altered according to her state of health and the weather.

The spare rooms and separate living and dining areas facilitated migration around different rooms in their house as they required. In summer, the couple migrated to cooler areas.

Mary – Different times of the day I like different spots. In the evening I like the lounge room because it is cool, that is the south east side [of the house] and it is cooler there, but you get the lovely evening sun, light showing ...

Martin – I tend to use the rumpus [office space]... it's a cool place in summer – and I normally spend a lot of time down there because I am there anyway.

Mary – The bedroom would be hot – but we knew it would be hot today. We closed it up to keep it cool.

Martin – Before we did this recent work [insulating the ceiling and hanging block-out curtains], the bedroom was a place where you wouldn't want to go even with a fan until it loses the sun in early afternoon (summer interview 17/03/08).

In colder periods, the couple tended to close up and zone off areas, instead of changing rooms, in efforts to stay comfortable. Mary found that the practice changes required to maintain comfort levels in winter could become challenging, especially when she had a bad day with her illness.

Mary – In winter it was me especially that found it unpleasant in the cold. We were just using column heaters. We would keep the doors shut. But in the evening [we] would be going back and forth into the lounge room and I would get so sick of opening the door and the sliding door if you were carrying something ... And one is a sliding door that is a bit slower than others. You have got to get it to right back into the groove (laughs). So ... that is one thing that prompted some improvements (autumn interview 26/05/08).

Mary and Martin decided they would need to supplement their day-to-day and seasonal adaptation of practices with physical adaptations if they were to achieve real comfort energy efficiently and affordably. They did some research and called in some design and energy efficiency consultants to discuss the adaptations planned for their home.¹³⁷ Mary went to the effort of producing a comprehensive home improvement brief, which focussed on goals of energy efficiency and comfort. She and Martin were prepared to spend some money to improve their house, but had to be careful about overspending. They did not want to overcapitalise as their locality traditionally had limited real estate growth prospects.

During 2007, the couple was able to use the GGAER rebate program to realise some of the physical changes they wanted to make. They decided, among other things, to install more effective heaters and better curtains, and to insulate the roof. With new heaters and insulation in place, they felt better able to use the living and dining areas of their house.

Martin – We also put a heat pump in here and in the lounge. With the insulation I figure we can close that door and close the door that goes out of the lounge room ... It means that we can have the whole front of the house as one [heating] zone (summer interview 17/03/08).

Mary's and Martin's story illuminates how people can be affected by climate enough to reassess both the site of dwelling as well as day-to-day dwelling practices. They chose their new dwelling location in response to a major bushfire event. After moving, the daily climate also influenced their daily dwelling practices. They did not, however, choose their new dwelling space according to passive design qualities, which they understood well. Instead, they chose the site because it could accommodate Martin working from home, Mary's illness and extra family visitors. After they had settled in they began to respond to climate and the performance of the house, identifying optimal comfort practices. Their awareness of climatic issues, advanced planning and design abilities, and knowledge of consultants all influenced

¹³⁷ Mary and Martin found some consultants very helpful, but one consultant had been insulting and they had been left with a bad feeling after his visit. Consultants who are perceived as offensive are clearly counterproductive as people will not happily use their advice.

the physical adaptations they conducted to improve their comfort, energy efficiency and affordability.

6.3.4 Mel's experience learning new skills

'Do-it-yourself' skills involving hardware contribute to householders' capacities to complete physical dwelling adaptations. In circumstances where money has to be managed carefully, such handy skills become an even more important aspect of adaptive capacity. Mel was one of the 14 household participants, out of 26 householders altogether, who either had no handy skills or no capacity to use the handy skills they once possessed (Appendix S, Table S-4). After separating from her husband, Mel purchased a three bedroom suburban house in 2006 to ensure that there was space for her teenage daughter and young adult son to stay with her. The house was new having been built in 2005 and had only been used as a display house. Mel still needed to complete jobs around the house that required handy skills. Mel's ex-husband had undertaken all the handy work around their marital home, and had seen the handy jobs as one of his responsibilities, and she had never developed her own handy skills.

To overcome this limitation, Mel thought to trade her own skills with friends in return for handy help to adjust physical aspects of her home. Trading skills enabled physical changes in the home but progress was often slowed by complications. For example, over the course of the interviews Mel was working towards having a ceiling fan installed. She could not afford to pay a tradesperson to do the installation, so she had asked her son to help her out, but he was having trouble organising the time to get around and help her. Mel had just applied for a GGAER rebate to install curtains but decided not to go ahead with the curtain installation, being unable to find readymade curtains she liked and finding the installation of pelmets above the curtains complicated and costly. Mel had thought about trading skills and asking others to help with the pelmets:

I mean there are people that I can ask if I got them [the proposed curtains and pelmets for the living room]. I could find somebody and they could do it. But sometimes you wonder, are they going to get it right? I mean you don't want it

crooked or that sort of thing when you are relying on volunteers or friends.

Yeah you need somebody with the skills to do it properly ... And that wouldn't be me (laughs) (summer interview 06/03/08).

Mel was aware that her lack of handy skills was a limitation, especially when she wanted to do some maintenance or home improvement work. She was interested in learning some handy skills to limit her reliance on others. Since moving into the new dwelling, she had bought some tools to develop her handy skills and began by hanging some pictures on the wall. 'I bought the cheap and nasty \$10 [tools] at the hardware store! And I was never allowed to do anything in the other house. Like I hung up all the things on the walls [in her new house] and that is just an achievement!' (summer interview 06/03/08).

Mel's story contains some useful insights about how small changes made to dwelling practice may empower; about the importance of encouraging capacity building among householders; and about the challenges people face as a result of socialisation and gender roles. Her story underscores the importance of community relationships, and highlights that home-maintenance skills and abilities may not be as widespread as might be assumed by policy makers. Mel had to improve her skill levels and re-establish her role in the home with the change in her living arrangements. It was clear in her new dwelling arrangement that she would either have to conduct all her dwelling adaptations by herself, or negotiate assistance from others. Developing handy skills (and practices) was a way to improve her chances of making adaptations when needed.

6.3.5 Del and Kirk's experience of physical change affecting practices

Physical home 'improvements' can have both positive and negative impacts on dwelling practices. Del and Kirk experienced some negative impacts on their practices from the installation of their solar hot water (SHW) system in late 2007 (Appendix S, Table S-5). They were resourcefully minded, having lived through the Second World War and on the land as farmers. They could see the benefits of using the sun for electricity. With the GGAER rebate the couple installed a SHW system

for energy efficiency gains and to reduce electricity costs. They felt the benefits would support them against unnecessary living costs as they aged. They had chosen to install an all-in-one system where the solar collectors and the tank were placed on the roof. Previously, they had housed their (electric element) hot water tank in a cupboard in the laundry, which was positioned conveniently next to the kitchen and near the outside drying area. After the SHW installation Kirk realised that he had lost the utility that the hot water tank's waste heat had provided in an internal cupboard, which meant that drying clothes, drying paper and raising the bread dough became more difficult.

Kirk – ... and I wish that this is one of the things that the solar hot water would do for us. We had a tank in there. It was in the cupboard and the whole thing was an airing cupboard. Well to get the solar water, we had to have the electric water heating taken out. So it was no longer an airing cupboard and I miss that ...

Del – He used to rise his bread...

Kirk – Not only that, it dries the sheets and the ... it even dries the printing paper ... If something is half dry you can bring it in and hang it over the tank. And if Del is playing at cooking with appliances ... you cannot dry [the clothes] in a million years (summer interview 26/02/08).

Removing the hot water tank from the cupboard had forced Del and Kirk to change some of their habitual laundry and cooking practices. Kirk indicated that he was trying hard to work out ways to recreate a warm airing cupboard.

Kirk – There has to be a way around it.

Del – We were wondering whether we could find a heater [to put] in there but most electricians said, no way, that would be dangerous. We were wondering about a heated towel rail in there but it wouldn't really do the same job (summer interview 26/02/08).

When I next met Del and Kirk at the end of autumn, I asked how they might influence others to be energy efficient, to which Del promptly replied: 'I'd tell them to keep their hot water tank! (laughs)' (autumn interview 21/05/08). Del explained

that Kirk particularly missed the airing cupboard; had managed to work out a way to raise the bread dough; but had not found ways to reinstate the other practices.

Kirk – I haven't solved everything – but I solved the bread ... I brought from the Op Shop [opportunity or second-hand store] an esky [cooler bin] and I put a couple of hot water bottles in and raise [the dough] in there ... I also had a thought, and it is just a thought – you can get pet warmers for their basket. But I have no idea whether it would provide enough warmth for an airing cupboard (autumn interview 21/05/08).

We explored the idea of installing a pet warmer in the cupboard and Kirk realised that it would require a lot of electricity to run and the safety vent in the cupboard would allow too much heat to escape. Other solutions we explored also required electricity which was an unattractive option because Del and Kirk had previously been able to use waste heat to air clothes and prove dough, and they thought their electricity bill was high enough already.

A cautionary tale is provided by Del and Kirk's experience. They introduced a technology in order to reduce energy use, but in doing so lost the use of waste heat that had actually limited the need for mechanical ventilation, clothes dryers and extra heating. Del and Kirk had to devise new strategies to meet their lost housing functions, but this proved difficult. In addition, their SHW system did not actually reduce their electricity use (or their bill), so they were hesitant to reinstate missing practices using energy-hungry solutions.

6.3.6 Frank's experience of the importance of emotional influences and life changes

Frank's wife's death effectively halted many of his household maintenance and improvement practices for a number of years (Appendix S, Table S-6). However, recovery from grief eventually provided motivation and impetus to garden and do maintenance around his dwelling space. Sharing domestic duties with a friend also assisted Frank's recovery. Sharing his house with his granddaughter now and again

was also instructive, showing Frank how resourceful he was in his dwelling practices.

Frank was retired when I spoke with him and one of the first things we spoke about was his vegetable garden. Tending his garden was a pleasurable activity. He was gradually building up soil and organising beds, although such tasks had not always progressed smoothly:

I am trying to tidy [the garden] up – it got away from me. Slowly, I am making a [garden] bed and starting to tidy it up and do a bit of maintenance around the place. My wife died 10 years ago and I sort of lost it. And I didn't feel like doing much, for years! I found other things to do, let's put it that way ... This last year it is the first year I have put in a garden for four years. I just got it all sorted when [I was told] 'you are not allowed to stay on your leg'! (laughs)
(summer interview 23/02/08).

Frank had had a bad fall and broken his ankle late in 2007. The break had been complicated and healed slowly, which prevented Frank from working in his garden and taking long walks. By the summer interview in 2008 Frank's ankle was on the mend and he was spending as much time in the garden as possible, gradually building up endurance for long walks. While he was incapacitated, maintenance jobs had been put on hold and gardening jobs were completed with the help of a friend.

I had to get a friend to come over to water and weed ... Oh we sort of share – she was my wife's best friend ... Whatever comes out of the garden we share, we eat (summer interview 23/02/08).

Frank and this good friend shared produce from the garden, as well as a dog, and alternated meals at each other's houses. Together they benefitted from company, fewer individual domestic chores, the enjoyment of an animal with less stress, and reduced energy bills. Frank only had to use his cooking facilities and heater every other night: 'so its scratch my back, I'll scratch hers' (autumn interview 31/05/08).

When his dwelling had accommodated a whole family, Frank and his wife had extended the house for extra space and to improve the living room; renovated the exterior to improve aesthetics; and insulated the ceiling and extension walls for comfort. Frank had an older-style oil heater in the living area, and when oil was

inexpensive in preceding decades he and his wife would leave the oil heater on for extensive periods of time: 24 hours a day if the weather was cold. Underfloor heating in the downstairs study had been built in with an extension some years prior to our conversations.

When the whole family had lived at home, Frank had regularly used the in-floor heating in the downstairs study, but when we spoke in 2008 he had not used it for many years, despite still paying for it to be connected to the electricity metre. The oil heater in the living area was still in use, but not as much as in the past, and in general, Frank heated the house a lot less than he used to. His lifestyle and dwelling practices had changed after his children departed and again after his wife died.

Well yeah [now] I don't use the clothes dryer unless I have to. When my wife and I were both working it was wash the clothes every couple of days and throw it in the clothes dryer – because we were both working as teachers and 'don't worry about it – just pay the bills (summer interview 23/02/08).

He explained that in this stage of his life he tried to limit his resource use and be practical.

You know, I have discovered the washing line and use the washing machine only when I have a load which normally works out twice a week (summer interview 23/02/08).

Frank found he was even being careful to minimise wear and tear on his sheets, making sure he did not wear them too much in one place. He thought his retirement-stage dwelling practices were influenced by the resourcefulness he saw in his family when he was a child.

My gran used to cut them [sheets] in half and join the good sides...So there was a join up the centre ... I find the fitted sheets wear out first. So that you end up with good top sheets and so you have got to go and buy new fitted sheets. Being a bloke and not worrying about that, they are a rough match (summer interview 23/02/08).

Frank talked about his teenage granddaughter coming to stay at intervals and how she would use more heating than he normally would. She tended, he said, to sit over

the heater without worrying about a putting on a jumper. He found it quite amusing that she admitted to caring about the environment and society, and yet made no connection between her professed values and sitting on the heater.

She would sit by the heater rather than go and have a shower and put all her [day wear] clothes on and then realise she doesn't need it [the heater]. Breakfast is more important than getting, you know [warmed up through showers and extra clothing]. Got to get the fuel in first, read the magazine, while we [the granddaughter] are almost back up to the heater full-bore. I don't know how she does it (autumn interview 31/05/08).

Frank also mentioned how his neighbours looked out for him. After noting his curtains needed renewal, one neighbour had taken it upon themselves to find him some second hand ones that were better quality. He appreciated the care and concern involved in the gesture, especially since he used his curtains daily to moderate indoor temperatures and supposed the frayed curtains had sent a message to his neighbours that he was incapable of fixing the curtains. This was not actually the case: Frank simply felt that as long as the curtains did their job there was no need to replace them (the aesthetics did not concern him).

Frank's story illustrates the ways in which grief, sharing, life stages and extra occupants can influence dwelling practices. In earlier times when Frank's house had been full of people he had felt too busy to think about being resourceful, but more recently, as the only regular occupant, he felt he had more time to think about it. He had set up a partnership of sorts with a friend to reduce resource use, did chores more enjoyably, and benefitted from having an animal half-time each week. Various hurdles had limited Frank's ability to maintain his house, his comfort and develop his garden, but other people had assisted during these times. When Frank was able to return to maintaining his house and garden, and act for his health and comfort through exercise, he did. Finally, Frank's granddaughter offered an interesting dynamic in his house as her dwelling practices were less resourceful than his own current dwelling practices.

6.3.7 Steve and Gwen's experience of priorities affecting useful practices

Steve's gardening practices changed when his elderly parents needed more of his time and attention and when Gwen became ill (Appendix S, Table S-7). Steve had put a lot of effort into his fruit and vegetable garden in the two years he and Gwen had lived in their house. When the couple had purchased their dwelling, they thought that Steve may permanently have to be in a wheelchair, but that had not eventuated. In the wake of his health scare, Steve was philosophical and found enjoyment in his garden and other domestic jobs. We discussed Steve's vegetable garden in summer, and Gwen and Steve proudly explained that they had had so much produce they had shared it with their friends and family.

When I returned in autumn, Steve and Gwen explained that Steve's day-to-day priorities had changed because his parents were now unwell. His mother had had a fall and had not told Steve; and his father, who had dementia, had also fallen down some stairs and broken his arm. Steve had to go to his parent's house every day to check on them. Gwen explained that the amount of care that Steve's parents had needed had taken its toll on Steve's own health, and he was stressed. The new responsibilities meant that the garden was receiving a lot less attention and that dwelling improvement plans were also stalled. The garden, while being tended a little less, was maintained enough so that when things settled down Steve would be able to make it productive again.

When I spoke to Steve and Gwen in winter, Steve was still 'in and out with Mum and Dad and things like that' (Gwen, winter interview 30/09/08) but had managed to find a nursing home for his father. As a result, he had gained a little time back each day to plan adaptations and work in their garden. Steve was pleased to be able to tend the garden again. With the GGAER rebate, the couple had been able to install a SHW system. They had plans for a rear extension to the house and an ornamental garden in the front yard in-keeping with the era of the house.

Gwen's health had emerged as a challenge during the first half of 2008, and she had been advised to slow down. Despite the hurdles, the couple were philosophical and

felt positive that they would soon be able to put more effort into the garden and pursue their adaptation plans.

Gwen – Now that [Steve’s] Dad is in a nursing home it will be just a matter of time [before we are back into the garden more] ... It has not been easy and we have been told we have to sell the shop as well, for my health. That’s a bummer. I’m not in any rush to do that but it is on the market. What happens, happens.

Interviewer – And you still managed to get a tree in the front yard. Well done!

Gwen – Two (winter interview 30/09/08).

Steve and Gwen prioritised their elderly parents over dwelling practices and adaptations, even though the practices were extremely useful and enjoyable. The couple understood that having to slow down and attend to family needs did not mean abandoning their aspirations. After some of the hurdles had passed, they reinstated food gardening practices and persisted in working towards their planned goals.

6.3.8 Trent’s experience of working towards new comfort requirements and technology management

Trent and his partner were trying to create and sustain comfort practices for their young family and, as part of that, were trying to work out how to efficiently use their new solar hot water (SHW) technology (Appendix S, Table S-8). Trent and their toddler¹³⁸ lived in a suburban detached house on sunny block. They had undertaken a number of improvements to the house and garden over a number of years. Trent was skilled and practical and, in part, credited these capacities to having grown up on a farm. He had undertaken many improvements on their dwelling himself, which included constructing raised vegetable beds and working on an extension. Trent was the main financial provider for the family at the time we met. He was making significant efforts to ensure their home was as comfortable as possible, and he wanted to support his family’s needs as best he could.

¹³⁸ Trent’s partner and child did not take part in the interviews.

Trent thought that the arrival of their baby daughter had changed their practices and priorities. Since his wife and child were home a lot during the day, they found they needed more heating in more areas of the house to maintain indoor comfort. The extension, including the addition of new panel heaters and a heat pump, was completed after their daughter's birth, and facilitated much more extensive heating through the house.

Just prior to our summer interview, Trent and his partner had installed a SHW system using a GGAER rebate. Trent explained that the rebate had made the system affordable: he wanted to install a SHW for a long time but had thought it was not financially feasible at full price. He was still working out how to use the SHW system optimally, and with minimal electric boosting.

I'm not sure [about the particulars of the SHW system]. I know there is a thermostat on the tank. I know the water kicks in when the temperature is five degrees warmer on the solar panels than what it is on the tank – it is automatic, but after that I'm not sure how it works. Basically at the moment what I do is after we've had our shower in the morning I just switch off the mains [electric booster switch] on the tank ... on the way to work. It is a bit of a test because I don't know how much it is actually going to work at the moment. I am doing that just to see how much (summer interview 15/03/08).

Trent was aware of how the family consumed energy and was interested in monitoring their use in more detail using the information on the electricity provider's website. He was particularly interested to see his electricity bill after the SHW installation. He was not sure that he would be able to isolate the electricity that had been saved from the SHW system because electricity prices had increased, and would be rising again soon, so prices would vary. In addition, the format of information provided by the energy supplier did not separate out the electricity used for hot water heating, and it was impossible for him to work out the energy use of different appliances. Electricity use histories were available from Aurora on the internet, so Trent eventually organised a password to access his electricity information, and found he could access much more information than was presented on his printed bill, but he still could not isolate the consumption of individual appliances.

On the basis of prior experience, Trent and his partner had not considered compact fluorescents (CFLs) as a viable form of lighting in (most of) their house. They did not particularly like the light quality CFLs produced; but had one on in the hallway much of the time. In the summer of 2008, we talked about new developments in fluorescent lighting, and I reported that there were new and warm 'sunlight' colours being produced. When next I met with Trent he and his wife had trialled the new CFLs, found they liked the light quality and had decided to use them in several places inside the house.

In summary, due to a change of practices that came with family life and a young child, Trent and his partner had been working to adapt their dwelling. Their new priorities and new dwelling practices led to increased use of heaters to keep indoors more comfortable, more regularly. For Trent, a significant driver of adaptations was his family's comfort. After the new SHW system and heaters were installed, Trent reflected on and adjusted practices that affected the use of the SHW, heating and lighting, so that the technologies were used optimally and affordably.

6.3.9 Steve and Gwen's experience of accommodating a consumptive guest

At our summer meeting in 2008, Steve and Gwen explained that they were careful to minimise energy use and adjusted comfort practices accordingly. They used the 'pay-as-you-go' (PAYG) electricity supply method and pre-paid for electricity in \$50 increments. This method allowed the couple the capacity to monitor energy use regularly and, if necessary, adjust consumption accordingly. PAYG did not provide them with printed (quarterly) bills, so they relied solely on that minimisation strategy. While PAYG has been criticised in Tasmania (Urbis Keys Young 2006), Steve and Gwen liked the system, and used it effectively.

Steve and Gwen had an adult son come to stay in the autumn of 2008 (Appendix S, Table S-9). The visit resulted in a significant increase in electricity use which they felt was excessive, and in a series of insights about energy and consumerism.

At the couple's autumn conversation with me, I asked about their household electricity consumption:

Steve – I would have been able to tell you [the electricity consumption] now but somebody moved back home and that blew the calculations completely out the window. Even though he was brought up on a farm with full solar power, rain water and conserving water and power all the time, it has just gone completely by the board now. If you walk in there [another part of the house], there will be half a dozen things on (autumn interview 23/05/08).

The 'half a dozen things' Steve spoke about included a plug-in fan heater, which his son used for long periods in the rooms he occupied, and gaming appliances, which included a large television that used large amounts of electricity. Steve and Gwen appeared most annoyed that their son forgot to turn off appliances when he left to go out. The couple used little electricity themselves, so their son's use practices were in stark contrast to their normal behaviours.

They explained that for many years their family had lived in a rural environment where they had been self-sufficient in energy and water. On their farm they had to be prepared and practical. For example, firewood was cut a year in advance to dry out, and energy and water use was monitored and changed according to the availability of sun and rain. Steve and Gwen's understanding of energy and water systems was extensive, and they had maintained resourceful practices after moving into the suburbs. Steve could see that many people in the greater Hobart area, including decision makers in government, were unaware of resource supply issues as they related to dwellings. Steve illustrated his concern about this matter by reference to a new subdivision at Dodges Ferry, where holiday shacks were becoming permanent homes despite limited water infrastructure and water supply planning. The Dodges Ferry dwellings relied upon on-site water collection systems, but because the dwellings had originally been designed for holiday use these were rare or non-existent. Consequently whenever there was a dry spell, residents had to get water delivered by truck.

After their son moved out, Steve and Gwen noticed a significant decrease in the electricity bill.

Steve – Well [our son] ... put the heater on just to get up, and then he would have the heater on of a night and of course, big flat plasma screen, plus Sony play station, so the power bill was through the roof.

Gwen – We were recharging [the PAYG electricity meter] every week it seemed.

Steve – Just about, fortnightly anyway... But when ... [our son] took all his appliances and left –

Gwen – massive drop...

S - The play stations chew power like you wouldn't believe. They are almost as bad as the plasma, so put them together and watch what happens. Get warm, standing by the [PAYG electricity] metre (winter interview 30/09/08).

For Steve and Gwen the higher electricity use that resulted from their son staying with them was an annoyance and in all likelihood a financial stress. Their son's extra appliance use was mainly for the purposes of comfort and leisure. As Steve and Gwen were frugal with heating for comfort, they would have found the amount of heating used surprising; their leisure activities did not require anywhere near as much energy use from the domestic electricity supply.

6.4 Key findings of adaptation analysis

There is benefit in isolating various aspects of the aforementioned narratives for discussion because of the insights and direction they may provide for policy formation, intervention design and, more generally, for understanding adaptation. This section therefore brings attention to the key points from analysis of the participant stories and in doing so presents an answer to the second half of the chapter question *what can be learnt about how to support residents in improving the sustainability of dwelling practices and dwelling fabric?*

Key findings from the analysis (see Appendix S) are discussed here under the analytic categories used to identify them, which were described earlier in this chapter. The discussion begins by relating findings around the overall processes of adaptation (problem-solving), adaptation goals and strategies used, as these are

fundamental aspects of any adaptation process. The discussion then moves onto other prevailing influences identified in analysis that critically affect practice adaptations. While many important differences between practice and physical adaptations were identified, many findings do apply to both aspects of adaptation. Where there is analytic commonality, discussion is only pursued in one chapter.

6.4.1 Problem solving processes

In early analysis of household interview data, I determined that all householders used problem solving processes when adapting their dwelling situations like those proposed by problem, design and learning theorists (Beckman et al. 2007; Lawson 2006; Popper 1999; Zeisel 2006). Reviewing adaptive processes of participants progressed my understanding further and identified a number of important problem-solving characteristics typical to adaptations. First, in alignment with problem theory, *a catalyst* was needed to create the impetus to adapt for energy efficiency, comfort, and affordability. Catalysts such as financial problems, thermal discomfort, or wanting to live to certain values created pressure that prompted householders to make changes to dwelling practices and/or dwelling fabric.

Second, problem solving processes transpired *slowly* over time. Solutions took anywhere from months to years to be resolved, if they could be resolved at all. No adaptation cases that I observed were quickly resolved. To date this fact has not been recognised in the design of government support programs and policies.

Third, participants often devised solutions that could ‘piggyback’ upon existing problem-solution paths, and existing practices and strategies. Del and Kirk’s story about extending the doona shows how existing solution paths and embedded practices can be enhanced in order to solve new problems. If a solution is built on a previous solution pathway, and uses trusted help for extra capacity, then the adaptations will be efficient and also have a greater likelihood of success.

Fourth, again in alignment with problem solving theory, participants regularly assessed and tested various solutions before selecting a solution-path. Testing and assessment also enabled people to refine practices associated with chosen solutions

and to consider the usefulness of those solutions for future needs when new problems (or circumstances) emerged. Testing was carried out in various ways by householders. Like Olive and Trent,¹³⁹ people reported trialling different heating and SHW routines in dwellings; and testing curtain-opening and ventilation routines. The feedback gained from testing allowed the development or adjustment of dwelling practices to optimise energy efficiency, affordability and comfort outcomes.

Fifth, realising a solution's benefits and seeing its application as an achievement was motivating and raised confidence. Whether adaptations were simple or complicated, small or large, gains experienced by householders provided confidence for future adaptations. Both Mel's and Del and Kirk's stories underscore this point.

Understanding how outcomes motivate further adaptation would be helpful in the design of interventions.

In summary, adapting dwelling to solve problems related to thermal comfort and energy efficiency occurred over time and after people felt sufficiently keenly the need for a solution. Thereafter they began with problem identification and delineation using prior knowledge and experiences, and often progressed to solutions by working through the viability of possible solutions. The problem solving process as discussed here occurs within an intricate system of relationships, priorities and understandings that occur in place, and are affected by goals, priorities, capacities and numerous other influences that I now discuss in more detail.

6.4.2 Dwelling goals and strategies

As dwelling problems were being defined, people were simultaneously identifying goals they held for their dwelling adaptations and developing strategies to meet those goals. Goals of adaptations varied but, as should be expected from householders who applied for the GGAER rebate, energy efficiency was an important goal for adaptations. Householders also valued comfort (variously defined) as an important

¹³⁹ Edward, Trent, Terry, Olive, and Martin and Mary all discussed testing practices around technologies and every participant reported trialling various passive practices.

goal and often related it to energy efficiency. Physiological comfort was a primary goal, especially for people who were ill. Energy efficiency was often only an element of the greater goal householders held to be resourceful (that is, to use resources efficiently with as little waste as possible). Resourceful dwelling was an important, albeit often implicit, goal of adaptations that was driven by strong underlying *values* of resourcefulness as well (which are further discussed in chapter seven).

Interestingly, while goals (like saving money, improving comfort) were discussed, they were rarely described as 'goals'. The lack of clarification and defining of goals (as goals) was curious because clear understanding of the problem and goals (that is, the brief) of an adaptation ensures better success in adaptations (Hyde et al. 2007; Watson 2004).

There was often tension between established goals. Clashes would occur when trying to meet goals of comfort, energy efficiency and affordability concurrently. Olive, for example, found it difficult to improve her comfort without increasing energy costs, yet she wanted to meet both goals. Tension between goals was often complicated by different occupants in the same house having different comfort needs and different dwelling expectations; living together was regularly about managing different needs and different schedules. Steve, Gwen and their son are a good example of how goals may clash between different occupants.

Priorities had to be set to avoid tension and clashes between goals, with pressing needs gaining highest priority. Care of other people (especially of family) was often prioritised over other practice change goals. Steve and Gwen provide an example of prioritising practices of care for family over other practices. Mel, and Mary and Martin provide examples of households who spent extra on their dwelling purchases to ensure they had extra bedrooms so loved ones could visit.

Strategies chosen to reach adaptation goals affected (both negatively and positively) overall adaptation processes and possible outcomes. Del and Kirk's choice of a technical strategy to meet their energy efficiency and water heating goals created a sudden physical change which caused more problems than it solved. Other adaptive strategies may have solved their problem more effectively. Householders may need

assistance to choose the most appropriate strategies to meet adaptations goals. This could be done, for example, by providing information in early decision-making about the potential impacts of various strategies available.

As problems evolved and priorities shifted, so too did the goals and strategies of adaptations. Olive, Mel, Frank and Trent all spoke about shifting goals and strategies. Participants felt that life stages, such as those related in Frank's and also Trent's stories, greatly influenced the types of goals aimed for and strategies used in adaptations.¹⁴⁰ Householder adaptive capacity was defined by time constraints, income levels and cultural expectations which all related to life stages. Cultural expectations at different life stages appeared to strongly influence what adaptations were conducted and with what capacity. Trent's roles as parent, full-time worker and financial provider for his family were all partly informed by cultural expectations. These roles largely defined the adaptive capacity he had available and also the types of adaptations he felt compelled to achieve.

In summary, choice of goals and strategies of adaptation were driven by expectations, underlying values, certain needs and opportunities. Goals and strategies (along with opportunities and capacities) shifted as adaptation problems evolved as well as with people's life evolution and change of situations. Previous attempts at interventions in Australia have assumed that people hold the same kinds of goals, use the same of kinds of strategies, and are in a position to respond to encouragement promptly and uniformly. This analysis shows that this assumption is unrealistic. Interventions need to distinguish between the goals, values, strategies and life stages of householders. In addition, due to the shifts that can occur through life stages and during single adaptations, interventions will need to be responsive to dynamic and evolving adaptive processes, which householders may not be able to clearly describe.

¹⁴⁰ Vanessa and Paul and Terry and a number of focus group members educated me about life-stage issues (SGFG & CEF, October 2007). One focus group member felt that during the stage of raising young families sustainable adaptation is particularly difficult and adapting in retirement is much easier. SLT staff also found that older people actively engaged with sustainability programs in the home and their communities but that people in their 30's and below did not often engage.

6.4.3 Capacities and their dependencies

Participants needed certain capacities to achieve their adaptation goals and where these were lacking; alternatives were needed or adaptations opportunities had to be suspended or abandoned. Adaptive capacity is generated through physical (infrastructural), personal and communal avenues, and furnishes the abilities, faculties and opportunities that allow householders to think through and act upon identified dwelling goals.

Capacity and skills, unsurprisingly, varied from household to household. Skills and abilities useful for adaptations generally included project planning and management; problems processing; social and communicative abilities; those in hardware and craft; the ability to choose dwelling space based on its strengths; and technical building, appliance and electrical understanding. Other capacities generally important to enacting successful adaptations included: being in good health; having paid employment; having money saved and available; having available time (and an accommodating routine); knowledge on relevant dwelling adaptation issues; connections and relationships with community networks (to trade with, be motivated by and learn from); ownership of the dwelling or a good relationship with a landlord; available building and technical resources; relevant backgrounds and previous energy efficiency and comfort adaptation experiences; and, physical dwelling features supportive of adaptation. Additionally all capacity available was undermined when people were spending large amounts of time caring for others or had any emotional concerns.

Particularly important capacities for practice adaptations were: having access to time and money; being in good health; having reasonable personal mobility; being part of a community with available information and skills; understanding technological solutions; and having access to organisational, management, creative problem solving and handy/ trade skills. Here I elaborate on capacities of time, health and personal mobility and skills. Further findings are related in chapter seven.

Time

Thinking through, planning and enacting solutions could take long periods of time and affected what type of adaptation householders could engage with. Having time available allowed for: awareness of problems to grow; different solutions to be designed and reflected upon; experimentation and assessment of new practices; and also to embed new practices as habits. Adaptations to practices often required new routines to be established, which often used time that had been allocated to other (existing) practices. Challengingly, sustainable and energy efficiency practices can take more time, rather than less, to achieve when compared with existing practices which is likely to be a barrier.

Health and personal mobility

Householder states of health and personal mobility affect existing practices and the priorities for adaptations. Achieving physical comfort appeared even more important when health and personal mobility were limited; associated restrictions of physical activity tended to equate with a greater need for supplementary heating.

Eight people (in seven households) had persistent or chronic illnesses that limited their capacity by constraining income opportunities and redirecting available money to medical issues; limiting the effort available for tasks; and slowing down decision-making. All physical activities were more difficult which meant monitoring, managing and maintaining the condition of dwellings was difficult. The constraints that poor health and personal mobility put on adaptive capacity could be seen in both Gwen's and Mary's experiences. Grief, as experienced by Frank, is a form of ill health that also reduced levels of physical activity and adaptive capacity. As states of health, including emotional health (Anderson et al. 2001), affected practice adaptations they require consideration in intervention design.

Skills

Skills were critically important capacities, especially when money was limited. Particularly useful for adapting practices were organisational skills, decision-making abilities, handy or do-it-yourself skills, craft skills, and gardening skills.

Problematically, opportunities for skills development in Australia, as Mel's story shows, are affected by cultural expectations around the roles that males and females should play in the home. Even in formal education programs skills like hardware / handy skills and crafts still tend to target a particular gender.

6.4.4 Information and information flows

Information was collected to help assess, plan and prioritise adaptation goals and strategies. Information flowed to householders through a wide variety of sources, including formal education courses; government supported websites; specialist design and energy efficiency advisors; the energy supplier; customer service personnel; heater and appliance sales people; and family and friends. Examples of the diversity of information sources can be seen by comparing Mary and Martin's sources of information to Olive's. For practice adaptations both feedback and the selection of language influenced adaptive activity. More discussion about information follows in chapter seven.

Feedback

Feedback on energy use allows households to assess their current and proposed energy use practices; testing and assessment could not occur at all without feedback to learn from. Feedback information comes in various forms including as lived experiences of comfort or discomfort; as electricity bills; and as measurements on monitoring equipment. Quantifying electricity and energy flows without a feedback device is difficult.¹⁴¹ There are in-home feedback devices available to measure electricity consumption and also to measure temperature and humidity performance in houses.¹⁴² Yet, participants only had electricity bills¹⁴³ and other creative home-

¹⁴¹ Electricity supplies are measured by a meter which often sits on the outside of the house and measures bulk supplies used. These meters generally do not identify the energy use of particular appliances. Additionally it can be hard to work out the rate of use and costs of gas and oil as energy sources and it is not clear how much gas or oil is used per unit of heat produced.

¹⁴² Real-time energy feedback strategies using a variety of interfaces were discussed in chapter three.

made mechanisms to provide feedback. Methods they used included observing change in overall electricity use between two comparable bills (Del and Kirk and Trent and his family did this); using comfort perceptions to assess the outcome of an adaptation (as Olive did); inviting a friend to assess a heating or comfort situation; and, a sense of achievement (discussed previously in this chapter).

Trent's monitoring and assessment of energy use provides an example of the effort householders will put into reviewing practices. Provision of better detailed energy use data would allow greater benefits to flow from assessment activities that householders like Trent undertake. Perhaps problematically, like Trent, most participant householders used the cost on their bill (rather than the kilowatt-hours summary) as an indicator of their electricity use, even though there were often two different tariffs used and cost per kilowatt-hour rates rose twice in 2008.

Language for communication

The choice of terminology used when conversing with householders emerged to be important. The importance of terminology was not surprising; most scholars and interventionists understand how critical the choice of terms is. Yet, understanding how to translate so that adaptation literature connects with householders is still an unrefined art (Leith 2009).

Householders responded differently to two words with similar meanings because of contextual understanding they had of the word. Choosing a descriptor familiar to the participant could mean the difference between success and failure of information sharing. Terminology that people were familiar with most often flowed through their closest and most familiar networks. The term energy efficiency was not a term commonly used by householders, but resourceful was a word that householders could identify and engage with easily in conversation. Likewise, the term sustainability was

¹⁴³ To complicate matters, around the same time as electricity rises in 2008, Aurora (the energy supplier) changed the information they included on their electricity bills. Previous electricity consumption was moved off the householder bills and put instead on a website that required householders to log in and use a password, which made a big difference to how, when and by whom electricity information could be accessed.

not regularly used—householders had many ways of talking about being sustainable, but rarely used the actual word.

While both information and communication techniques are generally understood to be important, there is little evidence that understanding of information sources, information flows, required feedback or key terminology has been incorporated into Tasmanian or Australia-wide interventions. Intervention approaches consequently need to reconsider the ways in which information is presented to householders, how it is accessed by householders and what householders need.

6.4.5 Connections, relationships and networks

There were regular examples of householders being influenced in their decision making by other people in their social networks. Householders gleaned and shared information and advice through their communities and networks, sales people and suppliers, and skilled tradespeople. Advice from individual, non-expert advisors as described in Olive's story (and in Susan's in chapter seven) was commonly very influential, highlighting the potential power that rests with neighbourhood connections and friendly advice. Just one person can be a significant motivator of others and critically influence decisions. Trust in the advisor's character was more important than the advisor's level of expertise. Behavioural psychologists are familiar with this phenomenon and use the influence of people (on people) in interventions to encourage change (Cotter 2012; Mackenzie-Mohr et al. 2011).

Social influence worked in every direction; and people in interview settings are not immune to the effect of personal influence. From my position as someone knowledgeable about energy efficiency I imparted useful information and knowledge to householders, but they also interacted and imparted information and knowledge to me. Experiencing the two way flow of education and experience in the interviews emphasised the influence that people-to-people interaction has and highlighted the potential of reciprocal communication for intervention design.

6.4.6 Sharing the dwelling with others

The dynamics of sharing a dwelling with housemates, family, friends and animals, and the period of time it was shared significantly affected dwelling practices, yet is not considered in Tasmanian energy efficiency interventions.¹⁴⁴ Living together was regularly about managing different needs and different occupant schedules. Some people stayed at home all day whilst others went out and required better levels of indoor comfort (such as children and the elderly). Dwellings housing multiple occupants were likely therefore to have householders with different dwelling goals for adaptations.

Participants reported temporary occupants, visitors or family members who came to stay affected their dwelling practices. Visitors and temporary occupants often meant an increase in energy use and also disruption to energy efficient dwelling practices.¹⁴⁵ Steve and Gwen's experiences provide a good example of the effect of an extra occupant on electricity consumption. Increases in the consumption of energy and reported cases of excess energy use could occur because visitors did not have the same values and dwelling goals as permanent occupants; were used to warmer climates; acted differently out of their own house (perhaps they felt 'on holiday'); and, may not have realised the effects of their behaviours (they did not have to pay the energy bills and had no feedback). In addition, increases in energy use due to visitors may have seemed high to permanent householders because these householders were already fairly frugal with energy.

Householders felt it was important to offer guests the best service and care and made great efforts to ensure the comfort of their guests. Efforts to enact such a high level of care may have added to increases in energy consumption caused by visitors. Even if it was financially challenging, as it was in Olive's case, householders ensured the house was heated to the guest's liking (which was often higher temperatures than the

¹⁴⁴ Household occupants are identified in Appendix E and animal occupants are identified in Appendix Q and are discussed in chapter five.

¹⁴⁵ Frank, Trent, Terry, Steve and Gwen, Cara and Edward all shared stories about energy use increases with specific visitors.

householders lived with). The participants were often surprised at how much heating their visitors, especially their interstate visitors, required.¹⁴⁶

The temporary nature of the visitors' stays defined how the householders dealt with the changes to practices that came with the visits: Steve and Gwen were willing to put up with the energy use because their son was only staying with them for a while; Frank indulged his granddaughter because he appreciated her company; and Olive just wanted to make sure her elderly friend was well cared for.

Householder choices around visitors and temporary occupants provide some important insights. Firstly, when left to their own devices householders maintained energy use and comfort practices that met their goals and values. Secondly, householders ignored their goals and values to care for others in their home (the care was more important). Thirdly, acclimatisation to personal home environments and the local climate made it easier to maintain comfort and use less energy.

6.4.7 Background experiences and knowledge

Backgrounds are developed according to the sorts of experiences a person is exposed to, the knowledge they gain, the values they develop and the skills they learn over their lifetime. Background experiences and knowledge clearly influenced householder values, goals, capacity and decision making around energy management, comfort and adaptations (see Appendix E and Appendix S).

Despite the general influence background experiences had, there were cases in the practice adaptation stories where background experiences, knowledge and values did not greatly influence consumption and comfort practices. Knowledge and value-to-action gaps are recognised phenomena but are not necessarily well understood (see for example: Moloney et al. 2008; Wilson et al. 2007). The most obvious breaks between background goals, values, capacity and actions in this inquiry were apparent with teenagers and younger adults staying in houses temporarily. Gwen and Steve's

¹⁴⁶ Visitors from mainland Australia often find Tasmania too cold, so it is common for Tasmanians to advise interstate visitors to avoid visiting during winter.

son and Frank's granddaughter provide examples of situations where other priorities overrode background exposure to practical and resourceful living. In both these cases, the temporary and young visitors were relatives of the owners of the houses who were authorities in their lives. It is possible that these younger visitors would have different practices and be more responsible in their own houses, especially if they paid for their electricity use. Findings linked to the influence of background experiences are further described in chapter seven.

6.4.8 Garden spaces and gardening

Gardens, gardening and food production significantly influenced comfort and energy practices in households and, as Steve found, garden activities were likewise influenced by other life events.¹⁴⁷ Eleven households included active gardeners who spent time managing ornamentals, producing food, maintaining windbreaks, engaging with animals and relaxing. Gardening required effort, infrastructure, time and management: soil needed to be nourished, weeds needed to be removed, vegetables had to be planted, and ornamentals had to be maintained. Yet, all gardeners were happy to put effort into their gardens as they recognised the benefits (such as exercise, time with animals, and food production).

Gardening required regular, often seasonal, adjustment to practices. Gardening in general, and food production in particular, required prioritisation of time and space (which was a problem for Steve); and acknowledgement of the dynamics of the seasons, and plant growth cycles. Weather and seasonal changes necessitated week to week changes of garden practices with watering, soil nourishing, raising of seedlings, planting, and harvesting being prioritised in different seasons. Fruit trees, for example, required significant commitments of time and effort during harvest seasons. Gardeners therefore had to be responsive and flexible all year round to sustain successful gardens. In essence gardeners were engaging in constant small problem-identification-adaptation cycles.

¹⁴⁷ Garden contexts are described in chapter five.

As Steve and Gwen showed, garden harvests also sparked change to other practices; lots of produce meant less visits to shops and sharing (of produce) with others. Gardeners in the study shared produce enthusiastically, highlighting strong sharing values, consideration of others and general goodwill. Sharing such lovely food potentially also promoted the benefits of food production and gardening to others.

In this inquiry, despite the effort they required, householders like Steve and Gwen were happy to engage with garden spaces in a flexible and adaptive way and were happy to share their rewards. Further observation of householder –garden relationships would be useful, as they are poorly understood, yet offer the chance to advance understanding of dwelling adaptation and therefore what is needed in intervention designs.

6.4.9 Place, climate and seasons

Place, climate and seasons all greatly affected people's dwelling practices and required cycles of practice adaptations through the seasons. A number of participants made the ultimate (but fairly common) adaptive response of migrating to Tasmania to avoid hot summers or large crowds that lived elsewhere (Preston et al. 2009). Once settled, climatic changes across seasons affected indoor dwelling practices and outdoor leisure and garden practices. Mary and Martin's experiences show how both place and seasonal practices can lead to adaptations: they moved to a suitable climate and then set up practices to suit the seasonal climate of the place they were in. Place, climate and seasons therefore need to be considered as influences on adaptation at both a macro-demographic scale and at the local and domestic scale.

6.4.10 Adaptive methods

Alongside energy efficiency and comfort-specific adaptations strategies, household stories showed that there were more general methods and skills of change householders also applied to adaptations. I have labelled these general skills and methods 'adaptive methods' (Appendices S and T).

Householders often appeared to maintain open minds as to their solutions paths and were prepared to consider and try a variety of methods to change their practices. One important adaptive method householders often used was to try practice adaptations for a given goal before trying physical change adaptations for that goal. Olive, and Martin and Mary provide examples of households that attempted various practice changes before physical changes. The persistence of these householders to solve their comfort and energy efficiency problems and the flexibility they showed when exploring solutions is admirable. Their approaches show strong inner motivation, even when faced with barriers.

Analysis of stories identified householders used a huge array of general adaptive skills and methods. To meet adaptive goals householders would:

- move (place-to-place or room-to-room) to find more comfortable climates and dwelling situations;
- change practices to prevent ill health;
- maintain some flexibility in their practices (especially to maintain affordability);
- stretch their thermal (physiological) comfort zones to reduce the need for change;
- adjust old practices for new effects (using familiar solution paths where possible);
- adjust /change their physical environment;
- use previous experience and knowledge to guide new adaptations;
- try new ways to reach a solution;
- devise various possible solutions for one goal;
- test solutions were viable using various methods (which included experiencing the solution);
- gather new information to assist to build adaptive knowledge;
- seek and use advice and information from friends, community, sales people, books, websites and sales organisations to crystallise and clarify problems and solution strategies;

- reassess problems and redesign goals and strategies as new parameters were encountered;
- adjust goals and priority values if existing ones were not attainable;
- find the capacity they lacked from elsewhere;
- use trusted capacity to assist them;
- improve their own skills;
- collaborate with others;
- using technical solutions;
- be resourceful and maintain affordability;
- conduct change incrementally and gradually;
- conduct change so it had minimal impact on existing practices whilst also meeting new goals; and
- try to limit their reliance on outside supply systems (by, for example, growing their own food or learning new skills).

The number of adaptive methods and skills used in each case pointed to householders having reasonable capability to engage with change in their lives. In addition, the large number of skills and methods used at various points in adaptive processes shows that householders were often flexible, persistent, and resilient when trying to achieve change.

6.5 Chapter Conclusions

In this chapter I related stories and analysed the characteristics of practice adaptations in order to develop a more detailed understanding of how dwelling practices are adapted and what influences them. Understanding gleaned from the analysis shows that intervention designs would benefit from better understanding of nuance in all the categories of influences analysed. Chapter seven explores the processes and details of adaptations to physical features in order to identify further influences that need consideration when designing interventions. The findings from this chapter and chapter seven then directly feed discussion of interventions in chapter eight.

Chapter 7. Explorations of physical dwelling adaptation in participant households

7.1 Introduction

This chapter explores the physical adaptations householders made to their dwellings and the influences on their adaptation processes. This exploration builds on chapter six's examination of dwelling practice adaptations in order to develop a more complete picture of the influences that affect dwelling adaptation for energy efficiency and comfort. To this end the chapter asks *what happens when adaptations to the physical features of a house are thought about, sought and made, and what can be learnt about how to support residents in improving the sustainability of dwelling practices and dwelling fabric?*

Evidence-based, detailed understanding is derived from the stories of household participants. There is not enough room in the thesis to relate all the physical adaptation stories that inform the findings; the stories are quite complicated and would require lengthy retelling. Therefore, the chapter relates three stories in narrative form and seven stories (including the three in the chapter) in tabulated form in Appendix T (Tables T-1 to T-7). Focusing on only a handful of stories enables me to share the rich detail, complexity and variation of adaptation experiences. These narratives and the tabulated stories provide examples of the types of adaptive characteristics and key influences that affected adaptations and their outcomes for all household participants. To provide extra examples of phenomena, this chapter will also refer to chapter six stories and non-tabulated participant stories where required.

The chapter relates the stories and analysis of physical dwelling adaptations in three parts. Firstly, it provides an overview of the physical adaptations household participants have made to their homes. Secondly, three stories that illuminate the various methods and strategies householders engaged in to make change are presented in narrative form. Thirdly, the chapter presents the key findings from analysis of the physical adaptation stories.

7.2 Selecting and analysing the stories

The seven stories of attempted and actual physical change to homes were selected because they illuminated a range of different outcomes, approaches, occupant situations and capacity mixes. These stories help to explore the first part of the aforementioned chapter question *what is happening when physical dwelling adaptations are thought about, sought and made?*

The narrative and tabulated tables are collated from pertinent moments householders shared with me over the course of the three longitudinal conversations held with each household and, as such, are limited co-productions of much richer lived experiences. They comprise direct extracts from interviews; field notes about householders' characteristics or non-verbal communications; and my readings of the dwelling spaces in which our conversations were held.

The stories present adaptations that ranged from: those (only) contemplated (but not acted upon) to those that were attempted and/or completed; the successful to the unsuccessful; small to large (fridge replacements to house extensions); short term to long term; once-off changes to multiple changes; changes with involvement from householders to those without; and changes supported by rebates to those fully paid for by owners. The selected stories cover some of the key physical adaptations strategies used to achieve comfort and energy efficiency, in particular changes to: building shells and floor areas; passive comfort features of the home; appliances (hot water systems, heaters and fridges); and, gardens. The stories also occur in both owned and tenanted homes.

As in chapter six tabulating the example stories allows the various points in the stories to be analysed and key influences to be identified. In particular, the tabulated stories highlight: the stages of decision-making and problem solving householders move through; the goals of the adaptations and the home improvement strategies used to achieve the goals; the more general adaptive methods being used to realise goals and strategies; the stakeholders involved; and other influences such as capacity issues, information flows, driving values, and key background influences.

7.3 The seven households

The seven households, the type of change their occupants made, and the reason their stories are included is briefly introduced here.

Cara, Edward and their child Veronica (Table T-2) adapted their home bit-by-bit in order to be more sustainable. They are a family who actively try to reduce environmental impacts generated from their dwelling and had taken this as far as adapting the physical features of the dwelling. The family's experience provides an example of strategic and driven, but incremental change being made to the home with the purpose of creating more sustainable living spaces. Their story also shows that changes can be made even in situations where money is tight, as long as capacity is considered and managed carefully.

Susan (Table T-3) was a participant who clearly believed in being resourceful. This belief was apparent in her decision-making for adaptations around the home. This story shares Susan's purchase of a new fridge and the adjustment of the fridge's position (on the advice of others) to minimise overheating from the sun. Susan's story is an example of how someone living with physical disability can make change using background knowledge, local advice, borrowed effort from others and her own project management capability.

Henry (Table T-4), a recently separated man, lived in a cheap and basic rental unit. Henry's experiences provide insight into a situation where making physical changes was difficult and made no logistic or financial sense. On tight finances and in a disempowered rental situation, Henry was constrained in what he could achieve at home. He was, however, proactive in other areas of life, highlighting that a lack of capacity in one situation in life, does not mean that a person is uniformly disadvantaged.

Vanessa and Paul (Table T-5), who had previously lived in Hobart years before, moved back to Glenorchy in 2006 and began their retirement by renovating and extending their recently purchased house. They did as much as they could in one big effort to create an enjoyable dwelling space that would allow them to live as

comfortably and as self-sufficiently as possible over the years to come. They extended the house while they lived in a retrofitted garage on-site and also planted a large and productive cottage garden. Their story provides an example of significant change being made in the home by people with a strong sense of purpose and citizenship.

Helen (Table T-6) is a mother of young children who, at the time of the interviews, was studying full time. Helen and her family managed to successfully install a more energy efficient hot water system through the GGAER rebate program even though their adaptive capacity was particularly stretched. In addition to this change, Helen felt that her house needed general upgrading, some retrofitting and extending to meet comfort, energy efficiency and other goals. Despite having access to a trade-skilled husband and his skilled family, tight finances; severely limited time; and problems sourcing durable and appropriate products meant that Helen found making physical adaptations difficult. Consequently, Helen had to carefully choose what changes she was prepared to attempt.

Troy and Nat (Table T-7), an extremely careful and resourceful couple, were semi-retired and lived with their dog. The couple had gradually adapted their home over a number of decades. Their experience installing a recycled door (to zone off their dining area from the hallway) provides insight into the intricacies involved in making a single change to a home and also how physical change has to fit in around other issues and priorities. Their caring relationship with their dog is also a reminder of the part that animals play in the home as occupants, companions and influencers of adaptations.

Mary and Martin (Table T-8), some of whose story was shared in chapter six, spent a lot of time in their home because Martin worked from home and Mary was chronically ill. Their story shows that when people are regularly at home or unwell, comfort and energy efficient physical adaptations can become more of a priority. After moving into their home Mary and Martin replaced the heaters and then, with the opportunity of the GGAER rebate program, also added curtains and insulated the roof space. Whilst their physical adaptations provided significant improvement to

comfort levels and allowed Mary some physical relief, there were ongoing problems with the installation of the insulation.

7.4 Overview of physical dwelling adaptations completed, planned and contemplated

A wide variety of physical adaptations were contemplated, planned or completed by householders (Appendix T, Table T-1). Approaches to adaptations and the reasons driving physical adaptations also varied. Householders' efforts to make change ranged from attempting many changes in one go to gradually working towards changes over time as capacity became available.

Most householders had undertaken many minor and one or two major physical changes. A number had extended their houses and others had added large vegetable gardens and water tanks. Householders who had not conducted many physical changes either lived in a new dwelling, one they built themselves, were renting, or were under extreme time and money pressure. All householders had more ideas for physical changes for the future and ideas that had been shelved due to barriers emerging. If conditions changed, for example because of the introduction of a rebate, then shelved or suspended ideas and goals might be reconsidered.

While reasons and priorities driving adaptations varied, they centred on ideas of creating better function, more space, enhancing the aesthetics, and improving comfort. These reasons were often underpinned by other broad goals such as ageing-in-place, maintaining health and improving the affordability of day-to-day living. In the majority of cases (physiological) comfort changes were often made early in the list of adaptations. Energy efficiency and sustainability, and associated attitudes about being resourceful, seemed to be more thoroughly considered in later adaptations householders made. Upgrading redundant technology and design and maintenance needs also influenced adaptations made.

Physical changes made included draught-proofing, hanging curtains and pelmets, retrofitting kitchens, replacing and installing heaters, installing roof ventilation

(called ‘whirly gigs’), adding vegetable gardens and fruit trees, adding chickens, double glazing, insulation, hanging a door, moving the position of a fridge and extending the floor area. Whilst many physical adaptations were successful, a number were unsuccessful or caused problems after installation. The outcomes of physical adaptations are shared in the tabulated stories in Appendix T and the narratives below.

7.5 Stories of adapting physical dwelling features

Three of the seven stories recorded in Appendix T are shared here as rich narratives in order to describe *what is happening when adaptations to the physical features of a house are thought about, sought and made*. The three stories present different physical adaptation processes. Cara, Edward and their daughter Veronica’s story of successful sustainable adaptation is presented first. Susan’s story of a resourceful move of the fridge is second. Henry’s story of the difficulty of making change in a rental is presented last. The first story is the longest and is included at such length to highlight the nature of incremental change.

7.5.1 Cara, Edward and Veronica’s experiences moving towards sustainable living bit-by-bit

Cara, Edward and their ten year old child Veronica are a family who actively try to reduce the environmental impacts of their dwelling activities and, because of this, adapted their home bit-by-bit (Appendix T, Table T-2). Their physical adaptations were successful at reducing their environmental impacts and increasing their comfort.

When we met, Cara, Edward and Veronica had lived in their home in Tasmania for two summers—since Cara had taken a job in the State. Cara was working full time, Edward was studying and Veronica was at school. The family wanted to ensure they lived as sustainably as possible so they had originally planned, when they moved to Tasmania, to find a piece of land just outside of Hobart and build a new passive solar

house and set up an extensive and productive garden. Familiar with passive design, Edward had designed a house while they searched for a block of land. After some looking they realised, however, that living close to services and public transport would be much more sustainable way to live. If they lived out of town they would have to commute into town every day for work, school and shopping. They then therefore adjusted their plans and began to look for a house in the suburbs that they could renovate to support their sustainable ethic. The trio then found a detached 1950s house on a standard sized suburban lot in Glenorchy located near shops, schools, services and public transport.

The house has three bedrooms, is a timber and weatherboard structure with a tile roof and a suspended timber floor on a low brick apron (that enclosed a low underfloor space). The interior walls are mainly clad with 'lathe and plaster' wall lining (Appendix M, Table M-2). Much of the dwelling, including the electrical wiring in the house, was in its original state, but previous owners had done some renovation, in particular: concreted large areas around the house; tiled over the old corrugated iron roofing; and added a room for a kitchen space out the back (the north east) of the house. The dwelling neighbours a busy road, some suburban housing, a school playground and some light commercial industrial sheds. The dwelling is 600 m² in area and is unusually flat for greater Hobart as it is part of a broad area around a waterway. The flat yard provides large amounts of useable space in the garden. The house's position on the block and the block's position in the landscape opens the dwelling to all day sunlight (see dwelling plans and solar access in Appendix L). Access to all day sun also means though that the dwelling is exposed to strong winds (which often hit the house).

The family's drive to sustainably adapt their home was influenced by Cara's and Edward's childhood and religious backgrounds. Cara grew up in a co-operative housing community that incorporated environmental care and sustainability considerations in all aspects of dwelling. Edward grew up knowing the importance of indoor thermal comfort from experiencing cold winters in England; and developed his own values around sustainability through his adult Buddhist practices. Growing up with Cara and Edward as parents, Veronica also had a background where she had

developed understanding about environmental and social impacts of living and also therefore made significant effort to act sustainably. The family knew they were an unusual and perhaps extreme example of housing adaptors. Cara explained: 'We are pretty ideological. If we find things difficult to do other people, who are less motivated, would find it pretty difficult to do' (autumn interview 30/05/08).

With such a strong drive to live sustainably the family were clear about what they wanted to achieve through their dwelling adaptations and worked at adapting their home from the moment they moved in. As they were paying off a mortgage and Cara's full time job was the main income source, they did have to save and manage money carefully. Cara and Edward consequently planned things that were able to be researched and constructed by Edward on their limited budget first and more complicated adaptations that required more money and outside skills (like solar hot water) for later in the future as savings became available. Edward's choice to study was, in part, to fit in with the time their adaptations would need. Edward applied himself to one change at a time as money and time permitted. In addition, Veronica actively assisted in various ways with adaptation decisions and activities.

When I met the family, their dwelling space still had the original house, garage, and shed but had new vegetable gardens and a large chicken coop on the north side of the block. Edward had also managed to remove most of the concrete in the yard. The family reported that they had began their adaptation activities, in the first four months after moving in, by changing over all the light bulbs to fluorescents, creating garden space and installing vegetable gardens. Recognising the benefits of a productive garden, Edward had immediately set to constructing raised vegetable beds in the back yard. In conjunction, Edward had broken up and removed 20m³ of concrete from the garden space which enlarged the garden and also reinstated access to the underfloor areas of their house. A chicken coop and chickens were introduced soon after these first activities. All these adaptations were intended to, and did assist to, limit their energy use; improve affordability; enhance enjoyment of living at the dwelling; and, also limit their environmental footprint. At the summer interview the family reported that they had not bought vegetables or eggs from the shops for 6 months and had enough eggs to give some away.

After their early efforts, Cara and Edward then considered installing ceiling insulation in 2007 to improve indoor comfort and reduce the need for supplemental heating. As they planned and saved to purchase the insulation, they came across the GGAER rebate offer which encouraged Cara and Edward to reconsider their next adaptation. Installing insulation, they reasoned, was something they (particularly Edward) could handle by themselves, but GGAER would allow them to do something more expensive and more technical; the rebate opened the possibility for them to install solar hot water (SHW) much earlier than planned. Solar hot water seemed a great way to reduce water heating energy, which would significantly reduce their electricity use. Veronica explained:

Veronica – solar panels... are more sustainable – Because energy on its own really just – even if you do limit it, it is still not environmentally-friendly.

Edward – Is it because of the source?

Veronica – ... It's about how much energy and where you get it from (summer interview 02/03/08).

Edward and Cara also reasoned that because the ceiling was made of foam and the walls were lathe and plaster they had a little heat-flow resistance anyway (and more than other houses would have had). Consequently the family applied for a solar hot water rebate through the GGAER program and laying ceiling insulation would be held off until later.

Cara and Edward took out a personal loan to purchase the SHW system. In addition to the rebates, Sustainable living Tasmania (SLT) organised GGAER rebates to go straight to the businesses supplying the appliances, which meant Cara and Edward paid less up-front and could borrow a smaller amount on their loan.¹⁴⁸ Their rebate offer came in the second round of offers so there was only a short amount of time (about one month) to organise the personal loan, choose, purchase and install the SHW system. Although the installation was quite quick, getting hold of the system and booking the plumber within the time limit (late November 2007) proved a

¹⁴⁸ SLT's approach was novel, as many rebate programs wait and provide the rebate after the purchase and installation is completed.

challenge. Due to the complexity of the technical choice being made, the short timeframe, and the personal loan, the installation process was stressful for the family. In addition, the family also applied for a federal SHW rebate available at the time. The federal rebate took more than three months to arrive, which was stressful because it meant they were paying more of the personal loan for longer than anticipated.

Edward and Cara felt that research was important before making any product choices for adaptations. They felt that sales people had ulterior motives and selection and purchase of products could be pressured. Edward felt purchasing of products often came down to a battle of wills with the salespeople: 'If you didn't have confidence in the knowledge you receive, the person that sells you the product is going to sell you the product that they want' (winter interview 23/08/08). Edward therefore always researched prior to a purchase for an adaptation. Before selecting their SHW system, and in consultation with Cara, Edward reviewed the information SLT provided, found information via the internet and also talked to plumbers who installed SHW units. Using this process Edward selected a SHW product and also engaged the plumber to complete the installation.

The SHW system Edward chose (the Hills evacuated tube 315 L split system) was one he thought would be superior to those suggested by SLT.¹⁴⁹

Edward – That's a hills solar system as opposed to their [SLT's suggested] Apricus... It's just a slightly better quality in terms with the manifold and how it interacts with the tubes. It's got a hot pressure release valve on top of the roof... I took my advice from the plumber who wound up doing it for me. ... He advised the alternate product. He had installed both systems.

Cara – Getting the plumber was the trick and there weren't that many that had done solar hot water (summer interview 02/03/08).

The family had their system installed with a manual electric booster, and an on-ground (indoor), oversized tank. They chose an oversized tank because 'it gives us a

¹⁴⁹ As part of the information handed out for the GGAER rebate, SLT provided information about various SHW technologies and products.

longer duration, so if we don't have sun for 48 hours we [still] have hot water in the tank' (Edward in summer interview 02/03/08). The plumber later said that he thought Edward's choice of product with the oversized tank was such a good one that he had decided to install the same system in his own house.

The family chose to have the manual electric booster switch installed on the mains power board outside the front door, rather than inside. They did not install a reminder light that would light up when the electric booster was in use. They thought they would be able to monitor the electric booster carefully without it as they could access the mains power board easily enough. They got the plumber to install a cold water mixer on the hot water pipes leading into the bathroom (to limit the temperature to 60 degrees for safety).

Two weeks after the installation, while friends were staying, the pump for the solar hot water system failed. The system was still under warranty so they were able to rectify the issue easily.

Veronica – [This was the] first time they [the suppliers] had had a failure in this range of products they sold. ... Probably just unlucky I guess.

Interviewer – Was it a big issue?

Edward – Just three or four days of just flick back on the mains switch [to warm the water] – it's also got an electric element, just like a normal heater. Initially thought it [the water] was cold because we had guests, but it just wasn't pumping at all ... So I turned the electric booster on thinking it was a shit day and too many people showering – but it was the pump that was broken! ... Once we replaced the pump it was all good (summer interview 02/03/08).

Whilst the pump was not working they turned on their electric back-up booster. After this, they were quite happy with the system's performance overall. After the initial pump failure, the family had only had to use the electric booster a couple of times before our summer conversation and then only irregularly through to our autumn conversation. They could feel that the unmixed hot water flowing to the kitchen was really hot in summer and believed that their large tank had kept the water hot for longer throughout summer and autumn as well. 'It's a battery bank effectively' Edward explained (summer interview 02/03/08).

In winter, in response to the grey and cold weather, the electric booster was manually switched on about every 48 hours. If the water was not very warm at night they would switch the booster on manually to heat up over night.

Edward - If we forget, then it's 7.00 am and we've go 'shit'. We have a cold shower.

Cara - The only exception there might be was if you got a day where it was really continuously sunny, not like this morning where we had sun this morning and then it is gone – has to be really sunny.

Interviewer – Stable kind of sun?

Edward - It is not heat dependent, it is actual sunlight (winter interview 23/08/08).

The family found they had saved energy with the SHW and their boosting practices. Edward commented that his habits had changed since installing the system. He was actually having longer showers than he used to because the hot water was heated by the sun. Like many other greater Hobart residents, Edward did not worry about the extra water use because water was seen to be plentiful in the area. Despite the success, Cara was concerned about maintaining and protecting the exposed parts of the system's technology from outdoor elements; she was worried that the evacuated tubes, which were on the roof, would be damaged in the strong winds that often hit their house.

After the first summer with the SHW, the family moved onto their next physical adaptation: replacing an old ceiling fan. The ceiling fan, they had realised, had to be replaced before they laid the ceiling insulation. Complications arose when the electrician came to pull out the old fan and discovered that the entire house was wired with old 'baker lite' covered electrical wiring from the 1950s. The baker lite was too unsafe to work with; the house needed total rewiring before any other electrical work could be done. The re-wiring of the house therefore became the new adaptation priority and, between our summer and autumn meetings, the family contracted electricians to rewire the house and replace the ceiling fan. The rewiring was challenging for the electricians because of the lathe and plaster, the wall framing and the limited access to underfloor areas.

Over winter, and after the electrical wires were replaced and the fan was installed, the ceiling insulation could finally be considered. After researching and ordering the R3.5¹⁵⁰ recycled polyester batts from Victoria, Edward worked to install the batts gradually over four weeks. At one point during the installation, Edward's foot had broken through the foam-board ceiling and it was at this point that Veronica decided to help to install the batts in the awkward areas. They noticed the effect of the extra insulation immediately as it significantly improved indoor comfort levels, increased the effectiveness of their heat pump heater and also reduced the noise pollution from their busy street.

The family felt that all the changes they had made to the physical dwelling, including the insulation and the SHW had positively affected their comfort levels, affordability of living, energy efficiency and dwelling sustainability. Overall they felt that they had 'the resources over time to do most of the things that are probably best to do for our house' (Cara, winter interview 23/08/08) but that lack of money did slow them down. Cara said they would use rebates again if they were available because 'short term rebates inspire us to do things quickly' (ibid).

The family were looking forward to undertaking more of their planned renovations as they moved into spring. The kitchen was now a primary focus for planning and design. Whilst the kitchen had lots of sun it had little thermal resistance and a poor relationship to the garden. The family were keen to better capture the sun and to relate the space to the garden. Cara and Edward had also been gathering quotes and ideas for curtains and pelmets throughout the first half of 2008. The pelmet adaptations were expected to be finished before the kitchen renovations began.

Some adaptations Cara and Edward had decided they would not undertake.

Edward - We have decided not to put in solar power, not in Tasmania. We are going to invest in a company, because it is a global issue so it doesn't matter where you put your panels - might as well stick them where they can get the most amount of sun per kilowatt of panel and get a return.... You spend your

¹⁵⁰ R stands for level of resistance.

\$10,000 but then you get a dividend every year which you can re-invest back into the company (winter interview 23/08/08).

In summary Cara, Edward and Veronica planned their adaptation well with clear intent and priorities made according to their current adaptive capacity, which resulted in successful adaptations. They made change to physical dwelling features, despite the effort needed, because they believed these changes would allow them to live more sustainably. Their persistent (impressive) adaptation efforts came from a drive to care for the environment and for people. Everyone was able-bodied and committed to their goals. However, while committed, the family were also open to change, opportunity and better ideas as they emerged. The GGAER rebate was an important opportunity that encouraged them to reorder and re-prioritise their physical adaption plans. They engaged with the process of change as a team, Cara making the money, Edward and Cara planning, and Edward enacting the research and the change. Veronica also helped with the planning and changes however she could.

7.5.2 Susan's experiences being resourceful

Susan, a retired lady who lived alone, made efforts to be resourceful and energy efficient at home (Appendix T, table T-3). In order to respond to her strong resourceful drive Susan made sure she kept the sun off her new fridge.

Susan reported that her background experiences in the civilian military and on a farm as a child and practicing affordable living predisposed her to be resourceful.

I have pay as you go ...Well myself and a lady from unit one..... we took part of the trial for pay as you go... Oh – people say why don't you have normal [electricity meters or bills] - because you are more careful with your power. Because we were bought up in the country. We had tank water and dad was strict with us turning lights on and off. I mean if you turned lights on too many times he'd say 'thruppence..... sixpence!'. It got taken out of our pocket money. I am very careful with water use with being bought up on tank water...I don't let taps run unnecessarily. I try to be very mindful of all those sorts of things. If I find a dripping tap I get mad, like in public toilets (summer interview 12/03/08).

Whilst Susan is skilled at crafts and is good at planning and organising, she has some critical capacity deficits in regards to making physical adaptations. Susan lives on a pension because of a physical disability, using a walker to move around. Her pension means that she has to save up and plan any physical changes carefully. Her disability means that maintenance, cleaning and adaptation jobs are difficult. The capacity issues are somewhat lessened because Susan is part of a close-knit family who help Susan with difficult jobs like seasonal hanging of curtains and heavy lifting. The family even used their group buying power to purchase Susan's house (in consultation with her) so she could live comfortably and affordably. In return for her family's care, Susan pays the family rent; looks after young family members; and house sits and minds family pets whilst her family are away.

Susan's house is a strata-titled, standalone, small two bedroom townhouse. Susan had lived in the dwelling for 11 years when we met. The kitchen was small and received low angled sun all morning, all year (see dwelling plans and solar access in Appendix L). The small area of the kitchen and the direct sun meant that the fridge sat in a sunny position. By 2007 Susan's old fridge was not performing very well and needed to be replaced. A visitor commented that the sun on the old fridge would affect its performance. This comment from her friend led her to think that not only did she need to buy new fridge, she also needed to resolve overheating issues from the sun hitting it at the same time.

As Susan began to look around for a new fridge she heard the same advice about the sun from others: 'I just got talking to the people in the shops and that was something that they actually pointed out, to keep the sun off it' (autumn interview 02/06/08). The 'proof' of the need for a change of fridge position (and management) was growing from various advisors and examples. When visiting her sister some time before, Susan had observed that her sister's freezer 'was under a window and she had an old big floor rug folded up on top of it to prevent the sun from affecting it' (autumn interview 02/06/08). Susan had a freezer, but had it in the dark, so had not realised the potential of the insulating practice for her fridge. Always prepared to add or change dwelling practices if they improved her resourcefulness, Susan processed options, and planned to move in the fridge at the same time as making other changes

that were needed. Having family as landlords meant that Susan knew she had a stable rental space and could afford to fit new curtains. A new position was consequently created for the fridge in the kitchen and, at the same time, new curtains were made to better protect it. Susan organised family to come and help move out the old fridge and move the new one in and set about organising the new curtains.

Two sets of new curtains were made so she could change them seasonally, as she did for comfort elsewhere in the house. During the autumn interview Susan explained the cycle of seasonal curtain changes she now used to limit the amount of sunlight hitting the fridge.

In the summertime, I don't have curtains at the kitchen window I just have a lace frill, but in the winter time to keep the sun off the fridge I put up cotton curtains. I usually put them up about the beginning of May and take them down early to mid October when the sun is above the eaves (autumn interview 02/06/08).

In summary, Susan's background, her prior knowledge and her experiences supported her willingness to consider the problem of the fridge's age and inefficiency. Susan's decision to protect her fridge from the sun came from years of experiences that went back to her childhood. Susan was exposed to an onslaught of examples and advice from others. A gradual gathering of knowledge and experience from these various sources influenced Susan so much that, in order to be make sure her fridge run efficiently, she replaced her fridge, hung curtains and instigated seasonal curtain practices. By acting to make all the changes at once, Susan was able to ask for help from her family once, rather than many times. Susan was therefore able to solve two problems at once: how to move the fridges (in and out) and how to stop sun hitting the fridge.

7.5.3 Henry's experience being disempowered within the home

Henry, a man recently separated from his wife, lived in a cheap and basic rental unit (Appendix T, Table T-4). He considered hanging new curtains in the unit but decided against it. Henry's experiences with decision-making in his unit provide some insight

into a situation where making physical change does not make logistic or financial sense.

Henry supported himself with a casual, seasonally affected job in food production and was therefore careful to choose a rental that was affordable. The rental is a ground floor unit that is part of a block of single storey units, all of which were 40 years old and in original condition. As such, the rental only provided a basic standard of accommodation.

Henry engaged with the study because he thought researchers probably would not have much exposure to rental situations like his.

You needed to see some of these areas. See this is just a low income rental location. It is pretty basic. I took it for that reason. I am just a separated [from my wife] individual male and I thought well, my needs are not that great and there would be a great deal of other people in the same situation, whether they are male or female, ... endeavouring to be in low income rentals (summer/autumn interview 18/04/08).¹⁵¹

The unit is a basic rectangular plan with small living, bedroom, kitchen and bathroom/laundry areas sitting next to each other (see dwelling plans and solar access in Appendix L). Except for the bathroom/laundry area, the house is semi-open-plan with partitions, but no doors, between rooms. The house receives very little direct sunlight because the units all line up north to south on the long thin block and sun can only enter through eastern and western windows. There are no northern windows. High fences along the east and west sides create overshadowed, cold microclimates around the units. The living room sits on the east overlooking the driveway, which runs parallel to the units and acts as an entry way for all the units. The bedroom area is in the middle of the unit and therefore receives very little natural light.

In addition to the poor positioning, the thermal resistance (and the sounds resistance) is poor. 'I don't think it is a very heat retentive house' Henry explained, 'these places

¹⁵¹ As I received Henry's response to be involved in the research later than others, Henry's summer and autumn interviews were conducted in one sitting and winter in another.

leak, leak like sieves' (winter interview 20/08/08). One external wall is thin fibro and the other, in the living room, mainly consists of a large, steel framed and single glazed window, providing very little thermal resistance (see materials of houses and thermal resistance in Appendix M, Table M-2). The single-thickness concrete block partition walls; the uninsulated, flat, corrugated iron roof and the uninsulated concrete slab floor also provide little thermal resistance.

Henry spent a cold winter in his unit and so had used a plug-in heater to manage the cold. The unit was not overheated though. Henry thought that Tasmanian householders (him included) were a particular breed in regards to comfort. He was not surprised I had been finding houses were cooler than the United Nations suggested indoor environments should be.

Yeah, well people are adjusted to it or accustomed to it. A lot of people, if it gets warm they consider it stuffy but that is mainly because they don't ... allow the air to circulate, so ... they are not getting the benefit of the warm. I also believe that the fact that we persevere with colder weather conditions is why we suffer a lot in Tasmania from cold-related illness such as rheumatism, [and] arthritis (winter interview 20/08/08).

There were changes that Henry wanted to make to improve the passive performance of the unit: curtains would have been better than the vertical blinds that currently hung over the huge area of glazing in the living room; and reflecting light into the house would assist to improve the dim interior. He also needed a new washing machine (the one that came with the unit was broken) and a smoke alarm (it was also broken when he moved in). Henry felt that 'the main or most beneficial thing I could put in would probably be heat saving curtains, but the whole property really has no heating as such [and] it has no exhaust extraction for cooking' (summer/autumn interview 18/04/08).

Henry did attempt to alter and adjust where he could. He placed a mirror he was given in the living room to reflect natural light further into the unit and he attempted to alter the living room blinds.

These blinds are just poorly constructed and there are gaps in them when you close them, quite wide gaps. I just went into one of the places in town and got a

strip of curtain material and cut them, not very well, and then got some iron-on tape and joined the sections at the top, and shoved a bit of wire up in the top there, and hung them there; so that when you close them up of a night you've got a bit of privacy, so you can't look through the gaps [from outside to] inside. Also, you haven't got as much heat loss, I suppose (summer/ autumn interview 18/04/08).

The new strips of material on the blinds assisted with privacy a little but did very little to reduce heat loss. Henry then applied for a GGAER rebate so that he could install curtains in the living area and purchase the energy saving pack's shower head. As Henry thought more about the installation of the curtains and even purchasing the energy efficiency pack, he realised there would be no pay back in adapting. The curtains would need to be custom made to fit his odd window-wall and would not fit in another house. The showerhead was unlikely to work because the water pressure was poor. Henry was not afraid of renovating and making physical changes to homes; in the house he had owned with his wife, he had made changes, including insulating a ceiling and upgrading a bathroom. This unit was not his long term home though and was just a place to stay while he was in transition in his life. Importantly, he could not afford to outlay money for curtains that he would have to leave with the unit when he moved on. After thinking through the curtains, Henry felt that

sometimes you find that your rental... situation is such that the aspects of the building don't give you any leeway to improve it. I would put curtains up but there is no way I could actually do it without paying to actually put the rods and everything in myself. Then they become theirs [the Landlord's] because they are a fixture (winter interview 20/08/08).

Asking the landlord to make any change to the unit was also seen as difficult and risky.

Chasing these rental property owners and agents to get satisfaction is pretty difficult, that is what I have found by experience and I think most other people do. ... They [the Landlords] put rents up, they pressure in many ways and anybody that makes a disputation becomes a bit like somebody complaining about work place safety with employers, rocking the boat, 'ah, let's try and ease them out' (summer/autumn interview 18/04/08).

Henry realised that his tenure, his financial position, the low quality of the housing stock and his insecurity about his length of stay meant there was less of an argument for adapting. While Henry was restrained in what he could achieve in his current dwelling, he was still proactive in other areas of life, showing that a lack of capacity in one situation does not mean that a person or householder is (or chooses to be) uniformly disempowered. Henry simply adjusted his responses according to his capacity to have an effect.

Henry used his available capacity to incite change elsewhere and in broader societal systems and recognised that his effort, his agency, could be used in various ways (outside of the house) to bring about adaptations and improvements in living. Henry saw that governments and commercial systems affected his personal agency and the lives of others and he wanted to help make change for everyone. He therefore spent time writing to governments to encourage change and made efforts to ensure workplace health and safety laws were upheld in the place(s) he (had) worked. He also spent time writing to council about public transport, public infrastructure and to state and federal governments about workplace health and safety. His proactive social monitoring was also why he participated in my study.

Henry commented on the 2008 release of State and Federal government climate change papers which stated government positions in relation to climate change issues (phone conversation June 2008). Henry was concerned because of arctic melt and felt there were small actions everyone could be taking to help, but also felt we also needed large scale massive alterations to systems to combat climate change. He was worried that Australians still had an isolated mind set, particularly his generation and above. Henry was also concerned that change rested in educating our children about empathy to open children's minds to caring for the environment and society.

He was aware that trying to take action and make change could be seen as making trouble, that 'it is only a courageous group of people that actually stand up and do a lot about it [social and environmental issues], such as protest and such things'.

Despite this, he thought 'it is more important to have empathy with your surroundings' and to take action because 'there are many other people that build up a

resistance in their mind to what is going on' and do not act (winter interview 20/08/08).

Despite being proactive where he could, Henry had experienced circumstances where his lack of adaptive capacity, low income^{and} limited power had caused him to be disempowered. Acting alone in his home for change, he knew, was not currently an option. After thinking through possible adaptations and deciding there was no pay-back, Henry decided to again focus his time and efforts on changing other scales of social systems through representation and communication for the benefit of both himself and others.

7.6 Key findings of adaptation analysis

The stories presented above and the tabulated stories of physical housing adaptations in Appendix T (tables T-2 to T8) provide insight into the various influences affecting adaptation processes. Isolating the adaptive characteristics and influences from stories (Appendix T) is useful when attempting to design policy and interventions; and developing understanding of adaptation more generally. This section brings attention to the key points from analysis of the participant stories and in doing so answers the second half of the chapter question *what can be learnt about how to support residents in improving the sustainability of dwelling practice and dwelling fabric?*

Chapter findings are described according to the categories used for analysis. The discussion begins by relating findings around the overall processes of adaptation (problem-solving), adaptation goals and strategies used, as these are fundamental aspects of any adaptation process. The discussion then moves onto other prevailing influences: capacities; connections, information, networks and relationships; background experiences; occupant relationships; adaptive skills and methods; relationships with dwelling spaces; and values. Findings offered here are often discussed under the same headings used in chapter six and are intended to build on that chapter's findings. While findings discussed here are drawn from physical dwelling adaptation experiences they are often also relevant to practice adaptations.

7.6.1 Problem solving (adaptation) processes

The decision-making and problem solving stages observed in stories of practice change are again evident in the stories of physical change to dwellings. Problem solving still: progresses through key stages; is initiated via a prioritised pressure or catalyst; progresses over what may be long periods of time; builds on previous understanding and solutions; and entails assessing and testing of solutions.

Problem solving for physical adaptations did progress somewhat differently due to the materiality and permanency of physical change, as well as increased need for money and skilled capacity to make changes. The permanency of solutions, the multiple actions required, and the technical complexity involved meant that problem solving had to be better planned and more cautiously enacted than for practice changes. It was difficult to recover from unsuccessful physical changes, as Mary and Martin's experience with a leaking roof shows. The permanency of physical adaptations meant that testing and assessment were less likely to lead to adjustments of the current physical solutions. Instead, testing and assessment were used either: to develop and refine new practices that supported the new physical changes; or to learn what to try and what to avoid when making change in the future.

Considering and then also adapting physical dwelling features were regular activities for most household participants. The popularity of adapting dwelling features highlights the strong drive householders had to make change. In Australia 'a craze for home renovations is one of the defining elements' of contemporary life (Allon 2008: 12). The long-term commitments of time and effort that are required to make physical change and progress through the problem solving/decision-making processes of physical adaptations was well understood by household participants. Martin and Mary elaborated on their experience of the Australian renovation culture.

Martin – A big thing amongst some people I knew was renovating. I guess I am talking 30 years ago when people would buy this cheap terrace in Brunswick¹⁵²

¹⁵² Brunswick is an inner city suburb of Melbourne, Victoria, where old, run down houses were gentrified over a period of decades.

or something and then they would do the renovations, a lot of it themselves and it would mean for years they were living in this dump...

Mary – And often they wouldn't get it quite finished.

Martin - ... We had some friends ... there are parts of the house not finished after 35 years. ...

Mary – Kath and Kim¹⁵³, Kath said one time 'we decided that the best way to save our marriage is to renovate and live in the unit while we are doing the renovation' (laughter)! And of course it [the Kath and Kim renovation] is a disaster, they are fighting constantly (winter interview 18/08/08).

Householders regularly had ideas for physical adaptations that were not currently achievable. 'Shelved' or stored adaptive ideas were kept in mind in case the opportunity arose to enact the change in the future. Helen, for example, had many ideas for physical adaptations but had to wait until she had more time and money to achieve them. Cara and Edward, on the other hand, were at a stage where, with the support of the GGAER rebate, they were finally able to enact one of their thought-through, stored solutions. Solar power was an adaptation that was often considered by householders (for example, Troy) and stored away as an adaptation they may work towards in the future.

In overview, the popularity of adapting dwelling features, and the extensive amount of time householders spend on present and possible future adaptations, provides many opportunities for interventions to connect with and encourage householders. In addition, interventions could also find ways to encourage householders to take action on energy efficient and comfort adaptations they have already thought through and have stored for the future.

¹⁵³ 'Kath and Kim' is the name of a popular Australian comedy series about a mother and daughter (Kath and Kim) and their escapades in suburban Australia.

7.6.2 Dwelling goals and strategies employed

Goals were informed by needs and cultural expectations of what functions dwellings should provide. As would be expected for people interested in the GGAER rebate, goals of comfort and energy efficiency were regular drivers for participants' physical dwelling adaptations. Comfort was *always* one of the ultimate goals of physical dwelling change. In contrast, energy efficiency was often a means to another goal, such as to be resourceful, to live affordably, or to be sustainable.

Goals for energy efficiency and comfort were regularly coupled with other goals, such as improving aesthetics, providing shelter, and creating areas for food production. That there are multiple drivers for any act of adaptation has implications for the way interventions are designed. Crosbie and Baker (2010) argue that for energy and comfort interventions to be successful, they need to understand other goals, such as aesthetics, that are influencing decisions made by householders.

The long list of adaptations householders aspired to mean that, as with practice adaptations, goals had to be prioritised. Priorities were guided by various drivers, for example: Cara and Edward prioritised physical adaptation goals according to their current capacities; and Mary and Martin prioritised physical adaptations that would keep Mary physically comfortable. Notably goals from other aspects of life could override goals for adaptations, especially if those other life goals required money allocated to adaptations.

Householders used a range of strategies to pursue their goals to make physical change. As with practice adaptations strategies varied due to available capacities and other influences such as underlying value sets, background understanding and available information. Physical change strategies could broadly be grouped as approaches that: improved the physical dwelling space's passive performance in terms of comfort and energy; improved or introduced technological systems and appliances to meet a function more efficiently; and, maintained body-scale comfort. Improving the passive performance of the dwelling space was achieved through making change to the house or the garden space and features and included adding insulation; making more indoor space; hanging doors to create better zoning; hanging

curtains with pelmets; altering the vegetation to moderate the micro climate; and producing food. Technological solutions included introducing new fridges, heaters and SHW systems. Body-scale strategies included adding more clothing, setting up blankets next to chairs, and installing electric blankets in beds.¹⁵⁴

The adaptation stories show that technological strategies and solutions were popular and, in a number of cases, were the first solution thought of and tried.¹⁵⁵ The preference for technological strategies likely comes from a common view that installing technologies is the easiest way to reach goals and to solve problems. The often slow and logistically complicated upgrading of the house building shell, that accompanies some passive adaptations, can make passive strategies appear time-consuming and complicated. The potential of passive strategies can also be poorly understood. Technologies, on the other hand, can seem more tangible than invisible insulation or double glazing, and their effects are more directly recognised. In addition, technologies are often sold as individual products that are easy to conceptualize, carry, move and install. As such, technologies are often heavily marketed and information on them is therefore more readily available.

Preferences for technological solutions indicated householders liked easier, more familiar and faster adaptive solutions, even if the solutions needed supplied energy to run. Time and complexity, therefore, looked to be key influences on the choice of strategies used to meet goals. Hot water replacement provides a good example here. Both stakeholders and householders pointed out that people would choose standard electric element hot water systems (EEHW) over SHW systems most often because of the ease of replacement, the complexity of solar technology and the difference in cost. Often hot water system replacements were urgent and if SHW had not been previously considered, there was little hope that it would be chosen over an EEHW unit.

¹⁵⁴ These strategies and how they were currently used by householders during the interview period is discussed in chapter four.

¹⁵⁵ Susan, Olive, Frederick / Keira, Trent, Lorraine / Robert and Mark all prioritised technology as a solution as they all installed new heaters or technologies before embarking on passive building shell upgrades, or with minimal passive upgrading beforehand (Appendix T, Table T-1).

Strategies chosen using poor planning processes or strategies affected by poor installation led to unsuccessful or problem-prone outcomes. Mary and Martin planned well, but were let down by poor installation of their roof and poor follow-up by the installers when there were problems (table T-8). Del and Kirk (chapter 5, Appendix S) did not plan well for effects of the introduction of the SHW system and also experienced a sub-standard installation process. Householders often failed to consider that a physical adaptation may have negative effects. When installing insulation, for example, householders planned to improve winter heat retention, but did not realise that ceiling insulation could limit heat loss from inside houses in *summer* as well (which would be amplified by limited ventilation).¹⁵⁶

Despite the downsides, the range of strategies used and the assessment and prioritising of goals that I witnessed does suggest that householders are reasonably thoughtful and careful and have reasonable skills in problem solving. Interventions could build on these strengths.

Inconsistent outcomes, the complexity of problems and the multiple goals of any given adaptation suggest that more understanding of the solution processes people use would be helpful when designing interventions. In addition, inconsistent adaptive outcomes suggest that expert help in planning, enacting and assessing adaptation strategies could improve the chance of adaptive success.

7.6.3 Capacities and their dependencies

As occurred with dwelling practice adaptations, capacities were important to physical adaptations and a lack of any needed capacity caused critical barriers. Adaptive capacities particularly important to physical adaptations were: having available finances; skills in planning, project management, handy skills, craft, and technical understanding; health and personal mobility; time to conduct changes; the ability to trade capacity or use unpaid capacity; access to information; and connecting with

¹⁵⁶ This was a problem for Helen, Susan, Frank, Mark, Steve and Gwen, Cara and Edward and Veronica, Mel and Trent.

others and networks. Capacity related to finances, skills, health and mobility, time and exchanging capacity are elaborated on further.

Finances and the GGAER rebate

Financial capacity was important; money was needed to purchase materials, skills and labour. All households, except one, were on constrained budgets due to limited earning capacities that arose because of parenting duties, study, retirement, illness, physical disability, and carer duties. Despite limited financial capacity, most households were able to save for important dwelling adaptations. The slow rate of adaptation was often influenced by the time it took to save money for the next adaptation. For the GGAER retrofits most householders saved from wages, pensions or superannuation allowances and a couple of households used money from loans.

Rebate programs like GGAER provide encouragement to make physical adaptations for energy efficiency by improving financial capacity. Although only a small program, the GGAER program did motivate householders to consider, prioritise and act on previously unobtainable physical adaptations (for example Cara and Edward); consider new possible solutions for any given problem or goal (for example Helen); and undertake more physical changes than were planned in major renovations (for example Vanessa and Paul).

The way GGAER rebates were delivered to participants affected their stress levels and financial capacity. SLT were aware of this and so paid GGAER rebates direct to suppliers so overall monetary outlays were reduced for householders. Some participant householders were also eligible for Federal Government rebates. The federal rebates were slow to be delivered to households and could not be directly paid to suppliers and so caused financial stress. Cara and Edward's were particularly anxious to receive the federal rebate because they had taken out a personal loan to buy their new SHW system.

If rebates are the only encouragement on offer in an intervention, people like Henry, who have no money to spend on home improvements, will be excluded (Productivity Commission 2005). Helen was dubious rebates would have much of an effect in her community because many of the people she knew could not afford appliance

installations or larger adaptations at all. Rebates will therefore only engage a proportion of households and leave households with the lowest incomes without any support to make adaptations. Interventions using rebates alone are therefore unlikely to drive the amount of sustainable dwelling change sought in low income communities; other avenues of intervention will be required.

Householder experiences with rebates show that engagement with interventions and adaptation outcomes can be compromised due to problems with financial management. Interventions need to be designed with understanding of household financial management techniques or they are likely to cause significant amounts of stress, some financial instability and could also exclude low income householders from utilising intervention support.

Skills and technical understanding

Other capacities helped householders to circumvent financial issues. Skills in planning; design; problem solving; information collation and synthesis; handy do-it-yourself hardware and craft capabilities; and the ability to understand and use technologies flexibly were all extremely useful in physical adaptations.

No matter what, all householders *had* to have some capability in problem-solving, planning and project management skills (as a minimum) in order to enter into adaptation processes. There was evidence that householders were on the whole reasonably thoughtful and skilled with problem-solving and planning and some were also skilled at project management.¹⁵⁷ Problems were thought through carefully and thoroughly, and often also creatively. When capacity was lacking, new strategies and solutions were sought to work around barriers. More sophisticated (quasi professional) decision-making, design and research skills, and understanding of energy efficiency were also apparent in four households. Mary and Martin, Cara and Edward, and Vanessa and Paul all provide examples of households who educated

¹⁵⁷ Such strengths in key skills may be concentrated in this participant group.

themselves on energy efficiency, passive design, construction processes and technologies so they could plan and enact their adaptations carefully.¹⁵⁸

Handy do-it-yourself hardware skills and related manual labour skills were also required to complete physical adaptations, but were only available to 12 participants in 11 (of 17) households. Most who had these skills only had basic handy skills. Craft and sewing skills, while only available in four of the 17 households, were also useful for physical adaptations, particularly for curtain-making and hanging. Without handy and craft skills, householders had to source much more external capacity.

Having handy and craft skills meant that householder's were in a position to work with second-hand and free materials in their adaptations. Refinishing and utilising old fixtures and fittings provided opportunities to be more resourceful with materials. Troy and Nat and Vanessa and Paul provide examples of households who used second hand materials in their renovations. Troy made efforts to refurbish and old door and Paul refurbished and rehung old sash windows and an entire old house.

Understanding of technology and technicalities of dwelling were useful adaptive skills to have. Positive adaptation outcomes were helped along by understanding of the technicalities of dwelling such as the house structure, fixtures and fittings; installed technologies; and heat-flow cycles through the house. In addition understanding of the electrical supply system, the appliances and how they consumed electricity was useful.

Householders who recognised the importance of understanding technology and technicalities did seek advice. Mary and Martin sought design and energy efficiency advice. They had to consult a number of people though, because technical understanding of energy efficient home improvement is separated into a number of separate professions. Consulting and collating the advice of different advisors was frustrating. Mary and Martin, along with some of the other householders, felt there was a place for project managers who could understand the specifics of energy efficiency and the technicalities of both the products and the house at the same time.

¹⁵⁸ Martin and Mary even developed a design brief, which is unusual but extremely helpful.

Understanding specific appliances was also useful. Martin and Edward are examples of householders who made efforts to understand the performance of newly installed appliances so they could run them optimally. A lack of understanding of the performance of an appliance, for example in Olive's case, can cause confusion and energy inefficient use of the device.¹⁵⁹

The influence of particular skills on adaptation processes and outcomes suggest that intervention designs need to both consider what skills householders have available and support improvement in critical skills.¹⁶⁰ Improving householder skills seems a relatively easy task that could be conducted through interventions in various forums, for example, community talks, or hardware store education nights, community supported skill sharing for disadvantaged youth, or formal college courses. Henry thought that skills development was essential in situations of serious disadvantage, especially for disadvantaged youth. He suggested that the 'men's sheds'¹⁶¹ program could be expanded to provide young adults with mentored assistance to learn dwelling adaptation skills.

Health and personal mobility

The health status and personal mobility of householders influenced physical adaptation outcomes as they did in adaptations of practices. Illness both motivated householders to undertake changes to physical features and limited householder capacity to make physical changes themselves (for example, Susan and Mary and Martin).

Stress was an issue of health and wellbeing that was experienced in many adaptations due to issues with project management; negotiation with trades; finding and

¹⁵⁹ Another participant, Mark, whose story was not tabulated, also provides an example of a lack of understanding of technology and technical systems (see: Gabriel et al. 2012a). Mark relied heavily (and had to trust) in the installers and the technologies themselves to do their job without much input or management.

¹⁶⁰ Skills education to support dwelling adaptation for energy efficiency and sustainability is advocated by the 'Transition Towns' movement, an international movement that encouraging reduction of oils dependency to create more resilient adaptive communities (Hopkins 2008).

¹⁶¹ Men's sheds are places where men can teach young men handy skills. Whilst this particular movement is for men, similar movements could also be established.

managing money; and a lack of technical and construction understanding. Stress, as with other illnesses, limits the capability to enact tasks, including when managing comfort and energy use and during adaptations (Brunner et al. 2012). Cara, Mary, Olive, Del and Kirk all reported being stressed by the process that was involved in their GGAER adaptations. Stress developed in adaptations due to time pressures; lack of understanding about the rebate requirements; and, financial management (for Cara and Edward this included their personal loan). Troy also reported being stressed when his door renovation did not go to plan and Henry was too stressed by other aspects of life to even begin to adapt. The effects of stress on adaptation are not well understood, yet appear to be a barrier to adaptations progressing. Further understanding of this emotion and its effects would be helpful when designing interventions (Anderson et al. 2001).

Time

Householders had to make large amounts of time available for physical adaptations; often more than was needed for practice adaptations. Lack of time to think through problems and/or act on adaptations was a significant barrier to the progress of adaptations. Some householders (for example Vanessa and Paul and Cara and Edward) managed to speed-up physical adaptations by inputting large amounts of time, effort and money.

The GGAER rebate did help to speed-up physical adaptation processes that were hampered by monetary barriers. Significantly though, all the householders who used the rebate offer had already recognised that energy efficient adaptations were useful and had invested time thinking through their problem in preparation; they were motivated and poised to act. Conversely, the time limit on the rebate also limited household involvement because many decisions and activities had to occur relatively quickly: money had to be found; research had to be conducted; technologies had to be purchased; trades people had to be engaged and the installation had to be completed all within three to six months (depending which round the rebate offer was made). Interventions that have time limits may not allow householders the time they need to take all the necessary steps to act. The Green Loans intervention (introduced in chapter three) provides an example of an intervention where it was

wrongly assumed that financial support would be enough to encourage people to adapt quickly (Australian National Audit Office 2010a).

For physical adaptations that are made gradually, the longer the time-span people had lived in their dwelling, the more likely they were to have adapted, especially when the occupants were conducting the physical adaptations themselves. Regular house moves can therefore be seen as a barrier to physical adaptations. Problematically for adaptation, Tasmanians, and Australians more generally, are quite mobile. A representative Australian survey (Australian Bureau of Statistics 2009) reported that 40 per cent of Tasmanians have lived in their current dwelling for four years or *less* and around 40 per cent of Tasmanians had moved at least once in the last five years. Renters (as opposed to owners with or without mortgages) were the most likely households to have moved in the last five years and additionally were also more likely to be younger adults and living on a lower income. These trends suggest that young householders, especially young renters, are likely to move house in timeframes that limit opportunities for physical adaptations and that older householders are more likely to remain in houses long enough to adapt (ibid.). Furthermore, it is likely that it is actually low-income households who have to move most often and therefore have less time to conduct adaptations.¹⁶² In the case of a household that is moving, money used for any ‘speedy’ adaptation would likely be spent on aspects that improve resale value such as aesthetics and less likely be spent on invisible comfort and energy efficiency features.

Exchanging capacity

Whilst some households had the ability to undertake physical adaptation works themselves (working as a team and using all the household’s adaptive capacities), many households needed to use capacity from outside the household. Where a capacity was missing from inside the household and the planned adaptation had become a priority householders would borrow, exchange, or pay for capacity to

¹⁶² The move rate is complicated by the higher likelihood that low-income householders and especially renters are more likely to live in uncomfortable and energy inefficient housing anyway.

achieve their goal. Householders exchanging skills (as opposed to paying outright for them) relied heavily on their network of family, friends and community.¹⁶³

There was widespread use of builders, electricians and plumbers to complete physical changes. However, if a dwelling had a handy-skilled, able-bodied occupant, trades were used as little as possible. Households who had to limit their use of paid trades but needed to bring in extra capacity had to work more creatively and borrow or swap capacity. Access to and utilisation of unpaid skills outside the house distinguished a particular sort of adaptation technique and also distinguished households in terms of general access to capacity. When people were in a familiar community group or network they appeared more able to access unpaid help. Mary and Martin and Vanessa and Paul, having only recently moved into the State a couple of years before, did not report using much unpaid community help. Having moved over a few suburbs Henry also seemed to have moved away from his community and from viable outside capacity sources somewhat, but a new neighbour did provide him with a mirror to lighten up his dim unit. Susan, Helen, Troy and Nat, and Frank (Appendix S), on the other hand, were well settled in their communities and had access to outside, unpaid capacity. Most participants preferred to exchange capacity rather than borrow or take it from others. Exchanges of capacity often centred on swapping skills, time and effort. Knowledge and information was often more freely shared; there was less of a requirement for these capacities to be exchanged.

Susan's experience provides a clear example of adapting by exchanging capacity. Susan was part of a family and a community. Her inability to do all that was physically required around the house meant she sought help from others outside the house, often by exchanging capacity. Susan would use organisation, planning, communication and project management skills to organise and conduct capacity exchanges. In exchange for the capacity others provided her with, she would mind children, provide love and support, house sit, mind animals and engage with community groups. Susan didn't see her swaps as dry or emotionless transactions:

¹⁶³ This assertion is supported by Brunner et al (2012) who found that people embedded in their social network had more access to social capital to help them cope with fuel poverty.

she was part of her community and was a committed and loving member of her family.

For large or technical physical adaptation jobs, trades people were commonly required and had to be paid for. Organising trades people with the appropriate installation experience was a challenge for almost all households, especially for SHW installations. In addition, householders were concerned that installation jobs were not checked by standards organisations or government to ensure they were installed correctly and to the required standards. Householders felt success rates would be higher and fewer corrections to installations would be needed if there were more official checks on trade work.

7.6.4 Connections, information, networks and relationships

Each interaction householders had effectively connected them to a complex social network. Householders were aware of the reciprocal relationships they had with connections and networks outside their home, especially in their communities, and regularly referred to their problem solving being influenced by: family and loved ones, trusted friends, visitors to their house, neighbours, professional advisors; community groups; trades people, sales people and product suppliers; government systems and legislation; cultural expectations and the environment.

Information sharing and influences in networks

Information and knowledge that flowed from householder networks was reported to influence decisions made during adaptation processes. Information flows worked in parallel with the networks and connections people were exposed to and flowed through various avenues, many of which are not currently recognised or used in standard interventions.

Local conversations (over the fence and in the neighbourhood) helped householders to share their new adaptations and to send knowledge developed during adaptations out to their networks. Sharing adaptation experiences informed others about the successes, potential pitfalls and failures of change processes and was also a way of

gaining feedback and advice. Businesses involved in the GGAER program recognised the marketing value in neighbourhood chat networks and viewed the access they gained to these networks through the program as one of the benefits of being involved (business organisation interview 17/10/08). Participants found that their audiences were interested in hearing about adaptations experiences. Sharing their experiences over the back fence tended to motivate neighbours to consider making adaptations of their own.

Awareness of the GGAER program and other energy efficiency interventions was mixed. At least one member of each participant household understood GGAER well, because they had applied, but federal rebate and intervention processes were not that well known. Participants reported that neighbours and friends they talked to often did not know about the GGAER program or the federal interventions, which indicated that all interventions were poorly marketed.¹⁶⁴ This lack of knowledge of GGAER may not have been the fault of the program though as SLT made significant effort to target local shopping centres, libraries and the local council newspaper in order to connect with Glenorchy householders. Federal programs in contrast, did not use local marketing techniques and mostly relied on connecting with householders through government websites.

There were many examples of family friends, visitors and people from networks providing advice and information that influenced adaptations. Susan's experience provides an example of the real influence others in household networks can have on adaptation decisions. People who, like Susan, live alone may actually be in greater need of the connections with their network to support their decision-making than others, but it was not only lone householders who sought outside feedback. Mary and Martin and Olive all sought outside feedback from various networks. Despite community interconnections and community normative influences being used in interventions overseas to change behaviour in sustainability programs (Mackenzie-Mohr et al. 2011), the method is underutilised in Tasmania and Australia.

¹⁶⁴ In another study that explored energy efficiency upgrade activity of Tasmanian and Victorian landlords, participants had often not heard of major intervention programs or were unaware they were allowed to use the programs to upgrade rental housing (Gabriel et al. 2012b).

Trades and sales connections

Householders often sought advice from tradespeople, particularly builders, plumbers and electricians, who visited their homes to quote, install technology, or conduct other physical adaptations. Advice from trades was often sought before householders had decided what solution (adaptation) pathway they would take, so input from trades critically influenced the adaptation choices made. There were instances where trades people were the only advisors with any relevant understanding helping with the selection of technologies for adaptations. Troy's relationship with his plumber when replacing an EEHW system provides an example of the position of influence tradespeople hold. Initially, the plumber checked the hot water system and its failing valve and advised Troy that because valves were expensive he should replace the entire system. Troy took this advice a month or so later when the valve fully failed and engaged the same plumber to install a new EEHW system outside the house. Troy asked the plumber whether it was worth adding insulation to the hot water tank. The plumber advised that the hot water tank had all the insulation it needed as it was designed for outside use. Troy accepted the plumber's advice.¹⁶⁵ In contrast to the plumber's advice, home energy efficiency advisors and studies have argued that standing heat loss from hot water cylinders can be significant so it is worth adding extra insulation to hot water tanks (Pollard et al. 2008: 10; Sustainable Living Tasmania 2007b). Troy and I discussed his conversations with the plumber and what extra insulation on his water tank may achieve. Troy had actually thought extra insulation on the tank was a good idea but had been confused by the plumber's advice.

Similar problems emerged around the advice provided by installers for the use of heat pump air conditioning heaters. Householders reported that tradespeople installing heat pumps advised that heat pumps should be turned on all the time on a minimum temperature, for example 16°C, and turned up when extra warmth was

¹⁶⁵ Other participants and also people outside the study reported being advised the same way.

needed.¹⁶⁶ This advice did not make a lot of sense to householders (or to me). I could not find any references to support this practice, especially when the housing was draughty, had poor thermal resistance and householders were only needing supplementary heating for a couple of hours a day. Vanessa and Paul and Mary and Martin received this advice. Despite questioning the advice, they were a little uncertain about rejecting it outright as they did not have any expert information to backup their reasoning.

Advice and information from product suppliers was also influential. Like trades people, sales people were often in direct communication with householders at critical points in their problem solving/adaptation processes and were often householders' only source of information for product selection and setting up new product related practices.

Householders were vulnerable to the influence of misinformed advisors. Whilst people appreciated the often practical advice provided by trades and sales people, unfounded advice from the advisors was also taken on board. Troy and Nat, Vanessa and Paul, and Olive were all provided with questionable advice that caused confusion, misinformed product purchases or suspension of adaptations. The willingness of householders to listen to unfounded advice (even when they often did not fully trust the trade or salesperson) may in part be due to the complexity of some of the technology being installed and the confusion this can cause; or due to householders not being able to source the same information and services elsewhere easily.

Both the sales and trades people were offering advice at a point of choosing a product and this point is well known to be where home improvement decisions can be influenced (Wilson et al. 2007). Product branding and the information provided by the supplier and sales people seemed to have a key role in both the selection of products and the choice of solution paths chosen for adaptations. Therefore clear and

¹⁶⁶ I received the same advice when my husband and I installed a heat pump. The advice seemed widespread as it was also discussed by attendees of an energy efficiency workshop called 'Chills and Bills' held by the Hobart City Council in 2008. Advisors at the energy efficiency workshop argued against using this heating practice.

factual information was required by householders when deciding on products. Hardware stores were particularly influential points of product sales¹⁶⁷ as well as being visited at other stages of problem solving processes, even before the householders had fully identified a problem to act on. If householders visited prior to understanding the problem, the hardware store could assist to define both the problem and possible solutions.

Householder position in the network of influence

Householders recognised that their ability to develop and use adaptive capacities and to make change depended on the right social, economic, and environmental conditions outside the dwelling. Householders were aware of their position in their community and social network as citizens and understood the importance of the relationship between them as householders and greater government and institutional systems. Henry worked in his role as citizen by reporting and communicating with government and acting as a representative at work to try to influence societal networks. His position as a citizen allowed him to lobby for change, despite having experienced disempowerment at the scale of dwelling.

Householders watched government activity carefully and critiqued it because they knew the influence it had on their lives, their housing, their communities, infrastructure and services and the environment. Maintaining awareness allowed for strategic and timely action on issues when needed. They recognised that government policy, trade and supply systems affected their ability to act both in the home and on broader issues of climate change, sustainability, and social care. For example:

- Martin talked about subsidies for electricity provided to major commercial industrial companies provided by government (to keep the industries in the state) and the impact he was having on the planet

¹⁶⁷ In relation to the product selection I noted that local brand names were often used to identify a product instead of using generic or technical names. Technical and generic terminology would often cause confusion in our discussions, which indicated that they could also cause barriers in information dissemination and understanding on a bigger scale. For example, ‘charlie fluff’, the name of an old brand of cellulose fibre insulation, was commonly used to describe cellulose insulation to me in discussions.

because he was connected (physically and financially) to that electricity supply system.

- Troy talked about the value of the railway line, freight systems, public mobility (through buses and trains), and the water supply systems. He was concerned about the management of these systems and thought such vital community infrastructure was essential to people and their communities.
- Mary, Martin, Troy and Henry linked carbon pricing to the forests of Tasmania and government decisions.
- Frederick talked about the health care systems and how its smooth running was important to his wellbeing and day-to-day resilience.
- Frank related his concern about methods used to develop and construct suburban dwellings. The developers of his suburb had been allowed to bulldoze the dwelling sites clear of vegetation, damaging the environment and reducing resources available to the community (including place aesthetics, wind protection, shade, and place identity) when they moved in.
- Mary and Martin and Vanessa and Paul felt that Tasmanian Government's energy efficiency and water efficiency policies were under-developed when compared to other states of Australia. They wondered why Tasmania had done so little to encourage energy efficiency when the climate was so cold.

Trust in connections

Whether or not householders would use the advice from other people was in large part based on the amount of trust they placed in the person giving the advice. Trust is known to make people more likely to absorb and act on information given (Cotter 2010; Mayer et al. 1995) and motivated householders to proceed with changes they may not otherwise have attempted. Having trust or confidence in a tradesperson, a neighbour or a friend meant householders often took advice with little assessment or critique of the information provided. The advisors did not need to be expert (even very knowledgeable) about the issue to be believed. When exchanging or buying

capacity, trust in the other trading party meant that transactions were less anxious and less stressful. Helen and her husband, for example, used a trusted friend, who was an electrician, to wire in their appliances and advise them about electrical issues. Despite some of the electrician's advice being incorrect, Helen felt comfortable that she had a friend helping.

If householders lost trust in an advisor they were not as likely to trust the solution the advisor provided and could lose faith in that solution-type altogether. The discovery that an advisor, supplier, trades person or friend's advice could not be trusted was remembered by householders and was likely to inform how they approached future adaptations. Mary and Martin, Vanessa and Paul, Cara and Edward, Del and Kirk and Olive all exercised caution when engaging trades people for adaptations because they had previously had bad adaptive experiences.

In overview, householders worked to become informed, to purchase products, enact adaptations and to influence other people and systems through relationships and connections they had with community, commercial establishments, and government organisations. The quality of relationships, how well informed members of the networks were and the trust people had in those relationships all informed adaptation outcomes. In cases where information was misleading, householders would have benefitted from having access to an informed, impartial source of factual information that could be trusted. Interventions design therefore needs to consider: key networks, key relationships within the networks; that people are receiving quality information through key networks and relationships; and whether householders can effectively feed information and experiences back into networks.

7.6.5 Background experiences

Adaptation problems being solved in the present were actually prepared for in the past when householders gathered background experiences.¹⁶⁸ Background experiences influenced the development of various values; adaptation goals and strategies; skill bases and other capacities (such as abilities to synthesise information and problem solve). Householders regularly used background experiences to contextualise discussion points, to explain their philosophical positions, their values and goals, and their current capacities for physical and practice adaptations. Background experiences were therefore important influences on both action and communication.

Background experiences, including knowledge, were gathered through both formal and informal experiences such as through schooling; childhood play; work; monitoring of community discourse and activity; watching others' behaviours; or conversations in shops. Householders reported particular experiences and settings being critical to the development of energy efficient and comfort related behaviours, skills, knowledge and values. In particular previous experiences with, farming; living in a sustainably focused community; Buddhism; political and environmental activism (for example against dam developments and timber felling); poverty; serving in the armed forces; and exposure to broad scale emergencies and upheaval (such as war, natural disasters and water shortages) were reported as having positioned householders to act for energy efficiency, comfort, sustainability and social care. Participants who had worked for the Australian armed forces (four people in various roles) thought the army had taught them to be practical; resourceful; self sufficient; and personally well managed. Participants who had had lived on farms (four people, two as children) felt they had learnt how to be resilient; manage resources carefully; act self-sufficiently; and appreciate the value of natural resources (such as sunlight).

¹⁶⁸ In decision-making and problem-solving literature scholars describe background experiences as 'prior knowledge' (Popper 1999) and 'knowledge and experiences' (Beckman et al. 2007). I have used 'background experiences' instead because the term encompasses more than just knowledge, and suggests that kinetic and intuitive understanding and skills may also be gathered in those experiences.

Susan and Cara, Edward and Veronica's experiences relate examples of how background experiences effect present day adaptation decisions.

Interventions could focus on encouraging energy efficiency and sustainability indirectly while background experiences are being gathered (way ahead of adaptations). Interventions that approach people before adaptations occur could connect with people at any age, in a variety of settings and could provide people with knowledge of how to dwell resourcefully, energy efficiently and resiliently prior to comfort and affordability problems arising. These early interventions can equip householders with skills to identify the most effective adaptation solutions. It is also possible to use an understanding of backgrounds as a way to connect and appeal to householders to consider energy efficiency in their dwelling adaptations.

7.6.6 Occupant relationships

A primary predictor of whether or not an adaptation will proceed appears to be the degree of occupant involvement with the endeavour. The number of people in the house; their availability; the relationships between them; the skills they contribute; and their preparedness to be involved all influence adaptation outcomes. Cara, Edward and Veronica were all focused on the same goals, and had a mixed set of skills and capacities, which meant they steadily progressed towards successful adaptations. Troy and Nat, Mary and Martin, Vanessa and Paul were all households (of couples) who shared dwelling goals and worked together closely to bring about dwelling adaptations. In contrast, Helen's husband initially felt dubious about the benefits of the new hot water technology and so left Helen to engage and drive the adaptation alone. Helen did convince him to help during the installation.

Animal occupants also had an impact on the physical (and practice) adaptations householders attempted (see animals and associated infrastructure in Appendix Q). Some dwelling adaptations were made just for the animals and many other adaptations were influenced by their presence. Troy was regularly at home during the day with his dog. He had installed a dog flap and a dog house on the deck, but also managed door opening and closing practices so that his dog could get in and out of

the house freely all year round. Other households (whose stories were not tabulated) also worked dwelling adaptations and practices around their animals. Lorraine and Robert, for example, had a large number of animals and had put effort into building enclosures for the animals in the yard. The couple had decided not to get new indoor blinds (which would improve the house's thermal resistance) because the cats were likely to shred them. The cats had, in fact, already shredded draught-proofing around the doors. Animal-occupants were clearly important and considered members of households, yet their effects on dwelling decisions appear poorly investigated. More investigation is needed into the way occupant relationships affect adaptations and also the effects that animals can have on adaptation goals and processes.

7.6.7 Adaptive methods

As with practice changes, there were a range of general adaptive methods being applied to progress physical dwelling adaptations. Adaptive methods commonly used in physical adaptation cases included:

- Ensuring physical structures and features were maintained and structurally sound, so that physical adaptations could be made as easily as possible.
- Solving problems with technology, because technology often seemed like the simplest solution-path.
- Ensuring adaptations were carefully thought-through and planned to minimise any costly and permanently-installed mistakes.
- Gathering knowledge and planning possible solutions ahead of time so that faster decisions could be made when the conditions were right to adapt.
- Assessing the viability of possible solutions prior to enacting them to minimise any costly and permanently-installed mistakes and to ensure the details of solutions maximised effectiveness of solutions.
- Conducting two adaptations at once. Making adaptations in parallel ensured that householders used their effort efficiently; limited

disruptions to dwelling as much as possible; and, borrowed or paid-for capacity was used efficiently.

Householders adjusted the scale and timing of adaptations to match their adaptive capacities. Some people therefore worked at adaptations gradually (for example Troy and Nat) and others made multiple changes in one large effort (for example Vanessa and Paul¹⁶⁹). Some adaptations replaced entire service systems (for example installing solar power generation or a self-sufficient food garden), whilst others only augmented systems already in place. By choosing the pace they adapted, householders effectively showed they had the adaptive skill to recognise their own capacity to make change.

In conjunction with other adaptive skills determination and persistence were also useful. When barriers were encountered during an adaptation, it was the determination and persistence of householders that pushed them to find a way to keep moving towards their adaptive goal. Ironically though, a lack of persistence or determination in any household may well be because the householders did not have enough general adaptive methods and skills available.

7.6.8 Relationships between householders and dwelling space

The way people viewed and related to their physical dwelling space also affected adaptations processes. Adaptations proposed, attempted and conducted were affected by whether householders: enjoyed their dwelling space; saw it as a long term home; viewed it systematically or object by object; expected the dwelling functions to be met through technologies without their involvement; had significant and pressing physical dwelling problems to deal with; and, felt the house had any resale value.

Enjoyment or dissatisfaction could lead to householders striving to make change. Helen and Henry expressed considerable dissatisfaction with their dwelling spaces. Helen's lack of enjoyment of the dwelling space generated various plans for change

¹⁶⁹ Vanessa and Paul undertook an extension, the creation of a very large food garden, the upgrading of housing shell and fittings, the installation of new technologies and the installation of a granny flat all in one go.

because it was her long term home. Henry's dwelling, on the other hand, was just transition housing, so he accepted he would not achieve great satisfaction with the unit and decided to leave the unit as it was.

Some householders did expect (or need) technology to achieve comfort and energy efficiency goals without much interaction from them.¹⁷⁰ This technically-supported relationship with dwelling space and dwelling functions lead to:

- a lack of interaction with indoor climate control features (particularly passive);
- limited flexibility in practices, which lead to more incidences of discomfort;
- high expectations of indoor environs always being comfortable; and
- too much focus on technology as solutions to dwelling problems.

These technology-focussed expectations and behaviours often correlated with poor comfort outcomes and increases or higher energy use.

7.6.9 Values

Value sets often drove dwelling adaptations by influencing dwelling adaptation goals and strategies. Comfort and energy efficient adaptation goals were driven by a wide range of values often based in greater goals such as affordable living, sustainability, health and being a good citizen (Appendix U). While the significance and implications of values as drivers has been explored by others, it is useful to identify the locally prevalent sets of values to incorporate in targeted local interventions (Barr et al. 2007; Miroso et al. 2011).

Significantly, discussions about values often emerged later in the longitudinal interview series after technical and logistic discussion points had been shared.¹⁷¹ The

¹⁷⁰ Del and Kirk; Frederick and Keira; and Mark were the most reliant on technology (see Appendices N, O and P). Mark was quite reliant on his technology. His experience is described in Gabriel and Watson (2013).

order of discussion may have been influenced by the interview schedule, but also appeared to be influenced by a 'getting to know you' protective politeness in early stages of the series of interviews. Hence, values were discussed after participants had assessed me and developed trust in me. In addition, values may have emerged later in conversation because participants had not verbalised a value or linked that value to their actions yet. The value discussions held during interviews suggest that exploring values with householders (in research or interventions) may require specific approaches and reasonable amounts of effort. A clear picture of values may not be able to be accessed by interventions through short surveys, short interviews and impersonal discussions.

Once values were brought into discussion, references to them emerged in conversations, often without direct questions being asked. People used many devices of conversation to express their values including examples of personal dilemmas, family situations, community issues, urban management, forestry (including carbon and monocultures) management, power supply and management, and government decision and effectiveness. Some values could be discerned from a focus on certain activities by householders; for example, Del and Kirk shared their people care values by expressing concern about the impact of electricity costs on families and disadvantaged people. Keira expressed her environmental and people care values by saying, for her, it was 'the world' that motivated her to make an effort with energy efficiency.

Importantly, even important values householders held sometimes had to take a back seat to basic dwelling needs, constrained living conditions and generally disadvantaged circumstances. Henry's housing situation, for example, only provided for basic dwelling needs in an affordable way, but did not allow him to live as energy efficiently as he would have liked, or to action other initiatives to increase his resourcefulness.

¹⁷¹ Terry, whose story is not tabulated, as well as Cara Edward and Veronica did however discuss values early on.

Values reported to drive comfort and energy efficiency adaptations regularly centred on the meta-values of: care (for people, animals and the environment); respect; acknowledging and maintaining interconnections / relationships with people; responsibility and active citizenship; the community; aesthetics; and resourcefulness (Appendix U).

People, animal, environmental and community care were commonly expressed values which were often acted on by supporting the health and wellbeing of others, their community and the environment. These values underpinned job choices; actions taken in dwelling and in the community; and awareness of world affairs and around social justice issues. Care values were even expressed in relation to products and materials, in particular, in relation to the management of timber product chains.¹⁷² In the home, care values were expressed through garden, animal and people care. Self-care values were not often mentioned but were evident through activity to improve comfort in the home (for example Martin and Mary) and householder's efforts to exercise regularly (for example, Frank). Self-care values also drove adaptations made to support ageing-in-place in the home (for example, Vanessa and Paul and Del and Kirk).

Respecting other people emerged as a partner value to care. Participants made efforts to act respectfully towards others, animals and the environment. The effort made to maintain respectful relationships with others was related to the high value householders placed on relationships and interconnections. Connection is known by scholars to be important to people; most people require healthy connections in their lives in order to stay emotionally resilient (Brown 2010; Goleman 2006). This study has also shown that healthy, productive relationships and connections support adaptation activity.

Responsibility and active citizenship, or being a 'good' citizen, also emerged as an important value set in many households. Care, respect and valuing interconnections and relationships all related to values of responsibility and being an active citizen.

¹⁷² A focus on timber is not surprising as Tasmania is a timber producing state and there has been much debate around forest and timber production and sustainability over the last 50 years.

Participants saw that they were responsible for themselves, the health of the environments in which they lived (from local urban environments to broader ecologies) and for broader societal issues. Responsibility was expressed in numerous ways: For Cara, Edward and Veronica responsibility involved acting to dwell more sustainably; and for Troy and Nat responsibility meant trying to reuse and save food and building resources. At the scale of the home responsibility fell mainly on the home owners; visitors were not expected to have the same responsibility to care for the house, which can be seen in Frank's and Steve and Gwen's stories (Appendix S and chapter six).

Being an active or 'good' citizen was linked with being responsible, caring and proactive in relationships inside and outside of the home. Being involved as a member of the local community, paying attention to how governments managed the community and the State, being careful with water and energy resources, and picking up litter were just some of the ways that people expressed their value of active citizenry. Because of their values of care, responsibility, active citizenship and valuing interconnections and relationships, the participants also talked about their concerns about the way energy supply and sourcing was managed in Tasmania, as well as the way the government managed electricity subsidies.

Aesthetic values affected physical dwelling adaptation goals, adaptive briefs and chosen solution paths. Maintaining certain aesthetic standards was important for a variety of reasons, for example to: preserve the history of the dwelling; communicate that the occupants had high standards of cleanliness and cared for their house; show that responsible citizens lived in the dwelling; create a visually pleasing dwelling environment; and, to maintain a modern look. Maintaining a certain aesthetic could also provide a sense of comfort. Vanessa and Paul's front garden, for example, was ornamental, but also contained fruit trees. The garden communicated, among other things, that they were a neat and tidy household; that they could contribute to the neighbourhood and would do their bit to keep things looking good; had some style; and were productive and resourceful people. As well, the garden and front porch were restored to the original style and era of the house, suggesting that they appreciated and supported the historical roots of the house. Interestingly, lighting was an important intersection of aesthetics and energy efficiency goals. In some

cases, values of aesthetics were strong enough to stop people installing compact fluorescents lights.

Resourcefulness was a regularly expressed, important value that translated into adaptation goals, strategies and skills. As a value, resourcefulness underpinned dwelling management performance expectations and activity for energy efficiency, comfort, and financial management. Resourceful values could be seen in various practices and adaptation goals, some of which were: minimising energy use; storing water resources; purchasing and revitalising of second hand items; passing of used items on to others for reuse; buying on sale; growing vegetables; composting waste; and recycling. Driven to be resourceful Troy and Nat minimised the use of their heat pump, only used one light at a time at night, refurbished a second hand door for an adaptation and bought food on special. Troy said ‘we are just like that [resourceful], you know... We just try to be efficient with everything’ (summer interview 28/02/08). The practical and efficient influence of resourcefulness as a value supports Miroso et al’s finding (2011: 16) (in their value study) that people are strongly ‘guided by what they believe is a sensible way to behave’.

Being resourceful meant that people only used what they felt was their fair share; shared; and appreciated where things came from. Householders generally identified with the idea of resourcefulness better than the idea of energy efficiency. The term resourceful was better understood by older participants, although younger generations definitely shared values associated with the concept.

Resourceful values and actions often appeared to be driven by the need to maintain living affordability and to care for the environment. Resourcefulness was a particularly obvious driver in situations where people had to make-do due to financial limitations (for example Olive and Helen), or where resources had been limited, such as on farms, during wars, or during civil unrest. Susan, like Steve and Gwen (Appendix S), honed their resourceful ways of living through background experiences on farms and in the military. Trent (Appendix S) was also driven by a need to be resourceful which he learnt growing up on a farm.

Associated with resourcefulness were values and capacities related to resilience and perseverance. Resourcefulness was also closely related to values of active and good

citizenship, as being resourceful meant householders were not overburdening their communities and government systems.

In overview, the householders showed that there were a key set of interrelated meta-values they commonly saw as important. Understanding local values sets such as these provides opportunities for interventions to connect directly with what householders see as important.

7.7 Conclusion

This chapter has explored the types of physical adaptations householders made to their dwellings and the factors that influenced their adaptation processes, in order to learn how to better design interventions to improve dwelling energy efficiency and comfort. Response to the chapter question was made by first presenting an overview of the types of physical adaptations households had undertaken; then by presenting stories of physical housing adaptation; and, finally by identifying adaptive characteristics (the processes, key influences and key relationships) that affected adaptation processes and outcomes for participant householders.

The analysis identified a large array of influences and relationships affecting physical dwelling adaptations in participant households. The prominent influences for physical adaptations are somewhat different to practice adaptations and therefore some separate consideration is needed in intervention design. The overview of physical dwelling adaptations showed that adaptation activity was regular and repeated in most households and was undertaken to meet different functional requirements, which included comfort and energy efficiency. Influences were identified in all adaptive categories used in analysis. The large array of relevant influences emphasises the importance of understanding the detail and variability of lived experiences of adaptation before designing interventions. Identifying influences highlighted avenues through which interventions can interact with households and their adaptive processes. Chapter eight further explores the way influences identified can be used to design effective interventions for comfort and energy efficiency improvements in the home.

Chapter 8. Measures for interventions and conclusions

8.1 Introduction

This, the final chapter, presents measures that may be used for intervention design, an assessment of the research approach taken, and overall conclusions. The chapter's primary task is to distil research findings into measures that can be used to support the design of interventions encouraging dwelling adaptations for energy efficiency and comfort for Tasmanians with low adaptive capacity. To achieve this, the chapter responds to the main research question *in Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?* The contents of this chapter are intended to complete the description of the research inquiry and to inform housing stakeholders (in government, commerce and social support sectors working to and affect housing outcomes). Measures discussed in this chapter have been distilled out of the discussions and conclusions of previous chapters.

This chapter is organised in five sections. The first section reviews findings from chapters three to seven. The second section discusses and assesses the research approach taken in this inquiry. The third section relates measures for intervention design based on findings from earlier chapters. The fourth section discusses future research that would assist to refine intervention designs and approaches further by improving understanding. The final section concludes the thesis.

8.2 Review of findings

The thesis investigated contextual influences affecting dwelling adaptations and lived experiences of dwelling adaptations in order to understand how interventions can be designed to further encourage dwelling adaption for comfort and energy efficiency, in households with low adaptive capacities (see Table 8.1). Chapter one introduced

the investigation by outlining problems with unsustainable housing in Tasmania and the difficulty of improving dwelling energy efficiency and indoor comfort (to improve occupant health and affordability and reduce environmental impacts) in situations where householders were disadvantaged. Key concepts were defined and a research question was proposed to develop measures that could inform the design of interventions encouraging energy efficiency and comfort improvements in Tasmania.

The research approach was described in chapter two by outlining methodological underpinnings, methods and the key heuristics used in analysis. Research methods used acknowledged context; concepts of dwelling and sustainability; the interconnections of social-ecologies; and the complexity of the research problem. Engaging with a multifaceted and somewhat unknown problem, the research took an incremental and emergent approach so that the research trajectory could be adjusted as new findings came to light. Background and context were investigated through literature reviews, focus groups with housing professionals (stakeholders) and contextual observation. In-depth, longitudinal interviews (and observation of their homes) were then conducted with 17 volunteer households. All the households had applied for rebates on energy efficient fixtures and fittings through the Glenorchy Greenhouse Action Energy Rebate (GGAER) program. Household investigations provided detailed and rich data of experiences of dwelling adaptations made to improve comfort and energy efficiency.

Issues of context relating to dwelling adaptation and intervention in Tasmania were reported in chapters three and four. Chapter three related: key historical legacies influencing dwelling change opportunities and culture; housing stock conditions; and renovation activity. The chapter identified that current housing stock had developed from legacies of: artificial transplantation of colonial society to Australia; a do-it-yourself building and renovation culture; legislation that focused on lowest possible standards, rather than quality; housing being provided as basic welfare; modernist design paradigms; mass production; and more recently, deregulation and market-driven housing development and design. In relation to dwelling stock condition, it was identified that large proportions of Tasmania's current stock are uncomfortable and energy inefficient and require adaptation if they are to support householders more

sustainably. High levels of renovation activity and a renovation culture in the state offer hope that interventions can work on the back of other renovation activities.

Chapter four further reviewed context exploring: concepts of equity, comfort and energy as motivators for dwelling adaptation activity; current intervention approaches encouraging energy and comfort improvements; critiques of intervention approaches; and theories that can help to improve intervention approaches. Concepts of equity, comfort and energy were shown to be accepted goals for adaptations. However, barriers did get in the way of these motivators. Review of interventions revealed that various approaches had been used (locally, nationally and internationally) to try to encourage better dwelling energy efficiency, comfort, affordability, and sustainability. These intervention attempts had often not been as successful as intended. In Tasmania, interventions used have been applied disparately and at relatively small scales. Observers have called for integration of various intervention approaches and the incorporation of understanding of the detail and complexity of householders' experiences into interventions. It was shown that using a process lens and understanding adaptation cycles can assist with this integration.

Chapters five, six, and seven related investigation of the dwelling stock conditions and dwelling adaptation experiences of participants. Chapter five indentified the dwelling conditions and key dwelling practices of households that related to comfort and energy efficiency. Overall the participant dwellings had poor thermal resistance which meant that supplemental heating was used regularly in cold weather and houses overheated in hot weather. Households did use various passive management practices, and were careful with their use of appliances; heating was kept to a minimum in most households. Solar gain opportunities critically affected comfort practices. Suburban lots regularly allowed better solar access to dwellings, and provided space for gardens which moderated the microclimate, encouraged physical activity and supported food production. In winter most householders lived indoors at temperatures lower than those recommended by the WHO general comfort guidelines. Electrical supply was poorly understood by many householders and, added to this, the information from suppliers was often inadequate for householders

to assess their electricity use patterns. Participants did, however realise their energy use was connected with a broader scale of systems and political management and reflected upon these connections. Overall chapter five's review identified opportunities for further change in physical and practice aspects of dwelling that would improve energy efficiency and comfort.

Chapters six and seven related stories of dwelling adaptation to identify how people engaged in adaptation and what influenced their decisions. Chapter six focussed on practice adaptations and chapter seven focused on physical dwelling adaptations. Householder stories offered insight into the nuance and contextual complexity of adaptation experiences. Key influences of adaptations were identified under the categories of decision-making and problem solving; timing of processes of change; dwelling adaptation goals; strategies used to meet goals; general adaptive methods used; and, other influences on the process including stakeholders involved, capacity issues, backgrounds, values, information flows, place relationships, and interconnections.

It was found that each household had a unique mixes of capacities and conditions; there were various forms of pressure that urged people to adapt; and various strategies and capacities were engaged to meet various goals. Despite the variation and messiness, common key influences emerged, for instance it was found that:

- comfort, energy efficiency and affordability were common adaptation goals;
- strategies used to achieve goals were affected by capacity, values, background experiences and knowledge, and social network interactions;
- values of care, responsibility, active citizenship, aesthetics and resourcefulness were part of what motivated adaptations;
- adaptations were easier to complete if they built on existing solution pathways;
- adaptive solutions were always tested and assessed;
- missing adaptive capacities would be collected through purchase or exchange of capacities;

- networks and information flows were important to the trading of skills and knowledge exchanges which were needed to progress adaptations;
- occupants living in the house, including animals affected adaptation goals, available capacities, processes and outcomes;
- background experiences and knowledge had an important role all the way through adaptations providing the value sets, skills, learnt strategies and adaptive methods with which adaptations were progressed;
- an array of general adaptive methods helped to engage with dwelling adaptations; and,
- householders often showed flexibility in problem solving and adjusted goals strategies and solutions in order to overcome barriers and progress adaptations.

The progression, characteristics and influences of physical adaptations did vary when compared to practice adaptations. Physical adaptations required particularly long problem solving, goal definition, design and planning stages because physical changes were often costly, complex and permanent. Key capacities for physical adaptations included having money, time, project management and handy skills and the opportunities to trades skills.

Chapters six and seven found that the participant householders consistently and persistently considered adaptive possibilities for the dwellings and acted for change, including for energy efficiency and comfort goals, when they could. Householders did often improve their dwelling circumstances through the adaptations they made. However, even comparatively 'fast' adaptations, progressed over relatively long periods of time. Well-considered interventions could support adaptation activity householders had disregarded due to a lack of capacity and could also speed-up adaptations somewhat. In all the chapters, all of the influences identified offer ideas for measures that could be used to improve intervention design to better encourage dwelling adaptation for energy efficiency and comfort.

Table 8.1: Summary of chapter content and findings

Chapter	Research Question	Chapter Content	Findings
Chapter 1. The challenge of unsustainable housing in Tasmania	<p>What is the problem? What are the aims and the research question that will guide the response?</p> <p>In Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?</p>	<p>Describes the unsustainable housing problem in Tasmania. Argues for dwelling adaptation with a focus on energy efficiency and comfort to meet sustainability needs in households with low adaptive capacity (often due to socio-economic disadvantage). Presents the research question and key concepts: housing, dwelling, adaptation, adaptive capacity, sustainability and describes Tasmanian's unsustainable housing situation.</p>	<p>Unsustainable dwellings in Tasmania need to be adapted to improve energy efficiency, comfort and equity. This research attempts to assist in this action by understanding the measures that could be taken by stakeholders to improve intervention design.</p>
Chapter 2. Methodology	<p>What is the approach?</p> <p>What are the methodological underpinnings?</p> <p>How did I explore the research question and meet the aims?</p>	<p>Describes the multi method (mainly) qualitative emergent research approach by outlining relevant researcher background, the methodology, research methods, participants involved and the rationale for analysis. The approach engages with the complexity of the problem and its context to generate key findings from the lived experiences of participant households.</p>	<p>The research approach was emergent, incremental and mainly qualitative to consider socio-ecological context and engage with complexity and lived experiences. Context was investigated through literature reviews, observation and housing stakeholder focus groups. Detailed understanding of householder experience was gathered through interviews and household observations. Key realisations around problem solving and critical relationships structured the analytic approach.</p>

Chapter 3. Tasmanian dwelling adaptation context	What colonial and contemporary legacies of dwelling adaptation are evident that may affect future interventions in Tasmania? What are the conditions of current housing stock, and the status of renovation activity?	Describes the dwelling adaptation context for energy efficiency, comfort and equity in Tasmania including historical legacies; stock condition and renovation activity.	Multiple legacies affect how we can now adapt dwellings; they can either support or hinder adaptation opportunities. Overall literature and focus groups indicate that Tasmanian housing stock is uncomfortable and energy inefficient and requires adaptation. The popularity of renovation may support further adaptation.
Chapter 4. Motivations, intervention approaches and adaptation processes	How do equity, comfort and energy efficiency influence dwelling adaptation? What intervention approaches exist to encourage dwelling adaptation for energy efficiency, comfort?	Describes contextual views and positions taken about equity, comfort and energy efficiency to establish them as motivators for dwelling adaptation. Major types of interventions used around the world are reviewed. Current understanding of the processes of adaptation are presented in order to provide the means with which to approach the complex issues of dwelling adaptation and household lived experiences.	There is recognition of the need for dwelling adaptation for energy efficiency, comfort and equity. Various intervention approaches have been used and tested. Critics argue that approaches need to be integrated and to better understand lived experiences of householders. Understanding of adaptation processes may help to integrate intervention approaches and better understand adaptation for better effect.

<p>Chapter 5. Physical dwelling conditions and practices among participant households</p>	<p>What dwelling conditions are experienced by household participants? How were they attempting to manage comfort and energy efficiency in their dwellings?</p>	<p>Physical dwellings conditions and dwelling practices relating to energy efficiency and comfort are described for the 17 households participating in the study. Reviews are made of the comfort perceptions of participants, features and practices affecting the dwelling microclimates, heat flow resistance, input and extraction of heat, venting, lighting, water heating, food growing and management, occupants, power supply perceptions and appliances.</p>	<p>Participant houses do not perform well for comfort or energy efficiency. Adaptations made a difference, but thermal challenges remained. Energy efficiency and comfort practices (and strategies) varied. Participants were generally careful with energy use, but many did not understand electricity systems. Householders changed their comfort behaviours seasonally and lived at comparatively cold temperatures in winter. Solar access was important.</p>
<p>Chapter 6. Explorations of change to dwelling practices in participant households</p>	<p>What happens when adaptations to practices are thought about, sought and made, and what can be learnt about how to support residents in improving the sustainability of dwelling practices and dwelling fabric?</p>	<p>Stories of adaptation to practices are shared and characterized in detail to identify what processes, relationships, stakeholders, capacities, backgrounds, information and values critically influence the adapting process.</p>	<p>Insight into key influences to practice adaptation was gained using detailed stories of household practices adaptations. Various influences affected change to dwelling practices including: occupants and their skills; whether change could piggyback on previous solutions; the values behind decisions; stage of life; outside contacts and information. Goals adjusted according to priorities. Comfort and energy efficiency were common adaptation goals.</p>

<p>Chapter 7. Explorations of physical dwelling adaptation in participant households</p>	<p>What happens when adaptations to the physical features of a house are thought about, sought and made, and what can be learnt about how to support residents improving the sustainability of dwelling practice and dwelling fabric?</p>	<p>Stories of adaptation to dwelling features are shared and characterized in detail to identify what processes, relationships, stakeholders, capacities, backgrounds, information and values critically influence the adapting process.</p>	<p>Physical dwelling adaptations emerged to be influenced by many of the factors that affected practice adaptations, but with some key differences. Due to the materiality of the physical change, the complexity and the expense, physical change had to be well planned. Various goals and strategies defined adaptive processes. Background experiences, information availability, ability to exchange capacities and values are examples of key influences.</p>
<p>Chapter 8. Measures for interventions and conclusions</p>	<p>In Tasmania, what measures could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for improved comfort and energy efficiency in households with low adaptive capacity?</p>	<p>Using findings from chapter three to seven, suggestions are made as to measures that can be incorporated into intervention design to improve intervention outcomes. These suggestions are intended to guide the design of effective adaptation interventions and to target stakeholders of housing organizations and in government. Conclusions to the research are made.</p>	<p>Critical characteristics and influences of adaptations need to be considered and interventions must be tailored accordingly if they are to be successful. Measures are suggested for improved design of interventions and for further research.</p>

8.3 Discussion of the research approach taken

This research has engaged with a complex problem related to sustainability and dwelling. The large number of issues and the diversity of stakeholders and householders whose choices, practices and needs required consideration challenged the idea of using a single method, or focussing on one aspect of the problem. I therefore explored ways to approach this rich topic matter and investigated in a way that would pay attention to the many interconnections and relationships that influenced its path. Alongside the practical research question and aims, I also explored the potential of: the ability of qualitative research processes to accommodate investigation of complex issues of dwelling and sustainability; and, the capacity of the fieldwork and analysis techniques used to relate legitimate participant stories and to engage with social-ecologies.

The inquiry consequently took an emergent, qualitative approach. The approach allowed me to collect nuanced and detailed data that acknowledged various scales of influences, interconnections, key relationships and many critical influences. I was able to acknowledge various perspectives and had space apply what I learnt along the way to later research stages. Qualitative methods also allowed me to engage with householder lived experience in way that was respectful and caring. From the exploration emerged complexity, but also commonalities of experience that provided structure for further analysis and useful insights.

However, there were some significant challenges with the approach I used. In particular, the approach required multiple meetings with stakeholders and householders, which was extremely time-consuming; and generated large amounts of raw data, which was overwhelming for a single researcher with few resources. In addition collecting detailed data on lived experience can be complicated to collate, analyse and translate (Engle 2011). These difficulties lead me to suggest that the scope of the project and the multiple methods used are not appropriate for small-scale research investigations. This approach requires larger groups of researchers to be involved and significant amounts of funding to support the interactive approach.

Through investigations of multiple scales of influence, of interactions and of relationships, this approach also sought to acknowledge social ecological influences on sustainable dwelling adaptations. The methods used did allow some acknowledgement of social ecologies but there is room for further improvement in the ways that these aspects of the research problem were investigated. More comprehensive acknowledgement of interactions, relationships and social ecologies more broadly would again require a larger research team and more funding, or a smaller research scope.

In 2013 there is a three year research project beginning that will review energy efficiency interventions being made in two communities in Tasmania. The project involves a number of researchers and is funded to conduct qualitative and quantitative investigations at both broad and detailed scales. Methods used in this doctoral investigation are being applied to the new project. I will therefore have the opportunity to improve the methods I used to approach complex dwelling and sustainability problems in this inquiry.

8.4 Measures recommended for interventions

Insights from chapter explorations are used here to generate a list of measures to guide planning, design and enactment of intervention programs encouraging dwelling adaptation for comfort and energy efficiency.¹⁷³ The measures suggested are intended to support improvement in the design of interventions so that interventions are more successful in application, especially in circumstances where householders have low capacity for dwelling adaptation. Measures listed include direct and indirect ways to understand, consider and approach intervention design. As with the thesis chapters, measures listed here endeavour to acknowledge the scope (the dynamics and variation) that may occur in adaptation experiences. Many any measures are suggested here; they would need to be prioritised if being used in

¹⁷³ Measure is used here in its meaning as ‘a plan or course of action intended to obtain some object’ (Little et al. 1992: 1297).

intervention design. Measures are suggested under three sub-headings: intervention design guidelines; priority measures for interventions; and then further research.

8.4.1 Intervention design guidelines

Incorporate understanding of context and lived experiences

Adaptation processes in householders are particular to context and personal lived experience. All scales and systems involved in housing in a particular context influence dwelling outcomes and therefore need to be acknowledged and assessed as possible points of influence in adaptation activity (Dalton et al. 2008; Franklin 2006; Guy et al. 2000). Reviews of context and lived experiences illuminate various influences including key institutional and government systems; critical stakeholders; dwelling conditions and practices; relationships and networks; information flows; capacities; knowledge bases; trades and sales positions and activities; householder and stakeholder attitudes; and driving values. With understanding of context and experiences, governments, community support organisations and commercial entities can come together with a local and detailed understanding of the types of support that householders need to make change to their habits and dwelling spaces for energy efficiency and comfort.

Conditions and problems that affect dwelling adaptation are unique to the place. Solutions that work in one place cannot just be transferred to other places because ‘despite seeming similarities among wicked problems¹⁷⁴, one can never be certain that the particulars of a problem do not override its commonalities with other problems already dealt with’ (Rittel et al. 1973: 165). Dwelling adaptation context was not well investigated during the design of the last two major federal interventions (Australian National Audit Office 2010a; Australian National Audit Office 2010b) and is not well understood in Tasmania. The government’s next round of interventions, beginning in 2013, are much more focussed on understanding

¹⁷⁴ Meaning they are complex, multifaceted problems.

contextual influences (Australian Government 2012d). From the findings I suggest that contextual studies need to assess:

- housing stock quality;
- government activity related to housing sustainability, housing energy efficiency, health and housing and building standards;
- commercial activity in relation to housing and housing energy efficiency;
- housing stakeholder activity and capacity;
- social and community support sector activity; and
- international intervention attempts and theories.

Identifying persisting legacies from previous housing activity (culture, laws and construction practices, housing expectations) will assist to understand contexts.

However, legacies were not comprehensively discussed in any reports or literature I examined on dwelling adaptation. This inquiry identified a number of legacies that affect dwelling adaptation opportunities in Tasmania:

- Sudden colonial transplantation of English and European building styles and construction methods to the Australian context limited the opportunity for optimum vernacular responses in dwelling styles, material selection, construction, siting, design and use.
- Building regulations focus on worst-case scenarios and the minimum standards allowed, which limits attention paid to housing quality or amenity.
- Significant areas of suburban housing were constructed in waves in the 20th century due to Australian government welfare policy. Rudimentary housing was provided as welfare at these times, which has left many householders dwelling in energy inefficient housing stock.
- Suburban living predominates, is popular and is the most available housing type.

- Affordable dwellings to purchase and rent were, and still are, most often available in the suburbs on the margins of cities and are mostly energy inefficient.
- Evident in historical activity are strong drives in householder to do-it-yourself and build themselves and also to maintain resourcefulness.
- Neo-liberal shifts in politics led to market-led housing activity and deregulation which limited attention and funding for welfare housing and encouraged householders to view their dwellings as financial investments.
- Technological advances; modern design and construction methods; and the advent of cheap and commonly available resources have meant that householders have become reliant on energy-hungry technologies to meet building functions and aspirations.
- Tasmanian hydroelectricity supplies have allowed householders to feel comfortable with their high levels of energy use as they view the source as having little effect on the environment.

The detail of lived experience significantly influences adaptive decisions.

Consideration of household lived experience in intervention designs and dwelling adaptation literature is currently lacking. Finding feasible ways to investigate and record lived experiences in a way that helps in the design of intervention has been one of the intents of this thesis. From this study I suggest lived experience can be understood and considered through:

- daily routines and practices related to comfort and energy efficiency;
- attitudes, including values and goals;
- dwelling adaptation goals and priorities made in relation to comfort and energy efficiency;
- the relationships householders have with other people, places and systems that influence adaptation processes; and
- influential social/community networks.

More specific elements of the context and lived experience that need to be considered for interventions design are suggested in the measures outlined below.

Formalise understanding of the relationship between dwelling comfort, dwelling energy performance, occupant health and empowerment.

The Federal and State governments do not have an *explicit* formal understanding of the relationship between dwelling comfort and energy performance and occupant health, and levels of empowerment and capacity for householders. In contrast, the New Zealand government has acknowledged these relationships and has tested and quantified the health benefits of various forms of energy efficiency adaptation (Free et al. 2010; Howden-Chapman et al. 2011; Howden-Chapman et al. 2007).

Recognising and formalising understanding of this relationship further in Australia and Tasmania by measuring and publically reporting the impacts of adaptations will ensure stakeholders feel confident about pursuing interventions. The relationship could be measured in a number of ways, for example by identifying change in visits to the doctor; health support visits; self-reported health (including asthma incidences); ability to maintain a career path; contentment with housing; or through householder reports on the comfort performance in the home.

Collect more information on Tasmanian dwelling stock

Lack of information about dwelling stock limits the ability to plan ahead, assess risks or develop strategies for interventions. Aside from the information compiled in this thesis, there is currently little data of Tasmanian dwelling stock performance in relation to comfort or energy efficiency. Yet, understanding the state of the stock in relation to its level of thermal resistance, opportunities for passive design, electrical safety, reliance on heaters, use of other appliances, opportunities for local microclimate mitigation and food production is essential before embarking on intervention programs. Collection of stock data will identify prevalent physical issues in dwellings; what potential there is for adaptation; how much dwelling adaptation is needed and where; and whether other physical issues need resolution before energy efficiency and comfort interventions commence. Criteria assessed in this study (see

chapter three and five stock reviews) could provide key investigation categories in surveys.

This study identified that participants had issues with the comfort and energy efficiency of their dwellings (for example, poor thermal performance; unsafe electrical wiring; and no disability access) that drove them to adapt. Poor thermal performance of building shells was a problem in both cold and hot weather. With extreme weather events (both hot and cold) likely to continue to increase in number in the state due to climate change, poor thermal performance of stock (in particular) warrants prioritised attention by various stakeholders who work in housing, sustainability, and climate change fields. These stakeholders are likely to be employed in government, research, commercial and non-government organisations and would therefore need to coordinate collection of housing stock data.

Tailor interventions according to capacities and key influences

I have argued that blanket interventions and general policy do not distinguish enough between various life stages, health and mobility, income levels, tenure, capacities and other critical influences. An interventions approach that is responsive to the lived experience and the local context will recognise critical influences and therefore be a more tailored intervention approach. Tailoring in this instance means that interventions can be adjusted according to the key householder groups, key influences and key barriers and would work with known, rather than assumed barriers and influences. Tailored intervention would be especially helpful when engaging with disadvantaged households because critical barriers to adapting can be removed in a way that would not be available in generalised interventions. An OECD (OECD 2011a: np) review looking at the role of policy in encouraging green household behaviour supports tailoring. Their review found that demographic and socio-economic characteristics ‘can be used to define distinct segments of the population for which policies are likely to be most effective.’

This investigation has shown that there are many possible barriers to adaptation; a number of these barriers are particularly difficult to overcome. Identifying the primary barriers and then tailoring intervention approaches in accordance with this

understanding will increase the success of the interventions. From the explorations in chapters five, six and seven I therefore suggest that interventions should be tailored to focus on and respond to households who:

- rent their dwelling and live on low to moderate incomes;
- own their dwelling and live on low incomes;
- manage chronic/recurring health issues and live on low to moderate incomes;
- manage physical disabilities and live on low to moderate incomes; live in houses that are regularly overshadowed in winter;
- have limited adaptive capacities, for example, have problem management skills but no handy hardware or craft skills;
- have low to moderate adaptive capacity and limited access to outside (other) capacity;¹⁷⁵
- are without the ability to assess their physical or technical situations; and
- have no or limited social and community networks.

Targeting certain issues of capacity and certain barriers would require interventions to have some built-in flexibility. Crabtree (2006a: 730) argues ‘there is much scope for governmental, institutional, societal and economic uptake of flexible, diverse, embedded practice and design on the basis of an ethic of care’ which would allow ‘concerns of justice’ equity and fairness to influence outcomes in dwelling. I see that tailored, responsive and flexible intervention programs would be more flexible, diverse and fair than what is presently available.

Respond to the capacities available and provide those missing

As well as identifying missing capacities causing significant barriers for certain groupings of householders, understanding the capacity householders need (and have) will ensure that interventions provide the right sort of support. As part of reviews of

¹⁷⁵ Access to capacity could be via social networks, community support networks or through commercial pathways (as discussed in chapters five and six).

capacities, skills needed for adaptations and their availability need to be identified. The study showed that even when interested in making energy efficient and comfort changes, householders were seriously limited by various skills deficits. Key skills identified in participant households are described in chapters six and seven.

Targeting development and enhancement of important skills through interventions has been argued to be useful. Traditionally skills training courses have mainly been run in colleges and TAFEs as part of vocational training. Yet, this inquiry has found that householders could also use this training to help with dwelling adaptations. As participant householders pointed out, skills education has the added bonus of feeding confidence levels for future dwelling adaptations and is also likely to enhance social capital (Stretton 1999). Skills development programs could be conducted in workshops that are part of dedicated interventions, or they could be run through existing organisations and programs that work with particular parts of the community (for example ‘Men’s Sheds’¹⁷⁶). Programs could be developed through education related sectors of government at state or federal level and could involve TAFEs and adult education facilities.

Trades people (who have experienced some vocational training already) were also found to be lacking in certain skills that would have helped to produce more positive adaptive outcomes. While skilled at installing products, trades people were not necessarily skilled at communicating, time management, resolving conflict, or critically assessing a product’s performance. Further support for tradespeople to develop such important skills as these in their vocational training would effectively support more successful adaptations in homes.

The organisations involved in enacting interventions will also need certain organisational capacity. It is therefore important for state government to identify missing capacity in these organisations and ensure they have the capacity to encourage householders.

¹⁷⁶ Men’s Sheds is an organisation that provides mentors for young men and centres their efforts on sharing hardware skills.

Support capacity exchange

Exchanging capacities allowed households to share, trade and buy capacity, and was often essential for the completion of adaptations. Householders who are connected and involved with neighbourhood and community networks have been shown in this thesis to be more likely to have the ability to exchange capacity. Interventions therefore need to (at least) understand capacity exchange opportunities, but could also work to support relationships important to capacity exchanges. Further exploration of the way that capacities are traded in communities would help to design targeted interventions and would be useful to non-government social support, commercial and government organisations alike.

Understand and work with social networks and key relationships

The extent to which householders were involved with their (various) social networks greatly influenced adaptation processes and outcomes. The reliance on social connections to perform exchanges of capacities highlights the importance of social networks and key relationships. Through social networks householders were able to gather and share information, adaptive experiences, encouragement, capacities, and cultural normative influences (see key relationships listed in Appendices S and T). Interventions can use these networks and key relationships (in the networks) to connect with and influence householders.

Identifying key relationships in householder networks provides specific points of contact at which interventions can act in, what often appears to be, nebulous networks. Advice from product sales people, trades and friends and family were all very influential. Family, friends and community tended to influence practice adaptations and sales and trades people tended to have more influence in physical adaptations. Personal, local and community (often neighbourhood) networks and relationships were normatively important and provided the opportunity to relay information and knowledge. More intimate networks appeared to be *the most* influential; larger information networks (such as ads on television) appeared less influential. When networks were well trusted and people were comfortable in their networks, then advice would be accepted without any proof of expertise.

Relationships that interventions could work through include those between householders and hardware stores, trades people, sales people, non government organisations, local friends, neighbours and household visitors.

Clarify government stakeholders, relationships and influences

All dwelling adaptation interventions involve government. Therefore it is important to understand the roles various government sectors play in interventions and in adaptations. Transition management and new ecology theory (looking to encourage change for sustainability) argue that policy intervention has to engage in long term planning using an iterative and responsive approach that acknowledges context (Crabtree 2008; Voß et al. 2009: 276). Participants have also argued that government needs to be clear about their relationships and influences over householders, recognise their part as stakeholders in dwelling adaptation outcomes, and seek responses and opinions from householders. Crabtree and Neiman argue that social outcomes are co-produced through transactions or partnerships (Crabtree 2009; Neiman 1989) with governments. I suggest, therefore, that governments need to: identify all influences and roles they (need to) play in interventions; clearly communicate with householders about interventions; allow householder input into decisions they make regarding interventions; and, make explicit their reasons for intervening.

Identify information flows via key networks and relationships

Information flows through networks and relationships. Understanding specifically how, where and when information flows will help with the design of interventions. Identifying recurrent suppliers of information will allow interventions to focus efforts on a handful, rather than hundreds of social connections and information flows.

Interventions can direct efforts towards ensuring important information being provided to householders is clear, and uses locally understood terminology. Creating feedback alongside information flows will help householders to assess both the quality of information they are receiving and any practices or physical adaptations

they make. Improved technical information (including electrical information), that is in clear and understandable formats, is needed by householders and could be made available to social networks through interventions.

Monitor effects of interventions and adaptations to ensure they are equitable

Disadvantaged households with low adaptive capacity will not be able to engage as easily in making change as more advantaged households. Disadvantaged communities, as discussed in the thesis, may actually experience amplification of disadvantage if interventions are poorly designed (Gleeson 2006). Governments and other key stakeholders must therefore act to limit detrimental effects of policy and adaptive change on disadvantaged households and their communities. Monitoring of the effects of policy on more disadvantaged members of the community is essential so as not to further reduce their adaptive capacities. Monitoring of policy effects is currently mostly enacted by social care and advocacy organisations. These organisations do not have the capacity to engage in this important task alone and will require government assistance.

Respond to the complexity of dwelling and adaptation

Interventions need to consider and respond to the inherent complexity of dwelling and adaptation and structure designs of approaches and administration accordingly (Brown et al. 2010). Dwelling and adaptation is complex both because there are multiple issues to consider and because these issues are interconnected and influence each other. Shove (2003: 203) points out that goals for dwelling (and dwelling functions) are achieved through 'active co-ordination of complexes of devices and products' and therefore concludes that sustainability interventions need to attend to 'the way that appliances, tools and devices are assembled and used together in the course of defining and maintaining 'normal' ways of life'. With this in mind, caution must be exercised when intervention approaches compartmentalise and engage with only a few or single physical traits as such a focus is likely to have unanticipated effects elsewhere in dwelling.

Engaging with and accommodating variable dwelling conditions, complex interactions and tailoring to various needs requires clear, deliberate intervention designs that are flexible and responsive. Multiple techniques for administration, connecting with householders, and monitoring outcomes become important (Crosbie et al 2010). To complicate the matter further, from the position of the householder, interventions must remain easy to comprehend and straightforward to enact. Tailoring to critical capacity issues, recognising commonalities and structuring according to adaptive stages (as discussed in this thesis) will assist with developing more flexible and responsive interventions. Engaging with and managing complexity will be the job of intervention designers and administrators.

Recognise the nature of adaptation

Understanding of the nature of adaptation, and the ways that it can progress, helps to identify effective intervention approaches and structures that can accommodate complexity. As discussed adaptive change can take incremental through to transformational pathways and progresses through stages (Park et al 2011; Popper 1999). Dwelling adaptations investigated in this study were all incremental types of change that reworked or added to existing practices and features, rather than reinventing them entirely. Interventions looking for transformational (radical, comparatively sudden and systemic) change from households with low adaptive capacity would be unlikely to be successful unless they are offering significant levels of adaptive support. Some transition and adaptation scholars argue that transformational and larger systemic types of change are important. With large emission reductions required to lessen the impacts of climate change, government are likely to move towards transformational types of change in dwelling systems.¹⁷⁷ If Government support and encourage more incremental adaptation now, disadvantaged households will be more prepared for more systemic, transformational change that may occur (due to government policy) in the future.

¹⁷⁷ More radical, transformational styles of adaptation may be needed with an increase in extreme weather events, for example.

Structuring interventions to correlate with stages of adaptations can help to target and tailor interventions. Building on existing theories of problem solving, decision-making, learning and design (Beckman et al. 2007; Lawson 2006; Popper 1999; Zeisel 2006) I suggest that interventions can be targeted at problem solving / adaptive stages of: gathering background knowledge and experiences (prior knowledge); problem identification (including developing a brief of issues); design of possible solution; solution enactment; solution testing and assessment; and development of new background knowledge.

Although adaptive stages are not necessarily sequential or discrete problem-solving moments (a solution and a re-definition of a problem may occur simultaneously, for example), particular adaptive activities do tend to relate to certain adaptive stages. The generation of goals, use of methods, availability of capacities and influences from relationships all tend to become more important at certain stages of adaptation. Identifying what influences are important at what stage will allow interventions to offer targeted and specific support.

The progress (and timing) of incremental dwelling adaptation is influenced by differences in adaptive methods used, capacities available and physical conditions. Physical adaptations and practice adaptations often progress differently even though the same stages of adaptation are progressed through. Adaptation processes are therefore particular to goals and circumstance and are somewhat unpredictable, again highlighting the need for interventions to understand detail, and engage flexibly according to conditions. Intervention designers should therefore explicitly state the adaptive stages they will target and the particular goals and targets they will support or encourage. I have not previously seen this level of detail described in interventions so I have no examples to offer here.

Acknowledge the time needed to make change

Incremental problem solving and adapting takes time, often years. The long time periods involved mean that intervention programs have plenty of opportunity to approach and influence householders, but will not see the outcomes of their efforts for long periods of time. In physical adaptations early adaptive stages (devising and

planning) can be lengthy which means that interventions have many opportunities to influence the path of adaptations before they are enacted, but after they have been prioritised.

Factoring in the time periods needed to reach adaptation outcomes is rare in government interventions in Australia.¹⁷⁸ This lack of acknowledgement of time is most likely due to having political voting terms of three years. Governments need to recognise that dwelling transitions will not always be able to be achieved in three year terms (Voß et al. 2009). Policy expectations need to be reconsidered in the light of understanding about adaptation timing. When developing policies and interventions, all departments in Federal and State government need to incorporate more sophisticated understanding of the time it takes to make decisions and adapt. If they do not, policies and interventions relying on action from householders are likely to *continue* to have a high failure rate.

The time that householders have lived, or are intending to live, in a dwelling also affects the likelihood of adaptations being undertaken. Renters, people on low incomes and younger adults tend to have shorter stays in any given dwelling, which means that adaptations may even not be attempted. These younger, poorer, more transient groups are very likely to live in poor quality housing stock. Interventions need to target improving the physical stock of this more mobile group of householders as they are unlikely to be able to do it themselves.

Capitalise on the regular adaptive activity that occurs in households

Adaptation and change happens continually in people's lives, especially in the home environment (Allon 2008). Participant householders demonstrated that they were skilled at incremental dwelling adaptation and flexible and resilient in their adaptation approaches. Interventions can capitalise on the culture of home improvement and existing change activity and encourage households to make energy efficiency and comfort adaptations in parallel with other changes. This study

¹⁷⁸ A lack of recognition of the true time periods needed to carry out adaptations is one of the reasons that the Federal Government's Green Loans intervention program was unsuccessful (Australian National Audit Office 2010a).

identified that householders felt positive about conducting adaptations in parallel as it was a more efficient use of their effort. Encouragement to conduct comfort and energy adaptations in conjunction with other renovations may mean, for example, rebates being advertised through building industry stakeholder (such as building certifiers, designers, engineers, supplier stores); or, new permanent incentives placed in the BCA.

Work with familiar general adaptive methods

Participant householders displayed a range of general skills and methods they used to achieve change, for example they: engaged in planning and problem solving; prioritised their goals; consulted others for knowledge; exchanged information; traded capacities; trialled and assessed solutions; and learnt about new technology. Interventions can act to enhance or work with these skills and methods in order to facilitate further dwelling adaptation or the skills can be utilised by interventions.

Understand householder goals, and strategies and recognise the need to prioritise

Understanding what goals drive adaptations is another way to ensure interventions target the intended group of households. Making goals entails identifying a problem (due to a pressure) and then prioritising the goal for action. Goals acted on are those perceived to be the most important or accessible. Yet, identifying priority goals that define householder's adaptations has not been attempted in intervention designs. Intervention programs instead offer incentives with the assumption that householders will change their priorities to work towards the goals of the intervention program. The goals identified in Appendices S, T and J show goals and drivers shared by participants.

Participant householders and ABS studies (reported in chapter three) identified that comfort and energy efficiency were common adaptive goals. Participant householder supported these sources. However, these goals were often sought in adaptations *alongside* other goals, such as maintaining historical aesthetics of the house or creating leisure opportunities in the home. Understanding the nests of goals that

comfort and energy efficiency are aligned with would offer strategic understanding to interventions designers.

Strategies chosen to meet goals varied; the choice of strategies could mean the difference between successful and unsuccessful adaptive outcomes. Interventions can help householders to identify their personal goals and assist them to devise multiple strategies (including low-tech and low energy approaches) to meet their goals. Assisting in this way offers householders the ability to choose between various solution paths so they can enact their adaptations flexibly according to personal constraints and capacities. This sort of personalised guiding assistance is in part already available, but not in such a targeted way. Personalised strategic advice could be offered through a variety of stakeholders in a variety of ways, for example as: personal home sustainability assessments; responsive tailored online advice; an element of the building assessment process; or part of design consultations.

A special note needs to be made about using technological strategies to solve problems. These strategies are popular, yet because they are not always well understood, their effects can be negative. Technology adaptations could be simpler than other strategies to install, but generally required a significant financial outlay; technical understanding (not a skill everyone had); and could change or negate existing practices that had helped to maintain energy efficiency. Caution is therefore needed when using technological strategies in interventions; both positive and negative effects should be understood and considered.

Adaptations take various forms as do the strategies used to achieve them. Interventions need to be designed with understanding of the various strategies that may be used to achieve energy efficiency and comfort goals. Identifying popular strategies for solving adaptations will pinpoint the sort of support that householders would be open to accepting from intervention programs; and help clarify the sorts of strategies an intervention program has the capacity to support. Interventions that only meet a few goals and use a few strategies will only be able to support a limited number of householders.

The sorts of aspirations organisations hold about the outcomes of interventions are important to clarify because, similar to households, organisations are more likely to align with and support interventions that meet their own organisational goals. The Tasmanian government in particular needs to define, from their perspective, exactly why energy efficiency is sought from dwellings, so that interventions strategies can be designed to align with their goals.

Acknowledge the importance of background understanding and exposure

Background knowledge and experiences influenced all aspects of adaptation. Adaptation decisions were based on years of information and experiences householders had collated over many years. For example, householders' previous exposure to passive comfort management, energy efficiency and resourceful experiences assisted people to find sustainable solutions in the present. Intervention designs can capitalise on supportive background exposure and also expose people to the background knowledge and experiences that are beneficial to prepare for adaptations of the future. Intentions by governments and the community to create certain outcomes in adult population (for example, respectful behaviour, ability to manage money and maintenance of health) have meant that education about these matters occurs in childhood. A similar path could be used to embed knowledge and understanding of energy efficiency, comfort and equity issues by including topics on sustainable living and energy efficiency in education courses undertaken in primary school, TAFE, and college.

Acknowledge the influence of values

This and other studies have found that values often drove adaptation activity (Barr et al. 2007; Miroso et al. 2011). The values of care (for people, animals and the environment); respect; acknowledging and maintaining interconnections / relationships with people; responsibility and active citizenship; the community; aesthetics; and resourcefulness were particularly strong drivers for participants. Targeting identified values related to dwelling comfort, energy efficiency and sustainability through interventions creates the possibility of connecting with people who have not yet decided to act, but hold the same values.

Resourcefulness was a particularly important value for participants and therefore should be explored for its potential use in wider interventions. The value participants placed on being resourceful is not surprising, as all except one participant household had to manage money and other resources reasonably carefully. Resourcefulness is as a value that arguably would be familiar to a wider Tasmanian audience due to their familiarity with socio-economic disadvantage. Connection could be made with values through communication activities of interventions; examples of how this has been achieved to date were presented in chapter four.

Factor in stress

Feelings of stress were common when householders undertook more substantial adaptive change, especially physical feature adaptations. Interventions need to acknowledge that adaptations are often stressful and that if adaptations are too stressful, householders will refrain from conducting them. Incorporating an understanding of stress in intervention design means ensuring that the risks the interventions ask the householders to take are not too high and that interventions are presented in a clear and streamlined manner. In addition any advisors or trades people going into the home need to be skilled (and therefore previously educated) in respectful, clear communication.

Design interventions to be consistent, transparent, and understandable

Instances of mistrust and confusion reported by householders and the effects of these shows that interventions need to be consistently applied, transparent in intentions and communicate information so that it is understandable.

Maintenance of trust emerged from this study to be an essential ingredient for successful adaptation outcomes. Trust had to be earned. Interventions therefore need to ensure their goals are transparent, that there is consistency in programs (regular or long-term programs), and that people working with interventions are skilled and respectful. Trust could also be developed by ensuring householders have access to a pool of trustworthy trades people and by providing follow-up checks after installations are complete.

Trust in government and major organisations was low. Householders, having observed what they felt were instances of poor decision-making over time, did not trust the decision-making processes or the value sets that government leaders and stakeholders were working from. In addition, householders felt there was not enough consultation in relation to important decisions about energy supply and housing. Therefore, a number of householders did not agree with the management of societal and infrastructural systems, such as energy supply systems. Household participants wanted a two-way reciprocal relationship with governments and government decision-making. Participants also wanted to be clear on what was available in terms of adaptation assistance and for assistance to be available in the years to come so they could use it as adaptive capacity became available (also see: Gabriel et al. 2012b).

Technical systems, construction issues, the electrical metering and the heat-flow physics of housing were often difficult for householders to understand. Confusion associated with a lack of understanding of these aspects of adaptations led to householders being stressed, shelving their adaption plans or perhaps taking easier, less energy efficient routes to their goals. In light of the ways people responded to confusion, intervention approaches should be aware that specialist assistance from trusted sources may be needed by householders to provide clear information to help with decisions.

Use multiple methods and multi-scaled approaches

Adaptations were observed to have come about due to multiple influences working together to produce change. This finding suggests that to encourage positive adaptive outcomes, interventions need to work on multiple influences all at one time. Elle et al. (2002: 51) found the ‘notion of being able to identify and isolate a single ‘barrier’ to technology take-up and to remove it with a single adjustment to existing institutional arrangements appears, ... to be problematic’. In reality, interventions need to work at multiple scales and with multiple methods to engage with influences effectually. A multi-pronged approach can take into consideration the various ways people might achieve an outcome, recognising the messiness of the adaptation

process. Scholars suggest that existing interventions approaches can be used together to achieve multi-pronged, more tailored approaches (Wilson et al. 2007).

Multi-pronged interventions may be significantly harder for stakeholder institutions to design so government assistance may be required to collate a list of effective interventions ideas that also describe how and where each intervention has been successful (see chapter three). This would allow intervention organisations to conduct multi-pronged and tailored interventions, but within their organisation's capacity. The Australian government is currently trialling multiple approaches to energy efficient interventions for low income households around Australia through a program called LIEEP (Australian Government 2012d). Further interventions can use the LIEEP program's findings to identify beneficial mixes of approaches.

Consider whether adaptation is also needed in organisations and institutions

Aside from households, dwelling adaptation interventions can be used to encourage change in communities, institutions, and organisations. Interventions could support communities, organisations and institutions to generate more capacity so they are better able to support householders in their dwelling adaptations long-term. This type of intervention would require the involvement of peak bodies and government.

8.4.2 Priority measures for interventions

This section outlines intervention measures that can be used as part of multi-method interventions to encourage dwellers to adapt for energy efficiency and comfort. I have chosen to describe measures that would encourage dwelling adaptation in Tasmania and that are feasible to enact in relatively short timeframes. The measures described are not original ideas, but are listed here because they have been assessed in this study to be priorities. To be truly effective the measures suggested should be applied as part of a suite of measures.

Continue to upgrade low quality dwelling stock

Governments should continue to upgrade energy inefficient and uncomfortable housing stock that is home to occupants with low adaptive capacity. Providing physical upgrades circumvents barriers to adapting caused by low incomes, missing skills, disability and limited time availability. Reviews of participant house shells indicated they only had poor to moderate thermal resistance and were energy inefficient. Most participants reported, however, that physical improvements made a noticeable difference to indoor energy use and comfort. There are already organisations skilled to conduct these upgrades in Tasmania, but they rely on Government funding to run upgrade programs. The effectiveness of upgrades coupled with the availability of upgrade skills in current organisations leads me to recommend that Federal and State government agencies provide regular funds to sustain these programs.

Upgrade teams can install: insulation in ceilings and under floors, draught proofing around doors and windows, energy efficient lighting, electricity feedback devices, hot water systems, hot water system insulation, heating systems, double glazing, pelmets and curtains, and productive gardens. In-home education in relation to dwelling energy efficiency can (and is normally) conducted during upgrade visits.

Housing of low income renters requires particular attention from upgrades programs. Experiences in the GGAER program, and this study, have shown that renters are difficult to engage but are most likely to need assistance as they tend to live in particularly poor quality housing stock and have little capacity to adapt.

Solar gain was regularly reported to be an important influence on energy use and comfort levels. Yet, adjusting existing dwellings to improve solar gain is regularly difficult. It would therefore be useful to trial various ways of upgrading dwellings for better solar gain and solar control; and introduce stricter solar orientation requirements in planning documents (to limit this problem in the future).

Build on current passive management practices in households

Participants did use passive practices to moderate the climate in their home and showed they were prepared to think through practice changes to improve passive management of their dwellings. Therefore it is recommended that interventions work with households to adapt passive practices. Passive practices that can be encouraged include opening and closing curtains, doors and windows; managing the garden and producing food in the garden; using layers of clothing and exercising; monitoring energy use; and using hot water bottles and blankets. Various workshops and education programs already exist in Australia and in Tasmania¹⁷⁹ that educate people on passive techniques to use in the home. These programs could be used as the basis for further interventions. This intervention measure could take the form of single or multiple workshops, home meetings, casual education at community events, or formal education programs. As dwellings often did not effectively support passive behaviours, it is useful to conduct physical modifications in parallel with this intervention method.

Improve householder electrical supply knowledge

Governments, commercial entities and social support organisations need to intervene to improve the knowledge householders have about electricity use. Poor understanding of electricity systems and consumption tended to limit householders' ability to assess household electricity use and, therefore, also misdirected decision-making for adaptations. Householders lacked understanding of their electricity use due to a lack of: detailed information being available; and understanding about electricity measures. Electricity bills were somewhat helpful but did not support householders to accurately identify which appliances and for what purposes electricity was being consumed.

Intervention to improve electrical supply knowledge would include providing explanations of household electricity bills and accurate and categorised information

¹⁷⁹ For example SLT presents workshops and CSIRO ran a behaviour change program called Energymark teaching passive home management strategies (CSIRO; Mendham et al. 2010).

about electricity use. This information would allow householders to be more particular and deliberate about electricity use. Providing accurate electricity information can currently be provided on electricity bills, through ‘smart metering’, or through various other feedback devices (Fischer 2008; Foster et al. 2012).

Support the development of key skills

Handy do-it-yourself, craft and technical understanding are skills required regularly in adaptations. Governments and social support organisations, in partnerships with businesses, can run workshops to teach adaptive skills to householders. With improved skills householders will likely to be able to conduct more small adaptive changes that typically have been left undone (such as pelmets which are thought to be too small to get a trades person out for). Skills taught could include installing draught proofing; making and hanging curtains and pelmets; assessing electrical use of appliances and systems around the house; adjusting the hang of a door; insulating; installing extra layers of glazing and coating on windows; working with wood; assessing the energy performance of a house; and project management. All adults should be invited. Women are likely to need extra support in learning handy skills and men are likely to need assistance learning craft skills. Skills improvements would also feed capacity exchange networks, leading to more social capital for adaptation in communities (Stretton 1999).

Provide technical expertise for decisions

Governments could make (respectful) technical experts and sustainability advisors available to support householders to begin the process of thinking through energy efficiency and comfort and to clarify adaptations they could make. Previous federal programs have trained scores of sustainability assessors so there are many informed people available to help guide householders. In Tasmania, as part of upgrade projects, SLT has provided ‘home energy helpers’ to assist householders to think through energy efficiency in their homes; these advisors could expand their discussion topics to further help householders to plan adaptations. Advice would be provided to relatively disempowered householders, often renting, so it would be important to be able to directly refer them to intervention programs that can be used

immediately. Advisors could work with social support teams that are familiar with the constraints householders in disadvantaged circumstances face.

Make information available to key networks

The plethora of information already compiled on energy comfort and sustainable adaptation could be made more readily available through social and community networks such as the ones identified in this thesis. Ensuring information flows through to householders can be achieved by working in local community networks and through influential stakeholders in these networks, such as local progress associations, craft groups and councils. Information could also be fed through key suppliers of tradespeople and products, such as hardware stores; electrical appliance stores; and building associations.

Facilitate the trade of skills and capacities

Governments and social support organisations can facilitate the exchange of capacities, particularly basic skills through more formal skills trade networks. Exchange of capacity has not yet been applied as a dwelling intervention for sustainability. More formal or facilitated exchange of capacity will allow people who are less connected with local networks to be able to seek out adaptive assistance. The skills exchange would require a local program manager working from the local council or a social support organisation and could be run through a website and/or local bulletin boards. Sharing and carpooling programs and their websites could provide templates for an adaptive skills exchange program.

Provide monetary assistance

Government should provide monetary assistance to householders with low adaptive capacity providing either materials and labour, or reduction in costs. The method of providing monetary assistance needs to be tailored to the householder group being focussed on. As discussed, rebates often do not provide enough of a reduction in cost to encourage low-income householders to adapt. Support that reduces the overall amount of money outlaid will work better than rebates. Complex gifting and rebate systems of repayment can be stressful and confusing and should be avoided.

If rebates are used, they need to be determined according to the overall cost of a particular item. Disproportionate rebates for curtains were identified as a problem in this study. The curtain rebate provided through the GGAER program was relatively small, despite curtain and pelmet instalment in a living room costing a comparable amount to an energy efficient washing machine or fridge.

Support normative influence through neighbourhoods and communities

Normative influences can be extremely influential (Mackenzie-Mohr et al. 2011). Social support organisations, non-government organisations and government organisations can create normative influences in communities by establishing discussions and providing visually interesting examples of energy efficient adaptations. Neighbourhood and community discussions of energy efficiency can be formally supported and encouraged along the lines of CSIRO's Energymark meetings and workshops run by SLT (CSIRO et al. 2010; Sustainable Living Tasmania 2008b). For example, visually obvious upgrades can be conducted on groups of houses in the same area to encourage new visual norms in dwelling and examples of what is possible to others in the neighbourhood.

Remove energy efficiency, comfort and affordability problems from new build

Federal, State and Local government should ensure that newly built dwellings are passive thermal designs that can *run* energy efficiently to avoid the energy use and comfort problems of existing housing stock. In addition, legislation should ensure that new houses are designed for (inevitable) future change so physical adaptations are as easy as possible to enact. Some legislation already exists to improve the energy efficiency of housing, for example, there are energy efficiency requirements in the BCA (Australian Building Codes Board 2007a). Legislation and planning can be used to generate further energy, comfort and affordability improvements in new-build dwellings. For example, house orientation is difficult to adjust, so council planning ordinances can ensure houses are appropriately oriented when they are built. In addition to the current energy efficiency requirements, new build housing needs to:

- suit the upcoming demographic trends;
- have access to sunlight to the site and indoors;
- have access to (individual or shared) garden space; and
- be designed and constructed for disassembly and adjustment of physical features.

8.5 Further research

Further understanding is needed to support the design of more effective interventions. This thesis has identified issues related to context and the experience of householders, including the variance of their experiences, but has not identified the statistical prevalence of influences, practices and other related phenomena. Therefore further study of trends is needed. In addition, this thesis has identified areas of research that are understudied. Suggestions for further research are therefore related below.

Confirm prevalence and importance of critical influences

The prevalence and importance of critical influences needs to be confirmed, possibly through surveys. This information would guide priorities for interventions and would also guide intervention designers to avenues for intervention most likely to be effective. This work can be conducted through government, the ABS, consultancies or universities.

Clarify the main goals householders aspire to

Clear understanding of the problem and goals (that is, the brief) of any given adaptation ensures that adaptive solutions will be better planned (Hyde et al. 2007; Watson 2004). Further research is needed to identify the goals householders aspire to; the prevalence of those goals; and whether householders were able to identify goals clearly. Intervention approaches can use knowledge of goals to identify what attracts and drives householders to adapt and how comfort and energy efficiency relate to other goals.

Assess the effects of climate and weather change on dwellings

This study identified that the building shells of houses were reactive to weather changes. As more extreme weather events are being predicted for the future in Tasmania, both colder and hotter weather scenarios need to be tested against the heat-flow resistance of house building shells. The poor thermal performance of the house building shells in winter is well understood in the Tasmanian context, but the passive thermal performance in summer requires further exploration.

Further assess the thermal bands at which Tasmanian householders are comfortable

A more systematic investigation is needed of the thermal bands at which low-income Tasmanians live and are comfortable during the coldest and warmest parts of the year. Participants in this inquiry were comfortable at temperatures much colder than were recommended by WHO (Ranson 1988b). Energy efficiency models for housing and also air conditioning guidelines are guided by WHO guidelines. Reviews of the health status of householders who live at various temperatures should also be conducted to ascertain whether low-income Tasmanians are living in cold temperatures that are detrimental to their health.

Specify how much change in energy efficiency, comfort and equity is needed.

Currently it is not clear exactly how much change is needed, in the energy efficiency and comfort performance of existing dwellings, to achieve affordable, healthy, environmentally sensitive, resilient and equitable living. Further exploration of the changes aimed for is needed so that specific targets can be identified. Identifying goals will guide policy development and help to define priorities for dwelling adaptation interventions. Specific targets, as part of these goals, will provide a common focus for all organisations and institutions involved, so they can work together on improving dwelling sustainability. Previously, the State government identified social aims and goals under the Tasmania Together project (Tasmanian Government 2006) and environmental trends have been reported in the State of the Environment reports (Australian State of Environment Committee 2011). A process that builds on these two approaches is what (I see) is needed for identifying and specifying dwelling goals for sustainability.

Participants in this study have shown that achieving adaptations can take a lot of effort and adaptive capacity over a long period time. In addition to identifying goals, participant adaptation outcomes suggest that questions of timing and impact of techniques need to be explored. In particular:

- Will the form of interventions chosen produce results fast enough?
- Are the interventions approaches too much of a risk for householders?
- Was the difference participants achieved in their homes enough?
- Do the changes made create noticeable differences for householders in terms of energy efficiency, comfort and affordability?
- If large numbers of disadvantaged households across the state made the same types of changes as were made to individual dwellings, would it create a noticeable change in energy use for Tasmania?
- Are changes to physical dwelling features going to create the most effect, or will there be a heavy reliance on changes to dwelling practices?
- If incremental change is not enough, what types of adaptation processes will have the effects required?

Government and institutional capacity to make change

Intervention approaches require government and institutional organisations to have capacity to plan and conduct interventions, but this institutional capacity may not be available or prioritised in a wider context of competing priorities. The capacity of various key organisations that need to be involved in interventions therefore needs to be identified. In particular, understanding the capacity issues experienced by the state government, the federal government, local governments and social support agencies would assist in understanding how to progress dwelling interventions for sustainability.

Understand animals' roles as housing occupants

Animal residents of participant houses both positively and negatively affected daily practices as well as adaptations made. The roles that animals have in households and

the effects they have on energy use, comfort and adaptation goals require further investigation. Research in relation to animal occupants could formalise understanding of the roles animals play in dwelling, in householder health outcomes and also in the Tasmanian economy.

Further examine the relationship between venting practices, thermal comfort, mould growth and indoor air quality.

The relationships between venting, moist air, mould, air temperatures, heating and household practices in Tasmanian dwellings requires further investigation. Strategies used to achieve comfort and energy efficiency in the home rely on particular heating, cooling, closing/opening, zoning and venting practices. These practices along with thermal resistance features of houses affect mould growth, air quality and the overall health of occupants (Baggs et al. 1996). This study showed that there were issues with the management of indoor environments for comfort and health. In cold weather households either closed their houses up for long periods, which could cause significant mould growth, or they vented through the day to maintain high levels of ‘fresh’ outdoor air coming in, which meant their houses remained cold. Further understanding is needed of the impacts of these different comfort and health management practices.

Further explore the impact of garden activities on comfort and energy efficiency

This study observed that gardens assisted with microclimate management, food production, and maintaining health and dwelling comfort. The relationships between gardens, adaptive practices, energy efficiency, comfort, health and dwelling affordability are not well explored in the Tasmanian context. Further exploration of these relationships would help to identify priorities for interventions seeking energy efficiency and comfort improvements in homes.

Examine the influence of various social networks and social ecologies.

Social networks and the key relationships householders held with these networks were observed in this study to greatly affect adaptation choices and outcomes. Social networks affecting housing are, however, under-researched in the Tasmanian

context. Further understanding of influential networks and ecologies that exist around housing in Tasmania would allow more strategic and cost effective design of interventions.

8.6 Conclusions

This thesis has described an inquiry that ultimately aimed to support more sustainable (especially equitable) dwelling opportunities for disadvantaged householders in Tasmania. To this end, the investigation sought to identify measures, that could be taken by housing stakeholders to improve the design of interventions that encourage dwelling adaptation for energy efficiency and comfort in households with low adaptive capacity.

To identify what measures interventions should take, the inquiry sought to understand dwelling adaptation for energy efficiency and comfort in the Tasmanian context. This was achieved in two broad stages of research. In the first stage reviews were made of contextual issues related to dwelling energy efficiency, comfort and equity, Tasmanian dwelling stock trends, and existing intervention approaches. In the second stage in-depth explorations were conducted of the lived experiences of 17 Tasmanian households who were adapting dwelling practices and physical features to achieve better energy efficiency and comfort in their homes.

Tasmanian context, dwelling and intervention reviews found that there is recognition in the State of the need to improve the energy efficiency and comfort of dwellings for sustainability, but that Tasmanian dwellings are (on the whole) energy inefficient and there are cultural legacies hindering adaptation efforts. Reviews of intervention approaches found that there was a need for better integration of approaches and a need to improve understanding of the lived experiences of householders.

The investigation of lived experiences found that participants were reasonably resourceful and adaptive and prioritised energy efficiency and comfort in their dwelling practices and adaptation. Participant houses were found to (mostly) be energy inefficient which meant they did not support optimal comfort or affordability.

Examining lived experiences in detail also exposed new understanding of the problem solving involved in adapting and the various influences that affect adaptation processes and their outcomes. Householders progressed through incremental adaptation processes with identifiable stages of problem solving that required significant amounts of time and effort. Influences were examined in thematic groupings described as: adaptation goals; strategies used; general adaptive methods; adaptive capacity; background experiences; key stakeholders; values; information flows; place relationships; and interconnections.

The findings of this research confirmed that there is scope and (indeed) the necessity to consider the detail of householder experiences and the local context before designing interventions encouraging adaptations for energy efficiency and comfort. Insight gained from the findings from chapters three to seven were used in this, the final chapter, to advise on measures that should be undertaken by housing stakeholders to ensure intervention design and enactment effectively improves dwelling sustainability for householders with low adaptive capacity.

The findings from the inquiry improve the knowledge base in Tasmania in regards to: contextual influences affecting dwelling energy efficiency, comfort and equity; dwelling conditions and dwelling practices as they relate to energy efficiency and comfort; the key influences and processes that shape dwelling adaptations for householders; and the considerations and types of variance that need to be accommodated in the design of interventions.

By applying this new knowledge to interventions approaches, Tasmania will be able to better support dwelling adaptation for energy efficiency and comfort in households with low adaptive capacity. These improvements will ultimately lead to more sustainable, particularly equitable, dwelling opportunities for disadvantaged householders in Tasmania.

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